GeoBerlin 2015

4—7 October 2015 | Annual Meeting of DGGV · DMG

DYNAMIC EARTH ·
from Alfred Wegener to today and beyond

Abstracts

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Welcome

Alfred Wegener revolutionized the way we see planet Earth. It has been exactly one hundred years since Wegener published his theory of continental drift and laid the groundwork for modern science and plate tectonics. Scientific experts today are still reaping the benefits of Wegener's research. His research provides geoscientists the basis for gaining new ground from which future generations of researchers will in turn profit.

By exploring how human activities affect the earth system, the geosciences deliver crucial information for our daily life. Georesearch is also very important as we look ahead to future challenges – our demand for natural resources and energy, for example. The use of the geological subsurface to store energy and the exploration of the oceans as sources of mineral resources will play a major role in this regard.

Knowledge and experience in the geosciences will be more and more in demand in future. That knowledge and experience will also provide the basis for political decision-making processes. The Federal Ministry of Education and Research (BMBF) therefore supports activities in the entire geoscience spectrum. At the same time we also want to expand on Germany's strong international position in this field. The BMBF's future funding programme "Georesearch for Sustainability (GEO:N)" will move us nearer to achieving that goal.

In addition, conferences such as GeoBerlin 2015 provide the necessary forums for expert exchange. Through discussions about Alfred Wegener's achievements, GeoBerlin 2015 in particular encourages us to reflect on the successes of georesearch in the past and throughout time. This conference is also an opportunity to devote some thought to the potential of geosciences for the future.

May all the conference participants gain interesting input and inspiring new knowledge for their work in the geosciences.

Prof. Dr. Johanna Wanka
Federal Minister of Education and Research

Dear Geoscientists,

Exactly 100 years ago the most outstanding German Geoscientist Alfred Wegener published the first edition of his seminal book "Die Enstehung der Kontinente und Ozeane" ("The Origin of Continents and Oceans"). Today we all know that his seminal hypothesis was only accepted once the pieces of the "plate tectonics" puzzle were put together in the 1960's. Wegener was 50 years ahead of his time. We should never forget that Wegener was a metereologist and astronomist. He pursued his research on the thermodynamcis of the atmosphere and impact craters with as much energy as his development of "continental drift". In our meeting Dynamic Earth – from Alfred Wegener to today and beyond we will review how Wegener's findings evolved into to modern Earth system science including its impact on climate and the Earth surface, and how this system affects our daily life: where humans live, what risks we are exposed to, where we find our resources. In the meeting we invite the societies to propose sessions that cover the entire geoscience spectrum (from mineral physics over solid earth geodynamics to the climate sciences). We have invited keynote speakers that are eminent international scientists in these fields. In events open to the general public we will get an account of Wegeners final trip to Greenland on the history of science of his hypothesis.

The conference takes place in the Henry Ford Bau of the FU Berlin, is staged by the FU Berlin and GFZ Potsdam, and is supported by the Potsdam-Berlin Geosciences coordination platform Geo.X. It is the joint annual meeting of the Deutsche Geologische Gesellschaft / Geologische Vereinigung (DGGV) and the Deutsche Mineralogische Gesellschaft (DMG), The Potsdam-Berlin research platform Geo.X will stage the Geo.X School "Methods in Geosciences" in the week before the conference: 28th September – 1st October 2015.

Alfred Wegener was born in Berlin. Hence it is timely that we review his hypotheses and their impact for our lives today in a stimulating geoscience meeting in Berlin. We are looking forward to welcome you here!

With best regards • for the Organising Committee

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FU Berlin

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Plenary Lectures

The Lithospheric Structure of Pangea and Central Asia: The rules of craton assembly

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We now have a good understanding of how oceanic lithosphere is formed by upwelling and melting beneath ridges, and how it cools before it is destroyed by subduction. However, our knowledge of the evolution of continental crust and lithosphere is much poorer. An important new approach to this problem has come from surface wave tomography, which provides global models of the shear wave velocity V_s as a function of depth z. Since V_s is principally controlled by temperature, rather than by composition, it can be used to map the lithospheric thickness. Extensive regions of thick lithosphere underlie some, but not all, cratons. More surprisingly, thick lithosphere underlies some belts of active deformation. Because of this lack of correspondence between cratons and thick lithosphere, and because the lithospheric age cannot be determined from seismology, we refer to regions of thick lithosphere as 'cores' rather than 'cratons'. The cores underlying Tibet and Iran have a velocity structure that closely embles that of the cores beneath cratons, though Iran and Tibet have thicker, hotter, crust. These regions appear to be places where cratons are now being formed by lithospheric shortening. Furthermore simple thermal models of the evolution of thickened crust and lithosphere can account for a variety of well known features of cratons. Maps of the lithospheric thickness beneath Pangea can be also obtained by reconstructing the continental arrangement in the Permian. The resulting reconstruction shows that a contiguous arc of thick lithosphere underlay most of eastern Pangea. Beneath the western convex side of this arc there is a wide belt of thinner lithosphere, underlying what is believed to have been the active margin of Pangea. This geometry suggests that lithospheric thickness has an important influence on continental deformation and accretion.

Sea Level During Past Warm Periods - Rethinking the Bathtub Model

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Oscillations of sea level, whether rapid or gradual, influence the degree and style of shoreline formation including reef framework construction, destruction, and preservation. Using insight from modern shoreline systems, members of the PLIOMAX project have mapped mid-Pliocene, MIS11, and MIS5e shorelines at numerous localities around the world and modeled the effects of subsequent glacial isostatic adjustment (GIA) on their current position. For both MIS5e and MIS11 we conclude that an ice sheet stability threshold was crossed in the last few kyr of each interglacial resulting in the rapid collapse of polar ice sheets with a rise in eustatic sea level to 8m or more above present. We further show that dynamic topography, supported by convectively maintained stresses generated by viscous flow in the mantle and associated buoyancy variations in the lithosphere, plays a significant role in the post-depositional displacement of Pliocene and even much younger Pleistocene shorelines. We will discuss how we are using predicted global patterns of GIA and dynamic topography to guide field efforts aimed at extracting the eustatic component of sea level change during past warm climates. We also discuss how our field data is helping, in turn, to constrain uncertainties in models of both GIA and the long-term convective evolution of the Earth (uncertainties in mantle viscosity, for instance).

Global mantle imaging in the age of high speed wavefield computations

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A key observation that does not fit, to first order, within plate tectonic theory, is that of mid-plate hotspot volcanoes. Morgan (1972) proposed that hotspots are the surface expression of long-lived narrow plumes rooted in the deep mantle, as would be expected in a convecting fluid heated from below. In this classical view, plumes are composed of broad mushroom shaped heads and thin tails. Opponents to the plume theory propose a very different origin for hotspots, controlled by shallow lithospheric processes. Regional seismic tomographic studies have consistently revealed low seismic velocity conduits in the uppermost mantle beneath major hotspots such as Hawaii and Iceland, but there is no consensus on: 1) their vertical continuity at greater depth; 2) how distinct they are from other low-velocity 3) whether they represent blurred images of the thin expected thermal plumes. Low velocity bodies of limited lateral extent are difficult to image with standard travel time tomography, as they are hidden due to wavefront healing effects. Owing to recent advances in numerical computations of the seismic wavefield in a 3D earth, it is now possible to exploit the information contained in whole waveforms more accurately, and to have access to scattered energy that can indirectly constrain such low velocity structures. Applying this new seismic imaging technique at global mantle scale clearly establishes the presence of wide, vertically continuous conduits in the lower mantle near many prominent hotspots. These plumes extend from the core-mantle boundary to 1000 km depth. They are resolvably broader than classical thermal plume tails and rooted in patches of strongly reduced shear velocity, that may contain large Ultra Low Velocity Zones. Above 1000 km depth, their character changes: they become thinner, meander into the upper mantle, merging into horizontally oriented low velocity fingers, aligned in the direction of absolute plate motion.

Paleomagnetism and Plate Tectonics

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Since Wegener proposed that all of the Earth's land areas once formed a single 'Urkontinent' (later known as Pangea) that later moved apart (continental drift), our description of the movement and deformation of the Earth's outer layer have evolved into seafloor spreading and then to plate tectonics by the mid-late 1960s. In the 1950s, Cambridge physicists discovered key differences between European and North American palaeomagnetic poles. This was the first independent geophysical evidence that the continents had moved ('continental drift' sensu Wegener), and paleomagnetism has proved crucial in the objective positioning of older rocks, some dating from as far back as the Archaean. If we compare Wegener's Pangea with modern reconstructions, there are many similarities, but the most striking difference is that we are now able to position Pangea at its original latitude, and it actually never included all the continents at any one time. The most important amalgamation phase was at about 320 Ma, during the Late Carboniferous, when Gondwana, Laurussia and intervening terranes collided, and in the process produced the Alleghenian-Hercynian orogenic belt. Recently-developed techniques also now allow us to determine the longitude of Pangea and its dispersal history for the first time. Those techniques have linked the distribution of both large igneous provinces and kimberlites at the Earth's surface to plumes that have been derived from the edges of two stable thermochemical reservoirs (Tuzo and Jason) at the core–mantle boundary. Using this surface-to-core–mantle boundary correlation to locate continents in longitude it is now possible to develop models for absolute plate motion before Pangea, for the entire Phanerozoic and perhaps back to the previous supercontinent Rodinia, which formed about a billion years ago. This paves the way to develop global plate tectonic models (including synthetic oceanic lithosphere) into the deep past.

Faszination Alfred Wegener: Leben, Aktivitäten und wissenschaftliche Leistungen

Das Weltbild der Geowissenschaften – von Alfred Wegener bis heute

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Alfred Wegener hat mit seiner Hypothese der Kontinentalverschiebung die Erdwissenschaften revolutioniert, auch wenn die Revolution erst ein halbes Jahrhundert später erfolgte. Die Antwort auf die Frage, warum diese Verzögerung stattfand, ist symptomatisch für die Erdwissenschaften im zwanzigsten Jahrhundert und darüber hinaus. Wegeners geniale Theorie entstand nicht im luftleerem Raum. Hinter ihr steht das richtungsweisende Werk von Eduard Suess Das Antlitz der Erde (1883-1909). In diesem Buch, und auch dem vorhergehenden Die Enstehung der Alpen (1875), zeigte Suess, dass die grossen Gebirge einen asymmetrischen Bau haben, dass Horizontalbewegungen während der Gebirgsbildung dominieren, dass Gebirgsbildung kein phasengebundener, sondern ein lang andauernder kontinuierlicher Vorgang ist, dass junge Ozeane Zerrungsstrukturen entlang ihren Rändern, ältere dort aber Einengungsstrukturen aufweisen, dass das Meeresniveau nicht konstant, sondern veränderlich ist und dass die Ursachen für die Meeresniveauveränderungen innerhalb der Ozeanbecken liegen. Suess betonte ferner, dass geologische Vorgänge ein chaotisches Verhalten aufweisen, d. h. obwohl nachträglich verständlich, nicht im Detail voraussagbar seien. Er legte seinen Interpretationen den Lyell'schen Aktualismus zugrunde. Suess lehnte die damals bestehende Isostasievorstellung ab und versuchte, seine Beobachtungen im Rahmen der thermalen Schrumpfungstheorie in ihrer von Constant Prévost (1787-1856) verteidigten Version zu erklären. Die meisten Zeitgenossen von Suess lehnten diesen Erklärungsversuch ab und gingen zurück zu einer Version der Schrumpfungstheorie, die 1829 von Élie de Beaumont entwickelt und später von dem Amerikaner James Dwight Dana bekannt gemacht wurde, wobei sie die meisten geologischen Deutungen von Suess ablehnten. Wegener sah ein, dass man an den Beobachtungen und geologischen Interpretationen von Suess festhalten musste. Er hat sich die Frage gestellt: Was passiere wenn man den Suess'schen Wissensschatz im Rahmen der Isostasie umzudeuten versuchte? Die Antwort auf diese Frage war, dass nicht nur die angenommenen primären vertikalen Hebungen der Lithosphäre, die bereits von Suess abgelehnt wurden, sondern auch die primären Absenkungen der Lithosphäre durch radiale Senkung (die Suess nicht negierte) abgelehnt werden mussten. Horizontale Einengung reichte aus, um die Hebung der Gebirge und tangentiale Zerrung um die Senken zu erklären. Die Geometrie der Kontinentalränder um den Südatlantik und deren Geologie zeigten, dass Südamerika und Afrika früher direkt aneinander gelegen haben müssen. Wegener sah, dass er die Suess'schen Beobachtungen mit dieser neuen Theorie gut erklären konnte. Als er später mit seinem Schwiegervater Wladimir Köppen auch paläoklimatische Interpretationen zur Überprüfung seiner neuen Theorie heranzog, wurde ihm klar, dass Kontinentalverschiebung stattgefunden haben musste. Einwände kamen sowohl von den Geologen, die eine kunstvolle Theorie des Erdverhaltens im Rahmen der Ideen von Élie de Beaumont und James Dwight Dana ausgearbeitet hatten, als auch von den Geophysikern, die die von Wegener angenommene Widerstandsfähigkeit der Ozeanböden und die für das Treiben der Kontinente benötigten Kräfte nicht glauben konnten. Interessant ist, dass beide Gruppen nicht nur die Interpretationen, sondern auch die Beobachtungen von Suess negierten. Und hier liegt der wichtigste Schluss für die Zukunft der Erdwissenschaften: Wer geologische Beobachtungen ignoriert, kann weder die Erde noch irgend einen anderen steinigen Planeten verstehen. In unseren Tagen haben wir zwei Hauptgruppen in der Geologie: die eine verlangt, dass sich jede geologische Erklärung von selbst aus den Beobachtungen ergeben soll (z. B. Terranologie). Diese Gruppe übersieht die erste Regel der historischen Methode, die bereits von Wilhelm von Humboldt unterstrichen wurde, dass ein sehr grosser Teil der Anhaltspunkte für die Deutung vorzeitlicher Ereignisse heute nicht mehr zu Verfügung stehen. Die zweite Gruppe glaubt, aus den Grundgesetzen der Physik und Chemie die Vergangenheit vollständig modellieren zu können ohne den geologischen Beobachtungsschatz zugrunde zu legen (z. B. viele Zirkulationsmodelle des Erdmantels). Diese Gruppe übersieht das chaotische Verhalten natürlicher Systeme, die die geologischen Vorgänge nicht voll voraussehbar machen. Die Geologie kann nur mit Sicherheit voranschreiten, wenn sie weder eine rein empirische noch eine rein rationalistische, sondern eine kritisch-rationale Haltung adoptiert. Dafür stehen unsere grossen Lehrer Eduard Suess und Alfred Wegener und ihre Nachfahren wie Émile Argand und J. Tuzo Wilson.

The Wegener Memorial Expedition to the Greenland Caledonides

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2012 marked the 100st anniversary of the seminal publications on Continental Drift Theory by Alfred Wegener. These publications (and Wegener's book "On the origin of the continents", published three years later) are widely accepted to be the fundamental breakthrough that opened the path to the Theory of Plate Tectoncis and ultimately the path to modern Geodynamics some 50 years later. In the same historic year of the 1912 publications, Alfred Wegener set off for what was to become the most dramatic of his three Greenland expeditions. On this expedition Wegener and Koch crossed the entire northern icecap of Greenland. In honour of the hundreds anniversary of Wegener's publications, the Austrian Academy of Sciences funded an expedition to trace the footsteps of the 1912 expedition in the spirit of Alfred Wegener, while also conducting modern Earth Science. This expedition that was conducted in summer 2014. For the expedition, a 1952 Cessna180 was acquired in Alaska, adapted with bush wheels, wing extensions and extra tanks and was flown by the author and one of the worlds most renown bush pilots from Alaska in a 10 day effort to Greenland. There, the entire NE Greenland Caledonides were covered and photographed. Field work for a masters projects was conducted and samples were collected from a series of some of the most remote locations in the Caledonides ever visited. Most spectacularly, the original sled of Wegeners 1912 expedition was found some 30 kilometers from its expected location in the Dove Bugt Region of northeastern Greenland.

Wie dachte Alfred Wegener über die Ursachen der Kontinentalverschiebung?

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Zunächst stolperte Alfred Wegener über die Kontinentalränder des Südatlantik. Die Idee der Kontinentalverschiebung erregte sein Interesse am ganzen Erdsystem. 1912 trat er an die geologische Öffentlichkeit und spekulierte da auch über eine dynamische Rolle der Ozeanrücken, ähnlich unserem heutigen Bild der Meeresbodenweitung. 1915 ist die frühe Idee in seinem Buch „Die Entstehung der

Kontinente und Ozeane" kommentarlos verschwunden und durch „Sial-Flöße" ersetzt, die durch „Sima" driften, ohne überzeugende Antriebsmechanismen angeben zu können. Seine „Sial-Kruste" entspricht etwa der „modernen" kontinentalen Lithosphäre, doch ihm fehlt die „moderne" ozeanische Lithosphäre. Wie kam es dazu, dass Wegener die Idee aufgab? Einiges kam zusammen: seine Erfahrungen in Island und im Grönland-Eis. Bei seinem Ritt durch Island sah er die klaffenden Zerrspalten nicht und erlebte das Grönland-Eis hautnah als „fließendes Gestein", während er über Kontinentverschiebung nachdachte. Zudem sprachen damaligen Daten (Doelter, 1906: Petregenesis, Vieweg, Braunschweig) für festere „sialische Kruste" als „Sima-Mantel": nur kontinentale, keine ozeanische „feste" Lithosphäre. Die Drift der Kontinente dagegen war so gut belegt durch Geophysik, Geologie, Paläontologie und Paläoklimatologie, dass Wegener sie als realistische Hypothese akzeptierte, während die alten Ideen der Kontraktion der Erde oder versunkener Landbrücken im Atlantik der Isostasie, dem „Schwimmgleichgewicht", widersprachen. Hätte Wegener nicht übersehen, dass temperatur-bedingt auch ozeanische Lithosphäre existiert, hätte er vielleicht die Plattentektonik entdeckt.
Aber der Antriebsmechanismus? Trotz Wegeners Kenntnis von Konvektion in Luft hielt er sie in „Sima" wegen Unkenntnis über ihre Viskosität und Temperatur für verfrühte Spekulation, obwohl auch driftende Kontinentalschollen fließendes „Sima" implizieren und Wegener schon 1915 „Unterströmung" unter Indien schrieb. Erst 1929 in der 4. Buchauflage hielt er Konvektion für möglichen Antrieb – durch Mitschleppen der Kontinente, während aktuell die Lithosphäre in der Mantelkonvektion eine aktive Rolle spielt. – Nicht zufällig wurde Wegener nach Graz berufen, wo Robert Schwinner (Otto Ampferer folgend) „Unterströmung" unter den Alpen und Anden vorgeschlagen hatte. Leider kam es lange zu keiner Zusammenarbeit zwischen Wegener und Schwinner, und Wegener starb in Grönland 1930 viel zu früh. Die Entdeckung der Plattentektonik hatte dann noch bis zu den neuen Daten der 60er Jahre zu warten. Jedenfalls blieb Wegener fest davon überzeugt, dass das Phänomen der Drift nicht durch das Fehlen einer Erklärung widerlegt ist.

Die Wahrnehmung der Ideen von Alfred Wegener und Wladimir Köppen in der Öffentlichkeit – ein Stück Wissenschaftsgeschichte

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Die Geschichte der Anerkennung der 1912 zum ersten Mal vorgestellten Theorie der Kontinentalverschiebung von Alfred Wegener wurde von Thomas S. Kuhn als ein Modell für einen Paradigmenwechsel in den Geowissenschaften genutzt. Es war die Ablösung der damals herrschenden geologischen Vorstellungen, die in dem poetischen Satz des Geologen Eduard Süess gipfelte „Der Zusammenbruch des Erdballs ist es, dem wir beiwohnen.", durch die horizontale Bewegungsmöglichkeit von Kontinenten. Ein physikalisch geschulter Naturwissenschaftler wie Alfred Wegener konnte die alte Lehre widerlegen, wurde jedoch auch von Geophysikern seiner Zeit, wie z.B. Sir H. Jeffries, und der Mehrheit der amtierenden Geologen, insbesondere aus Amerika, aus unterschiedlichen Gründen abgelehnt. Jedoch nicht nur einzelne Forscher wie z.B. Alexander du Toit, sondern auch ein großer Teil von interessierten Laien hielt das Bild der im Sima schwimmenden Kontinente lebendig und dies wurde zum Teil auch im schulischen Bereich weitervermittelt.
Die größte Unterstützung erfuhr Alfred Wegener durch seinen Schwiegervater, den anerkannten Klimaforscher und Meteorologen Waldimir Köppen durch das gemeinsame Werk „Die Klimate der geologischen Vorzeit" (Köppen und Wegener, 1924). Trotz der gegenseitigen Anerkennung war die öffentliche Wirkung von Alfred Wegener durch seine visionären Themen und Vorträge eine grundsätzlich andere als die von Wladimir Köppen, der unter seinen Kollegen hoch angesehen war und noch im Jahr 1936, also als 90-jähriger Forscher durch sein Werk „Geographisches System der Klimate" auch in der heutigen Klimaforschung eine Bedeutung hat.

Der frühe Tod von Alfred Wegener 1930 bedeutete für seine Frau Else Wegener, geborene Köppen, die Herausforderung die Arbeitsweise und Entdeckungen ihres Mannes, besonders in der Biographie von 1960 (Wegener, E. 1960: Alfred Wegener. Wiesbaden), der Nachwelt zu erhalten. Ein Erbe von dem wir alle heute noch profitieren.

Waldimir Köppen, Alfred Wegener and Milutin Milankovitch, Early Pioneers and Partners in Paleoclimate Researchs

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Alfred Wegener is famous because of his ideas on the origin of continents and oceans (Wegener 2005) since 1912. It is less well known that Wegener published, together with his father-in-law Wladimir Köppen, on climate change in the geological past (Köppen & Wegener 1924). This book is of interest because: 1) It contains an inventory of the arguments which Wegener used in his paleogeographic reconstructions. Early in the last century Köppen had developed concepts of modern global climate zones. The close cooperation between Wegener and Köppen led to their conviction that these zones could also be deduced from fossil climate indicators. 2) The book critically describes paleogeographic reconstructions for most of the Phanerozoic periods. 3) The book then ventures into hypothesizing about climate changes in Earth history. The most important element of this discussion stems from a close collaboration with Milankovitch. He claimed that the Late Cenozoic climate changes were controlled by variations of the earth´s orbit around the sun generating differences in insolation. 4) Acceptance of the principles of the Milankovitch frequencies made it possible for the first time to establish a time scale of Late Cenozoic glacial-interglacial history. Nowadays the orbital parameters calculated by Milankovitch can be substantiated by means of geological time series. Milankovitch's frequencies can also be predicted for the future. Consequently, this reflects an important piece of tradition of our understanding of how climate evolved in the course of time, reaching from Köppen, Wegener and Milankovitch to modern days.
Köppen, W. & A. Wegener 1924: Die Klimate der geologischen Vorzeit- (Publ. Gebr. Borntraeger) Berlin, 255 pp.
Wegener, A. 2005: Die Entstehung der Kontinente und Ozeane - Nachdruck der ersten (1915) und vierten Auflage (1929) mit handschriftlichen Anmerkungen von Alfred Wegener, 481 pp., (Gebr. Borntraeger) Stuttgart (Krause, R., G. Schönharting & J. Thiede, eds.).

Alfred Wegener (1880–1930) – an idea conquers the world

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Based on impressive images of the original venue, the presentation provides an overview of Alfred Wegener's biography. Following up his scientific LifeWork an outline will be illustrated. Revealing the origin and development of his groundbreaking ideas will be tempted.

Poster Session on Regional Geology Products

The Geological Wall in Berlin-Blankenfelde

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At the turn to the 20th century, a time when Berlin became a big town, nature and landscape were far away. At the same time the exploration of the geosphere forced the understanding of how the actual landscapes had been developed. The secondary-school teacher Dr. Eduard Zache wanted to give the townspeople an understanding of this knowledge. He created a 50 m long and about 2,5 m high Geological Wall, demonstrating the composition of the upper earth crust in Central Europe north of the Alpes. This section presents the geological formations, their stratification as well as

The Geological Wall in Berlin-Blankenfelde

the main tectonical and magmatic events and it gives the possibility to realize the stones visual and haptic. 123 different stones from German territory had been used, especially from the Harz region, from Thuringia, Saxony as well as Franconian, Rhenian and Silesian stones. Some regional geological pattern are constructed exemplary: the Nossen-Wilsdruff-Schiefergebirge in Northern Saxony is an example for older palaeozoic strata, the stones of the Harzer Devonsattel are modeled as a fold, the Carboniferous/Permian sedimentation including volcanism as it is developed in Thuringia, the Zechstein-sequences with Kupferschiefer and salts at the southern margin of the Harz, etc.; even decorated with fossils and ores. The region of Berlin/Brandenburg is represented by the whole Muschelkalk-sequence of Rüdersdorf, the Sperenberg-gypsum, Tertiary clay of Bad Freienwalde, brown coal as well as the Quarternary sediments with glacial sands, gravel and erratics. This more than 100 years-old Geological Wall corresponds with the current state of research in general as well as in nearly all details! In these days a complete restoration of the wall is going on.

Die Stratigraphische Tabelle von Deutschland 2015

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Mit der Stratigraphischen Tabelle von Deutschland 2002 (STD 2002) wurde die Vereinigung von West- und Ostdeutschland in der Stratigraphie vollzogen. Zudem gelang es, unsere stratigraphische Nomenklatur und Klassifizierung voll an die internationale Entwicklung anzupassen. Entscheidend war die in sich konsistente Klassifizierung wohlbekannter Schichten als Formationen bzw. Gruppen entsprechend des International Stratigraphic Guide 1976 (ISG 1976, HEDBERG 1976). So wurden Rotliegend, Zechstein, Buntsandstein, Muschelkalk, Keuper und Schwarzer, Brauner und Weißer Jura zu Gruppen; zuvor waren sie zumeist als Abteilungen bzw. Serien klassifiziert. Die Deutsche Stratigraphische Kommission aktualisiert derzeit die STD 2002. Die markantesten Entwicklungen betreffen die Kreide und das Quartär mit zahlreichen neuen Formationen und Gruppen, während es anderweitig z. T. nur moderate Anpassungen gibt. So wurden 2009 für Perm und Trias Formationen auch im zentralen Mitteleuropäischen Becken eingeführt anstelle von Folgen (SUBKOMMISSION PERM-TRIAS 2011). Folgen bleiben aber in modifizierter Form erhalten als „regionale geochronologische Einheiten“. Sie haben dort eine Dauer von rund 100 ka bzw. 400 ka, sofern sie orbital-klimatisch induziert sind: sie sind dann die besten Indikationen für die Kalibrierung der geologischen Zeitskala von Mitteleuropa. Die STD 2015 zeigt >1100 stratigraphische Einheiten. Zahlreiche „Schichten“ wurden seit 2002 als Formationen bzw. Gruppen gefasst und neue sind hinzugekommen. Auch unsere geologische Zeitskala 2015 spiegelt die Entwicklung wieder. Doch ändern sich nur die Alter von 13 der 100 Stufen des Phanerozoikums um >3 Ma.

ISG (1976) (Hedberg, H. D., Ed., 1976): International Stratigraphic Guide. – Int. Union Geol. Sci.: 200 p., New York (Wiley).
STD 2002 (Deutsche Stratigraphische Kommission, Hrsg.; Koordination und Gestaltung: M. Menning & A. Hendrich 2002): Stratigraphische Tabelle von Deutschland 2002. – Potsdam (GeoForschungsZentrum), Frankfurt a. M. (Forsch.-Inst. Senckenberg).
Subkommission Perm-Trias (2011): Beschlüsse der Deutschen Stratigraphischen Kommission zu Perm und Trias 1991–2010. – Z. Dt. Ges. Geowiss., 162, 1: 1–18; Stuttgart.

Stones in Towns and Cities – Public Geo-Education

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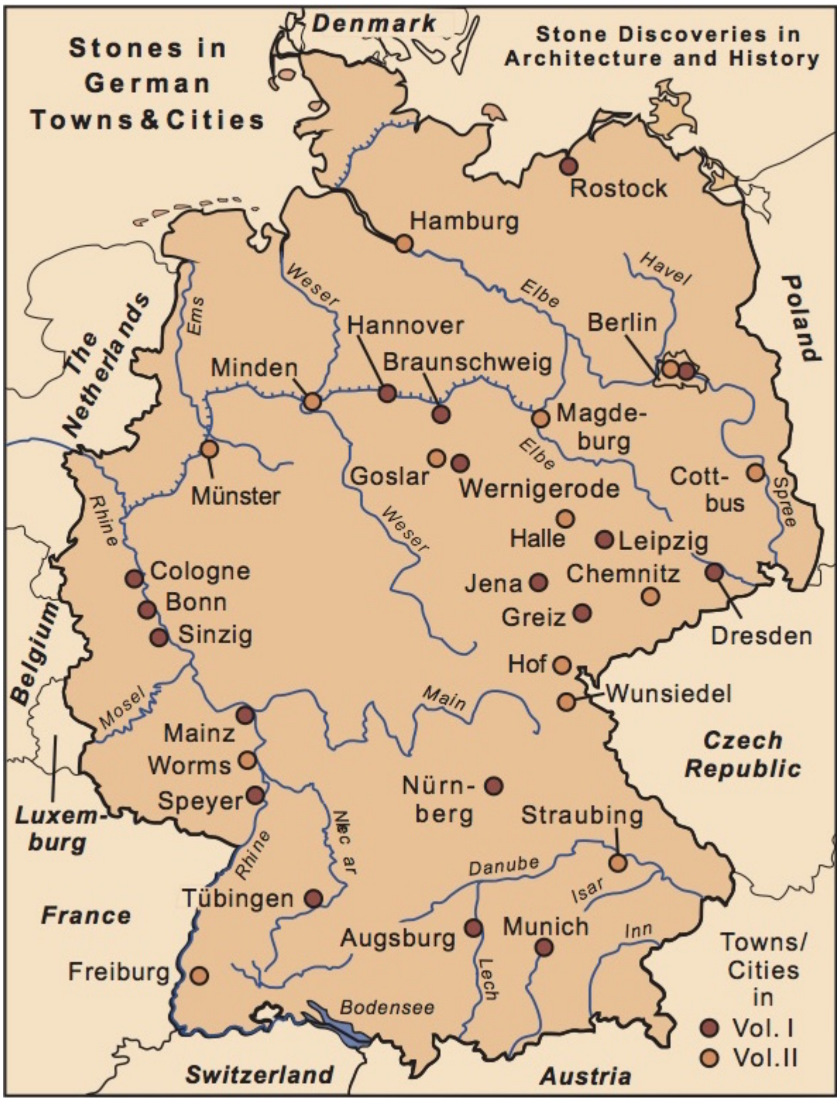
Stones - termed dimension, decorative or ornamental stones - offer splendid subjects for public education not only in big historical cities, but also in large and small towns, even in some villages. Their use ranges from historical buildings such as cathedrals or town halls, monuments of all kinds and ages, springs, all the way to pavement and toilet-houses. The broad use in kind and in building history puts the geological observations for the visitor into an attractive historical and regional frame of reference/ interest. Considering respective historical adversaries and boundaries, routes of trade and transport at various periods even political aspects enter the picture. An important advantage of the subject is that people do not travel to distant outcrops, but stay in their usual environment:

They just step out of their door and walk along their street to their market place – and meet geology at home! In many places a variety of stones can be shown within a short distance. The surfaces



Stones in german towns and cities

of these stones often show immediately internal fabrics and structures. For the preparation of the field trip research is required: The stones need be identified with respect to their compositions and properties, geographical origins and ages: The more information at hand, the better the respective story each stone tells. On site hand lens must suffice as tool; comparisons with samples from collections help. In addition the study of oral and written records, for example those of owners, stonemason and architects involved as well and as of various administrations concerned with the particular site. Since 1995 a small team worked in Berlin and presented a guide to the stones in its architecture and history (Schroeder, 1999, 2. ed. 2006; `www.geo.tu-berlin.de/geovereinbb/selbst-verlag/fuehrer_zur_geologie_von_berlin_und_brandenburg/band_6`; see also

Fieldtrip 01 of GeoBerlin 2015). An interdisciplinary network of colleagues concerned with stones in different German cities and towns was initiated in 2005; presently there are 135 participants. Annual workshops in various places across Germany serve for internal exchange and mutual consultations. For the public an annual "Day of stones in towns and cities" (in mid-October) was established; participants and others interested persons present their stones to the respective local public by guided tours, exhibits, talks, visits to stonemasons, etc. 51 authors contributed to the two publications of the network, entitled "Steine in deutschen Städten" (Schroeder, 2009, 2013), which offer 32 routes to discover stones in architecture and history of 31 towns/cities (See map and `www.tu-berlin.de/steine-in-der-stadt/fuehrer_steine_in_deutschen_staedten`).

Field guides "Geology in Berlin and Brandenburg"

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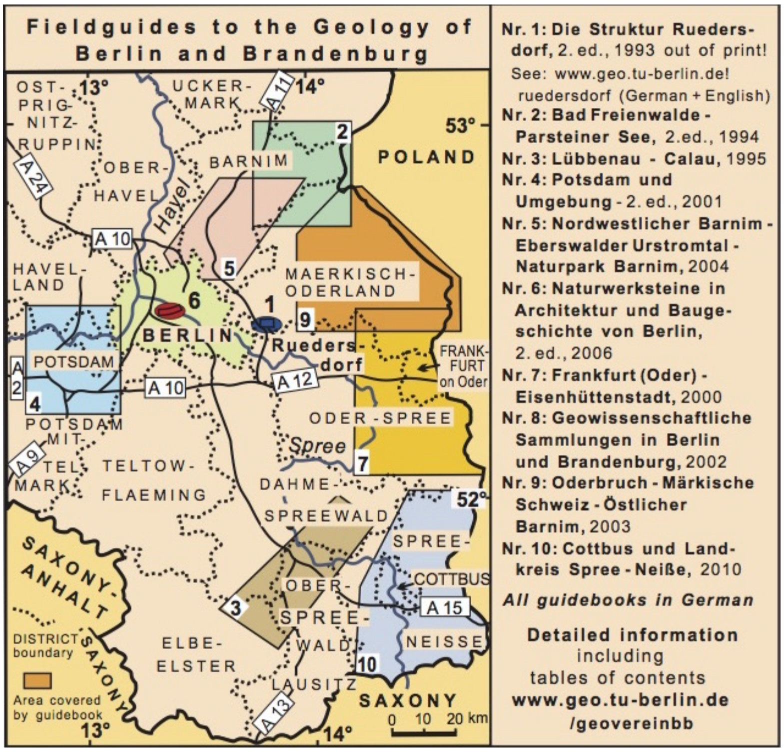

Fieldguides to the geology of Berlin and Brandenburg

25 years ago the unification of Germany and specifically of Berlin had, of course, its impact in politics and economics, in personal life and travelling, but also very particular impacts for geoscientists of the region: All of a sudden the region with its geological treasures became accessible. Simultaneously we realized extent, variety and quality of the joint Geo-Community as well as extent and quality of research. Immediately we began to share general as well as highly specific geo-knowledge not only from East to West and vice versa, but also among colleagues in the East, where strict rules of

confidentiality had limited mutual exchange. We formed the non-profit association "Geoscientists in Berlin and Brandenburg". Presently there are about 250 members in various institutions and companies – many active, others retired; it was intend-ed for and continues to be successful in serving as vehicle for activities and exchange: Individual lectures and joint symposia as well as field trips offer opportunities to present and to receive knowledge on a wide variety of geo-topics. The association also serves as regional network helping to obtain information and solving various regional problems. Ten "Field guides to the Geology of Berlin and Brandenburg" were published by the association (see map and www.geo.tu-berlin.de/geovereinbb/selbst-verlag). Geo-information on various areas/ topics of Brandenburg and Berlin was contributed by 185 colleagues, by many repeatedly. Most authors had worked in the East, some for decades in the respective region. The guidebooks facilitate geo-access to the regions, assembles general knowledge and results of many scientists and their work. In addition it provides links to more specific topics, e.g. details of the Pleistocene sequence, of Tertiary stratigraphy, as well as geo-conservation. The language of the guides is directed also to the general public in geo-education, therefore as much as possible professional jargon is avoided, translated or explained in glossaries.

Newly published: The Geology of Brandenburg

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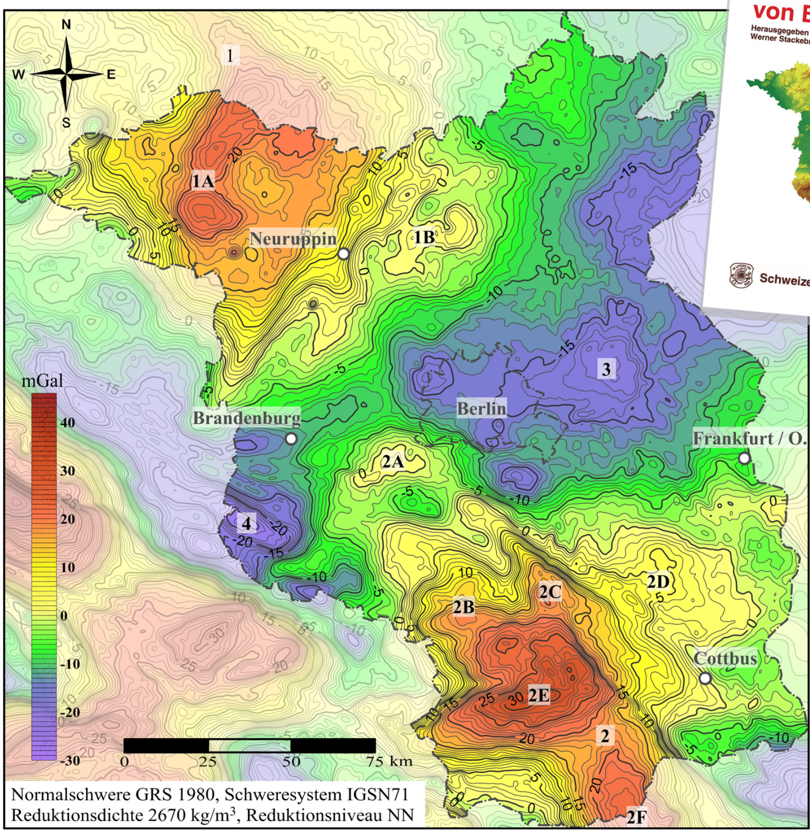
The geology of Brandenburg has been studied for more than two centuries. During this time, many geological data were acquired by mapping campaigns including extensive borehole programs (down to >7000 (!) m depth) as well as seismic, gravimetric and magnetic surveys. But nevertheless since 1922 (Hucke, K.: Geologie von Brandenburg. – Enke–Verlag, 1–352, Stuttgart) there has been no synoptic publication of the Geology of Brandenburg. The now existing enormous amount of data allows new insights into the complex structure and dynamic development of Brandenburg, which was compiled by researchers even beyond Berlin and Brandenburg institutions. Because of its complex nature, the views to the geology of Brandenburg differ enormously: - As frontal area of the Variscan deformation - As central part of the deep subsided intracontinental North German basin - As study object for intraplate relations in front of the Alpine-Carpathian-Pyrenean collision front - As type location of the Quaternary north European glaciation The geology of Brandenburg cannot be understood by its own; the main processes must be discussed in a wider European sense then focussed again to the core region. Main chapters are • geologic and morphologic overview, • stratigraphy, • regional geologic evolution (from late Proterozoic time to recent), • tectonics and structural evolution (including salt-, neo-, and glacial tectonics, • geophysical and geochemical surveys, • geopotentials and resources including the widespread brown coal layers of the Tertiary and newly explored Permian copper, but also water and mineral resources, • soil types of Brandenburg, • geo-risks, • changing landscapes, • important outcrops, • references. More than 250 figures illustrate the geological overview and reveal at once the relations between different structural stages of the complex composed Earth's crust of Brandenburg.
W. Stackebrandt & D. Franke (eds.): Geologie von Brandenburg, ISBN 978-3-510-65295-2, Schweizerbart 2015.



Gravity anomalies in Brandenburg (from Chapter 5: Geophysikalische und geochemische Landesuntersuchung, G. Gabriel et al.)

Scientific Programme

A1-01: Monitoring Plate Boundary Systems and Observing Megathrust Earthquakes

- Keynote: Jean-Philippe Avouac ....
  Seismic and Aseismic Fault Slip on Megathrust, application to the 2015 Gorkha earthquake, Nepal
- Zari Bordbar, Hadi Hoseini, Mohammad Reza Hatami ....
  Earthquakes Depth Accuracy of the Zagros Continental Collision Zone using Nonlinear Probabilistic Method
- Stefanie Rieger, Nico Adam, Anke M. Friedrich ....
  The vertical surface-deformation pattern of Crete (Greece) from Persistent Scatterer Interferometry
- David W. Scholl, Stephen H. Kirby, Roland von Huene ....
  Attributes of Subducting Lower Plate Relief that Hinder (Through Roughness) and Promote (Through Smoothness) the Rupturing of High-Magnitude (≥Mw8.0) Megathrust Earthquakes
- Monika Sobiesiak, Theresa Schaller, Benjamin Gutknecht, Hans-Jürgen Götze ....
  Can batholithic structures influence the seismogenic behavior of the North Chile Seismic Gap?
- Stephan V. Sobolev, Iskander Muldashev ....
  Modelling Seismic Cycle of a Megathrust Earthquake across the Scales
- Frederik Tilmann, Bernd Schurr, Günter Asch, Ben Heit, Torsten Dahm, Patricio Raul Arias Ortiz, Dietrich Lange, Ingo Grevemeyer, Marcos Moreno, Jonathan Bedford ....
  Observing the Iquique aftershock sequence: the HART deployment
- Pia Victor, Bernd Schurr, Monika Sobiesiak, Gabriel Gonzalez, Onno Oncken ....
  Triggering and remote triggering of the Atacama Fault System monitored with the IPOC Creepmeter Array (N-Chile)

A1-02: Fluids in subduction zones – from a deformation to geochemistry perspective

- Samuel Angiboust, Josephine Kirsch, Onno Oncken, Johannes Glodny, Patrick Monié, Erik Rybacki ....
  Probing the transition between seismically coupled and decoupled segments along an ancient subduction interface
- Wasja Bloch, Jörn Kummerow, Timm John, Peter Wigger, Serge Shapiro ....
  Evidence for Metamorphic Slab Dehydration in the Central Andean Subduction Zone, Derived from Volumetric Vp/Vs Measurements And Thermodynamical Modeling
- A.M. Currin, P.E. Wolff, J. Koepke, R. Almeev, B. Ildefonse ....
  Amphiboles extremely enriched in chlorine as evidence for interaction between rock and saline fluid

- Marcel Dietrich, Harald Behrens, Christian Schmidt, Max Wilke . . . .
  In situ determination of sulfur speciation in fluids at high P-T and controlled redox conditions
- Silvio Ferrero, Patrick J. O´Brien, Lutz Hecht, Martin Ziemann, Bernd Wunder . . . . . .
  Primary carbonate-rich melt in stromatic migmatites of the Bohemian Massif as result of partial melting of metasediments in the middle-lower crust.
- Fatma Gülmez, Dejan Prelevic, Ş. Can Genç . . . .
  Can slab-rollback trigger ultrapotassic volcanism in an active arc setting: an example from Northern Anatolia, Turkey
- Timm John, Oliver Plümper, Hans Vrijmoed, Yuri Podladchikov, Marco Scambelluri . .
  From porosity formation to permeability generation and the initiation of flow in dehydrating rocks: deciphering fluid flow mechanisms in subduction zones
- Achim Kopf, Michael Tryon, Simone Kasemann . . . .
  Deep-seated fluid ascent in mud volcanoes off Japan
- Walja Korolevski, Oliver Ritter, Ute Weckmann, Anatoly Rybin, Vitali Matiukov . . . . . .
  Crustal structure of the Southern Pamir - insights from the TIPTIMON magnetotelluric experiment
- Kenni Dinesen Petersen . . . .
  Mantle temperature and the time scale of extensional basin subsidence
- Christian Schmidt, Terry M. Seward . . . .
  Raman spectroscopic determination of sulfur species concentrations in aqueous solutions
- Marius J. Walter, Javier Quinteros, Stephan V. Sobolev . . . .
  Numerical modeling of fluid migration in subduction zones

A1-03: From oceanic subduction to continental collision: a metamorphic and magmatic geochemical perspective

- Peter Appel . . . .
  Xenotime and Monazite Ages and Polymetamorphic Evolution of Kyanite-Staurolite Schists from the Northern Part of the Usagaran Belt (Tanzania)
- Albert Riehm, Yannick Ruppert, Kirsten Drüppel, Jens C. Grimmer . . . .
  New constraints on the metamorphic evolution of metabasites of the Central Schwarzwald Gneiss Complex, Germany
- Juergen Koepke, Sandrin Feig, Paul Eric Wolff . . . .
  Shallow magmatism during subduction-zone initiation: Constraints from the Oman ophiolite and related experiments
- Ganxian Li . . . .
  Analysis of the Dynamic Mechanism of Continental Drift and Plate Motion
- Anselm Loges, Dina Schultze, Jana Rehm, Gerhard Franz . . . .
  Paleosedimentological reconstruction of amphibolite facies metasediments: a holistic approach
- Martina Mennekenn, Timm John, Andreas Läufer, Jasper Berndt . . . .
  Zircon chemistry of granitoids from the Wilson Terrane of northern Victoria Land (Antarctica): evidence for an immature Andean-type continental margin

- Ralf Oeser, Anselm Loges, Gerhard Franz, Dieter Rhede, Dina Schultze . . . .
  Sector zoned tourmalines as a thermometer in blackwall sequences, southwestern Tauern Window (Austria)
- Bernhard Schulz . . . .
  Resolving the complex structure in Mediterranean microplates: The evolution of the Austroalpine Basement in the Eastern Alps
- André Stechern, Tobias Just, Magdalena Banaszak, François Holtz . . . .
  Decoding Magma Plumbing and Geochemical Evolution Beneath the Lastarria Volcanic Complex (Northern Chile) - Evidence for Multiple Magma Storage Regions

A1-04: Mountain building on the scale of grains and atoms

- Lutz C. Götze, Ralf Milke, Susan Schorr, Rainer Abart, Richard Wirth . . . .
  In-situ monitoring of mineral reactions using synchrotron X-ray diffraction
- Keynote: Gerlinde Habler, Thomas Griffiths, Olga Ageeva, Rainer Abart . . . .
  Microfabrics of mineral host-inclusion systems: constraining formation mechanisms
- Zakaria Hamimi, Basem Zoheir . . . .
  East-West Gondwana collision: microstructural evidence for earlier timing
- Florian Heidelbach . . . .
  Garnet formation in the CMAS system under deviatoric stress
- Agnes Matysiak, Claudia Trepmann . . . .
  The deformation record of olivine in mylonitic peridotites from the Finero Complex, Ivrea Zone - separate deformation cycles during exhumation
- Dina Schultze, Gerhard Franz, Richard Wirth, Dirk Berger, Hans-Peter Schertl . . . .
  The dissolution-precipitation reactions and the role of aqueous fluids in the transformation of corundum to kyanite - three natural examples on a metamorphic cycle
- Christian Soder, Rebecca Ziergöbel, Rainer Altherr . . . .
  Eclogite xenoliths from post-collisional mafic dykes in the Variscan Odenwald (Germany)
- Claudia Trepmann . . . .
  Deformation and stress history during burial and exhumation – the quartz microstructural record of rocks from the Talea Ori, Crete, Greece

A1-05: Motion and time in orogenesis

- F. Boekhout, J. Berndt, A. Gerdes, H. Bahlburg . . . .
  Geological bias in the provenance record: an example of Rodinia margin granites from the Seychelles
- Shuyun Cao, Franz Neubauer, Manfred Bernroider, Johann Genser, Gertrude Friedl, Junlai Liu
  Low-grade retrogression of a high-temperature metamorphic core complex: Naxos, Cyclades, Greece
- Kathrin Fassmer, Gerrit Obermüller, Thorsten Nagel, Frederik Kirst, Nikolaus Froitzheim, Sascha Sandmann, Irena Miladinova, Raúl O.K. Fonseca, Carsten Münker . . . .
  Coherent vs. non-coherent subduction of ophiolite complexes – new insights from the Zermatt-Saas Zone (ZSZ) in the Western Alps

- Andreas Gärtner, Michel Villeneuve, Ulf Linnemann, Nasrrddine Youbi, Axel Gerdes *The Adrar Souttouf Massif (Moroccan Sahara) - a key to the Avalonia and Meguma conundrum?*
- Axel Gerdes . . . .
  Dating shear zones, volcanism and ore mineralisation by insitu U-Pb small scale isochrones
- Ralf Halama, Johannes Glodny, Matthias Konrad-Schmolke, Masafumi Sudo . . . .
  Episodic re-crystallization during subduction-related metamorphism (Sesia Zone, Western Alps)
- Nikola Koglin, Gerhard Franz, Johannes Glodny, Ulrich Schüssler, Armin Zeh, Axel Gerdes, Helene Brätz . . . .
  Münchberg metamorphic complex: nature and ages of the nappe protoliths
- Silviu O. Martha, Gernold Zulauf, Wolfgang Dörr, Paraskevas Xypolias, Rainer Petschick, Janina Schastok . . . .
  The Asterousia Crystalline Complex in the Aegean region: insights from structural analyses and U-Pb zircon dating on Anafi Island (Cyclades, Greece)
- Irena Miladinova, Sascha Sandmann, Nikolaus Froitzheim, Thorsten J. Nagel, Marian Janák, Neven Georgiev, Carsten Münker, Raúl O.K. Fonseca . . . .
  Late Cretaceous eclogite in the Eastern Rhodopes (Bulgaria): a link between the Rhodope Metamorphic Complex and the Stredna Gora volcanic arc
- Keynote: Oliver Nebel . . . .
  On the virtue and wickedness of modern Rb-Sr dating
- Thomas Reischmann, Axel Gerdes, Hans-Gerhard Fritsche, Heinz-Dieter Nesbor . . . . . .
  Late Devonian subduction and ocean closure: Evidence from zircon ages from the northern Böllsteiner Odenwald
- Marion Tichomirowa . . . .
  Zircon dating compared by different methods (SHRIMP/SIM, evaporation, high-precision CA-ID-TIMS) - how accurate and precise can we date zircons?
- Armin Zeh, Allan H. Wilson, Maria Ovtcharova, Urs Schaltegger . . . .
  Zircons of the Bushveld Complex – When and How did they form?
- Sascha Zertani, Jörg Giese, Mark Handy, ...
  Kinematics and low-temperature thermochronology of the Skutari-Pec-Fault in northern Albania: a combined structural and apatite fission-track study

A1-06: Subduction systems – missing link between Wegener´s concept of continental drift and plate tectonics

- Marzieh Baes, Stephan Sobolev . . . .
  A missing element in Wilson Cycle scenario
- Christian Brandes, Karsten Piepjohn, Dieter Franke, Christoph Gaedicke . . . .
  Paleostress field analysis of collisional tectonics along the margin of the Alaska-Chukotka microplate
- Jacob Geersen, Karen Leever, Kathrin Lieser, Lisa McNeill . . . .
  Fault reactivation and landward vergent thrusting in the accretionary prism of Northern Sumatra revealed by analogue experiments

- A. C. Glerum, C. Thieulot, C. C. Pranger, D. J. J. van Hinsbergen, M. Fraters, W. Spakman
  Three-dimensional instantaneous dynamics modeling of present-day Aegean subduction
- Ruth Keppler, Michael Stipp, Jan Behrmann, Florian Heidelbach . . . .
  Subduction channel flow by dislocation creep in eclogites of the Tauern Window, Austria
- Uwe Kroner, Rolf L. Romer . . . .
  Contrasting subduction modes in the Variscan collisional orogen
- Robert M. Kurzawski, Michael Stipp, Ralf Doose, Detlef Schulte-Kortnack . . . .
  Triaxial testing of marine sediments from offshore Costa Rica (Costa Rica Seismogenesis Project – IODP Expeditions 334 and 344)
- Caroline Mantey, Manfred R. Brix, Bernhard Stöckhert . . . .
  Prolonged tectonic history of a thin crustal lid on top of a subduction zone: The polygenetic mélange on Crete
- Hannah Pomella, David Flöss, Romed Speckbacher, Peter Tropper, Bernhard Fügenschuh
  The Eoalpine High Pressure Event in the western Eastern Alps
- Gerben Schepers, Douwe J.J. van Hinsbergen, Martha E. Kosters, Lydian M. Boschman, Wim Spakman . . . .
  Testing causes of Andean flat slab subduction in an absolute plate motion frame
- Sebastian Trütner, Matt J. Ikari, David Völker, Achim J. Kopf . . . .
  CLIP - Chile Large-slip: Initiation and Propagation mechanisms
- David Völker Michael Stipp . . . .
  Water input and water release from the subducting Nazca Plate along southern Central Chile (33°S-46°S)
- David Völker Jacob Geersen Achim Kopf . . . .
  Coseismic seafloor displacement by the 2010 Maule Earthquake offshore Central Chile - relation to fault activity and fault strength

A2-01: Plate tectonics, plate boundary deformation and intraplate tectonics: Observations and models on global, regional and basin scales

- Marco Bohnhoff, Patricia Martínez-Garzón, Fatih Bulut, Eva Stierle, Yehuda Ben-Zion
  Maximum earthquake magnitudes in relation to fault zone evolution: The case of the North Anatolian Fault Zone
- Christina Raub, Stefano Parolai, Peter Malin, Marco Bohnhoff . . . .
  Analysis of near-surface properties using waveform recordings from the GONAF-Tuzla vertical array, SE Istanbul
- Lydian M. Boschman, Douwe J.J. van Hinsbergen, Cedric Thieulot, Wim Spakman, Martha Kosters . . . .
  How the largest plate on Earth originated in a point
- Sascha Brune, Nathaniel Butterworth, Simon Williams, Dietmar Müller . . . .
  Oblique Rifting during Pangea Dispersal: The Rule, not the Exception
- Mauro Cacace, Magdalena Scheck-Wenderoth . . . .
  Why intracontinental basins subside longer - 3D feedback effects of lithospheric cooling and sedimentation on the flexural strength of the lithosphere

- M.V.Chertova, W.Spakman, A.P. van den Berg, D.J.J. van Hinsbergen . . . .
Rheological and kinematic control on the subduction evolution of the western Mediterranean region.
- Anke M. Friedrich, Simon Kübler, Manfred Strecker . . . .
Coseismic origin of transgranular gravel fractures in non-lithified deposits
- Derya Gürer, Douwe van Hinsbergen, Liviu Matenco, Fernando Corfu, Murat Özkaptan, Cor Langereis, Nuretdin Kaymakcı . . . .
Subduction zone configuration of Central and Eastern Anatolia since the late Cretaceous reconstructed from sedimentary basins in the Neotethyan suture zone
- Andrea Hampel, Ralf Hetzel . . . .
Three-dimensional finite-element modelling of horizontal surface velocity and strain patterns near thrust and normal faults during the earthquake cycle: implications for interpreting geological and geodetic data
- Mark R. Handy, Sebastian Cionoiu, Joerg Giese, Philip Gross, Eline Le Breton, Kujtim Onuzi, Jan Pleuger, Stefan M. Schmid, Kamil Ustaszewski, Sascha Zertani . . . .
Orogen-parallel and orogen-normal extension related to ongoing clockwise rotation at the junction of the Dinarides and Hellenides (Northern Albania)
- Friedrich Hawemann, Neil Mancktelow, Sebastian Wex, Alfredo Camacho, Giorgio Pennacchioni
Intracontinental earthquakes – from 550 Ma to present day in the Musgrave Ranges of Central Australia
- Ritske S. Huismans . . . .
Depth-dependent extension, two-stage breakup and depleted lithospheric counterflow at rifted margins
- Fabian Jähne-Klingberg, Frithjof Bense, Jonas Kley . . . .
"Geological elevators"? – the example of a Muschelkalk block surrounded by Zechstein next to the Sontra Graben (NE Hesse)
- Jonas Kley, Fabian Jähne-Klingberg, Alexander Malz, Frithjof Bense . . . .
Mesozoic intraplate structures in Germany: trying to understand the crucial details
- Eline Le Breton, Mark R. Handy, Kamil Ustaszewski . . . .
Kinematic reconstructions and possible driving forces of the Adriatic microplate
- Hailing Liu, Yang Zhou, Baoyun Shen, Yuhan Li, Yin Wang, ...
Ancient Shuangfeng-Bijia collisional orogenic belt in the South China Sea, a "witness" to processes of drifting of fragments from Gondwana, subduction of Tethys and accretion of southeastern Asia
- Patricia Martínez-Garzón, Marco Bohnhoff, Yehuda Ben-Zion, Georg Dresen . . . .
Scaling of maximum observed magnitudes with geometrical and stress properties of strike-slip faults
- Austin M. Gion, Simon E. Williams, R. Dietmar Müller . . . .
The Wegener Fault revisited: Building a deforming plate model for the Eurekan Orogeny
- Bita Najdahmadi, Marco Bohnhoff Fatih Bulut, Zachary E. Ross, Yehuda Ben-Zion . . .
Systematic imaging of bimaterial interfaces at the at the Karadere-Düzce segment of the North Anatolian Fault Zone, Turkey

- Laziz Ouided, Boularak Moussa, Benabbas Chaouki . . . .
  Quaternary tectonics, regional structure and of reverse fault N100° of Djebel Kellal mount, Constantine area (north-east of Algeria)
- Keynote: Kenni Dinesen Petersen . . . .
  Mantle temperature and the time scale of extensional basin subsidence
- Judith Sippel, Christian Meeßen, Mauro Cacace, Magdalena Scheck-Wenderoth, Stewart Fishwick, Christian Heine, Manfred R. Strecker, James Mechie . . . .
  Lithospheric strength variations across the Kenya Rift region as constrained by data-driven 3D gravity and thermal modelling
- Wim Spakman, Maria Chertova, Shalaleh Mohammadi, Arie van den Berg, Cedric Thieulot and Douwe van Hinsbergen . . . .
  Slab dragging and the recent geodynamic evolution of the Africa-Iberia plate boundary region
- Cornelia Spiegel, Julia Lindow, Peter Kamp, Samuel Mukasa, Frank Lisker, Gerhard Kuhn, Karsten Gohl . . . .
  Activity of the West Antarctic Rift System along Marie Byrd Land and the Amundsen Sea area
- Franz Tessensohn. Karsten Piepjohn, Detlev Damaske, Solveig Estrada . . . .
  The Case of the Arctic Wegener Fault - Postulations and present state of knowledge
- Kosuke Ueda, Dave May, Taras Gerya, Sean Willett . . . .
  Sensitivity of active continental margin evolution to different surface process models
- Henry Wichura, Javier Quinteros, Daniel Melnick, Sascha Brune, Wolfgang Schwanghart, Manfred R. Strecker . . . .
  Evolution of the Lake Victoria basin in the context of coeval rift initiation in East Africa: a 3D numerical model approach
- Christopher Wollin, Ludger Küperkoch, Marco Bohnhoff . . . .
  Kinematics of the Marmara segment of the North Anatolian Fault Zone from fault-plane solutions derived from a refined high precision hypocenter catalogue (2007-2010)

A2-02: Continental breakup and passive margin evolution

- Friederike U. Bauer, Joachim Jacobs, Benjamin Emmel, Finlay M. Stuart, Matthijs C. van Soest
  Tracing the evolution of an orogen passive margin system by apatite and titanite (U-Th)/He data
- Romain Bousquet, Thierry Nalpas, Ronny Lompa, Roman Chelalou, Abdeltif Lahfid . . .
  Consequences of HT metamorphism during sedimentary basins formation
- Eva Bredow, Rene Gassmöller, Bernhard Steinberger, Juliane Dannberg, Trond Torsvik
  Models and observations of plume-ridge interaction in the South Atlantic and their implications for crustal thickness variations
- Roderick Brown Mark Wildman, Romain Beucher . . . .
  The topographic evolution of southern Africa: what's all the fuss about and why are we still arguing about this?
- Sascha Brune, Simon Williams, Nathaniel Butterworth, Dietmar Müller . . . .
  Abrupt plate accelerations controlled by rift strength: A global analysis of Pangea fragmentation
- Hans-Peter Bunge, Lorenzo Colli . . . .
  Spreading changes in the South Atlantic region: observations and geodynamic interpretations

- Ingo Dressel, Magdalena Scheck-Wenderoth, Mauro Cacace, Hans-Jürgen Götze, Dieter Franke, Hans-Peter Bunge . . . .
  Subsidence history of the South Atlantic passive margins
- Erik Duesterhoeft, Henry Wichura, Romain Bousquet, Roland Oberhänsli . . . .
  Pre-rift topography of the East-African Plateau induced by metamorphic density changes in the lithosphere
- François Guillocheau and the TopoAfrica working group . . . .
  Passive margins of Austral Africa: long term evolution, mantle dynamics, erosion and sedimentation
- Sebastian Kollenz, Ulrich A. Glasmacher, Sabrina Pfister, Eduardo A. Rossello, Claudio Gaucher, Thomas Will . . . .
  Thermokinematic evolution of the passive continental margin in NE-Argentina and SE-Uruguay, constrained by fission-track ages and (U-Th-Sm)/He ages and 2D-modelling
- Martha Kosters, Douwe van Hinsbergen, Lydian Boschman, Gerben Schepers, Peter Bijl, Wim Spakman . . . .
  Opening of the Drake Passage: due to Mantle Anchoring and Absolute Plate Motions?
- Frank Strozyk, Peter Kukla, Stefan Back . . . .
  Regional comparison of the syn- and post-rift tectono-stratigraphic evolution of megasequences in salt and salt-free basins offshore Brazil and Africa, South Atlantic
- F. Lisker, J.D. Prenzel, M.L. Balestrieri, A. Läufer, C. Spiegel . . . .
  Exhumation and uplift of the Terra Nova Bay segment of the Transantarctic Mountains
- Webster Mohriak . . . .
  Continental breakup and passive margin evolution based on plate tectonic concepts developed from the South Atlantic and the Red Sea
- Franz Neubauer . . . .
  Middle and lower passive margin crust preserved in mountain belts and its correlation with upper crust: significance for rifting models and tectonic reconstructions
- Elisa Josiane Rindraharisaona, Frederik Tilmann, Xiaohui Yuan, Miriam Reiss, Georg Ruempker
  Lithosphere structure in the southern Madagascar from receiver function and ambient noise surface wave dispersion analysis.
- François Roure . . . .
  The Wilson cycle revisited
- Jana Schierjott, Francesco Maccaferri, Valerio Acocella, Eleonora Rivalta . . . .
  A numerical and analogue study of dike ascent in asymmetric continental rift zones
- Cornelia Spiegel, Wolfgang Reiter, Frank Lisker, Volkmar Damm . . . .
  Evolution of northwest Greenland margin along Baffin Bay
- Nicky White, Mark Hoggard, David Al-Attar . . . .
  Causes and Consequences of Spherical Harmonic Models of Observed Dynamic Topography
- Mark Wildman, Roderick Brown, Cristina Persano, Romain Beucher, Finlay Stuart . . . .
  Patterns and timing of post-rift denudation across the southwest African continental margin and interior plateau as revealed by apatite fission track and (U-Th-Sm)/He thermochronology

A2-03: Large Igneous Provinces: relation to continental breakup

A2-04: Magmatism in oceanic and continental intraplate environments

- Jörg Büchner, Olaf Tietz, Lothar Viereck, Michael Abratis, Axel Gerdes, Peter Suhr *The Lausitz Volcanic Field – insights into a continental magmatic evolution*
- Keynote: Albrecht Hofmann . . . .
  Canonical Element Ratios as Tracers of Mantle Circulation – a Reassessment
- Tom Járóka, Thomas Seifert . . . .
  New investigations of Paleozoic Ni-Cu-Co-PGE-enriched gabbroic rocks in the Upper Lusatia, Germany and Czech Republic: preliminary results
- Irum Kahn, Muhammad Arif, Muhammad Sajid, Humaad Ghani . . . .
  Petrographical Study of Rocks from Indus Suture Zone and Jijal Complex, NW Pakistan
- Fabian Kemner, Christoph Beier, Karsten Haase . . . .
  The geochemical evolution of oceanic intraplate volcanoes
- Friederike Körting, Christian Rogaß, Horst Kämpf, Michael Schudack . . . .
  Drill core mineral analysis by means of the hyperspectral imaging spectrometer HySPEX, XRD and ASD in proximity of the Mytina Maar, Czech Republic
- Shiladitya Mazumdar, Ralf Milke, Timm John . . . .
  Ohre rift related volcanism in Silesia (Poland): Insights from mineral micro-chemistry
- Ralf Milke, Sarah Schwiddessen, Anna Charlotte Noll, Anne Weit . . . .
  Reactions between mantle xenoliths and trachyandesite host melt from Pigroot, New Zealand
- Julia Neukampf, Armin Freundt, Timm John . . . .
  Study of the evolution of the intra-plate magma plumbing system beneath Fogo
- Dejan Prelevic, Regina Mertz-Kraus, Stephan Buhre, Dieter Mertz . . . .
  Petrological characterization of the seismic low-velocity anomaly beneath the Eifel volcanic field (West Germany) using major and trace element compositions of olivine macrocrysts
- Maxwell Marzban Thiemens, Peter Sprung . . . .
  West Eifel xenolith analyses via multiple isotopic systems
- Thomas Meier, Riaz Soomro, Christian Weidle, Luigia Cristiano, Michael Abratis, Sergei Lebedev, Joerg Büchner . . . .
  Memory of the LAB for melt generation in Central European intraplate volcanic fields
- Sören Wilke, Torsten Bolte, Renat Almeev, Eric H. Christiansen, Francois Holtz . . . . . .
  Experimental calibration of a new geobarometer for rhyolitic melts based on cotectic melt compositions
- Aurelia L.K. Zirner, Chris Ballhaus, Roman Botcharnikov, Raúl O.C. Fonseca, Carsten Münker

  Anorthositic dykes in Cyprus – precipitates of magmatic fluids?

A3-01: Meeorites and Early Planetary Evolution

- Moritz I. F. Barth, Dennis Harries, Falko Langenhorst . . . .
  Polycrystalline Sulfide-Assemblages in Acfer 094 - Clues to Heterogeneous Nebular Conditions of Sulfide and Oxide Formation
- Gregory A. Brennecka, Lars E. Borg, Meenakshi Wadhwa . . . .
  Isotopic Fingerprints of Early Solar System Events

A3-02: Impact Cratering in the Planetary System

A3-03: Earthlike Planets: Plate tectonics vs stagnant lid tectonics

- A. Rozel, G.J. Golabek, P.J. Tackley . . . .
  Evolutionary models of the Earth with a grain size-dependent rheology
- Keynote: Vlada Stamenković, Adrian Lenardic, Tobias Höink, Doris Breuer . . . .
  From exoplanets to the importance of shear stresses for plate tectonics on Earth-like planets
- Bernhard Steinberger, Stephanie Werner, Tobias Rolf . . . .
  Mantle dynamics models of the gravity spectrum of Mercury
- Paul J. Tackley, Diogo Lourenco, Antoine Rozel, Takashi Nakagawa . . . .
  The key influence of magmatism on the thermo-chemical-tectonic evolution of terrestrial planets
- Nicola Tosi, Ondrej Cadek, Marie Behuonkova, Michela Kanova, Ana-Catalina Plesa, Matthias Grott, Doris Breuer, Sebastiano Padovan, Mark Wieczorek . . . .
  Mercury's Low-Degree Geoid and Topography from Insolation-Driven Elastic Deformation
- Teresa Wong, Viatcheslav S. Solomatov . . . .
  Variations in timing of plate tectonics initiation on Earth-like planets due to chaotic nature of mantle convection

A4-01 Mantle flow: geophysical imaging and large-scale geodynamic modelling

- Roberto Agrusta, Jeroen van Hunen, Saskia Goes . . . .
  The influence of mantle phase transformations on the slab dynamics
- Andrew Fowler, Peter Howell, Tania Khaleque . . . .
  Convection of a fluid with strongly temperature and pressure dependent viscosity
- Maral Hosseinpour, Nicolas Flament, Simon Williams, Maria Seton, Rakib Hassan, R. Dietmar Müller . . . .
  Fate of Mesozoic Tethyan slabs in the deep mantle
- Charitra Jain, Antoine Rozel, Paul Tackley . . . .
  Is there any correlation between continents and elevated temperatures in the subcontinental mantle?
- Mikhail K. Kaban, Walter D. Mooney and Alexey G. Petrunin . . . .
  Cratonic roots under North America are shifted by basal drag: new evidence from gravity and geodynamic modeling
- Simeon Kostyanev, Georgi Trapov, Velislav Stoyanov. . . . .
  Numerical modelling of heat flows in Black Sea
- Keynote: Maureen Long, Colton Lynner, Heather Ford, Anwar Mohiuddin, Neala Creasy, Xiaobo He . . . .
  Observations and models of seismic anisotropy in the deep mantle and implications for mantle flow
- H. Marquardt, G.J. Golabek, L. Miyagi, T.V. Gerya . . . .
  The response of subducting slabs to a strength increase in the shallow lower mantle constrained by numerical modelling
- Maxime Maurice, Nicola Tosi, Ana-Catalina Plesa, Doris Breuer, Christian Huettig. . . .
  Evolution and Consequences of Magma Ocean Solidification

- Athanasia Nikolaou, Nicola Tosi, Ana-Catalina Plesa . . . .
  Modelling magma ocean evolution and volatile outgassing using a 1-D atmosphere-interior coupled model for the early earth.
- Andy Nowacki, Hein van Heck, D. Rhodri Davies, J. Huw Davies James Wookey . . . . .
  Plumes, piles or puddings? Testing hypotheses of lowermost mantle dynamics with geodynamic and seismic calculations
- Anthony Osei Tutu, Bernhard Steinberger, Stephen Sobolev, Irina Rogozhina . . . .
  Linking global mantle dynamics with lithosphere considering the effect of visco-elasto-plastic rheology in the upper 300 km
- Tobias Rolf, Fabio A. Capitanio, Paul J. Tackley . . . .
  Dynamic characteristics of plate motions and continental drift in global mantle flow
- Thomas Ruedas . . . .
  Effects of impacts on the thermochemical evolution of Mars
- Keynote: Henri Samuel, Scott King . . . .
  Mantle convective dynamics and mixing processes across scales
- Teh-Ru Alex Song, Xuzhang Shen, Lars Stixrude, Carolina Lithgow-Bertelloni . . . .
  Seismic constraint of a dry, basalt-rich transition zone near a stagnant slab region beneath China
- Bernhard Steinberger . . . .
  Inferring mantle flow and dynamic topography from seismic tomography
- Frank Walter Wagner, Ana-Catalina Plesa . . . .
  Modeling the convective heat transfer in solid planets

A4-03: Properties of Earth Materials and Constraints on Mantle Flow

- Nicole Biedermann, Hans-Josef Reichmann, Sergio Speziale, Monika Koch-Müller, Gerhard Heide . . . .
  High-pressure phase transitions of strontianite
- H. Idrissi, C. Bollinger, P. Cordier, F. Boioli . . . .
  In situ deformation of olivine in the transmission electron microscope: from dislocation velocity measurements to stress-strain curves
- Johannes Buchen, Hauke Marquardt, Takaaki Kawazoe, Alexander Kurnosov, Tiziana Boffa Ballaran . . . .
  High-pressure single-crystal elasticity of wadsleyite: Constraints on seismic anisotropy in the transition zone
- Francesca Boioli, Philippe Carrez, Patrick Cordier . . . .
  Modeling the rheology of olivine using 2.5D dislocation dynamics simulations
- J. Amodeo, B.S.A. Schuberth, H.-P. Bunge, Ph. Carrez, P. Cordier . . . .
  On the role of thermal heterogeneities on the rheology of MgO under conditions of the Earth's lower mantle
- Robert Farla, Anja Rosenthal, Caroline Bollinger, Sylvain Petitgirard, Takaaki Kawazoe, Jérémy Guignard, Daniel Frost . . . .
  In situ deformation of eclogite and depleted peridotite compositions at high pressure and temperature

- Keynote: Ulrich Faul, Ian Jackson, Emmanuel David, Christopher Cline, Andrew Berry
  Experimental constraints on seismic properties and rheology of the upper mantle: Effects of water and melt
- Susanne F. Herting-Agthe . . . .
  Calcite – star-shaped oriented intergrowths with other minerals
- H. Marquardt, L. Miyagi, Sergio Speziale, Hanns-Peter Liermann . . . .
  Deformation of (Mg,Fe)O ferropericlase at high-pressures and high-temperatures and slab stagnation in the shallow lower mantle
- Alexander Kurnosov, Hauke Marquardt, Tiziane Boffa Ballaran, Daniel .J. Frost . . . . . .
  The effect of iron and aluminium incorporation on the single-crystal elasticity of bridgmanite at high pressure
- Nobuyoshi Miyajima, Yang Li, Florian Heidelbach . . . .
  Electron channeling contrast imaging of dislocations in geological materials using a scanning electron microscope
- Jan Müller, Monika Koch-Müller, Sandro Jahn . . . .
  In-situ Raman and infra red spectroscopy on siderite up to 60 GPa and maximum 1000 K
- Michael Riedel, Shoichi Yoshioka . . . .
  Impact of olivine-spinel phase change kinetics on the deformation of the Mariana Slab
- Kirsten Schulze, Hauke Marquardt, Takaaki Kawazoe, Monika Koch-Müller, Alexander Kurnosov, Tiziana Boffa Ballaran . . . .
  The effect of iron content and hydration on the high-pressure single-crystal elasticity of ringwoodite derived from an internally consistent approach
- Sergio Speziale, Hanns-Peter Liermann, Giacomo Lo Nigro, Hauke Marquardt, Hans-Josef Reichmann . . . .
  Compression of $(Mg_{0.9}Fe_{0.1})_2SiO_4$ olivine at ambient temperature to lower mantle pressures
- Herbert Wallner, Harro Schmeling . . . .
  Induced stress in stiff lithosphere by melt emplacement
- Zhongqing Wu, Renata Wentzcovitch . . . .
  Spin crossover in ferropericlase and velocity heterogeneities in the lower mantle

A4-04: When and How did Plate Tectonics Begin on Earth

- Keynote: Jean H. Bédard, Lyal B. Harris . . . .
  Subductionless Archaean continental drift and implications for secular tectonic evolution on Earth
- Keynote: David Bercovici, Yanick Ricard . . . .
  Origin of plate tectonics: Grain-damage, inheritance and hysteresis
- Priyadarshi Chowdhury, Taras Gerya, Sumit Chakraborty . . . .
  Continental crustal recycling by modern-day plate tectonics and its plausible nature in the early Earth: A numerical modeling approach
- Keynote: Kent Condie, Cin-Ty Lee, Richard C Aster, Jeroen van Hunen . . . .
  Secular Changes in the Mantle and the Onset of Plate Tectonics

- Ria Fischer, Taras Gerya . . . .
  Early Earth tectonics: A high-resolution 3D numerical modelling approach
- Taras Gerya, Robert Stern, Ria Fisher, Elena Sizova, Marzieh Baes, Stephan Sobolev, Scott Whattam . . . .
  Plume tectonics and subduction in the early Earth
- Lyal B. Harris, Jean H. Bédard . . . .
  Indentation and lateral escape in Western Ishtar Terra, Venus and the Archaean Superior Craton, Canada — "Wegenerean" continent-like drift without subduction and modern plate tectonics
- J. Elis Hoffmann, Emmanuel Musese, Alfred Kröner, Carsten Münker . . . .
  Hf-Nd and trace element constraints on granitoid-greenstone relationships of the >3.46 Ga Dwalile Greenstone Belt, Ancient Gneiss Complex (Swaziland)
- Ali Polat . . . .
  Convergent plate margin processes in the Archean Craton of West Greenland between 3.8 and 2.5 Ga: Evidence for the operation of plate tectonics in the early Earth
- Kathrin P. Schneider, Jörg E. Hoffmann, Carsten Münker, Alfred Kröner . . . .
  Are mafic and ultramafic rocks from the lower Onverwacht Group (Barberton Greenstone Belt) crustally contaminated?
- Keynote: Viatcheslav S. Solomatov . . . .
  Emergence of plate tectonics from magma ocean
- Robert J Stern . . . .
  A Wegenerian Approach to Understanding When Plate Tectonics Began
- J. van de Löcht, C. Münker, J.E. Hoffmann, R.Kleinschrodt, M.T. Rosing . . . .
  Eoarchean peridotites from southern West Greenland: remnants of Eoarchean mantle or ultramafic cumulates?
- Karen Ziaja, Stephen F. Foley, Richard W. White, Stephan Buhre . . . .
  Metamorphism and melting of picritic crust and its contribution to continental crust formation in the early Earth

A4-05: Archean environments and ecosystems

- Keynote: Alessandro Airo, Martin Homann . . . .
  Links between morphology and metabolism of modern and Archean microbial communities
- Saskia Bläsing, Marc Grund, Christoph Heubeck . . . .
  Petrography and Structural Geology of the westernmost Dycedale Syncline (Barberton Greenstone Belt, South Africa) – Implications for Archean tectonics and depositional environments
- Paul Fugmann, Christoph Heubeck, Eleutherios Profitis . . . .
  Sedimentology of the "Tsunami"- chert-slab conglomerate of the Archean Fig Tree Group (3.24 Ga), Barberton Greenstone Belt, South Africa
- Christoph Heubeck . . . .
  Reassessing evidence of Moon-Earth dynamics: No evidence of shorter lunar months from tidal bundles of the Moodies Group (Barberton Greenstone Belt, 3.22 Ga)
- Christoph Heubeck . . . .
  Architecture of Moodies Group (Barberton Greenstone Belt, 3.22 Ga) suggests partial convective overturn of unstable lithosphere

- Martin Homan, Christoph Heubeck, Alessandro Airo . . . .
  Morphological adaptations of 3.22 Ga-old phototrophic microbial mats to Archean coastal habitats (Moodies Group, Barberton Greenstone Belt, South Africa)
- Martin Homann, Christoph Heubeck, Tomaso R. R. Bontognali, Alessandro Airo . . . . . .
  Evidence for cavity-dwelling life in 3.2 Ga tidal deposits (Moodies Group, Barberton Greenstone Belt, South Africa)
- Matthias Müller, Alessandro Airo . . . .
  Modeling Microbialite Growth
- Sami Nabhan, Christoph Heubeck, Michael Wiedenbeck, Harald Strauß . . . .
  Biogenic overgrowth on detrital pyrite in Archean paleosols in the ∼3.2 Ga old Moodies Group, BGB, South Africa.
- Sami Nabhan, Tim Luber, Christoph Heubeck . . . .
  Climatic and geochemical implications of Archean pedogenic gypsum of the Moodies Group (∼3.2 Ga), Barberton Greenstone Belt, South Africa
- Carolin Rabethge, Christoph Heubeck . . . .
  Depositional environment of ferruginous sediment in the Moodies Group, Barberton Greenstone Belt, South Africa
- Marc-Nicolas Rentinck, Alessandro Airo . . . .
  Bioflumology: Cyanobacterial biomat morphologies under flow conditions
- Christof Sager, Julia Hulin, Alessandro Airo . . . .
  Bioflumology: Cyanobacterial biomat morphologies under tidal conditions
- Nicolas Schley, Martin Homann, Alessandro Airo . . . .
  Mico-CT analysis of Archean microbial mats
- Laura Stutenbecker, Christoph Heubeck . . . .
  Deltaic progradation under high tidal range: the lower Moodies Group, Barberton Greenstone Belt, South Africa

A5-01: Palaeoenvironmental, sedimentological and biogeographic consequences of the formation and breakup of upercontinents

- Rainer Brocke, Robert Bussert, Dawit Lebenie . . . .
  First discovery of Early Palaeozoic post-glacial (post-Hirnantian/latest Ordovician-early Silurian) mudstones and cryptospores in northern Ethiopia
- Annika Brüske, Stephan Schuth, Lingang Xu, Marie C. Arnold, Nadja Pierau, Stefan Weyer
  Stable vanadium isotopes – a potential new proxy for paleo-oceanography
- Robert Bussert, Ali A. M. Eisawi . . . .
  Late Cretaceous tropical coastal wetlands at the southern shoreline of the Tethys in central Sudan
- Zahra Zandinasab, Javad Darvishi Khatooni, Behruz Rafiei . . . .
  Sedimentology and Sea level changes of the offshore deposits South of Caspian Sea (Noshahr-Tonekabon)
- Javad Darvishi Khatuoni, Razyeh lak, Ali Mohammadi, Alireza salehipuor Milani . . . . . .
  Verification of the important factors that causes of rapid falling of Urmia Lake water table (Northwestern of Iran)

- Benmessaoud Hassen, Bouzekri Abdelhafid . . . .
  The satellites data used for monitoring the degradation process of natural resources in semi arid zones (Algeria)
- Veit Höfler, Christine Wessollek, Pierre Karrasch . . . .
  Modelling prehistoric terrain Models using LiDAR-data - a geomorphological approach
- Johannes Müller, Robert Bussert, Nicole Klein, Khalaf Allah Salih, David Evans . . . . . .
  Late Cretaceous vertebrate faunas from northeastern Gondwana: regional endemism, vicariance, and continental break-up.
- Elahe Rahimi, Ali Mahfroozi . . . .
  Study of coastline changes in south Caspian sea by geochronology of ancient sites during Holocene (Iran)
- Fatemeh Dabaghi Sadr, Gerhard Schmiedl, Christian Betzler, Mohammad Parandavar .
  Biostratigraphy and Lithostratigraphy of the Qom Formation in the Navab Anticline section, southeast of Kashan area, Iran

A5-02: Major environmental changes in Earth history: short- and long-term trends

- Leonid Anisimov . . . .
  Comparative hydrogeochemistry in global perspective
- Konstantin Frisch, Silke Voigt, Sietske Batenburg, Saida Nigmatova . . . .
  Tectonic and climatic forcing of lake level and salinity in the Miocene lacustrine succession of the Aktau Hills, southeastern Kazakhstan, Central Asia
- Keynote: Stephen Hesselbo . . . .
  New Developments in Understanding Jurassic Earth History
- Stefan Huck, Ulrich Heimhofer . . . .
  Rudist bivalve versus bulk carbonate chemostratigraphy: towards an improved chronostratigraphy of Urgonian carbonate platform demise in the run-up to the Oceanic Anoxic Event 1a
- Silviu O. Martha, Andrej Ernst, Joachim Scholz . . . .
  Plate tectonic and bryozoans: Biological response during times of extreme environmental changes (Devonian and Upper Cretaceous)
- Ralf Oeser, Michael Tatzel, Gerhard Franz, Jan A. Schuessler, Friedhelm von Blanckenburg
  Genesis of chert nodules in Ediacaran black shales: implications from micro scale Si isotope analyses using fs-laser ablation MC-ICP-MS
- Xiaojuan Sun, Christoph Heubeck . . . .
  Facies analysis of lowermost Cambrian carbonate platform in East Yunnan, South China: An implication of the importance of depositional hiatus
- Clemens V. Ullmann, Robert Frei: Christoph Korte, Stephen P. Hesselbo . . . .
  Reading the Record: Understanding heterogeneity in macrofossil geochemistry

A6-01: Tectonic and climatic imprints on the evolution of landscapes

- Edward R. Sobel, Alejandro Bande, Alexander Mikolaichuk, Euan Macaulay, Chen Jie .
Oligocene - Miocene exhumation of the Tian Shan
- Olaf Tietz, Jörg Büchner . . . .
Quantification of neotectonic movements after volcanic edifices and Quaternary deposits – an example from the Lausitz block-faulted area (Germany)
- Keynote: Peter van der Beek . . . .
Tectonics, Climate, Relief and Erosion: disentangling driving forces within a complex system
- Wei Wang, Vincent Godard, Jing Liu-Zeng, Dirk Scherler, Chong Xu, Qiang Xu, Kejia Xie, Olivier Bellier, Didier Bourles, Claire Ansberque . . . .
River-sand ^{10}Be Concentration after 2008 Wenchuan Earthquake: Tracing the Transportation of Landslide Debris
- E. Wenger, J. Büchner, O.Tietz, D. Sauer . . . .
Implications for landscape evolution in the Zittau Mountains (Eastern Saxony) inferred from the low erosion level of the Lausche Volcano (Lusatian Volcanic Field)
- Henry Wichura, Louis L. Jacobs, Manfred R. Strecker, Andrew Lin, Michael J. Polcyn, Fredrick K. Manthi, Dale A. Winkler, Clemens Matthew . . . .
A tale of a whale: How does a ziphiid fossil pinpoint the onset of uplift in East Africa?
- Jinyu Zhang, Jing Liu-Zeng, Dirk Sherler, Maoyun Tang, Zhanfei Li, and Ning Zhong *Late Quaternary incision rates of the Lancang River (Upper Mekong) in southeastern Tibet*

A6-02: The Sediment Factory: Tectonic and Climatic Forcing of Erosional and Depositional Processes

- John Armitage . . . .
Landscape response due to sediment transport and bed-rock detachment
- Alexander Bassis, Matthias Hinderer, Guido Meinhold . . . .
Provenance of Saudi Arabian Palaeozoic sandstones using whole rock and single grain geochemistry
- Bodo Bookhagen, Manfred R. Strecker . . . .
Evolution and erosional dynamics of intermontane basins on the Puna Plateau, NW Argentina
- Dennis Brüsch, Jens Hornung, Rainer Petschick, Olaf Lenz, Sandra Schneider, Matthias Hinderer *Upper Miocene to Pleistocene sedimentary record and its paleo-environmental implications in the Kaiso-Tonya area (northern Albert Rift): A multi-proxy approach*
- Martin Elsner . . . .
Structure and Stratigraphy of the Upper Freshwater Molasse of the North Alpine Foreland Basin in Western Bavaria
- Alexandra Hellwig, Silke Voigt, Andreas Mulch, Axel Gerdes, Thomas Voigt . . . .
Paleoclimatic implications from Cenozoic terrestrial calcrete formation in the Ili Basin, SE Kazakhstan
- Keynote: Matthias Hinderer . . . .
Control on large-scale sediment fluxes
- Jan-Hendrik May, Frank Preusser, Heinz Veit . . . .
Geomorphic and chronological constraints on the mid- to late Holocene evolution of the Río Grande megafan (Bolivia)

- Wolfgang Reiter, Simon Elfert, Christoph Glotzbach, Cornelia Spiegel . . . .
  Plio-Pleistocene evolution of the north Alpine drainage system: constraints from detrital thermochronology of foreland deposits
- Taylor Schildgen, Ruth Robinson, Sara Savi, Bodo Bookhagen, Stefanie Tofelde, Dirk Scherler and Manfred Strecker . . . .
  Landscape response to millennial-scale climate forcing from fluvial fill terraces: Humahuaca Basin, NW Argentina
- Sarah Schroeder, Richard Gloaguen . . . .
  Progress in code development for calibration of tectonically coupled surface evolution
- Nadja Franziska Stalder, Maria Giuditta Fellin, Wilfried Winkler . . . .
  Provenance Analysis of the Laga Formation (Messinian, Central Apennines)
- Laura Stutenbecker, Fritz Schlunegger . . . .
  Geomorphological response of a landscape to long-term tectonic and glacial processes: the upper Rhône basin, Central Swiss Alps
- Christoph von Hagke, Elco Luijendijk, Robert Ondrack, Julia Lindow . . . .
  Lack of correlation between relief and exhumation in the North Alpine Foreland Basin revealed by thermochronometry and a new thermal model
- Hella Wittmann, Friedhelm von Blanckenburg . . . .
  Dampened Holocene sediment fluxes across the lowlands of the Amazon and Ganga basins

A6-03: Ocean Gateways – Arteries of Tectonic-Climate Interaction

- Sietske J. Batenburg, Silke Voigt, Oliver Friedrich, Anne Osborne, Tina Klein, Christoph Neu, Martin Frank . . . .
  Atlantic Ocean Circulation during the Latest Cretaceous and Early Paleogene: Progressive Deep Water Exchange
- Keynote: Yannick Donnadieu and Emmanuelle Puceat . . . .
  Late Cretaceous changes in continental configuration: toward a better-ventilated ocean?
- Keynote: Karsten Gohl, Graeme Eagles, Wilfried Jokat . . . .
  The challenge of polar ocean gateway reconstructions
- Keynote: Ann Holbourn, Wolfgang Kuhnt, Karlos G.D. Kochhann, Mitch Lyle, Nils Andersen
  Reconstructing Miocene climate history from Pacific deep sea sedimentary archives
- Keynote: Wolfgang Kuhnt, Ann Holbourn, Jian Xu, Jan Schröder, Elena Lo Giudice Capelli, Rina Zuraida, Marfasran Henrizan . . . .
  Indonesian Throughflow and Indo-Australian Climate History through the last glacial cycle
- Michael Sarnthein, Nabil Khélifi, Martin Frank, Nils Andersen, Dieter Garbe-Schönberg
  Late Pliocene–to–early Pleistocene Mediterranean Outflow Waters in the N.E. Atlantic: Where? When? Forcings and Implications of Change?
- Michael Stärz, Wilfried Jokat, Gregor Knorr, Gerrit Lohmann . . . .
  Tipping point in North Atlantic-Arctic circulation controlled by the Oligocene-Miocene subsidence of the Greenland-Scotland Ridge

A6-04: Weathering and Global Biogeochemical Cycles - Crossing the Scales

- Julien Bouchez, Jérôme Gaillardet . . . .
  Weathering of shales under a tropical climate in the Bolivian Andes
- Keynote: Jérôme Gaillardet, Julien Bouchez, Mathieu Dellinger . . . .
  From plate tectonics to plate weathering
- Yves Godderis, Yannick Donnadieu . . . .
  The role of palaeogeography in the Phanerozoic history of atmospheric CO_2 and climate
- Michael Lindner, Ulf-Niklas Berninger, Alexander Reul, Guntram Jordan, Eric H. Oelkers, Jacques Schott . . . .
  Experimental studies on low calcian magnesite growth
- Nils Moosdorf, Mithra-Christin Hajati, Kathrin Haßler . . . .
  Groundwater as transport pathway in biogeochemical cycles: from local observations to global estimates
- Martin Schoell, Ralf Tappert, Karlis Muehlenbachs, Alexander P. Wolfe, Ryan C. McKellar
  Orogenetically driven weathering as major control of atmospheric oxygen during the Phanerozoic
- Eva E. Stüeken . . . .
  Characterizing Precambrian lakes as unique habitats for the early evolution of life
- Lyla Taylor, Steve Banwart, David Beerling . . . .
  Responding to anthropogenic climate change and ocean acidification: insights from a global weathering model
- Friedhelm von Blanckenburg, Julien Bouchez, Daniel E. Ibarra, Kate Maher . . . .
  Stable weathering fluxes into the oceans over glacial-interglacial cycles from $^{10}Be/^{9}Be$ records and global runoff-weathering models

A6-05: Quaternary Environmental Changes and Sediment Dynamics

- Anne Bernhardt, Manfred R. Strecker . . . .
  Propagation of paleoclimatic perturbations to turbidite systems, Chile convergent margin
- Bernhard Diekmann, Boris Biskaborn, Oleg Dirksen, Veronika Dirksen, Ulrike Hoff, Larisa Nazarova, Luidmilla Pestryakova, Dmitry Subetto, Pavel Tarasov . . . .
  Limnogeological Records of late Quaternary Palaeoenvironments in eastern Siberia
- Wolf-Christian Dullo, Sascha Flögel, Max Boxleitner, Jacek Raddaatz, Claudia Gudopp, Andres Rüggeberg, Volker Liebetrau . . . .
  Cold-Water Coral occurrences on the American Shelf
- Keynote: Philip Gibbard . . . .
  The Anthropocene; a formal stratigraphical unit, an informal designation, or an interval of Holocene time?
- Eberhard Gischler, Anja Isaack, Harold Hudson, Flavio Anselmetti, Marc Humblet, Juan C. Braga, Anton Eisenhauer, Gilbert Camoin . . . .
  Late Quaternary reef response to sea-level rise and subsidence in Bora Bora, Society Islands, South Pacific (French Polynesia)

A6-07: Glacial tectonics: from push moraines to glacial isostatic adjustment

- M. Al Hseinat, C. Hübscher ..... *Ice-load Induced Tectonics Controlled Tunnel Valley Evolution – Instances from the Southwestern Baltic Sea*
- M. Al Hseinat, C. Hübscher, J. Lang, I. Ott, U. Polom, C. Brandes, A. Hampel, J. Winsemann

  Ice-load induced salt tectonics controlled crestal collapse graben evolution – Instances from the Southwestern Baltic Sea
- Christian Brandes, Holger Steffen, Rebekka Steffen, Patrick Wu ....
  Climate-change induced earthquakes in northern Central Europe
- Anna Gehrmann, Martin Meschede, Heiko Hüneke, Stig A. Schack Pedersen, Karsten Obst

  Constructing Balanced Cross Sections from 2D Cliff Profiles of the Jasmund Glaciotectonic Complex (Rügen Island, NE Germany)
- Anna Gehrmann, Martin Meschede, Heiko Hüneke, Henrik Rother, Karsten Obst......
  The Jasmund Glaciotectonic Complex (NE Rügen Island): Geomorphological Mapping and Landform Analyses based on LiDAR Data
- Jürgen Mey, Dirk Scherler, Andrew Wickert, David L. Egholm, Magdala Tesauro, Manred R. Strecker ....
  Estimating the contribution of GIA to the present-day uplift of the European Alps considering post-glacial sediment redistribution and variations in lithospheric strength
- Peter B. E. Sandersen, Flemming Jørgensen ....
  Deglaciation-induced reactivation of deep-seated faults in southern Denmark – an example of temporary tectonic instability in the early Holocene
- David C. Tanner, Jan Igel, Thomas Günther, Christian Brandes, Charlotte M. Krawczyk
  Glacial structures revealed in County Kerry, Ireland, by detailed 3D geophysical investigation

A7-01: Geomaterials as indicators for Earth's light element cycles

- Eleanor Berryman, Bernd Wunder, Andreas Ertl, Monika Koch-Müller, Wilhelm Heinrich, Gerhard Franz ....
  Linking crystal structure to composition in tourmaline: A multi-method investigation of synthetic dravite, maruyamaite, magnesio-foitite, and oxy-uvite
- Andreas Ertl, Hans-Peter Meyer..
  Pneumatolytic overgrowth of fluor-schorl on earlier formed schorl from Zschorlau, Erzgebirge, Germany
- C. Kusebauch, T. John, M. J. Whitehouse..
  Using apatite as a fluid probe for halogens to decipher fluid-rock interaction
- Martin Kutzschbach, Bernd Wunder, Robert Trumbull, Anette Meixner, Dieter Rhede, Wilhelm Heinrich, Gerhard Franz ....
  The effect of tetrahedral B on the B isotope fractionation between tourmaline and fluid
- Horst R. Marschall, Adam R. Sarafian ....
  Apatite as a recorder of crustal and planetary evolution

A7-02: Structure, dynamics and properties of silicate melts and magmas

- Donjá Aßbichler, Dirk Müller, †Karl Thomas Fehr, Soraya Heuss-Aßbichler . . . .
  Sanidinites – an example for solvothermal transport of Zr in volcanic systems and its relevance for technical applications
- Danilo Di Genova, Daniele Morgavi, Kai-Uwe Hess, Daniel R. Neuville, Diego Perugini, Donald B. Dingwell . . . .
  A Raman model for determining the chemical composition of silicate glasses
- Katherine Joanna Dobson, Donald Bruce Dingwell, Kai-Uwe Hess . . . .
  Going down the tubes: complex kinematic indicators in tube pumices revealed by X-ray tomography
- Ilya Veksler, Katherine Joanna Dobson, Kai Uwe-Hess . . . .
  Quantifying melting and mobilisation of interstitial melts in crystal mushes
- Christoph Helo, Kai-Uwe Hess, Jon Castro, Donald B. Dingwell . . . .
  Water-speciation in silicate glass from partial Raman spectra
- Irum Kahn, Tahseenullah Khan, Humaad Ghani . . . .
  Petrography and Geochemistry of Part of the Mansehra Granite, Khyber Pakhtoonkhwa Pakistan
- Daniela Künzel, Johannes Wagner, Sandro Jahn . . . .
  First-principles prediction of Ni partitioning between silicate and metal melts
- J. Pohlenz, S. Pascarelli, O. Mathon, S. Belin, A. Shiryaev, O. Safonov, A. Veligzhanin, V. Murzin, T. Irifune ,M. Wilke . . . .
  Structural of Silicate-Carbonate Melts: An EXAFS Study on Y and Sr Properties
- Maria Stuff, Jan A. Schuessler, Max Wilke . . . .
  Experimental constraints on Fe isotope fractionation between silicate and carbonate immiscible melts
- Ilya Veksler . . . .
  Silicate liquid immiscibility in magmatic systems
- Johannes Wagner, Sandro Jahn . . . .
  Y and La compatibility in silicate melts and its dependence on melt structure: A first principles simulation study
- Sebastian Wiesmaier, Daniele Morgavi, Christian Renggli, Diego Perugini, Cristina De Campos, Kai-Uwe Hess, Werner Ertel-Ingrisch, Yan Lavallée, Donald B. Dingwell . . . .
  Magma mixing enhanced by bubble segregation

B1-01: Multi-scale evolution of sedimentary basins

- Jashar Arfai, Rüdiger Lutz, Lutz Reinhardt, Christoph Gaedicke . . . .
  3D petroleum system modelling and hydrocarbon generation potential: the Entenschnabel area, northwestern German North Sea
- Heinrich Bahlburg . . . .
  On restoring sedimentary basins for post-depositional deformation – Paleozoic basins of the central Andes

- Benjamin Emmel Krzysztof, Jan Zieba . . . .
  Thermochronology based revised Cenozoic uplift and erosion estimates for the western Barents Sea
- Arne Grobe, Ralf Litte, Janos Urai . . . .
  Structural and thermal history of the Oman Mountains
- Peter Klitzke, Sebastien Gac, Jan Inge Faleide, Magdalena Scheck-Wenderoth . . . .
  Lithospheric Strength and elastic thickness of the Barents Sea and Kara Sea region
- Simon Müller, Rüdiger Lutz, Lutz Reinhardt, Christoph Gaedicke, Hauke Thöle . . . .
  Correlation of shallow gas indicators and seismic stratigraphic units in the German North Sea
- Robert Ondrak, Ursuala Hammes . . . .
  Modeling the burial and maturation history of the Haynesville Shale in the East Texas Salt Basin and the Sabine Uplift area
- Victoria Sachse, Zahie Anka, Jorge F. Rodriguez, Rolando di Primio . . . .
  The impact of Andes tectonics on hydrocarbon generation in the northern Austral Basin, southern Argentina, South America
- David C. Tanner, Jennifer Ziesch, Thies Beilecke, Charlotte M. Krawczyk . . . .
  Kinematic analysis of syn-sedimentary normal faults in the Otway Basin, Australia
- S. Theissen-Krah, D. W. Schmid, J.-I. Faleide, S. Planke, L. H. Ruepke, E. H. Hartz . .
  Extension and thermal evolution at the Mid-Norwegian Margin – Insights from basin modelling between Greenland and the Møre Margin
- Michael Warsitzka, Jonas Kley, Nina Kukowski . . . .
  Understanding salt structure evolution in the Central Glueckstadt Graben (Northern Germany) by means of restoration of minibasins
- Johannes Wendebourg, Frank Adler, François Lorant, Bertrand Chevallier . . . .
  Hydrodynamics: a key to exploration success in the South Caspian Sea
- Krzysztof Jan Zieba, Arnt Grøver . . . .
  Glacial erosion, deposition and ice loading: Impact on structural development of the western Barents Sea sedimentary basins

B1-02: Rock and Fluids Properties and Interactions in Hydrocarbon Systems

- Esther T. Arning, Steffen Häußler, Yunjiao Fu, Wolfgang van Berk, Hans-Martin Schulz
  Integrated hydrogeochemical modelling of rock-water interactions in shallow marine sediments: implications for biogenic methane prediction
- Keynote: Knut Bjørlykke . . . .
  Constraints on fluid flow and mass transport on diagenesis in sedimentary basins. Predicting physical properties of sandstones and shales
- Marie-Louise Grundtner, Doris Groß, Hans-Gert Linzer, David Misch, Reinhard Sachsenhofer, Lorenz Scheucher, Reinhard Gratzer . . . .
  Diagenesis of Upper Eocene clastic reservoir rocks in the Alpine Foreland Basin (Austria)
- G. Purser, K. Bateman, A.D. Kilpatrick, L. Selby . . . .
  An experimental investigation of the fluid-rock reaction of Bowland Shale with a shale gas injection fluid.

- Joyce Schmatz, Jop Klaver, Guillaume Desbois, Janos L. Urai . . . .
Cryo-BIB-SEM and Wood's Metal Injection to image pore morphology, pore connectivity, and fluid distribution in hydrocarbon bearing rocks

- Yaling Zhu, Andrea Vieth-Hillebrand, Brian Horsfield . . . .
Investigating water-soluble organic compounds released from black shales and coals

B1-03: Shales and Coals:source and reservoir for oil and gas

- Alireza Baniasad, Ahmadreza Rabbani, Victoria Sachse, Ralf Littke . . . .
Organic Geochemistry and Basin Modeling Study in the Northwestern Part of the Persian Gulf

- Martin Blumenberg, Jolanta Kus, Lutz Reinhardt, Christoph Gaedicke, Karsten Piepjohn, Georg Scheeder, Stefan Schlömer, Philipp Weniger, Christian Ostertag-Henning . . . .
The oil generation potential of coals from Svalbard and the Northern Barents Sea

- Samer Bou Daher, Fadi H. Nader, Ralf Littke . . . .
Source rocks potential and maturity modelling of the east Mediterranean Levant basin and its eastern margin

- Bandar Ghassal, Victoria Sachse and Ralf Littke . . . .
Source Rock Assessment of Upper Albian to Turonian Sedimentary Rocks from the Tarfaya Basin, SW Morocco

- Assad Ghazwania, Ralf Littke, Reinhard Finka, Christoph Hartkopf-Fröder, Nicolaj Mahlstaedt, Victoria Sachse . . . .
Organic Geochemistry, Petrology and Palynofacies of Middle Devonian Lacustrine Flagstone in the Orcadian Basin, Scotland: Depositional Environment, Thermal History and Petroleum Generation Potential

- Torsten Gorka, Ernst Bernhard Teigler, Stephan Peters . . . .
Geological parameters for successful shale gas plays – why is testing so crucial?

- Jop Klaver, Guillaume Desbois, Ralf Littke, Janos L. Urai . . . .
Pore space morphology and distribution in mature and post mature Posidonia Shale samples from the Hils area, Germany

- Stefan Ladage & Team BGR - NIKO Project . . . .
Shale Gas and Fracking in Germany - Resources and Environmental Risks

- Helena Pfunt, Georg Houben, Thomas Himmelsbach . . . .
Fracking and potential risks for fresh water aquifers – Numerical modeling of fluid flow due to hydraulic fracturing of shale formations in the North German Basin

- Stefanie Poetz, Nicolaj Mahlstedt, Heinz Wilkes, Brian Horsfield . . . .
Tracking the retention, mobilization and chemical evolution of major NSO compound classes in petroleum systems

- Alexander T. Stock, Ralf Littke . . . .
Analysis of oils from the Lower Saxony Basin and the Gifhorn Trough – Oil quality and biodegradation as related to reservoir depth and source rock maturity

- Heidrun Stueck, David Houseknecht, Dieter Franke, Donald Gautier, Andreas Bahr, Stefan Ladage . . . .
Shale gas assessments - Comparison of performance-based vs. gas in place approach

- Heidrun Stueck*, Carsten Helm*, Rüdiger Lutz, Steffen Biermann*, Christian Ostertag-Henning, Andreas Bahr, Dieter Franke, Stefan Ladage . . . .
  Shale Gas and Shale Oil in Germany: In-Place assessment and technically recoverable resources
- Philipp Weniger, Martin Blumenberg, Bernhard M. Krooß, Christian Ostertag-Henning, Jürgen Poggenburg, Stefan Schlömer . . . .
  Arctic petroleum source rocks - Development of an open-system, non-isothermal pyrolysis system to investigate stable isotope specific kinetics of hydrocarbon generation

B1-04: Exploration and development of natural resource projects

- Ezzadin Najmadin Baban . . . .
  Study of the gravity data of south of Talafar - Mosul area – NE Iraq
- Bernhard Cramer, Katrin Kleeberg, Uwe Lehmann . . . .
  Ore Mountains reloaded – new exploration of ore and spar deposits in Saxony
- Fadli Faturrahman R, Andri Dian Nugraha, Rachmat Sule. . . . .
  Three-Dimensional (3-D) Attenuation Tomography in "FF" Geothermal Field
- K. Berglar, M. Blumenberg, D. Franke, M. Krüger, R. Lutz & PANORAMA team . . . .
  Hydrocarbon Potential of the European Arctic - Chances and challenges
- Hartwig Gielisch . . . .
  Coal Fires of the Jharia Coal Field/India – A national disaster endangered the Indian Coking Coal Production and the development of the most important natural resource of India
- Torsten Gorka, Stephan Peters . . . .
  Nutzung von Kohle durch untertägige Vergasung (UCG) am Beispiel von zwei aktuellen Pilotversuchen in Polen
- J. Grötsch, M.C. Pöppelreiter, H-J. Kloosterman and E. van Zeeland . . . .
  Where Models Meet Rocks – Building Capabilities through "DIGITAL GEOLOGY"
- Marcus Liebner, Jörg Neßler, Thomas Seifert . . . .
  SEM-EDX-based mineralogical, paragenetic and geochemical characterization of Nb-Ta-minerals in granites and greisen of the Sn-W-Li-deposit Zinnwald, Erzgebirge, Germany
- Florian Lowicki, Tim Horner . . . .
  Blötberget Iron Ore Project - From Resource and Mining History to Present
- R. Lutz, L. Reinhardt, A. Lückge . . . .
  Triassic source rocks in the Barents Sea – Input for hydrocarbon assessment of the European Arctic
- Philip Mittelstädt, Henry Gräßel, Carlos García Piña . . . .
  Airborne hyperspectral and geochemical mineral exploration – challenges and opportunities
- Tim Rödel, Gregor Borg . . . .
  East Greenland copper exploration: Geological features and the application of field methods around the Jameson Land basin, Greenland
- Thomas Seifert . . . .
  Comparison between the Marienberg-Pobershau, Seiffen-Hora Sv. Kateřiny and Ehrenfriedersdorf-Geyer Sn-polymetallic districts and their potential for tin resources

B2-01: Marine ore deposits

- Melissa Anderson, Mark D. Hannington, Timothy F. McConachy . . . .
  Massive sulfide accumulation along a submarine scoria cone row at the Tinakula Deposit, New Hebrides Arc, Solomon Islands
- Nico Augustin, Froukje M. van der Zwan, Colin W. Devey . . . .
  New Evidence for Increased Potential of Hydrothermal Occurrences in the Red Sea Rift
- Nikki Blaauwbroek, Wolfgang Bach, Manuel Keith, Sven Petersen . . . .
  Metalloid - noble metal relations in hydrothermal systems from the Manus Basin, Papua New Guinea
- Hannah Grant, Thomas Monecke, Sven Petersen, Mark Hannington . . . .
  Critical Metal Potential of Seafloor Massive Sulphide Deposits
- Peter E. Halbach, Andrea Koschinsky, Andreas Jahn . . . .
  The influence of water depth on concentration and fractionation of Rare Earth Elements in marine ferromanganese crusts
- John Jamieson, Sven Petersen, Mark Hannington . . . .
  Exploration and Resource Potential of the Semyenov Vent Fields, on the 13°30' Oceanic Core Complex, Mid-Atlantic Ridge
- Meike Klischies, Sven Petersen, Nico Augustin, Colin Devey . . . .
  Structural, magmatic and tectonic controls of hydrothermal venting at the Menez Gwen segment, at 37°50' N on the Mid-Atlantic Ridge
- Andrea Koschinsky, James R. Hein, Katja Schmidt, Lydia Somers . . . .
  Seamount Phosphorites as Potential Resources for Rare Earth Elements and Fluoride
- Sven Petersen, Mark Hannington, Thomas Monecke, John Jamieson . . . .
  The Global Resource Potential of Seafloor Massive Sulfides in Various Tectonic Settings
- Florent Szitkar, Sven Petersen, Fabio Caratori Tontini, Luca Cocchi . . . .
  High-resolution magnetics reveal the deep structure of a volcanic-arc related basalt-hosted hydrothermal site (Palinuro, Tyrrhenian Sea)
- S. Theissen-Krah, L. H. Ruepke, J. Hasenclever . . . .
  Anhydrite precipitation in hydrothermal systems

B2-02: Terrestrial ore deposits

- Moritz Albrecht, Insa Theresa Derrey, Ingo Horn, Axel Müller, Francois Holtz, Stefan Weyer
  UV-fs-LA-ICP-MS analyses of fluid inclusions from tin ore deposits
- Matthias E. Bauer, Thomas Seifert, Ralf Schlüter, Helmut Mischo . . . .
  In-situ bioleaching in a historical mining district – an experimental approach for the potential of strategic element extraction
- Jim Garganese, Kirsten Drüppel, Elisabeth Eiche, Javier Castro Larragoitia . . . .
  Characterization of the Au-Cu skarn deposit of the Sta. Teresa Mine, La Paz Mining District, San Luis Potosi, Mexico
- Marguerita Duchoslav, Michael A.W. Marks, Catherine McCammon, Horst Marschall, Thomas Wenzel, Gregor Markl . . . .
  Major- minor and trace element variations in tourmaline as monitors for magmatic differentiation, fluid un-mixing and associated ore precipitation

- Keynote: Hartwig E. Frimmel . . . .
  From early life to gold deposits
- H. Albert Gilg, Adrian M. Hall, Anthony E. Fallick, Frank Friedrich, Ulf B. Andersson .
  Hydrothermal clays in Fe oxide deposits of Norrbotten County, northern Sweden
- Hendrik Haneklaus, Bernhard Stöckhert . . . .
  Formation of greisen-type mineralization (Zinnwald/Cínovec, Erzgebirge) – a microstructural approach
- Julius Ludwig Jahn, Sabine Walther . . . .
  Geochemical differentiation of barite vein-type mineralization in the Ilfeld Basin, Harz Mountains, Germany
- Andreas Kamradt . . . .
  Comparative particle analysis of mineral processing products of black shale-hosted Kupferschiefer-type ore
- Dennis Kraemer, Michael Bau . . . .
  Investigating New Biogeochemical Approaches for Prospection of Concealed Metal Deposits: Enhanced Release and Fractionation of ‚Immobile' High Field Strength Elements (REY, Zr, Hf, Th, U) by Leaching in Presence of Biogenic Ligands (Siderophores)
- Marina Lazarov, Aleksandar Pačevski, Stefan Weyer . . . .
  Unravelling processes of ore formation in porphyry Cu deposit with chalcopyrite Cu isotope compositions
- Friedrich Lucassen, Wolfgang Pritzkow, Martin Rosner, Simone Kasemann . . . .
  Nitrogen and Carbon elemental and isotope chemistry in guano deposits – Pacific margin of Northern Chile
- Anette Meixner, Friedrich Lucassen, Ricardo Alonso, Benjamin Heit, Simone Kasemann
  Sr and Li isotope distribution in space and time - Salar de Pozuelos, NW Argentina
- Edith Müller-Huber, Kersten Kühn, Sebastian Schmidt, Michael Maurer, Frank Börner,
  Petrophysical, mineralogical, and geochemical investigations of a Li-Sn-W deposit – A contribution to develop a borehole probe for quantitative element determination in ores of natural deposits
- Dongmei Qi, Harald Behrens, Roman Botcharnikov, Insa Derrey, Francois Holtz . . . . . .
  A synthetic fluid inclusion study of copper solubility in NaCl-H_2O fluids at 800°C and 200 MPa
- Lisa Richter, Volker Lüders, Thomas Dittrich, Thomas Seifert . . . .
  Stable carbon isotopic composition of fluid inclusions from the Archean Bikita LCT pegmatite field
- Rolf L. Romer, Uwe Kroner . . . .
  Contrasting tectonic setting of magmatic Acadian-Variscan-Appalachian tin and tungsten mineralization
- Rolf L. Romer, Uwe Kroner . . . .
  Gondwana-links of Phanerozoic magmatic tin and tungsten mineralization
- Bernhard Schulz, Sabine Haser . . . .
  The ilmenite-pseudorutile-leucoxene alteration sequence in placer sediments in the view of automated SEM mineral liberation analysis

- Volker Steinbach, Ulrich Schwarz-Schampera . . . .
Initiative „Research Assignments in the Field of Ore Deposit Research" – what has been achieved?
- Georgios Alevizos, Athanasios Apostolikas, Antonios Stratakis . . . .
Mineralogical and ore-petrographic investigation of the nickeliferous lateritic deposit of Hudenisht in Pogradec area (Albania)
- Philipp Weis . . . .
The physical hydrology of porphyry copper systems

B2-03: Scenarios for the Raw Material Supply of the Far Future

- Keynote: Lawrence Cathles . . . .
The Earth has the energy and mineral resources to indefinitely sustain 10.5 bn at an EU standard in an environmentally acceptable way
- Keynote: Jens Gutzmer . . . .
EIT Raw Materials - perspectives for research on raw materials in Europe
- Thorben Amann, Jens Hartmann . . . .
Application of agrominerals from selected rocks to supply geogenic nutrients via Enhanced Weathering
- Wolfgang Jacoby . . . .
Limits of Earth
- Katrin Kärner, Herwig Marbler, Peter Buchholz, Thomas Oberthür, Malte Junge . . . . .
PGE resource potential of mine tailings and oxidized ores in the Bushveld Complex, South Africa
- Martin Schoell, Ralf Tappert, Karlis Muehlenbachs, Alexander P. Wolfe, Ryan C. McKellar
A New Atmospheric pO_2 *record allows the assessment of quantities of organic carbon deposited in episodic organic carbon burial events (OBE) during the Phanerozoic*
- Friedrich-W. Wellmer*, Volker Steinbach . . . .
Is a Road to Sustainable Use of Non-Renewable Mineral Raw Materials possible?

B3-01: Operational Earthquake Forecasting, Early Warning and Real-Time Risk Reduction

- Piero Brondi, Matteo Picozzi, Antonio Emolo, Aldo Zollo, Marco Mucciarelli, ...
Rapid Estimation of Macroseismic Intensity for On-site Earthquake Early Warning in Italy from Early Radiated Energy
- Lunio Lervolino, Eugenio Chioccarelli . . . .
Operational Earthquake Loss Forecasting: a Retrospective Analysis of some Italian Seismic Sequences
- Stefano Parolai, Joern Lauterjung, Dino Bindi, Massimiliano Pittore, Marc Wieland, Toby Boxberger, Marco Pilz, Annamaria Saponaro, Shahid Ullah, Bojana Petrovic, Michael Haas, Kevin Fleming . . . .
Activities of the Centre for Early Warning Systems, GFZ Potsdam
- Massimiliano Pittore, Marc Wieland, Michael Haas, Stefano Parolai, Kevin Fleming . . .
On-demand and near-real-time earthquake impact forecasting for Central Asia: the CARAVAN tool

B3-03: Geological signatures of extreme events

- Heinrich Bahlburg, Michaela Spiske, ...
  Styles of early diagenesis and the preservation potential of onshore tsunami deposits - a re-survey of Isla Mocha, Central Chile, two years after the February 27, 2010 Maule tsunami
- Marc Ostermann, Anja Dufresne . . . .
  Rockslide dams in the European Alps
- Anja Dufresne, Christoph Prager, Annette Bösmeier . . . .
  Morphology and sedimentology of a large carbonate rockslide – rock avalanche deposit (Tschirgant, Austrian Alps)
- Gösta Hoffmann, Klaus Reicherter, Christoph Grützner, Frank Preusser . . . .
  The geological signatures of extreme wave events within the archaeological record – examples from the coastline of the Arabian Sea.
- Li Li, Jürgen Böhner . . . .
  Coastal storm surge flooding impact under different climate scenarios in Pearl River Delta
- B.-G. Luehr, A. Anggraini, T. R. Walter , R. Wang, S. Parolai, J. Zschau, P.J. Prih Harjadi, Kirbani Sri Brotopuspito . . . .
  The role of volcanic deposits related to the destructive Bantul Earthquake 2006
- Keynote: Anselm Smolka . . . .
  Managing the risk from natural perils
- David Völker, Achim Kopf, Matt Ikari, Sebastian Trütner, Jörg Bialas . . . .
  The Reloca Slide offshore Central Chile - a revision based on geotechnical sliding plane characterization and tsunami modeling
- Wei Li, Shiguo Wu, David Völker, Fang Zhao, Achim Kopf . . . .
  Evolution of the Baiyun Slide Complex and stability of the unfailed slopes on the northern margins of the South China Sea
- Janusz Wasowski, Fabio Bovenga . . . .
  Toward better exploitation of satellite multi-temporal interferometry in landslide hazard research

B4-01: Topography, Climate and Human Habitat

- Markus Böttle, S Kriewald, L Costa, Diego Rybski, Jürgen Kropp . . . .
  Coastal Floods Threatening European Cities: a Large Scale Damage Function Assessment
- Ramana Venkata Gudipudi, Till Fluschnik, Anselmo García Cantú Ros . . . .
  City Density and CO_2 Efficiency
- Keynote: Martin Medina-Elizalde . . . .
  Pervasive drought during the fall of the Classic Maya Civilization: are we better prepared?
- D. Pentari, A. Turnavitou, G. Alevizos, E. Repouskou, K. Komnitsas . . . .
  Synthesis of nanoscale iron, for waste water treatment, using red mud as an iron precursor
- Martin Wattenbach, Richard Redweik, Stefan Luedtke, Ben Kuster . . . .
  Uncertainties in city greenhouse gas inventories
- Steven Zierold, Lars Angler, Sven Dörfer, Lothar Viereck . . . .
  Mapping of the background-gamma-dose-rate in the urban area Erfurt, Thuringia – Germany

B4-03: Transforming the Geo-Biosphere by Humanity: Agriculture and Water Management

- Iskandar Abdullaev . . . .
  Transformastions in water sector in Central Asia: from hydraulic mission to socio-political control
- Christine Bismuth, Hans-Georg Frede, Hermann Kreutzmann, Oliver Bens, Reinhard F. Hüttl
  Major Water Engineering Projects as key driver for the transformation of landscapes: An analysis of case studies from the Fergana Valley and the Lower Jordan Valley
- Christopher Conrad, Fabian Löw, John P.A. Lamers . . . .
  Satellite remote sensing-based indicators for an improved understanding of irrigation water use, and agricultural area dynamics in the Aral Sea basin
- Keynote: Giuliano Di Baldassarre . . . .
  Socio-hydrology: capturing the interplay between societies and floods
- Werner Gerwin, Reinhard F. Hüttl, Oliver Bens, Wolfgang Schaaf, Christoph Hinz . . . .
  Observing ecosystem interactions and feedbacks – the Chicken Creek Landscape Observatory
- Philipp Huttner, Markus Disse . . . .
  Regionalization of groundwater levels along the Tarim River in North West China as precondition for a sustainable management of water resources
- Goran Kniewald . . . .
  The geological and tectonic structure of the Krka river estuary - integrated coastal zone management issues of the Adriatic Sea
- Gunnar Lischeid, Tobias Hohenbrink, Christian Lehr, Steven Böttcher, Jörg Steidl, Christoph Merz, Uwe Schindler, Ralf Dannowski, Thomas Kalettka . . . .
  Multiple causes, multiple effects: Forensic hydrology approaches to elucidate complex relations between drivers and effects in landscape hydrology and biogeochemistry

B5-01: Numerical Simulation for geological underground utilization : Linking geological information to process modelling

- Mauro Cacace, Guido Blöcher, Johannes Aichele, Norihiro Watanabe, Florian Wellman, Antoine Jacquey . . . .
  Linking geology to numerical modelling: application for geothermal reservoir applications
- Keynote: Guillaume Caumon . . . .
  Accurate geological modeling for subsurface applications and the need for uncertainty assessment
- Jessica Freymark, Judith Sippel, Magdalena Scheck-Wenderoth, Kristian Bär, Manfred Stiller, Johann-Gerhard Fritsche, Matthias Kracht . . . .
  Structure and thermal field of the Upper Rhine Graben – a lithospheric-scale 3D model
- Nora Goretzki, Nimrod Inbar, Christian Siebert, Eliyahu Rosenthal, Michael Schneider, Fabien Magri . . . .
  Inverse problem of large-scale coupled fluid flow and heat transport using FEPEST: The Tiberias Basin example
- Mauro Cacace, Judith Sippel, Magdalena Scheck-Wenderoth . . . .
  Geological characterization and modeling of the Berlin sub-sedimentary basin

- Antoine B. Jacquey, Mauro Cacace, Guido Blöcher, Norihiro Watanabe, Magdalena Scheck-Wenderoth . . . .
Thermo-Hydro-Mechanical numerical modelling for faulted geothermal reservoir systems: case study of the Groß Schönebeck reservoir
- Markus Adams, Elena Tillner, Thomas Kempka, Martin Feinendegen, Martin Ziegler *An innovative hydro-mechanical coupling approach for fault reactivation*
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Flexible simulation framework to couple processes in complex 3D models for underground utilization assessment
- Thomas Kempka, Marco De Lucia, Michael Kühn . . . .
Integrated long-term site behavior assessment in geological underground utilization by coupled thermo-hydro-mechanical-chemical numerical simulations
- Elco Luijendijk, Mark Person . . . .
Quantifying permeability and modelling fluid and heat flow in an evolving sedimentary basin
- Fabien Magri, Sebastian Möller, Nimrod Inbar, Christian Siebert, Peter Möller, Eliyahu Rosenthal, Michael Kühn . . . .
Convective regimes in the Tiberias Basin, Israel/Jordan, and their consequences on relic brine migration
- Jan Niederau, Anozie Ebigbo, Gabriele Marquart, Ivano Dini, Martin Thorwart, Wolfgang Rabbel, Renate Pechnig, Ruggero Bertani, Christoph Clauser . . . .
How minor changes in a geological model can affect simulation results: An example of a geothermal reservoir in Tuscany, Italy
- Christopher Otto, Thomas Kempka . . . .
Thermo-mechanical simulations of rock behavior in underground coal gasification show negligible impact of temperature-dependent parameters on permeability changes
- Anna M. Przybycin, Magdalena Scheck-Wenderoth, Michael Schneider . . . .
The origin of deep geothermal anomalies in the German Molasse Basin assessed by 3D numerical model of coupled fluid flow and heat transport
- Philipp Schendt, Mark Lindsay, J. Florian Wellmann . . . .
Understanding the effect of seismic uncertainty on geological models
- Elena Tillner, Thomas Kempka . . . .
Comparison between one-way and two-way hydro-mechanical coupling for assessment of fault fluid flow by numerical simulations
- Victoria Unger, Thomas Kempka . . . .
Hydro-mechanical simulations demonstrate wellbore system integrity during entire lifecycle at the Ketzin pilot site
- Hui Wang, J. Florian Wellmann . . . .
Pattern-based analysis of subsurface heterogeneities and its application to generate spatial property distributions for process simulations

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- Stephanie Lerm, Rona Miethling-Graff, Markus Wolfgramm, Kerstin Rauppach, Andrea Seibt, Hilke Würdemann . . . .
Influence of iron- and sulfur-oxidizing bacteria on the operation of a geothermal cold storage system in the North German Basin: impact on well injectivity and filter lifetime
- Franz May . . . .
How can environmental monitoring date be used in the Risk Management of CO_2 storage sites?
- Christian Mueller, Gabriela von Goerne, Project Group . . . .
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- Karsten Obst, Sabine Matting, André Deutschmann, Juliane Brandes . . . .
TUNB-Projekt (TP3): Recherche geologischer und geophysikalischer Daten und digitale Aufbereitung für ein 3D-Landesmodell Mecklenburg-Vorpommern
- Katrin Lademann, Thomas Liebsch-Dörschner, Petra Offermann . . . .
Geological 3D modeling of the deep underground in Schleswig-Holstein and Hamburg (north german basin). – A part of the joint project TUNB (Tieferer Untergrund Norddeutsches Becken)
- Holger Ott, Jeroen Snippe, Sjaam Oedai . . . .
Multiphase flow and unstable calcite-dissolution patterns from the core to reservoir scale
- Nicole Pastrik, Katharina Bairlein . . . .
Petrophysical and geoeletrical investigations on analogue outcrops of the South German Malm
- Markus Peltz, Georg Grathoff, Laurence N. Warr, Karsten Obst . . . .
The influence of CO_2-charged brine on mineralogy and pore space of caprocks: An XRD and FIB-SEM study on Toarcian claystones
- Lukas Pollok, Markus Hölzner, Stephanie Fleig, Jörg Hammer, Sascha Gast, Cornelia Riesenberg, Gabriela von Goerne, Sabine Donadei, Péter László Horváth, Dirk Zander-Schiebenhöfer, Dirk Zapf, Kurt Staudtmeister, Reinhard Rokahr . . . .
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- Julia Rienäcker, Sabine Sattler, ...
How to improve a large-scale geological 3D model? -The TUNB3D-NI project-
- Yvonne Röbbert, Amrita Bhattacharyya, Luca Loreggian, Thomas Borch, Nadja Pierau, Rizlan Bernier-Latmani, Stefan Weyer . . . .
Biotic and abiotic $^{238}U/^{235}U$ fractionation – applications to bioremediation and U ore roll-front deposits
- Sabine Sattler, Julia Rienäcker . . . .
New techniques to create a 3D structural model of the deeper underground in the North German Basin in Lower Saxony
- Christoph Jahnke, Andreas Simon, Thomas Höding . . . .
Challenges within the project TUNB
- Stephan Steuer, Fabian Jähne-Klingberg, Frithjof Bense, Marco Wolf . . . .
Are you sure? – Visualizing geological uncertainties in structural 3D models
- Victor Tatarinov, Vladislav Morozov, Tatiana Tatarinova . . . .
Prediction geodynamic safety in the disposal of high-level radioactive waste in geological formations

- Gabriela von Goerne, Christian Müller, Project Group . . . .
  Project TUNB - a 3D Model of the North German Basin

- Mario Wipki, Axel Liebscher, Fabian Möller, Bernhard Prevedel, Stefan Lüth, Cornelia Schmidt-Hattenberger, Martin Zimmer, Ronald Conze, Thomas Kempka, Tanja Kollersberger . .
  CO_2-Storage – from Site Assessment to the Post-Closure Phase

- Jan Lennard Wolf, Dorothee Rebscher, Jacob Bensabat, Auli Niemi . . . .
  Reactivity vs. transport: Geochemical impact of SO_2 in CO_2 flue gas and its spatial dissolution pattern in the reservoir system

- Marco Wolf, Stephan Steuer, Frithjof Bense, Fabian Jähne-Klingberg . . . .
  Seismo-stratigraphic subdivision of the Triassic in the Central German North Sea

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- Robert Balzer, Ute Bauer, Anna-Maria Welsch, Harald Behrens . . . .
  Investigation on hydrous phosphate glasses

- Ute Bauer, Harald Behrens, Michael Fechtelkordb, Stefan Reinsch, Joachim Deubener
  Water- and boron speciation in hydrous soda-lime borate glasses

- Keynote: Georges Calas, Laurence Galoisy, Laurent Cormier, Gérald Lelong . . . .
  Linking optical and structural properties of glasses

- Katja Gröger, Christian Selleng, Patrick Fontana, Birgit Meng . . . .
  Effect of 90 $^\circ$C thermal treatment on Ultra High Performance Concrete

- Otto Krause, Helga Kemnitz . . . .
  Behaviour of spinel-forming DVM using crucible induction furnaces. A case study on material failure

- Holger Kletti, Bernd Möser, Christiane Rößler . . . .
  Electron backscatter diffraction (EBSD) - an additional technique for a more reliable estimation of alkali reactivity potential of rock aggregates in concretes

- Moritz Liesegang, Ralf Milke . . . .
  Photonic structures in natural amorphous silica - Sedimentation and Replacement

- Dawid Murawski, Sebastian Roß, Harald Behrens, Martin Lerch . . . .
  Ionic mobility in lithium silicate glass powder during compaction

- Claudia Nickel, Florian Mittermayr, Petra Bachhuber, Franziska Rümmele, Bernhard Fercher, Dietmar Klammer, Joachim Juhart . . . .
  Performance oriented durability testing of eco-concrete for the precast industry

- Roland Pierkes . . . .
  Automated quantitative XRD in the quality control of the cement production process

- Roland Pierkes, Matthias Böhm . . . .
  Evaluation of Portland Cement CLINKER with optical microscopy – Case Studies

- Stefan Reinsch, Christian Roessler, Ute Bauer, Ralf Müller, Joachim Deubener, Harald Behrens
  Water, the other network modifier in borate glasses

- E. Rigo, K. Unterderweide, D, C. H. Rüscher . . . .
  Vibrational spectroscopic investigations of heated concrete

- C.H. Rüscher, W. M. Kriven, L. Schomborg, Z. Assi, H. Tchakoute, J. Temuujin, F. Jirasit, L. Lohaus, J. C. Buhl . . . .
Geopolymers, additions to Portland-cement and hosting hydrogen storage materials
- Achim M. Schaller, Detlev Götz, Herbert Pöllmann . . . .
Three-dimensional analysis of highly porous building and ceramic materials with computed tomography (CT) on laboratory X-ray diffractometers
- Christian Selleng, Patrick Fontana, Birgit Meng . . . .
Thermal Treatment of Ultra-High Performance Concrete
- Sebastian Simon, Christian Selleng, Birgit Meng . . . .
A new sample holder for fast xrd investigation on uhpc
- Veit Steinbauer, Maco Herwegh, Theo Bühler, Renzo Raso, Josef Kaufmann, Roger Zurbriggen
Understanding hail damage of External Thermal Insulation Composite System (ETICS)
- Georgios Triantafyllou, Georgios Alevizos, Antonios Stratakis . . . .
Experimental study of the carbonation process in natural hydraulic lime binders
- Anna-Maria Welsch, Harald Behrens, Franziska Fritsche, Ingo Horn . . . .
Mobility of Lithium in borate glass networks
- Daniel Werner, Birgit Meng . . . .
The damage potential of alkali-silica reaction by using sand and fine gravel grain sizes for various reactive aggregates
- Daniel Werner, André Gardei, Sebastian Simon, Birgit Meng . . . .
Microscopic and microchemical investigation of building materials affected by alkali-silica reaction

B6-02: Archaeometry, monument conservation and dimension stones

- K. Bente, R. Wirth, Ch. Berthold, A. Schreiber, M. Keuper . . . .
Microstructural and chemical mechanisms of the transformation of red (corallium rubrum) to white corals
- Gerald Buck, Isabel Zutterkirch, Christoph Lauer, Christoph Berthold, Patrick Schmidt, Klaus G. Nickel . . . .
Materials Science of the Middle Stone Age: Heat treatment of flint and silcrete
- Axel Gerdes, Klaus Bente, Christoph Berthold . . . .
Origin of bead decorations of celtic fibulae: Constraints from in-situ Sr and B isotope composition
- R. Gradmann, C. Berthold, U. Schüssler . . . .
Indentification of coloring agents in glazes of Islamic tiles and tableware ceramic from the 10th -18th century using EMPA and μ-XRD2
- Jochen Lepper, Angela Ehling . . . .
Wesersandstein: Building, dimension and ornamental stone, used yesterday and today
- Moslem Mishmastnehi, Ralf Milke . . . .
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Decorative Stones in Berlin: Monument Conservation and Public Education

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- Nadja Wichtner, Christoph Berthold, Klaus G. Nickel . . . .
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- Geerke H.Floor, Ignasi Queralt, Manuela Hidalgo, Eva Marguí . . . .
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  Characterization of amorphous contents in brown coal fly ash
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  New developments in microanalytical techniques for sulfur isotope analysis
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  Stable Vanadium isotope analyses by femtosecond LA-ICP-MS, and solution MC-ICP-MS
- Frank Tomaschek, Alexander Heuser, Alexander Nemchin, Thorsten Geisler . . . .
  Replacement of uraniferous opal by chalcedony and disturbance of the U-Pb system

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  Marine Minerals Database and Information System at GEOMAR
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- Mike Sips, Doris Dransch, Patrick Köthur . . . .
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- Stefan Baltruschat, Michael Fritz, Jaroslav Obu, Hugues Lantuit, Matthias Hinderer . .
  Soil organic matter characteristics in surficial permafrost sediments on Herschel Island, Yukon Territory, Canada
- Jean Cors, Ulrich Heimhofer, Thierry Adatte, Stefan Schouten . . . .
  The neglected story of Oceanic Anoxic Event 2 in the terrestrial realm: A high-resolution multi-proxy study on the mid-latitude Cassis Section in Southern France
- Ingmar Frese, Eckhardt Stein, Thomas Kenkmann . . . .
  Investigation of the Western Badenweiler-Lenzkirch-Zone with respect to sedimentological, structural and economical aspects
- Annette Leuschner, Frank Mattern, Stephan van Gasselt . . . .
  Alluvial Fans of the Oman Mountains: Morphometry and Hydrodynamic Characteristics
- Adrian Linsel, Matthias Hinderer, Jens Hornung, Kristian Bär . . . .
  Well-logs beneath Messel penetrating the post-Variscan unconformity (Sprendlinger Horst)
- Jürgen Mutzl, Olaf K. Lenz, Günter Landmann, Matthias Hinderer, ...
  Palynology and micropalaeontology of Holocene lacustrine sediments of the Layla Lakes in central Saudia Arabia and implications for palaeoenvironment and palaeoclimate
- Linda Prinz, Andreas Schäfer, Torsten Utescher, Tom McCann, Sven Asmus, Peter Lokay
  Coastal high-energy Neurath Sand in Cenozoic-age Lower Rhine Basin (W Germany)
- Linda Prinz, Tom McCann, Andreas Schäfer, Torsten Utescher, Sven Asmus, Peter Lokay
  Sand bodies in the Frimmersdorf Lignite Seam, Garzweiler open-cast mine, Lower Rhine Basin
- Michaela Ridder, Stefan Back, Johannes Belde, Lars Reuning . . . .
  2D Seismic-Reflection Analysis and 3D Reconstruction of the Development of Cenozoic Carbonate Systems along the Lynher-Lombardina Structure, Browse Basin, Northwest Australia
- Sophia Rütters, Tom McCann . . . .
  An overview of Neogene-age deposition within the Vera Basin, SE Spain
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  Pre-Messinian Salinity Crisis sedimentary successions of the southern Vera Basin, SE Spain
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  Controls on intramontane 'cool'-spring limestones, Austria (Eastern Alps): Implications of a quantitative approach.
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  Petrography, Provenance and Diagenetic study of sandstone from Murree Formation, Peshawar Basin, NW Pakistan
- El Hadj Youcef Brahim, Mohamed Chadi, Rami Djeffal . . . .
  Sedimentary Dynamics And Structural Evolution Of The Constantinois Platform During The Cretaceous

- Fanfan Zuo, Ulrich Heimhofer, Stefan Huck, Jochen Erbacher . . . .
  Carbon-isotope chemostratigraphy and sedimentary characteristics of Kimmeridgian shallow-water deposits in the Lower Saxony Basin of northern German

C5: Probing and Monitoring the Earth by Scientific Drilling

- Michael Abratis, Thomas Wiersberg, Marco Görlitz, Willi A. Brand, Lothar Viereck, Nina Kukowski, Kai Uwe Totsche, INFLUINS Scientific Drilling Team . . . .
  Geochemistry of drilling mud gas from the INFLUINS Scientific Deep Drilling into the Thuringian Syncline, Germany
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  Gas hydrate dynamics of pockmarks at continental margins – Results from MeBo sea floor drilling offshore Nigeria
- Jörg Geldmacher, Maria Luisa G. Tejada, Folkmar Hauff, Kaj Hoernle, Dieter Garbe-Schönberg, Ken Heydolph . . . .
  Late stage evolution of Shatsky Rise volcanism and possible connection to Hess Rise (NW Pacific)
- Ulrich Harms, Henning Lorenz . . . .
  Caledonian thrust sheet emplacement along basal mylonites in the COSC-1 borehole in Central Sweden
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  A novel sediment coring instrument combining classical piston corer with hydraulic downhole hammer
- A. Hüpers, S.A. Kasemann, A.J. Kopf, A. Meixner, T. Toki, R. Shinjo, C.G. Wheat, C-F. You
  Boron isotope geochemistry of pore water fluids sampled across the active Nankai Trough subduction zone forearc
- Keynote: Christopher Juhlin, Henning Lorenz, Bjarne Almqvist, David Gee, Christophe Pascal, Chin-Fu Tsang, Karsten Pedersen, Nick Roberts, Jan-Erik Rosberg . . . .
  Exploration of the Caledonian Mountain Belt in Scandinavia by Deep Drilling
- Felix Krauß, Helge Simon, Peter Hedin, Rüdiger Giese, Stefan Buske, Christopher Juhlin, Henning Lorenz . . . .
  Borehole seismic in the ICDP borehole COSC-1
- G. Wefer, G. Bohrmann, D. Hebbeln, K. Huhn, G. Martinez-Mendez, M. Mohtadi, T. Freudenthal
  Scientific drilling in the deep sea with the sea floor drill rig MARUM-MeBo

C6: 3D Geology and Geoinformation – Modelling, Data Storage and Distribution

- Hannah Budde, Christian Hoselmann, Rouwen Lehné, Gudrun Radtke, Heiner Heggemann, Andreas Hoppe . . . .
  3D Modelling of the Quaternary and Tertiary units as a key for sustainable groundwater management in an urban area (Frankfurt, Germany)
- Humaad Ghani, Ehtisham Javed, Irum Yousuf . . . .
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- Michael Nolde, Malte Schwanebeck, Ehsan Biniyaz, Rainer Duttmann . . . .
  Subsurface Spatial Planning: Development of a 3-D online tool for the evaluation of potential underground energy storage sites
- Stefan Rautenberg, Thomas Schmitz, Rouwen Lehné, Ivo Sibul . . . .
  Challenges and chances of geological 3D-modelling – a case study for the northeastern part of Estonia
- Hanna Reinheimer, Rouwen Lehné . . . .
  Geological 3D-Modelling as a perspective for mining planning in open pit mines
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  Brandenburg 3D - delivering geological information to the public
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  First steps towards a 3D structural model of the Southern Baltic Sea, Northeast of Rügen Island
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  3D-Mapping of sedimentary and tectonic structures applying "Terrestrial LIDAR" and "Structure from Motion (SfM)" in view of developing multi-scale digital geologic models
- Peter Wycisk, Lars Schimpf . . . .
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  Glass laser engraving 3d-models – Innovative techniques of visualization

Scientific Abstracts by Last Name

Transformations in water sector in Central Asia: from hydraulic mission to socio-political control

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Oral in Session B4-03

This paper presents the analysis of historical transformation of water management in Central Asia with the specific focus on Uzbekistan. The period of the analysis is from mid ages to contemporary times, with different political, social and economic settings in the framework of theory of transformative capacity of institutions. Empirical evidence suggests that the approach of the hydraulic mission has not changed dramatically over the years, but transformed into various forms of control on water management. In recent decades, integrated water resources management paradigms are gaining momentum, while the traditional, state–centric, hydraulic mission approach is losing its attractiveness in the arid Central Asian region. The state-centric model of water management persists in the region with clear signs that water management is still more under socio-political control.

Geochemistry, petrography and radiometric ages of the Heldburg Phonolite: Implications on magma mixing and mingling

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Poster in Session A2-04

The Cenozoic Central European Volcanic Province (CCEVP) is characterized by mafic volcanic rocks whereas differentiated magmatic rocks such as trachyte and phonolite are volumetrically subordinate (exceptions are the East Eifel and the Rhön volcanic fields). Within the volcanic field of the 'Heldburg dike swarm' (Heldburger Gangschar) the phonolite of the Burgberg near Heldburg represents the only known occurrence of differentiated magmatic rocks. However, the Heldburg phonolite is famous foremost for containing mantle xenoliths (spinel lherzolite). Former studies proposing a cogenetic relationship between the phonolite and the peridotites concluded that the phonolite magma must have evolved under upper mantle conditions. Here we present petrographic and geochemical evidence for magma mixing and mingling in the Heldburg phonolite melt due to the intrusion of mantle derived basanitic magma which is exposed today as dikes at the foot of the Heldburg Burgberg. During this process of incipient magma mixing the mantle xenoliths were introduced into the phonolite melt as they all contain rims of basanitic magma. Extensive mingling features (e.g., schlieren layers, load casts, flame structures, mafic enclaves) are developed, indicating that the basanite as well as the zoned phonolitic body were melts at the time of mixing. These petrographic

and geochemical indications of two coeval melts of different composition are substantiated by $^{40}Ar/^{39}Ar$ dating revealing identical ages of ca. 15 Ma.

Geochemistry of drilling mud gas from the INFLUINS Scientific Deep Drilling into the Thuringian Syncline, Germany

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Oral in Session C5

Drilling mud gas was monitored and sampled during standard rotary and core drilling of the 1179 m deep INFLUINS borehole EF-FB 1/12 to gain information on the composition of gases and their distribution at depth of the Thuringian Syncline (Germany). The total abundance of formation gases in drilling mud was low. Methane, helium, hydrogen and carbon dioxide were detected in drilling mud when the drill hole encountered gas-rich strata, reaching maximum concentration of 55 ppmv He, 1400 ppmv of CH_4, 400 ppmv of hydrogen and 1.1 vol-% of CO_2. We therefore consider the INFLUINS borehole to be relatively dry. The drilling mud gas composition is linked with the drilled strata: Buntsandstein and Muschelkalk show different formation gas composition and we therefore conclude that they are hydraulically separated. The correlation between hydrogen and helium and the high relative helium abundance rules out any artificial origin of hydrogen and suggest a radiolytic origin. Ratios $CH_4/(C_2H_6/C_3H_8)$ <50 imply that hydrocarbons derive from thermal degradation of organic matter. Stable isotope studies of carbon and hydrogen yield $\delta^{13}C$ CH_4 ranging from -26.3‰ to -40.5‰ and δD CH_4 ranging from -109‰ to -268‰. This points out to a thermogenic instead of a biogenic source for the methane. Abundances of all noble gases and isotope ratios of He, Ne and Ar were determined on five samples. While Ne and Ar isotope ratios for all samples are indistinguishable from air, $^3He/^4He$ ratios are always lower than air, revealing the presence of a deep helium source in all samples. Two samples from shallower depth yield air-corrected $^3He/^4He$ ratios $\leq$0.03 Ra typical for radiogenic helium production in the crust. For two samples from greater depth, slightly higher air-corrected $^3He/^4He$ ratios of 0.188 $\pm$ 0.076 Ra and 0.220 $\pm$ 0.058 Ra, respectively, were observed, indicating small contributions of non-radiogenic helium.

An innovative hydro-mechanical coupling approach for fault reactivation

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Poster in Session B5-01

Estimating the efficiency and sustainability of underground utilization requires an integrated risk assessment approach, considering the occurring coupled processes, i.e., the potential reactivation of existing faults. In this context, hydraulic and mechanical parameter uncertainties have to be considered and quantified to elaborate reliable environmental assessments. Consequently, the required sensitivity analyses consume significant computational time due to the high number of realizations that have to be carried out to assess all relevant parameter uncertainties. Due to the high computational costs of two-way coupled simulations in large-scale 3D simulations, these are not applicable for the purpose of risk assessments. Hence, an innovative approach for a hydro-mechanical two-way coupling is introduced based on a quasi-two-way coupling. This approach determines the evolution of volumetric strain in representative fault elements using a preliminary single phase flow simulation considering a specific pore pressure distribution and one set of hydro-mechanical parameters. The development of volumetric strains is then approximated by linear functions for a reference pressure at the fault base. The resulting functions are directly implemented into a multiphase flow simulator to carry out the scheduled quasi-coupled simulations. Hereby, the iterative parameter exchange between the multiphase and mechanical simulators is omitted, since the update of porosity and permeability is controlled by one reference pore pressure at the fault base. The suggested procedure is capable to significantly reduce the computational time required for coupled hydro-mechanical simulations in risk assessments.

The influence of mantle phase transformations on the slab dynamics

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Oral in Session A4-01

Seismic studies reveal a large range of subducting morphologies. Most notable are the variations near the base of mantle transition zone, where some slabs seem to penetrate straight into the lower mantle, whereas others seem flatten to form stagnate slabs. The dynamics of cold subducting slabs are mainly controlled by negative thermal buoyancy forces and by buoyancy anomalies due to density contrasts of the different mineralogical phases However, mineral physics studies showed that due to extremely low transformation rates, low-pressure olivine and pyroxene may potentially persist like metastable phases in subduction zones over large volumes and to great depths. A self-consistent subduction model has been used to investigate the influence of metastable phases on the dynamics of subducting oceanic lithosphere, and the results show that metastable pyroxene affects slab buoyancy at least as much as olivine metastability. However, unlike metastable olivine,which can inhibit slab penetration in the lower mantle only for cold, old, and fast slabs, metastable pyroxene is likely to also affect sinking of relatively young and slow slabs.

Links between morphology and metabolism of modern and Archean microbial communities

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Keynote in Session A4-05

The Early Archean rock record provides ample evidence for microbial communities that flourished in the photic zone of shallow marine environments; ranging from well-preserved microbial mats present in the 3.2 Ga-old Moodies Group (Barberton Greenstone Belt, South Africa) to conical stromatolites present in the 3.4 Ga-old Strelley Pool Chert (Pilbara Craton, Australia). However, the communal complexity and metabolic activity of these microbial ecosystems remain highly debated. Considering the limited preservation of Archean microfossils and lack of associated biomarkers, the analysis of microbial mat morphologies and stromatolite growth habits becomes even more relevant for unlocking the nature of these ancient ecosystems. Morphological analysis of modern microbial mats (e.g. Bahar Alouane, Tunisia) and microbialites (e.g. Lago Sarmiento, Chile) as well as the study of laboratory-grown cyanobacterial mats and numerical modeling of microbialite growth indicate a high degree of structural similarity between modern and Archean specimens. If the argument of morphological analogy can be extrapolated to metabolic similarity, it can be concluded that Early Archean coastal habitats were populated by complex photosynthetic microbial communities.

Ice-load induced salt tectonics controlled crestal collapse graben evolution – Instances from the Southwestern Baltic Sea

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Marine high-resolution multi-channel seismic data from the Eckernförde Bay in the SW Baltic Sea show two major NNW-SSE striking faults above a salt diapir that evolved above eastern Glückstadt Graben faults. These normal faults are parallel and dip in opposing directions towards the core of an anticline, forming a crestal collapse graben above the crest of the salt anticline. Fault displacement proves that the crestal graben evolved mainly in the Cenozoic. The faults partly pierce the surface and are consequently active. The glacial erosional unconformity between the major faults is concave upwards and dissected by faults, implying that the Quaternary thin-skinned extension in the crestal graben pursued. A High-resolution P-wave seismic data reveal asymmetric and irregular normal and reverse faults atypical of thin-skinned extensional subsidence. Numerical modelling suggests that the recent tectonic overprinting of Pleistocene sediments results from differential loading by advancing ice-sheets, which squeezes salt into the salt diapir and causes diapir rise. During complete ice coverage the entire diapir is pushed down but rises again during ice retreat. The resulting absolute vertical displacement is low due to the repeated reversals of the sense of movement. Beside the deformation of Pleistocene sediments we attribute the reactivation of the crestal graben faults to ice-load induced salt movements. Ice-marginal uplift provides favourable conditions for the observed push-moraine formation, while subglacial subsidence of salt structures will enhance erosion and contribute of tunnel-valley incision as in the village of Surendorf. We explain the generation of the major collapse-faults in the upper crust as a consequence of ice-load induced salt tectonics that occurred by reactivating of basement fault. Thus, the rise of the diapir and the supra-salt collapse-faults were reactivated during the Pleistocene ice advances.

Ice-load Induced Tectonics Controlled Tunnel Valley Evolution – Instances from the Southwestern Baltic Sea

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Advancing ice sheets have a strong impact on the earth's topography. For example, they leave behind an erosional unconformity, bulldozer the underlying strata and form tunnel valleys. The conceptual models of the reactivation of faults within the upper crust, due to the ice sheets' load, are also established. However, this phenomenon is rather under-explored. Here, we propose a causal link between ice-load induced tectonics, the generation of near-vertical faults in the upper crust above an inherited deep-rooted fault and the evolution of tunnel valleys. The Kossau tunnel valley in the SW Bay of Kiel was surveyed by means of high-resolution multi-channel seismic and echosounder data. It strikes almost S to N and can be mapped over a distance of ca. 50 km. It is 1200–8000 m wide with a valley of up to 200 m deep. Quaternary deposits fill the valley and cover the adjacent glaciogenic unconformity. A near-vertical fault system with an apparent dip angle of $>80^\circ$, which reaches from the top Zechstein upwards into the Quaternary, underlies the valley. The fault partially pierces the seafloor and growth is observed within the uppermost Quaternary strata only. Consequently, the fault evolved in the Late Quaternary. It is associated with an anticline that is between 700 and 3000 m wide and about 20–40 m high. We suggest that these structures formed as a consequence of the differential ice-load induced tectonics above an inherited deep-rooted sub-salt fault related

to the Glückstadt Graben. Lateral variations in the ice-load during the ice sheet's advance caused differential subsidence, thus rejuvenating the deep-rooted fault. As a result, the inherited fault propagated upwards across the Zechstein and post-Permian overburden and further grew during the ice sheet's retreat. The developing fault and anticline system under the ice sheet created a weakness zone that facilitated erosion by pressurized glacial and subglacial melt-water, as well as by the glaciers themselves.

UV-fs-LA-ICP-MS analyses of fluid inclusions from tin ore deposits

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Oral in Session B2-02

The transport and enrichment of metals in the earth crust is under control of magmatic and hydrothermal fluids. LA-ICP-MS analyses of fluid inclusions from ore deposits and controled HP/HT experiments may provide information about the mechanisms resulting in metal enrichment in ore forming fluids.[1] With a novel analytical method composed of a UV-fs-LA-SF-ICP-MS in combination with a heating-freezing cell [2], fluid inclusions from different tin-bearing granites have been analysed. By comparing samples from tin granites of the Altenberg-Teplice caldera (Erzgebirge), representing F-rich fluids, and Cornwall (UK), representing Cl- and B-rich fluids [3], we expect to get new insights about the transport mechanisms of Sn and W. We investigated fluid inclusions from the granites and the mineralized veins to get new information about both, the magmatic pre-enrichment of metals and the hydrothermal evolution of ore forming fluids. Fluid inclusion trace element data from a miarolitic quartz of the Zinnwald Sn-W deposit (Erzgebirge) show a continuous depletion of metals during the hydrothermal stage. Genetically older inclusions (330 μg/g Sn, 150 μg/g W) have higher metal contents than younger inclusions (<5 μg/g Sn, <1 μg/g W). Hypersaline primary inclusions in the associated granite show up to 700 μg/g Sn and 200 μg/g W. These findings indicate that initial fluids were capable of leaching Sn-W pre-enriched zones. The results will be compared to ongoing studies on tin granites from Cornwall.

[1] Heinrich et al. (2003), Geoch Cosmoch Ac, 67, 3473-3496.
[2] Albrecht et al. (2014), J Anal Atom Spectrom, 29 (6), 1034-1041.
[3] Müller et al (2006), Eur. J. Mineral., 18, 429-440.

Mineralogical and ore-petrographic investigation of the nickeliferous lateritic deposit of Hudenisht in Pogradec area (Albania)

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Poster in Session B2-02

Significant deposits of lateritic nickel ore are located in different regions of Albania, some of which have occasionally been exploited. The nickeliferous ore is associated genetically with the geotectonic zone of Mirdita. The Mirdita zone corresponds to a large ophiolitic complex that is representative of the Hellenic-Dinaric orogenic belt. The nickel-mineralisation in the Mirdita zone was developed during the Early Cretaceous to the Eocene. The deposit of Hudenisht is located 12 km north of Pogradec. The Fe-Ni-ore occurs in the form of layers with a total thickness of about 8.5 m between the altered ultramafic rocks (harzburgites - serpentinites) and overlying limestones (Upper Cretaceous). The mineralogical composition of the ore is mainly hematite, goethite, chromite and to a lesser extent nickel chlorite, nickel spinel, lizardite and calcite. The ore is characterized by the presence of large amount of spheroids such as ooids, pisoids, peloids and complex spheroids.

Complex spheroids were also found in all layers of ore, having integrated preexisting ooids, peloids as well as grains of chromite and spinels (intergranular texture). Plenty of clastic chromite grains were observed scattered in the binder of the ore. The x-ray examination also showed the presence of nickel spinel and nickel chlorite. The clay ore material goes to gradual replacement by ferrous solutions of epigenetic origin. The ore is generally characterized by an allotriomorphic inequigranular structure and an oolithic-pisolitic texture. The concentration of nickel in the ore is 0.49-1.61 %. The presence of ooids, peloids, complex spheroids, as well as the clastic grains of chromite in Fe-Ni-ore, support the view that allochthonous pisolitic material was transported and redepositioned onto ultrabasic rocks. According to the fabric of Fe-Ni ores, the nickel lateritic ore of Hudenisht is described as secondary pseudo-autochthonous deposit, overlying a typical autochthonous laterite horizon.

Application of agrominerals from selected rocks to supply geogenic nutrients via Enhanced Weathering

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Poster in Session B2-03

The application of rock flour on suitable land acts as a CO_2 sink ("Enhanced Weathering") and in dependence of the rock product provides geogenic nutrients to ecosystems. With an increasing CO_2 concentration in the atmosphere, the biomass productivity is expected to be enhanced, but it will be limited by terrestrial nutrient availability. It is hypothesised that a global application of suitable rock powder/flour has the potential to change this nutrient limitation and would increase carbon dioxide removal (CDR) via inorganic CO_2-consumption by weathering and via biomass productivity. Furthermore, the application of rock powder will alter the nutrient retention capacity and thereby tackle known problems with rapid nutrient losses in depleted tropical soils and sandy substrates. Other CDR strategies demanding large quantities of geogenic nutrients, like afforestation, biofuel production, and biochar application will benefit from the Enhanced Weathering of rock powder. We analysed about 120,000 geochemically characterised volcanic rock samples from the literature. Applying basic statistics, theoretical release rates of nutrients, like K, P and trace elements (e.g. Zn, Se) were evaluated for typical rock types. (Ultra-) basic rocks feature the highest CO_2 drawdown potential, while acidic rocks sequester less CO_2. The rock material can contain significant amounts of essential or beneficial nutrients. Their release can partly cover the demand of major crops like wheat, rice or corn, thereby increasing crop yield on degraded soils. The rock powder application could partially substitute industrial mineral fertiliser usage and would be a preferred supplement for certain soil types. In order to deploy this method on a global scale, an infrastructure has to be created in the same order of magnitude as the current coal mining industry, which implies a significant alteration of global mass movements.

with the graveyard of old subducted oceanic lithosphere.

On the role of thermal heterogeneities on the rheology of MgO under conditions of the Earth's lower mantle

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Poster in Session A4-03

The Earth's mantle is characterised by large thermal heterogeneities associated with hot rising plumes and cold downwelling slabs. These lateral temperature variations in excess of 1000 K may have a crucial influence on the rheology of mantle rocks. Here we use a numerical multiscale model that allows us to make predictions from first principles with no adjustable parameters on the deformation of MgO under the extreme conditions of mantle pressure, temperature and strain rate, in order to investigate the sensitivity of mantle viscosity to the temperature heterogeneities inferred from a global high resolution mantle circulation model. Our results show that under the very low strain rates of the mantle, MgO deforms mostly at low stresses (few tens of MPa) in an athermal regime, where the deformation is insensitive to both temperature and strain rate, leading to a very weak phase throughout much of the upper half of the lower mantle. At greater depth, the weak phase gives way to high material strength with thermally activated viscosities in the cold downwelling slabs, while much of the hot upwelling flow remains in the athermal regime, resulting in large lateral variations in the inferred material strength of MgO in the lower half of the lower mantle. Our results suggest the presence of large lateral viscosity variations in the deepest parts of the lower mantle, associated in particular

Massive sulfide accumulation along a submarine scoria cone row at the Tinakula Deposit, New Hebrides Arc, Solomon Islands

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Oral in Session B2-01

Seafloor massive sulfide (SMS) deposits are associated with diverse volcanic styles and compositions in many different tectonic settings. For the first time, SMS mineralization has been discovered in association with a row of scoria cones, located in the New Hebrides arc. Here, we examine the volcanic and structural features of the Tinakula deposit through high-resolution geological mapping, and describe the volcanic facies architecture revealed through detailed core logging. The Tinakula deposit occurs 30–80 km behind the New Hebrides arc at a water depth of 1070–1204 m. The structural setting involves a strong rift fabric, reflecting north-south extension, and a series of horsts and grabens. A large fissure, extending over 5 km along a WNW-trending structure hosts numerous monogenetic scoria cones and maars, which are similar to those in terrestrial environments. Mineralization is widely distributed as hydrothermal mounds and chimneys along the flanks and tops of the scoria cones, as well as within the craters of the cones and maars, for a strike length of more than 1200 m. The volcanic facies relationships suggest that phreatomagmatic eruptions created a number of discrete maar volcanoes consisting mainly of country rock with lesser juvenile clasts. Subsequent strombolian eruptions built up the scoria cones with variable proportions and sizes of volcanic clasts. A change in eruption style from explosive to effusive is indicated by the presence of autobrecciated lava flows on the flanks of several of the cones. The hydrovolcanic fragments of the scoria phase quickly cooled in the water, with the precipitation of numerous secondary minerals that filled the pore spaces and cemented the breccias. The entire volcaniclastic sequence was then argillically altered and infilled by anhydrite. These processes reduced the permeability of the volcanic substrate, allowing the hydrothermal fluids to become focused and vent to the seafloor.

Probing the transition between seismically coupled and decoupled segments along an ancient subduction interface

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Oral in Session A1-02

Although of paramount importance for understanding the nature of mechanical coupling in subduction zones, the portions downdip of the locked segments of subduction interfaces remain poorly understood. These deep transition zones often are sites of megathrust earthquake nucleation and concentrated postseismic afterslip, as well as the focus sites of episodic tremor and slip features, recently discovered at several plate boundaries. The extensive, exhumed remnants of the former Alpine subduction zone found in the Swiss Alps allow analyzing fluid and deformation processes at the original depths of 30-40 km, typical for the depth range of such transition zones. We identify the shear zone at the base of the Dent Blanche complex (Dent Blanche Thrust, DBT) as a lower blueschist facies, fossilized subduction interface where granitic mylonites overlie a metamorphosed ophiolite. We report field observations from the DBT region where a complex, discontinuous network of meter- to tens of meters-thick foliated cataclasites is interlayered with the basal DBT mylonites. Petrological results indicate that cataclasis took place at near peak metamorphic conditions (450-500°C, c. 1.2 GPa) during subduction of the Tethyan seafloor in Eocene times (42-48 Ma). Despite some tectonic reactivation during exhumation, these networks exhibit mutual cross-cutting relationships between mylonites, foliated cataclasites and vein systems indicating multiple switching between brittle deformation and ductile creep. Whole-rock chemical compositions, in situ ^{40}Ar-^{39}Ar age data of newly formed phengite, and strontium isotopic signatures reveal that these rocks also underwent multiple hydrofracturing events via infiltration of fluids mainly derived from the ophiolitic metasediments underneath the DBT. From the rock fabrics we infer strain rate fluctuations of several orders of magnitude beyond subduction strain rates (c. 10-12s^{-1}) accompanied by fluctuation of near-lithostatic fluid pressures.Our results demontrate that the DBT region constitutes a unique target to image and understand deformation processes and fluid-rock interactions taking place in the transition zone.

Comparative hydrogeochemistry in global perspective

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Oral in Session A5-02

Regional hydrogeology and geochemistry always raised the question of the origin of groundwater and handled it primarily on the basis of their chemical composition. Supporters of the concept of permanent ocean salinity, at least since the Cambrian, based on the fact that very complex organisms living today only in the oceans, there are during the whole of the Phanerozoic. To explain the origin of the deep brines, belonging mainly to the Cl-Ca type, there are several hypotheses which is placed usually the crucial role of any one of physico-chemical factor. On the other hand, there are evidences about the existence Paleotype, Mesotype and Cenotype subsurface waters. It is proposed that the chemical composition of oceans is not constant but has varied significantly over geological time. Conditioning factor of high salinity water was the low volume of surface water (hydrosphere) in Paleozoic. Some authors emphasize that since the Proterozoic and to Quaternary development prevailing sedimentary basins occurred at line: shallow sea - lake like sea on the continents - marginal seas and oceans. Comparison of the "sedimentation water" of the same age for the different pools, located within the various continents shows a significant impact on their composition climatic zonality and global climate change resulting from the drift of the continents. These data show the inconsistency of various physical and chemical theories for the explanation of the processes of concentration of groundwater. New data on the nature of the processes of degassing of the Earth, changing the amount of surface hydrosphere and ocean levels reflect a very large changes of processes of emission of chemical elements, dilution of natural waters by volcanic emanations including magmatic water and different level of salinity of sedimentary basin in the different periods of geologic history.

Xenotime and Monazite Ages and Polymetamorphic Evolution of Kyanite-Staurolite Schists from the Northern Part of the Usagaran Belt (Tanzania)

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Poster in Session A1-03

In this study pelitic staurolite-kyanite-garnet bearing schists from the northern part of the Paleoproterozoic Usagaran Belt in Tanzania were dated and petrologically investigated to find out to which extend younger Neoproterozoic orogenic events effect the Usagaran Belt in its northern part. Rare sillimanite includsions occur in anhedral and partly resorbed garnet porphyroblasts and most possibly represent a relict of an early metamorphic stage. Staurolite poikiloblasts of cm-size possibly formed pre- to synkinematically as their inclusions mainly show random orientation in contrast to the external fabric and lack grain coarsening. Kyanite formed during the peak stages of metamorphism. It occurs as euhedral to subhedral laths, overgrowthing biotite and staurolite. This sequence of prograde mineral growth is in accordance with phase diagrams of equilibrium assemblages that show that P-T fields of assemblages that contain both staurolite and kyanite, are small in pelitic compositions and that most kyanite will form above the staurolite stability. The peak metamorphic P-T conditions for coexisting garnet-kyanite-biotite-plagioclase assemblages point to peak conditions of about 670°C at 9 to 10 kbar. EPMA U-Th-total Pb dating of xenotime yielded Paleoproterozoic ages of about 1.9 Ga for these rocks. Annuli of high yttrium contents that occur in some garnets provide evidence for Paleoproterozoic growth of these garnets. Age maps of monazite from the same samples show Paleoproterozoic core and in some cases Neoproterozoic rims. U-Th-total Pb dating of the monazite cores yielded ages that are very close to those of xenotime and a Neoproterozoic age of 557 Ma for the late stage growth of the rims. This study provides evidence that Neoproterozoic metamorphism took effect up to the border of the Tanzania Craton without leading to significant re-equilibration of the assemblages.

3D petroleum system modelling and hydrocarbon generation potential: the Entenschnabel area, northwestern German North Sea

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A 3D basin modelling study is conducted to investigate the maturation and the hydrocarbon generation potential of source rock units within the northwestern part of the German North Sea (Entenschnabel area). The study area includes parts of the southern end of the North Sea Central Graben and its surrounding platforms and structural highs. The geological model is built from recently compiled maps and structural information from the Entenschnabel area (www.gpdn.de). This includes thickness and depth maps of important stratigraphic horizons as well as positions of faults and salt structures. Petrophysical values and facies information from wells are assigned to the different geological layers. The model is further calibrated with temperature and maturity data from wells and publications. The time span from the Late Palaeozoic to the Present is represented by the model including three erosional phases related to large-scale tectonic events: the Saalian (Late Carboniferous-Early Permian), the Late Kimmerian (Late Jurassic) and the Subhercynian inversion phase during the Late Cretaceous. Additionally, the salt movements through time expressed as diapirs and pillows are considered within the model.

Landscape response due to sediment transport and bed-rock detachment

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Oral in Session A6-02

Sediments are predominantly transported out of the upland catchment by flowing water. The transport of sediment along river channels leads to both erosion and deposition. A key question is therefore: Are all the sediments that are in transport carried out of the catchment on geological time-scales (>10 kyr), or is there a degree of sediment storage that must be accounted for? Within the Himalayas, for example, sediment is stored within the catchment for more than 10 kyr (Blothe & Korup, EPSL, 2013), suggesting that we cannot model catchments as exclusively eroding domains. A domain where transport is instantaneous leads to erosion that is only limited by the detachment of rock, or the creation of mobile sediment. The basic assumptions behind such a heuristic model leads to the classic stream power model, which has received great attention in recent large scale numerical experiments. If however the transport is not instantaneous, then erosion is governed by the transport of sediment and the classic stream power model is no longer valid. Erosion by the transport of sediment or detachment of bedrock leads to different transient system responses to change in surface water flow, a first order measure of climate change. I find that for similar model elevation and catchment size, the stream power model rapidly responds to change in run off when compared to the sediment transport model (response time of 500 kyr compared to 2 Myr). This response is reflected in both change in trunk stream profile and output sediment flux. Yet both of these end-member models create realistic trunk stream slope vs. $\sim$catchment area gradients, which suggests that using derivatives of this measurement, such as chi-plots, are not a indicator of the mechanisms behind landscape evolution. Instead the response to change in forcing, in terms of sediment flux, recovery time and grain-size distributions within

the deposits, may provide a better indication of the controls on landscape evolution.

Integrated hydrogeochemical modelling of rock-water interactions in shallow marine sediments: implications for biogenic methane prediction

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Oral in Session B1-02

Accumulation of biogenic methane-dominated gas is widespread and occurs in a variety of depositional settings and rock types. However, the potential of biogenic methane remains underexplored. It is our mission to establish a modelling tool for retracing diagenetic signals and to predict early diagenetic products in marine sediments. The focus is on biogenic methane formation and the developed model enables us to estimate amount, timing, and kind (hydate, dissolved, or gaseous) of biogenic methane. The driving force for the formation of diagentic products is the irreversible redox-conversion of metabolizable organic matter. Here, biogenic methane formation in shallow sediments just below the sulfate reduction zone is considered as well as biogenic methane formation at higher temperature ("40°C maximum") in deeper sediments. Further, the model calculates mineral precipitation and dissolution, carbon mass balances, and determines pore water composition. The modelling tool is PHREEQC (version 2), a computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. We have coupled PHREEQC to an entry mask of the ExcelÓ-format that enables the user to define geochemical and mineralogical initial boundary conditions and to visualize PHREEQC calculation results in ExcelÓ. The so-called "PEaCH4 v. 2.0" (Potential of Early CH4) platform has been tested on usability for different environmental settings (Amazon Fan sediments, Peru shelf and slope sediments, carbonate-dominated systems) and offers the opportunity to test several scenarios on their feasibility of methane formation and storage. Carbon mass balance calculations and quantifications can be used to conclude whether the amount of methane will be worth more detailed investigation. Beyond predicting possible reservoirs of biogenic methane, the platform predicts hydrate formation and may be used as a tool to plan drilling in areas with shallow methanogenic sediments.

Semi-automatic segmentation of thin section images with an application to characterize subarkose sandstone

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Accurate imaging of minerals in petrographic thin sections using (semi)-automatic image segmentation techniques remains a challenging task chiefly due to the optical similarity of adjacent grains or grain aggregates rendering definition of grain boundaries difficult. We present a new semi-automatic image segmentation workflow for the quantitative analysis of microscopic grain fabrics. The workflow uses an automated seeded region growing algorithm, which is based on variance analysis of five or more RGB images. The workflow is implemented in the open-source geographic Information System (GIS) software SAGA (System for Automated Geoscientific Analyses). SAGA provides all required tools for image analysis and geographic referencing. It also features a graphical user interface that allows the user to simultaneously display and links multiple images and, thus, facilitates manual post-processing of the images. SAGA's capabilities for vector data analysis offer instant calculation and visualization of the compiled geometric database within a GIS environment. Specifically, grain contacts are automatically identified by lines of intersection and manually classified by contact type to characterize the mineral fabric of petrographic thin sections. To demonstrate the effectiveness of the workflow, 39 transmitted light images of 13 weathered sandstone samples of the Buntsandstein Formation in northwestern Germany were analyzed. Based on the segmentation results obtained from the samples, a number of parameters, including modal composition, geometry of grain contacts, porosity, and grain size distribution were determined and statistically evaluated. The results of the image analysis are utilized to assess the weathering susceptibility of the sandstone samples and point to the importance of cementation determining the geotechnical properties of a given sandstone sample.

Sanidinites – an example for solvothermal transport of Zr in volcanic systems and its relevance for technical applications

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Poster in Session A7-02

Sandinites are holocrystalline volcanic ejecta of explosive volcanoes observed in a small number of localities worldwide, including Laacher See in Germany, the middle Italian volcanic province and Mt. Vesuvius, and the Azores. They consist almost entirely of sanidine and sodalite group minerals. The formation processes of these rocks are not yet solved, e.g. the effect of metasomatism is in debate. However, several observations support the arguments for the formation of sanidinites by solvothermal processes within the magma chamber. The very porous rocks consist of large sanidine crystals (up to several centimeters) with interlocking structure, creating large cavities between some crystals. Within these cavities euhedral crystallites of zirconium minerals as oxide (baddeleyite ZrO_2) or silicate (zircon $ZrSiO_4$) can be observed indicating their formation out of the gas phase. All these features point to their aggregation from a gaseous magmatic phase. Whole rock analysis of sanidinites from Laacher See (Germany) show a positive correlation of Zr with K and a negative correlation with Na. Notable, the positive correlation of Zr with the volatile species Cl, sulfate, and CO_2. These observations indicate the transport and recrystallization of HFSE (high field strength elements) like Zr by the gas phase and to present an example of solvothermal processes in natural systems. A technical application of this process are Y-stabilized, solvothermally densified Zr-oxide ceramic layers as protection against corrosion in waste incineration plants. The gas composition in waste incineration plants is comparable to the composition in magma chambers. The main gas phases in the magma chamber are Cl, sulfate, CO_2 and H_2O. In addition they are enriched in incompatible and volatile elements. The results of this study can be used to improve the conditions for solvothermal reactions in synthetic Zr-oxide ceramics.

New Evidence for Increased Potential of Hydrothermal Occurrences in the Red Sea Rift

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Poster in Session B2-01

Latest multibeam data and magmatic geochemical information revealed new details about the nature of the ultraslow-spreading Red Sea Rift (RSR). These data show that the RSR, which was believed to be different from other mid-ocean ridges (MOR), is well comparable to ultraslow-spreading rifts elsewhere but partially covered by evaporite glaciers. These glaciers led to many complications in the interpretation of geophysical data and to the theory of spreading initiation at multiple nodes separated by continental crust. Our data show that although the discrete deeps undoubtedly exist, they are not separated by tectonic boundaries but represent "windows" onto a continuous spreading axis which is locally masked by slumped evaporites. The data that was previously used to support the presence of continental crust between the "nodes" can be equally well explained by processes related to sedimentary blanketing and subsedimentary hydrothermal alteration. Thus, volcanically and tectonically the RSR aligns very well with (ultra)slow-spreading rifts globally. New indications for the location of hydrothermal activity outside the brine pool areas are given by chlorine (Cl) concentrations in basalts. Differences in the Cl concentrations between MOR basalt and seawater makes Cl a sensitive tracer for hydrothermal circulation. Assimilation of hydrothermal fluids or hydrothermally altered crust by rising magma can thus be traced by measuring excess Cl in erupted lavas. The Red Sea, with its axial brine pools and thick evaporite sequences flanking the young rift provides ideal conditions to see Cl-excess in the Red Sea magmas by hydrothermal activity. Basalts from seafloor areas with other evidence of hydrothermal activity always show Cl-excess in the local basalts. Further we see a positive correlation between Cl-excess and intensity of local volcanism. Cl-excess in basalts can therefore be used to guide prospection for additional past and present hydrothermal circulation.

Seismic and Aseismic Fault Slip on Megathrust, application to the 2015 Gorkha earthquake, Nepal

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Keynote in Session A1-01

Understanding the partitioning of seismic and aseismic fault slip is central to seismotectonics as it ultimately determines the seismic potential of faults. Thanks in particular to advances in tectonic geodesy, it is now possible to image the spatio-temporal evolution of slip over the seismic cycle and determine the budget of seismic and aseismic slip on faults. I'll review studies of subduction zones and a number of continental faults (the Longitudinal Valley Fault in Taiwan, the Sumatra megathrust, the Parkfield segment of the San Andreas Fault) which show that aseismic creep is common within the seismogenic depth range; interseismic locking is observed to be spatially heterogeneous defining locked patches of stress accumulation to be released in future earthquake or aseismic transients. Clay-rich tectonites, high temperature and elevated pore fluid pressure are key factors promoting aseismic creep and heterogeneous coupling on these faults. By contrast, interseismic coupling on the Main Himalayan Thrust is remarkably homogeneous. The Mw 7.8 Gorkha earthquake of April 25, 2015 ruptured the lower edge of the locked fault zone. A slip budget analysis, and eventually dynamic models of the seismic cycle, can be used to assess the magnitude and probability of occurrence of the largest earthquakes on such fault systems. I'll discuss promise and pitfalls of using these approaches to assess the seismic potentials of fault systems and plate boundaries.

Study of the gravity data of south of Talafar - Mosul area – NE Iraq

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Poster in Session B1-04

To analysis and interpretation the Bouguer anomaly map of south Mosul and Tal Afar area studied to delineate the subsurface structures. After the gridding the Bouguer anomaly data, several analytical methods of regional- residual separation are used such as, Griffin method, moving average and inverse distance methods. Regional and residual gravity maps were constructed. Most of the regional anomaly maps show large and regional high and low anomalies. These large and wide anomalies may be reflected a high and low blocks within Basement rocks and extended into sedimentary rocks such as Mosul block. These blocks bounded by several deep faults having NW-SE, E-W and NW-SE trend. Several small scale (shallow) positive gravity anomalies are detected which may be reflected the effect of the subsurface anticlines within the sedimentary cover trending NW-SE, E-W and NE-SW. These anticlines occurred during Najd and Hejaz orogeny (NE-SW trend) and Alpine orogeny (NW-SE and E-W, "Zagros and Torus trend"). Also, several small scale negative anomalies are detected on residual maps which may be reflected the effect of subsurface synclines within the sedimentary cover having the same trends of anticlines such as NW-SW, E-W and NE-SW. Several assumed Fault locations are referred on residual and second vertical derivative maps too. Most of them having NW-SE trend (Zagros trend). Also there are E-W (Torus trend) and NE-SW (Najd and Hejaz trend). These faults are having different lengths. Some of them which are occur within sedimentary rocks, extending into Basement rocks too. Finally by using Wollard, 1962 equation, the depth of Moho discontinuity (thickness of crust) map constructed. It is appear that the depth of Moho ranges 33-35km in the area.

A missing element in Wilson Cycle scenario

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Oral in Session A1-06

The major problem of classical Wilson Cycle concept is the hypothesized conversion of the passive continental margin to the active subduction zone, which is impeded by the high strength of thick continental lithosphere and old oceanic plate. Here we propose a new triggering factor in subduction initiation process that is mantle suction force and based on that we suggest a modified version of Wilson Cycle. Following opening of oceanic basin, continental passive margin moves over the slab remnants of former subduction zones in deep mantle. Such slab remnants or deep slabs of neighbouring active subduction zones produce a suction mantle flow which impose additional compression at the passive margin. This eventually results in initiation of a new subduction zone and starting of the closing phase of Wilson Cycle. In this scenario the inherited weakness of rifted continental crust near the passive margin, hydration weakening of continental mantle lithosphere and push force induced from far-field topographic gradient within the continent facilitate subduction initiation process. We test our hypothesis using FEM thermo-mechanical modeling. Our results show that additional forcing provided by mantle suction flow is able to break the lithosphere and convert the passive margin into an active subduction zone. Subduction initiation depends on several parameters such as magnitude, domain size and location of suction mantle flow, far-field topographic force and strength of continental lithosphere. We show that mantle flow-induced subduction initiation at passive margins is a long-term process that takes 50 Myr or more, which explains a lack of Cenozoic examples. We propose that Argentina and US East Coast passive margins are currently at initial stage of the subduction initiation process induced by the mantle suction flow driven by sinking remnants of Farallon and Phoenix slabs in deep mantle. The well-known M5.8 Virginia Earthquake of 2011 is likely an indication of this process.

On restoring sedimentary basins for post-depositional deformation – Paleozoic basins of the central Andes

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The reconstruction and interpretation of sedimentary basins incorporated into folded and thrusted mountain belts is strongly limited by the style and intensity of shortening. This problem is exacerbated if deformation is polyphasic as is the case for the Paleozoic basins in the central Andes. Some of these have been deformed by folding and thrusting at least 3 times in the Late Ordovician, the Late Paleozoic and Cenozoic. A realistic reconstruction of the original basin dimensions and geometries from outcrops and maps appears to be almost impossible. We present first results of a stepwise reconstruction of the Paleozoic basins of the central Andes by restoring basin areas and fills accounting for crustal shortening. The structurally most prominent feature of the central Andes is the Bolivian Orocline which accomodated shortening in the last 45 Ma on the order of between 300 and 500 km. In a first step basins were restored by accounting for Cenozoic rotation and shortening by deconvolving the basins using an enhanced version of the oroclinal bending model of Ariagada et al. (2008). Results of this step were then restored stepwise for older deformations. Constraints on these subsequent steps are significantly poorer as values of shortening can be derived only from folds and thusts apparent in outcrops. The amount of shortening accomodated on unexposed and therefore unknown thrusts can not be quantified and is a significant source of error very likely leading to an underestimation of the amount of shortening. Accepting these limitations, basin restoration results in an increase in basin area by $\geq$100%. The volumes of stratigraphically controlled basin fills can now be redistributed over the wider, restored area, translating into smaller rates of accumulation and hence subsidence. These restored rates conform to those of equivalent modern basin settings and permit a more realistic and actualistic analysis of drivers of subsidence and the respective tectonic framework.

Styles of early diagenesis and the preservation potential of onshore tsunami deposits - a re-survey of Isla Mocha, Central Chile, two years after the February 27, 2010 Maule tsunami

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The style of early diagenesis and preservation of onshore tsunami deposits are poorly constrained. We present the results of a re-survey in 2012 on Isla Mocha following our post-tsunami survey conducted after the February 27, 2010 Maule tsunami in central Chile. In 2010, a large number of boulders weighing up to 12 t had been transferred from the tidal zone onto the coastal plain. Sediment mixtures of pebbles, granules and sand were entrained on the beach and at coastal plain terraces, and transported up to the maximum runup position c. 600 m from the coast by the inflow. They were subsequently redistributed and deposited by the backflow as extensive blankets on the lower coastal plain. In 2012 a thin soil had redeveloped and vegetation had covered the 2010 tsunami deposits. The spatial distribution of tsunami deposits was reduced by 50% by runoff and grazing cattle. Grain-size distributions of the preserved sediment show an increase of the sand fraction at the expense of the coarser grain sizes. Boulders consisting of clay-rich fine sandstones had disintegrated into a variety of smaller grain-sizes. Dried algae veneers documenting the derivation of the boulders from the tidal zones had flaked

off from most rock surfaces. At the northern coast a c. 130 m long and 1.2 m high beach ridge had formed most likely by sediment derived by a combination of tsunami outflow and runoff driven erosion of tsunami deposits into the foreshore. This material was subsequently transported back onto the beach by waves and swell. This case study documents that the degree of modification to the Isla Mocha tsunami deposits strongly affects the applicability of inverse models using paleotsunami deposit thickness and clast-size distributions to infer parameters and magnitudes of the causative tsunamis. Our study gives strong evidence in support of re-survey studies following the deposition of tsunami sediments by tracing and quantifying the changes affecting them.

The growth of a mountain belt forced by base-level fall: Tectonics and surface processes during the evolution of the Alborz Mountains, N Iran

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The idea that climatically modulated erosion may impact orogenic processes has challenged geoscientists for decades. The central-western Alborz Mountains in the northern sectors of the Arabia-Eurasia collision zone constitute a promising area to explore these potential feedbacks. This region is characterized by asymmetric precipitation superimposed on an orogen with a history of spatiotemporal changes in exhumation rates, deformation patterns, and prolonged, km-scale base-level changes. Our analysis suggests that despite the existence of a strong climatic gradient at least since 17.5 Ma, the early orogenic evolution (from $\sim$ 36 to 9-6 Ma) was characterized by decoupled orographic precipitation and tectonics. In particular, faster exhumation and sedimentation along the more arid southern orogenic flank point to a north-directed accretionary flux and underthrusting of Central Iran. Conversely, from $\sim$ 6 to 3 Ma, erosion rates along the northern orogenic flank became higher than those in the south, where they dropped to minimum values. This change occurred during a $\sim$3-Myr-long, km-scale base-level lowering event in the Caspian Sea. We speculate that mass redistribution processes along the northern flank of the Alborz and presumably across all mountain belts adjacent to the South Caspian Basin and more stable areas of the Eurasian plate increased the sediment load in the basin and ultimately led to the underthusting of the Caspian Basin beneath the Alborz Mountains. This underthrusting in turn triggered a new phase of northward orogenic expansion, transformed the wetter northern flank into a new pro-wedge, and led to the establishment of apparent steady-state conditions along the northern orogenic flank (i.e., rock uplift equal to erosion rates). Conversely, the southern mountain front became the retro-wedge and experienced limited tectonic activity.

Soil organic matter characteristics in surficial permafrost sediments on Herschel Island, Yukon Territory, Canada

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Recent mobilisation of soil organic matter (SOM) in permafrost of the northern high latitudes is thought to have a significant impact on the carbon balance in the atmosphere. However, the environmental processes which influence SOM accumulation and remobilisation still need to be investigated more accurately. This study investigates the quantity and quality of SOM on Herschel Island in the western Canadian Arctic in relation to various landscape characteristics. To reach this goal, soil moisture, total organic carbon (TOC) and total nitrogen (TN) contents, stable carbon isotopes (δ^{13}C) and TOC/TN ratios (C/N) were determined on 128 samples from twelve sediment cores reaching up to 250 cm depth. Drilling locations were chosen based on morphology, vegetation and soil properties and supported by satellite imagery and air photos. Seasonal thaw depths (active layer depths) correlate with ground disturbance and vegetation cover and lie between 20 and 100 cm. Well-preserved SOM is accumulated in the active layer and subjacent ice-rich permafrost of wet polygonal tundra. Uplands, hummocky tussock tundra and alluvial fans cover more than 50 % of the island and show heterogeneous SOM storage characteristics with considerable TOC contents being limited to the active layer. Disturbed areas with slope gradients greater than 6° show strong SOM degradation with low TOC contents throughout the active layer and permafrost strata. Linear regression and principal component analysis (PCA) shows that a decreasing SOM content is driven by increasing ground disturbance and reduced vegetation cover. Improved drainage decreases the preservation of SOM in the active layer. Future deepening of the active layer because of increasing temperatures and ground disturbance will remobilise SOM stored in ice-rich permafrost. This might increase carbon dioxide and methane emissions from permafrost landscapes.

Investigation on hydrous phosphate glasses

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This study focuses on the effect of water on the structure of lithium-magnesium-phosphate (LiMgP) and lithium-magnesium-aluminum-phosphate (LiMgAlP) glasses. For this purpose LiMgP and LiMgAlP glasses have been synthesized with water content varying between 0 and 8 wt% and compacted at 5 kbar. The composition of the starting glasses has been investigated by inductively coupled plasma atomic emissions spectroscopy (ICP-OES) and electron-probe micro analyser (EPMA). The water contents were determined by Karl-Fischer titration (KFT) and near infrared spectroscopy (NIR) confirming that the water distribution is homogeneous. The density measurements of dry and hydrous glasses show that the dry compacted glasses have higher density than the dry starting glasses and the density is decreasing with rising water content. Density increase for LiMgP was 2.29 % and for LiMgAlP 3.12 %. The changes in glass structure have been investigated using Raman spectroscopy and nuclear magnetic resonance spectroscopy (NMR). The structure of our metaphosphate glasses comprises primarily of phosphate tetrahedra linked via two bridging oxygens (Q2 species) and with two non-bridging oxygens per [PO4]-unit. The results of MAS-NMR are in good agreement with the literature. Furthermore, a strong depolymerisation of the glasses with increasing water content can be

concluded. The integration of aluminum in the glass structure (ca. 7 wt%) shows the formation of Al(IV), that serves as network former in the structure. At lower aluminum contents only five and six-fold coordinated aluminum, Al(V) and Al(VI), were present in the glass structure that serve as network modifier. It can be concluded that the network-modifying Al and the rising water content both have a depolymerizing effect on LiMgAlP glasses.

Organic Geochemistry and Basin Modeling Study in the Northwestern Part of the Persian Gulf

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Poster in Session B1-03

Most of the Iranian offshore oil production comes from oilfield reservoirs located in the northwestern part of the Persian Gulf. These oilfields are situated around a depression known as Binak Trough where the most important source rocks of the region are present. Comprehensive geochemical analyses were conducted on oil samples collected from these oilfields in order to identify genetically distinct oil families, their characteristics and local extent. Furthermore, to better understand the petroleum system and active source rocks, burial histories were reconstructed through the study area. Evaluation of the geochemical properties using statistical analysis indicates the existence of two distinct oil families in the study area. Inversion correlation confirmed that the marls and carbonates of Cretaceous formations bearing type II and II-S kerogen are the main-oil generating facies for the identified oil families. These source rocks were deposited under dysoxic to anoxic conditions in an open marine environment Maturation-, thermal- and burial history reconstruction as well as modeling of hydrocarbon generation and migration for the Cretaceous source rocks indicate that Kazhdumi formation could be considered as the main source rock for the oil family II whereas oil family I has been probably originated from Garau formation. The model indicates the migration pathways in the study area. It also explains the role of Binak Trough in charging the reservoirs located in the northwestern part of the Persian Gulf.

Polycrystalline Sulfide-Assemblages in Acfer 094 - Clues to Heterogeneous Nebular Conditions of Sulfide and Oxide Formation

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Polycrystalline (P-type) sulfide assemblages have been described in earlier studies from CM chondrites, in which they consist of 4C-pyrrhotite, magnetite, pentlandite and merrillite (in the interstices). Some P- and Cr- bearing sulfides associated with P-type sulfides are carriers of CrN [3]. In this study, we have sampled concentric P-type sulfides within the ungrouped carbonaceous chondrite Acfer 094 using FIB-TEM. This meteorite is among the most primitive early solar system materials, e.g., the petrologic type is 3.00 and the abundance of presolar grains is very high [1]. Hence, the study of sulfide assemblages in Acfer 094 may provide fundamental insight into early metal-gas reactions. In Acfer 094, the concentric P-type sulfides contain anhedral crystals of NC-pyrrhotite, pentlandite, and, in some cases, Cr-bearing magnetite in the inner part of the assemblages. In the outer part, anhedral olivine- and pyroxene crystals occur, as well as troilite that is intergrown with NC-pyrrhotite. The observed mineral assemblages and the concentric character of the P-type sulfides indicate a change of conditions during sulfide and oxide formation. Occurrence of magnetite within the sulfide grains indicates a change of $f(O_2)$. The heterogeneous occurrence of mechanically incorporated silicates reveals changes in dust density during sulfide formation. Mineralogical similarities to previously described cosmic symplectite (COS) [4,5] might suggest that formation mechanisms of COS and P-type sulfides were related.

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Provenance of Saudi Arabian Palaeozoic sandstones using whole rock and single grain geochemistry

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Oral in Session A6-02

Despite having been intensely studied, the Saudi Arabian Palaeozoic clastic succession still proves to be difficult to correlate in both outcrop and subsurface, due to the high maturity of sandstones and scarcity of fossils. To better understand stratigraphic relationships and sedimentary provenance on a passive margin, Palaeozoic sandstones from two study areas in southern (Wajid area) and northern (Tabuk area) Saudi Arabia have been analysed for whole rock and single grain geochemical data of detrital rutile and garnet and internal zircon morphology. Most common geochemical discrimination diagrams suggest a craton interior dominated provenance in a passive margin tectonic setting for both study areas, which is in accordance with the tectonic framework of the Arabian Plate during the Palaeozoic. Trace element ratios of Th/Sc and Zr/Sc suggest sediment recycling in some units. The data also tentatively suggest a change in provenance during the Devonian in the Wajid area, which was not observed in the Tabuk area. Internal zircon morphology obtained from cathodoluminescence images suggest a dominant magmatic source, with a minor contribution of metamorphic zircons in Wajid area sediments. Here, the distribution of morphotypes is remarkably similar throughout the succession. Data from the Tabuk area will be available at the time of the conference. Rutile geochemistry from the Tabuk area suggest a mainly felsic source (e.g., micaschists, paragneisses, felsic granulites, granites), while southern rutiles are of mixed mafic and felsic origin. Zr-in-rutile thermometry reveals a high-T population in northern samples, that is absent in the Wajid area. Garnets were only found in Late Palaeozoic (Devonian and Carboniferous-Permian) sandstones. Their composition is mostly similar in both study areas. Most garnets are derived from metasedimentary or granitic rock. A minor population of high-grade metabasic garnets has been observed in the Tabuk area only.

Atlantic Ocean Circulation during the Latest Cretaceous and Early Paleogene: Progressive Deep Water Exchange

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Poster in Session A6-03

The Atlantic deep ocean circulation in the Latest Cretaceous (75-66 Ma) was dominated by regional processes, as indicated by the presence of distinct deep water masses. Due to the opening of the Atlantic Ocean, its different sub-basins became progressively connected and a global mode of ocean circulation commenced in the early Paleogene, ~60 Ma. To understand the evolution of deep water formation and exchange, Nd-isotope data and δ^{13}C stratigraphies are generated for a range of sites in the North and South Atlantic.

These permit to identify different intermediate and deep-water masses, to recognize their potential source regions and to determine the timing of deep water connection. The carbonate-rich pelagic sediments of Site U1403 near Newfoundland expose relatively negative seawater $\mathcal{E}$Nd(t) signatures in the 67-62 Ma interval that are distinct from those recorded further south in the North Atlantic. Possible explanations could include elevated non-radiogenic weathering inputs from the North American craton. In the latest Maastrichtian, the Site U1403 $\mathcal{E}$Nd(t) record displays a short-term positive excursion before the K/Pg boundary (67-66 Ma) followed by a sudden drop to unradiogenic values at the boundary. Changes in ocean circulation might be related to climatic changes in the pre-extinction interval and the impact itself. The first data of Sites 1267, 525, 516 (Walvis Ridge - Rio Grande Rise) and U1403 indicate the occurrence of a common deep-water neodymium isotope signature in the North and South Atlantic since 60 Ma. At this time, the sub-basins of the deep Atlantic became fully connected. A deep-water mass with a common $\mathcal{E}$Nd(t) signature, likely originating in the high southern latitudes, prevailed over a broad range of water depths, indicating vigorous deep ocean circulation.

Tracing the evolution of an orogen passive margin system by apatite and titanite (U-Th)/He data

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Poster in Session A2-02

The African continent was subjected to intense structural and geomorphic reorganization. Major geodynamic events in the geological history of East Africa trace back to the consolidation of Gondwana and subsequent break-up, later followed by the formation of the East African superswell and the extension of the East African Rift System. The various phases of topographic growth, equilibrium and decay are stored in the rocks thermal history. In this cycle, forming landscapes and continental margins, inherited basement structures play a major role. In Mozambique, for example, a broad geo- and thermochronological dataset demonstrates that "Pan-African" structures of the East African-Antarctic Orogen (EAAO) were decisive during Gondwana break-up and margin formation. In this presentation we focus on the continental margin of Mozambique, which represents an orogen passive margin system, as the area underwent compressive tectonics forming the EAAO prior to Gondwana break-up. We use apatite and titanite (U-Th)/He thermochronology in this area to a) further characterize the post-collisional thermal evolution of northern Mozambique, b) narrow down the thermal history of the plate margins since initial break-up in Permian times, and c) test the applicability of titanite (U-Th)/He dating in alike geodynamic settings. From the obtained apatite and titanite He data different crustal blocks can be distinguished in northern Mozambique, separated by the Lurio Belt, a narrow repeatedly reactivated structure. The basement north and south of this SW-NE oriented belt experienced different thermal histories, with earlier cooling in the north and later cooling in the south, while the overall youngest titanite He ages from the Lurio Belt indicate reactivation during Gondwana break-up.

In-situ bioleaching in a historical mining district – an experimental approach for the potential of strategic element extraction

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Poster in Session B2-02

Detailed mapping, sampling and mineralogical characterization of a hydrothermal polymetallic sulfide vein in the Freiberg mining district resulted in a preliminary evaluation in regard to its indium potential. This research intends to characterize the vein for its indium potential in regard to an interdisciplinary underground in-situ bioleaching project of the Biohydrometallurgical Center for Strategic Elements (BHMZ) at the TU Bergakademie Freiberg, and further aims to comprehend the genesis of indium-enriched polymetallic sulfide deposits. The implementation of the underground in-situ bioleaching facility is the main project of 13 subprojects, comprising the scientific fields of geosciences, geoengineering, biology, chemistry, process engineering and metallurgy. The subprojects of Economic Geology and Underground Mining are dealing with the identification of a potential mining block under consideration of general mineralogy, ore vein geometry, indium potential and infrastructure, and consequently with the conditioning approaches at the ore vein, considering the setup of feeding and drainage boreholes and methods of crack initiation in order to achieve a sufficient leaching circle. The mineralogical evaluation showed that the indium-bearing sulfides belong to the Late-Variscan Zn-Sn-Cu mineralization association, which is composed of Fe-rich sphalerite, chalcopyrite, stannite and acicular cassiterite. The fissure vein has complex vein textures typical for vein-style infill and hydrothermal fragmentation. Indium concentrations are not equally distributed. The upper unit and the centre have in average 40 ppm of indium (up to 70 ppm In). Indium contents in bulk ore samples of the footwall unit are significantly lower (mean 12 ppm In). Quartz dominates as main gangue mineral, carbonates occur to a small extent in the centre of the vein. The presence of carbonates nevertheless is a severe problem to the intended experimental acidic in-situ bioleaching operation.

Subductionless Archaean continental drift and implications for secular tectonic evolution on Earth

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Characteristic arc facies (andesites, high P/T rocks, ophiolites) are rare to absent from Archaean cratons and greenstone belts. Phanerozoic arc magmas show Th/Yb vs Nb/Yb trends (Pearce 2008 Prec.Res.) parallel to the OIB/MORB array due to mantle wedge flux melting. In contrast, most Archaean lavas show oblique assimilation-fractional crystallization arrays. Phase equilibria and trace element models imply Archaean felsic melts (the AFC contaminant) formed by remelting of older felsic rocks, or by anatexis of tholeiitic metabasalt during underplating by hot plume-derived magmas. Although the evidence seems inconsistent with subduction, Archaean terrains commonly exhibit shortening fabrics that require horizontal tectonics. Continental drift in response to mantle currents resolves this conundrum. Once a deep high-viscosity mantle keel develops beneath a proto-craton it would become subject to pressure from mantle currents and could drift; whereas immature cratons or oceanic lithosphere would be static. Buoyant Archaean oceanic lithosphere would subcrete beneath the leading edges of drifting Archaean cratons, generating syntectonic pulses of anatectic magma. This scenario differs from

modern plate tectonics because there is no true subduction. There are similarities because modern continents also drift primarily in response to mantle currents, not plate boundary forces as many believe. Comparisons are made with Venus, a plume-dominated planet (Harris & Bédard this vol.). The Venus data imply the existence of continental drift and orogenesis on planets with no subduction or seafloor-spreading. We propose that Plate Tectonics today is constituted of two systems with different driving forces: a bottom-up continental drift system driven by mantle currents that started in the early Archaean, and a top-down subduction driven system that began in the Proterozoic. The fundamentally different Archaean rock associations and geochemical signatures are thereby explained.

Water- and boron speciation in hydrous soda-lime borate glasses

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Boron-bearing oxide glasses were intensively investigated in the past because of their various technical applications. Alkali borosilicates have been used as thermal shock-resistant glasses, whereas alkaline earth borosilicate glasses can be applied as substrate glasses for liquid crystal displays. Limitation in the use of borate glass comes from its sensitivity to corrosion by water. In order to better understand the mechanisms of corrosion, we performed structural investigation of hydrated borate using spectroscopic methods. Three soda-lime borate glasses (NCBx with x = 5, 15 and 25 corresponding to x Na_2O, 10 CaO, 90-x B_2O_3 in mol%) were prepared with water contents up to 8 wt%. The water speciation in the glasses was derived by near-infrared (NIR) spectroscopy while boron speciation was investigated by 11B MAS-NMR (Magic Angle Spinning - Nuclear Magnetic Resonance). For the three glasses effective molar absorption coefficients were determined experimentally for the bands at 5200 cm-1 and 4600 cm-1, corresponding to combination modes of H_2O molecules and OH-groups, respectively. In contrast to silicate glasses, in which at most ~2 wt% H_2O are dissociated to OH-groups, the amount of dissociated H_2O may even exceed 5 wt% in borate glasses. The fraction of tetrahedral to total boron (N4 = BIV/ BIV + BIII) is predominantly controlled by the ratio of Na_2O + CaO/B_2O_3, but only weakly affected by the water content of the glasses. When increasing the H_2O content from 0 to 8 wt%, N4 increases from 25% to 26% for NCB5 and from 42% to 47% for NCB25 glasses.

Implications from lateral zoning of plumes approaching ridges

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The interaction of mantle plumes and neighbouring mid-ocean ridges provides the unique opportunity to determine the causes of melting and melt mixing. It is here, where the distinct geochemical signatures allow to constrain the physical nature of the mixing process and the distribution and preservation of variably enriched and depleted sources. Here, we present new major element, trace element and Sr-Nd-Pb isotope data from the Foundation seamount chain and the local Pacific-Antarctic Ridge (PAR) along with published data. The distribution of enriched sources alike those found in other intraplate settings is limited to the central Foundation seamounts while the northern and southern seamounts of the Foundation chain erupt melts even more depleted in trace elements

and radiogenic isotopes than the local PAR. Based on the incompatible element ratios and radiogenic isotopes we develop a model in which the interaction between the central Foundation mantle plume and the PAR is dominated by melt-mixing as opposed to a solid-state mixing between a normal depleted and enriched plume mantle prior to melting at the outer plume. The distribution of these laterally distinct mixing processes is the result of an increased viscosity at lower temperatures along the outer plume compared to the central plume. In addition, the outer seamounts preserve evidence for a metasomatic overprint from the hotter, more enriched plume conduit. These signatures are likely only preserved in the less-well mixed melts of the outer plume and will be blurred in the central plume conduit by higher degrees of partial melting and thorough melt mixing. The implication of this observation is that the distribution of source signatures in mantle plumes depend on the distance to the faster upwelling plume conduit dominated by melt-mixing processes contrasting solid-state mixing on the outer plume rim where the melts reflect much of their original small-scale mantle heterogeneity.

Assessing the storage potentials in the subsurface of the northwestern German North Sea ("Duck's Beak") – challenges and opportunities

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Poster in Session B5-02

We present results from the investigation of storage potentials in the Duck's Beak area carried out within the project "Subsurface Potentials for Storage and Economic Use in the North German Basin" (TUNB). This investigation close the regional gap remaining from previous work determining the storage potentials in the central German North Sea Sector (GPDN) and onshore Germany (Speicher-Kataster Deutschland). Any estimation of storage potentials in the geological subsurface requires inter alia the identification and mapping of appropriate reservoir rocks (rocks with high porosity and permeability; i.e. sandstones) and barrier rocks (rocks with low porosity and permeability; i.e. claystones and salt rocks). A major challenge within the area investigated is given by its geological complexity caused by multiphase extension during Triassic to Late Jurassic times, halokinetic movements with formation of rim-synclines as well as Late Cretaceous structural inversion, resulting in strong local variations of the sedimentary record. Nevertheless, the high quality and quantity of available data (e.g. 3D seismic data and detailed 3D models) allowed not only to assess the storage potentials in the same level of detail as presented in previous studies, but also to focus on individual horizons, e. g. for a more detailed differentiation of the stratigraphic record into potential reservoir and barrier-rock horizons. An example is provided by Lower and Middle Jurassic subgroups, previously considered as a barrier and reservoir rock unit, respectively. In this study we envisage a formation-based mapping of the subgroups and their subdivision into individual "horizons" each of which comply with the criteria for a reservoir- or barrier-rock unit.

Microstructural and chemical mechanisms of the transformation of red (corallium rubrum) to white corals

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Red corals (corallium rubrum) are used from antique times until today as jewelry and because of mythological reasons. But mainly in the Iron Age calcite decorations of fibulae and chains are only white even suggested to derive from red corals. While those decorations from central Germany (Kleinkorbetha, Gräfen-hainichen, Hänichen) do not contain polyene pigments and low or no Mg contents, white decorations from south Germany (Langenau) and from Austria (Dürrnberg) imply red polyene pigments determined by Ra-man spectroscopy and Mg content of about 8%. TEM and e-diffraction studies of red corals reveal calcite mesocrystals each of them built up by nearly identically oriented nanocrystals confirmed by spotty 2D X-ray diffraction images. EELS data allow a local differentiation of the Mg contents in agreement with overall XRD data. TEM-studies of recent red corals transformed to white by NH4NO3 simulating color transitions of coral skeletons show, that, although the red polyene pigments remain stable. This color loss should be occurs attributed to the coarsening and/or loss of orientation of the calcite nanocrystal. Since, 2D-XRD images of transformed materials show typical Debye-rings without single crystal diffraction spots. A real color loss by the decay of polyene pigments can be produced only by annealing at $\sim 200°$C. These chemical and temperature treatments do not change the Mg contents of the coral calcites. The results are applied to archaeological question with respect to coral decorations on artefacts provided by Landesmuseum Württemberg Stuttgart, Salzburg Museen, Kreismuseum Bitterfeld, Landesmuseum für Vorgeschichte Halle and Naturkundemuseum Leipzig.

Origin of plate tectonics: Grain-damage, inheritance and hysteresis

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The emergence of plate tectonics was Earth's defining moment. How and when plate tectonics started is shrouded in mystery because of the paucity of observations in the Archean as well the challenge of understanding how plates are generated. The damage theory of lithospheric weakening by grain-reduction provides a physical framework for plate generation. This model builds on grain-scale processes to elucidate planetary-scale tectonics, and is consistent with lab and field observations of polycrystalline rocks and lithospheric shear zones. The grain-damage model accounts for the evolution of damage and healing (by grain growth) at various planetary conditions, hence predicts plate boundary formation and longevity, and how they depend on surface environment. Indeed, sparse evidence that prototectonics co-initiated with liquid water hints at the link between tectonics, water and surface conditions. The establishment of wide-spread plate tectonics started between >4Ga and 2.7Ga, and may have taken over a billion years to develop. Under Earth-like conditions, combining grain-damage with intermittent Archean protosubduction produces persistent weak zones that accumulate to yield well developed plates within 1Gyrs. In contrast, Venus' hotter surface conditions promotes healing, suppresses damage and inhibits weak zone accumulation, which explains why plate tectonics failed to spread on our sister planet. New work shows that the suppression of interface damage until moderately small grain-sizes (because other energy sinks for deformational work – like dislocation creep, grain-boundary sliding and inter-phase mixing – are potentially more facile) causes a hysteresis loop in which three possible equilibrium grain-sizes for a given stress coexist. These states include a stable small-grain-size high-shear state in diffusion creep analogous to ultramylonites, a

stable large grain-size weak-deformation state, and an intermediate unstable state comparable to protomylonit

Hydrocarbon Potential of the European Arctic - Chances and challenges

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While vast areas of the Arctic are still widely unexplored, the potential for undiscovered oil and gas resources is typically considered as very high. Besides the challenge of an environmental-safe potential exploration, it is presently unclear if such numbers as a "quarter of worldwide undiscovered petroleum resources" are meaningful. This is the background for the PANORAMA project (Potenzialanalyse des Europäischen Nordmeeres und angrenzender Randmeere der Arktis) at the Federal Institute for Geosciences and Natural Resources (BGR) to estimate the petroleum potential of underexplored regions in the European Arctic. This comes along with investigations about the environmental impact of a potential exploration in this sensitive area. We will present our approach to estimate the petroleum potential, which is based on literature, but also on geophysical, geochemical and microbiological data acquisition. Key issues are the regional distribution of potential source rocks and their respective quality. The aim of the study is to provide sensible and comprehensive estimates about the oil and gas potential of the area as basis for decision-makers and to substantiate discussions about exploration in the Arctic.

Propagation of paleoclimatic perturbations to turbidite systems, Chile convergent margin

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The details of how sediment-routing systems respond to millennial-scale climatic cycles are still strongly debated. Key questions include if, how, and how fast these signals propagate through a system, and how they are manifested in the sedimentary sinks. Cyclic climate change is widely recognized in (hemi-) pelagic sediments, where cyclicity is controlled by the direct influence of climate changes on the depositional environment (e.g., δ^{18}O of marine organisms). Some marine proxies partly depend on the efficiency of the mediating sediment routing system (e.g., detrital silt, clay mineralogy, organic biomarkers). Deep-marine turbidite successions may constitute another group of paleo-environmental proxies. They are dependent on the connectivity of the marine sink with the terrestrial sediment source and fluvial sediment delivery, and are underrepresented in paleoclimate studies. Five turbidite cores (0-26 ka BP) offshore the arid (30°S) and semiarid (32.5°S) sectors of the Chile continental margin were dated, quantified, and statistically compared to multiple marine and terrestrial climate proxies. Independent marine paleoclimate proxies (δ^{18}O, sea-surface temperatures), linked to Milankovitch cyclicity, correlate with the turbidite record. The highest correlation coefficients with the eustatic sea-level curve are obtained when lag times of 3-4 ka are inferred. The turbidite record is also highly correlated with marine proxies based on clay mineralogy, the carbon-preference index, and the humidity index based on grain-sizes; proxies that partly depend on terrestrial sediment routing. In this environment, the post-LGM decrease in humidity is co-registered in terrestrial and marine proxies and in the turbidite record almost simultaneously. Our observations highlight the rapid transmission of climatic signals through

terrestrial-marine sedimentary systems and the possible use of turbidite records as paleoclimate proxies along continental margins with narrow shelves.

Linking crystal structure to composition in tourmaline: A multi-method investigation of synthetic dravite, maruyamaite, magnesio-foitite, and oxy-uvite

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To date, there are 30 tourmaline endmembers $[XY_3Z_6T_6O_{18}(BO_3)_3V_3W]$, which are subdivided based on the dominant occupancy of the X site by Na, Ca, K, or vacancies (□). Tourmaline's variable chemistry reflects the flexibility of its structure, allowing each site to incorporate ions of variable size and charge. We synthesized 4 Mg-Al-tourmalines, each with a different X-site composition at 0.2 – 4.0 GPa, 700°C; namely, dravite [ideal: $NaMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_4$], oxy-uvite [$CaMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_3O$], maruyamaite [$KMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_4$], and magnesio-foitite [$\square(Mg_2Al)Al_6Si_6O_{18}(BO_3)_3(OH)_4$]. To investigate how composition affects the short- and long-range crystal structure, the endmembers were characterized by electron microprobe analysis (EMPA), single crystal X-ray diffraction and polarized Raman spectroscopy. The restricted composition of the crystals facilitated band assignment in the Raman spectra, a task that can be challenging for natural tourmalines. With increasing size of the X-site-occupying ion and concurrently the X-site polyhedron ($\square$ < Na = Ca < K), the unit cell volume expands from 1558.4(6) through 1571.7(3) and 1572.4(2) to 1588.1(2) $Å^3$. Locally, the O-H bond in the X-site-neighboring W site is sensitive to the X-site composition. The Raman spectra in the O-H stretching range show the O-H bondlength to be inversely proportional to the size of the X-site-occupying ion. The completely vacant X-site of magnesio-foitite results in deformation of the Si_6O_{18} ring and, correspondingly, an increase in the length of the V site O-H bond. The presence of local X-site vacancies (magnesio-foitite components) in the other tourmalines does not result in comparable bands in the Raman spectra. Deconvolution and integration of bands in the O-H-stretching range allows the net Mg and Al contents, as well as their disorder between the Y and Z sites, to be quantified. The obtained values are in good agreement with the results of EMPA and single crystal structure refinement.

Reductive biogeochemical sequence triggered by hydrogen in experiments using aquifer sediment and groundwater

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The fluctuating power production of renewable energy sources is a major challenge for the power supply system, and could be stabilized by subsurface energy storage. Geological hydrogen storage is potentially able to balance over/underproduction of up to several TWh energy over several months. A potential risk of such storage facilities is the accidental leakage (via fractures or well failure) of hydrogen into overlying shallow aquifers protected for drinking water production. No experimental studies are available evaluating the effects of intruding hydrogen gas, which produces dissolved hydrogen in concentrations of around 1 mM on the groundwater composition. Within the presented investigation, batch and column experiments were carried out representing different sediment-groundwater conditions to evaluate biogeochemical processes potentially changing the quality of protected groundwater

resources. Immediate reduction of nitrate was identified following introduction of hydrogen in the experiments. The magnitude of the reactions is limited by the amount of dissolved hydrogen available. If it is provided in surplus, the full sequence of available electron acceptors (nitrate, sulfate and carbonate) is entirely consumed. At the same time, sulfide and nitrite are produced, the later rising above the limits allowed for German drinking waters. Additionally, pH increases and conductivity decreases continuously, the later suggesting a possibility for geoelectric monitoring of hydrogen leakages. This study provides the first experimental results of this topic, and further studies have been started aiming at the quantification of the induced chemical reactions of hydrogen intrusions. Site-scale numerical models for risk assessment and monitoring utilize such experimental parametrization to quantitatively predict changes in water composition due to hydrogen intrusions. This work is part of the ANGUS+ project (03EK3022A) funded by the German Ministry of Education and Research.

High-pressure phase transitions of strontianite

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Carbonates are among the most important crustal materials, but they are also present in the deep Earth as it is confirmed by their presence as inclusions in transition-zone diamonds (Brenker et al., 2007). Carbonates control carbon cycling in the Earth's mantle, and knowing their high-pressure behavior is a major focus of mineral physics research. Strontianite ($SrCO_3$) is isostructural to aragonite, a major high-pressure polymorph of calcite. $SrCO_3$ is thus an analogue material to investigate high-pressure phase behavior of aragonite-group minerals. The few available high-pressure studies of $SrCO_3$ disagree regarding both pressure stability and structure of the post-aragonite phase (Lin & Liu, 1997; Ono et al., 2005, Wang et al. 2015). To clarify such controversies we investigated the high-pressure behavior of synthetic $SrCO_3$ to 78 GPa by Raman spectroscopy. Strontianite was synthesized at 4 GPa and 1273 K for 24h in a multi anvil apparatus. We compressed single-crystals or powder samples in the diamond anvil cell, and measured Raman scattering up to 78 GPa. $SrCO_3$ presents a complex high-pressure behavior. We observe mode softening above 20 GPa and a phase transition at 26.9 GPa, which we interpret as due to CO_3 groups rotation, in agreement with Lin & Liu (1997). Finally we observe new Raman bands at 41.8 GPa in single crystals that suggests a second transition. The interpretation of the Raman observations in terms of structural transitions will be discussed. References:

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Major Water Engineering Projects as key driver for the transformation of landscapes: An analysis of case studies from the Fergana Valley and the Lower Jordan Valley

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During 3 years the Interdisciplinary Research Group (IRG) Society – Water – Technology of the Berlin Brandenburg Academy of Sciences and Humanities addressed the central question on the impact of major water engineering projects (MWEPs) on the development of coupled socio-technical systems in water management. Two case studies served as references for the findings of the IRG: The Fergana Valley in Central Asia and the Lower Jordan Valley. Besides the questions of socio-economic relevance with concern to MWEPs the IRG treated the question how landscapes in the case studies had been transformed by major water engineering projects for irrigation purposes and which effects could be observed on the water resources. For the evaluation of MWEPs in the case studies, an evaluation framework has been designed. The framework is subdivided in different arrays of attributes and primary classes of entities, which are embedded in a social, economic and political setting: • Resource systems attributes • Governance systems attributes • Stakeholder attributes • MWEPs attributes In this study we will concentrate our analysis on the the resource systems attributes and how they had been altered by MWEPs in the case studies. With the Aral Sea, the Lake Tiberias, and the Dead Sea we have three examples of inland seas which water balances but also water qualities had been dramatically altered by the consequences of MWEPs. In both case studies the purposes of MWEPs had been to establish and extent irrigated agriculture. We will analyse the effects of the current water uses by agriculture on groundwater resources, water qualities and on the water balance in general. In the last decade we could observe in the two case studies efforts to mitigate the negative effects of the MWEPs. We will analyse if those efforts had been sufficient to stabilize the levels of the inland lakes or if we have to reconsider in a perspective of sustainable development of water resources the applied strategies.

Constraints on fluid flow and mass transport on diagenesis in sedimentary basins. Predicting physical properties of sandstones and shales

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The properties of sedimentary rocks depend mostly on the primary mineralogical and textural composition at the time of deposition prior to deeper burial. Significant mass transport involving net dissolution and precipitation of minerals is limited to flushing of sand by meteoric water at shallow burial in wet climates and dry evaporitic conditions. Clays and mud and also many sandstones are to a little extent flushed by meteoric water in marine environments, thus preserving their chemical composition. Burial diagenetic mineral reactions can therefore be written as balanced equations driven by thermodynamics and kinetics. With increasing temperatures the pore water will approach equilibrium with most of the minerals present reducing the effect of both advective and diffusive transport. Advective flow of pore water is limited by the rate of porosity loss during compaction with the exceptions of hydrothermal activity around igneous intrusions. In basins like the North Sea the pore water composition often show stratification. The composition of marine mud varies greatly as a function of provenance and depositional environments. Nearshore and deltaic mud tend to contain much kaolinite while more distant clays contain more fine grained clays like illite and smectite resulting in very different shales after burial diagenesis. Organic components like silica and carbonate are also controlled by facies and they strongly influence porosity, permeability and fracture properties of shales. It is also important for the sealing capacity of shales as cap rocks. Lamination of organic matter may strongly influence the vertical permeability and wetting properties of shales and the expulsion of oil and gas. Basin analyses should include detailed sedimentological analyses of not only sandstones and carbonates, but also of the composition of

shales, particularly the textural and mineralogical composition.

Petrography and Structural Geology of the westernmost Dycedale Syncline (Barberton Greenstone Belt, South Africa) – Implications for Archean tectonics and depositional environments

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It is debated how Archean crust formed and was deformed; thus, the complex history of the Kaapvaal Craton of southern Africa and its greenstone belts remains incompletely understood. In a case study of interrelated sedimentation and deformation, we investigated an excellently exposed region ca. 1 km2 in size of the westernmost Dycedale Syncline (DS) in the north-central Barberton Greenstone Belt (BGB). The DS is a steeply southwest-plunging, northwestwardly overturned, fault-bounded syncline made up of ca. >600 m of sandstones and siltstones, subordinate conglomerates, BIFs, and volcanics of the 3.22 Ga-old Moodies Group, the uppermost stratigraphic unit in the BGB. Lithostratigraphic correlation of the synclinal fill of the Dycedale Syncline which includes a distinctive basaltic lava was based on stratigraphic measured columns, paleocurrent data, sandstone petrography and a detailed, 1:1,500-scale geological map. Fourteen lithofacies document a basal alluvial unit overlain by braided fluvial, shoreline and tidal strata which can be assigned to units MdS1, MdQ2, MdI2 and MdL2 of conventional BGB stratigraphy. Provenance analyses of submature sandstones indicate at least three sediment sources, largely located to the northwest of the study area. Gravelly braided-stream facies host large shreds of microbial mats; shoreline sands contain abundant evaporitic concretions, and at least two surficial lava flows show indications of subaerial weathering. Significant bed thickness variations in the absence of penetrative strain indicators suggest that strain was taken up along discrete cryptic planes or that sedimentation occurred simultaneously with folding. If the latter was the case, the westernmost DS would represent a small part of a cool, ductile "greenstone drip" which became arrested between rising plutons while sinking into hot Archean lithosphere.

Metalloid - noble metal relations in hydrothermal systems from the Manus Basin, Papua New Guinea

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The Manus basin is a young and rapidly opening back-arc basin and has been considered a typical setting, in which VMS deposits may have formed. Water and rock samples were collected from different hydrothermal areas in the eastern Manus Basin to assess the effects of variable magmatic fluid inputs and crustal composition on vent fluid geochemistry in relation to arc vicinity. We measured trace element contents (Au, Ni, Cr, Pt, Co, Cu, Zn, As, Se, Mo, Ag, Cd, Sb, Te, W, Pb, Bi) of sulfides by LA-ICP-MS. Vent fluid compositions [1, 2] were used to compute the speciation of Sb and As and the solubility of solids incorporating these metalloids. Whole rock analyses were employed to determine the distribution of Sb and As in polymetallic massive sulfides. Vent fluid temperatures and pH vary between 100 and 350°C, and 1 and 5, respectively, but As and Sb are most enriched in fluids with T=250-270°C and pH=2-3. The main host phase of As is tennantite, occurring as inner conduit lining along with chalcopyrite, and As contents are as high 2.7 wt.% in the bulk sulfide samples. Sb-minerals are not present, but Sb may partition into tennantite, leading to As-Sb correlations in Cu-rich massive sulfides. More commonly, Sb enrichment (to 0.22 wt.%) is observed in Zn-Fe-Ba-rich beehive chimneys. Increased contents of both metalloids is restricted to black smoker systems from felsic basement (PACManus, South Su). Acid-sulfate vents (at Desmos and North Su) and the basalt-hosted Vienna Woods vent field have exceedingly low Sb and As contents. The two metalloids may be useful index elements in exploration, as both fluids and solids reveal tight relations between Sb and Ag as well as As and Au.

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Evidence for Metamorphic Slab Dehydration in the Central Andean Subduction Zone, Derived from Volumetric Vp/Vs Measurements And Thermodynamical Modeling

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In the subduction process oceanic lithosphere descends into the mantle and is exposed to higher pressures and temperatures. Predominantly the increase in temperature drives the breakdown of water bearing minerals within the oceanic lithosphere. Through this process, mineral-bound water is continuously released into a dynamically evolving pore-space. To which extend the water resides in the subducting plate and how it flows within the subduction system is not yet conclusively resolved. The presence of free fluids within a given rock volume leads to an increase in the seismic P- to S- wave velocity ratio (Vp/Vs). Here, we use this phenomenon to detect the presence of free fluids within the Central Andean subduction system. We derive the three-dimensional distribution of Vp/Vs from precise differential arrival-time measurements of local earthquake body waves. In the subducted oceanic crust between 20 and 50km depth we observe typical Vp/Vs ratios near 1.75, between 50 and 60km depth low values near 1.60 predominate and below 90km high values above 2.00. In the oceanic mantel between 50 and 60km depth, we observe high values between 1.90 and 2.00, below 90km depth we find very low values below 1.50. The comparison of the seismologically derived Vp/Vs ratios with values that we computed form the elastic properties of the thermodynamically modeled mineral assemblage shows that values between 1.70 and 1.80 may be explained by non-porous, macroscopically isotropic rocks. Poroelastic modeling shows that high Vp/Vs ratios can be related to the presence of small volumes (<1%) of fluid-filled pores with a crack-like geometry. The depths of high-Vp/Vs-anomalies correspond to the depths of mineral dehydration reactions such as the breakdown of Antigorite in the oceanic mantle or Amphibole and Chlorite in the oceanic crust. Very low values hint towards the presence of macroscopic anisotropy.

The oil generation potential of coals from Svalbard and the Northern Barents Sea

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On Svalbard coals from the Late Paleozoic, the Mesozoic, and Paleogene are known. However, their geochemistry is not well understood. During BGR-expeditions to Svalbard coals from the Lower Carboniferous (Billefjorden Group), Cretaceous (Helvetiafjellet Fm.), and Paleocene (Firkanten Fm.) were sampled. Maceral and biomarker analyses demonstrated that organic matter from higher plants (i.e. gymnosperms) predominates (indicated by abundant sporinite (liptinite) and bicyclic diterpane hydrocarbons). A high degree of reworking is e.g. indicated by high contents of bacterial hopanes, which appear to have particularly affected the Paleocene coals. Hopanes may here either record the terrestrial origin of the bitumen or mirror a marine overprint due to the near-shore depositional setting. The latter scenario is supported by partially high S contents in the coals (up to 5 %). Coals may either be humic (mostly from vascular plant material) or sapropelic (with algal-, sporinite-, waxy coating-, resin- and other H-rich organic matter). All studied coals exhibit elevated hydrogen contents (HI up to 320 mgHC/gTOC). In contrast to humic coals sapropelic coals are known to generate abundant non-gaseous aliphatics and are thus oil-prone. Oil-prone coals of Paleocene age may only be abundant in and close to the Central Basin of Svalbard and are thus only an unlikely considerable source for petroleum in that region. During the Carboniferous, however, coals may be more widespread in the Barents Sea region and current findings support that respective coals have to be considered as an additional petroleum source rock in the Arctic. This would correspond to other regions in the world (e.g. in the Gippsland Basin), which also demonstrate that an understanding of the kinetics is crucial to understand the expulsion efficiencies from oil-prone coals. Respective information for the coals from Svalbard and the Barents Sea are still missing and are an objective of our current studies.

Geological bias in the provenance record: an example of Rodinia margin granites from the Seychelles

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Every sediment layer contains billions of detrital grains, and every grain preserves imprints of its geological story as the provenance signal. Recent studies have shown that combinations of source lithology, weathering and variable transport processes account for large differences in provenance signals. Geological bias in the provenance record is illustrated by the U-Pb zircon peak distributions in the Earth´s record, which has been shown to reflect the detrital fertility of certain lithologies. Provenance analysis may enable us to reconstruct the geological processes that shaped the Earth´s crust, but only if we understand more deeply the physical and chemical processes that modify sediment composition during the sedimentary cycle, and quantify how representative our samples actually are of the true geological history of Earth. To identify the extent of the geological bias in the provenance record, we focus on the granitic Seychelles islands, which are interpreted as the root of a continental magmatic arc that was active during, or slightly preceding, the break-up of the Rodinia supercontinent (~748-755 Ma). This natural granitic laboratory enables us to exclusively study granitic source to sink relationships. We compare whole rock geochemistry, U-Pb zircon and U-Pb apatite ages of different granitic rocks with the local beach sands. Additionally, the Hf isotopic signature of both magmatic and detrital zircons are compared to investigate how the different modes of crust–mantle evolution are preserved.

Maximum earthquake magnitudes in relation to fault zone evolution: The case of the North Anatolian Fault Zone

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Estimating the maximum likely magnitude of future earthquakes on continental transform faults has fundamental consequences for the expected seismic hazard. Since the recurrence time for those earthquakes is typically longer than a century, such estimates rely on well-documented historical earthquake catalogues. Here, we show that the maximum observed earthquake magnitudes along the North Anatolian Fault Zone (NAFZ) are related to fault zone evolution defined in terms of the cumulative offset, age of the fault and maximum length of coherent fault segments. The findings are based on a compiled catalogue of historical earthquakes in the region, using the extensive literary sources that exist due to the long civilization record. We find that the largest M7.8-8.0 earthquakes are exclusively observed along the well-developed part of the NAFZ in the east. In contrast, the western part is still in a development stage. Our results suggest that the maximum expected earthquake magnitude in the Marmara region including the 15-million population center of Istanbul will probably not exceed M7.5. The results are consistent with available knowledge for the San Andreas Fault and Dead Sea Transform. The obtained relation between maximum observed earthquake magnitudes and fault-zone evolution may be used to estimate hazard potential of transform faults in regions with sparse information on historical seismicity.

Gas hydrate dynamics of pockmarks at continental margins – Results from MeBo sea floor drilling offshore Nigeria

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Pockmarks are seafloor depressions commonly associated to fluid escape from the seabed. Such seafloor features occur globally in many different areas and geological contexts, and vary greatly in size and shape. During the Guineco-MeBo cruise in November 2011 on research vessel Pourqoi Pas? we studied a field of pockmarks south of Nigeria in the Gulf of Guinea seaward of the modern Niger delta in around 1,000 m water depth. Results obtained by deep coring with the MeBo drill rig up to 56 m through gas hydrate sediments together with geotechnical in situ measurements and pore-water analyses confirmed that pockmark formation and evolution are mainly controlled by hydrate growth. Outside the pockmarks no hydrates were found. An additional finding was that rapid growth of hydrate in shallow sediments is promoted by free gas migration from below. Gas flares in the water column have been found and debris of chemosynthetic animals sampled in gravity cores, showed that the gas hydrate is forming the basis for chemosynthetic live in distinct areas of the pockmarks. Free gas is co-existing with hydrates and thus is reducing the density of the sediments. We therefore conclude upward floating of hydrate/sediment pieces in our model of pockmark formation

Modeling the rheology of olivine using 2.5D dislocation dynamics simulations

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Large scale flow in the Earth's mantle involve plastic deformations of rocks and of their constitutive minerals. Due to the extremely slow strain rate conditions in the Earth's mantle, it is very challenging to identify the fundamental mechanisms controlling such process. Thus, the development of a multi-scale approach linking the atomic scale properties and the microscopic elementary mechanisms to the macroscopic behavior is needed [P. Cordier et al., Nature 481, 177 (2012)]. One of the key steps in this approach is the description of dislocation-based intra-crystalline plasticity. Within this framework, we present a model to investigate creep in olivine at the mesoscopic scale. In particular, we employ 2.5-Dimensional dislocation dynamics simulations to investigate the interplay between thermally activated glide and climb motion and to study the effect of climb on olivine creep strain rates [Boioli et al., submitted to Phys. Rev. B]. From our results it emerges that it is fundamental to consider the climb mechanism in order to reach steady state creep conditions. At high temperature (T>1400 K) and with applied creep stresses between 10 and 100 MPa, it is possible to describe the creep strain rates by a power law. A constant value for the stress exponent n close to 3 and an activation enthalpy of 489.2 KJ/mol are found in agreement with published experimental results. From an analysis of the average mobile dislocation density and velocity we formulate a semi-analytical model able to reproduce the creep behavior in olivine at low stress and high temperature. At lower temperatures and for larger applied stress values, deviations from this power law are found. Moreover, we find that recovery involving diffusion play a key role in the plastic behavior, even at low temperatures, under low strain rates conditions. Our simulations can help to understand the active deformation mechanisms in both the asthenospheric and the lithospheric mantle.

Evolution and erosional dynamics of intermontane basins on the Puna Plateau, NW Argentina

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The Puna de Atacama Plateau in NW Argentina and northern Chile is the southern part of the second-largest orogenic plateau on Earth – the Altiplano-Puna Plateau – with a mean elevation of 4.0 $\pm$ 0.5 km ($\pm 2\sigma$). The Puna is located in the south-central Andes that exhibit a steep topographic and climatic gradient: The first windward topographic rise in the western south-central Andes constitutes a significant orographic barrier resulting in high orographic rainfall. In contrast, the higher-elevation areas of the windward flanks become progressively drier, until arid conditions are attained in the orogen interiors and in the Puna. The Puna experienced significant paleoclimatic changes with deeper penetration of moisture into the orogen and thus an orogenward shift of the climate gradient. The southern Puna is dissected into more than 500 individual, internally-drained basins with varying catchment sizes. Here, we quantify the erosion-rate gradients and their impact on intramontane basin evolution and their importance on the plateau formation. We rely on sedimentary archives, digital topography, and a new set of cosmogenic inventories of river sands (^{10}Be) and bedrock-erosion rates (^{10}Be and ^{26}Al) from the eastern and central Puna Plateau in NW Argentina. Erosion rates from internally-drained catchments in the eastern Puna Plateau are similar to the externally-drained and dry intermontane basins to the east, but are ten-fold (or more) lower than erosion rates in the humid and steep sections at the mountain front. Interestingly, erosion rates in the central Puna are ten-fold lower than on the Puna margin to the east. In a final step, we compare fluvial with aeolian erosion rates in the interior of the orogen and show the increased aeolian contribution toward the central Puna.

Earthquakes Depth Accuracy of the Zagros Continental Collision Zone using Nonlinear Probabilistic Method

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The Zagros continental collision zone extending from eastern Turkey to the Makran subduction zone in the southern Iran. It resulted from the Arabian–Eurasian collision (Mouthereau et al., 2012).The studied area is part of south Zagros (26-31°N and 50-55°E). 2100 events , Mn≥2.5, 2006 to 2011 have been taken from IGUT-IrSC catalogue. Used data are arrivals time of the phases, include Pg, Pn, Sg, and Sn. Used crustal model, is Hatzfeld et al. (2003). Location of the recorded earthquakes in the studied catalog, has high rate of errors because of various reasons, such as inappropriate coverage of stations, inaccurate velocity structure, and using linear methods. Nonlinear method and Non Lin Log software for earthquake relocation was introduced by Lomax et al. (2000). Several factors such as Azimotal Gap, RMS, magnitude and number of phases affect earthquake relocation accuracy. In this study a profile perpendicular to the general trend of fault structures was considered in Zagros. Checking the depth and depth error using Nonlinear Probabilistic Method shows that deep earthquakes have higher rate of depth error, and thus when the depths are over 40 km, the depth error is over 10 km. In the relocation of the events that have depth error less than 10 km, obtained depth less than 40 km. For more reviews only earthquakes with less than 5 km depth error were examined, these earthquakes limited in less than 20 km. Number of these earthquakes are 86 events and error of epicenters is less than 20 km. Comparing the depth and depth error estimated in this study and the ISC catalogue for the 253 events have been revealed that depth of the earthquakes in ISC are 1 to 61 km, and earthquakes depth error are less than 10 km. In this study the depth of the earthquakes have been determined zero to 80 km, and earthquakes with less than 10 km depth error, have depth zero to 30 km.

How the largest plate on Earth originated in a point

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The oldest piece of oceanic crust of the Pacific plate contains Lower Jurassic magnetic anomalies in three orientations; the NE-trending Japanese, NW-trending Hawaiian and E-trending Phoenix lineations. These sets of anomalies form a triangle, with the oldest crust in the center and younger crust towards the northeast, northwest and south. The geometry of the magnetic anomalies implies that the Pacific plate formed as the result of ocean spreading in three ridges between the Pacific and three conceptual adjacent plates; the Izanagi, Farallon and Phoenix plates. Although some relics of these plates may still be present today, most of their surfaces have been subducted along circum-Pacific active margins. When reconstructing the Pacific anomalies and their mirrored counterparts back in time towards the moment of origin of the Pacific, it becomes clear that the Pacific plate originated in a point, that represented a triple junction between the Izanagi, Farallon and Phoenix plates. This is generally assumed to have been a ridge-ridge-ridge (RRR) triple junction. Many examples of such junctions exist that have been stable for tens of million years without formation of a new plate in the junction. The triple junction from which the Pacific plate originated fell apart into three RRR-triple junctions, and we postulate that the I-F-P triple junction was unstable and existed only at the moment of formation of the Pacific plate. Here, we show a scenario how a stable three-plate system develops into an unstable triple junction, subsequently evolving into a stable four-plate system. The transition from stable to unstable is not controlled by external forces, but is merely the result of plate boundary shape; a trench-transform-transform triple junction migrates towards a kink in the trench, creating an unstable transform-transform-transform triple junction at the location of the kink. We test the physical plausibility of this scenario through a simple numerical model.

Coastal Floods Threatening European Cities: a Large Scale Damage Function Assessment

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The objective of this study is to develop a standardised and transferable damage approach for coastal cities. The approach is based on a library of city-based impact functions for the case of coastal flooding and to provide estimations for the required efforts to protect the cities against floods of certain height. The work aims at combining the best of the two types of approaches, that is, the application of a consistent top-down approach that enables the comparability of results, and the use of high resolution data sets and proxies other than population in order to better depict local features and assets determining damages. From various freely available data sets we derive 140 macro-scale damage functions. Further analyzing the damage functions, we derive an indicator for the vulnerability to coastal floods of the corresponding cities, leading to a riskscape across Europe. Furthermore, results from analyzing the protection needs in the urban clusters are discussed. The results can serve as input pan-European assessment of coastal flood damages in view of sea level rise and protection measures.

Source rocks potential and maturity modelling of the east Mediterranean Levant basin and its eastern margin

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The Levant basin is a frontier basin that has in the last decade gained a lot of industrial and academic interest due to the huge gas discoveries that have been reported in its southern part. The reported gas in Miocene reservoirs has been assumed to be derived from biogenic sources, although little data has been published so far. The thickness of the sedimentary column and the presence of direct hydrocarbon indicators (DHI) observed in the seismic data suggest the presence of promising prospective thermogenic petroleum systems in deeper intervals in the Levant Basin and along its Margin. In this study we have analysed several potential petroleum source rocks exposed along the Levant margin (onshore Lebanon) and constructed a 3D thermal history and maturity model in order to evaluate the maturity of key source rocks intervals throughout the basin. Geochemical and petrographic data proved the presence of several immature oil prone and gas prone source rock intervals along the Lebanese onshore. Some of these source rocks can also be present in the deeper offshore. Modelling results suggest several prospective working petroleum systems, including a Cretaceous-Oligo-Miocene system (biogenic and thermogenic) in the deep basin, a Jurassic-Cretaceous along the margin, and a Permian-Triassic in the onshore. Oligocene and Miocene turbidites could be filled with oil

and gas from Cretaceous-Eocene source rocks in the deep basin. Lower Cretaceous sandstones, which have excellent reservoir quality onshore, might be charged with oil and gas from Jurassic and Lower Cretaceous shales along the margin. In the onshore area, Lower Triassic reservoirs sealed by middle Triassic evaporites in Miocene and pre-Miocene structures would most probably be filled with oil and gas from Permian and Triassic source rocks.

Weathering of shales under a tropical climate in the Bolivian Andes

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Because of plate tectonics, sedimentary formations are uplifted during mountain building and subsequently undergo rapid weathering and erosion. Because these rock types comprise such a large portion of the outcropping continental area, their weathering has a major impact on global biogeochemical cycles, solutes and particulate fluxes to the oceans, and evolution of atmospheric CO_2. Based on an extensive sampling of more than 20 rivers draining the Bolivian Andes (Beni and Mamoré basins) and the associated foreland and lowland areas of the Madeira Basin (Amazon), we quantify weathering and erosion rates of meta-sedimentary rocks. The Bolivian Andes are particularly well adapted to such a study as they are mostly underlain by sedimentary rocks, feature high erosion rates, and are part of the Amazon Basin, the largest river system in the world. After correction for inputs from the atmosphere and halite dissolution, we use an inverse method to solve a novel set of mass budget equations and estimate the contribution of the various weathering end members: silicate, carbonate, and evaporite. Silicate weathering contributes to around 70% of the chemical denudation in the upper Beni basin. The contribution of carbonate weathering attains 50% in some Andean rivers. In addition, we quantify the relative role of sulfuric acid (derived from the oxidation of sedimentary pyrite) as a proton supplier for weathering reactions. Sulfuric acid dominates weathering reactions in the upper Bolivian Andes but is much less significant at lowland sites. As a result, in the Andean area, weathering reaction consumes only a limited amount of acidity derived from atmospheric CO_2, while in the lowland area of the Madeira basin, weathering reactions represent a net sink of atmospheric CO_2. We find that the net atmospheric CO_2 sink related to weathering in the Madeira basin over long time scales is around 40 x 1064 mol y^{-1}, i.e. 3 times lower than previously suggested.

Consequences of HT metamorphism during sedimentary basins formation

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While several tectonic models are proposed to explain the formation of extensive basins and passive margins, only one single thermal model (McKenzie , 1978), as a dogma, is used to understanding and modeling the formation and evolution of sedimentary basins. This model is based on the assumption that the extension is only by pure shear and it is instantaneous. Under this approach, the sedimentary deposits occur in two stages, a short step controlled by tectonics and a longer one resulting of the cooling of the lithosphere. However, most stratigraphic data indicate that less thermal model can account for documented vertical movements. The study of the thermal evolution, coupled with other tectonic models, and its consequences have never been studied in detail, although the differences may be significant and it is clear that the petrological changes associated with changes in temperature conditions, influence changes reliefs. In addition, it seems that the relationship between basin formation and thermal evolution is varying between two end-members: - Some margins document a rise in geothermal gradient the temperature rise 50 to 100 Ma prior the tectonic extension. In the Alps, the HT event is Permo-Triassic and is followed by a "cold" extension , leading to the opening of the Ligurian-Piedmont ocean, from the Middle Jurassic . - Other examples show that temperature changes are synchronous with basin formation . The Cretaceous North Pyrenean (CNP) basins clearly indicate that an HT-event is contemporaneous of sediment deposit. By quantifying the temperature evolution of the sediments from the CNP basins, we discuss the consequences of the early HT event on the basin evolution (subsidence, mantle exhumation, . . .). Meanwhile we will discuss other important aspects of HT overprinting on the rocks of the basin: changes of physical properties (density, seismic velocities, . . .).

Paleostress field analysis of collisional tectonics along the margin of the Alaska-Chukotka microplate

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Subduction and collision are important processes that occurred during the formation of the Arctic region. In the last decades, plate tectonic models have been developed to explain the evolution of this area, but there are still open questions. A key element for the geodynamic evolution of the Arctic region is the opening of the Amerasia Basin and the collisional processes at the margins of the Alaska–Chukotka microplate. This microplate covers an area from the New Siberian Islands in northeastern Russia to the Yukon North Slope in northern Canada, with a southern boundary that is defined by a suture zone. Based on fault-slip data derived from outcrop studies, we determined the orientation of the paleostress field during the subduction-collision stage at the western edge of the Alaska–Chukotka microplate in the area of the New Siberian Islands. The fault-slip inversion indicates three paleo-shortening directions (NE–SW, WNW–ESE and NNW–SSE to NNE–SSW), which are Mesozoic in age. This horizontal shortening is most likely related to the closure of the South Anyui Ocean. The NE–SW-oriented paleo-shortening is the dominant tectonic direction in the study area and reflects the fold-belt formation during the collision. The WNW–ESE and the NNE–SSW- to NNW–SSE-oriented paleo-shortening directions are likely also a consequence of the formation of the South Anyui fold-belt. The NNE–SSW to NNW–SSE-directed contraction could have been the result of a bend in the suture zone and related along-strike changes in shortening direction during fold-belt formation. From the paleostress field orientation it can be derived that the South Anyui suture zone trends WSW-ENE in the area of Bol'shoi Lyakhov Island and shifts into a NNW–SSE–directed orientation between Stolbovoy and Kotel'ny Island. Remarkable are wide spread strike-slip faults that dominate the whole area. Cenozoic extension is the youngest tectonic phase in the area and was related to the evolution of the Laptev Sea Rift.

Climate-change induced earthquakes in northern Central Europe

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There is growing evidence that climate-induced melting of large ice sheets has been able to trigger fault reactivation and earthquakes around the migrating ice limit. Even today, the stress due to glacial isostatic adjustment can continue to induce seismicity within the once-glaciated region. Northern Central Europe lies outside the former ice margin and is regarded as a low-seismicity area. However, several historic earthquakes with intensities of up to VII occurred in this region during the past 1200 years. Here we show with numerical simulations that the seismicity can potentially be explained by the decay of the Scandinavian ice sheet after the Weichselian glaciation. Combination of historic earthquake epicenters with fault maps relates historic seismicity to major reverse faults of Late Cretaceous age. Mesozoic normal faults remained inactive in historic times. The spatial and temporal distribution of earthquakes (clusters that shift from time to time) implies that northern Central Europe behaves like a typical intraplate tectonic region as demonstrated for other intraplate settings. We suggest that many faults in northern Central Europe are active during postglacial times. This is supported by the results of the numerical simulations, expressed in the characteristics of δCFS graphs, which indicate the likelihood that an earthquake is related to GIA. All graphs show a change from fault stability to instability during the deglaciation phase. Here, we present the first consistent model that can explain both the occurrence of deglaciation seismicity and the historic earthquakes in northern Central Europe. Thus, we speculate that the historic seismicity in northern Central Europe is probably a kind of aftershock sequence of the GIA seismicity, which sheds new light on the distribution of postglacial faults in general.

Radiogeochemistry of Radium in a nuclear waste repository system

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Radium-226 is a decay product of U-238 and may play an important role regarding the dose rate in long term safety assessments for the direct disposal of spent nuclear fuel. The solubility control of Ra by the formation of a (Ra,Ba,Sr)SO_4 solid solution has been demonstrated in many cases. Co-precipitation leads to the formation of structurally incorporated Radium within the barite structure. Such solid solutions are ubiquitous in natural systems – most minerals in nature are atomistic mixtures of elements rather than pure compounds. In many cases the formation of solid solutions leads to a thermodynamically more stable situation compared to the formation of pure compounds, due to a negative excess Gibbs energy of mixing. However, radionuclide solubility control by solid solutions is currently not considered in long term safety assessments for a nuclear waste repository system. One reason is related to the fact that only a limited number of rather simple solid solution systems have been studied to a sufficient level. Nevertheless, the thermodynamic concepts for solid solution formation under repository relevant conditions are very well developed. Here, we have combined microscopic and spectroscopic experimental approaches to study how a Ra containing solution equilibrates with solid $BaSO_4$ and $SrSO_4$ under repository relevant conditions. Furthermore, a molecular level mixing model has been derived on the basis of first principle calculations. In general, Radium solubility is significantly reduced if it is controlled by a binary (Ra,Ba)SO_4 solid solution. Atomistic modeling indicates that a regular solid solution model may be applied. The thermodynamic parameters for the solid solution have been derived and can now be applied in the long-term safety assessment of the direct disposal of spent nuclear fuel.

Models and observations of plume-ridge interaction in the South Atlantic and their implications for crustal thickness variations

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Mantle plumes are thought to originate at thermal or thermo-chemical boundary layers, and since their origin is relatively fixed compared to plate motion they produce hotspot tracks at the position of their impingement. When plumes reach the surface close to mid-ocean ridges, they generate thicker oceanic crust due to their increased temperature and hence higher degree of melting. Observations of these thickness variations allow estimates about the buoyancy flux and excess temperature of the plume over time. One example is the interaction of the Tristan plume with the South Atlantic Mid-Ocean Ridge, however, conclusions about the plume properties are complicated by the fact that the Tristan plume track has both on- and off-ridge segments. In these cases, where a plume is overridden by a ridge, it is assumed that the plume flux has a lateral component towards the ridge (the plume is "captured" by the ridge). Additionally, sea floor spreading north of the Florianopolis Fracture Zone did not start until $\sim$112 Ma – at least 15 Ma after the plume head arrival – while the Atlantic had already opened south of it. Therefore, the plume is influenced by the jump in lithosphere thickness across the Florianopolis Fracture zone. We present crustal thickness and plume tracks of a three-dimensional regional convection model of the upper mantle for the Tristan-South Atlantic ridge interaction. The model is created with the convection code ASPECT, which allows for adaptive finite-element meshes to resolve the fine-scale structures within a rising plume head in the presence of large viscosity variations. The boundary conditions of the model are prescribed from a coarser global mantle convection model and the results are compared against recently published models of crustal thickness in the South Atlantic and hotspot tracks in global moving hotspot reference frames. In particular, we investigate the influence of the overriding ridge on the plume head.

Isotopic Fingerprints of Early Solar System Events

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Calcium–aluminum-rich inclusions, or CAIs, were the first solids to condense in the cooling protoplanetary disk and thus represent a snapshot of the isotopic character of the reservoir from which they formed. For a few specific elements, the isotopic character of the CAI-forming reservoir has been known for decades to be different from that of the reservoir of the "average" Solar System—as represented by inner Solar System rocks. For example, these difference are apparent for elements near the Fe-peak of nucleosynthesis [e.g., 1-2]. However, recent studies have shown that these subtle isotopic differences extend to elements at much higher masses, up to at least A$\approx$186 [3-5, references therein], and possibly higher. Interestingly, the isotopic signatures of most elements in normal CAIs (non-FUN) appear to be indistinguishable from other normal CAIs. This apparent homogeneity in the CAI-forming region, with the notable and puzzling exception of tungsten [5], suggests that two separate reservoirs likely existed—one reservoir for CAIs and a second reservoir for the terrestrial planets. These reservoirs could have been separated by space, time, or both [3]. It has been postulated that these isotopic differences were caused by the input of supernova material that was not incorporated into the CAI-forming region [3], thus providing the opportunity to determine the isotopic character of the last significant supernova to input material into the Solar System. References:

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First discovery of Early Palaeozoic post-glacial (post-Hirnantian/latest Ordovician-early Silurian) mudstones and cryptospores in northern Ethiopia

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Recently discovered outcrops of post-glacial Early Palaeozoic mudstones in northern Ethiopia have yielded a well-preserved assemblage of cryptospores. The cryptospores represent the first body fossil evidence of Early Palaeozoic sediments in NE Africa and have the potential to shed light on the post-glacial plant colonization of Gondwana. The mudstones overlay glaciogenic sediments of the end Ordovician (Hirnantian) glaciation in form of channel fills up to 20 m thick and several hundred meters wide. Grey mudstones form the basal and middle parts of the succession and are gradually overlain by highly bioturbated siltstones and sandstones. The succession is truncated by cross-bedded sandstones with marine trace fossils, e.g. Arthrophycus, and locally by a basal layer of quartz pebbles. The palynomorph assemblage is dominated by the enigmatic land-derived cryptospores and colonial algae of possibly freshwater origin. Typical marine elements such as acritarchs, chitinozoans and scolecodonts are extremely rare or are missing. We interpret the mudstones as the early post-glacial filling of a relic glacial topography, either of underfilled glacial troughs or sub-glacial channels in a terrestrial or marginal marine environment. The highly bioturbated silt- to sandstones at the top of the mudstones marks the start of marine conditions, whereas the sharp contact to overlying shallow marine sandstones formed as a transgressive ravinement surface of an inner shelf environment. The mudstones are the first indication of sediments in NE Africa east of NW Sudan, likely correlative to Early Palaeozoic post-glacial shales in North Africa and Arabia. Those are locally enriched in organic matter and form major regional hydrocarbon source rocks. The overlying Silurian shelf sandstones document a post-glacial transgression coming from the Palaeotethys which flooded far interior regions of Gondwana.

Rapid Estimation of Macroseismic Intensity for On-site Earthquake Early Warning in Italy from Early Radiated Energy

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Earthquake Early Warning System (EEWS) are effective tools for the risk mitigation in active seismic regions. Recently, a feasibility study for a nation-wide earthquake early warning system in Italy has been performed based on the National Accelerometric Network (RAN) and the EEW method PRESTo. This work showed that a reliable estimation of magnitude and epicentral location would be available within 3-4 seconds after the first P-wave arrival is detected at the RAN. On the other hand, given the RAN's density, a regional EEWS approach would result in a Blind Zone (BZ), within which the alert is not feasible, of 25-30 km in

average. Given the high density of municipalities in Italy, these results suggest the integration of regional and on-site approaches as the best EEW strategy for Italy. The present study is focused on the development of a new on-site EEW metodology for the estimation of the macroseismic intensity at a target site or area. In this analysis we have used a few thousands of accelerometric traces recorded by RAN related to the largest earthquakes (Ml >4) occurred in Italy in the period 1997-2013. The work is focused on the parameter Squared Velocity Integral (IV2) measured on the early P-wave signal and on its capability to predict the peak ground velocity PGV and the Housner Intensity. Through PGV and Housner Intensity an empirical relation between IV2 and the Macroseismic Intensity has been performed. To assess the performance of the developed on-site EEW relation, we used data of the largest events occurred in Italy in the last 6 years and recorded by the Osservatorio Sismico delle Strutture, as well as the recordings of the moderate earthquake reported by INGV Strong Motion Data. The results show that the macroseismic intensity values predicted by IV2 and the one estimated by PGV and Housner Intensity are in good agreement.

Modeling the Morasko strewn field

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Oral in Session A3-02

The Morasko strewn field located near Poznan, Poland is well preserved effect of the largest iron meteorite shower in Central Europe. It comprises at least 7 craters with diameters from 20 to 90 meters. All of them are formed in glacial tills and sands. Morasko projectile was composed of iron. The distribution of many found meteorites suggests meteoroid trajectory from NE to SW. The Morasko impact probably happened about 5500 years ago. In this study we combine modeling of atmospheric disruption with impact crater modeling to constrain the entry parameters of the Morasko meteoroid, reconstruct its evolution in the atmosphere, the formation of individual craters and the effect of this event on the local environments. Our work is a part of interdisciplinary project conducting field, laboratory and numerical research on the Morasko strewn field. In atmospheric entry model we used standard equations describing deceleration, ablation, and fragmentation of the meteoroid in the atmosphere and modified Pancake model. We varied initial parameters of the meteoroid when entering the atmosphere in a series of simulations. To investigate craters formation we used multi - rheology multi-material hydrocode iSALE-2D. We conducted a suite of 2D simulations of impact into targets with material properties representative for the conditions at the Morasko site to derive scaling parameters for standard scaling laws. The fragment mass and its vertical velocity defined by the atmospheric model are used as initial conditions in the model. As a results of this study we constrained a set of initial parameters (velocity, mass and trajectory angle) that may reproduce Morasko strewn field. We also found the most probably scenarios for this impact event.

The topographic evolution of southern Africa: what's all the fuss about and why are we still arguing about this?

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Some of the most influential literature and ideas on how continental topography is formed and evolves over geological time originated from work in southern Africa. Much of this was by contemporaries of Alfred Wegner in the early 20th century: Walther Penck, William Davis, and perhaps Wegener's strongest supporter, the South African geologist, Alex du Toit. The most prolific and enduring work is probably that of Lester King who followed these pioneers and championed the concept of the formation of extensive, low relief land surfaces or "pediments" by a process he called "pediplanation". This idea directly challenged the other dominant paradigm of "peneplanation" promoted by William Davis. After more than 100 years the controversial debate and intellectual wrangling over how fast, when and why the topography of this continent evolved to produce the classic present escarpment morphology still rages–even more vigorously than ever it seems. If you have visited South Africa and seen the spectacular landscape it will not be surprising that this area has fascinated geomorphologists for so long. The resurgence in interest has arguably been stoked, not by field geomorphology, but by major advances in seismology and geodynamic and surface process modelling capacity and sophistication. This work has focused on the properties and behaviour of the deep mantle beneath southern Africa and whether the mantle has anything at all to do with Africas unusually high topography. If anything, this has caused even more dissent and argument though. To some extent this stems from the ever increasing distance between the predictive capacity of these models and the empirical evidence that might constrain them. The purpose of this paper is to attempt to identify any common ground between the conflicting views and, more importantly perhaps, what actual data we have to hand, or could realistically obtain, that might help referee the current arguments and provide some common empirical benchmarks.

Climatic effects of the Chicxulub impact

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66 million years ago, one of the most devastating mass extinction events in Earth's history abruptly ended the reign of the dinosaurs. This end-Cretaceous extinction event is generally attributed to the effects of an asteroid impact, yet only few climate-modelling studies explored the global climate changes associated with such an event. Furthermore, earlier studies focused on the effects of dust particles which is now believed to play a minor role. Here, using a coupled climate model, we explore for the first time the climatic consequences of longer-lasting sulfate aerosols originating from the impact. Depending on the stratospheric residence time of the aerosols, surface air temperature decreased by at least 27 degrees in the year of minimum temperature, with 3 to 14 years subfreezing temperatures and a recovery time larger than 30 years. Together with the darkness caused by the ejected material, these dramatic temperature changes suggest a pivotal role of the Chicxulub impact in the end-Cretaceous mass extinction event.

Oblique Rifting during Pangea Dispersal: The Rule, not the Exception

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Poster in Session A2-01

Current knowledge of passive margin evolution is mostly based on 2D seismic interpretations, 2D concepts, and corroborated by 2D numerical modelling. But for which margin segments is the 2D assumption (that the rift trend is orthogonal to the extension direction) actually justified? We test the limits of the 2D assumption using revised global plate tectonic reconstructions for the past 240 million years. The analysis is performed via pyGPlates, a recently developed Python library that allows script-based access to the plate reconstruction software GPlates. We quantify rift obliquity, extension velocity and their temporal evolution for all major rift systems during Pangea fragmentation. Boundaries between continental and oceanic crust (COBs) mark the end of rifting and the beginning of sea floor spreading, which is why we use a global set of updated COBs in order to pinpoint continental break-up and as a proxy for the local trend of former rift systems. We show that the split between East and West Gondwana along the East African coast involved a mean obliquity of 45° (measured as the angle between extension direction and local rift trend normal). While rifting of the central and southern South Atlantic segment involved a low obliquity of 10°, the Equatorial Atlantic opened under a high angle of 60°. The separation of Australia and Antarctica involved a protracted extension history involving two stages with ∼25° prior to 100 Ma followed by more than 50° obliquity. Analysing the entire length of all major rift systems during the last 240 My, we find a mean obliquity of ∼40°. Only 25% of all rift segments feature an average obliquity of 20° or less indicating that oblique rifting during Pangea fragmentation constituted the rule, and not the exception.

Abrupt plate accelerations controlled by rift strength: A global analysis of Pangea fragmentation

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The velocity of extension has strong control on rift dynamics and rifted margin architecture. Yet, quantified extension histories of Earth's major passive margins became available only recently. Here we use state-of-the-art global tectonic reconstructions and the new geotectonic analysis tool pyGPlates to zoom on the transition from rifting to sea-floor spreading of all large rift systems during the last 240 My. We find that continental extension starts with a slow phase (<10 mm/yr, full extension velocity) and that rapid acceleration over periods of a few My introduces a fast phase. The transition from slow to fast extension takes place long before crustal break-up. In fact, we show that approximately half of the present day rifted margin area was created during the slow, and the other half during the fast phase. Given the strain-rate dependency of geological processes, this two-phase velocity evolution elucidates key differences between proximal and distal margin areas. We reproduce the transition from slow to fast rifting using numerical forward models with force boundary conditions, such that rift velocities are not imposed but rather evolve naturally in response to changing strength of the rift. These models show that the two-phase velocity behaviour during rifting and the rapid speed-up are an intrinsic feature of rifting and can be robustly inferred for all possible crust and mantle rheologies. While motions of Earth's large plates are thought to be governed by slab pull, basal drag, and ridge push, we show that plate motions during continental rifting are controlled by the non-linear decay of a resistive force: rift strength.

Upper Miocene to Pleistocene sedimentary record and its paleo-environmental implications in the Kaiso-Tonya area (northern Albert Rift): A multi-proxy approach

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Poster in Session A6-02

This project focuses on the western branch of the East African Rift System (EARS) and its related climatic changes. The study area lies in the western part of Uganda, north of the over 5000 m high Rwenzori Mountains situated along the eastern coast of Lake Albert. The aim of this sedimentological study was, to close existing terrestrial gaps in the paleoenvironmental and paleoclimatic record as well as the lack of a multi proxy approach to make conclusions more robust and meaningful. Therefore, a further focus was not only the sedimentology itself but also clay mineralogy, gamma-ray, petrographical as well as magnetic susceptibility and palynology. We logged ∼230m in the Kaiso-Tonya area at a centimeter to decimeter scale with sedimentological and geophysical methods. First results show an interfering system of near shore, lacustrine, deltaic towards a finally fully fluvial environment in the Pleistocene. The Rwenzori Mountains and an accelerated up-lift of the rift-flank combined with a subsidence of the rift floor most likely led to a general aridisation trend. That trend is supported by a gradual increase of smectite from 55% up to 80% towards the Pliocene and a decrease of kaolinite from around 35% to 5%. We found a two-fold hierarchy of stratigraphic baselevel cycles at macro- and mesoscale. Wavelet analyses of lithofacies and magnetic susceptibility (MS) indicate a significant cyclicity at 7m that is caused by lake level changes and related intermittently fluctuating sediment supply. Surprisingly the MS readings remain constant in the negative range despite abundant ironcrusts and impregnations. Heavy mineral studies of intercalated sand layers show a significant increased zircon content up to 70% in the Pliocene and support changed transport pathways and/or changed provenance caused by increased tectonism towards the Pliocene. Palynological data will be available at the conference.

Stable vanadium isotopes – a potential new proxy for paleo-oceanography

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Vanadium (V) has two stable isotopes marked by a high ratio ($^{51}V/^{50}V \approx 400$). Similar to U, Fe, and Mo, it is a highly redox-sensitive metal. In contrast to these metals, however, it can occur in nature in three different oxidations states (+3, +4, +5). Fractionation of stable V isotopes is therefore a potential and very sensitive redox monitor in low-temperature environment studies, e.g., of paleo-oceanography. This has not been investigated yet. Here we report the first $\delta^{51}V$ signatures of two profiles of early Cambrian black shales from the Niutitang formation, China [1]. A slightly modified ion chromatography method after [2] yielded a pure V fraction free of isobaric Ti and Cr. Isotope analyses employed standard-sample bracketing and high resolution-MC-ICP-MS. The V isotope data set was complemented by additional analyses of U isotopes on the same samples after the method of [3]. The $\delta^{51}V$ values are determined relative to an Alfa-Aesar standard solution. The black shales are marked by variable $\delta^{51}V$ values ranging from –1.7 to –0.4‰ (average 2s.d. ±0.1‰, n=84), and a range of $\delta^{238}U$ values from –0.4 to +0.7‰ (average 2s.d. ±0.05‰). Moreover, $\delta^{51}V$ and $\delta^{238}U$ values display a significant covariation. This coupled isotopic variation may be related to variations of redox conditions and likely traces events of coupled U-V mobilization and subsequent re-deposition. Microbes are capable of V cycling [4], and U isotopes can be used as a monitor for biotic U reduction [5]. Hence, coupled V and U isotope fractionation may indicate that microorganisms were important U and V reducers in early Cambrian times.

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High-pressure single-crystal elasticity of wadsleyite: Constraints on seismic anisotropy in the transition zone

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Flow patterns in the transition zone of Earth's upper mantle embody mantle convection styles and can be mapped by the analysis of seismic anisotropy observations. Seismic anisotropy results from the deformation induced alignment of elastically anisotropic minerals. Of the phases inferred to be stable at conditions of the transition zone, wadsleyite displays by far the strongest elastic anisotropy. The elastic behavior of wadsleyite combined with the prevailing rock fabric therefore governs seismic anisotropy in the (upper) transition zone. We will present measurements of the single-crystal elastic constants for $(Mg,Fe)_2SiO_4$ wadsleyite at high pressures by Brillouin spectroscopy and X-ray diffraction. Wadsleyite crystals with a chemical composition relevant for the transition zone (Fe/(Mg+Fe) = 0.11, 0.2 wt-% H_2O) were synthesized at 16 GPa and 1600 °C in a multianvil apparatus. Semicircular disks were cut from oriented single-crystal thin sections with a focused ion beam, and two complementary orientations were loaded together in the pressure chamber of the same diamond-anvil cell (DAC). This novel two-sample approach allows for a large enough spatial dispersion of the probed acoustic phonon wave vectors to determine all elastic constants at the same pressure-temperature conditions inside the DAC. The obtained high-pressure elastic tensors of wadsleyite are internally consistent and can be linked to seismic anisotropy observations via models for crystallographic preferred orientations in strained transition-zone rocks.

The Lausitz Volcanic Field – insights into a continental magmatic evolution

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The Lausitz Volcanic Field (LVF) is part of the Central European Volcanic Province (CEVP) and connects the volcanoes of the České středohoří Mts. (CS) in the Czech Republic as the westernmost volcanic region along the Ohře Rift with those located in Lower Silesia (LS) in SW-Poland. The LVF is characterized by volcanism ranging in composition from nephelinites to phonolithes (trachytes). The age of 28 Cenozoic volcanic rocks ranges from about 35 to 26 Ma with a focus at 30-32 Ma, the mean age of differentiated rocks being younger by about 1 Ma than that of the less differentiated basalts. Additional single volcanic "events" are dated with about 22 and 65 Ma. No age clustering regarding rock types or geographical location is detectable. Volcanism was associated with tectonic movements and basin development. Thus the main distribution of volcanic rocks can be found in the surrounding of the Cenozoic coal basins and their main faults. Away from these localities only small occurrences appear (Büchner et al. 2015). The basaltic rocks preserved mostly as small remnants of necks, plugs, lava lakes, or maars or dissected parts of formerly extensive lava flows. Phonolithic and trachytic rocks formed mostly small monogenetic domes or cryptodomes. The greatest variety of volcanic rocks can be observed in the southern part of the LVF whereas in the northern part mostly SiO_2 under-saturated volcanic rocks occur. In general the volcanic rocks in the Lusatian Volcanic Field represent an alkaline trend typical for intra-continental suites. References:

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Materials Science of the Middle Stone Age: Heat treatment of flint and silcrete

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The probably first effort of humankind in materials science was the thermal treatment of rocks and minerals to either improve the properties or the workability of early tools. Heat treatment of silica based materials is best known from the European Upper Paleolithic and the South African Middle Stone Age (MSA). The experimental finding of improved knappability after heat treatment is archaeologically well documented but the mineralogy and materials science of the process is in debate. Only recently the loss of silanol (SiOH) and the creation of new Si-O-Si bonds according to the reaction: Si-OH HO-Si $\rightarrow$ Si-O-Si + H_2O was identified as a main reaction in flint starting already at temperatures between 200°C and 300 °C. We present results on comparable studies on South African silcrete, the local alternative to flint. Silcrete is a quartz cemented sedimentary rock with quartz clasts, i.e. it consists like flint of nearly pure silica. We determined mechanical properties like elastic modulus, four-point bending strength, Weibull modulus, Vickers hardness and fracture toughness before and after heat treament at temperatures up to 600°C. Mineralogical changes were monitor ed by μ-XRD, Raman and FTIR spectroscopy. Despite the loss of silanol, similar to that of flint, we found a different development: the loss of the elastic modulus with increasing temperature of the treatment. We will discuss these findings in the context of the hardness, toughness and porosity changes and their implications for early stone tool production.

Hf-W chronometry of Allende chondrules and matrix

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Constraining the age and genetic relationship of chondrules and matrix provides unique insights into the early evolution of the solar system and earliest stages of planetary accretion. We present a new approach for dating chondrules by determining the time of siderophile element fractionation between matrix and chondrules [1, 2] using the short-lived Hf-W system. We analyzed the Hf-W isotope systematics of 3 matrix and 6 chondrule separates using a Neptune Plus MC-ICP-MS. The chondrule and matrix fractions display large and complementary nucleosynthetic W isotope anomalies (relative to Earth), reflecting different proportions of at least one presolar component in chondrules and matrix. The origin of this heterogeneity is unclear, but one possibility is that it reflects the sorting of presolar grains during formation of chondrule precursors. Because bulk Allende shows only small if any anomalies, the isotopic complementarity of chondrules and matrix implies that both formed from a single reservoir, followed by rapid accretion onto the parent body. After correction for nucleosynthetic W isotope anomalies, the chondrule and matrix separates define an isochron, which we interpret to date Hf-W fractionation during chondrule formation at ca. 2 Ma after CAI formation. This age is in good agreement with Al-Mg and Pb-Pb ages for individual chondrules ranging from ca. 1 to 3 Ma after CAI formation [e.g., 3]. This does not exclude that some chondrules formed earlier, perhaps as early as CAI [4], but our data show that the majority of Allende chondrules formed ca. 2 Ma later than CAI and within ca. 1 Ma of each other. Formation of Allende chondrules, therefore, appears to have been coeval to that of ordinary and CO chondrite chondrules [e.g., 3].

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3D Modelling of the Quaternary and Tertiary units as a key for sustainable groundwater management in an urban area (Frankfurt, Germany)

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A GOCAD and GIS based geological 3D- model of the Quaternary and Tertiary for the Lower Main Plains is being created, in order to address issues related to an important groundwater management area of the metropolitan region of Frankfurt / Rhine-Main. Bounded by the Rhenish Shield, the Spessart and the Odenwald, the 2,700 km^2 large project area comprises four Cenozoic basin structures: the Mainz Basin, the northern end of the Upper Rhine Graben, the Wetterau and the Hanau Basin. With up to 600 m of Quaternary and Tertiary sediments, the Lower Main Plains act as provider for georesources and become increasingly important for the development of the metropolitan region. Concurrently, the limited space consequently leads into conflicts of utilization between different economic and environmental interests. So, the aim of the model is to support daily decision making processes at the Environmental and Geological Survey (HLUG) by visualizing and attributing important Quaternary and Tertiary units as well as the tectonic inventory. In order to address different user groups and application fields, the model is mainly based on 'hard' data derived from boreholes to ensure high transparency for third parties. Since inconsistencies appear in large parts of the data, all project relevant boreholes, digitally provided by the HLUG, were manually checked for completeness and quality. Only 50%

of the 20,000 boreholes passed this control and were then analyzed semi-automatically regarding their stratigraphic belonging and consistency and implemented in GOCAD for 3D modelling. Results show a strong influence of tectonic stresses caused by the uplift of the Sprendlinger Horst and the Rhenish Shield as well as the subsidence of the northern Upper Rhine Graben. Especially the Tertiary units are affected by tectonic offset, whereas for the Quaternary target horizons erosional processes due to varying river beds of the Main and Rhine are dominating.

Spreading changes in the South Atlantic region: observations and geodynamic interpretations

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Oral in Session A2-02

The South Atlantic is the focus of the DFG Schwerpunkt Program SAMPLE. Over the past 4 years the program has resulted in important findings on the rift and postrift evolution of this archetypal passive margin region. In this presentation we will focus on the spreading history and the postrift topographic evolution of the region, showing that they may be linked by dynamic processes in Earth's mantle. The gradient in dynamic topography across basin (in excess of 1 km) implies westward, pressure-driven mantle flow, while rapid spreading rate changes in the Mid Atlantic rift (on order 10 million years) require decoupling of regional plate motion from the large scale mantle buoyancy distribution through a mechanically weak asthenosphere. Andean topographic growth in late Miocene may explain the most recent South Atlantic spreading rate reduction, but are unlikely in explaining the late Cretaceous/Tertiary spreading variations, as changes in Andean paleoelevation at the time are small. An unsteady pressure-driven flow component in the asthenosphere beneath the South Atlantic region yields a possible mechanism for the late Cretaceous/Tertiary spreading rate variations.

The Sm and Nd isotopic composition of chondrites and their bearing on the composition and evolution of the Earth

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The precise and accurate knowledge of the Earth's bulk elemental and isotopic composition is essential for a genuine description of its geologic evolution. Since the Earth's differentiated nature precludes a direct quantification of its bulk composition, the current paradigm takes the sun – and by inference chondritic meteorites – as proxies. However, the discovery of small mass-independent variations in the isotopic composition of chondrites compared to the Earth shows that the paradigm of a chondritic Earth may not always be valid. Small differences in 142Nd/144Nd between the accessible silicate Earth and chondrites are particularly important in this respect because their origin has a direct bearing on our understanding of the (early) Earth through the 146,147Sm-142,143Nd decay systems. Current scenarios to explain this offset include (i) global fractionation of a chondritic silicate Earth within 30 Myr after the start of the solar system and formation of a hidden early enriched reservoir, (ii) a super-chondritic Sm/Nd ratio of the Earth, possibly through collisional erosion of early-formed crust, (iii) a super-chondritic Sm/Nd in the BSE through sequestration of Nd to the core, and (iv) nucleosynthetic isotope variations between chondrites and the Earth (with a chondritic Sm/Nd). To assess which of these scenarios is correct we initiated a high-precision Sm and Nd isotope study on a variety of ordinary and enstatite chondrites. Only fresh meteorite falls of petrologic grade 4 or higher were processed to avoid artifacts due to undissolved presolar grains or terrestrial weathering. Measurements are preformed on a Triton TIMS at LLNL. The data acquired so far are most consistent with a nucleosynthetic ori-

gin of the offset (in-)between chondrites and the Earth. If confirmed by additional samples and tests, this would imply that the bulk Earth has slightly non-chondritic Nd isotope composition, but a chondritic Sm/Nd.

Late Cretaceous tropical coastal wetlands at the southern shoreline of the Tethys in central Sudan

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The formation of Cretaceous basins in Sudan and South Sudan in up to three phases of passive rifting and subsequent sagging is primarily the result of differential opening of the South Atlantic Ocean and related dextral strike-slip movements along the Central African Shear Zone, and NE-SW directed crustal extension. During sag stages, mainly continental sands were deposited. In Sudan, these sediments are commonly assigned to the 'Nubian Sandstone', although regionally broken down into formations. They are generally interpreted as purely continental, predominantly fluviatile deposits. However, study of the Campanian-Maastrichtian Shendi Formation in central Sudan has revealed a succession of coastal wetland sediments, including deposits of tidally-influenced rivers, mangrove swamps and tidal flats. Tidal indicators exist in form of inclined heterolithic stratification (IHS), bipolar palaeocurrent directions, rhythmic laminites, abundant sigmoidal cross-beds and reactivation surfaces, mud drapes and thick-thin laminae in cross-bedded sandstones. Above all, a marine influence is proven by fossil fruit casts and impressions of the mangrove palm Nypa. The fossils represent the southernmost evidence of Late Cretaceous tropical mangrove forests in NE Africa. Besides being inhabited by invertebrates such as crustaceans and bivalves, the coastal habitats were visited by large terrestrial vertebrates, including dinosaurs. The development of low-gradient coastal wetlands in central Sudan implies far south ingressions of the Tethys into NE Africa and the existence of a large marine embayment in this region during the Late Cretaceous. This paleogeography resulted from a combination of continuous slow subsidence of the basins during sag phases and eustatic sea-level highstands. Our results question views of a purely continental origin of the Shendi Formation and, principally, of a dominantly fluviatile depositional environment of sediments of the 'Nubian lithofacies' in Sudan.

Linking geology to numerical modelling: application for geothermal reservoir applications

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An important component of reservoir assessment relies on mathematical models integrating the relevant physics as well as estimations about the distribution of relevant rock properties. The latter is derived from 3D geological models, containing information about major structural elements. It is common practice to assign rock properties according to main geological units, identified in the structural model. This information is then included into numerical process simulations, to discriminate among relevant processes affecting reservoir behavior and long-term sustainability. An important consideration is that uncertainties in the distribution of rock properties can significantly affect the simulation outcome. Whereas rock properties are commonly adjusted and their significance in this context tested, uncertainties in the geological model are often not considered. We describe results from recent efforts to overcome this limitation. We present an automated workflow linking geological data to dynamic simulators. We identify uncertainties in the geological data and evaluate their influence on the outcome of the process sim-

ulation. We apply our approach to the geothermal facility of Groß Schönebeck consisting of a doublet system drilled within lower Permian sandstone and volcanic formations. Geological information built in a detailed 3D geological model (comprising fault zones, induced fractures and geothermal wells) is linked to an open source simulator by means of in house developed meshing software. TH simulations of the reservoir behavior during fluid injection and production are carried out. A sensitivity study is performed to quantify the impact of uncertainties in fault parameters and geometry on the reservoir behavior. The results, as constrained against available data, demonstrates the relevance of the approach for improving current predictive capabilities of reservoir models with a combined consideration of uncertainties in rock properties and structural features.

Why intracontinental basins subside longer - 3D feedback effects of lithospheric cooling and sedimentation on the flexural strength of the lithosphere

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The aim of this study is to re-evaluate the character and evolution of the large-scale subsidence of intracontinental basins using 3D thermo-mechanical numerical simulations accounting for the coupling between sedimentation, rheology-dependent lithospheric flexure and thermal contraction by lithosphere conductive cooling. The flexural rigidity of the lithospheric plate is controlled by elasto-brittle-plastic rheology thus enabling the computation of thermal and mechanical feedback processes occurring during basin subsidence. Numerical results show that, depending on the sediment loading history, a rheologically stratified lithosphere can subside over geological time scales without imposition of ad hoc geometric and kinematic initial conditions. 3D feedback effects of sedimentation on the thermo-mechanical structure of the plate result in a weakened lower crust mechanically decoupled from the underlying mantle and therefore easily reactivated even under relatively low background stresses. Our results explain the first order characteristics of the subsidence in intracontinental basins and reconcile basic observations of their deformation history.

Geological characterization and modeling of the Berlin sub-sedimentary basin

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One of the main challenges in basin modeling is to populate a 3-D geological model with physical, and in particular hydraulic properties. Complexity of geological system, lithological heterogeneity and lack of data make the characterization of geological formation a tedious task. We describe how combining the inverse modelling with forward simulation could provide useful information and bridge this gap. The subsurface beneath the city of Berlin is characterized by a system of aquifers with varying salinity, separated by aquitard formations. Among the latter, the Rupelain Clay, is of special interest since it hydraulically separates the shallow fresh-water aquifer from the deep saline aquifers. The Rupelain aquitard is discontinuous and particularly where the Rupelian clay is absent or quaternary is eroded, there is a vertical hydraulic communication between aquifers (hydrogeological windows). Despite recent efforts, a proper characterization of the regional hydraulic behavior of this aquitard is still missing. Hence, an inversed modeling approach was employed to estimate the spatial distribution of hydraulic and thermal conductivities, representative of Rupelian clay, by minimizing the difference between observed and calculated hydraulic head and temperature, respectively. The pressure and temperature fields, were calibrated and compared with observed data. Moreover, the transport properties of Rupelian clay were estimated. The results of inverse modeling suggested a more continuous Rupelian clay layer within berlin area in compare with previous studies. Hence, the convective heat and fluid flow are more restricted, and there is less interaction between aquifers. The results from the inverse modelling stage served as an input into a forward numerical simulation which has been used to predict the pressure and thermal field. The predicted thermal field in calibrated model is warmer than reference model. The temperature increase is more pronounced at deeper strata.

Linking optical and structural properties of glasses

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Since the discovery of glass making, the coloration caused by transition elements has always been one of the most attractive properties of glasses. Still now, transition metal ions constitute the most important source of glass coloring agents. Coloration varies, for a given transition element, as a function of chemical and physical parameters such as glass composition or melting/fining conditions. At the same time, the electronic transitions responsible for light selective absorption and glass coloration provide unique information about the local structure and chemical bonding of glasses. This presentation aims to review optical absorption data at the light of complementary information provided by a broad range of experimental and numerical structural approaches, providing a unique harvest of results: unusual coordination numbers as 5-fold coordination, distribution of site geometry, sensitivity to the chemical bond, medium-range organization, heterogeneous spatial distribution... Some of these structural characteristics are inherited from the peculiar dynamics of silicate melts and may show a significant modification as a function of temperature. As transition elements can be connected to the various structural subsets of glasses, they are useful color indicators of the complex structure of these materials. Vice versa, using a better knowledge of the structural behavior of transition elements, the variation of colors may be rationalized as a function of glass composition and melting conditions.

Low-grade retrogression of a high-temperature metamorphic core complex: Naxos, Cyclades, Greece

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Retrogressive deformation and metamorphism are common in the hanging wall detachment of a metamorphic core complex (MCC). Based on an integrated microstructural, textural, Ar-Ar dating and thermobarometric study, we provide a new perspective on retrogression of the Naxos MCC (Aegean Sea).We found three stages of retrogressive deformation, which also affected major portions the migmatite-grade core and remnant HP-units in the southern part of the MCC. Retrogressive fabrics of calcite marbles in the central migmatite dome of the MCC resulted from late-stage E-W shortening by folding and formation of a steep axial plane foliation within waning greenschist facies conditions. There, chloritization of siliciclastic rocks at temperatures of ca. 350 °C and twinning and undulosityof calcite grains in marbles are common. In southernsectors of the Naxos MCC, local retrogression of HP fabrics led to pervasive formation of new fabrics within greenschist facies with low-Si muscovite pervasively replacing phengite and dated ca. 16.48±0.19 Ma. Furthermore, Ar-Ar white mica ages at 14.22±0.33 Ma (Moutsounas shear zone) and 9.32±0.18 Ma (last ductile activity along northern Naxos-Paros shear zone)allow date two distinct stages of retrogressive detachment activity during exhumation. A younger stage of retrogression occurred along distinct low-angle normal faults within the Naxos Granodiorite at ca. 12–11 Ma. These distinct stages of retrogression between 16.5 and 8 Ma within and at top of the Naxos MCC are also reflected by similarly aged syntectonic collapse basin in the hanging wall unit. In sum, the results reveal that retrogression is common within the center of the Naxos MCC as well as along margins of the Naxos Granodiorite. Late-stage hydrous fluids resulted in resetting of fabrics and enhancement of ductile deformation. The various stages of retrogression are consistent with outward retreat of the subduction zone and with sequential activation of major detachment zones.

The Earth has the energy and mineral resources to indefinitely sustain 10.5 bn at an EU standard in an environmentally acceptable way

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Between now and 2100 the world's population will grow from 7 to 10.5 billion and then hold steady or decline. Does the earth have the energy and mineral resources needed to maintain 10.5 bn at a European standard for a protracted period of time (100 centuries), or will we need to fight over ever diminishing supplies? Considering the oceans (with a huge volume of dissolved minerals and an almost completely unexplored area equal to that to 2 moons and 2 Mars) it is fairly easy to show that the answer to this question is yes. I will describe one path forward to illustrate that, with faith in technology, free trade, utilization of ocean resources, and acceptance of risk , humanity has a bright and fully environmentally acceptable future.

Accurate geological modeling for subsurface applications and the need for uncertainty assessment

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Subsrface models are used to forecast the behavior of the earth regarding fundamental or applied questions as encountered for example in petroleum reservoir management. These models and the associated interpretations often obey the principle of parsimony, which tells that the simplest model able to explain observations should be considered. This quest for simplicity is certainly useful to identify trends and make sense out of the various measurements made about the subsurface. However, this practice also raises some questions. Indeed, incomplete spatial coverage, limited resolution and data processing errors raise ambiguities during interpretation. Would it be useful to capture the associated uncertainties? Do they have an impact on forecasts? Did the interpretation miss some important unseen features? In the flow simulation community, many facts suggest that these questions should be answered positively. This raises another set of questions about how to come up with several possible models representing what is seen, poorly seen, possible and at what scale. In this talk, I will review some recent work addressing these questions in the field of three-dimensional (3D) structural modeling. First, I will present some results about the impact of structural uncertainties in the case of a poorly imaged segmented normal fault for three physical problems: stress field estimation, flow simulation, wave propagation and gravity response. Then, I will discuss some uncertainties related to the spatial layout of faults and stratigraphic formations. Depending on the data at hand, these uncertainties may relate to the position of faults and horizons, their lateral extent and the connectivity of fault networks. In some instances, they also relate to the internal structure of faults and to their existence. To sample these uncertainties, prior knowledge must be formulated in probabilistic terms and a new breed of object-based simulation is needed to reflect the interactions between geological structures. I will illustrate this by showing some examples of recently developed 3D stochastic structural simulators, and will discuss avenues for further improvements of these simulators and challenges ahead.

Rheological and kinematic control on the subduction evolution of the western Mediterranean region.

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This work is concerned with various aspects of subduction evolution of the western Mediterranean region since 35 Ma which are investigated by means of 3D thermo-mechanical numerical modeling. On the basis of the preferred numerical subduction model of Chertova et al. (2014), which gives the best fit to the tomographical and temporal constraints for this region, we evaluate the influence of rheological parameters and far-field forces. The latter are represented here by prescribed lithospheric velocities and/or prescribed mantle flow on the sides of the model domain. We demonstrate that even small changes in the rheological strength of the lithosphere and/or mantle have a strong influence on the evolution of the subduction process, e.g. resulting in an incorrect present day Alboran slab position. Differences of 30-50 Mpa in strength of the continental margins may significantly decrease/increase the speed of margin/lithosphere tearing process and associated slab rollback. In the case of the Iberian margin this results in slab striking in NS direction, which is not observed in tomography. Our models demonstrate that lithospheric plate motions are one of the major factors controlling the evolution of the subduction system. Changing the absolute plate motion reference frame (Doubrovine et al., 2012) to a Africa-fixed or Iberia-fixed reference frame, commonly used for neotectonic modeling, leads to significant differences in the development of the subduction process. Prescribed mantle flow, which simulates the real mantle flow in the region since 35 Ma influences the subduction process to a lesser extent than tectonic plate motions. However, it leads to some deviations in final slab morphology from the reference case that could be compensated by adjusting the rheological parameters. We conclude that simulating natural subduction is very dependent on the interplay between absolute plate motions, the spatially varying rheology and ambient mantle flow.

Continental crustal recycling by modern-day plate tectonics and its plausible nature in the early Earth: A numerical modeling approach

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Oral in Session A4-04

While the recycling of continental crust has been considered (e.g. [1], [2] for a review), the geodynamic parameters which control such recycling remain unclear. We have carried out 2D petrological-thermo-mechanical numerical modeling to investigate continental recycling by slab detachment (e.g. [3]) as well as by delamination (e.g. [4]) and quantified the volume of continental mass recycled by these two processes for a range of plausible values of different model parameters. Rheological weakening of continental crust changes the collision geodynamics from a slab break-off to a delamination driven regime [5]. Continental recycling by slab break-off is episodic in nature, occurs when the leading, detaching oceanic slab carries a continental fragment along with it, and upper and lower continental crusts are recycled in comparable amounts. Increasing oceanic slab age, slab length and convergence velocity enhance the volume of continental crust returning to the mantle by this mode. Delamination driven continental recycling is a continuous process, recycles the lower continental crust preferentially, and its extent increases with oceanic slab age and decreases when convergence rate slows down although the total volume of recycling is not affected significantly. Our numerical models yield an average recycling rate of $\sim$0.5 km^3/yr. by slab failure and a more efficient $\sim$2 km^3/yr. by delamination (for the present-day length of collisional suture, i.e., $\sim$12000 km). Considering the parameters found to favor one mode or the other in this study, delamination driven continental crustal recycling could have been even more widespread in an early hot earth. References:

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Heat transport characteristics of large terrestrial exoplanets

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Poster in Session A3-03

Recent progress in detection techniques resulted in discoveries of numerous Earth-size exoplanets and inspired increasing number of studies focused on their internal dynamics. Thermal evolution of exoplanets has already been investigated by means of numerical simulations of subsolidus convection and several effects that influence the style of convection were discussed, among them pressure and temperature dependent viscosity and thermal conductivity, complex rheologies including yielding-induced plate tectonics and damage-grainsize feedback. Here we will present heat transport characteristics for a high pressure and temperature range relevant for large terrestrial exoplanets (M <15 Me). Our numerical model is based on truncated anelastic liquid approximation (TALA) of compressibility and takes into account nonlinear composite rheology. As for material parameters (density, thermal expansivity and heat capacity) we assume either parameterized properties or complex thermodynamic description of mantle material based on the multi-Einstein vibrational approach. We will compare heat transport characteristics in TALA models with these obtained in models based on extended Boussinesq approximation (EBA) of basic equations and show that compressibility effects may be important for mantle dynamic processes and consequently also for formation of planetary athmospheres, through outgassing, and the existence of magnetic field, through thermal coupling of mantle and core dynamic systems.

Secular Changes in the Mantle and the Onset of Plate Tectonics

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Thermal and compositional characteristics define two major types of mantle: enriched (EM), sampled today chiefly in mantle plume heads, and depleted (DM), sampled at ocean ridges. In addition hydrated mantle (HM) is associated with subduction and komatiites (KM) with plume tails. Incompatible element ratios (IER) such as Zr/Nb, Th/Yb and La/Sm are useful in tracking mantle domains into the geologic past and prior to 2.2 Ga, IERs of EM and DM show tight groupings centered near primitive mantle composition. This suggests that the early mantle was well mixed compositionally, although primordial crustal components and restites near the base of the mantle may have escaped this mixing. As evidenced by greenstone basalts, beginning about 2.7 Ga, EM and DM reservoirs developed in the mantle and became widespread by 2.0 Ga. HM and KM can be tracked to ca. 3.8 Ga with the oldest volcanic rocks. Median mantle potential temperatures (Tp) calculated from primitive basalt compositions show that DM Tp decreases with time from 1500°C in the Archean to 1380°C today, whereas EM Tp stays high and relatively constant at ca.1500°C. These two types of mantle begin to deviate in temperature beginning soon after 2.5 Ga. Through time, HM is thermally indistinguishable from DM and KM stays relatively constant at 1600-1650 °C. Geodynamic models suggest that in hot, low viscosity Archean mantle, plumes are small and plume heads do not survive. After 2.5 Ga, as the mantle cooled, plume heads began to retain more of their heat and often reached the base of the lithosphere. These various lines of evidence are consistent with an Earth model in which plate tectonics begins about 3 Ga, evolves through an episodic stagnant lid regime from 3 to 2 Ga, and stabilizes into a plate tectonic regime after 2 Ga. The spread of subduction after 2.5 Ga can explain the divergence of EM and DM compositional and thermal domains after this time. HM may form in both plate tectonic and stagnant lid regimes.

Satellite remote sensing-based indicators for an improved understanding of irrigation water use, and agricultural area dynamics in the Aral Sea basin

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During the Soviet Union (SU) the expansion of the irrigated agriculture in Central Asia (CA) led to an increase of irrigated land to more than 9 million hectares. By the end of the 1980s, more than 90% of all freshwater previously provided by the two main rivers filling the Aral Sea, was consumed by irrigation. By the end of the SU era, irrigated crop yields experienced a constant decline. After independence vast agricultural areas were abandoned. However, the magnitude as well as the key driving determinants of the observed land use change largely remain ill-understood. We highlight the potential of satellite earth observation for providing spatial indicators for monitoring and explaining spatial and temporal pattern of land use change and its relation to the use of available water resources. Based on results from three research projects in CA (CAWa, LaVaCCA, ZEF/UNESCO Khorezm-project) we demonstrate promising methodological avenues for monitoring changes in land use intensity (e.g. frequency of usage, crop rotations), dynamics in productivity (e.g. crop yield), crop water demand, and irrigation water depletion (evapotranspiration) at different spatial scales. The ongoing processes of land use patterns in relation to water availability in the Syrdarya catchment were assessed. Statistical analysis applied to spatially distributed land use intensity in 2001-2012 highlighted irrigation subsystems depending heavily on the annual runoff in the upper catchment. A poor dependency of irrigated area extent was found in the irrigation systems of Kazakhstan, where land abandonment is growing. The overarching results point at the dependency between runoff and land use intensity despite the existence of regulating water reservoirs located between the runoff formation zone and the irrigation systems. The case-study underlines how remote sensing-based results can be used by decision makers and planners to guide and improve agricultural and water resource management.

The neglected story of Oceanic Anoxic Event 2 in the terrestrial realm: A high-resolution multi-proxy study on the mid-latitude Cassis Section in Southern France

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Major changes in Cretaceous climate and carbon cycle received considerable attention in the past decades, unfortunately almost exclusively with regard to the marine realm. Marine sediments of middle Cretaceous age (Aptian – Turonian) have been repeatedly punctuated by black shale horizons, representing the sedimentary expression of brief episodes of drastic climatic perturbations, the so-called Oceanic Anoxic Events (OAEs). The role of terrestrial ecosystems in this context is still largely unknown and the impact of these OAEs on the continental environment has yet to be analyzed. Terrestrial ecosystems may have acted as a trigger or amplifying mechanism of OAEs or it may have simply responded to temperature and humidity changes as a consequence of the perturbations in the carbon cycle. To date, stratigraphically

well-constrained and continuous records based on well-preserved terrestrial palynomorphs covering longer time intervals are scarce. Here we present a high-resolution quantitative palynofacies and spore-pollen record combined with stable carbon isotope analyses, TEX86 and clay mineral composition of the Cassis section (Southern France) covering the Cenomanian-Turonian OAE 2, the most widespread and best defined OAE. The record is well constrained by the use of ammonite, planktonic foraminifera and inoceramid biostratigraphy as well as chemostratigraphy. The characteristic positive carbon isotope excursion (CIE) has been identified and correlated with the reference section from Eastbourne (Southern England). Palynofacies and lithofacies analyses indicate a relatively stable and hemipelagic marine depositional environment without evidence for euxinic conditions. Stratigraphic changes in the spore-pollen assemblage are considered to reflect shifts in the terrestrial plant community as a response to environmental and climatic variations rather than to depositional conditions.

Ore Mountains reloaded – new exploration of ore and spar deposits in Saxony

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The Ore Mountains and relevant parts of the Voigtland belong to the Fichtelgebirge–Erzgebirge Anticlinal Zone, which mainly consists of Upper Proterozoic and Cambro-Ordovician metamorphic rocks. Significant ore and spar deposits were formed by Variscan deformations with pulses of matter and energy. Tin and tungsten deposits in greisen and skarn and vein-bound enrichments of base metals (Pb, Zn, Ag, Cu) and fluorite are of relevant economic importance. At the latest in the 12th century mining in the Ore Mountains was initiated by findings of silver. Since then ore mining developed rapidly and dominated the economy of the region over centuries. Most intense mining took place during GDR times in the uranium mines of the SDAG Wismut. In 1992 last producing ore and spar mines were shut down due to economic problems. With increasing metal prices the region attracted interest again of mining companies and investors. Since 2005 40 new applications for exploration licenses were filed. Today 17 exploration projects and 2 concessions for new mines cover a wide area of the mountains. These projects differ in current state and activities, ranging from surface sampling, mineralogical investigations, geophysical prospecting, intense drilling, to mine planning. 2013 the first new fluorite mine started production in Niederschlag. Known deposits and ongoing exploration characterize the district as prospective especially for tin, tungsten and fluorite. As remain of intense mining in the past, the geology of the region is known as one of the best explored worldwide. However, geoscientific data and reports are spread over many archives. In the joint project ROHSA 3 the Geological Survey and the Mining Authority of Saxony collect and digitize all available geoscientific data. Finally, geoscientific information will be available in digital form for the public. This will decrease the necessary investment of exploring companies and will open up new opportunities for geoscientific research.

Amphiboles extremely enriched in chlorine as evidence for interaction between rock and saline fluid

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The interaction between rock and chlorine-rich fluids is an important process controlling mass and heat transfer in the lithosphere beneath subduction zones as well as in the oceanic crust. As an attempt to investigate these processes, the study of minerals in rocks which underwent such interactions can be used to trace fluid transport. Here we present amphiboles extremely enriched in chlorine from the deep oceanic crust which are of particular interest to trace the record of chlorine-rich hydrothermal fluids and assess the extent and conditions of the interactions. Samples were collected from gabbroic dikes cutting layered gabbro of the Semail Ophiolite (Oman Sultanate). Amphiboles in these dikes show a broad textural and compositional variability, including domains that are strongly enriched in chlorine. Methods used to investigate these amphiboles include EMPA and LA-ICP-MS. In addition, high resolution EBSD measurements have been carried out, in order to document the crystallographic orientation link between different compositions of amphiboles. We are also performing an experimental study in order to understand the conditions of chlorine incorporation into the amphibole. The target lithologies include products of both magmatic and hydrothermal reactions that took place in the deep oceanic crust, thus documenting a complex history of fluid/rock interaction. The amphiboles show a spectacular zoning with transition from magmatic pargasite via amphibolite-facies hornblende to greenschist facies actinolite, often within the same grain or aggregate. Some of the pargasites contain up to 5 wt% chlorine, implying that these were formed by involvement of an exsolved brine formed after phase separation from a chlorine-rich hydrous fluid. We conclude that the chlorine content in pargasites has the potential to constrain the conditions and the extent of fluid-rock interaction.

Verification of the important factors that causes of rapid falling of Urmia Lake water table (Northwestern of Iran)

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Poster in Session A5-01

Urmia Lake is one of the biggest hypersaline Lakes of the world. In this research, undisturbed sedimentary cores of western part of the Lake were prepared by Auger coring method. 16 cores having a maximum depth of 9 meters, and totally 98m of the Lake subsurface sediments were taken. Sedimentary facies were separated by colour, grain size, mineralogy specifications, sedimentary fabrics and evaporative minerals. With regard to vertical sedimentary facies changes, geography, climatic conditions and Lake water level fluctuation were re-constructed. Results indicated 17 separable types of sedimentary facies in cores. Facies consistes Lacustrine, Playa, Swamp, fluvial and terrestrial environments. Coring and verification of Lake Sub-environment sedimentary facies indicate that sequential drying up tracks are visible only in the coastal areas of Urmia Lake Results: However, the main part of the Lake has had lacustrine environment (6.5m of the Lake floor sediments). Sedimentation was continuous during the mentioned period and previous seismic data confirm this issue. Climate change and particularly evaporation increment are significant agents in downfall of Lake water but these are not the main causes for drought in Urmia Lake region. Iran has experienced a long-term drought since 13000 years ago up to now. sedimentation rate is about 0.5 mm per year The facies sequence of the great drought in the lake at a depth of 650 cm with an approximate age is 13,000 years since

there is continuous deposition of supersaturated salt in a lake. It is important to note that Urmia Lake has never experienced dryness except in coastal areas. The main stage of Urmia Lake region drought commenced about 13000 years ago. This event indicated coincidence with the last Ice Age. Therefore, today, the important agent in downfall of the Urmia Lake water is anthropogenic factor.

Pleistocene vertical movements along the Hellenic arc (S-Greece): analysis of marine terraces through high-resolution DEMs

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Oral in Session A6-01

Studying deformation along subduction zones can provide valuable insights into coupling between plates on a lithospheric scale. The Hellenic subduction zone is located at the SW boundary of the Anatolian extrusion system, and we test the hypothesis that propagation of the North Anatolian Fault into the Aegean (~5 Ma) has changed the boundary conditions along this subduction zone, and caused the (Plio-) Quaternary uplift of the islands along the arc. To quantify both the regional uplift along the entire arc, and possible local uplift caused by active faulting, we have selected 8 locations on the Peloponnesus peninsula and the islands of Cythera, Crete and Rhodes that contain flights of marine terraces. For a detailed analysis of the terrace geometry we have produced high-resolution digital elevation models (DEMs) from Pleiades tri-stereo satellite imagery, covering 100-200 km2 per selected location. Tie-points for the three 0.5m resolution images were extracted using the program OTB, the images were oriented by the program Euclidium, and the software Micmac was used to calculate 0.5 m pixel resolution DEMs from the oriented images. The data was downsampled to 2 m resolution, reducing noise and facilitating the detection of the terraces. In this study we use the DEMs to study the marine terraces of Corinth (Greece), which is one of the most extensive and well preserved flights of terraces in the eastern Mediterranean, and therefore ideal to test the quality of our data and our methodology. The resolution allows us to add more detail in discriminating the different structures, in a more quantitative matter than was done before. It is an encouraging perspective that we are not limited by topographic information, as the geometrical uncertainties are strongly outweighed by uncertainties in the climatic and tectonic processes involved.

Landscape evolution driven by an analytical stochastic hydrological model

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The stream power incision model (SPIM) has a long history of use in modelling long term erosion in supply limited bedrock rivers, making it key to understanding the evolution of mountain ranges. In its simplest form, it relates the downstream slope and contributing catchment area (a proxy for mean river discharge) to the long term erosion rate at a given point in a river. Pioneering work by Tucker and Bras (Water Res. Res. 2000) demonstrated that if there is a minimum threshold for erosion, then the SPIM may have to be reformulated to describe how often, and by how much the threshold is exceeded. They achieved this by using a stochastic description of rainfall, but did so with a simple description of hydrology only applicable in small catchments The seminal work of Lague et al. (J. Geophys. Res. 2005) continued this work using a realistic

description of discharge, accounting for the variable, stochastic nature of daily discharge and incision on millennial timescales of landscape evolution. However, they also avoided catchment hydrology by beginning directly with discharge, making it both challenging to achieve a quantitative understanding of how climate influences erosion rates within their framework, and difficult to apply the theory in a 3D model. Using a physics based hydrological model that accounts for the stochastic nature of precipitation and simply, but accurately, captures the catchment response to this stochastic forcing, we present a derivation of the SPIM that allows for the explicit inclusion of climatic and ecohydrological dynamics such as precipitation magnitude and frequency, interception, evapotranspiration, soil thickness, and catchment storage upscaled from daily to millennial time scales. Because the hydrological model is valid for catchments ranging from tens to thousands of square kilometers or more, we present as well a 3D orogen scale landscape evolution model based on the new SPIM.

Impact Processes: From Alfred Wegener to Chelyabinsk and beyond

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Oral in Session A3-02

For decades "Impact cratering" was a rather uninteresting topic in geoscience (and to a certain degree in astronomy too). Nearly no one noticed the discussion on the origin of the Meteor crater, AZ [1], and the simple crater experiments by Alfred Wegener [2]. Likewise the landmark book of Baldwin [3] was know only to a marginal group of scientists. In preparation for the landing on the Moon, and especially with the certainty that virtually all lunar samples show traces of impact processes, impact came in the focus of geo-/planetary sciences. Since that time, impact research is a very fast growing field in science [e.g., 4]. The awareness of the public was raised by spectacular events like the collision of comet Shoemaker-Levi 9 with Jupiter in 1994, the explosion of an extraterrestrial bolide close to Chelyabinsk in 2013 [e.g., 5], and especially the causal link of the end-Cretacious mass to the Chicxulub impact event [6]. The talk will cover some interesting aspects and recent advance in impact research.

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Socio-hydrology: capturing the interplay between societies and floods

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Socio-hydrology aims to better understand the interplay between physical and social processes via an iterative process of theory development and empirical research. In this context, a novel approach capturing water-society interactions in a changing environment is presented. The approach is then applied to explore the dynamics of flood risk changes for two main prototypes of societies. Green societies, which cope with flooding by resettling out of flood-prone areas; and technological societies, which deal with flooding also by building levees or dikes. This application shows that the proposed approach is able to capture and explain the long-term dynamics (e.g. adaptation and levee effect) emerging from the feedbacks between physical and social processes. It is then discussed how these outcomes can contribute to a better understanding of changes in flood risk.

A Raman model for determining the chemical composition of silicate glasses

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In this study we combine chemical analysis from magma mixing experiments between remelted basaltic and rhyolitic melts, with a high spatial resolution Raman spectroscopy investigation; we focus on tracking the evolution of the Raman spectrum with chemical composition of silicate glasses. The mixing process is driven by a recently-developed apparatus that generates chaotic streamlines in the melts, mimicking the development of magma mixing in nature. From these experiments we obtained a glassy filament with a chemical composition ranging from a basalt to a rhyolite. Raman and microprobe measurements have been performed on a filament of 400 μm diameter. The evolution of the acquired Raman spectra with the measured chemical composition has been parametrized by combining both the Raman spectra of the basaltic and rhyolitic end-members. Using the developed Raman model we have been able to determine the chemical composition (mol% of SiO_2, Al_2O_3, FeO, CaO, MgO, Na_2O and K_2O) of the investigated filament. Additionally, the proposed Raman model has been successfully tested using external remelted natural samples; reference glasses (Jochum et al., 2000), a remelted basalt, andesite from Etna and Montserrat respectively. Finally, as the Raman spectrum depends on the silicate structure yielding information about network-forming structural units (Qn species, where n indicates the number of bridging oxygen), we combined the deconvoluted Raman spectra, in the rhyolitic field, with the chemical analyses and abundance of Qn species. This demonstrate how the evolution of silicate structure might control the bimodal eruptive style (explosive vs effusive) as shown by silica-rich volcanic systems.

Limnogeological Records of late Quaternary Palaeoenvironments in eastern Siberia

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Compared to other places on the northern hemisphere, the climate-sensitive region of eastern Siberia is very underrepresented in palaeoenvironmental studies. Situated at the border of northeastern Eurasia, it offers the potential to pinpoint connections of Arctic to sub-Arctic palaeoenvironmental changes between the periglacial and highly continental landmasses of eastern Siberia and the maritime influences at the northern Pacific margin. Sediment records from different lake systems were studied on north- south and west-east transects. The studies followed a multi-proxy approach, using sedimentological and geochemical data as well as fossil bioindicators. The possibly oldest lakes of Yakutia were formed in proglacial settings in the Verkhoyansk Mountains and the Stanovoy Mountains foreland during the Weichselian ice age. As in other worldwide regions, this time was punctuated by warmer interstadials at millennial time scales, as documented by short-term changes in hydrological lake status and surround- ing vegetation. The last glacial maximum was characterized by dry conditions and low lake level. High-resolution records of Holocene climate variability are preserved in lakes on the Kamchatka Peninsula and are included in the widespread thermokarst lake districts of the Yakutian lowlands. They document a regional climate optimum between 7.0 and 4.5 ka BP. Superimposed on the long-term climatic trend are short-term climate punctuations and cyclic changes in lake level at centennial time scales, which demonstrate a high impact of internal climate variability on the palaeoenvironment, likely related to atmospheric oscillation pat- terns. Many of the thermokarst lakes, however, reveal changes in the lacustrine depositional environment that were driven by permafrost dynamics, only mediately related to climate change.

Cross-border 3D geological modelling for subsurface potential assessment – lessons learned from the transnational GeoMol project.

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The subsurface, as a finite spatial resource, faces increasing competition from many different users. The utilization of the subsurface potential of groundwater, minerals, geothermal and other energy resources, and for underground storage and repositories are important aspects for the security of supply and economic development. The preparation of tools and methods for subsurface planning and utilization inherently require an unbiased and holistic three-dimensional approach which will enable vertically defined licensing areas for multipurpose use to ensure resource efficiency and sustainability. As geology and the potentials connected with do not respect political boundaries, the sustainable management and impact assessment of subsurface exploitation requires an integrated transnational approach whose extent must be guided by the geological structure rather than by political and administrative boundaries. GeoMol (www.geomol.eu), integrating a multi-national and multi-sectoral partnership, responds to that by providing trans-nationally harmonized 3D geological models ready for the unbiased geopotential assessment, and for raising the public's awareness. The structural inventory of the Alpine Foreland Basins, crucial for any underground storage, is portrayed and evaluated on a large scale. However, the disparity in data policy in the partner states strongly impeded the more detailed assessment and the full harmonization of the information, causing uncertainties and requiring an oversimplification of the open disclosure products.

Investigation on the system $C_3A{\cdot}CaSO_4{\cdot}nH_2O$ - $C_3A{\cdot}Ca(MnO_4)_2{\cdot}nH_2O$ – hydration phases of the Mn-CAC

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Poster in Session B6-03

Regarding the fixing of manganese in calcium sulfoaluminate cements as an result of the usage of manganese-rich additives the binary system $C_3A{\cdot}CaSO_4{\cdot}nH_2O$ - $C_3A{\cdot}Ca(MnO_4)_2{\cdot}nH_2O$ has been analyzed. Therefore different sets of samples with an increasing content of manganese have been prepared for the system $C_3A{\cdot}(1\text{-}x)CaSO_4 {\cdot}xCa(MnO_4)_2{\cdot}nH_2O$ with $0 \leq x \leq 1$. To guarantee the exclusion of carbonate the preparation took place under nitrogen atmosphere. For three months the samples has been aged at 25 °C under constant agitation. Afterwards the phase composition has been analyzed using X-ray diffraction while the samples have had a relative humidity of 100 % and 35 %. The samples have been dried in a desiccator under nitrogen atmosphere to avoid carbonization. A quantitative analyze of the containing phases has been made by using infrared spectroscopy. Furthermore thermoanalytic methods, like thermal gravimetric analysis and differential scanning calorimetry, have been used to understand alteration in mass and amount of heat as a function of temperature and time.

In situ determination of sulfur speciation in fluids at high P-T and controlled redox conditions

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Sulfur-bearing aqueous fluids play an important role in the degassing of magmas and in the formation of most hydrothermal ore deposits. Generally, such fluids are not quenchable, and therefore the central issue in this study is the determination of the sulfur speciation in situ at high pressure and temperature using Raman spectroscopy. A new optical cell was developed, which has a conical sapphire or diamond window for acquisition of Raman spectra in backsattering geometry. The cell is designed for pressures to 200 MPa and temperatures to 800 °C and allows for abrupt or continuous changes of pressure at constant temperature to mimic degassing processes. A flexible gold bag enables to change the sample chamber volume and thus to control the pressure and to separate the pressure medium from the fluid in the sample. Because oxygen fugacity is a key parameter for the stability of sulfur species in the fluid, it can be controlled by adding a buffering redox pair such as Fe/FeO, Co/CoO, or Ni/NiO in a perforated capsule. The assemblage $Fe_{1-x}S/FeS_2$ was used to control the sulfur fugacity. In some experiments, no buffer assemblage was added and the redox conditions were determined by equilibria in the fluid. First experiments on 3 molal $(NH_4)_2SO_4$ solutions were successfully performed to temperatures of 750 °C at constant pressure of 130 MPa. With increasing temperature, the dominant sulfur species changed from SO_4^{2-} to HSO_4^- to SO_2 and H_2SO_4. Reduced sulfur species, mainly H_2S and lower concentrations of HS- formed at 750 °C in the experiments without a buffer assemblage, and at about 550 °C in the experimental series with the $Fe_{1-x}S/FeS_2$ buffer. Correspondingly, the stabilities of SO_4^{2-} and HSO_4^- shifted towards lower temperature in that run.

Going down the tubes: complex kinematic indicators in tube pumices revealed by X-ray tomography

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The deformation of crystals mushes and separation of melts and crystals in is critical to understanding the development of physical and chemical heterogeneity in magma chambers and has been invoked as an eruption trigger mechanism. Here we investigate the behaviour of the melt in the well characterised, classic crystal mush system of the Skaergaard Igenous Complex by combining experimental petrology and the non-destructive 3D imaging methods. Our experiments raise a suite of samples from the X Series to temperatures of X-Y C and hold them isothermally for between 24 hours and one week. We then use spatially registered 3D x-ray computed tomography images, collected before and after the experiment, to determine the volume and distribution of the crystal framework and interstitial phases, and the volume, distribution and connectivity the interstitial phases that undergo melting and extraction while at elevated temperature. Image analysis has allowed us to quantify these physical changes with high spatial resolution. Our work is a first step towards quantitative understanding of the melt mobilisation and migration processes operating in magmatic systems.

The Kara impact structure: general overview and particular features

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Oral in Session A3-02

The Kara impact structure is located on the northeastern shore of the Yugorsky Peninsula and partly on the shelf of the Kara sea. It is the third of the largest known impact structures in Russia and eighth in size on Earth. It is considered to be a twin impact structure that comprises two large astroblemes: Kara (onshore) and Ust-Kara (almost entirely covered with water) of ca. 60 and 70 km in diameter, respectively. Current models suggest that it formed on a shallow shelf as a result of an impact of two large fragments of a single projectile, broken apart while entering the Earth's atmosphere. Target rocks are shales and limestones, cut by diabase dykes and sills, all covered by coal-bearing molasse. The Kara impact-derived rocks are allogenic breccias and suevites with lenses of impact melt rocks and impact breccia dykes. The total thickness of the impact rocks is ca. 2 km. The impact origin of the structure was established in 1972 by the presence of shock-metamorphic effects in the rocks and high-pressure mineral polymorphs such as diamond, stishovite, and moissanite. So far, no reliable geochemical signatures of the projectile could be identified in the rocks. The K-Ar and ^{40}Ar-^{39}Ar ages of the impact glasses range between 65 and 74 Ma. The impact melt rocks comprise <1% of the entire volume of the impact rocks exposed. Fresh glasses with fluidal textures are still preserved in the rocks. They bear several poorly understood features: spherulitic alumosilicatic inclusions arranged near-parallel with the fluidal structures in the glass, skeletal Fe-Mg silicate phenocrysts, and other radiating structures of unknown origin. The impact rocks are of practical value because they are diamond-bearing. Average grade is reported around 5,5 carats per ton but this figure may be an overestimation because of the presence of X-ray amorphous carbon material that represents a transition stage of impact alteration between the original coal and the impact diamonds.

Late Cretaceous changes in continental configuration: toward a better-ventilated ocean?

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Keynote in Session A6-03

Oceanic anoxic events (OAEs) are large-scale events of oxygen depletion in the deep ocean that happened during pre-Cenozoic periods of extreme warmth. Last global OAE occurred at the Cenomanian-Turonian boundary (OAE2) prior to the Late Cretaceous long term cooling. Ever since, and despite the occurrence of warming events, Earth no more experienced such large-scale anoxic conditions. Here we explore the role of major continental configuration changes occurring during the Late Cretaceous on oceanic circulation modes through numerical simulations using a General Circulation Model (GCM), that we confront to existing neodymium isotope data (ϵNd). Except from a continuous deep-water production in the North Pacific, the simulations at 95 Ma and 70 Ma reveal major differences marked by a shift in the southern deep-water production sites from South Pacific at 95Ma to South Atlantic and Indian oceans at 70Ma. Our modelling results support an intensification of southern Atlantic deep-water production as well as a reversal of the deep-water fluxes through the Caribbean Seaway as the main causes of the decrease in ϵNd values recorded in the Atlantic and Indian deep waters during the Late Cretaceous. We conclude that the change from a sluggish to a much more active circulation depicted by the model in the Atlantic from 95Ma to 70Ma may have driven the disappearance of OAEs after the Late Cretaceous.

Subsidence history of the South Atlantic passive margins

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The mechanisms behind the subsidence histories of the South Atlantic conjugate passive margins are a matter of debate. It remains questionable to which extent the margins were affected after breakup by additional processes, such as compression in response to ridge or mantle plumes. Within this study, present a 3D subsidence analysis of the passive margins offshore Argentina and SW Africa. We make use of available information about the present-day structural configuration of the sedimentary basins along these passive continental margins and apply a 3D subsidence analysis. Our approach considers the complex interplay between thermal and mechanical processes in order to get new insights on the basin evolution in general and vertical movements in particular. Therefore, detailed isostatic and thermal calculation have been carried out to investigate the subsidence history. The modeling results help to quantify variations of vertical movements along the margins which give new insights on their evolution. Especially timing and spatial distribution of vertical movements along both margins are reconstructed and compared to derive interpretations of possible causative processes.

Major- minor and trace element variations in tourmaline as monitors for magmatic differentiation, fluid un-mixing and associated ore precipitation

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The Cu-Sn-W ore deposits of the Variscan Cornubian Batholith (SW England) are particularly suited for studying the formation of ore deposition related to magmatism and the associated hydrothermal activities. For a better understanding, it is important to investigate the distribution of Sn, W, Cu between various phases during melt differentiation, fluid exsolution and precipitation. In our study we test the ability of tourmaline for monitoring these processes. The compositions of various tourmaline generations include dravite, schorl, feruvite, uvite, foitite, and Mg-foitite, with each species occurring with their respective O-, OH- and F components. The composition exhibits a trend from Ti-rich tourmaline with high Mg/Fe ratios in the magmatic stages to Ti-poor tourmalines with lower Mg/Fe ratios towards the intermediate hydrothermal stages. During the latest hydrothermal stages FeO decreases again, whereas MgO and CaO increase. Some trace elements reflect the major-element trends. For example Sr increases strongly with Ca. Some economically important elements, such as Sn do not reflect those changes. Sn concentrations increase from magmatic to the hydrothermal stages (from <65 to 6000 μg/g), but reach high concentrations already in the tourmalines of the intermediate hydrothermal stages. Mössbauer spectroscopy reveals that precipitation of cassiterite (SnO_2) takes place only after a certain $Fe^{3+}/\Sigma Fe$ ratio of approximately 0.3 in tourmaline has been reached, which we assume reflects an elevated redox state of the system. With the precipitation of SnO_2, other

elements in tourmaline such as Sr, Ca, Mg and Cr increase. This could be related to the influence of an externally-derived fluid or to a reaction with the host rocks and may, therefore, indicate the opening of the granitic system. Other elements, such as Cu and W, show a more complex behavior. We, therefore, plan a detailed fluid-inclusion study to obtain further insight into these ore-precipitating processes.

Pre-rift topography of the East-African Plateau induced by metamorphic density changes in the lithosphere

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Oral in Session A2-02

It is broadly accepted that rifting processes represent the initial stage of separating two lithospheric plates as it can be observed in the East-African Plateau region (EAPR). The EAPR is dominated by a pronounced topography with a modern elevation of more than 1000 m. Syn-rift uplift processes such as rift-shoulder uplift or mantle impingement generally explain this topography. However, recent studies on a beaked ∼17 Ma old whale fossil (Ziphiidae) found at an elevation of 620 m as well as the emplacement of the 13.5-Ma-old Yatta lava flow at an elevation of ∼1400 m document an important pre-rift topographic feature in the Kenya rift before the onset of rifting (∼11 Ma). We propose that the pre-rift topographic variations are caused by metamorphic density changes in the lithosphere, due to mantle plume-lithosphere heat interactions. Based on this hypothesis, we developed a model, which calculates density as a function of pressure, temperature, and chemical composition, based on the fact that heat variations in the continental lithosphere and crust influences rock density. Thus, we present a new petrologic aspect for plateau uplift, because models on plateau uplift generally do not take into account the effects of metamorphic phase transitions and ignore the fact that chemical reactions influence both, the stability of mineral assemblages and rock density. In order to better understand the temporal characteristics of pre-rift topography we calculated the timing to generate significant topographic uplift induced by metamorphic density changes. Our results suggest considerable surface uplift of approximately 700 m after 20 Myr as a viable mechanism for the formation of so-called anorogenic plateaus. Hence, our model gives new insight in lithospheric processes below rift systems and may explain the generation of long-wavelength topography of the EAPR before the onset of rifting. Reference:

Duesterhoeft, Bousquet, Wichura & Oberhänsli (2012), JGR 117, B07204

Morphology and sedimentology of a large carbonate rockslide – rock avalanche deposit (Tschirgant, Austrian Alps)

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Poster in Session B3-03

Morphological and sedimentological features of rock avalanche deposits are clear signs of their geological setting and emplacement dynamics. At the Tschirgant (Tyrol, Austria) deposit, we systematically investigated the interrelationships of emplacement modes, predisposition (i.e. lithology), and terrain and sediment interactions in shaping the morphology of the final deposit. First, two different emplacement modes of rock-sliding and rock avalanching are morphologically identified in the same event. Longitudinal ridge axes on the central rockslide deposit point straight back to the source scarp, thus these sliding blocks travelled along the main rockslope failure direction without being affected by runout path topography. The orientations of longitudinal ridges of the rock avalanche part, on the other hand, evidence motion change to radial spreading. These ridges are present exclusively in competent lime- and dolostones (Wetterstein Fm.), whereas weaker siliciclastic-carbonate beds (Raibl Group) cannot form high ridges. Yet, offset clayshale marker beds document lobe formation also in Raibl deposits. Extensive field mapping shows that the source stratigraphy was preserved in that the initial sub-vertical configuration of lithological units in the Tschirgant mountain ridge was translated into a radial, sub-horizontal geometry of broken, highly fragmented, spread, and sheared granular mass during rock avalanche deposition. We furthermore found strong connections between deposit facies and terrain conditions, source lithology, and emplacement processes. Lastly, runout path materials were not only involved in shaping the rock avalanche morphology, but also acted as tracers for internal/basal rock avalanche deformation (e.g. shear bands, zones of extension). Overall, the Tschirgant deposit impressively demonstrates the variant mechanical influences of runout path conditions and rock mass properties on the emplacement dynamics of large rockslides and rock avalanches.

Cold-Water Coral occurrences on the Amorican Shelf

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Oral in Session A6-05

In the northeast Atlantic cold-water corals (CWCs) are known to build different ecosystems. While reefs in Norway, mound structures off the coast of Ireland and in the Gulf of Cadiz are relatively well studied, comparably little is known about the Bay of Biscay, a region that connects the eastern temperate Atlantic with the more northern regions. In order to examine the CWC distribution and its history in the Bay of Biscay, this study analyses coral samples from six sediment cores that were retrieved during METEOR Cruise M84/5 in June 2011 along a depth transect (539 – 980 mbsl) in the St. Nazaire Canyon in the northern Bay of Biscay. The dating of the samples revealed coral ages from 12.5 ky BP to present-day ages. This shows that since the end of the last glacial the St. Nazaire Canyon represented a suitable setting for CWC growth. While other CWC ecosystems further south, seem to have thrived predominantly during glacial times, the dated coral samples of this study indicate, that the St. Nazaire canyon rather belongs to the CWC ecosystems that flourish during interglacial times like in regions further north. In addition sixteen species of planktonic foraminifera have been identified from sediment cores. The assemblages are dominated by Neogloboquadrina incompta or Neogloboquadrina pachyderma as well as by Globigerina bulloides, and are referred to the "Transition Zone", the region in both hemispheres where cold- and warm-water species overlap in distribution. A shift from the N. incompta (preferred temperatures between 10°C and 18°C) dominated assemblage to a N. pachyderma (preferred temperatures between 0°C and 9°C) dominated assemblage indicates the shift of Pleistocene (glacial) to Holocene time. These observations are confirmed to the calculated bottom water temperatures. They range between 6.5°C and 10.4°C, consistent with known temperature range (4°C to 14°C) conductive for CWC growth and development during the end of the deglacial and the Holocene.

Simulation of impact melting processes: An experimental approach using high-energy laser beam

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Oral in Session A3-02

This study introduces an experimental approach using a high-energy laser beam simulating the virtually instantaneous melting associated with meteorite impact. Laser-induced melting experiments (LE) were conducted with a laser welding facility at the TU Berlin, aiming at the production and investigation of target (sandstone) and projectile (iron meteorite and steel) melts and their mixtures. The LE were able to produce features very similar to those of impactites from meteorite craters and cratering experiments [1-4], this includes formation of lechatelierite, partially to completely molten sandstone, and injection of projectile droplets into target melts. Target and projectile melts experienced modification during chemical interaction of these coexisting melts. Emulsion textures, observed within projectile-contaminated target melts, indicate phase separations of silicate melts with different chemical compositions during quenching. This liquid immiscibility phenomenon was recently described for the impact glasses of the Wabar craters [2,3] and Meteor crater [3]. The laser technique does not reproduce typical high-pressure shock effects, e.g. planar deformation features in quartz, but it can be definitely used to simulate high-temperature effects of an impact, mainly for the investigation of geochemical processes. LE allow (i) high-temperature melting to better constrain primary melt heterogeneities before mixing, and (ii) the quantification of element partitioning processes between coexisting projectile and target melts. Processes of minor partial melting of single minerals up to complete melting and homogenization of target and projectile material can be simulated within one laser-induced melting experiment. Ref.:

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[3] Hamann et al. (2014) 77th Meeting of the Meteoritical Society, Abstract 5222.
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Data Publication and Citation

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During the past decade, the relevance of research data has been rising significantly and data publication has become more familiar. Preservation of scientific data for long-term use, including the storage in adequate repositories has been identified as a key issue by the scientific community as well as by politics and research agencies. Very often, however, these data are not used to their full extent because they are not systematically archived or made readily accessible. Another impediment to free and open data exchange is the reluctance of researchers to share their data in the absence of appropriate credit for the large investment of time and intellectual effort that went into collecting the data, as well as concern that their data may be misused or misinterpreted. The newly formed Coalition for Data Publication in the Earth and Space Sciences aims to jointly implement and promote common policies and procedures for the publication and citation of data across Earth Science journals. In addition, the signature of their 'Statement of Commitment' by many publishers and data centres opens ways for proper citation of datasets in scientific articles and changes the playing field in a big way. They further promote that datasets should be stored in appropriate, theme specific repositories and be accompanied by sufficient metadata that re-use is possible without constraints. Many of these are assigning a digital object identifier to their research datasets, making them persistently accessible and citable products of research. Data publication is well established as supplementary material to scientific articles.

Many disciplines have newly developed Data Journals that aim to publish scientific articles about datasets or –portals; with a detailed data description, distributed storage of the adjoined data, and without scientific interpretation. For standalone publication of datasets where neither format is an option, data reports are a convenient and flexible tool for enhanced data description.

Structure and Stratigraphy of the Upper Freshwater Molasse of the North Alpine Foreland Basin in Western Bavaria

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Oral in Session A6-02

The North Alpine Foreland Basin was filled with predominantly siliciclastic sediments derived mainly from the Alps. The youngest stage of sedimentation is the Upper Freshwater Molasse (Karpatian to Pannonian; MN4 to MN9), for which radial alluvial fans can be distinguished from an east-west running axial drainage system. Sediments of the latter are divided into four lithostratigraphic units: The Limnische Untere Serie, the Fluviatile Untere Serie, the Geröllsandserie, and the Obere Serie. These units are interpreted as a coarsening upwards sequence followed by a fining upwards sequence, with the gravel-bearing Geröllsandserie being the coarsest unit. This pattern is allocated to different subsidence of the western and eastern part of the basin and a subsequent tilt of the basin axis. Within the Upper Freshwater Molasse lies the isochronous Brockhorizont, containing ejecta of the Ries impact event at c. 14.9 Ma, and the diachronous, petrographically defined A-Grenze, representing a change in provenance by redirection of a former tributary river, the Ur-Enns. Published and new field data from Brockhorizont as well as from base and top of the Geröllsandserie were interpolated in each case for the area between Biberach and Aichach. Comparison with each other and with published stratigraphic data resulted in new structural and stratigraphic findings. The thickness of the Geröllsandserie rises slowly from c. 110 m in the east it to 140 m in central parts of the working area, agreeing with subsidence variations. Further to the west, thickness decreases rapidly to less than 50 m, coinciding with a retrogradation of the Geröllsandserie of c. 100 km. This is interpreted to be caused by a reduction of stream power after the redirection of the Ur-Enns. In addition, the stratigraphic model of the Upper Freshwater Molasse had to be refined. The top of the Geröllsandserie turned out to be at least MN7 in central parts of the working area and thus younger than thought previously.

Thermochronology based revised Cenozoic uplift and erosion estimates for the western Barents Sea

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Poster in Session B1-01

From a hydrocarbon exploration perspective, the Norwegian Barents Sea is an immature area and until now the discoveries of gas and oil fields are below expectations. One main reason for this might be the complex Cenozoic thermo-tectonic and climate history of the region. During the Cenozoic the Barents Sea was affected by several episodes of vertical tectonic movements and build-up and retreat of ice sheets. These episodes were associated with sediment mass re-distribution influencing the rock and fluid properties of the underlying sedimentary units. Dry hydrocarbon traps with residual oil indicate trap filling during the geological past. Trap drainage most probably occurred during the Cenozoic. We reviewed published and in house apatite fission track data of ca. 120 surface samples to identify locations and quantify amount and timing of major erosion events. Youngest apatite fission track ages (<ca. 70 Ma) appear along the western most margin of the Barents Sea and along the north western continental margin of Norway. Joint inversion of apatite fission track and vitrinite reflectance data of some samples suggest major Cenozoic

rock cooling. However, timing and magnitude are uncertain and vary significantly for different fault bounded structural elements. We speculate that the differential rock cooling is related to the Cenozoic development of positive and negative structures during transtension and transpression along the western Barents Sea transform margin. In contrast youngest rock cooling of along near coastal regions (NW Norway) might be related to sea-level drop and subsequent exposure to erosion. In future, we will use apatite (U-Th)/He dating to further constrain the cooling history of critical areas.

Pneumatolytic overgrowth of fluor-schorl on earlier formed schorl from Zschorlau, Erzgebirge, Germany

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Two traverses were measured by electron microprobe across a black tourmaline crystal (rectangular to the c-axis) with ~5 mm in diameter, from Zschorlau, Erzgebirge, Germany. This locality is the type locality for schorl and fluor-schorl (Novák et al., 2009; Ertl et al., 2011). The core area of this crystal is composed of 35.1 wt% SiO_2, 0.1 wt% TiO_2, 35.2 wt% Al_2O_3, 14.5 wt% FeOtot, 0.1 wt% MnO, 0.2 wt% MgO, 1.5 wt% Na_2O and 0.58 wt% F. Hence this tourmaline can be assigned to schorl. The rim area is composed of 34.2 wt% SiO_2, 0.3 wt% TiO_2, 34.1 wt% Al_2O_3, 15.5 wt% FeOtot, 0.1 wt% MnO, 0.3 wt% MgO, 2.0 wt% Na_2O and 1.01 wt% F. Hence this tourmaline can be assigned to fluor-schorl. Fluor-schorl crystals from this locality can contain even up to 1.2 wt% F, 16.5 wt% FeOtot, 0.9 wt% MgO, 0.7 wt% TiO_2 and 2.4 wt% Na_2O. During tourmaline crystallization F, Fe, Mg, Ti and Na increase significantly, while Si and Al decrease. These relatively high amounts of F (up to ~0.7 apfu), [4]Al (up to 0.26 apfu) and relatively low X-site vacancies (≥0.15 pfu) usually only occur in tourmalines from high grade metapelites (Henry & Dutrow, 1996). Hence, there is evidence to suggest temperatures ≥700 °C during the crystallization of the fluor-schorl. Contrary, the earlier crystallized schorl exhibits relatively high X-site vacancies (0.34-0.48 pfu) and lower F contents (~0.3 apfu), which leads to lower temperatures of ~500-600 °C. We conclude that the fluor-schorl rim was overgrown during increasing temperatures under pneumatolitic conditions in the presence pneumatolytic fluids.

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The Cretaceous High Arctic Large Igneous Province (HALIP): Temporal and geochemical variations of occurrences on the Canadian Arctic islands

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The opening of the Amerasia Basin of Arctic Ocean since the Mesozoic was accompanied by multiphase igneous activity manifested onshore in the circum-arctic regions (Svalbard, Franz Josef Land, De Long Islands, the Canadian Arctic islands, North Greenland) and offshore by the oceanic Alpha-Mendeleev Ridge. These magmatic occurrences were assigned to a High Arctic Large Igneous Province (HALIP). On the Canadian

Arctic islands, predominantly tholeiitic continental flood-basalt volcanism occurred between ca. 130–95 Ma, followed by mafic to felsic, alkaline, rift-related igneous activity in the Canadian Arctic and North Greenland since ca. 95 Ma. The genetic relationship between the tholeiitic and the alkaline magmatism is still unclear. Our studies focus on northern Ellesmere Island (NE Canadian Arctic islands) because only here both tholeiitic and alkaline igneous suites are found in close spatial association. In the Yelverton Bay area of NW Ellesmere Island, basaltic dykes dated at 122 to 94 Ma (Ar-Ar age) represent equivalents of the tholeiitic flood basalts further west. Rhyodacite volcanism was active at around 100 Ma, almost contemporaneously with mildly alkaline flood-basalt volcanism in NE Ellesmere Island at ca. 96 Ma. Alkaline gabbro to granite plutonism at ca. 92 Ma was followed by alkaline basaltic volcanism at ca. 80 Ma. The youngest phase of alkaline volcanism (known from volcanic pebbles in Palaeocene clastic sediments near Nares Strait) was active in NE Ellesmere Island at ca. 61–58 Ma. We interpret the Late Cretaceous to Palaeocene alkaline volcanism to be linked to the opening of the North Atlantic–Labrador Sea oceanic system on the one hand and the Eurasian Basin of Arctic Ocean on the other hand, which led to a reactivation of pre-existing fault zones parallel to the north coast of Ellesmere Island and to strike-slip tectonics through Nares Strait (the "Wegener Fault").

In situ deformation of eclogite and depleted peridotite compositions at high pressure and temperature

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Oral in Session A4-03

In this study, we explore the rheology and phase relations of residual bimineralic eclogite and depleted peridotite (harzburgite) compositions, which will provide crucial information for modeling mantle flow. Experiments were done at the Bayerisches Geoinstitut (BGI), University of Bayreuth and at the European Synchrotron Research Facility (ESRF). We determined the strength contrast variability during progressive deformation on a stack of eclogite and olivine or orthopyroxene. The samples were pressurised to 4–5 GPa and heated at different temperatures (1100–1470 K) in a large volume press (D-DIA / 6-ram type), and then deformed by the advancement of a pair of differential rams. At the ID06 beamline at ESRF we used in situ angle-dispersive X-ray diffraction and radiography to estimate stress and strain / strain rate respectively. The strain was obtained from the positions of Re-discs between the sample-sample and sample-piston interfaces. The deformation proceeded step-wise with increasing increments of displacement/strain rates ranging between 3x10^{-6} s^{-1} and 5x10^{-5} s^{-1} to reach total strains between 20–35%. The stresses were estimated for each phase from lattice d-spacing changes (micro-strains) on given crystallographic planes as function of azimuth visible in the 2-d diffraction images. Preliminary results suggest olivine is generally weaker than bimineralic eclogite by 10–40%, especially at higher strain rates. Eclogitic clinopyroxene did not recrystallize but grains appear to have developed a shape/crystallographic preferred orientation. The population of small eclogitic garnet grains (1–5 μm) from the starting material have locally formed thin layers likely by grain boundary sliding processes. In contrast, bimineralic eclogite appears equally strong as fine-grained orthopyroxene (1–5 μm), and is slightly weaker (10%) than coarse-grained orthopyroxene (10–60 μm) at higher strain rates. Results from texture analysis and phase relations are forthcoming.

Coherent vs. non-coherent subduction of ophiolite complexes – new insights from the Zermatt-Saas Zone (ZSZ) in the Western Alps

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The ZSZ in the Western Alps is one of the few exposed ophiolites that contain UHP metamorphic rocks. It has been interpreted either as a rather coherent piece of subducted and exhumed oceanic lithosphere or as a stack of several slices accreted at different times. In addition to the ophiolites, several eclogite-facies slices of continental material are present within and on top of the ZSZ. One of these, the Etirol-Levaz Slice (ELS), is sandwiched between the ZSZ and the overlying, blueschist-facies, oceanic Combin Zone. It has been interpreted as an extensional allochthon from the continental margin of Adria, emplaced onto oceanic lithosphere of the future ZSZ by Jurassic, rifting-related detachment faulting, and was later subducted together with the oceanic lithosphere. Alternatively, the ELS could be derived from a different paleogeographic domain and juxtaposed with the ophiolites during subduction/exhumation. This question has far reaching implications for how subduction channels are organized. We present a new geological map of the ELS, detailed petrology of two eclogite samples, and Lu-Hf whole-rock-garnet ages of them. The samples are from two subunits of the ELS, separated by a serpentinite- and metagabbro-bearing shear zone. Despite being quite different, assemblages, mineral compositions and garnet zoning in both samples point to a clockwise PT-path and peak-metamorphic conditions of 550-600°C/20-25kbar. Prograde garnet ages of the two samples are 61.8 ±1.8 Ma (upper subunit) and 52.4 ±2.1 Ma (lower subunit). Prograde garnet growth in the underlying ZSZ has been dated at 48.8 ±2.1 Ma with the same method (Lapen et al. 2003). These results speak against coherent subduction of oceanic lithosphere. We rather interpret the ELS to represent fragments of continent-derived material from the hanging wall of the subduction zone that were incorporated into the subduction factory by tectonic erosion. Lapen at al. 2003. Earth and Planetary Science Letters, 215, 57-72

Three-Dimensional (3-D) Attenuation Tomography in “FF” Geothermal Field

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Poster in Session B1-04

Three-dimensional (3-D) attenuation tomography (Qp, Qs, Qp/Qs) of FF geothermal field is derived from micro-earthquake data. The data were recorded continuously from October 2012 until August 2013 by 49 seismometer stations. The stations recorded 193 events, consist of 1090 P-wave phase and 1057 S-wave phase. The waveforms were analyzed using spectral fitting method to determine the operator attenuation (t*) values. That values are to be used to calculate three-dimensional (3-D) attenuation model, using 3-D velocity model from the previous study. The attenuation operator (t*) ranged from 0.001-0.045 seconds with a corner frequency (fc) ranging from 1.599-19.80 Hz. The result from this research described the reservoir zone under well A and B associated with low Vp/Vs ratio, low Qp, high Qs and low Qp/Qs ratio. This zone is interpreted as a partial saturated zone, steam dominated. Keywords: Geothermal, micro earthquake, tomography, attenuation, spectral fitting, fluid saturation.

Experimental constraints on seismic properties and rheology of the upper mantle: Effects of water and melt

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Keynote in Session A4-03

Experiments indicate that both melt and water significantly affect seismic properties as well as the rheology of upper mantle rocks. The extend of the velocity reduction and decrease in viscosity may not be the same for all conditions. Our deformation and seismic property measurements are performed predominantly with synthetic Fo90 olivine aggregates, ensuring that no melt is present at experimental conditions, unless deliberately added. The effect of water is investigated by doping the synthetic olivine with titanium and surrounding the samples in FeNi foils or Pt capsules. The different surrounding metals allow retention of variable amounts of water under water-undersaturated conditions. Infrared spectroscopy shows that the hydrogen is structurally bound in olivine in a defect consisting of titanium on a metal site and two hydrogens on a silicon vacancy. This titanium-clinohumite-like point defect produces absorption bands that are also found in the majority of natural olivine. Deformation experiments on the so prepared samples show a near linear dependence of the rheology on water content. Seismic property measurements on a sample with relatively high water content shows substantially higher levels of attenuation and a correspondingly lower modulus compared to dry samples, suggesting that water has a similar effect on seismic properties as on the rheology. Previous experiments showed that small amounts of melt also significantly affect seismic properties, as well as reducing the strength in diffusion creep. Intragranular melt however has comparatively little effect on the strength during dislocation creep. If the low velocity zone in the upper mantle is due to water, seismic properties and viscosity will be similarly affected. However, if the low velocity zone is due to melt but deformation occurs in the dislocation creep regime, the low velocity zone may not coincide with a minimum in viscosity.

Dimensioning and optimizing of gas storage caverns in flat bedded salt formations using the example of storage site Bernburg (Central Germany)

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Oral in Session B5-02

The natural gas cavern storage site Bernburg, situated in the federal state of Sachsen-Anhalt (central Germany), is operating since the early 1970ies. Starting with a few caverns for the storage of natural gas and LPG the cavern field has been enlarged step by step to more than 30 caverns with a storage volume >1 bcm of working gas. The concept of cavern leaching technology as well as cavern dimensioning has been developed significantly during this period. The gas storage caverns are placed in the Zechstein salt pillow „Bernburger Sattel". The geological conditions are well known in the central and northern part of the structure by numerous boreholes. However, the development of a new cavern field in the southern part of the salt pillow gave reason to execute an investigation program which is directed to the optimization of the cavern parameters as cavern height and volume for a maximum brine production and the following gas storage operation. Additionally the program aims for keeping respectively improving the high safety standards and for saving costs. The investigation program comprises three main components. A 2D-Seismic survey provides data of depth and structural behavior of the overburden and the Stassfurt rock salt body. Several boreholes were drilled and investigated by a comprehensive well logging program and by detailed lithological and stratigraphical studies. An In Situ Pneumatic Pressure Test program was realized to increase the accuracy of determination of the maximum storage pressure at Bernburg site. The presentation gives an overview of the exploration procedure, of the geological and technical approaches and of the results.

Primary carbonate-rich melt in stromatic migmatites of the Bohemian Massif as result of partial melting of metasediments in the middle-lower crust.

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Poster in Session A1-02

The Pamir is a high plateau located north of the western syntaxis of the Himalaya. Pamir's present-day geometry is a result of Cenozoic indentation of India into Asia during which it was displaced northward by about 600-900 km with respect to the Tarim basin. Although the Pamir shares many geodynamic aspects with Tibet, it has several unique features, such as: 55-64% N-S internal shortening, exposure of middle-lower crustal crystalline rocks with Cenozoic metamorphism, and occurrence of intermediate depth seismicity caused by intracontinental subduction. Models of Pamir plateau formation and its present day kinematics propose crustal thickening and orogenic material flow whereby the ductile middle or lower crust is dragging the middle-upper crust NNW-to WNW. To investigate the structure of the lithosphere, particularly the extent and the depth range of the ductile crust, a magnetotelluric survey was conducted in the Southern Pamir as a part of the interdisciplinary TIPTIMON (Tien-Shan-Pamir Monitoring Program) project. Overall, we installed 85 wide-band magnetotelluric stations covering a 200 km x 100 km wide region between Murghab and Chorog in Tajikistan, with a site spacing of approximately 8km. Results of 3D inversion show a resistive upper crust for the entire southern Pamir. Starting at around 10km depth, a prominent low-resistivity zone (below 10 Ωm) appears in the SE part. The conductive zone extends towards the center of the southern Pamirs but does not reach to the west. The conductive channel can be explained with interconnected partial melt of 3-10%. Low seismic velocities and high heat flow support this interpretation. In the southwestern part of the survey area a resistive core extends to larger depths (>30 km) and a few conductive regions appear as isolated structures with limited extension. We interpret these zones of high conductivity as faults which can provide pathways for fluids and which partly seem to coincide with hot springs at surface.

The magmatic structure of the Mozambique Ridge

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The Mozambique Ridge (MozR) is located in the southwestern Indian Ocean and is discussed as part of the South African Large Igneous Province (LIP). It consists of four major geomorphological units, which are associated with multiple phases of volcanic activity between 140 Ma and 120 Ma. This project tries to decipher the gradual development of the Mozambique Ridge as well as its role within the break-up of Gondwana. In order to address these open questions high-resolution seismic reflection data was gathered during cruise SO-232 with RV Sonne. Seismic reflection data reveals various magmatic centres and intra-basement reflections that extend up to several hundred ms TWT below top of basement. Such massive flows are characteristic of oceanic plateau eruptions. Primary volcanic features associated with the formation of the different segments of the MozR can be identified and separated from secondary volcanic features, indicating magmatic reactivation after its initial build-up. The internal reflections generally dip away from their magmatic centres and individual reflectors are typically traced 5-15 km. Various faults cutting through basement and sedimentary units are interpreted as extensional tectonic features. These observations imply that MozR is of LIP origin and underwent multiple magmatic and tectonic phases during its development. This will lead to a better understanding of the opening of the South African gateway associated with the Gondwana break-up and the development of the MozR as a LIP in general.

Early Earth tectonics: A high-resolution 3D numerical modelling approach

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Oral in Session A4-04

Early Earth had a higher amount of radiogenic elements as well as a higher amount of leftover primordial heat. Both contributed to the increased temperature in the Earth's interior and it is mainly this increased mantle potential temperature that controls the dynamics of the crust and upper mantle and the style of Early Earth tectonics. We conduct 3D petrological-thermomechanical numerical modelling experiments of the crust and upper mantle under Early Earth conditions using a plume tectonics model setup. For varying crustal structures and a mantle potential temperature increase (ΔTp, compared to present day conditions), a hot lower thermal boundary layer introduces spontaneously developing mantle plumes and after repeated melt removal, depleted mantle lithosphere is formed self-consistently. New crust is produced in the form of volcanics and plutonics. For a major increase in the mantle temperature, presumably corresponding to an Archean mantle (ΔTp = 200-300 K), models show large amounts of subcrustal decompression melting and consequently large amounts of volcanics, which in turn influence the dynamics. Mantle and crust are convecting separately. Dome-shaped felsic plutons can be observed in the crust. Between these domes elongated belts of downwelling basalt and sediments are formed. Both crust and lithosphere thickness are regulated by thermal-chemical instabilities assisted by lower crust eclogitization: linear or cylindrical drips originating at the crust or lithosphere bottom or delamination of lower crust or lithosphere. Very similar examples of dome and belt structures are still preserved in Archean cratons. One example is the Kaapvaal craton is South Africa where the elongated shape of the Barberton Greenstone Belt, mainly built from mafic rocks and sediments, is surrounded by multiple plutons of both felsic and mafic composition.

Implementing SO_2 as a CO_2 stream impurity in geochemical simulations of different sandstone formations potentially suitable for geological CO_2 storage

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In recent time, potential impacts of impurities in a CO_2 stream in the context of CO_2 storage are gaining wider attention. This paper addresses the impact of SO_2, an impurity that is likely present in CO_2 captured from coal combustion. Geochemical effects of CO_2-SO_2 mixtures were investigated via numerical simulations in the frame of the projects CO_2QUEST and COORAL. The comparative study evaluates geochemical reactions occurring within the Lower-Cretaceous Heletz sands formation of the Heletz reservoir (Israel), and the Rotliegend and Bunter Sandstone in the North German Basin. All three formations have been investigated for geological CO_2 storage. Two different simulation strategies were applied: (a) 1D reactive transport simulations with TOUGHREACT and (b) basic geochemical batch simulations with PHREEQC. Simulations were performed using measured and calculated data including mineral composition, in situ p-T conditions, and formation water chemistry. Sulfur dioxide as an impurity is of particular interest, due to its high solubility in aqueous solutions and its chemical reactivity comprising both acid formation and redox activity. Compared to CO_2, SO_2 behaves rather differently in a storage reservoir. Depending on injection rates, prevailing hydraulic conditions and reservoir rock compositions, distinct spatial SO_2 migration patterns were observed in reactive transport simulations. These result in a spatial differentiation of the amounts of dissolved SO_2 and therefore of the SO_2 availability for geochemical reactions, which governs the extent of SO_2-triggered reactions. All simulated scenarios indicate that dissolved SO_2 primarily affects carbonates rather than silicates. A number of batch simulations with varying amounts of SO_2 can provide valuable information of key fluid-rock reactions related to impure CO_2. Reactive transport simulations supplement batch simulations by adding the influence of spatial and temporal migration patterns of dissolved SO_2.

Investigating the genesis of impact-generated melt rocks of Araguainha, Brazil

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Poster in Session A3-02

The 252 Ma, 40 km Araguainha impact structure (Brazil) consists of crater rim, inner concentric rings, annular basin, and central uplift. The core of the central uplift exposes Ordovician alkali granite with abundant veins/pods of impact-generated melt rock; it is surrounded by deformed Paraná basin supracrustal strata. Former investigations of melt rock have remained inconclusive regarding a genetic model for the melt rocks. Preuß and Fischer undertook field studies in 2011 and 2014. Throughout the alkali granite cm- to m-thick dikes/pods of impact-generated melt rock are found. They consist of recrystallized alkali granite clasts set in a semicrystalline matrix of feldspar and quartz. Microscopic analysis showed for some of the dikes that they are pseudotachylitic breccias with or without a melt matrix. Occurrences of massive impact melt rock could be identified at

some higher elevations and would correspond to a 30-m-thick melt sheet postulated by [1]. A high level of erosion makes it difficult to confirm whether a melt sheet really existed directly above the currently exposed granitic basement. Petrographically, the massive and dike-like impact melt rocks are similar. At numerous exposures transitions between primary alkali granite and impact melt rock were identified ("transitional granite"). This rock is partially melted but still retains portions of precursor alkali granite with typical igneous texture. XRF analysis of the various lithologies, as well as EMPA spot analysis of matrix feldspar, did not show any significant differences in chemistry of the melt rocks, in comparison with alkali granite. This supports v. Engelhardt et al.'s finding that the formation of impact melt rock took place without involvement of supracrustals. The presence of high-silica melt clasts in Araguainha suevite indicates, however, that the supracrustal target sequence was involved.

Ref.:
[1] v. Engelhardt, W. et al. (1992), Meteoritics 27, 442-457.

Analysis of dissolution rate components in potential nuclear waste forms: The example of pyrochlore

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The long-term stability of ceramic materials which are considered as potential nuclear waste forms is governed by heterogeneous surface reactivity. Consequently, the identification of the dominant contributors to the overall dissolution rate is crucial to predict the stability of such waste forms quantitatively. Direct surface measurements by vertical scanning interferometry (VSI) and their analysis via material flux maps and resulting dissolution rate spectra provide data about dominant rate contributors and their variability [1,2]. Using pyrochlore (Nd2Zr2O7) pellet dissolution under acidic conditions, we demonstrate the identification and quantification of dissolution rate contributors for this example of a potential waste form. We identified multiple rate contributors that are responsible for the observed overall dissolution rate range. The application of the proposed concept offers the opportunity to increase our mechanistic understanding of ceramic waste form alteration. Thus, it provides an important prerequisite for quantitative predictions of waste form stability.

[1] Fischer et al. (2012), GCA, 98, 177-185;
[2] Fischer et al (2014), Appl Geoch 43, 132-157

Prediction of porosity evolution in polycrystalline material: A combined experimental and Kinetic Monte Carlo study using the rate spectra concept

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The quantitative predictability of porosity evolution as a result of water-rock interaction is of great interest in multiple disciplines of Earth science. Related data are required as input parameters in reactive transport models dealing with challenges such as CO_2 sequestration, extraction of thermal energy, nuclear waste management, and reservoir rock diagenesis. Crystal surface reactivity is an important but not constant bounding condition for the dynamic evolution of porosity. Dynamic systems can be successfully simulated using Kinetic Monte Carlo (KMC) methods. Here we utilize KMC simulations to study the evolution of reaction rates and surface pores in crystalline structures built-up of domains characterized by constant surface reaction energies but having varying defect densities. For the first time, we apply the rate spectra concept [1] to KMC results in order to analyze systematically the rate contributors in the frequency domain of rate datasets [2]. We discuss simulation results with respect to both, inheritance and passivation of initial reactivity in polycrystalline material. Furthermore, AFM and interferometry data are used to analyze experimental results in terms of material flux maps and dissolution rate spectra of multiple polycrystalline materials. The combined information out of both, experimental and KMC rate spectra data provides insight into critical constraints that govern the observed variability in pore volume and distribution with great potential for many interesting applications.

[1] Fischer et al. (2012), GCA, 98, 177-185;
[2] Fischer et al (2014), Appl Geoch 43, 132-157

Isotopic Evidence for the Origin of IIE Iron Meteorites

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Poster in Session A3-01

Non-magmatic iron meteorites are distinguished from magmatic irons in having abundant silicate inclusions and element-Ni trends that cannot be explained by fractional crystallization. Unlike the magmatic irons, the non-magmatic groups (i.e., IAB-IIICD, IIE) are, therefore, not considered as samples of the metal cores of planetesimals. They more likely formed on partially differentiated bodies or within impact-generated melt pools near the surface of undifferentiated asteroids. To better constrain these processes and the origin and formation history of non-magmatic iron meteorites, we initiated a detailed isotopic study of IIE iron meteorites. To this end we use Ru and Mo isotopes to assess a potential genetic link between IIEs and ordinary chondrites, Hf-W isotope systematics to constrain the timing of parent body melting and Pt isotopes to monitor isotope shifts induced by secondary neutron capture during cosmic ray exposure. The IIE irons examined so far exhibit variable Pt isotope compositions, indicative of significant and variable neutron capture-induced isotope shifts. After correction for these shifts, all IIE irons examined display nucleosynthetic Ru isotope anomalies consistent with a deficit in s-process Ru nuclides. These anomalies overlap with those of ordinary chondrites and as such support the genetic link between IIEs and H chondrites that has previously been proposed on the basis of similar O isotope compositions. Variations in the neutron capture-corrected W isotope compositions among the investigated IIE irons correspond to model ages of metal segregation of between ca. 4 and ca. 15 Ma after CAI formation. This range in ages combined with the relatively young ages of some IIEs is consistent with formation of the IIE irons in separate impact-generated melt pools.

Measurement uncertainty in total reflection X-ray fluorescence

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Poster in Session C1

Total reflection X-ray fluorescence (TXRF) spectrometry is a multi-elemental technique using micro-volumes of sample. This work assessed the components contributing to the combined uncertainty budget associated with TXRF measurements using Cu and Fe concentrations in different spiked and natural water samples as an example. The results showed that an uncertainty estimation based solely on the count statistics of the analyte is not a realistic estimation of the overall uncertainty, since the depositional repeatability and the relative sensitivity between the analyte and the internal standard are important contributions to the uncertainty budget. The uncertainty on the instrumental repeatability and sensitivity factor could be estimated and as such, potentially relatively straightforward implemented in the TXRF instrument software. However, the depositional repeatability varied significantly from sample to sample and between elemental ratios and the controlling factors are not well understood. By a lack of theoretical prediction of the depositional repeatability, the uncertainty budget can be based on repeat measurements using different reflectors. A simple approach to estimate the uncertainty is presented. The measurement procedure implemented and the uncertainty estimation processes developed were validated from the agreement with results obtained by inductively coupled plasma – emission spectrometry (ICP-OES) and/or reference/calculated values.

Convection of a fluid with strongly temperature and pressure dependent viscosity

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Plate tectonics on the Earth is a surface manifestation of convection within the Earth's mantle, a subject which is as yet improperly understood. The early success of the high Rayleigh number constant viscosity theory was later tempered by the absence of plate motion when the viscosity is more realistically strongly temperature dependent, and the process of subduction represents a continuing principal conundrum in the application of convection theory to the Earth. A similar problem arises if the equally strong pressure dependence of viscosity is considered, since the classical isothermal core convection theory would then imply a strongly variable mantle viscosity, which is inconsistent with results from post-glacial rebound studies. In this talk we address the problem of determining the asymptotic structure of high Rayleigh number convection when the viscosity is strongly temperature and pressure dependent, i. e., thermobaroviscous. By a method akin to lid-stripping, we are able to extend numerical computations to extremely high viscosity contrasts, and we show that the convective cells take the form of narrow, vertically-oriented fingers. We are then able to determine the asymptotic structure of the solution, and it agrees well with the numerical results. Beneath a stagnant lid, there is a vigorous convection in the upper part of the cell, and a more sluggish, higher viscosity flow in the lower part of the cell. We then offer some comments on the meaning and interpretation of these results for planetary mantle convection.

Large igneous provinces - a consequence of plate tectonics?

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Traditionally active rifts are thought to evolve in response to thermal upwelling of the asthenosphere, whereas passive rifts develop in response to lithospheric extension driven by far-field stresses. We provide evidence that initiation of rifting occurred in the South and North Atlantic distal from proposed hot-spot locations (Tristan and Iceland, respectively) with a rift migration toward the hotspot position, and there is consistent delay in break-up at the proposed location of hot-spots and the location of abundant volcanism. This challenges the idea of a major controlling mode of deep, hot-spot related mantle processes on the rift evolution, leading subsequently to the formation of the North and South Atlantic. Break-up–related extrusive magmatism, imaged in reflection seismic data as seaward-dipping reflectors (SDRs, the offshore LIPs), extends symmetrically along the volcanic margins of the Atlantic Ocean, questioning the influence of single radial sources. Also the sharp transition from magma-poor to volcanic rifting as observed at the southern Atlantic margins argues against a deep mantle origin for the rift-related magmatism. A plume rising from the deep mantle is expected to generate a smooth transition from magma starved to volcanic rifting over a few hundreds of kilometers rather than over a few 10th of kilometers. A numerical model, which is based on these observations shows that rift-parallel mantle flow and locally enhanced rates of volcanism are the result of delays in rift propagation and segmented opening. Rift propagation delay, as e.g. at triple junctions, is proposed to play an important role in the distribution of extrusive volcanism. and rift related magmatism.

Investigation of the Western Badenweiler-Lenzkirch-Zone with respect to sedimentological, structural and economical aspects

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The Badenweiler-Lenzkirch-Zone in the Southern Black Forest represents an important geological region for the Variscan orogeny where the Upper Viséan Kulm-Sediments are remarkable due to an economic and geological interest. Yet previous structural and sedimentological interpretations lack important information or contain conflicting ideas. Therefore a new mapping was carried out to clarify the basin formation due to an active collision in the late stage of the Variscan orogeny. Convergent movement in NW-SE direction in the Upper Viséan led to the collision of the Central Black Forest Gneiss Complex and the Southern Black Forest Complex for which reason the area was uplifted. The continental Kulm-Succession started to accumulate in an intramontane trough formed by a transtensional movement due to NE-SW convergence and lithospheric loading. Dextral dip-slip- and strike-slip faults represent the boundaries of the basin. Numerous debris flows which were triggered by these active faults deposited material along the flanks of the valley. Also, tropical storms resulted in several sediment gravity flows and flash floods. Small rivers and flood plains with swamps developed at steady times in the center of the basin where vegetation evolved to capacious horsetail- and fern forests which were a source for coal formation. Large coal beds did not develop due to the impact of debris material. The Kulm-Succession is mostly undeformed but brittle deformation is present. Structural measurements indicate that the normal stratification dips to the SW with 40 to 50°. Varying data results from syndepositional unconformities and an anastomosing strike-slip fault pattern. In conclusion, brittle deformation influenced strongly the succession of the transtensional trough which formed from dip-slip and strike-slip movement. Sediment supply increased

and debris flows were triggered along the basin margins, covering or reworking older sediments.

Structure and thermal field of the Upper Rhine Graben – a lithospheric-scale 3D model

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Understanding the structure of the Upper Rhine Graben is not only interesting because of its ongoing evolution as part of the European Cenozoic Rift System, but also because of its socioeconomic relevance as one of the sedimentary basins in Germany that provide a large potential for geothermal energy. In the framework of the EU-funded project "IMAGE" (Integrated Methods for Advanced Geothermal Exploration), we apply a data-driven numerical modelling approach to quantify the processes and properties controlling the spatial distribution of temperature variations in the subsurface. We use a multidisciplinary data set (e.g. well data, seismic reflection data, existing structural models) to construct the geometries of the sediments, the crust and the lithospheric mantle that control the spatial distribution of thermal conductivity and radiogenic heat production and hence temperatures. In particular, we integrate 2D reflection and refraction seismic profiles (e.g. DEKORP lines) and the measured gravity anomaly of the area into a 3D gravity modelling approach to map out units with different reflectivity and density within the crystalline crust. The resulting 3D structural model includes 7 sedimentary units, 5 different Variscan domains in the upper crystalline crust, the lower crust and the lithospheric mantle. By applying a data-based and lithology-dependent parameterisation of this lithospheric-scale 3D structural model and a 3D finite element method, we calculate the steady-state conductive thermal field for the entire region. Available measured temperatures (down to depths of up to 3.5 km) are considered to validate the 3D thermal model. Our model shows that the Variscan domains with their different thermal properties control the regional thermal field, while a thermal blanketing effect due to thick thermally low conductive sediments locally causes higher temperatures.

From early life to gold deposits

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Keynote in Session B2-02

Witwatersrand-type conglomerate hosted deposits represent the largest and oldest known concentration of gold. While a (hydrothermally modified) palaeoplacer origin for this gold is generally favoured, the source of the gold has remained enigmatic. Comparison of Witwatersrand-type deposits worldwide revealed that the primary concentration of gold in the continental crust resulted from Archaean atmospheric and biological evolution. The chemistry of the Mesoarchaean hydrosphere enabled very high Au solubility and high Au-flux off the Archaean land surface. When early life gradually changed from anaerobic anoxygenic to oxygenic photosynthesizers at c. 3.0 Ga, first "whiffs" of photosynthetic O_2 under an overall reducing atmosphere provided the ideal trap for Au dissolved in meteoric and shallow sea water. Oxidative precipitation of gold on the surface of first O_2-producing microbes is suggested to have fixed huge amounts of gold over large areas. Remnants of this microbially fixed gold can be observed in kerogen layers that typically drape erosional unconformities, scour surfaces and bedding planes in 2.9 Ga near-shore sedimentary successions. This gold provided the principal source for the rich placer deposits that formed by subsequent sedimentary reworking of the delicate microbial mats on aeolian deflation surfaces, into fluvial channels and delta deposits, represented by Meso- to Neoarchaean auriferous conglomerates, best preserved in the Witwatersrand rocks of South Africa. Elsewhere, these gold-rich sediments became tectonically reworked, which explains the secular peak of orogenic-type gold deposits at c. 2.7-2.4 Ga. As the gold-enriched Archaean sediments became progressively eroded, covered or tectonically reworked, their role as source for younger placer deposits diminished. This explains why Witwatersrand-type deposits younger than 2.4 Ga are rare and far less endowed, and effectively missing after 1.8 Ga.

Tectonic and climatic forcing of lake level and salinity in the Miocene lacustrine succession of the Aktau Hills, southeastern Kazakhstan, Central Asia

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Throughout the Cenozoic, continental settings of Central Asia witnessed increased desertification and the establishment of monsoonal climate conditions. These continental-scale climate shifts are thought to be connected to global cooling, tectonic uplift and the final Paratethys retreat. Despite general aridification, a period of lacustrine sedimentation during the Miocene refers to elevated moisture transport into Central Asia´s continental interior. In this study, we present first field results from an exceptionally well exposed Miocene succession of the Aktau Hills (Ili Basin, SE Kazakhstan). Sediments of the Aktau consist of reddish-coloured floodplain deposits that grade into grey lacustrine deposits. The basal age of the succession (early Miocene, MN 4-5) is constrained by occurrences of mammal remains. The lower part of the succession represent conditions that started with a dry mudflat environment supporting the formation of ephemeral saline lakes in the Early Miocene. The recurrent drying of the lakes lead to the cyclic deposition of carbonates, gypsum and anhydrite. Thin section and field observations point to hypersaline lake conditions hostile to life. Higher up, a gradual shift towards a perennial water body close to freshwater conditions is documented by the disappearance of gypsum-yielding strata and the occurrence of ostracods. The succession yield several laminated deep water intervals, which are rich in fish bone fragments but barren of benthic fauna. These horizons indicate periods of tempory water column stratification relative to lake level fluctuations. First results of time series analysis, based on measurements of magnetic susceptibility and rock colour, indicate a cyclic alternation of various lake facies. This suggests an orbitally forced control on lake level changes and moisture supply imprinting the long-term trend of lake freshening. Further improvement in the age model will be achieved by paleomagnetic studies.

Sedimentology of the “Tsunami”-chert-slab conglomerate of the Archean Fig Tree Group (3.24 Ga), Barberton Greenstone Belt, South Africa

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Poster in Session A4-05

Slab conglomerates are common on Archaean submarine slope deposits and provide unique records of transport mechanisms. We recorded detailed stratigraphic profiles from the ∼6m thick “tsunami conglomerate” of the Mapepe Formation of the lower Fig Tree Group (Barberton Greenstone Belt, South Africa, ∼3.24 Ga). This conglomerate is erosional in and overlain by interbedded tuffaceous shale and silicified fine– to medium-grained sandstone on a submarine slope. It consists of a single, up to 6 m thick, excellently exposed unit. The conglomerate

is, except in its upper 10%, densely packed and clast-supported. Slab-shaped clasts are angular, planar and dominated by translucent, black-and-white banded, and black chert of Fig Tree provenance; their median size is 1±0.3 by 15±7 cm (±2s), and the largest clast measures 68 by 1.5 cm. Sorting is poor; slab orientation is dominantly subhorizontal. Vertical variations on dm-scale in mean slab size, sorting, orientation, and internal degree of folding define several internal flow units in gradual contact with each other. Clast concentration abruptly decreases near the top where the slab conglomerate grades into a Tabc (de) chertarenite. Clast population textures and sedimentary structures allow to infer that deposition largely occurred as a single but pulsed, cohesive, hyperconcentrated laminar flow of packed chert slabs lubricated by little shaly matrix. Frictional freezing of the lower body involved settling, shear folding, and fluid escape while the finer-grained top fluidized by water intake and gradually developed into a turbidity current. Regional mapping suggests that transport was NW-directed and S.

Improvement of mechanical properties in poly-nanocrystalline composite ceramics

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State-of-the-art high pressure technologies allow synthesizing novel nano-polycrystalline materials, in particular ceramics with excellent mechanical properties made from Earth's highly abundant geomaterials. The positive correlation of grain fining and increasing hardness known as the Hall-Petch relation is widely observed for metals and was also found in ceramics, e.g., MgO [1]. The opposite effect - a decreasing hardness below a threshold grain size - is called the inverse Hall-Petch relation [1]. This study focuses on synthesizing nano-polycrystalline composite ceramics using components of the hardest and second hardest oxides, stishovite and corundum, respectively [2, 3, 4], to produce materials with improved mechanical properties. Aggregates of Al_2O_3 (corundum) and SiO_2 (stishovite) were synthesized from glasses with Al_2SiO_5 composition produced by container-less processing in an aerodynamic levitation furnace. High resolution X-Ray powder diffraction shows that Al_2SiO_5-glass completely decomposes into corundum and stishovite with Si^{4+} and Al^{3+} in octahedral coordination. For these composites, Hall-Petch and inverse Hall-Petch relationships were observed. Our results show that poly-nanocrystalline geomaterials made from low-cost raw substances are very promising for the production of materials with excellent mechanical properties, even exceeding those of high quality metal alloys, which is a great challenge of material science so far. References:

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From plate tectonics to plate weathering

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Keynote in Session A6-04

Chemical weathering is one of the major geological processes on Earth and is a specificity of our planet. Chemical weathering is linked to physical erosion and therefore plays a key role in the denudation of the Earth's relief. Not only is erosion the main mechanism of relief destruction on Earth, it is also chemically regulating atmospheric, oceanic and lithospheric composition. Although plate tectonics and erosion are often seen as opposite processes, they act together to shape the surface of the Earth and to stabilize atmospheric and ocean composition. The most evident feedback between plate tectonics and erosion is via topography and geography. By creating relief, tectonic uplift and erosion are intimately coupled in particular via the water cycle. However recent studies have shown that a number of other couplings between plate tectonics and weathering exist. - Lithology is one of the most important controls on erosion, and lithology is mostly controlled by plate tectonics (volcanic and igneous rocks vs. sedimentary rocks). - Plate tectonics continuously recycle crustal components and this recycling has a strong impact on chemical weathering over the long-term. - Erosion rates have been determined more and more precisely with different techniques and we now have a relatively good picture of global rates of erosion. Hot spots of erosion occur at the boundary between tectonic plates in particular when volcanic lithologies are involved and under high heat flow conditions. - Erosion and weathering processes are producing material with a lower density than the initial bedrock, thus having a key importance in the evolution of the lithosphere with time.

Characterization of the Au-Cu skarn deposit of the Sta. Teresa Mine, La Paz Mining District, San Luis Potosi, Mexico

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Poster in Session B2-02

The La Paz Au-Cu skarn deposit exposed in the Santa Teresa Mine in San Luis Potosí State, Mexico, is genetically linked to adakite-like magmatism at ca. 37 Ma (Pinto-Linares et al., 2008). Host rock to the monzogranites is Cretaceous limestone. The Sta. Teresa Mine is located in between the Cu-Au skarns of the Dolores Mine to the west and the (Ag-)Pb- Zn vein mineralization of the San Agustin Mine to the east. In order to characterize the Sta. Teresa mineralization type(s) and to elucidate the paragenetic ore sequence, petrographic investigations were combined with geochemical analysis of selected drill core samples. Three major types of mineralization were identified. (1) Altered granodiorites display a disseminated mineralization of early arsenopyrite and pyrite, followed by chalcopyrite and sphalerite. Texturally late pyrrhotite is associated with tennantite, stannite, and/or stannoidite. (2) A skarn mineralization is abundant in metamorphosed limestone in proximity of the monzogranite intrusion, mainly represented by early disseminated pyrite and pyrrhotite. These phases are rimmed by chalcopyrite and associated with native bismuth and texturally late bornite and tennantite. (3) Both mineralization types are transected by Cu-, Pb-, and/or Zn-rich ore veins of variable composition. Main ore phases in narrow fissures in altered monzogranite are arsenopyrite, sphalerite, and chalcopyrite. In some of the veins, these phases are associated with late tennantite, stannite, and/or stannoidite. Veins and broad areas of fracturing in the skarn itself either contain galenite and sphalerite (with clausthalite exsolution) or arsenopyrite, chalcopyrite, pyrite,

together with late bornite. A transition between the vein-like and the skarn mineralization is observable in most samples.

Pinto-Linares, P.J., et al., 2008, Revista Mexicana de Geológicas, v. 25, p. 39-58.

The Adrar Souttouf Massif (Moroccan Sahara) - a key to the Avalonia and Meguma conundrum?

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Oral in Session A1-05

Situated at the W margin of the West African Craton (WAC), the Adrar Souttouf Masif (ASM) consists of several NNE-SSW trending geotectonic units. They are obducted onto the Archaean basement of the Reguibat Shield and contain various igneous, metamorphic and sedimentary rocks. Two major phases of metamorphic overprint are evidenced for the entire region and can be linked to a Neoproterozoic and the Variscan-Alleghanian orogeny. Combined data of >5.000 U-Pb and >1.000 Hf isotope studies on zircon and U-Pb analyses on some hundred apatites reveal a complex, polyphased geologic evolution of this poorly studied area. According to the zircon U-Pb-Hf record, the eastern parts of this massif are made of Archaean and Neoproterozoic igneous rocks, overlain by WAC detritus. The central part of the ASM is interpreted as an oceanic island arc, set up at $\sim$635 Ma. Metamorphism due to amalgamation of this part to the eastern units took place at $\sim$605 Ma. Most of the zircons from this unit show Hf values that are typical for juvenile magmas. The unit following to the west also shows strong relations to the WAC, except some granitoid intrusions of Devonian age. As the latter are well known from the Meguma terrane, which is thought to be of WAC origin, we interpret this unit as one of its fragments. Obtained U-Pb-Hf values of zircons from the westernmost unit are in stark contrast to all the others. While the igneous rocks indicate Silurian-Devonian and Ediacaran magmatic activity with some Mesoproterozoic to Archaean inheritance, the sediments are dominated by Cambrian-Ediacaran and Mesoproterozoic zircons. All of this is known from W-Avalonia, which is interpreted to be the counterpart of this unit. A comparison of our results and published data from Avalonia, Meguma, Amazonia, Baltica, WAC, etc. allows to introduce some new aspects to the history of the circum-Atlantic peri-Gondwanan terranes.

Fault reactivation and landward vergent thrusting in the accretionary prism of Northern Sumatra revealed by analogue experiments

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Poster in Session A1-06

Seismic investigations have identified landward vergent thrust faults in the accretionary prism of Northern Sumatra that differ from the common fold-and-thrust belt model in the dip direction of the thrust sheets. A number of parameters that may control the formation of landward vergent structures have been put forward, including strength, position and dip of the décollement, pore-fluid pressure, heat-flow/thermal structure, dip direction of a backstop, strength of the wedge, and subduction of topographic features. A parameter that has not yet been investigated in the context of landward vergence in accretionary prisms is faulting of the sedimentary input section prior to subduction and possible reactivation of these faults during prism building. Here we test whether fault reactivation during prism building is supported by analogue models. Models are realized in a 3 m long box where horizontal shortening is generated by a conveyer belt at the bottom. Input sediments are simulated by a 2 cm thick layer of sand that is sieved on a 2 mm thick layer of glass beads acting as the weaker décollement. Weak planes that should resemble the pre-subduction faults are generated by pulling out thin wires that were placed on the glass beads before the sieving of the sand. We conducted several model runs with different pre-subduction fault angles and dip direction. The models were recorded with digital cameras. Digital image analysis was used to determine displacement fields and to calculate the slip on individual fault segments. First results indicate that new prism thrust faults preferably develop at the positions of pre-existing faults. In the case of seaward-dipping pre-existing faults some component of horizontal shortening in the accretionary prism is accommodated along antithetic thrusts. We will next adopt the model set-up to the detailed structural setting of northern Sumatra with both, landward and seaward dipping faults concurrently present in the input sediments.

Constructing Balanced Cross Sections from 2D Cliff Profiles of the Jasmund Glaciotectonic Complex (Rügen Island, NE Germany)

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Oral in Session A6-07

During the last decades, different structural models have been developed to unravel the complicated genesis of the Jasmund Glaciotectonic Complex (NE Rügen, Germany). On the basis of new LiDAR data, the existing models can be proved and modified. Several methods, which comprise among others geomorphological mapping and spatial analysis, are applied using a 5 m resolution digital elevation model (DEM5, provided by the LAiV M-V). This includes especially the morphometric investigation of the single morphological ridges (width, height, slope angles) and the assessment of their spacing. First results show that the northern sub-complex is cut and partly superimposed by the southern sub-complex, which indicates an earlier formation of the northern part of Jasmund Peninsula. Additionally, the morphometric investigations make obvious that the analysed landforms must be composite ridges and not (annual) push moraines. The ridges have a symmetrical profile, which is unusual for push moraines, but rather reflects fault bend folds in the subsurface. After modern classifications of glacigenic landforms (cf. Aber & Ber 2007) the term push moraine is not suitable for Jasmund and should be avoided. The morphology and the internal structural conditions (large scale folds and imbricate fans) are more typical of glaciotectonic complexes as exemplarily described by Pedersen (2000) for Møns Klint (SE Denmark).

Aber, J. S. & Ber, A. (2007): Chapter 5 Composite ridges – In: Aber, J. S. & Ber, A. (eds.): Glaciotectonism. Developments in Quaternary Science 6: 59-82, Amsterdam (Elsevier).
Pedersen, S. A. S. (2000): Superimposed deformation in glaciotectonics. – Bulletin of the Geological Society of Denmark, 46: 125-144.

The Jasmund Glaciotectonic Complex (NE Rügen Island): Geomorphological Mapping and Landform Analyses based on LiDAR Data

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Poster in Session A6-07

During the last decades, different structural models have been developed to unravel the complicated genesis of the Jasmund Glaciotectonic Complex (NE Rügen, Germany). On the basis of new LiDAR data, the existing models can be proved and modified. Several methods, which comprise among others geomorphological mapping and spatial analysis, are applied using a 5 m resolution digital elevation model (DEM5, provided by the LAiV M-V). This includes especially the morphometric investigation of the single morphological ridges (width, height, slope angles) and the assessment of their spacing. First results show that the northern sub-complex is cut and partly superimposed by the southern sub-complex, which indicates an earlier formation of the northern part of Jasmund Peninsula. Additionally, the morphometric investigations make obvious that the analysed landforms must be composite ridges and not (annual) push moraines. The ridges have a symmetrical profile, which is unusual for push moraines, but rather reflects fault bend folds in the subsurface. After modern classifications of glacigenic landforms (cf. Aber & Ber 2007) the term push moraine is not suitable for Jasmund and should be avoided. The morphology and the internal structural conditions (large scale folds and imbricate fans) are more typical of glaciotectonic complexes as exemplarily described by Pedersen (2000) for Møns Klint (SE Denmark).

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Pedersen, S. A. S. (2000): Superimposed deformation in glaciotectonics. – Bulletin of the Geological Society of Denmark, 46: 125-144.

Late stage evolution of Shatsky Rise volcanism and possible connection to Hess Rise (NW Pacific)

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The NW Pacific hosts two Large Igneous Provinces: Shatsky and Hess Rise located just ∼1200 km apart. The igneous basement of Shatsky Rise was recently drilled during IODP Exp. 324, confirming that Shatsky volcanism started 145 my ago at the Pacific-Farallon-Izanagi triple junction (Geldmacher et al., 2014, Int. J. Earth Sci. 103). Although petrological and geochemical characteristics of the recovered lavas support the involvement of a thermochemical mantle plume at Shatsky Rise, ultimate evidence for a deep mantle plume origin is still difficult to provide. One of the outstanding problems for a (fixed) mantle plume origin is the absence of a post-plateau, time-progressive hotspot track that can be unequivocally related to Shatsky Rise. Potential expressions of such tracks could be the shallow Papanin Ridge that forms a continuation of Shatsky Rise towards the northeast and/or a broad belt of seamounts to the East of the main plateau, the Ojin Rise Seamounts. An inferred (but speculative) hotspot track through Papanin Ridge/Ojin Seamounts leads to neighboring Hess Rise, which could represent a second large pulse of the Shatsky plume source (Bercovici and Mahoney, 1994, Science 266). Not much is known about Hess Rise, which was formed during the Cretaceous magnetic quite zone preventing further constraints on its tectonic setting. Based on old DSDP drill core samples, the igneous basement of Hess Rise most likely formed between

~110-100 Ma (Vallier et al., 1983, Geol. Soc. Am. Bull. 94), about 35 my later than Shatsky Rise, a similar time lag as suggested for the two main volcanic pulses detected at Ontong Java, the largest known oceanic plateau (e.g. Tejada et al. 2002, J. Petrol. 43). In this study we present new trace element and Nd, Pb, and Hf isotopic data from representative Ojin Rise Seamounts and Hess Rise DSDP drill core samples, in order to evaluate a possible genetic relationship among them.

O2A - supporting data managment from observation to enhanced data product

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Over the recent years, there has been a growing demand to handle heterogeneous sensor and (near-)realtime-data of increasing complexity and volume. Technical implementations are required to suit a wide range of project-specific workflows, and there is no one-size-fits-all solution. This has led us to build a generic, modular, and cost-effective framework (O2A) to enable the flow of observation data to archives - and data products. O2A bundles a number of extensible and exchangeable components and various interoperability services. It offers practical solutions for typical scientific workflows from data acquisition to final archival and data publication. Among these modules, there are: * an AWI-specific SensorML profile supporting raw data ingest, * a web-based monitoring tool box for dashboard-aided data visualization, spatio-temporal subsetting, and sensor range checking and fault detection, * project workspace areas and dispatcher middleware, * AWI's GIS infrastructure, * a ticket and data curation system supporting data archival and publication. In the context of the large-scale multi-disciplinary project "Frontiers of Arctic Monitoring" Project (FRAM), we illustrate how the O2A framework will assist scientists in developing enhanced data products and facilitate data re-use in the future.

Dating shear zones, volcanism and ore mineralisation by insitu U-Pb small scale isochrones

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Oral in Session A1-05

The U-Pb isotope system is widely applied for dating crystallization and re-crystallization of mineral assemblages during HT events in earth history. Alongside with improvements on instrumentation over the last decades, considerable efforts have been spent to develop and refine methods for dating single crystals or even individual growth domains of high-U (>50ppm) accessory phases. Whereas in general these methods are very successful to date magmatic and metamorphic events, there are some rock types and processes that often can not be dated as appropriate accessory minerals are absent, too small and to complex, respectively. Examples for such rocks can be found in many shear zones, e.g. protomylonites and tectonic carbonates but extend to diagenetic formed carbonates and opal and various types of ore mineralisation. This study focus on the application of in-situ U-Pb isotope analyses of low-U (0.001 to 10 ppm) minerals in thin/thick sections by laser ablation ICP sector-field mass spectrometry (LA-ICP-SFMS). For this rock forming minerals and mineral assemblages that (re-)crystallised and equilibrated during an event, containing low but variable amounts of U and μ (^{238}U/^{204}Pb) will be analysed. Instead of dating a single accessory phase, multiple analyses with variable U/Pb within an mm- to cm-area of a thin section form an array in the ^{207}U/^{206}Pb versus ^{238}U/^{206}Pb space; the lower intercept with the Concordia is interpreted as crystallisation age and the Y-intercept as the intial Pb isotope composition. Examples will be shown where this method have been applied to different rocks (protomylonites, cataclasites, carbonatites, slickensides, calc-silicates ...) formed during Precambrian to Cenozoic time. The results will be discussed. In many cases the smale scale isochrone (SSI) ages agree very well, if available, with the known age of these lithologies.

Origin of bead decorations of celtic fibulae: Constraints from in-situ Sr and B isotope composition

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White decorations of celtic fibulae are commonly described by archaeologist as bleached red corals from the Mediterranean Sea. Archaeometric studies, however, imply that coral beads were originally white. Based on Xray diffraction, white coral beads from middle German fibula differ by low and the ones from south Germany and Austria medium Mg contents (6-8%) compared to red corals from recent sea water and bead decorations (10-12%; Schrickel et al. 2013). Raman spectrometry indicates that red and white corals are characterised by varying polyenes in their organic matrix. Polyenes responsible for the red colour can be degenerated by aggressive acid leaching and heating above 200°C, resulting in a white colour. Low Mg contents likely point to fossil, re-crystallised carbonates used for bead decorations. To better understand the origin, provenance and possible alteration of white decorations from celtic fibulae we applied in-situ $^{87}Sr/^{86}Sr$ and B isotope analyses by LA-MC-ICPMS. With spot sizes of 0.04 to 0.15 mm this method allows (almost) non-destructive and precise in-situ trace element and isotope analyses of precious collectors' items as large as 10x15 cm in size. Short analyses time (<2 min) allows studying sample heterogneity as well as surface contamination and surface alteration due to depth profiling. In addition to various coral beads we analysed recent corals from various types and origin as well as fossil carbonates of well-known stratigraphic position. $^{87}Sr/^{86}Sr$ isotopes allow distinguishing marine carbonates of different deposition ages and together with B isotopes to monitor alteration and weathering effects. B isotope composition differs between different marine coral types and is very distinct to that of fresh and meteoric water.

Direct insitu U-Pb dating of secondary carbonates by LA-SF-ICPMS

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Oral in Session C1

Direct dating of carbonates, except of young ones (>0.5 Myr), is a general challenge. This applies in particular to terrestrial carbonates (e.g., pedogenic, diagenetic, tectonic) which yet not have been dated directly. Absolute ages of diagenetic carbonates formed by meteoric fluids and during subsidence can constrain the burial history and timing of fluid migration; while carbonate veins and slickensides can help to unravel the Mesozoic and Cenozoic tectonic history. The age of pedogenic carbonates will unravel surface processes and can be crucial for reconstruction of the Cenozoic climate. U-Pb dating of carbonate has been shown to be viable in a few cases but was restricted due to application of the very time consuming ID-TIMS methods. Recently Parrish and Rasbury (2014) have shown that LA-MC-ICP-MS (used routinely in zircon U-Pb dating) is very promising method for dating carbonates with U contents of 0.4 to 5 ppm. They successfully applied it for dating of speleothems, paleosols, lacustrine carbonates, tufa, early marine cements (in ammonite chambers), calcite veins from fractures in MORB and marine fossils. Their ages ranges from Permian to late Quaternary, as young as 250ky with uncertainties as little as ±4% at 95%

confidence. This study has been inspired by these results. Laser ablation allows a quick assessment of the U/Pb ratios of carbonate phases in a thin section to determine if the sample has potential for dating. Using a somewhat modified approach and a single collector SF-ICP-MS a wide range of carbonate rocks have been dated at GUF. Uranium concentration can be as low as 0.005 ppm and usually are not the limiting factor for determining a successful age. Examples of applications on carbonates of paleosols, tectonic veins, slickensides and vein fractures in MORB will be presented.

Observing ecosystem interactions and feedbacks – the Chicken Creek Landscape Observatory

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Poster in Session B4-03

Built in 2005 the constructed Chicken Creek catchment is a unique landscape observatory for studying interactions between external drivers and single ecosystem compartments. The site offers the opportunity to investigate regime shifts during the transition from an initially abiotic to a biotic dominated ecosystem state. These state transitions are reflected by changes of dominating feedback processes occurring between abiotic and biotic system compartments. Ecosystem development can be considered as the formation of increasingly complex functional networks integrating single compartments at different spatial scales. The Chicken Creek Observatory offers great potentials to investigate ecosystem state transitions both in a high spatial and temporal resolution. It represents an ecosystem in its early successional state and is characterized by huge dynamics and a stepwise increasing complexity which facilitates the investigation of the influence of external drivers and of internal interactions. Vice versa, the site offers the opportunity to validate model predictions against the real system development described and quantified by the ongoing monitoring investigations. In this paper we present most important features and potentials of the Chicken Creek Observatory. Selected results of 10 years of comprehensive ecosystem monitoring will be used to show the influences of external drivers and of increasingly important internal interactions during ecosystem development. The focus of the presentation will be on processes and patterns of surface development, both abiotic and biotic, and their changes during the observed period of time.

Plume tectonics and subduction in the early Earth

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Modern geodynamics is critically driven by subduction and plate tectonics, however how this tectonic regime started and what geodynamic regime was before remains controversial. Most present-day subduction initiation mechanisms require acting plate forces and/or pre-existing zones of lithospheric weakness, which are themselves the consequence of plate tectonics. In contrast, spontaneous plume-induced subduction initiation does not require pre-existing lithospheric fabric and is viable for both stagnant lid and mobile/deformable lid conditions. Here, we present results of 3D numerical modelling of plume-induced subduction and associated crustal growth resulting from tectono-magmatic interaction of an ascending thermal mantle plume with oceanic lithosphere. We demonstrate that weakening of the lithosphere by plume-induced magmatism is the key factor enabling subduction initiation at the margins of a crustal plateau

growing above the plume head. We argue that frequent plume-arc interactions recorded in Archean crust could reflect either plume-induced self-sustained subduction or plume-induced episodic lithospheric drips predicted by our models for hotter mantle conditions. We furthermore suggest a distinct plume-tectonics regime operated on Earth before plate tectonics, which was associated with widespread tectono-magmatic heat and mass exchange between the crust and the mantle. This regime was characterized by weak deformable plates with low topography, massive juvenile crust production from mantle derived melts, mantle-flows-driven crustal deformation, magma-assisted crustal convection and widespread development of lithospheric delamination and crustal drips.

3D Structural modelling of Central Salt Range, Pakistan

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Oral in Session C6

Salt Range marks outer boundary of Himalayan deformation in Pakistan. Strata ranging from Precambrian to recent is thrusted along Salt range thrust over youngest sediments of Punjab plain deposits. Previous models proposed that Salt range evolution is related to simple fault bend fold geometry related to thin skinned tectonics. The 3D structural model in this research suggests that the Salt Range thrust emanating from the basal detachment ramp upsection across pre-existing normal fault in the basement.. The salt range thrust terminates in subsurface with tip line buried under the hanging wall ramp of the anticline or under the resent deposit of Punjab plain. Absence of faults zones along the previously proposed trace of the salt range thrust also support this idea that salt range thrust act as blind thrust along most of its trend . Presence of series of anticlines and synclines in the crestal portion shows that geometry differs from ordinary fault bend fold geometry rather it could be best explained as multi bend fault bend fold. It is concluded that Salt range evolved as multi bend fault bend fold along blind thrust (Salt range thrust) with staircase trajectory.

Source Rock Assessment of Upper Albian to Turonian Sedimentary Rocks from the Tarfaya Basin, SW Morocco

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Poster in Session B1-03

A detailed organic geochemical study on a sample set from the Tarfaya Basin, Morocco, confirms at least 4 potential source rocks within the Upper Albian to Turonian succession. A total of 242 core samples were collected from the Tarfaya Sondage-4 well, located 40 km east of Tarfaya. TOC, Fe and S contents as well as carbonate/silicate ($CaCO3$/Sil) ratio are variable throughout the succession of more than 300 m thickness. All samples show low Tmax values indicating low thermal maturity. The Albian source rock ranges in TOC from 0.7 to 6.4% and in HI from 208 to 696 mgHC/gTOC. Moreover, the Albian samples are rich in Sil and Fe and thus contain much pyrite and little organic sulfur. Depositional conditions changed in the Cenomanian with less Fe and Sil input especially toward the younger part of this stratigraphic interval. The Cenomanian source rocks have a TOC average of 5.5% and HI values greater than 600 mgHC/gTOC. The samples from the Cenomanian/Turonian boundary (CBTE) represent the third potential source rock and are characterized by excellent source rock quality. They are also rich in $CaCO3$ and low in Fe leading to S being incorporated into kerogen during early diagenesis. These samples range in TOC from 1.9 to 15.4% and have similar HI values compared to the Cenomanian samples. The youngest potential source rock was identified in the Turonian showing similar OM quantity and quality compared to the source rocks below. TOC ranges from 1.7 to 15.4 % and HI is on average 721 mgHC/gTOC. The organic richness increases toward the younger samples with variable organic sulfur contribution. Qualitative Sorg evaluation classifies the Albian as an Sorg-poor type, the Cenomanian as a moderately-Sorg-rich type, the CMT as a very rich in Sorg and the Turonian as an Sorg-rich type. This classification is essential for utilization of oil shale resources.

Organic Geochemistry, Petrology and Palynofacies of Middle Devonian Lacustrine Flagstone in the Orcadian Basin, Scotland: Depositional Environment, Thermal History and Petroleum Generation Potential

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Poster in Session B1-03

During the Mid Devonian a series of half-grabens developed providing accumulation space for thick sequences of organic matter-rich, lacustrine flagstone sedimentary rocks within the Orcadian Basin. These petroleum source rocks crop out in northern Scotland (coastal areas of Moray Firth, Caithness, Orkney and Shetland Islands). Moreover, they are co-sourcing the Beatrice oil field located offshore in the inner Moray Firth. Nineteen samples were studied using organic petrological, palynological and geochemical methods in order to characterize kerogen type, depositional environment, thermal maturity and petroleum generation potential. Corg, carbonate and sulfur content as well as HI values are quite variable (e.g. HI from 79 to 744 mg/Corg). Organic matter mainly originates from aquatic organic matter deposited under lacustrine conditions with oxygen-depleted but not permanently anoxic bottom waters. Petrography reveals small quantities of vitrinite particles, indicating minor input of terrestrial material which is supported by geochemical data. Maturity of the sequence in Caithness and Orkney is between immature and oil mature based on low Rock-Eval Tmax (e.g. from 424 to 442 °C) and vitrinite reflectance (from 0.42 to 0.84 % VRr) values as well as hopane isomerization ratios. 1-D basin modeling shows that the source rocks entered the first phase of oil generation during the late Devonian reaching temperatures of about 80 °C and vitrinite reflectance of 0.56 % VRr. In the offshore area, however, the main phase of oil generation occurred later due to burial induced by deposition of thick Upper Jurassic to Upper Cretaceous sediments. This phase of sedimentation increased thermal maturity of the Middle Devonian source rocks leading to advanced transformation ratios (up to 50 %). Oils from the Middle Devonian lacustrine source have significantly contributed to the accumulation in the Beatrice field.

The Anthropocene; a formal stratigraphical unit, an informal designation, or an interval of Holocene time?

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In recent years 'Anthropocene' has been proposed as an informal stratigraphic term to denote the current interval of anthropogenic global environmental change. A case is also been made for its consideration as a formal series/epoch, based on the recognition of a suitable marker horizon or event, such as the start of the Industrial Revolution in northern Europe. In order for the Anthropocene to merit designation as a formal stratigraphic unit, however, such an event would need to leave a global signature consistently distinct from that of the Holocene or of previous interglacials of the Pleistocene, and be marked by novel biotic (i.e. biostratigraphical), sedimentary and geochemical change. Although there is clear evidence in recent geological records of anthropogenic effects on the natural environment (atmospheric trace gas increase, sea-level rise, accelerated erosion, etc), it is far from certain that the stratigraphic signature of these trends is sufficiently distinct, consistent, and adequately dated at the global scale, for the proposal for a Holocene/Anthropocene boundary to be substantiated on stratigraphic grounds. As a consequence, there is a view within the Earth-science community that, if the term is to be employed, it should remain an informal label. Here the Anthropocene will be considered in the context of the formal definition of geological time-scale units, particularly of the requirement for relating such units to Global Stratigraphic Section and Point ("golden spike") localities, and that adoption of the term "Anthropocene" will ultimately depend on whether such an event layer or horizon can be identified globally. In the absence of such a marker, it will be concluded that there is no justification for decoupling the Anthropocene from the Holocene, and that if the term Anthropocene is deemed to have utility, it should be as an informal historical term rather than a formally-defined stratigraphic unit (of whatever status) within the Geological Time Scale..

Coal Fires of the Jharia Coal Field/India – A national disaster endangered the Indian Coking Coal Production and the development of the most important natural resource of India

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2013 India produced 81.2 Mill. Tons of steel and is today the No. 4 in the world in steel production. Today India produces around 600 Mill. Tons coal per year. Only 2-5 % of this production are coking coals. The high valued coking coals of India are located in the Jharia Coal Field in Jharkhand former West Bengal. The coal field lies in the Damodar River Valley, and covers about 110 square miles (280 square km), and produces bituminous coal suitable for coke. Most of India's coal comes from Jharia. Jharia coal mines are India's most important storehouse of prime coke coal used in blast furnaces, it consists of 23 large underground and nine large open cast mines. These most important coal field of India is endangered by underground, hidden surface near and open coal fires. Around 68 locations in the Jharia coal field are under fire. Coal fires pollute seriously the environment in the newly industrialized countries like India. These coal fires are manmade and emerge from crude mining activities. There are a lot of coal fires in active mines, but the main danger are uncontrolled fires in inactive mines. Following the results of a Sino-German Research project the coal in open pit and unprotected, inactive underground mines starts to burn on account of self-combustion. This self-combustion results only from the grain size of the coal, with an increasing danger of oxidation the smaller the grain size. In India the end of the British colonial rule and serious standards of mine safety were the reason of the burning coal field in Jharkhand. General data about the amount of coal which burns in Indian coal mines are not available. The burning coal blocks are lost for mining and for exploration. How many coal was destroyed or wasted in the past is unknown. The extinguishing of these coal fires is one of the major environmental and industrial issues India has to tackle in the nearer future to protect the environment, the local people and the coking coal resources of the nation.

Hydrothermal clays in Fe oxide deposits of Norrbotten County, northern Sweden

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The largest Fe oxide deposits of Europe are hosted in Paleoproterozoic supracrustal rock of the Fennoscandian Shield in the northern Norrbotten province, Sweden. Significant clay alteration zones occur at the present land surface and at a depth in the Kiirunavaara, Malmberget, Gruvberget, Leveäniemi and Mertainen iron oxide-apatite deposits that are hosted in Svecofennian, mostly intermediate to acid volcanic and subvolcanic rocks, but also in the vicinity of skarn-rich iron formations in the upper part of the older Karelian Greenstone group. The whitish to greenish, up to 50 m thick clay alteration zones occur within the ores, at the hanging and in part footwall contacts as well as several tens of meter away from the ore. The predominant clay mineral in the alteration zones at Vathanvaara, Kirunavaara, Malmberget (ViRi), and Mertainen is a dioctahedral Fe-poor, Mg-bearing, and Al-rich sodium smectite. Minor amounts of zeolite minerals of the stilbite group, chlorite-smectite, chlorite, phlogopite, talc, albite, sulfides and rare calcite have been detected. At the Johannes orebody at Malmberget, an illite-rich R3 illite-smectite is observed and kaolinite at Gruvberget. Stable hydrogen and oxygen isotope data of Na-smectites from Vathanvaara clearly indicate a low-temperature hydrothermal origin of the expandable clay mineral consistent with their close association with stilbite group minerals. The Na-smectite $\pm$ stilbite group mineralization at Vathanvaara, Kiirunavaara, and Malmberget may be related to regional post-metamorphic hydrothermal events that overprinted Fe ores in the northern Norrbotten area and that have been dated between about 1.62 and 1.73 Ga. At Kiirunavaara, the earliest clays may even date back to the time of ore emplacement, at about 1.88 Ga.

The Wegener Fault revisited: Building a deforming plate model for the Eurekan Orogeny

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Poster in Session A2-01

The Eurekan Orogeny is a Paleogene tectonic event driven by sea floor spreading in the Labrador Sea and Baffin Bay, expressed on Ellesmere Island and surrounding structures, particularly along the "Wegener Fault", a term coined by Tuzo Wilson for the fault separating Greenland from the Canadian Arctic along the Nares Strait. The complexity of the region has prompted the development of multiple tectonic models over the last 100 years. We present a new tectonic model that incorporates a suite of recently acquired regional geophysical data in addition to published geological field data, utilizing the newly developed capacity of the open-source GPlates software to incorporate diffuse plate deformation within traditional rigid plate models. Our model incorporates two phases of tectonic events during the orogeny from ~65-35 Ma. Phase one, ~65 to 55 Ma, incorporates ~85 km of Paleocene extension between Ellesmere Island and Devon Island with extension of ~20 km between Axel Heiberg Island and Ellesmere Island and ~85 km of left-lateral strike-slip along the Nares Strait, a range of 50-100 km is in indicated by the offset of marker beds, facies contacts, and platform margins mapped between the conjugate Greenland and Ellesmere Island margins. Phase two, 55 to 35 Ma results in east-west shortening of ~30 km and ~200 km of north-south shortening from Ellesmere Island to the Canadian Arctic Island. Compression driven by Greenland's northward motion contemporaneous with sea floor spreading

in the Labrador Sea, shortens Ellesmere Island in a "fan" like pattern, creating a series of thrust faults. Our model extends the boundaries of the Eurekan Orogeny northward, considering its effect on Lomonosov Ridge, Morris Jessup Rise, and the Yermak Plateau. In our model the Lomonosov Ridge moves attached to the Pearya Terrane, the region between Ellesmere Island and the Lomonosov Ridge, supported by recent magnetic and gravity data indicating Cenozoic tectonic quiescence in this region.

Late Quaternary reef response to sea-level rise and subsidence in Bora Bora, Society Islands, South Pacific (French Polynesia)

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Sea-level rise and subsidence were crucial for Holocene fringing and barrier reef development in Bora Bora, Darwin's type barrier reef, in that they have created accomodation space and controlled reef architecture. Antecedent topography also played a role, because the Holocene barrier reef is located on a Pleistocene reef. There are no indications of a Darwinian fringing-to-barrier-reef transition. Both reef types developed contemporaneously during the Holocene. The occurrence of coral assemblages indicate an upcore increase in wave energy. Age-depth plots suggest that barrier and fringing reefs have prograded during the Holocene. The Holocene fringing reef is up to 20 m thick and comprises coralgal and microbial reef sections, and abundant loose sediment, overlying Pleistocene basalt and soil. A Montipora-Porites assemblage transitions upcore to a Pocillopora assemblage. Fringing reef growth started 8,780±50 kyrs BP; accretion rates average 6.54 m/kyr. Modern sea level was reached during 5,130±20 - 1,960±20 YBP. The barrier reef consists of >30 m thick Holocene coralgal and microbial successions, characterized by an upcore transition from an agaricid-rich to a robust-branching Acropora assemblage. Coral-rich deposits of an underlying Pleistocene reef contain laminar Montipora and agaricids. Holocene reef growth began 10,030±50 YBP and modern sea level was reached during 4,960±20 - 2,620±20 YBP; accretion rates average 6.15 m/kyr. The underlying Pleistocene reef formed 116,930±1,100 YBP, i.e., at the end of marine isotope (MIS) stage 5e. Assuming deposition close to sea level and a +6 m sea level during marine isotope stage 5e, the maximum subsidence rate of Bora Bora is calculated to 0.31 m/kyr. The Pleistocene coral assemblage suggests somewhat deeper water for the MIS-5e-reef though, which would result in a lower subsidence rate. Investigations of the coralline algal flora are in progress and will help to further constrain bathymetric reconstructions.

Highly siderophile and chalcophile elements in lunar impact melt rocks: evidence for mixing of impactor compositions

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The compositional record of ancient lunar impact rocks provides important constrains on the composition of material accreted late to the Moon and the terrestrial planets. The composition of impactors and their contribution to the impact debris is usually constrained by the absolute and relative abundance of highly siderophile elements (HSE) and the isotopic composition of osmium. Many lunar impact melt rocks display suprachondritic HSE/Ir ratios (except for Os/Ir) and suprachondritic 187Os/188Os ratios, higher than any known chondrite compositions but similar to some members of magmatic iron meteorite groups. The observed variety was interpreted either as chemical fingerprints of specific basin forming impactors, some of them outside the range of known meteoritic compositions, or to reflect mixing of chondrite-like compositions with a suprachondritic iron meteorite-like composition and subsequent homogenization by younger impacts. Expansion of the data base to less siderophile and moderately volatile elements will help to better constrain the composition of impactor components. We will present the full set of HSE and S data of nine lunar impact melt rocks from the Apollo 15 and 16 landing site and additional Se-Te data of four of these. All samples display suprachondritic HSE/Ir and 187Os/188Os ratios, outside the chondritic range. Average S/Ir ratios are subchondritic in most samples, but suprachondritic ratios occur also. Initial results for a sample based on multiple aliquots yield an average Se/Te ratio of 7.9$\pm$2.3 and an S/Se ratio of 2800$\pm$120. These values fall into the range of carbonaceous chondrites (Se/Te=6.6 to 8.5, S/Se=2600 to 2750). These observations support a mixing model in which the HSE are controlled by variable contributions of carbonaceous chondrite-like material and chalcophile element poor fractionated impactor compositions. In contrast, the chalcophile elements are mostly controlled by the chondritic component and minor crustal contributions.

Three-dimensional instantaneous dynamics modeling of present-day Aegean subduction

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Poster in Session A1-06

The Aegean region (Eastern Mediterranean) is exemplary of the interaction between crustal tectonics, plate motion, subduction and mantle flow: African subduction underneath the region has been continuous for at least the last 100 My, leading to about 2100-2500 km of subducted lithosphere residing in the mantle (van Hinsbergen et al., 2005). During this subduction, decoupled upper continental and oceanic crust accreted into a wedge of stacked nappes. In turn, these nappes have been significantly extended, predominantly during the last 25 My, due to the retreat of the African slab relative to Eurasia (van Hinsbergen and Schmid, 2012). As a first step to better understanding the coupling of the tectonic evolution of the crust and the underlying mantle dynamics, we are developing 3-D numerical models of the instantaneous dynamics of the present-day Aegean subduction system using the finite element code ASPECT (Kronbichler et al., 2012). The instantaneous models are set up with initial slab geometries derived from tomography and realistic plate boundary configurations and incorporate the major crustal weak zones of the overriding plate. Our modeling results in predictions of flow fields and stress, strain rate and rotation rate fields for the present-day tectonic setting of the Aegean region. By comparing our various model predictions to the widely available observations, such as focal mechanisms, GPS velocities and seismic anisotropy, we aim at an improved understanding of how mantle flow, subduction morphology and possibly slab segmentation, as well as the rheological behavior of the overriding plate, control present-day tectonic deformation. We will show preliminary results of this comparison.

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The role of palaeogeography in the Phanerozoic history of atmospheric CO_2 and climate

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Oral in Session A6-04

The role of the palaeogeography on the geological evolution of the global carbon cycle has been suspected since the development of the first global geochemical models in the early 80's. The palaeogeography has been rapidly recognized as a key factor controlling the long-term evolution of the atmospheric CO_2 through its capability of modulating the efficiency of the silicate weathering. First the role of the latitudinal position of the continents has been emphasized: an averaged low latitudinal position promotes the CO_2 consumption by silicate weathering, and is theoretically associated to low CO_2 periods. With the increase of model complexity and the explicit consideration of the hydrological cycle, the importance of the continentality factor has been recognized: periods of supercontinent assembly coincide with high pCO_2 values due to the development of arid conditions which weakens the silicate weathering efficiency. These fundamental feedbacks between climate, carbon cycle and tectonic have been discovered by pioneer modelling studies and opened new views in the understanding of the history of Earth's climate. Today, some of the key features of the Phanerozoic climate can be explained by (1) continental drift, (2) small continental blocks moving to tropical belts, and (3) modulation of the climate sensitivity to CO_2 by palaeogeography changes. Those results emphasize the need for a careful process-based modelling of the water cycle and climate response to the continental drift.

The challenge of polar ocean gateway reconstructions

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Keynote in Session A6-03

At large geological timescales, the global circulation is affected by geodynamic and tectonic processes, which control the motions of the lithospheric plates as well as crustal uplift and subsidence. In particular, the geometries of oceanic gateways are key parameters for simulations of paleo-ocean current systems in paleo-climate scenarios. The reconstructions of the past geometries of ocean gateways, basins and their continental margins are essential to realistically model the effects that tectonic motions have had in the long-term transition from climatic greenhouse to icehouse conditions. The Arctic Ocean is a restricted basin receiving freshwater from rivers and exchanging seawater through three Arctic gateways. This exchange influences deepwater formation in the North Atlantic and Pacific as well as the saltwater budget of the Arctic Ocean, and it has controlled the periodic oscillations between greenhouse and icehouse conditions, including the formation of the large ice sheets in North America, Europe and Asia. In the circum-Antarctic oceans, the last barriers to development of a continuous circumpolar deep-water pathway were the South Tasman Rise, the Drake Passage and the Kerguelen Plateau. Free flow of seawater past these obstacles was a pre-requisite for the initiation of the Antarctic Circumpolar Current (ACC). Recent modeling studies yield differing results on the question of whether or not inception of the ACC was the primary cause of large-scale ice sheet development on Antarctica. However, there can be little doubt that its initiation had widespread effects on global ocean circulation and climate. In this review presentation, we will discuss summarize existing and new gateway opening models, focusing on the polar deep-water gateways Fram Strait in the Arctic as well as Drake Passage/Scotia Sea and Tasmanian Gateway in the Southern Ocean.

Inverse problem of large-scale coupled fluid flow and heat transport using FEPEST: The Tiberias Basin example

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Abstract Salty and thermal springs form along the lakeshore of the Sea of Galilee, in the Tiberias Basin (TB), northern Dead Sea Transform, Israel/Jordan. It is important to study the salinization and heating processes that may pollute this unique freshwater reservoir. Numerical simulations show that relic brines are flushed by the regional flow from the surrounding heights and thermally induced groundwater flow within the faults (Magri et al., 2015). Here, inverse problems (IP) are solved along a NW-SE profile to better constrain (a) hydraulic conductivity and (b) thermal conductivity. The PEST code (Doherty, 2007) is applied via the graphical interface FEPEST in FEFLOW (Diersch, 2014). The results show that both thermal and hydraulic conductivity are consistent with the values determined with the trial and error calibrations. However, the IP indicated that the hydraulic conductivity of the Senonian Paleocene aquitard is 0.3 m / yr, which is three times lower than the originally estimated value. This finding is in agreement with recent geological investigations in the Yarmuk Gorge where a 400 m thick sequence of impermeable chalk has been found. Our study shows that solving the IP allows to cover a wide range of parameter values, providing additional solutions not found with the trial and error method. References:

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Geological parameters for successful shale gas plays – why is testing so crucial?

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In contrast to conventional hydrocarbon plays, where source, migration and trap are key components, unconventional hydrocarbon plays require additional conducive parameters for economic success. Despite general similarities in composition, genetic and tectonic histories conditions vary from site to site. Experiences made in USA are useful indicators, but will not be applicable on a one-to-one basis for shale plays in Europe. Initial crucial parameters like depth, thickness, content of total organic carbon, type of organic carbon and maturity are readily to determine. However, parameters conducive to hydraulic fracturing and impacts on fracturing are more difficult to determine. Aim of hydraulic fracturing is the generation of pathways in low permeable rocks. Primary porosity is the key indicator for the potential of gas-in-place, and hence volumes. Mineralogical composition and sedimentary environment controls primary porosity, while diagenesis and deformation significantly modify original conditions. Behavior during fracturing is controlled by the current stress regime, existing joints and fractures and mineralogy, especially clay minerals. If all parameters combined indicate hydraulic fracturing can be used successfully to generate the required artificial reservoir, fracturing can be tested. However, experience in the other countries shows that parameters of hydraulic fracturing will have to be modified to fit local conditions, therefore testing will finally show the economic viability of the hydrocarbon play in more regulated setting of Europe.

Nutzung von Kohle durch untertägige Vergasung (UCG) am Beispiel von zwei aktuellen Pilotversuchen in Polen

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In zwei polnischen Steinkohlebergwerken wurden unter Tage zu Versuchszwecken Flözbereiche zur insitu Kohlevergasung (UCG) kontrolliert entzündet. Die beiden Versuche erfolgten oberflächennah bzw. in einer Teufe von 450 m. Im Rahmen des derzeit laufenden EU-geförderten RFCS-Projektes COGAR ist die untertägige Kohlevergasung messtechnisch begleitet worden. Bei den beiden Tests in Polen sind zwei V-förmig angeordnete Bohrungen in das jeweilige Zielflöz spitzwinklig aufeinander zu gebohrt worden. Die eine Bohrung wird zur Einspeisung des Prozessgases verwendet, die andere Bohrung dient zur Förderung des Syngases. Der Verbrennungsprozess wird durch die Zugabe eines Oxidationsmittels, v.a. Sauerstoff und Wasserdampf, gesteuert und aufrecht erhalten, das durch die Injektionsbohrung eingeleitet wurde. Der Prozess kann durch die optimale Mischung von O_2, N_2 und anderen Gasen gesteuert werden. Das bei diesem Prozess generierte Syngas wurde durch die Produktionsbohrung gefördert und kann über Tage separiert und zur Energiegewinnung verwendet werden. Die Zusammensetzung des Syngases ist von den Prozessparametern abhängig und bestand überwiegend aus CH_4, H_2, N_2, CO und CO_2. Bei der Aufrechterhaltung des Prozesses bildet sich eine Kammer im Bereich der verbrauchten Kohle aus. Die nicht verwendbaren Bestandteile der Kohle, z.B. die Asche, verbleiben im Untergrund. Durch die im Rahmen des Projektes durchgeführten Messungen ist der Einfluss des Reaktionsraumes auf die das Flöz umgebenden Nebengesteinsschichten untersucht worden. Dazu wurden vor und nach den Versuchen die geotechnischen, geologischen und hydrologischen Parameter insbesondere durch Bohrlochmessungen und Probenanalysen untersucht. Da die beiden UCG-Versuche in einem laufenden Grubenbetrieb durchgeführt wurden, ist eine Überwachung von allen Seiten möglich. Bei den Versuchen wurden ca. 250 Tonnen Kohle umgewandelt. Die ersten Ergebnisse des laufenden Untersuchungsprogramms werden in dem Vortrag dargestellt.

In-situ monitoring of mineral reactions using synchrotron X-ray diffraction

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We monitored mineral reactions of geologically relevant phases in-situ using energy-dispersive as well as angle-dispersive synchrotron X-ray diffraction in combination with an ex-situ assessment of the run products by focused ion beam (FIB) assisted transmission electron microscopy (TEM). We used the pulsed laser deposition technique (PLD) to deposit nanoscale reactant layers on top of single crystalline substrates. By using a thin film geometry and by applying low temperatures

and short run durations, nanoscale reaction bands were synthesized. The in-situ experiments provide constraints for the temperature-dependent onset of a mineral reaction and the subsequent growth kinetics. For one experimental setup initially amorphous MgO layers were deposited on top of (0001)-oriented corundum (α-Al_2O_3) substrates. In this setup spinel ($MgAl_2O_4$) growth was detected at temperatures $\geq$900°C. The spinel grows (111)-oriented into the substrate and the reactant layer. A corundum-grown spinel sublayer can be distinguished from a periclase-grown sublayer in TEM micrographs. The diffusion mechanism in this system – namely counterdiffusion of the cations through a rigid oxygen sublattice – can be deduced from the relative thickness proportions of these sublayers. Largely diffusion-controlled reaction kinetics were inferred from the evolution of the integrated intensity of the 111 spinel Bragg reflection at 900°C whereas at higher temperatures the interface reactions became increasingly rate-limiting [1]. A thermodynamic model [2] was applied to the data to extract the kinetic parameters characterizing spinel rim growth. Faster reaction kinetics were found using periclase substrates. Coherent interfaces and a negative reaction volume at the periclase/spinel phase boundary seem to promote the spinel-forming reaction in this setup. [1] Götze et al. (2014) PCM 41, 681-693. [2] Abart and Petrishcheva (2011) AJS

Indentification of coloring agents in glazes of Islamic tiles and tableware ceramic from the 10th -18th century using EMPA and μ-XRD2

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Poster in Session B6-02

The historical buildings of the Islamic world represent the advanced civilisation and the highly developed craftsmanship of this ancient culture. The rich tile décors of the colourful facades form an essential part of the appearance of the buildings and will be investigated exemplarily in this study. Together with glazed tableware ceramic, our samples comprise glazes from Uzbekistan, Afghanistan, Iran, Turkey, Bulgaria, and Morocco from the 10th-18th century. Beside the major element composition, particularly the colouring agents of the glazes are investigated. Within the colourants, it has to be distinguished between pigments and transition metal oxides, which are incorporated in the glassy matrix with electron microprobe (EPMA). The measured metal oxides are assigned to following colours (Nassau, 2001): CoO for blue glazes, CuO for green in lead glazes, Fe_2O_3 for brown and black glazes, and manganese oxide depending on its valence for black or violet glazes. Crystalline particles which are also detectable in the glazes are identified by X-ray microdiffraction. Using a large 2D-detector (μ-XRD2) in our setup the distinction between uniformly distributed crystallites and sporadic larger single crystals is possible. As whitening pigments, SnO_2, SiO_2 and $PbSiO_4$ are found. Especially crystallites of SnO_2, but also SiO_2 occur in turquoise glazes, turning the blue coloured Cu2+ alkali glass matrix into a light blue-turquoise colour. The opacifying SnO_2 particles are widespread in almost every epoque and geographical site of the analysed samples. The use of yellow and black pigments instead varies already within buildings from the same epoch from the city Bukhara: Cr crystals and clinopyroxenes are in the black glazes of the mosque Khoja Zainuddin; Cu-Cr-Mn-oxides are in the madrassa Mir-i Arab, both from the 16th century. $PbSiO_4$ and $Pb_2Sn_2O_6$ are found in the yellow glaze, from which only the lead tin oxide causes the yellow colour (Easthaugh et al., 2004).

Critical Metal Potential of Seafloor Massive Sulphide Deposits

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The global economy is dependent on specialty metals used in high-tech applications, with demand increasing as new technologies emerge. These so-called 'critical metals' are generally sourced only as low-tonnage by-products of large ore deposits. The European Union (EU) is particularly concerned about its strategic supply of critical metals as it consumes 25-30% of global production, but produces only 3% of the supply, with many important metals not produced in Europe at all. In 2010, the EU listed 12 critical metals deemed essential to economic growth, but the supply of which are at risk. This study focuses on the global distribution of critical metals in seafloor massive sulphide (SMS) deposits, which are now targeted for exploration for base and precious metals. Since the discovery of the first hydrothermal venting on the seafloor in 1978, more than 300 sites of active and inactive seafloor hydrothermal sites and associated SMS deposits have been discovered in the world's oceans in a variety of tectonic settings. We present an analysis of a global geochemical database of SMS deposits in order to determine whether these deposits could contribute significantly to critical metal supply if they were exploited. Results indicate that four critical metals (indium, germanium, gallium and antimony) are present at concentrations that could be important to a revenue stream if the deposits are mined. Indeed, recent trace element analyses of 100 samples of the Atlantis II metalliferous sediment suggest a significant contained critical metal content (based on 90 Mt dry weight, salt free) of 1290 t Ga, 540 t Ge, 2250 t Sb and 54 t of In. Gallium, Ge, Sb and In average 62 ppm, 29 ppm, Sb 498 ppm and In 21 ppm respectively in global SMS deposits with concentrations varying by orders of magnitude between different tectonic settings. This reflects a combination of diverse host rock lithologies, spreading rates, magma supply, crustal thickness, magma composition and volatile flux.

Structural and thermal history of the Oman Mountains

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Understanding sedimentary basin evolution is the key to access entrapped reservoirs. Especially for hydrocarbon (HC) reservoirs the knowledge of HC generation, migration and potential cap-structures is important. Hence, it is essential to understand the thermal and tectonic histories, their link and the related timing of events. Additionally, the exploration of new conventional or unconventional HC plays could highly benefit from studies in complex sedimentary basins. In this context, the Oman Mountains offer unique possibilities for scientific studies: They represent a source-rock-containing sedimentary basin of a former passive continental margin, rapidly buried by the obduction of a massive ophiolite, inverted and uplifted by Alpine Orogenesis, incised by deep canyons and preserved without much vegetation, easily accessible at the surface. Overall, the Oman Mountains offer the possibility to study the influences of orogenesis and large-scale over thrusting on a complex sedimentary basin and its HC potential. The main goal of our research is an integrated, numerical 2D model of the area combining thermal back-stepping modelling and

structural forward reconstructions of an area spanning from the foreland basin in the northeast over the Oman Mountains to the first oil fields in the southwest. Within the Oman Mountains different canyons provide access to 1,400 m of lithology accumulated through the last 300 My. We studied different sedimentary units focusing on their thermal and structural evolution. Thermal history was reconstructed using various maturity parameters (e.g. vitrinite and solid bitumen reflectance, fluid inclusion measurements), while reconstruction of the structural history was based on field mapping and stress field restorations. As a first result, we present the different thermal maturity parameters allowing for interpretation of heat as well as fluid flow and rock-fluid interplay. Links between thermal and structural evolution are discussed.

Effect of 90 °C thermal treatment on Ultra High Performance Concrete

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Poster in Session B6-01

Ultra High Performance Concrete (UHPC) is characterized by high strength and high durability. This is achieved by an optimized grain size distribution, especially within fine grains, and addition of superplasticizer, which allow the reduction of the water/cement ratio in the cement paste and thereby the increase of the density of UHPC. Thermal treatment, i.e. curing at elevated temperature and pressure, contributes to a further increase of compressive strength. The aim of the presented study was to analyze the effect of thermal treatment at 90 °C and atmospheric pressure on UHPC samples. Varying factors were the age of the samples when heat treatment started (initial storage time), the duration of heat treatment and the type of heat treatment. It was applied in three ways: 1. treated without any protection, 2. sealed in plastic foil and 3. treated in hot water. Afterwards the samples were analyzed with respect to their mechanical properties and their phase composition. Furthermore, the weight (water absorption) of the samples was observed over 28 days and was correlated with the strength test results. The development of strength depends on the combination of initial storage time and the duration of heat treatment and is also influenced by the type of thermal treatment. The highest compressive strengths have been observed by implementing the hot water treatment. Thereby the weight of the samples increase due to additional absorbed water. This enables an increased hydration of cement clinker inducing a higher strength.

Where Models Meet Rocks – Building Capabilities through "DIGITAL GEOLOGY"

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A new opportunity for subsurface capability building has been developed around the "DIGITAL GEOLOGY" concept that has recently been introduced in the Shell Learning Centre. "DIGITAL GEOLOGY" is seen as the 'Flight Simulator' for Explorers and Petroleum Engineers, where all sources of subsurface and field data are integrated into a single learning environment. Virtual and Augmented Reality is used to complement the physical rocks on display in five geological exhibits which represent different scales of observation. The five exhibits host real rock measurements and data analysis like a dedicated fully cored and logged research well drilled in an analogue for a deltaic environment together with academic and industry partners. Thinking geology in space (3D) and time (4D) is paramount for Geoscientists in general and for Petroleum Engineers in particular. Resulting concepts are a key input for constructing meaningful geologically and geophysically constrained subsurface models with predictive value to support optimization of business decisions. Visualizing such static and dynamic modelling results including their uncertainty ranges has fundamentally changed the way petroleum engineers work nowadays. The objective of "DIGITAL GEOLOGY" is to strengthen skills of young Geoscientists and Petroleum Engineers in integration of rock characterization and construction of subsurface models which are linked to business decisions effectively. Moreover, it allows engineers to iteratively test models including their uncertainties to evaluate possible field development options. These in turn can be analyzed with respect to hydrocarbon production and project value moving towards end-to-end integration in Upstream projects. Such is vitally important in increasingly complex projects with their interdependencies of key decisions and associated risks. The paper provides an overview of the "DIGITAL GEOLOGY" project as part of Shell's learning platform, its current status and some examples of its application. (`https://www.youtube.com/watch?v=bvf3wjdsCg4`)

Diagenesis of Upper Eocene clastic reservoir rocks in the Alpine Foreland Basin (Austria)

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The North Alpine Foreland Basin ranges from Geneva to Vienna and is filled by Eocene to Miocene sediments. In the Austrian part, two petroleum systems can be identified: (1) a thermal petroleum system, involving Lower Oligocene source rocks and Cenomanian/Eocene reservoir rocks; (2) a mainly microbial system, comprising Oligo-/Miocene source and reservoir rocks. However, mixing of thermogenic and microbial hydrocarbons exists. This contribution addresses the interplay of hydrocarbon generation, migration and alteration with pore space evolution. For this purpose, Eocene reservoir rocks from limnic and shallow marine facies and oil-, gas- and water-bearing zones were investigated using conventional sediment petrographic techniques and stable isotope ratios of calcite cements. In addition, petrophysical data were provided by RAG. The Eocene reservoir rocks are composed of (sub-)arkoses with low matrix content. Near the crest of the BH-N Field, isotopically light carbonate cement (-28‰ $\delta^{13}C$) formed before oil charging by degradation of early (microbial?) gas. Elsewhere, the early diagenetic pore space evolution is pre-determined by the depositional environment. Different clay minerals formed by feldspar disintegration. Late diagenesis is controlled by varying pore fluids. Kaolinite book staples, indicating acidic conditions, are abundant in hydrocarbon-bearing sandstones. Contemporaneously, calcite cement precipitated in the water-bearing zone. $\delta^{13}C$- (-4‰ [PDB]) and $\delta^{18}O$- (-8‰ [PDB]) isotope values of calcite cement are in agreement with a marine setting. Calcite with isotopically light carbon (-28‰ $\delta^{13}C$) precipitated near the oil-water-contact of the Sths Field, maybe triggered by biodegradation of oil. Hence, diagenetic features reveal valuable insights on pore fluid evolution. Changes in fluid chemistry result in precipitation of different cement generations and thus different pore space properties.

City Density and CO_2 Efficiency

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City population density is one of the key factors that influence urban energy consumption and the subsequent GHG emissions. However, previous research on the relationship between population density and GHG emissions led to contradictory results due to urban/rural definition conundrum and the varying methodologies for estimating GHG emissions. This work addresses these ambigui-

ties by employing the City Clustering Algorithm (CCA) and utilizing the gridded CO_2 emissions data. Our results, derived from the analysis of all inhabited areas in the US, show a sub-linear relationship between population density and the total emissions (i.e. the sum of on-road and building emissions) on a per capita basis. Accordingly, we find that doubling the population density would entail a reduction in the total CO_2 emissions in buildings and on-road sectors typically by at least 42%. Moreover, we find that population density exerts a higher influence on on-road emissions than buildings emissions. From an energy consumption point of view, our results suggest that on-going urban sprawl will lead to an increase in on-road energy consumption in cities and therefore stresses the importance of developing adequate local policy measures to limit urban sprawl.

Passive margins of Austral Africa: long term evolution, mantle dynamics, erosion and sedimentation

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The southern part of Africa is characterized by an usual topographic feature, a large plateau extending from Congo to Southern Africa. This very long wavelength structure (x1000 km) – the largest anorogenic plateau in the world – is classically related to the southern African superplume. Nevertheless a number of questions have yet to be answered: How old is that plateau? Why this plateau is still high when the superplume is now located below the East African Rift? Was that plateau really induced by the superplume? How to relate surface processes with that kind of plateau (top planation surfaces and escarpments)? To answer these questions, we did a coupled study: sequence stratigraphy of the margins of Austral Africa (from Congo to Zambezi Deltas) and onshore geomorphology based on the analysis of the planation surfaces. • The southern African Plateau results from a two steps uplift, during Late Cretaceous (90-70 Ma) and Late Eocene – Early Miocene (40-20 Ma). • The syn-rift topography is not preserved in the present-day relief. • The Late Cretaceous relief due to the first uplift (90-70 Ma) are (1) the planation surfaces of the top the plateau (base of the Kalahari sands) and (2) most of the escarpments of the Indian Ocean side (including the Drackensberg Escarpment). These reliefs are fossil landforms. Most of this first topography is eroded and preserved as sediments on the surrounding margins. • The present-day topography is due to a plateau-scale doming occurring during the second uplift (40-20 Ma) with growth of peripheral bulges. • The first uplift can be related to the migration of southern Africa over the superplume at time of the kimberlites emplacement. This migration is coeval with a westward tilting of the plateau with a differential uplift, earlier (90 Ma) to the east (Indian side) and younger (70 Ma) to the west (Atlantic side). In conclusion, the relief of southern Africa is old – Late Cretaceous (70 Ma) – but the present-day topography (the elevation) is younger, around 40-20 Ma. The consequences on the long-term evolution of the margin subsidence initiated as volcanic margins (Atlantic Ocean side south of Walvis Ridge) or as transform/oblique margins (Indian Ocean side) will be discussed.

Scaling impact crater dimensions in cohesive rock by numerical modeling and laboratory experiments

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Considering small impact craters on planetary surfaces, target material properties play an important role with regard to crater formation and resulting crater dimensions. Numerical cratering experiments and laboratory experiments have been performed into quartzite and sandstone targets to get a better understanding of the influence of petrophysical target properties. We quantify the cratering process by determining important so-called scaling parameters which are used in empirical relationships to predict crater dimensions as a function of impact velocity, gravity, impactor and target properties. We used the "Pi-group" scaling to relate results from small-scale laboratory experiments to the dimensions of natural craters. Numerical models using the iSALE hydrocode have been performed to expand the process of crater formation from laboratory scale, where crater size is strength dominated, to natural dimensions, where crater size is controlled by gravity. In particular, the models bridge the gap across the transitional regime, where both parameters gravity and strength control crater size. We determined the scaling parameters for two cohesive materials (sandstone and quartzite) linking a wide range of crater sizes. Coupling of experimental and modeling data was only possible due to the good agreement in crater dimensions obtained from the two different methodological approaches. Key for predicting crater dimensions by scaling is the accurate definition of strength, in particular in the transitional regime. We propose to introduce an effective strength parameter that accounts for the weakening of target material due to the accumulation of damage. Based on numerical modeling we determined an effective strength of 4.6 kPa for quartzite and 3.2 kPa for sandstone, which are almost 5 orders of magnitude smaller than the quasi-static experimental strength values in uniaxial-compressive tests that only account for the intact state of the target material.

Can slab-rollback trigger ultrapotassic volcanism in an active arc setting: an example from Northern Anatolia, Turkey

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In the active arcs worldwide, the most primitive magmas are dominantly calc-alkaline and with low-to medium potassium concentrations. There are only a few exceptions where K-alkaline ultrapotassic lavas with $K_2O/Na_2O > 2$ occur, such as Batu Tara and Colima volcanoes. When appears, the potassium enrichment is traditionally attributed either to contributions from the enriched mantle or deeply subducted crustal material. Generally, ultrapotassic volcanism occurs much more often in intraplate and orogenic areas where the extension is dominating tectonic regime. Beginning in the middle Triassic through upper Cretaceous, Pontide arc in Turkey was a southward growing subduction-accretionary complex. This complex was a part of an immense Andean-type subduction system called the Eurasian active continental margin. The timing and evolution of the arc suggests that it entered its waning stage during the late Cretaceous. Simultaneously, a southward retreat of the Neo-Tethys slab has taken place between Turonian and Campanian. After several million years of calk-alkaline volcanism dominated the Pontide arc, ultrapotassic lavas for which our new $^{40}Ar/^{39}Ar$ radiometric age analyses suggest (75.6 $\pm$ 0.5 and 75.9 $\pm$ 0.6 Myr) erupted. The ultrapotassic lavas comprise leucitites and lamprophyres and they are restricted to the forearc regions implying that the forearc transformed to a new arc system. Late Cretaceous ultrapotassic lavas from the Pontide arc originated by polybaric melting of a heterogeneous, most probably phlogopite-bearing mantle source. To yield hydrous and relatively low temperature phlogopite-rich metasomatic assemblages, cold forearc mantle has interacted with fluids/melts released from the subducted slab. The inferred slab retreat that also triggered transformation of the forearc to a new arc system has a great importance: it caused the mantle wedge to get wider and phlogopite-bearing forearc mantle to drag through the corner flow, and to get ready to melt.

Structural trends in off-stoichiometric $Cu_2ZnGeSe_4$ compound semiconductors

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Poster in Session B6-03

The research on sustainable solar energy conversion technologies has further branched to another promising alternative, based on kesterite-type absorbers Cu2ZnSn(S,Se)4 (CZTSSe). In comparison to other compound semiconductor materials kesterites are more favorably because the elements contained in the CZTSSe system are both earth-abundant as well as not seriously hazardous. Also, the optical bandgap fits well to the solar spectrum and, additionally, can be easily tuned by different anion ratios in the solid solution CZTS – CZTSe. Another possibility to adjust the bandgap is given by cationic substitution as done in this study, where tin is replaced by germanium. However, here we are focusing mainly on the structural and compositional phase properties. According to the different types of off-stoichiometric kesterite proposed by Lafond et.al [1] two series of powder samples were synthesized by solid state reaction in a one-zone tube furnace at Tmax = 700 °C. These sample series comprise, respectively, Cu-poor A-type (Cu2 2xZn1+xGeSe4) and Cu-rich C-type (Cu2+2zZn1-3zGe1+zSe4) kesterite. The deviation from stoichiometry was progressively done in the range $0 \leq x \leq 0.2$ and $0 \leq z \leq 0.125$, respectively. The products were compositionally characterized by means of quantitative electron microprobe analysis (EMPA) using WDX spectroscopy. Finally, X-ray powder diffraction (XRPD) was employed in order to retrieve information on structure and phase content. This study aims to provide an overview of the structural response both to the cationic substitution as well as the different off-stoichiometric types, especially in consideration of the extent of deviation from stoichiometry. [1] Lafond, A., et al., Crystal Structures of Photovoltaic Chalcogenides, an Intricate Puzzle to Solve: the Cases of CIGSe and CZTS Materials. Zeitschrift für Anorganische und Allgemeine Chemie, 2012. 638(15): p. 2571-2577.

Subduction zone configuration of Central and Eastern Anatolia since the late Cretaceous reconstructed from sedimentary basins in the Neotethyan suture zone

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Subduction and accretion of crustal fragments during the closure of the Neotethys since the Mesozoic formed the Anatolian fold-and-thrust belt. Sedimentary basins overlying key locations between accreted domains of different metamorphic grade may help to quantitatively kinematically restore subduction evolution, and to identify timing, directions and amounts of post-accretionary extension, shortening and strike-slip faulting. The Ulukışla basin straddles and is sandwiched between the HT-LP Kırşehir Block (KB) to its north, and the HP-LT Bolkardağ/Afyon zone (BD) to its south and lies on ophiolitic basement. At its southern margin a series of small-offset faults consistent with an early phase of (late Cretaceous-Paleocene) N-S extension, may have been associated with extensional exhumation of BD. Close to the contact with KB, a series of large-offset listric normal faults compatible with E-W extension

offsets sediments and the base of newly dated Paleocene volcanics, showing that E-W extension prevailed until beyond 56 Ma. This is likely genetically linked to regional extension in the KB and overlying basins. Subsequently, N-S directed contraction led to E-W striking folds and thrusts, to back-thrusting of the BD over the basin, probably in Oligocene time, and coeval left lateral strike-slip motion along the Ecemiș fault (EF) at the eastern basin margin. We explain the interplay between two extension directions in terms of a kinked subduction zone with N-S and E-W segments. The latter can be followed farther east, to the Sivas basin that covers the contact between the KB, the Pontides and the Taurides. We restore Cenozoic convergence across the Sivas basin, equivalent to $\sim$300 km shortening restored in Central Anatolia, 60-75 km displacement along the EF, and an eastward increase due to counter-clockwise rotation of the Taurides documented paleomagnetically. We propose a long-lived Cenozoic subduction scenario for the Sivas region.

EIT Raw Materials - perspectives for research on raw materials in Europe

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EIT Raw Materials was designated by the European Institute of Innovation and Technology (EIT), an independent body of the European Union, as a so-called Knowledge and Innovation Community (KIC) in December 2014. With more than 100 partners representing the three sides of the knowledge triangle defined by education, research and business, the EIT Raw Materials is the largest and most interdisciplinary consortium ever formed in the non-energy raw materials sector. Being both long-lived and well-funded the EIT Raw Materials is geared to place Europe at the forefront of global raw materials education, innovation and entrepreneurship. The KIC partnership is organised in six so-called co-location centres that are placed across the European Union; its head office is located in Berlin. It is the mission of EIT Raw Materials to boost the competitiveness, growth and attractiveness of the European raw materials sector via radical innovation and entrepreneurship. Tho achieve this ambitions mission, the activities of EIT Raw Materials will integrate multiple disciplines, across the whole raw materials value chain. The approach of the KIC partnership will pay particular attention to systemic thinking and de-siloing across different scientific disciplines and commercial value chains. Predictably, the geosciences play an important role, with all fields related to the exploration, characterisation, utilisation, modelling/valuation of primary mineral resources, as well as environmental research pertaining to the impact of raw materials utilisation being of particular relevance. EIT Raw Materials will thus provide ample opportunities for the development and implementation of innovative geotechnologies and geoservices. Nevertheless, the necessity for geoscientists wanting to participate in EIT Raw Materials to interact intimately to related disciplines, such as mining engineering, minerals processing or metallurgy, needs to be clearly emphasised.

The RAIN project and results from the terrestrial sites in South Africa

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As part of the SPACES programme, funded by the German Federal Ministry of Education and Research (BMBF), the RAIN (Regional Archives for Integrated iNvestigations) project focuses on closely integrated investigations of terrestrial and marine environmental archives in South Africa in order to assess paleoenvironmental change. RAIN aims to enhance the knowledge of land-ocean interactions following sediment transport pathways from source to sink. It integrates information obtained from paired terrestrial and marine archives in climatically contrasting areas, i.e., the three rainfall zones of South Africa. After an introduction to RAIN this contribution focuses on lacustrine archives from the year-round rainfall zone (YRZ) and winter rainfall zone (WRZ). A first field campaign targeted several coastal lakes on the southern cape Coast within the YRZ. The second campaign focussed on Verlorenvlei, a lake in the WRZ close to the Atlantic Ocean coastline. On the southern Cape coast a 30.5 m long sediment core from Eilandvlei was recovered. Radiocarbon dating reveals a basal age of 9000 cal BP indicating an average sedimentation rate of 3.4 mm a-1. Up to now, this ultra-high-resolution record of environmental change represents a unique discovery for southern Africa. Using XRF data from this core, different phases of deposition can be reconstructed. High Ca and Sr values can be linked to phases of enhanced deposition of marine sediments, while low Ca and Sr values are indicative for periods of reduced marine but dominant terrestrial sediment input. This is supported by initial ostracod and foraminifera investigations on core catcher samples. Further hydro-acoustic investigations reveal a sediment thickness of >100 m which would distinctively extend the record further back in time. At Verlorenvlei, in the WRZ, paired parallel sediment cores (16 and 10 m) were recovered. The lowermost 2 m of each core consists of sand, possibly a fossil beach, also dating back to 9000 cal BP.

Microfabrics of mineral host-inclusion systems: constraining formation mechanisms

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Microfabrics of mineral host-inclusion systems are used to infer P-T-t-d evolutions of tectonometamorphic events, as refractory host minerals may retain petrogenetic information not preserved in the rock matrix. Host-inclusion systems may represent chemical equilibria during or post-dating host crystallization. Non-equilibrium conditions may be reflected when pre-existing phases are passively overgrown, or host-inclusion assemblages are overprinted under different conditions. In these cases local equilibria in internal host domains do not necessarily correspond with rock matrix assemblages. Focusing on host phases with single crystal inclusions we discuss criteria for characterizing host-inclusion microfabrics and discuss how their phase relations might be inferred from these. Based on examples of natural metamorphic rocks we evaluate these criteria for different scenarios of host-inclusion system formation, highlighting challenges and opportunities in inferring formation mechanisms. The spatial distribution, shape and crystallographic preferred orientation of inclusions with respect to host lattices was studied in meta-pegmatites, metapelites and metagabbros from different localities, as well as mineral compositions and host-inclusion interface geometries. Different types of crystallographic orientation relationships (CORs) were identified. We conclude that CORs by themselves do not allow unambiguous discrimination between different processes of inclusion formation. Still, the mechanism of inclusion-reequilibration during eclogite facies metamorphic overprint of a host-inclusion assemblage could be determined by combining microstructural, microchemical and high resolution crystallographic orientation data (Griffiths et al, 2014). Understanding these formation mechanisms is mandatory in order to extract petrogenetic information from host-inclusion systems. Reference:

Griffiths et al (2014), Contrib. Min. Pet., 168, 1077

Episodic re-crystallization during subduction-related metamorphism (Sesia Zone, Western Alps)

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Poster in Session A1-05

Geochronology in metamorphic rocks faces the difficulty that different minerals may have formed, recrystallized and equilibrated during different times on the pressure-temperature-time path that the rock experienced. The interpretation of geochronological data is further complicated by effects of deformation and fluid-rock interaction that often accompany distinct metamorphic stages and may cause a complete or partial resetting of the age information. Here, in situ $^{40}Ar/^{39}Ar$ phengite data and Rb-Sr internal mineral isochrons from high-pressure metamorphosed rocks of the Sesia Zone, Western Alps, are investigated to systematically relate the geochronological information to the well characterised petrological and geochemical evolution of these rocks. The data are also compared to a large amount of published geochronological data, which has sparked controversy about the tectonic history of the Sesia Zone. Based on the new geochronological data in combination with geochemical and isotopic information from fluid-mobile trace elements, we are able to disentangle five distinct episodes of crystallization and re-crystallization: 1) Eclogite-facies high pressure crystallization at 85±3 Ma, 2) selective metasomatic overprint at 75±2 Ma, 3) deformation-induced recrystallization in a major shear zone at 65±3 Ma, 4) subsequent blueschist-facies recrystallization, again related to large-scale shearing, at 59±1 Ma, and finally 5) incomplete isotopic resetting from about 50 Ma to <40 Ma, related to a late greenschist-facies overprint. These results can be reconciled into a coherent single P-T loop with episodic (re)-crystallization events related to fluid-rock interaction and deformation.

The influence of water depth on concentration and fractionation of Rare Earth Elements in marine ferromanganese crusts

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Oral in Session B2-01

Ferromanganese crusts contain hydrous Mn and Fe oxides as main metal compounds together with some economically interesting minor elements such as Co, Ni, Ti and Cu and trace metals such as Mo, W, Nb, Te, Ga, Pt, and the REEs. All of them are highly enriched in the crusts compared to seawater composition. The Mn in the crusts mainly originates from the O_2 – minimum zone in the oceanic water column. The agent for Mn^{2+} oxidation is dissolved oxygen, transported upwards from deeper water layers by turbulent eddy diffusion. The Mn itself descends from surface waters and is carried down to the O_2-minimum zone by

fecal pellet transport. In contrast, Fe is mainly supplied from carbonate dissolution of planktonic skeletons in the water column. These geochemical relationships result in the fact that the oceanic water depth strongly controls the metal composition of ferromanganese crusts: the Mn – group metals are more enriched in shallower water, whereas the concentration of the Fe – group metals including the REEs increase with water depth. In seawater, REEs occur as carbonate complexes; preferably, the light rare earth elements (LREEs) form $REECO^{3+}$(aq) and the heavy Rare Earth Elements (HREEs) $REE(CO_3)^{2-}$ (aq) complexes. Due to the fact that REEs in seawater form cationic and anionic carbonate complexes, the two main hydrogenetic constituents, hydrous δ-MnO_2 and Fe-oxyhydroxide also fractionate the group of REEs by surface absorption processes. Concluding we can point out that the increasing REE concentration in marine hydrogenetic ferromanganese crusts with increasing water depth is (1) mainly controlled by the Fe content, (2) inversely related to the Mn/Fe ratio, (3) fractionated according to the atomic number of the REEs and (4) controlled by the depth - dependent partial pressure of CO_2 in seawater. However, the depth-dependant increase in REEs is associated with a strong decrease in Mn, Co, Ni and Mo contents in the crusts.

Formation of calcite melts in hypervelocity impact and laser melting experiments

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Oral in Session A3-02

A frequently discussed topic in impact cratering is the fate of carbonates upon impact [1]. Specifically, the question is whether carbonates released from high shock pressures will decompose and liberate CO_2 (e.g., [2]), or will be preserved as melt in impactites (e.g., [3]). Here, we present first evidence of calcite melts in impact and laser melting experiments recently performed in the Multidisciplinary Experimental and Modeling Impact Research Network (MEMIN) [4]. Impact experiment A30-5610, performed with a two-stage light-gas gun at Fraunhofer Ernst-Mach-Institut, Freiburg, involved the impact of a 6.17-mm-diameter basalt sphere onto a block of Carrara Marble at 4.94 km s^{-1}, resulting in $\sim$51 GPa peak pressure. The accompanying laser melting experiment A5, performed with a pulsed Nd:YAG laser at Technische Universität Berlin, involved the rapid melting and subsequent quenching of the contact zone between a basalt block and a calcite block. Both experiments yielded calcite grains that mostly show low-grade shock effects (i.e., pronounced twinning). Occasionally, ejecta particles composed of calcite and a silicate melt (likely originating from the basalt projectile) are found in the impact experiment, showing degassing and melting of calcite. In the laser melting experiment, degassing and melting of calcite is indicated near a basalt melt zone. In both cases, calcite melts are recognized by (i) loss of calcite grain boundaries and in-situ appearance of flow textures and vesicles, (ii) isotropisation of the material, and (iii) Raman spectra characterized by disappearance of the characteristic calcite bands at 155, 287, 714, 1087, and 1439 cm^{-1}. Based on optical microscopy, SEM, and Raman spectroscopy, we conclude that calcite melts were produced in both experiments.

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East-West Gondwana collision: microstructural evidence for earlier timing

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Oral in Session A1-04

The ophiolite-decorated Allaqi-Heiani suture zone along the Egypt-Sudan border is a key tectonic feature in the Arabian-Nubian Shield, the northern extension of the East African Orogen (EAO). This zone is commonly interpreted as a fold-and-thrust belt in which southward-vergent thrust segments of allochthonous ophiolites tectonically overlie medium-grade metamorphosed island arc rocks. Formation of this belt was attributed to collision between the SE Desert and Gabgaba arc terranes and ∼N-S shortening at ca. 750-720 Ma. Discrete NW-trending stretching lineations, asymmetric tails and rolling structures along the thrust planes indicate a left-lateral sense of shear obscured in places by crenulation cleavage and rootless NNW-trending folds. The geometry of the crenulation cleavage and association with 100s km-long wrench zones with common pull apart basins and swelling centers may express the accretion of the Arabian-Nubian Shield with the Saharan Metacraton in the west, which occurred concurrent with Gondwana assembly through progressive oblique convergence (640-580 Ma). Clear superimposition of older and younger structures are difficult to observe, but NW-SE foliation deflection and nucleation of NNW –trending foliation through C-S structure is very likely. Based on the microstructure of the foliated rocks along the thrust planes of the Allaqi-Heinai suture, we assume that these two foliations resulted from the same oblique convergence tectonics and preclude the early N-S accretion phase. Therefore, the East-West Gondwana collision should have started earlier than previously thought by at least 100 Ma.

Three-dimensional finite-element modelling of horizontal surface velocity and strain patterns near thrust and normal faults during the earthquake cycle: implications for interpreting geological and geodetic data

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Poster in Session A2-01

In recent years, more and more geological and space-geodetic data on the surface deformation associated with earthquakes on intra-continental normal and thrust faults have become available. Here we use three-dimensional finite-element models that account for gravity, far-field ("regional") extension/shortening and postseismic relaxation in a viscoelastic lower crust to quantify the surface deformation caused by an Mw ∼7 earthquake on a dip-slip fault (Hampel and Hetzel, Tectonics, in press). The coseismic deformation is characterized by horizontal shortening in the footwall of the normal fault and extension in the hanging wall of the thrust fault – consistent with elastic dislocation models, geological field observations and GPS data from earthquakes in Italy and Taiwan. During the postseismic phase, domains of extensional and contractional strain exist next to each other near both fault types. The spatiotemporal evolution of these domains as well as the postseismic velocities and strain rates strongly depend on the viscosity of the lower crust. For viscosities of 1018-1020 Pa s, the signal from postseismic relaxation is detectible for 20-50 years after the earthquake. If GPS data

containing a postseismic relaxation signal are used to derive regional rates, the stations may show rates that are too high or too low or even an apparently wrong tectonic regime. By quantifying the postseismic deformation through space and time, our models help to interpret GPS data and to identify the most suitable locations for GPS stations.

Numerical modelling of wind gap formation in fault-bounded mountain ranges

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Poster in Session A6-01

Among the most impressive geomorphological features that document the competition between rock uplift and surface processes are wind gaps, which form in active mountain ranges when rivers are defeated by tectonic faulting. Here we use a three-dimensional numerical model with full coupling between tectonic deformation and surface processes (Kurfeß & Heidbach, Comp. Geosci., 2009; Maniatis et al., EPSL, 2009) to investigate the formation and temporal evolution of wind gaps in mountain ranges bounded by an active thrust fault. Range growth in our model occurs by accumulation of slip on a fault plane embedded in a rheologically stratified crust. Our model results reveal that wind gaps do not necessarily form progressively from the center toward the tips of the mountain range. Rather, rivers abandon their valleys asynchronously depending on the evolution of their catchment area upstream of the range and the relative magnitude of diffusive and fluvial erosion. Our study further reveals that the presence of wind gaps are not an unequivocal indicator for lateral fault growth, because they may also form in mountains bounded by non-propagating faults with stationary tips. The elevation of wind gaps above the local base level is a good approximation for the amount of tectonic rock uplift since river defeat and valley abandonment. Overall, our models agree well with the geomorphology and growth history of active mountain ranges in northeastern Tibet (Hetzel etal., Terra Nova, 2004; Palumbo et al., Tectonics, 2009) and New Zealand (Amos et al., Tectonics, 2010).

Orogen-parallel and orogen-normal extension related to ongoing clockwise rotation at the junction of the Dinarides and Hellenides (Northern Albania)

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Oral in Session A2-01

The junction of the Dinarides and Hellenides in northern Albania is marked by two normal fault systems trending perpendicular and parallel to older (Paleogene) thrust contacts. In the first system, the most prominent is the SSE-dipping Skutari-Pec Normal Fault (SPNF) that accommodates orogen-parallel extension. New geological maps and cross-sections reveal increasing downthrow to the NE along strike of the SPNF, from zero near the city of Shkoder (Handy et al. 2014) to at least 2 km near the Albania-Kosovo border (Schmid et al. 2014). This differential orogen-parallel extension along the SNPF defines a vertical axis of rotation near Shkoder that is interpreted to have formed a pivot for 20-30° of clockwise rotation and SW-directed thrusting in the S. The second system of normal faults that trend orogen-parallel accommodate orogen-normal displacements of up to several km. Both systems cut Late Cretaceous to Oligocene thrusts, indicating a Neogene or younger age. Most of this normal faulting is probably Miocene to Pliocene based on syn-extensional deposits (e.g., Metohia Basin; Antonijevic 1969) and on thermal modelling of ZHe, AFT and AHe data suggesting accelerated cooling at ∼18 Ma (north) and between 4-6 Ma (central; Muceku et al. 2008). Further, both fault systems cut Holocene layers, indicating ongoing extension. This corroborates GPS data (Jouanne et al. 2012) and earthquake focal mechanisms (Pondrelli et al. 2006) indicating active extension of the area SE of the SPNF. We therefore propose that coeval orogen-parallel and –normal extension in this area has accommodated SW-retreat and radial expansion of the Hellenic arc during rollback subduction (e.g., Kissel et al. 1995).187

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Formation of greisen-type mineralization (Zinnwald/Cínovec, Erzgebirge) – a microstructural approach

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Poster in Session B2-02

Zinnwald mine near the village of Zinnwald/Cínovec in the eastern Erzgebirge is world-famous for its Li-, Sn-mineralization, bound to the roof of a granitic intrusion. The granitic body shows a vertical zonation, with transition from lithium-poor, porphyritic granite in the deeper parts to lithium-enriched albite-granite in shallow levels. In its upper part, the cupola is transected by several subhorizontal quartz veins, in many places surrounded by greisen. The objective of our study is to gain new insight into the genesis of the deposit, the late stage processes taking place in the uppermost levels of a cooling granitic body, and the nature of fluids involved in these processes. The question is whether the greisen formed by direct crystallization from residual hydrous melts or by metasomatic replacement of solidified granite at subsolidus conditions, referred to as greisenization. Microfabrics, phase relations, and bulk chemical composition in confined domains are used to identify possible solid-solid replacement reactions. In contrast, direct crystallization from a hydrous melt or fluid phase is indicated in cases, where miarolitic, intercrystalline cavities are coated by mineral assemblages with a variety of compositional zoning and systematic overgrowth relations. For instance, at low confining pressure in a shallow granitic cupola, stability of muscovite plus quartz may be taken to indicate crystallization at sub-solidus conditions. On the other hand, the high F- and Li-content of the melt inferred for the Zinnwald granite can shift the solidus of the system towards considerably lower temperatures, possibly allowing crystallization of muscovite plus quartz from low-temperature hydrous melt. Information on the fluids involved is provided by fluid inclusions in quartz, topaz and cassiterite, which in combination with characteristic microstructures of solid phase assemblages provide insight into processes of greisen formation in a shallow granitic cupola.

Chromium isotope heterogeneity in components and bulk rocks of carbonaceous chondrites.

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Oral in Session A3-01

Resolvable differences of ϵ^{53}Cr and ϵ^{54}Cr in unequilibrated chondrites can be a useful tool to understand and constrain early nebular processes. As chondrites represent a mixture of components such as chondrules, Fe-Ni metal, fine-grained matrix and refractory inclusions, different ϵ^{53}Cr and ϵ^{54}Cr in bulk rocks likely result from mixtures of different anomalous Cr-carriers. Here, we present preliminary results of high precision measurements of ϵ^{53}Cr and ϵ^{54}Cr in bulk rocks of Allende (CV3), Ivuna (CI1) and Orgueil (CI1) and some separated components of the Allende meteorite. The data were obtained on the Triton TIMS at Freie Universität Berlin. Bulk rock values (relative to NIST 3112a) of ϵ^{53}Cr for Allende, Ivuna and Orgueil are 0.11 ± 0.07, 0.27 ± 0.08 and 0.37 ± 0.07, respectively (uncertainties are 2σ). Bulk rock values of ϵ^{54}Cr for Allende, Ivuna and Orgueil are 1.37 ± 0.17, 1.63 ± 0.10 and 1.80 ± 0.12, respectively. These data are consistent with results of previous studies. Two magnetic separates with different grain sizes (20-80 μm and 80-150μm) from Allende show ϵ^{53}Cr values of 0.02 ± 0.06 and 0.20 ± 0.11 and ϵ^{54}Cr values of 0.98 ± 0.08 and 1.23 ± 0.09, respectively. Components of Allende show Mn/Cr variations of up to 50%. The correlation between Mn/Cr and ϵ^{53}Cr defined by magnetic separates and bulk rocks may have been caused by mixing of Mn and Cr bearing phases of different provenance in the early solar system and limited radiogenic ingrowth. Lower ϵ^{54}Cr and ϵ^{53}Cr in magnetic separates compared to chondrite bulk rocks likely resulted from heterogeneously distributed, ^{54}Cr rich carrier phases that appear to be different from ^{53}Cr carriers at the mm scale. More measurements will be carried out on other components to shed light on a suspected complementary behavior of Cr isotopes in the components.

Caledonian thrust sheet emplacement along basal mylonites in the COSC-1 borehole in Central Sweden

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Poster in Session C5

The Scandinavian Caledonides provide insight into the deep roots of Himalayan-style orogenic processes. Seismic data shed new light on long-distance transport of metamorphic nappe stacks and a 2.5 km drill hole sampled the high-grade Seve Nappe complex and underlying lower-grade units in Central Sweden. The goal of the ICDP project "Collisional Orogeny in the Scandinavian Caledonides" (COSC) is to investigate the deep crustal structure and the evolution of the orogen. The 2.5 km deep COSC-1 well was drilled in summer 2014 in Åre in Central Sweden and sampled the basal c. 2 km of the Seve Nappe Complex consisting of meta-sedimentary gneisses with intercalated metabasic rocks. Subparallel mylonitic bands increase in thickness (mm to m) and frequency below 1700 m and dominate below 2100 m. At c. 2350 m, lower grade meta-sandstones indicate that drilling reached a unit of yet undefined position or tectonic slivers of it. However, the drilling did not fully penetrate the bottom of the thrust zone as it ended in thick, remarkably garnetiferous mylonitic rocks while such garnet porphyroclast are absent in the lower-grade inclosures. High-resolution microanalyses of mylonites and neighboring host rock from different depths reveal chemical changes in the pattern of ductile deformation over their almost 1 km depth range. Mylonites record the physical and chemical conditions and fluid impact during high-grade thrust sheet emplacement. Investigation of COSC-1 drill core samples proves that the base of the high-grade Seve Nappe and uppermost indents of an underlying lower-grade nappe have been truncated. The transition into the lower Allochthon at about 2 km depth has been postulated based on high-resolution seismic data but its thickness of several hundred metres with complex interfingering was previously unknown.

Sub-micrometer impact craters on a regolith grain of asteroid 25143 Itokawa

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Oral in Session A3-02

The Hayabusa mission returned regolith particles from near-Earth asteroid 25143 Itokawa in 2010. The collected samples provide unique insights into the surface processes operating on small bodies of the inner Solar System. Effects of space weathering result from both solar wind irradiation and high-velocity impacts of small solid bodies. We investigated Hayabusa grain RA-QD02-0265, which consists of high-Ca pyroxene and minor olivine and plagioclase. The grain's surface showed 15 crater-like features measuring 210 to 500 nm in diameter. Nine of them were found clustered in an area of approximately 5×5 μm^2. We have sectioned the grain across the largest crater-like feature (500 nm) by FIB. The bulk high-Ca pyroxene contains abundant 20 to 300 nm wide twin lamellae parallel to (100). The twin boundaries are frequently decorated by (partial) dislocations, indicating a mechanical origin of the intense twinning, most likely by a large-scale, pervasive shock event. The volume below the floor of the 500-nm-crater shows distorted Bragg contours, indicating strain of the crystal down to a depth of about 400 nm. The likely sources of this strain are partial dislocations emitted during crater formation. A partially amorphous, solar-wind damaged rim of 20 to 30 nm thickness is present on the exposed surface and appears absent or greatly reduced in thickness below the crater floor. Several Fe,Ni metal particles <60 nm are embedded in the crater floor and clearly indicate that the crater formed from the impact of a natural, metal-bearing particle. The density of solar flare tracks is relatively low (ca. 1E9 cm^{-2}) and suggests, in accordance with a simple space weathering rim and absence of surface abrasion, that the grain experience no exceptionally long surface exposure. The cluster of craters therefore is most likely due to secondary impacts of particles generated by an nearby (micro-)impact event, postdating the pervasive shock event recorded by the intense twinning.

Linked plume-related rifting, regional transcurrent faulting and indentation tectonics on Venus interpreted from Bouguer gravity and radar — a precursor to plate tectonics

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Oral in Session A3-03

Venus is dominated by upwelling and downwelling mantle plumes within a stagnant lid or transitional convection regime. Magellan radar images do not show any evidence for single-sided subduction zones, spreading ridges and transform faults, nor arcuate volcanic chains that typify present-day plate tectonics on Earth and there is general agreement that plate tectonics does not occur on Venus. Magellan Bouguer gravity data and horizontal gradient edges define a hitherto unrecognized network of regional-scale crustal structures on Venus. Belts of long wavelength Bouguer gravity highs corresponding to areas of thinned crust indicate upwelling of denser mantle beneath regional-scale rifts largely obscured at the surface by basalt flows. Rifts are offset by transcurrent faults and flank zones of mantle upwelling between collinear, upwelling mantle plumes. Reversal of displacement senses along major regional transcurrent shear zones on the margins of, or displacing, continent-like plana, and fold and thrust overprinting relationships imply coherent, regional-scale changes in principal stresses in superposed tectonic events. The large displacements of plana (where Bouguer lows suggest felsic crustal constituents) are interpreted to result from mantle tractions/pressure acting against their deep 'keels' commensurate with horizontal outflow from upwelling plumes. Continent-like 'drift' on Venus resembles the westward translation of the Americas and the pre-collisional acceleration and continued northward displacement of India, both attributed to mantle flow tractions and plume-push (respectively) acting upon the deep Precambrian cratonic keels of N. America and India in addition to plate tectonics. Deformation features on Venus represent a precursor to plate tectonics and provide an analogue for an Archaean Earth where mantle flow against deep cratonic keels is similarly the driving force for terrane assembly, regional shortening and deformation.

Indentation and lateral escape in Western Ishtar Terra, Venus and the Archaean Superior Craton, Canada — "Wegenerean" continent-like drift without subduction and modern plate tectonics

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Oral in Session A4-04

Venus is presented as an analogue for a non-plate-tectonic Archaean Earth. Because of its high surface temperature, the form, scale, and deformation features interpreted on the surface of Venus from radar imagery are comparable to mid-upper crustal structures on Earth. The Lakshmi Planum area of W Ishtar Terra, Venus, is a highland plateau rimmed by mountain belts. Magellan radar images portray a broad fold and thrust belt in the mountainous region on its N margin. Folds, reverse and sinistral strike-slip faults along the NW planum margin define a sinistral transpressional regime. Both regional dextral and sinistral strike-slip belts are interpreted NE of Lakshmi Planum. The scale and kinematics of structures in W Ishtar Terra closely resemble the Indian-Eurasian collision zone and Indochina lateral escape corridor. Graben interpreted from radar images and a linear Bouguer gravity high, punctuated by sub-circular lower Bouguer anomalies, define a zone of crustal rifting and mantle upwelling linking mantle plumes S of Lakshmi Planum. We propose that northward displacement and indentation of Lakshmi Planum resulted from mantle flow directed away from collinear mantle plumes acting upon the base of its thick lithosphere along with commensurate mantle downwelling on the opposite convective cell margin. The striking resemblance of mapped reverse and strike-slip shear zones in the Abitibi Subprovince of the Superior Craton, Canada to structures interpreted about Lakshmi Planum suggests a similar, non-plate tectonic origin, mirroring Wegener's early concepts for continental drift. Similarly, shortening and rift inversion in the Abitibi is ascribed to cratonic mobilism, where displacement of the N Superior Province 'protocraton' resulted from mantle flow acting upon its deep lithospheric keel. Deformation in other Archaean cratons may also be the result of similar, "Wegenerean-like" mantle-driven processes prior to the onset of plate tectonics in the Proterozoic.

The satellites data used for monitoring the degradation process of natural resources in semi arid zones (Algeria)

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Poster in Session A5-01

The semi-arid region of the Aurès presents an undeniable diversity of flora and fauna, however weather conditions and actual adverse anthropogenic, caused degradation of the physical environment, which have the form of a regression in the natural forest cover. The objective of this study is to determine the contribution of satellite images in detecting changes in land use and monitoring of the degradation processes in the southern part of the Aurès region. As far as that goes, we used images: Landsat ETM + for 2014 and TM 1987.These last cover the southern region of the Aurès which presents a landscape exposed to the phenomena of degradation including forest

Beni-Mloul, Dj.Mezbel and Dj khaddou Ahmar, characterized by endemic species. The adopted step is to treat multi-dates satellite imagery by the method of supervised classification of Maximum likelihood to see global changes of land use that have occurred in this area. The results of treatment of satellite images show that the forest cover, rangelands and soil are being the object of advance degradation. This study is a multi temporal diagnosis, which has allowed us to identify at a time the degradation affecting vast semi-arid areas, causing regression of plant cover, and also the pace of its development.

Intracontinental earthquakes – from 550 Ma to present day in the Musgrave Ranges of Central Australia

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Poster in Session A2-01

The Petermann orogeny in Central Australia represents an outstanding example of an intracontinental orogeny, yet the reasons for localization are still poorly understood. The Musgrave Ranges, located between the North, West and South Australian cratons, expose mid- and lower crustal rocks affected by the ∼550 Ma intracontinental orogeny. The crust that localized the deformation within the continent is dry and strong, as seen from the presence of abundant pseudotachylytes in all of the observed shear zones. In recent years (2012, 2013), the central Musgrave Ranges experienced two Mw >5 earthquakes, the largest on the continent since 1997, rising the same questions with regard to the cause of intracontinental earthquakes as with the Proterozoic examples. The ∼1.2 Ga Musgravian orogeny stitched together the Australian cratons and resulted in amphibolite to granulite facies metamorphism in the study area (Camacho and Fanning, 1995). This high-temperature metamorphism and associated local partial melting produced a dehydration of the lower crust. The intracontinental Petermann orogeny, with a dominant N-S compression, resulted in the E-W trend observed today in the Musgrave Ranges. Lower crustal rocks in the south are brought in contact with mid-crustal rocks in the north by the Woodroffe Thrust, which extends for about 600 km along strike and dips shallowly to the south. While very shallowly dipping thrusts are typical for weak rocks, the thrust consists of several hundred meters of mylonites, ultramylonites and multiple generations of pseudotachylyte, without any evidence for marked rehydration. As shown by the 2012 and 2013 Pukatja and Mulga Park earthquakes, the Musgrave Ranges still localize deformation. Even though both events are in close proximity to the Woodroffe Thrust, the fault plane solutions for the earthquakes do not match the Woodroffe Thrust geometry and there is no evidence for reactivation.

Shells of bivalves and gastropods – perfect bio-composites

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Poster in Session B6-03

Shells of bivalves and gastropods are in the focus of biomaterial research; usually they are organic-inorganic composite materials with hierarchical topological arrangements. The combination of a small amount (∼5%) of organic macromolecules and a major part of mineral substance (generally polymorphs of calcium carbonate) in an interlaced way on different length scales provides superb mechanical function that natural minerals don't achieve. For example, the difference of hardness between shells and calcite can be as much as 2 orders of magnitude. The key for this excellent mechanical performance lies in the microstructure and texture, and most importantly influenced by the formation of these textures. It is generally believed that the layered inorganic minerals are controlled by the organic constituents when assembled, but due to the varieties of organisms and the difficulty of in-situ studies, the better understanding of these composite materials still remains an important task. In this study, different methods have been used to show that not only the organic constituents but also the crystallographic orientation, particle size and their complex arrangement have facilitated such special texture qualities. Eight species from both, bivalve and gastropod classes have been investigated using SEM comprehensively. Details about how one layer grows into another kind of layer have been revealed and differences between different classes were found. The distribution of chemical composition in these specimens gives perspectives on how different polymorphs are formed. From applying optical spectroscopy, further insight into the short-range crystallographic orientation is expected. The principle axes alignment and twinning structures should allow us to better understand how the inorganic substance influences the macroscopic properties of such bio-composite materials.

Gas phase formation during thermal energy storage in near surface aquifers

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So far only a few studies investigated the geochemical impacts of ATES applications in near surface aquifers. Although heating of ground water poses a potential for the formation of a separate gas phase, the necessary boundary conditions and potential effects of this process e.g. regarding transport behaviour were not focused within previous studies. Since the formation of a gas phase could change groundwater flow conditions, geomechanical behaviour, hydrochemistry and the efficiency of an ATES application, improved understanding of the associated process is needed. To investigate the potential of temperature induced gas formation under different geochemical conditions, the temperature of column tests with different Pleistocene sands was adjusted to 10, 25, 40 and 70°C. Beside the analysis of major ground water constituents, gas formation rates were quantified by weighing gas traps. The volume of the gas phase trapped within the sediment was calculated from induced pressure changes. Experimental results were compared with geochemical equilibrium modelling and supplemented by numerical scenarios representing different geochemical and hydrological conditions. The columns heated to 25, 40 and 70°C developed a separate gas phase with a maximum pore space saturation of 27% for 40°C and 18% for 70°C. 1-4 and 8-9 mL(gas)/L(ground water) at 40 and 70°C, respectively, were flushed out as bubbles from time to time. Scenario simulations considering only dissolved nitrogen in equilibrium to the atmosphere indicated gas formation until water saturated depths of up to 10 m. Deeper regions of an aquifer can also be affected, in case of additionally dissolved gases as e.g. H_2S, CO_2, CH_4. The results indicate that gas formation must be considered under various conditions and should be incorporated into application designs for aquifer heating. Acknowledgments: The presented work is part of the ANGUS+ project (03EK3022A) funded by the German Ministry of Education and Research (BMBF).

Garnet formation in the CMAS system under deviatoric stress

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The influence of concurrent deformation on garnet forming reactions in the simplified CMAS system was investigated experimentally with the reaction of clinopyroxene + orthopyroxene + spinel to garnet + olivine. Pure shear deformation experiments (strain = 30%) were compared with static phase transformation experiments of the same duration. Starting materials were produced from glasses in piston cylinder experiments at 1 GPa and 1000°C for up to 10 days resulting in a grain size of about 5-15 μm for all phases. Samples were then deformed (reacted) in a 6-axis multi-anvil press in the garnet + olivine stability field at 1100°C and 2.5 GPa. Strain rates (durations) of experiments ranged from 5×10^{-4} sec^{-1} (10 min) to $2.5\text{x}10^{-6}$ sec^{-1} (2000 min). Garnet was produced first by rim growth at the spinel-pyroxene interface and then proceeded rather rapidly to about 50% reaction progress after 30 minutes under deformation indicating the transition to the growth stage. The rapid increase was delayed in the static reference samples to 100 minutes run duration. Completion of the reaction was practically reached after 250 minutes in the deformed samples whereas in the static samples it was still not completed after the maximum run duration. Production of garnet was consistently higher in the deformed samples than in the statically reacted reference samples, indicating that deviatoric stresses enhance the reaction rates. The difference between dynamic and static transformation experiments was most pronounced at the beginning of the reaction, i.e., affecting the initialization of the garnet formation. With increasing duration and slower strain rates the difference in static and dynamic reaction rates became smaller as the completion of the reaction was approached. Applying these results to natural samples and strain rates indicates that enhanced reaction progress in shear zones is mainly due to stress-enhanced initialization of the reactions rather than plastic strain.

Paleoclimatic implications from Cenozoic terrestrial calcrete formation in the Ili Basin, SE Kazakhstan

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Central Asia yields a great opportunity of documenting Cenozoic climate evolution in a terrestrial environment far away from the sea and thus from any marine influence. Climate and regional tectonics appear to be the main controls. As paleosols are sensitive to environmental changes like temperature and moisture supply as well as to changes of erosional rates and detrital sediment supply, they have the potential to serve as paleoclimatic archives. During the development of paleosols in arid to semi-arid environments, calcrete formation is very common. However, the detailed geochemical interaction of host rock and calcrete is still not well constrained. Here we present geochemical data from an Oligocene-Miocene paleosol succession in the Ili Basin (SE Kazakhstan, Central Asia) to decipher processes of elemental exchange between sediment matrix and carbonate nodules during their formation. The exceptionally well developed calcrete profiles are formed in an 350-m-thick sequence characterized by an alternation of highly oxidized floodplain deposits and alluvial conglomerates. Sedimentological field observations, the Chemical Index of Alteration and the Ti/Al ratio suggest the establishment of a fluvial setting within an alluvial fan system. Our data show that readily soluble elements like Na and Ca became enriched in the carbonate nodules, while elements like Ba remain in the disperse carbonate fraction of the sediment matrix. A gradual decrease of the carbonate nodule size over the whole succession indicates changes in the basin drainage conditions towards more unfavourable conditions for calcrete formation.

Additional U-Pb ages derived from the pedogenic carbonates refer to an Late Oligocene-Early Miocene age of the succession.

A comparison of high resolution X-ray CT generated data with common analytical methods – Advantages of μ-CT analysis, models and numerical simulations

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The H2STORE (hydrogen to store) project is part of the lighthouse program "Energiespeicher" and is founded by the BMBF. The research focus is the potential underground storage of H_2, generated by renewable energy excess production, into depleted oil- and gas fields. In this context, different analytical methods like polarized light microscopy, image analyses, SEM, AFM, BET (specific surface area), petrophysical measurements (Hg-porosimetry, He-porosity, He-permeability) and high resolution computer tomography (μ-CT) combined with numerical pore models and fluid flow simulations were used to compare the reactions of hydrogen with several reservoir sandstone types. For these studies four industrial partners provided sample material from five, distinct stratigraphical regions. The analyzed sandstones samples comprise fine to coarse grain sizes due to different depositional/transport processes (e.g. aeolian/fluvial conditions), different source areas and therefore different detrital compositions. Also the burial history is different, which results in different diagenetic evolution, different burial depths (recent depths are 600-3500 m) and formation fluid composition (5-35 % salinity). The recent burial temperatures vary, with 40°C for the Tertiary and Late Triassic samples to 125°C for the Permian sandstones. This wide data range leads to a significant outcome which will cover the most important reservoir units in Germany. In comparing the data sets of the standard methods (2D porosity, He-porosity, Hg-porosity) with the μ-CT data, the achieved results of all methods are almost in the same order. Moreover, the specific surface area and the pore size distribution data measured with the standard methods are comparable and in the same order as the μ-CT data. Thus, the nondestructive imaging and timesaving (with appropriate computer hardware) μ-CT technique combined with numerical modelling is a most promising alternative/completion in geoscientific work.

Calcite – star-shaped oriented intergrowths with other minerals

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In rare cases, calcite crystals exhibit intergrowths with small amounts of another mineral, forming a threefold star according to the trigonal symmetry of the calcite crystals. Twelve different examples are provided, from ten different localities all over the world, involving six different foreign minerals and twelve different crystal morphologies of the calcite. A plausible interpretation for this phenomenon is given as follows. Imagine the beginning of the crystal growth of the calcite with a certain crystal morphology, a combination of two or more crystal forms. The atomic patterns on these crystal forms are different, providing different crystal surface energies. At this very moment, the foreign mineral is due to begin its crystallization, obviously preferring only one of these forms to settle upon, with suitable surface energies, using all crystallographically equivalent faces of this form, and avoiding all the other forms. After the end of the crystallization of the foreign mineral, the calcite crystal continues its growth, in all cases completing its form using another morphology, mostly using other crystal forms. Looking in the direction of the c-axis, the threefold nature of the foreign mineral settling can be seen, according to the crystallographically equivalent faces of the used crystal form. In most cases, the foreign mineral settles upon the calcite with innumerable tiny crystals in all orientations, apart or forming various aggregates randomly strewn upon the used faces. Only one of the introduced examples shows a real epitaxy, a new one from Holzen, Germany: cube faces 100 of pyrite parallel to rhombohedron faces 01-12 of calcite, [100] pyrite parallel to [1-101] calcite. So far, only one epitaxy of pyrite upon calcite has been described, following other rules (ZIMMER, P.W. (1966), Amer. Miner. 51, 1563).

Geological 3d modelling of the Northwest German Basin in Schleswig-Holstein for investigations of the geothermal potential of reservoirs and fault zones

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The extraction of geothermal energy from deep seated aquifers or fault zones may be an important part of the future energy strategy. One prerequisite for a successful and effective operation of a geothermal facility is a fundamental knowledge of geological conditions and processes. The Geological Survey of Schleswig-Holstein (LLUR SH) aims to support future geothermal projects by the evaluation of the geothermal potential of the deep underground and participates currently in the joint project "GeotIS-StörTief", which is funded by the Federal Ministry of Economic Affairs and Energy. The project partners are the Leibniz Institute for Applied Geophysics (LIAG, lead partner) and the Karlsruhe Institute of Technology (KIT). Main focus of this project is the investigation of the geothermal potential of deep reaching fault zones, which may represent permeable pathways for hot circulating fluids. The subproject of the Geological Survey of Schleswig-Holstein is focused on the geothermal potential of the Glückstadt Graben area and is split in two parts. One aim is the construction of a consistent geological 3d model to visualize the overall structure of the Glückstadt Graben, reservoir complexes and fault zones. The second aim is the lithological and petrophysical characterization of fault systems and relevant sandstone formations, especially in fault zone areas. The geothermal potential will be investigated by merging results of geometrical modelling and reservoir characterization. Intermediate modelling results will be presented to give insights into the spatial connections of salt diapirs, faults and reservoir formations. Moreover, the workflow and difficulties of the modelling process will be addressed.

Water-speciation in silicate glass from partial Raman spectra

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Water dissolved in silicate melts and glasses is usually present in the form of two species, free molecular water H_2Om, and OH-species. We used a mathematical approach similar to [1] to determine the H_2Om and OH content in hydrous rhyolitic glasses from Raman spectra at 3000 cm-1 to 3750 cm-1. The approach is based on a least-squares optimization algorithm and the key assumption that the water band can be expressed as a linear combination of two partial Raman spectra related to the two species. Our model makes no assumptions on the shape of the partial Raman spectra. Several hundreds of Raman spectra covering a water range from 0.6 to 3.1 wt. % served as input data. The key results are (Fig.1): (1) Both partial Raman spectra have strong spectral overlap. (2) Shape and position of the maxima is different, i.e., OH has a very broad and highly asymmetric band, whereas H_2Om shows mainly a narrower more symmetric band. (3) Partial Raman spectra can be used to determine water species concentrations in hydrous

glasses.

[1] Zakaznova-Herzog, V.P., Malfait, W.J., Herzog, F., and Halter, W.E. (2007), J Non-Cryst Solids, 353, 4015-4028.

New Developments in Understanding Jurassic Earth History

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We now perceive the Jurassic Earth to have been subject to extreme and rapid global and regional changes unlike any that have occurred subsequently. Crucial insights include the recognition of a dynamic carbon cycle linked to Oceanic Anoxic Events (OAEs) and supergreenhouse climates on the one hand, and periods of intense cooling and even glacial conditions on the other. Carbon-isotope stratigraphy has been key to this understanding, both as a correlation tool, and as an indicator of palaeoenvironmental change, leading to research focuses on the roles of growth and demise of carbonate platforms, marine gas hydrates, and large igneous provinces in driving global change. In recent years, a wide range of new elemental and isotopic proxies have been applied, each bringing insight into different aspects of the Earth system. Some of these geochemical techniques are painstaking in their execution, but others, such as hand-held XRF, are used to generate rapidly very long, high-resolution, elemental time series, and thus lay the foundation for cyclostratigraphic analysis and construction of astrochronological age models. The present combination of long, complete stratigraphic records from deep boreholes, the ease of generation of large palaeoenvironmental datasets, and renewed interest in fine grained sediments, offers the best prospect yet of disentangling the roles of the different extrinsic (e.g. tectonic and orbital) and intrinsic (e.g. autocyclic) controls on global change during the Mesozoic. The 1.4 km thick Early Jurassic sequence recovered from the Mochras borehole in Wales drilled in 1968-70, now the subject of a proposal to re-drill through the International Continental Drilling Programme (ICDP), shows well the potential for a fuller understanding of the Jurassic Earth system through integrated stratigraphic study.

Architecture of Moodies Group (Barberton Greenstone Belt, 3.22 Ga) suggests partial convective overturn of unstable lithosphere

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Whether early Earth lost its abundant heat through plate-tectonic processes (in which mantle convection drives overlying plate interactions) or through partial convective overturn (dominated by ascending isolated plutons and sagging dense volcanic rocks) is debated. The controversy has to-date largely been driven by structural and tectonothermal arguments. We here report results from a stratigraphic synthesis of the sandstone- and siltstone-dominated, alluvial-to-prodelta-facies quartz-rich Moodies strata (ca. 3.22 Ga), uppermost unit of the Barberton Supergroup, north of the greenstone-belt-medial Inyoka Fault which document first-ever access of sedimentary systems to granitic material. The following attributes suggest that deposition of Moodies strata may have taken place in a partial convective overturn setting: (1) Sandstone and conglomerate petrography suggests a high degree of regional and local compartmentalization, respectively; (2) Moodies strata are syndeformational and record provenance from nearby plutons, shed into adjacent, rapidly subsiding basins during a phase of initial extension, followed by syndepositional shortening; (3) paleocurrent analysis and facies architecture indicate that key Moodies units prograded along the axes of possibly narrow, elongate synclines between rising anticlines or fault zones; paleocurrents diverge from zones of uplift.

Reassessing evidence of Moon-Earth dynamics: No evidence of shorter lunar months from tidal bundles of the Moodies Group (Barberton Greenstone Belt, 3.22 Ga)

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Past Moon-Earth dynamics are poorly understood because they are affected by variations in tidal friction which in turn affect the rate of Earth-to-Moon momentum transfer. Hence, the Moon's past orbital parameters are difficult to constrain, and estimates of mean tidal frequency and amplitudes in the deep geologic past lack a solid foundation. Robust geological data sets recording systematic temporal variations in tidal current strengths, which conceivably could constrain these parameters, are also scarce. The data point reaching farthest back into the geologic past comes from the Moodies Group (ca. 3.22-3.21 Ga) of the Barberton Greenstone Belt where a thick sandstone bed on a superbly exposed stream-polished plate in the Eureka Syncline shows lateral variations in foreset laminae thicknesses, draped by mudstone partings. These have been interpreted as reflecting systematically varying strengths of tidal currents and analyzed quantitatively (Eriksson and Simpson, 2000). The obtained well-defined spectral peaks are thought to represent the oldest quantitative tidal record and to suggest that the anomalistic month (time from perigee to perigee) at 3.2 Ga was closer to 20 days than the present 27.5 days. Detailed mapping and section measuring of this site suggest that the sandstone bed in question is a migrating subaqueous dune formed within a wide erosional channel in a nearshore tidal complex between sandy and muddy intertidal flats. The reliability of measured foreset laminae thicknesses exposed over 20.5 m strike length is low because values are affected by small-scale faulting, uneven outcrop exposure, and vary with height above base. Repeated measuring failed to produce data sets with spectral peaks. Thus, while arguments from orbital mechanics strongly suggest a nearer Moon circling faster about a faster-rotating Earth and while some Moodies facies support hypertidal settings, quantitative constraints on Archaean Earth-Moon interaction remain to be established.

Control on large-scale sediment fluxes

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Various approaches exist to quantify sediment fluxes on medium to large scales. These are: (1) river loads, (2) terrigenous cosmogenic nuclides, (3) stratigraphically controlled sediment volumes, (4) negative volumes of dissected landscapes, (5) exhumation rates from thermochronological data. Upcoming of new methods (2, 5) and the idea of dynamic coupling of uplift and denudation led to intense application of these methods over the last two decades. Definitely, the wealth of new data revolutionized our picture of rates at which earth surface processes and uplift operate over space and time. Less straightforward, however, is the progress in interpreting the mechanisms controlling these rates and to define the state of a source-sink system in terms of steady-state or unsteady-state equilibria. This key note aims at highlighting some of these problems with respect to flux rates resulting from different methods and still hardly understood differences of their spatial distribution. Some examples and possible hypothesis will complete the talk and may stimulate further discussion in the session.

How can a “Super-LIP” break apart? – Indications from the crustal structure of the Manihiki Plateau, western Pacific

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The Manihiki Plateau is a Large Igneous Province (LIP) located in the western Pacific. It has been proposed that the Manihiki Plateau was emplaced as a part of the “Super-LIP” Ontong Java Nui by multiple magmatic phases during the Cretaceous Normal Superchron. The break-up of the “Super-LIP” caused the fragmentation of the Manihiki Plateau into three sub – provinces, which all exhibit individual relicts of the LIP break-up. We examined two deep crustal seismic refraction/wide-angle reflection profiles crossing the two largest sub-plateaus of the Manihiki Plateau, the Western Plateaus and the High Plateau. The modeling of P- and S-wave velocities reveals astonishing differences in the crustal structure between the two sub-plateaus. Whereas the High Plateau shows a constant crustal thickness of 20 km, relicts of multiple volcanic phases and break-up features at its margins, the models of the Western Plateaus reveal a Moho depth decreasing from 17 to 9 km. There is only little evidence of secondary phases of volcanic activity. Therefore, the main morphological structures on the Western Plateaus are fault systems and sedimentary basins. These significant differences in the crustal structure infer, that the initial break-up of the “Super-LIP” can be further constrained by the tectonic and magmatic activity exposed on the Manihiki Plateau. We therefore postulate that the initial break-up was characterized by rifting between the Hikurangi and the Manihiki Plateau with little crustal stretching, while massive crustal stretching occurred in the area of the break-up towards the Ontong Java Plateau along with rotational forces. These findings contribute to a better understanding of the plate-tectonic framework of the Pacific Ocean during the Cretaceous Normal Superchron, and the role of Large Igneous Provinces in this plate circuit.

Hf-Nd and trace element constraints on granitoid-greenstone relationships of the >3.46 Ga Dwalile Greenstone Belt, Ancient Gneiss Complex (Swaziland)

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The Dwalile Greenstone Belt (DGB) is the largest supracrustal enclave within the 3.20-3.66 Ga Ancient Gneiss Complex (AGC) of Swaziland. It comprises amphibolites, ultramafic rocks, meta-andesites and metasediment units, including BIF. Structurally underlying the greenstones, the adjacent trondhjemitic gneisses were dated to 3521±23 Ma and contain inherited zircon xenocrysts of up to 3.7 Ga [1]. The minimum age of the supracrustal units is given by intrusive tonalites dated at 3.46 Ga, and this suggests correlation with supracrustal units of the Barberton Greenstone Belt (BGB) farther northwest. In Harker diagrams, amphibolites and serpentinites of the DGB overlap with those of the BGB Komati Fm. and the ca. 3.50 Ga Schapenburg greenstone remnant. The amphibolites have island-arc like trace element patterns with Th and LREE enrichment as well as negative Nb-Ta and Ti anomalies. The ultramafic rocks chemically overlap with those of the Komati Fm. Nb-anomalies are correlated with SiO_2, MgO and La/Yb, suggesting crustal contamination rather than a subduction origin. Initial ϵHf values of the amphibolites range from -9 to +2.9 and for the ultramafic rocks from -0.3 to +3.1, respectively, whereas most samples fall in the range of +1.2 - +2.3. Initial ϵNd

values of the amphibolites and ultramafic rocks are near- chondritic, indicating that a possible contaminant had a similar isotopic composition. Combing the best-preserved amphibolite and ultramafic samples yield a Lu-Hf isochron of 3502 Ma ±79 Ma (MSWD: 7.3) and a Sm-Nd isochron of 3507 ± 71 Ma (MSWD: 3). Significant scatter of data defining these regression lines either reflects disturbance of the Hf-Nd isotope systematics or contamination with older felsic crust. References: [1] Kröner, A., Tegtmeyer, A., 1994. Gneiss-greenstone relationships in the Ancient Gneiss Complex of southwestern Swaziland, southern Africa, and implications for early crustal evolution. Precambrian Research 67, 109-139.

The geological signatures of extreme wave events within the archaeological record – examples from the coastline of the Arabian Sea.

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The Arabian Sea is regarded as one of the least studied regions in terms of coastal hazards such as storm surges and tsunamis. The Makran Subdution Zone (MSZ) is the dominating structure in the Arabian Sea. Here the Arabian Plate is subducted beneath the Eurasian Plate. The seismicity of the MSZ is comparatively low. The coastlines of the Northern Indian Ocean (NIO) are only sparsely populated. Therefore, the recurrence interval of large tsunamigenic earthquakes (MW>8) is unknown. We aim at reconstructing the Holocene tsunami history of the NIO by utilising archaeological evidence as the coastline of Oman is rich in archaeological remains. Besides tsunamis, storm induced extreme wave events are know to have effected the coast in the past. We analysed the sediments left behind by an extreme wave event within an Early Bronze Age settlement site at the easternmost tip of the Arabian Peninsula. We have evidence that the site was inundated at 4450 cal. BP and immediately re-occupied after the event, which attests to a certain resiliences of the Early Bronze Age coastal communities in the region.It is concluded that the causative event must have been a tsunami that was most likely generated within the MSZ. A severe inundation event can also be reconstructed for a recently discovered Early Islamic (1000 cal BP) site located close to Muscat. Here, thousands of pottery sherds, partly imported from neighbouring countries, indicate the presence of an important settlement. Sedimentological investigations support the inundation hypothesis. Block and boulder deposits along the entire coastline furhter support the timing of the event. We conclude that the archaeological record serves as a good archive for extreme wave events as the preservation potential appears to be good. Furthermore, the material culture associated with the events deposits usually allows a precise dating of the event.

Modelling prehistoric terrain Models using LiDAR-data - a geomorphological approach

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Terrain surfaces conserve human activities in terms of textures and structures. These surface properties can be observed easily in digital terrain model (DTM). Currently, there are different filter algorithms available for removing these structures (e.g. Vosselman). Recent surface structures, such as crop lands and settlements, get well preserved in some cases, while anthropogenic artefacts have partial elimination. The objective of geomorphological filters is to distinguish between anthropogenically undisturbed and disturbed surfaces. Filters applied over high-resolution DTM show a clear anthropogenic characters of contour lines and channels. The land features from these filters may be mislead with anthropogenic artefacts and natural one. The presented workflow uses functionalities of ArcGIS and the programming language R. The method starts with the extraction of contour lines from the digital terrain model. Through macroscopic analysis based on geomorphological expert knowledge, contour lines are selected representing the natural geomorphological surface. These selected contour lines pass through a 2 stage process. In a first step, points are determined along each contour line in regular intervals. This points and the corresponding height information from an original DTM is saved as a point cloud. Using the programme library gstat in R (cf. Pebesma) a variogram analysis is done, followed by Kriging. The result is a filtered DTM that considers expert geomorphological knowledge and shows no human degradation in terms of artefacts, also preserving the landscape-genetic character and hence called as prehistoric terrain model. For archaeology, this method offers an excellent approach to reconstruct ground surfaces. This method seems equally helpful for all scientific areas, which utilize the relief as a research object and which rely on context-based processes of filtering. The method allows both, the removal of disturbing factors, as well as the inclusion of simulated disturbances as required for risk analysis.

Canonical Element Ratios as Tracers of Mantle Circulation – a Reassessment

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Trace element ratios of oceanic basalts that reflect the respective mantle-source ratios, now known as canonical ratios, were originally defined by their perceived uniformity in MORBs and OIBs (e.g. Hofmann et al., 1986). However, OIBs in particular are heterogeneous, not only in their isotope ratios but also their canonical ratios. Moreover, because OIB data are derived from a small number of hotspots, any claim that a given trace element data set is representative of "average" OIB is a priori questionable. This introduces an element of circularity into the determination of "canonical" ratios. In contrast, global MORBs, while not homogeneous, yield a much more coherent and globally representative data set, which can be assessed by statistically valid methods. To escape the trap of circularity, I reassess canonical ratios, particularly those involving Nb, Ta, W, Pb, Ti, and K, using recently published, high-quality data sets of globally representative MORBs only, in order to use them as an independent basis of comparison with the respective OIB ratios. These ratios clearly reflect source ratios, contrary to some published assertions of the opposite. Remarkably, perhaps coincidentally, the purely MORB-based canonical values for Ce/Pb and Nb/U are nearly identical to those published in 1986. Minimal improvements include replacement of Nb/U by Ta/U as an optimal canonical ratio. Also, the effect of plagioclase fractionation in potentially falsifying Ce/Pb ratios in MORBs, while not negligible, is shown to be remarkably small. The MORB-based canonical ratios can serve as an independent basis for evaluating equivalent ratios in OIBs, which are more variable, not only in isotopically extreme OIB groups, such as the Samoan Islands, but also in more "ordinary" OIBs such as Iceland or Hawaii. When combined with isotope data, canonical ratios can thus provide a much richer picture of the nature of OIB sources than isotope ratios alone.

Reconstructing Miocene climate history from Pacific deep sea sedimentary archives

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Keynote in Session A6-03

During the Miocene, Earth's climate transitioned from a relatively warm phase (Miocene Climatic Optimum, MCO, ∼17–14.7 Ma) into a colder mode with re-establishment of permanent ice sheets on Antarctica after ∼14 Ma, thus marking a fundamental step in Cenozoic cooling. To date, comparatively little is known about the processes sustaining global warmth and about the chain of events that reversed this trend. Hypotheses focused on changing gateway configurations and atmospheric carbon dioxide concentrations, and most scenarios invoked carbon sequestration ending Miocene warmth. We integrate benthic stable isotope and XRF-scanner derived elemental data in continuous, well-dated successions recovered from Ocean Drilling Program and Integrated Ocean Drilling Program sites to explore the role of Pacific circulation changes during the MCO and transition into the "Icehouse" mode. Our records show that the MCO was characterized by high-amplitude climate variations, paced by southern hemisphere insolation maxima. Carbonate dissolution proxies additionally reveal that peak warmth episodes coincided with transient shoaling of the carbonate compensation depth and enhanced dissolution in the deep ocean, supporting a crucial role for the marine carbon cycle as climate regulator. From ∼14.7 Ma, a new pattern of climate variability emerges with dampening of the benthic oxygen isotope signal and shortening of the dominant rhythm from 100 to 41 kyr. This change also concurs with a general improvement in carbonate preservation and the onset of stepwise global cooling, culminating with extensive ice growth at ∼13.8 Ma. Comparison of carbon isotope profiles reveals an increasing offset between deeper and shallower locations starting at ∼14.6 Ma and intensifying after 13.8 Ma, as carbon isotopes become increasingly depleted at the deeper Pacific sites. This divergence suggests that enhanced stratification promoted carbon storage in the deep ocean, thus fostering global cooling.

Evidence for cavity-dwelling life in 3.2 Ga tidal deposits (Moodies Group, Barberton Greenstone Belt, South Africa)

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Cavities in sediments along coastlines were ideal habitats for life on early Earth because organisms found protection there against the intense Archean UV radiation and desiccation. However, the earliest evidence of cavity-dwelling microorganisms (coelobionts) has been found in Neoarchean strata. Here we present the results of a detailed investigation of early-silicified cavities occurring in the oldest well-preserved siliciclastic tidal deposit, the 3.2 Ga Moodies Group of the Barberton Greenstone Belt (South Africa). We found that downward-growing microstromatolites comprised of kerogenous laminae are commonly present in planar, bedding-parallel, now silica-filled cavities that formed in sands of the peritidal zone as decaying microbial mats evolved gas. δ^{13}CVPDB values of the kerogen, measured in situ with an ion probe, range from -32.3 ‰ to -21.3 ‰ with a mean value of -26.5 ‰. Such values are consistent with a biotic origin of the kerogen and also within the range of photosynthetic microorganisms. Scanning electron microscopy (SEM) investigations of the cavities showed

well-preserved filamentous microstructures and molds that we interpret as fossil microbial remains. The geological context, the morphology of the microstromatolites, the $\delta^{13}C$ composition of the kerogen, and the presence of microfossils all suggest that a microbial community inhabited the cavities. Our results extend the geological record of coelobionts by 0.45 Ga, supporting the view that cavities were among the first ecological niches to have been occupied by early microorganisms.

Morphological adaptations of 3.22 Ga-old phototrophic microbial mats to Archean coastal habitats (Moodies Group, Barberton Greenstone Belt, South Africa)

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Microbial mats of the 3.22-3.21 Ga-old Moodies Group, the uppermost unit of the Barberton Greenstone Belt (ca. 3.57-3.21 Ga), represent one of Earth's oldest macroscopic ecosystems and yield key information on early biosphere adaptation and Earth's atmospheric oxygenation. The fossil mats are exposed largely on the overturned limb of a major syncline over ~15 km strike length within ca. 1000 m thick, fine- to coarse-grained tidal-facies sandstones and estuarine conglomerates. They are preserved as abundant kerogenous laminae 0.5 to 1 mm thick with $\delta^{13}C$ values of -21.2 to -33.9‰. Mat morphology (planar, wavy, and tufted), the association and distribution pattern of distinct microbial-mat-related structures, and comparisons with modern analogs allow to refine their paleoenvironmental setting: Planar mats are typical of the coastal floodplain zone; tufted microbial mats are restricted to the upper inter- to supratidal zone (where they are commonly associated with shrinkage cracks, gas domes, and extensive gas- or fluid-escape structures); complex wavy-crinkly mat morphotypes, microbial domes, and mat chips are characteristic of the intertidal zone. The subtidal zone appears to be devoid of in-situ microbial mats. Moodies microbial communities had optimum growth conditions in the photic zone under moderate water agitation and flourished within extensive, mechanically abrasive, medium- to high-energy shoreline environments. The three distinct mat morphotypes apparently represent an adaptation of phototrophic microbial communities to frequently changing physiochemical conditions in these habitats. Importantly, the tufts suggest a high level of coordinated microbial growth which is commonly only known from modern cyanobacterial mats.

Feedback cycles in planetary evolution including continental growth and mantle hydration

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The evolution of planets with plate tectonics is significantly affected by several intertwined feedback cycles. On Earth, one of these feedback loops includes the cycling of water in the mantle. Water is transportet into the mantle at subduction zones and outgassed at mid-ocean ridges. In the Earth's mantle, water reduces its viscosity, and therefore increases the speed of mantle convection and plate subduction, eventually increasing the rates of mantle water regassing and outgassing. A second feedback loop describes the production and erosion of continental crust. Continents are formed in subduction zones, whose total length is determined by the fraction of continental crust. Furthermore, the fraction of continental crust determines the amount of eroded sediments. These sediments eventually enter subduction zones and affect the production of new continental crust. Both feedback loops affect each other: As a wet mantle increases the speed of subduction, continental production speeds up. On the other hand, the total length of subduction zones and the rate at which sediments are subducted (both being functions of continental coverage) affect the rate of mantle water regassing. A system that includes both cycles develop stable and unstable fixed points. We couple these feedback cycles to a thermal evolution model that reproduces present day observations. We show how the Earth has been affected by these feedback cycles during its evolution, and argue that the present day state of the Earth regarding mantle hydration and continental coverage might actually be unstable.

Characterization of amorphous contents in brown coal fly ash

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Multiple samples of brown coal fly ash (BCFA) were analyzed chemically and by X-ray diffraction. The crystalline and amorphous mineral phases were quantified by Rietveld refinement, using the internal standard method. The contents of mineral phases and the amorphous phase were verified, creating regression lines of admixtures with an increasing amount of inherent mineral phases. In the light of thermodynamic modeling of hydration of BCFA, the chemical composition of the amorphous content has to be characterized. The composition of the amorphous phase was calculated by subtraction of the calculated chemical composition of the quantified crystalline phases of the determined composition of XRF analysis of the BCFA samples. This calculated content of Al_2O_3 (10,4 - 22,6 wt%), SiO_2 (27,7 - 56,4 wt%), Fe_2O_3 (8,1 - 23,5 wt%), MgO (0,7 - 3,2wt%) and CaO (11,2 - 25,6 wt%) correlates with XRF analysis. The BCFA were treated with HCl in increasing concentrations. The residues were analyzed by XRF and X-ray diffraction with Rietveld-quantification. The compositions of the amorphous content in the residues were calculated. The calculated composition of amorphous phase in the residues shows a trend of the amorphous phase to Al_2O_3 and SiO_2 with less CaO and Fe_2O_3 and less reactivity. EDX analysis of amorphous content shows a broad range of compositions, caused by intense intergrowth of phases. The amorphous phase consisting of Al and Si shows a content of K up to 5%. This composition corresponds to an eutectic point of the system K_2O-Al_2O_3-SiO_2 [OSBORN E.F., MUAN A., 1960] and supports the evolved composition of amorphous phase in the solution experiments.

Osborn E.F and Muan A. (1960): Phase equilibrium diagrams of oxide systems, plate 5. Phase diagrams for ceramists, published by Levin E.M, Robbins C.R., McMurdie H.F., The American Ceramic Society, INC., 1964

Fate of Mesozoic Tethyan slabs in the deep mantle

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The structure of the mantle beneath the North Africa and the Mediterranean reflect a long history of subduction within the Western Tethys, dating back to the Jurassic. The regional tectonic and geodynamic evolution is well studied for the Cenozoic, where velocity anomalies imaged by seismic tomography provide a crucial link between the surface plate tectonic history and mantle dynamics. The Mesozoic history is less well understood, with starkly contrasting geodynamic scenarios proposed. Here, we explore the relationship between Tethyan subduction history and global mantle flow since the Early Jurassic with a particular focus on the poorly constrained pre-Cenozoic tectonic history. We use a series of geodynamic models with different boundary conditions and alternative plate reconstructions for the Tethyan realm, and compare the predicted lower-mantle slab volumes to seismic tomography. We find that a model case with intra-oceanic subduction of the Vardar Ocean during the Middle Jurassic to Early Cretaceous, and Cretaceous subduction of Alpine Tethys Oceans, better reconcile observed velocity anomalies than model cases without intra-oceanic subduction, or with uninterrupted subduction along the Eurasian margin since the Jurassic. Our results also favour the inclusion of Neotethyan intra-oceanic subduction between Arabia and Eurasia. Significant lateral displacement of slab material predicted by our models helps to reconcile surface kinematics with observed fast seismic anomalies beneath Northwest Africa.

Rudist bivalve versus bulk carbonate chemostratigraphy: towards an improved chronostratigraphy of Urgonian carbonate platform demise in the run-up to the Oceanic Anoxic Event 1a

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Deep-time shallow marine carbonate platform ecosystems have been proven to show distinct biotic responses to climate and environmental stressors. In particular in the run-up to the Early Aptian Oceanic Anoxic Event (OAE) 1a, subtropical carbonate platforms in the Tethyan and Atlantic Oceans recorded transient mass occurrences of opportunistic taxa or suffered repeated drowning episodes. Unfortunately, precise stratigraphic assignment of these biotic response modes is often complicated if not impossible due to a poor biostratigraphic control and/or a significant diagenetic overprint of the neritic bulk carbonate chemostratigraphic inventory. An accurate stratigraphic framework, however, is essential to better understand the causal relation between biotic events recorded by carbonate platforms and environmental changes culminating in OAEs. Here, we provide an integrated carbon-and strontium-isotope stratigraphy of the Early Cretaceous subtropical Provence carbonate platform that is solely based on pristine rudist bivalve shells. In contrast to bulk carbonate material, the outer low-Mg calcite shell layer of rudists is relatively resistant against diagenetic alteration and therefore serves as substrate for isotope and trace elemental analyses. The obtained characteristic carbon- and strontium-isotope pattern allows for a precise correlation with stratigraphically well-constrained Tethyan shallow-water and hemipelagic reference sections (Cluses, Angles). Based on this correlation, the Sausset and Martigues section in southern Provence contain a stratigraphic gap of at least 1.2 Myr, spanning large parts of the Upper Barremian. Moreover, the revised bio-chemostratigraphy of this part of the Provence platform provides first evidence for a synchronous demise and break-down of Northern Tethyan carbonate platforms in the run-up to the Oceanic Anoxic Event (OAE) 1a.

Depth-dependent extension, two-stage breakup and depleted lithospheric counterflow at rifted margins

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Uniform lithospheric extension predicts basic properties of non-volcanic rifted margins but fails to explain other important characteristics. Significant discrepancies are observed at 'type I' margins (such as the Iberia–Newfoundland conjugates), where large tracts of continental mantle lithosphere are exposed at the sea floor, and 'type II' margins (such as some ultrawide central South Atlantic margins), where thin continental crust spans wide regions below which continental lower crust and mantle lithosphere have apparently been removed. Neither corresponds to uniform extension. Instead, either crust or mantle lithosphere has been preferentially removed. Using dynamical models, we demonstrate that these margins are opposite end members: in type I, depth-dependent extension results in crustal-necking breakup before mantle-lithosphere

breakup and in type II, the converse is true. These two-layer, two-stage breakup behaviours explain the discrepancies and have implications for the styles of the associated sedimentary basins. Laterally flowing lower-mantle lithosphere may underplate both type I and type II margins, thereby contributing to their anomalous characteristics.

Boron isotope geochemistry of pore water fluids sampled across the active Nankai Trough subduction zone forearc

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Pore water geochemistry is a valuable tool to decipher water-rock interaction and fluid flow. In particular the study of pore waters sampled from subduction zones sediments at shallow subseafloor depths has shown that dehydration of clays during diagenesis is a key process in many sediment-dominated subduction zone forearcs and revealed migration of deep sourced fluids to the seafloor along permeable pathways. To investigate water-rock interaction and fluid migration in the active Nankai Trough subduction zone (SW Japan) we analyzed the boron concentration and B isotope composition of pore fluids sampled during four Integrated Ocean Drilling Program (IODP) Expeditions across the subduction zone forearc. The samples originate from four major structural regimes down to a depth of ~922 mbsf: (1) sedimentary input, (2) frontal thrust zone, (3) megasplay fault zone, and (4) forearc basin. When normalized over the conservative Cl, we notice that the B loss is remarkably similar for all sites, whereas δ^{11}B values scatter in the range of +15.2‰ and +49.2‰. We suggest that ash alteration and organic matter degradation are the major processes that control the observed B concentration and δ^{11}B pattern. However, the presence of volcanic ash layers close to the bottom of the investigated wells suggests that ash alteration also plays a role in deeper buried sediments in the accretionary prism. Enrichment of B observed at the tip of the megasplay fault zone and along silt and sand layers in the underthrust section of the sedimentary input suggest that those fluids are deeply sourced in the accretionary prism. We propose that the deep fluids are partially sourced in depths equivalent to 150-400°C (i.e., ~6-35 km subbottom depth), and that its δ^{11}B signature evolves during updip migration through mixing, illitization and re-adsorption as a function of fluid flow velocity.

Regionalization of groundwater levels along the Tarim River in North West China as precondition for a sustainable management of water resources

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Poster in Session B4-03

Within the Sino-German project SuMaRiO a Decision Support System will be developed, in order to support a sustainable water management in the Tarim River Basin in Xinjiang, north-west China, in the future. The elevation of the groundwater table is the most important quantity for determining agricultural yield, natural vegetation growth and land degradation due to salinization. However, due to poor data conditions a large-scale simulation of the groundwater in an area of about 30,000 km^2 encounters big challenges. Thereby, the current groundwater table must be assessed and the effects of future development have to be investigated. For this purpose a new regionalization method was elaborated, which is based on several coherent sub-projects conducted by the SuMaRiO partners. The final aim of the regionalization is to establish functional relations

between different land cover types and their effect on yearly water demand, contribution to groundwater recharge and salinization status. The first of four major stages were local measurements of groundwater elevations and salt concentrations, which were used in a second step to calibrate four small-scale water balance models along the river in MIKE SHE or MODFLOW. These local water balance models were analyzed and regionalization characteristics were derived. The next step was the application of this regionalization method for building up two large-scale groundwater models. Thereby, a first model simulates the water consumption in the upper and middle reaches. Subsequently, the remaining residual water provides the input for a second groundwater water model representing the lower reaches. In the last step, regionalization characteristics and dependencies were derived and transformed into functional relationships. The successive information exchange between the different scales enabled a reliable simulation of the groundwater table in the entire Tarim River Basin.

In situ deformation of olivine in the transmission electron microscope: from dislocation velocity measurements to stress-strain curves

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There is a growing consensus to recognize that rheological law established for olivine at high-temperature (ca. >1000°C) fail when extrapolated to low temperatures relevant for the lithospheric mantle. Hence it appears necessary to fit rheological laws against data at low temperatures where olivine tends to become more and more brittle. The usual approach consist in applying confining pressure to inhibit brittleness. Here we propose an innovative approach based on the use of very small samples and numerical modeling. New commercial in situ TEM nanotensile testing equipment recently developed by Hysitron.Inc is combined with weak-beam dark-field TEM diffraction contrast imaging in order to obtain information on the elementary mechanisms controlling the plasticity of olivine: namely glide of [001] screw dislocations. The olivine tensile beams dedicated for in situ TEM nanomechanical testing were produced using microfabrication techniques based on MEMS-type procedures. The testing geometry was designed as to induce maximum resolved shear stresses on the [001](110) slip system. Under tensile loads between 2 and 3 GPa, ductile behaviour was reached with the development and propagation of dislocation loops across the sample allowing to measure the velocity of screw and non-screw dislocations as a function of stress. This information is introduced into a numerical model involving Dislocation Dynamics in order to obtain the stress-strain curves describing the mechanical response of olivine single crystals deformed in tension at room temperature.

Holocene sedimentation in the barrier reef lagoon of Bora Bora, Society Islands (French Polynesia), South Pacific

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Bora Bora is an oceanic barrier reef system with a 40 m deep lagoon surrounding a volcanic island. Such lagoons have a great potential as archives of short-term paleo-environmental change and event deposition. Using shallow reflection seismic data as a guideline, twenty-one vibrocores up to 5.04 m long were collected. Sedimentological, textural and chemical analyses and radiocarbon dating were used to detail

Holocene sedimentation patterns and to identify possible event deposits. Seismic profiles show that Holocene sediments are up to 10 m thick. Drift deposits are common in the deepest lagoon parts. Holocene sediments overlie a Pleistocene karst topography with small incised valleys and patch reefs. Lagoonal successions in cores comprise Pleistocene soil and overlying peat and muddy carbonate sediments. Peat is dated to 9.4 kyrs BP, marking the initial flooding of the rising Holocene sea. After a hiatus, carbonate sedimentation began during 8.7-5.4 kyrs BP and has been continuing during the Holocene. Sedimentation rates range from 0.5-0.9 m/kyr. Lagoonal carbonate sediments contain 7-15% siliciclastics and organic material on average, with a slight decreasing trend upcore. Six facies characterize the lagoonal succession during the Holocene, based on quantitative analysis. The western lagoon is dominated by mollusk-foraminifer packstones, mollusk-rich wackestones and mollusk-foraminifer mudstones (from base to top). The eastern lagoon is characterized by wackestones overlain by foraminifer-algae wackestones and foraminifer-mollusk-peloid mudstones. First results of high-resolution grain size analyses indicate event deposition around 2.5 kyrs BP. This core section with coarser-grained layers might correlate with overwash deposits found in nearby Tahaa that accumulated during a period of elevated cyclone activity during 2.9-0.5 kyrs BP. Ongoing analyses and additional age data will help to constrain and extend the results summarized here.

Limits of Earth

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An objective survey of the energy resources and energy fluxes demonstrates that for 7 billion (or a bit more) people 2 kW/P (per person) can be supplied sustainably, without ruining land and sea. Much more would, however, result in just that. 2 kW/P is the current average primary energy consumption, but with large inequality (<0.5 to >10 kW/P). How can a satisfactory state of world population be reached? (1) Further growth must end: Prosperity without growth! (2) Inequality and injustice are reduced, otherwise no peace: the rich become more moderate and help the poor to raise their standards: moderate prosperity for all! (3) Intelligent supply systems based on sun, wind, other secondary solar energy forms and geothermal heat are urgently developed: intelligent prosperity"! Is all that realistic? "Realists" believe in market-driven development. But there have never been unreglemented markets. If we want to sustain Earth as a humane human habitat, we cannot exploit the whole planet forever and must adapt to the renewable energy fluxes. Anything else is a cynical illusion.

First Petrological-Geochemical results from SO-232 (SLIP) at the Mozambique Ridge (SW Indian Ocean)

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The SO-232 cruise took place in April-May 2014 at the Mozambique Ridge, a presumably 120-140 Ma-old submarine volcanic plateau located in the SW Indian Ocean. The major goal of this multidisciplinary project is to better understand the formation of the Mozambique Ridge, in relation to the opening of the Southern Ocean and the break-up of the Gondwana supercontinent. Three different models have been proposed for the origin for this plateau: 1) a continental fragment split off during the break-up of Gondwana, 2) an independent microplate, or 3) an oceanic Large Igneous Province (LIP). Our studies aim to characterize age and geochemical composition of magmatic samples in order to reconstruct the nature, origin, and spatial and temporal evolution of the plateau. The rock sampling mainly yielded basaltic lava (SiO_2 = 47-52 wt. %) indicating a volcanic origin of the plateau. Bathymetry data show small cones scattered on the plateau, which represent the latest stage of volcanism. The samples form tight correlations with fluid-immobile trace elements ratios such as Nb/Yb and Th/Yb. Most of the samples have relatively flat REE pattern. A few, however, show steeper Heavy REE patterns, indicating a more enriched source or lower degrees of mantle melting. The REE patterns are consistent with a LIP origin of the plateau basement and a less voluminous, younger phase of volcanism. Sr and Nd isotope ratios extend from present-day South Indian mid-ocean-ridge basalts (MORB) and ocean island basalts (OIB) to slightly more enriched values. Preliminary age correction improves the Sr-Nd isotope correlation, and thus superimposed alteration effects can be excluded. On the $^{207}Pb/^{204}Pb$ versus $^{206}Pb/^{204}Pb$ isotope diagram, the samples extend to higher $\Delta 7/4$ than the South West Indian array and overlap the South Atlantic MORB field. This observation implies that initial opening of the SW-Indian Ocean was rather influenced by South Atlantic than Indian MORB mantle.

Thermo-Hydro-Mechanical numerical modelling for faulted geothermal reservoir systems: case study of the Groß Schönebeck reservoir

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Significant pressure and temperature changes can occur within geothermal reservoirs caused by the injection and production of fluid which can affect transport properties of the rocks and therefore alter reservoir performance and sustainability. To understand the coupling between transport properties evolution and state variable changes, a complete description of the mechanical behaviour of the reservoir is required which should consider thermo- and poroelastic effects. This study aims to integrate transport properties evolution for coupled thermo-hydro-mechanical (THM) processes modelling of fluid-bearing reservoirs. In addition, attention is given to the integration of geological complexity (fault geometry or anisotropic formations) into coupled THM processes modelling. This approach has been applied to the geothermal research site of Groß Schönebeck (40 km north of Berlin, Germany) which consists of a doublet system at a target depth of about -4100 m in which both injection and production wells have been hydraulically stimulated. A 3D reservoir model including all geological layers, major natural fault zones and hydraulic fractures is integrated in the finite-element method-based simulator for modelling coupled THM processes during geothermal activity. The results presented here provide therefore valuable insights for understanding the porosity and permeability distributions and their evolution during geothermal energy production and their impacts on reservoir performance. Numerical simulations allow to quantify porosity and permeability enhancements due to injection of cold water. In this context, thermal breakthrough time of the geothermal system has been found to occur at 18 years after the start of injection by numerical simulations. Current work is focused on integrating new processes related to fault mechanics to better describe the dynamic evolution of geothermal reservoirs and especially of fault slip behaviour during geothermal activities.

Geochemical differentiation of barite vein-type mineralization in the Ilfeld Basin, Harz Mountains, Germany

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Poster in Session B2-02

Several appearances of vein-type mineralization have been investigated in the Ilfeld Basin, which is known for Fe/Mn- oxide as well as Cu-Ni-(Co) deposits that have been mined in historical times. Thereby this study focuses on three localizations in the Ilfeld Basin: the Gnade Gottes mine, a former mine at the Hummelkopf and the former mining district of the Braunsteinhaus. Investigations include mapping, sampling, microscopic and geochemical analyses. The "Gnade Gottes mine", nowadays called "Lange Wand", has been investigated since 2014 and two different types of barite veins have been recognized as well as a subordinate ankerite/calcite mineralization. All types are hosted in the Kupferschiefer and its adjacent strata (Rotliegend rhyolite/sandstone and Zechstein carbonates). Both barite occurrences are bearing iron and manganese (hydro)-oxides. Macroscopic and microscopic investigations show two different appearances of barite in both vein-type mineralizations. Barite mineralization at the Hummelkopf occurs as much thicker veins without any sulfidic ores, but some iron and manganese (hydro)-oxides have been identified in the veins. It only occurs within the Rotliegend rhyolite. The vein-type mineralization at the Braunsteinhaus mainly show iron and manganese (hydro)-oxides with sometimes very nice, macroscopically identifiable manganese crystals, e.g. manganite (MnO(OH)) and pyrolusite (MnO_2) in some places. The veins are located in the Rotliegend rhyolite host rocks and contain barite or calcite as gangue minerals. Due to structural and mineralogical similarities, all three locations have been investigated and compared. Thereby the focus of this study lies in the differentiation of different generations of barite. Thus geochemical analyses on the different barite types have been conducted, focusing on the Ba/Sr- ratio to identify and verify the macroscopic investigation. Furthermore the barites are analyzed by cathode luminescence.

"Geological elevators"? – the example of a Muschelkalk block surrounded by Zechstein next to the Sontra Graben (NE Hesse)

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NE Hesse is characterised by a variety of ESE-SE striking inverted narrow grabens and basement uplifts crossed by NNE striking complex grabens (e.g. Leinetal Graben) with kinematics still not well understood. Enigmatic features are i.e. allochthonous Middle Triassic blocks of a few tens to hundreds metres in diameter which are surrounded by Zechstein with unknown geometrical relationship. The underconstrained geometry led to divergent views on the kinematics of these structures. Möbus (2004) explained them as relicts of half-grabens whose listric master faults emplaced Muschelkalk (MK) of the hanging-wall on a footwall flat in Zechstein (Z) strata. He envisaged the extension to be caused by strike-slip faults in the basement. We concur on the importance of thin-skinned extension but prefer to explain most of the complex structures as a result of inversion tectonics along faults with mainly dip-slip characteristics. We discuss the kinematics of such a "geological elevator" and its relation to nearby structures based on a model (build from DGPS & Hi-Res. image data) of a quarry in an allochthonous lower MK-block within Z successions. Structural analysis show N-S to E-W directed extension recorded by normal faults and calcite veins. Axes of open folds trend NNE, but another fold set is tight, has SE-trending axes and a marked SW vergence, consistent with the shortening direction in the Sontra Graben. We explore the working hypothesis that the MK-block is wedged into a NE-dipping fault, formed as an important normal fault emplacing the MK on Z of the footwall and now representing the bounding fault of the Sontra Graben. Subsequent reverse motion returned the Buntsandstein approx. to its pre-extension position, but the lens of MK remained attached to the footwall, still marking the magnitude of extension. Möbus, H.-M. (2004). Allochthone Triasschollen am Unterwerrasattel als Schlüssel zum Verständnis saxonischer Grabentektonik. – Diss. Universität Marburg, 197 S.

Challenges within the project TUNB

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Poster in Session B5-02

From 2013 to 2014 the project Brandenburg 3D was realized by the geological survey of Brandenburg with assistance of the German Research Centre for Geosciences and private companies. Within this project a variety of analog data, e.g. drilling reports and seismic data from the petroleum exploration in the former GDR, were digitized. On the basis of these data a comprehensive 3D subsurface model for the deep underground of Brandenburg was developed. In the future this model shall be used to overcome issues concerning the utilization of the deep subsurface. Within the project TUNB the existing subsurface model shall be enhanced. Therefore intensive research and digitization activities are carried out at the LBGR to transfer unprocessed seismic investigation campaigns and geophysical well-loggings into the current state of knowledge. Additional data from actual exploration activities will be used as well. Because of the long period during the investigations were carried out, as well as the development of new technologies and the improving level of knowledge about the deep underground, the mapping of seismic interfaces in the profiles is not consistent over the territory of Brandenburg. To obtain a consistent data base for further 3D modeling, the digital seismic profiles of 1960s up to 1990s are checked and if necessary, corrected, by using new stratified boreholes. For this purpose, different (semi-) automatic procedures and workflows are developed and tested. Another challenge arising in the context of the TUNB project is the correlation of the model developed for Brandenburg with the models of the neighboring federal states (Mecklenburg-Western Pomerania, Sachsen-Anhalt and Lower Saxony). Therefore the different databases and data definitions (e.g. local definition of seismic interfaces and stratigraphic boundaries) need to be compared and merged, to develop a consistent 3D subsurface model.

Is there any correlation between continents and elevated temperatures in the subcontinental mantle?

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Poster in Session A4-01

Rolf et al. (EPSL, 2012) and Coltice et al. (Science, 2012) have previously shown that continents exert a first order influence on Earth's mantle flow by affecting convective wavelength and surface heat flow. However, how continents influence the development and location of mantle plumes remains a topic of considerable debate. Continental motion is attributed to the viscous stresses imparted by the convecting mantle and the extent of this motion depends on the heat budget of the mantle. Core-mantle boundary (CMB) heat flux, internal heating from decay of radioactive elements, and mantle cooling contribute to this heat budget. Out of these sources, CMB heat flux is not well defined. However, the recent determination of core's high thermal conductivity requires a CMB heat flow of at least 12 TW (de Koker et al., PNAS 2012; Pozzo et al., Nature 2012; Gomi et al., PEPI 2013). Thus it is necessary to characterize the impact of basal heating on mantle dynamics with continents and self-consistent plate tectonics. By systematically varying parameters such as CMB temperature, continental size, mantle heating modes (basal and internal), and Rayleigh number; we model Boussinesq, incompressible, thermo-chemical mantle convection using StagYY (Tackley, PEPI 2008). We observe correlation between continents and elevated temperatures in the subcontinental mantle irrespective of the variations in basal heating and continental size (except for very small continents). Moreover, with increasing Rayleigh number, correlation still exists with episodes of anticorrelation. We will also show first results for continental growth as opposed to having prescribed continents in StagYY.

Exploration and Resource Potential of the Semyenov Vent Fields, on the 13°30' Oceanic Core Complex, Mid-Atlantic Ridge

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Oral in Session B2-01

Seafloor hydrothermal circulation is commonly associated with oceanic core complexes (OCCs) that form on slow- and ultraslow-spreading mid-ocean ridges. To date, hydrothermally-derived seafloor massive sulfide (SMS) deposits have been found on all OCCs on the Mid-Atlantic Ridge (MAR) that have been investigated in detail, making OCCs a primary target for further exploration for SMS deposits. The Semyenov vent field cluster, located on the 13°30' OCC on the MAR, is known to host four inactive and one active hydrothermal field, and may contain one of the largest known SMS deposits found on the modern seafloor. Here, we present results from recent high-resolution autonomous underwater vehicle (AUV) mapping and remotely-operated vehicle (ROV) observations of the Semyenov deposits, as well as petrographic and geochemical analyses of sulfide samples collected from the deposits. Integrated analysis of the high-resolution mapping, ROV observations, and mineralogical and geochemical data are used to evaluate the resource potential of the Semyenov vent fields, including tonnage estimates and contained base and precious metal contents, and the implications of these estimates for the exploration and resource potential of other SMS sites along slow-spreading mid-ocean ridges. The relationship between the variable morphology of the individual deposits is interpreted in the context of local volcanic and deformation features associated with the OCC. The degree of surface oxidation and degradation of exposed sulfide material at the inactive sites provides insights into the preservation of extinct SMS deposits on the seafloor.

The cold-climate origins of Scandinavian mountain plateaux

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Climatic versus tectonic explanations for Scandinavian topography have sustained a dispute dating back to the time of Alfred Wegener's seminal work. The question of whether Late-Cenozoic cooling has influenced mountain erosion rates is especially apt at high latitudes because glaciations commenced more than ~10 Myr ago. Although selective glacial incision along valley troughs is well recognised in Scandinavia, the legacy of glacial cirque erosion coupled with periglacial activity has yet to be fully investigated. We explore the topographic legacy of mountain glaciation and frost action in the Caledonian Scandes mountains (~61–70° N). The Scandes currently hosts >3400 mountain glaciers and the distribution of >10,000 ice-free cirques indicates that glaciers have extended much lower and farther in the past. Previous work suggests that alpine glaciations focus erosion selectively at and above a zone of cirques, which approximates the long-term average 'palaeo-ELA'. We build on this perspective by examining the accompanying effects of periglacial frost weathering and creep on topographic evolution over the last ~10 Myr using a combination of topographic analyses and numerical modelling. Two general types of alpine landscape are recognised: i) plateau-dominant, where plateaux lie below modern ELA and are partly dissected by cirques and glacial troughs, and ii) arête/ridge-dominant, where peaks stand <800 m above modern ELA and flanking glacial troughs are cut >1500 m deep. The plateaux bear a long history of frost action in response to global cooling, and where elevations correspond to the 'zone of cirques' (~250–500 m below modern ELA) we show that the development of low-relief is an emergent property of the coupling of intervals of wet-based glacial erosion with prolonged periglacial processes. These results confirm the efficacy of alpine glaciation coupled with periglacial activity in exerting first-order control on topography at mountain belt-scale. We reflect upon the genetic links between widespread mountain plateaux and their blockfields, the elevation of cirque floors, and mountain peaks; namely, the erosional processes involved in generating a cold-climate topographic signature in postorogenic mountains.

New investigations of Paleozoic Ni-Cu-Co-PGE-enriched gabbroic rocks in the Upper Lusatia, Germany and Czech Republic: preliminary results

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Poster in Session A2-04

New investigations of Paleozoic Ni-Cu-Co-PGE-enriched gabbroic rocks in the Upper Lusatia, Germany and Czech Republic: preliminary results Tom Járóka1 and Thomas Seifert1 1 Technische Universität Bergakademie Freiberg, Department of Mineralogy, Brennhausgasse 14, D-09596 Freiberg, Germany The Cadomian Granodiorite Massif of the Upper Lusatia hosts numerous small-scale noritic to gabbroic dikes that belong to predominantly WNW-ESE striking Paleozoic mafic dike swarm-systems. The dikes are likely associated with Paleozoic rifting processes within the Lusatian Block. Several of these mafic dikes are characterized by small amounts of Ni-Cu-Co-PGE-bearing sulfides occurring in form of up to 2 cm large sulfide droplets. Larger, lense-like sulfide accumulations were found in the dikes of Sohland-Rozany (DE/CZ), Kunratice (CZ) and Grenzland-I (DE). One of these sulfide accumulations was mined between 1901-1920 in the Sohland-Rozany dike (20 kt ore @ 2 to 4 wt.% Ni, 1 to 2 wt.% Cu and 0.1 wt.% Co). The

Kunratice dike was mined between 1918-1920 (2.300 t ore @ 2.5 to 3 wt.% Ni and 0.5 to 1 wt.% Cu). Bulk geochemical analyses indicated a minor PGE and Au content of the sulfide ores (max. 0.8 ppm PGE, max. 0.5 ppm Au). In the 1980's geomagnetic and geoelectric exploration campaigns showed also a sulfide potential for other gabbroic dikes in the Upper Lusatia. Thus far, no trace element and isotope studies have ever been performed on these dikes. Our first microscopy and SEM analyses of sulfide-rich samples from the Sohland-Rozany dike show a predominance of pyrrhotite and chalcopyrite while pyrite, pentlandite, violarite and cobaltite occur subordinately. Small amounts of hessite, empressite, altaite, electrum and some Pd-bearing tellurides could be found by SEM analyses. The microscopy studies also revealed a high titanomagnetite and magnetite content within the sulfide droplets, usually in intergrowth with pyrrhotite.

From porosity formation to permeability generation and the initiation of flow in dehydrating rocks: deciphering fluid flow mechanisms in subduction zones

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Dehydration related water escape from subducting oceanic lithosphere is a key process for long-term global water and element cycles. Existing fluid flow models require a priori physical assumptions (e.g., preexisting porosity) and cannot resolve the evolution from initial fluid production to flow channelization at greater depth. In order to develop a model for this evolution, we need to unravel natural laboratories that display the incipient dehydration stages and the micro- to macro-scale fluid escape route evolution. The Erro-Tobbio meta-serpentinites (Italy) provide a unique snapshot into these early dehydration stages, recording the eclogite-facies breakdown of hydrous antigorite to anhydrous olivine plus fluid and the formation of an olivine-vein network. We find that dehydration, fluid pooling, and flow initiation are controlled by micro-scale compositional rock differences. Our model starts with a rock in which all water is stored in solid and any preexisting porosity is negligible (zero-porosity case). Increasing temperature will initiate dehydration reactions, dividing the rock continuously into a dry solid and a fluid-filled porosity. Spatially variable reaction progress results in dynamically evolving porosity/permeability and heterogeneous fluid-pore pressure distributions. Fluid-pressure gradient relaxation causes fluid flow and its thermodynamic feedback triggers reactions to progress, resulting in a self-amplifying process. Our new thermodynamic-mechanical model for reaction-porosity waves shows that fluid flow occurs solely in the reaction products and self-organizes into channelized fluid escape networks. This holds the key to formulating future quantitative models that address spatiotemporal processes such as the coupling between local fluid production and regional to global scale fluxes of elements.

Exploration of the Caledonian Mountain Belt in Scandinavia by Deep Drilling

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Cenozoic uplift of the Scandinavian Caledonides has exposed a lower- to middle-crustal level section through this Himalaya-type orogen, providing unique opportunities to better understand not only the Caledonides, but also on-going orogenies in modern mountains belts. The Collisional Orogeny in the Scandinavian Caledonides (COSC) project will also contribute to our knowledge of mountain belt hydrology, provide new data on deep thermal gradients, contribute new information about the deep biosphere, and improve our understanding of the geophysical response of the sub-surface. Two 2.5 km deep fully cored holes will help achieve these goals with the first one, COSC-1, completed in late August 2014. COSC-1 targeted the high-grade metamorphic complex of the Seve Nappes (SNC) and the contact with the underlying allochthon. Drilling resulted in nearly 100% core recovery to 2.5 km depth. On-site documentation of the core included photography, optical core scanning, physical property measurements and biological sampling. A number of geophysical logging suites were run during and after completion of drilling, including sonic, density, electric, temperature and acoustic televiewer logs. A near four week long seismic acquisition program followed in the Fall of 2014 with combined surface and borehole surveys in the vicinity of COSC-1. On-site core analysis indicates that the SNC is about 1.7 to 1.8 km thick and consists mainly of gneisses and amphibolites. A zone of extensive shearing is found in the lowermost 700-800 m of the borehole. Eight hydraulically conductive zones below 300 m were penetrated, in an otherwise tight rock down to 2.5 km. Pore waters appear to be relatively fresh throughout the borehole, suggesting deep circulation of meteoric waters. Bottom hole temperatures are close to 60°C after equilibration (about 20°C/km). The high seismic SNC reflectivity is due to the large contrast in impedance between the gneiss and amphibolite.

Cratonic roots under North America are shifted by basal drag: new evidence from gravity and geodynamic modeling

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Stable continental cratons are the oldest geologic features on the planet, and have survived 3.8-2.5 billion years of Earth's evolution. It has long been recognized that the key to the preservation of cratons lies in their strong and thick lithospheric roots, which are neutrally buoyant with respect to surrounding mantle. Despite their appearance of passivity, there is increasing recognition that cratons play a fundamental role in determining the thermal structure of the upper mantle, and hence mantle convective flow patterns. Here we present evidence that this mantle flow also alters the structure of the deepest portions of the "passive" cratonic roots. For the first time we show 3D image of the chemically depleted lithosphere derived from an integrative analysis of gravity, topography, crustal structure, and seismic tomography data. We find that the deepest portion of the cratonic root beneath the North American Superior Province has been shifted some 850 km to the west-southwest. Modeling of mantle convection beneath North America indicates that this shift is due to basal drag. This observation contradicts the conventional view of cratons as static, non-evolving geologic features and suggests that there is significantly more interaction (mechanical, chemical and thermal), between the convecting upper mantle and deep continental roots.

Petrographical Study of Rocks from Indus Suture Zone and Jijal Complex, NW Pakistan

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Poster in Session A2-04

Current research is based on study of blueschist and serpentinized harzburgite from the blueschist melange and the ophiolitic melange of the Indus suture zone and a sample of hornblende-spinel-garnet peridotite from the basal part of the Jijal complex. A thorough petrographic examination of rock thin sections through polarizing microscope and determination of modal mineralogical composition helped in characterization and understanding of the mode of formation and evolution of the mentioned samples. The blueschists are inequigranular, fine to medium-grained and consist of essential amounts of glaucophane, carbonate, phengite (mica), albite and accessory amounts of chlorite, jadeite, sphene, epidote, quartz, zeolite (?), ilmenite, pyrite and opaque ore. This mineralogy suggests its formation through subduction-related metamorphism of an originally basic igneous rock of the Neo-Tethys. The hornblende-spinel-garnet peridotite is medium to coarse-grained and subequigranular and comprised of abundant amounts of hornblende, garnet, pyroxenes and olivine together with accessory amounts of serpentine, green spinel, chlorite, carbonate and magnetite. This modal composition suggests its formation through solidification of melt at greater depth. The samples of serpentinized harzburgite are inequigranular and fine to medium grained, and consist of abundant serpentine (antigorite), bastite and olivine and accessory amounts of clinopyroxene and ore mineral(s). These petrographic characteristics suggest that these samples represent an altered (serpentinized) and subsequently metamorphosed spinel harzburgite of the mantle section of the Mingora ophiolite.

Petrography and Geochemistry of Part of the Mansehra Granite, Khyber Pakhtoonkhwa Pakistan

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Poster in Session A7-02

The igneous rocks from Mansehra Granitic Complex are studied for their petrographic and geochemical characteristics. On the basis of outcrop relationships and petrographic analyses, the rocks are divided into three categories; granites, doleritic dykes and metamorphosed volcanic rocks (andesite). Mansehra granite has typical mega-porphyritic texture with both fine grained and foliated varieties. During petrographic analysis it was observed that essential minerals of granites are quartz, perthitic and microcline alkali feldspar and plagioclase. It constitute the part of both phenocrysts and ground mass for other minerals like biotite, muscovite, tourmaline, quartz, apophyllite, apatite, monazite, andualsite, epidote, zircon, titanite, clay and ore mineral (s). The doleritic dykes display sub-ophitic to ophitic texture and essentially comprised of plagioclase and clinopyroxene while the metamorphosed volcanic rocks have foliated and fine grained texture and comprised of amphibole, quartz and plagioclase. On the basis of detailed geochemical analysis, the Mansehra granites are strongly per-aluminous and calc-alkaline. The per-aluminous property confirms its formation

as S-type and collisional granite. These granites are derived from plagioclase poor and clay rich sedimentary melt. The modal mineralogy of dykes indicates its alkaline nature. The foliated texture of above mentioned rocks represents low to medium grade metamorphism in these rocks. The comparison of Mansehra granites with Utla and Ambela granites indicates it's more resemblance with Utla granites rather than Ambela granites. Both these granites share same type of texture, modal mineralogy, geochemical characteristics and petrogenesis.

Comparative particle analysis of mineral processing products of black shale-hosted Kupferschiefer-type ore

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Poster in Session B2-02

Metal extraction of Kupferschiefer-type sulphide ore in the Mansfeld-Sangerhausen district was exclusively restricted to the black-shale-hosted ore and mineral processing to recover copper and byproducts was reduced to the energy- and cost intensive pyrometallurgical route and could only be maintained by government subsidies. In this study, various grinding/milling platforms were tested on Kupferschiefer-type black shale ore, originating from the Mid-European Mansfeld-, Sangerhausen- and Lubin districts, in order to examine resource and cost efficient mineral processing methods and to assess the performance of the particle size reduction ratio (PSRR) as well as the capability to liberate the minute sulphide ore particles (2 – 100 μm) sufficient for the subsequent beneficiation process. Additionally, pre-concentrates produced by froth flotation and residual samples from lab-scale bioleaching tests are compared in terms of metal recovery. Comminution products of a ball mill, a vertical roller mill and an impact crusher have been analyzed based on mineralogical investigation of polished mount blocks and particle size distribution has been carried out by granulometric methods. Generally, vertical roller mill and impact crusher products show higher liberation of the sulphide ore at much lower energy consumption by merging several comminution steps. Flotation of black shale ore is paired with serious issues caused by the general high amount of organic carbon (up to 15 wt. %) and clay-carbon-sulphide-intergrowths that leads to low recovery rates (70 %). Much more promising results in regards of metal recovery can be produced by microbial leaching of crushed black shale-hosted ore. Residual samples and chemical data show nearly complete consumption of the copper sulphide ore indicated by high recovery rates for Cu and Zn (up to 95%). Thus, bioleaching and alternative comminution can stimulated the metal recovery from black shale-hosted ore.

PGE resource potential of mine tailings and oxidized ores in the Bushveld Complex, South Africa

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The mining of PGE-bearing reefs of the Bushveld Complex, namely the Merensky, the UG-2 and the Platreef, has a long tradition, which over the years resulted in growing numbers and volumes of tailings dumps. Based on the interpretation of satellite imagery it is estimated that the PGE tailings dumps cover a combined area of more than 55 km2 and contain more than 800 million m3 material. Empirical densities and grades were applied to derive metric tonnes and PGE content (4E - Pt, Pd, Rh, Au). Accordingly, the existing PGE tails volume across the Bushveld Complex amounts to more than 2 billion tonnes containing approximately 40 Moz PGEs, the equivalent of several years of current mine production in South Africa (i.e., ~8 Moz PGE-4E in 2013). The development of improved extraction methods has already encouraged a number of companies

operating in the Bushveld Complex to recover PGEs from their tailings dumps. However, many dumps have not yet been considered for re-treatment. Another potential source of PGEs are the near-surface oxidized ores of the PGE-bearing reefs, which to date have been either left in situ, stockpiled, or discarded as all attempts to extract the PGEs proved uneconomic due to low recoveries. The problematic processing of oxidized ores is attributed to their complex mineralogical nature and polymodal distribution of PGEs in the ores, prohibiting a commercial upgrading by conventional metallurgical methods. However, alternative extraction methods including bio-leaching have been and are currently tested by a number of research groups in Germany. Using reef outcrops and sub-outcrops as well as a number of geological parameters (e.g., dip, strike, depth of weathering), empirical grades and densities we estimate the PGE potential of the oxidised ores at around 26 Moz. In summary, both secondary PGEs in mine tailings as well as PGEs in oxidized ores represent a valuable future resource potential for the South African mining industry.

The geochemical evolution of oceanic intraplate volcanoes

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Poster in Session A2-04

The temporal and geochemical evolution of the Hawaiian Chain is well known from analysis of drilled and dredged lavas. The evolutionary stages in Hawaii (preshield, shield, postshield, and rejuvenated) are geochemically distinct, with the early tholeiitic shield stage producing the largest amounts of erupted material. These stages reflect variations of partial melting and plume-asthenosphere/lithosphere mixing, that depend on the relative positioning of the plume centre to its overriding lithosphere. Here we show a compilation of published major and trace element data of shield and postshield lavas from several Pacific volcanic chains (Hawaii, Louisville, Society, Austral, Marquesas, and Samoa) in order to compare their evolutionary paths. Our results show that not all island chains follow the Hawaiian trend and thus cannot be explained by a simple plume-lithosphere interaction model. While Tahitian volcanoes show distinct trends of decreasing SiO_2 with decreasing age, in agreement with a continuous transition from tholeiitic shield to alkaline postshield stage magmas, tholeiitic compositions are absent in other island chains. Lava compositions of most of the studied volcanoes vary and single volcanoes show systematic variations between SiO_2 and REE enrichment suggesting variable degree and depth of melting. Tahiti lavas show higher (Ce/Yb)N for a given SiO_2 content compared to the Hawaii and Louisville lavas, probably indicating lower degrees of partial melting at Tahiti than beneath Hawaiian and Louisville volcanoes. These differences do not necessarily reflect changes in lithospheric age and thickness but may rather be due to different temperatures of their respective mantle sources. Here, we aim to test if the systematic major and trace element changes in oceanic intraplate volcanoes are representative of their mantle sources and lithosphere they are erupted on.

Behaviour of spinel-forming DVM using crucible induction furnaces. A case study on material failure

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Poster in Session B6-01

Modern crucible induction furnaces (CIF) in foundry industries are lined with spinel forming dry vibrated masses (DVM) that must guarantee a steady lifetime for more than 80 batches to meet the economic demands. In our case, linings of DVM from four different CIF for the production of steel showed an unusual early sintering, finally causing material failure. To solve this problem, we carried out a series of SEM-EDS supported microtextural and microanalytical studies. In a first series it showed that – aside of the well known infiltration reactions between slag and the inner sinter layer – that the early sintering of the outer part of the lining was caused by spinel formation. In principal, spinel formation is the expected reaction as it forms a barrier against infiltration and corrosion. The solution of the lining by slag attack is delayed due to the ability of spinel to incorporate different ions as Fe, Mn, Cr. This, however, concurrently leads to a loss in refractoriness. Here, the studied linings all showed transition to spinel after few batches even in the cold, porous fritted layer. The $MgO:Al_2O_3$ ratios of the newly formed spinels indicated lower crystallization temperatures. Since usually formation of spinel from DVM needs >1000°C under oxidizing conditions and temperature near the cold end of the lining should not have exceeded 300° C, we had to assume an additional factor accelerating the spinel growth. Theoretically fluorine, which was detected in remarkable amounts in samples of the porous fritted layer could have caused reducing of the formation temperature. However, this was proven for only one furnace. We therefore suspected that water (or moisture) might have played a decisive role. In a second series, test specimen from a spinel forming DVM were produced and dried each under different defined conditions, and subsequently fired at 1200°C and 1500°C. It showed that the dry-processed specimen gained their fully developed reaction texture not below 1500°C. The wet-processed specimen, in contrast, acquired spinel formation already at 1200°C. Here, the surface of primary magnesia grains exemplarily showed hydration microtextures. Though hydration textures in their initial stage were finally detected even in the dry-processed specimen at 1500°C, it can be concluded, that the material failure in the case study above resulted from a hydrated raw material (DVM). This might have been due to improper transport or storage conditions. If hydrated DVM [$Mg(OH)_2$] is fired, at c. 800° C a microcrystalline texture is generated which is highly reactive.

Integrated long-term site behavior assessment in geological underground utilization by coupled thermo-hydro-mechanical-chemical numerical simulations

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Poster in Session B5-01

The integrated assessment of long-term site behavior taking into account a high spatial resolution at reservoir scale requires a sophisticated methodology to represent coupled thermal, hydraulic, mechanical and chemical processes in numerical simulations. Our coupling methodology considers the time-dependent occurrence and significance of multi-phase flow processes, geomechanics and geochemistry. For that purpose, an innovative hydro-chemical coupling procedure was developed and validated against fully coupled hydro-chemical simulations. The numerical simulation results elaborated for the pilot site Ketzin demonstrate that mechanical reservoir, caprock and fault integrity are maintained during the time of operation. CO_2 dissolution is the dominating trapping mechanism after 10,000 years, while carbonate precipitation starts after some hundred years, resulting in a mineral trapping contribution of 10 % to 25 % with negligible changes to porosity and permeability.

Flexible simulation framework to couple processes in complex 3D models for underground utilization assessment

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Utilization of the geological underground for production and storage of hydrocarbons, chemical energy and heat as well as for waste disposal requires the quantification and mitigation of environmental impacts as well as the improvement of georesources utilization by means of efficiency and sustainability. The development of tools for coupled process simulations is essential to tackle these challenges, since reliable assessments are only feasible by integrative numerical computations. Coupled processes at reservoir to regional scale determine the behavior of reservoirs, faults and caprocks, generally demanding for complex 3D geological models to be considered besides available monitoring and experimenting data in coupled numerical simulations. We have been developing a flexible numerical simulation framework that provides efficient workflows for integrating arbitrary data and software packages to carry out coupled process simulations considering, e.g., multiphase fluid flow, geomechanics, geochemistry and heat. Simulation results are stored in structured data formats to allow for an integrated 3D visualization and result interpretation as well as data archiving and its provision to collaborators. The main benefits in using the flexible simulation framework are the integration of geological data and grid data from any third party software package as well as data export to generic 3D visualization tools and archiving formats. The coupling of arbitrary process simulators in time and space is feasible, while different spatial dimensions in the coupled simulations can be integrated, e.g., 0D batch with 3D dynamic simulations. User interaction is established via high-level programming languages, while computational efficiency is achieved by using low-level programming languages. We present three case studies on the assessment of geological underground utilization based on different process coupling approaches and numerical simulations.

New results of OSL dating of Weichselian sediments from the German Baltic Sea coast

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The German Baltic Sea coast offers a unique insight into the Weichselian time. At many cliff outcrops, particularly at Rügen Island, Pleistocene deposits are preserved. Hence we have the possibility to study sediments which potentially record the fluctuations of the Scandinavian Ice Sheet during Weichselian period. Our study focus on (glacial-) fluvial and (glacial-) lacustrine sediments intercalated between tills of Saalian and Weichselian age. Here we present a detailed investigation of these Weichselian sediments of four outcrops on the Jasmund peninsula (northeastern Germany). The sediments show evidence for a shift between cooler stadial and warmer interstadial climate conditions including vital information about the depositional environment in the time span of the Marine Isotope Stage 3. Based on several luminescence ages we reassess the chronostratigraphical position of the studied deposits with respect to the Weichselian history of the southwestern Baltic Sea basin (Kenzler et al. 2015).

The Weichselian deposits of the Jasmund peninsula (German Baltic Sea coast) – Chronostratigraphical reassessment based on luminescence dating

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The push-moraine complex mainly composed of Cretaceous bedrock, Saalian and Weichselian deposits. The Pleistocene sequence is exposed at more than 2 cliff outcrops around the Jasmund peninsula (southwestern Baltic Sea). This sequence can be differentiated into at least four till complexes and several intercalated beds of sorted clay, sand and gravel. The stratigraphic classification mainly based on provenance analyses of the individual tills and isolated radiocarbon and thermoluminescence ages of the intercalated (glacial-) fluvial and (glacial-) lacustrine deposits. Hence the correlation of the Pleistocene outcrops of Jasmund and outcrops in Denmark, Poland and Sweden are often problematic and contradictory. One key aspect of our study is the reconstruction of the depositional environment based on detailed lithofacies analyses. Furthermore we want to reassess the chronostractigraphical position of the investigated sediments using luminescence dating of quartz and feldspar. Based on the results we present implications for the dynamic of the Scandinavian Ice Sheet during the Weichselian period (Kenzler et al. 2015).

Subduction channel flow by dislocation creep in eclogites of the Tauern Window, Austria

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The Eclogite Zone of the Tauern Window (Eastern Alps) is an exhumed subduction channel, containing deformed fresh and retrogressed eclogites in a matrix of metasediments. Peak metamorphism was at 600°C and 20-25 kbar in the Oligocene. Exhumation occurred within a few million years, with the pressure-temperature trajectory passing blueschist grade conditions. To gain insights on deformation mechanisms in the eclogites during subduction as well as exhumation, we examined both, fresh and retrogressed samples. CPO data were obtained by time-of-flight neutron diffraction using the SKAT diffractometer at JINR, Dubna, Russia. Element distributions and grain boundary characteristics were analyzed with electron backscatter diffraction (EBSD). All investigated eclogites exhibit a pronounced CPO of omphacite. In retrogressed eclogites the glaucophane CPO is strong as well and matches topologically always that of omphacite. Omphacite microstructures consist of porphyroclasts with a small amount of recystallized grains. Subgrains in the omphacite porphyroclasts with sizes similar to the recrystallized grains point to subgrain rotation recrystallization, identifying high-stress dislocation creep as main deformation mechanism. In the fresh eclogites the jadeite content of the omphacite porphyroclasts increases from core to rim. Highest jadeite contents are observed for recrystallized grains. In contrast, in the retrogressed samples the jadeite content of omphacite decreases from core to rim, and lowest contents are measured in the recrystallized grains. The matching

CPO of omphacite and glaucophane indicates that progressive CPO-forming deformation spanned the whole high-pressure part of metarm-rphism and lasted until retograde blueschist grade.

Manufacturing of Ordered Porous Materials: Freeze Casting and Ionotropic Gelation

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Poster in Session B6-03

Porous materials are in use for many applications from filtering and heat insulation to lightweight constructive purposes. While most industrial porous materials are based on random structured foams, nature has often created graded and/or ordered porous structures to allow additional functionalities like the transport of media or the increase in properties by hierarchical structuring. While it is easy to make highly porous ordered structures with large pores (e.g. by weaving) it will be increasingly difficult to organize pores at or below the 100 μm-scale, which is typical for many skeleton or xylem constructions, which become of interest in the realm of biomimetics. Even modern 3-D generative manufacturing runs into problems at such length scales. Here we report on methods to manufacture such ordered highly porous materials with low pore sizes. Both freeze casting and ionotropic gelation rest on a self-organizing mechanism, where the filler substance of a colloidal suspension is placed in regular spaced channels during the process. In the first case ice crystal growth, in the latter a channel formation in alginate is responsible for the ordering. After the self-ordering the components are dried and sintered to create the final body. We will discuss the limitations and control mechanisms, which allow the modification of pore sizes, inter wall constructions, wall surface geometry etc. to demonstrate the versatility of the methods and show examples from our labs.

High-temperature studies on spodumene polymorphs

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High-temperature single crystal X-ray and Raman scattering measurements have been carried out to investigate the individual structural changes and corresponding thermal behaviour of synthetic tetragonal and hexagonal spodumene ($LiAlSi_2O_6$) single crystals in a temperature range from ambient to 800°C. The lattice parameters of these spodumene polymorphs were determined during heating with a 50°C-step throughout the investigated temperature range. The X-ray data show that the lattice parameters of tetragonal spodumene are characterized by a distinct anisotropic thermal expansion, while the a/b-axes contract of about 0.13 % the c-axis expands of about 0.57 % in comparison to the values at room temperature. This anisotropic thermal behaviour results in a very low thermal expansion of the unit-cell volume. The X-ray data of the hexagonal spodumene also indicate distinct anisotropic thermal expansion of the lattice parameters. However, in contrast to the tetragonal spodumene the a/b-axes expand of about 0.13 % and the c-axis contracts of about 0.52 %, resulting in the negative thermal expansion of the unit-cell volume. Furthermore, Raman scattering data indicate that the thermally-induced change of the unit-cell parameters is reversible for both polymorphs.

Evidence of environmental variability along the southern Cape coast, South Africa, during the Holocene

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Poster in Session A6-05

Coastal sediment dynamics are subjected to a range of environmental influences linked to their proximity to the ocean including ocean-atmosphere dynamics, sea level changes and its subsequent effects on the landscape and coastline. The Wilderness embayment is one such system, situated on the southern Cape coast of South Africa, the region experiences a modern climate seasonally influenced by the polar westerlies and the tropical easterlies as well as directly responding to the effects of the warm Agulhas Current. Sediment cores retrieved from Eilandvlei under the RAIN (Regional Archives for Integrated iNvestigations) initiative has provided long, continuous deposits for a high-resolution study of the system spanning the last 9000 years. The diatom assemblage clearly indicates higher sea levels during the mid-Holocene with minor fluctuations occurring during the late-Holocene. Concurrently, greater proportional representation of cold water species suggests an enhancement of localised upwelling events on the Agulhas Bank linked to prolonged exposure to easterly winds fuelled by the South Atlantic Anticyclone. The diatom-rich sediments provide a detailed account of the hydrology and inferences regarding the underlying climatic conditions during the Holocene. Salinity appears to be the driving mechanism governing the state of Eilandvlei, which in turn is a response to sea level changes and climatic fluctuations, in particular moisture availability. This makes moisture availability one of the primary controlling factors over the environment along the southern coastal plain. The evidence presented indicates that the changes are comparable with other climatic events recorded locally, regionally and even globally.

Pore space morphology and distribution in mature and post mature Posidonia Shale samples from the Hils area, Germany

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Organic-matter porosity is an important component of the storage capacity in organic-rich shales of gas-window maturity. In this talk we present the morphology and distribution of porosity, in particular within the organic-matter, of two organic-rich Posidonia Shale samples with different maturity using Broad Ion Beam milling and Scanning Electron Microscopy (BIB-SEM). The organic-matter porosity is investigated in a mature and a postmature mature sample. Results show that both samples show a similar trend in pore size distribution, though the pores in the mature sample are less frequent resulting in a lower visible porosity of 0.82% compared to 2.47% in the postmature sample. This difference is interpreted to be a combination of enhanced cementation and compaction in the mature sample and to a smaller extent because of the secondary organic-matter porosity in the postmature sample. The organic-matter pores as found in the postmature samples are mostly absent in the mature sample. The latter shows only crack-type porosity at the organic-matter – mineral interface and are interpreted as shrinkage and hydraulic fracturing because of hydrocarbon generation. The transition from the crack-type porosity into organic-matter pores is because of further thermal maturation. The total

BIB-SEM visible porosity is compared with bulk Mercury Intrusion Porosimetry (MIP) porosity to assess the pore connectivity, and evaluated by using Wood's Metal Injection (WMI). Pore orientations suggest, and WMI demonstrate, that the preferred transport pathways are sub-parallel to the bedding. Comparison between MIP porosity and BIB-SEM inferred porosity indicate that most of the pores are connected with pore throats below 10 nm. Overall, crack-porosity is insignificant, so its impact on transport in these investigated samples is expected to be minor.

Tungsten isotopes and the origin of the Moon

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The Moon probably formed by a giant impact onto Earth and consists of material from both the impactor and proto-Earth [1]. However, the isotopic similarity of the Earth and Moon is unexpected given the mixing of impactor and proto-Earth during the giant impact [2]. A recent model suggests that giant impactors are isotopically similar to the planet they impact, offering a potential solution to the enigmatic Earth-Moon isotopic similarity [3]. This model can be tested using ^{182}Hf-^{182}W systematics, because the ^{182}W compositions of planetary mantles vary as a result of core formation and not due to formation region of the parent planet. Thus, the mixing of material with distinct ^{182}W during the giant impact should have led to distinct ^{182}W compositions of the Moon and bulk silicate Earth (BSE). Here we show that the Moon exhibits a ^{182}W excess over the modern BSE [4], but that this excess entirely reflects the addition of a late veneer of primitive material to the BSE after the end of core formation [4,5]. Thus, the pre-late veneer BSE and the Moon had indistinguishable ^{182}W. The Earth-Moon ^{182}W homogeneity neither reflects formation of the Moon from the proto-Earth mantle [6,7] nor formation of impactor and proto-Earth from an isotopically uniform reservoir [2], because the giant impact itself should have led to a ^{182}WW difference by (1) modifying the ^{182}W of the proto-Earth mantle, and (2) by distributing W-rich but ^{182}W-depleted impactor core material to the lunar accretion disk. Thus, the new ^{182}W results seem to require post-giant impact isotopic equilibration of the BSE and Moon by a yet unknown mechanism.

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Electron backscatter diffraction (EBSD) - an additional technique for a more reliable estimation of alkali reactivity potential of rock aggregates in concretes

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The long term durability of concrete is a decisive criteria for the sustainability of the material. Among the various known deleterious reactions that affect concrete durability the alkali-silica-reaction (ASR) is a well known but in detail still not understood phenomenon. Typically ASR requires a certain degree of moisture and alkalinity in the porosity as well as a SiO_2 source to be dissolved [1]. The dissolved SiO_2 typically precipitates as an alkali-silica-gel. Depending on moisture content this gel has a strong ability to expand, causing cracks that penetrate through concrete structures and initiate disintegration of concrete. The major SiO_2 source in concrete usually is quartz, contained in river sand and gravel or as component of crushed rocks. It is known that rock aggregates containing amorphous SiO_2 are very prone for ASR. Thus knowing microstructural properties of SiO_2 components (mainly quartz) is important to estimate the ASR potential. Presently the evaluation of the ASR potential of aggregates is done by exposing concrete prisms in a climate change simulation chamber. The drawback of this evaluation procedure is its duration of up to 9 month. Light microscopy on thin sections [2, 3] and quantitative phase analysis via XPD are furthermore applied to characterise aggregates. To improve characterisation and to bring it to quantitative measures SEM-EBSD seems to be a promising tool [4]. By means of orientation imaging microscopy (OIM) EBSD is able to distinguish crystal orientations that differ by less than 0.25° at a spatial resolution as low as 10 nm. In the present study it is shown that quantitative analysis of the grain boundary misorientation angle of quartz per sample area can be used to estimate the ASR risk of concrete aggregates.

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Mesozoic intraplate structures in Germany: trying to understand the crucial details

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Germany has widespread intraplate structures of Mesozoic age. A network of extensional fault zones created in Triassic to Early Cretaceous time was contracted and partially inverted in the Late Cretaceous. The basic structural pattern of narrow grabens shortened by different degrees is in some cases complicated by peculiar structural elements: (1) lenses and slabs of Zechstein carbonates that appear along faults and rest structurally higher than either graben interiors or shoulders, and (2) isolated lenses of Muschelkalk (+ Keuper) lying on Zechstein and sometimes beneath Buntsandstein. So far, these „exotic" slivers have defied a full explanation. Proposed emplacement mechanisms include landsliding and diapirism. However, at least some outliers occur in locations inconsistent with sliding downslope. Diapirism is unlikely because exotic lenses occur where the primary thickness of Zechstein salt was presumably low. Thin-skinned extension emplacing Triassic units of hanging-walls on footwall flats in Zechstein strata is likely to have been involved. We show how faults active during extension and contraction could pluck lenses of Zechstein from their substrate and emplace them over younger strata, or leave lenses of Muschelkalk stranded on a Zechstein detachment, overridden by older rocks during inversion. An important implication of this model is that the magnitudes of extension and shortening can be severely underestimated when the exotic lenses are not accounted for. Several questions remain open: A fundamental problem is where and how the deformation was accommodated in the basement. On a smaller scale, the viability of the generic model must be tested through structural models for each case. Sometimes this task includes identification of the large faults predicted by the inversion model. Structure models can only be considered valid if strain magnitudes estimated from them are compatible between neighbouring segments with and without exotic lenses.

Structural, magmatic and tectonic controls of hydrothermal venting at the Menez Gwen segment, at 37°50' N on the Mid-Atlantic Ridge

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Axial volcanoes on slow- to intermediate-spreading mid-ocean ridges are known to favour the formation of large massive sulphide occurrences; however, local geological controls on the deposition are still not well understood. A detailed analysis of ship-based multi-beam data from the Menez Gwen segment at 37°50' N on the slow-spreading Mid-Atlantic Ridge (MAR) enabled geological mapping of the entire segment and neighbouring non-transform offsets, as well as the development of an age progression record of the recent spreading history of the segment (<2.5 Ma). In this region, the MAR is influenced by the Azores hotspot that causes increased magmatic spreading activity. At Menez Gwen, an axial hummocky crest dominates the spreading center of the shallow (<1900 m deep), 35 km long segment. Off-axis highs, bordered by inward facing fault scarps, are interpreted as rifted halves of former axial crests. Large rift faults are relatively evenly distributed, suggesting constant tectonic displacement over time. Rifted crest halves resemble phases of predominantly magmatic accretion that last on average ∼600 ka. A substantial focused magmatic event that ended about 150 ka ago formed the central Menez Gwen volcano. The volcano is rifted by an axial graben that hosts two hydrothermal vent fields in ∼800 m and 1000 m water depths (Menez Gwen and Bubbylon). Morphological similarities to other axial volcanoes (e.g. Axial Seamount or Lucky Strike) suggest a magma chamber underneath Menez Gwen that likely drives hydrothermal circulation. Axial graben wall faults rupture the entire volcano and serve as main fluid pathways. Over time, magmatic intrusions and mass wasting events reduced fault permeability. Venting locations on the seafloor are controlled by shallower, fresh, and therefore more permeable faults. Talus material and mass wasting deposits that cover those shallow faults favour mixing with ambient seawater, cooling and precipitation of metal-rich sulphides prior to venting.

Lithospheric Strength and elastic thickness of the Barents Sea and Kara Sea region

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The Barents Sea and Kara Sea region is characterized by a West-East structural asymmetry. The western Barents Sea is a shallow sedimentary platform crisscrossed by Late Palaeozoic – Mesozoic narrow rift basins separated by structural highs whereas the eastern part is marked by wide and deep sag basins. In addition, the western Barents Sea experienced stronger Late Cenozoic uplift than the eastern Barents Sea and the Kara Sea. Interpretation of tomography data suggests that the geological asymmetry is accompanied with a significant asymmetry in the lithosphere structure. The velocity configuration implies a thin and hot lithosphere in the west and a thick, cold and stronger lithosphere in the east. We assess the variations of lithospheric strength and the effective elastic thickness in the Barents Sea and Kara Sea region and discuss their implications on the crustal deformation. We develop rheological models assuming a temperature-dependent ductile and brittle rheology for the sediments, the crystalline crust and the lithospheric mantle. The geometry and the thermal configuration of the sediments, crystalline crust and lithospheric mantle are extracted from a recent 3D lithospheric model. Considering the uncertainties affecting lithology and physical parameters, especially in the Kara Sea and eastern part of the Barents Sea, we evaluate the lithosphere yield strength and elastic thickness maps for a range of lithological models. In the first model, we consider a homogeneous wet quartz lithology for the entire crust and a dry olivine lithology for the mantle lithosphere. In the second model, the lower crust has a stronger dry diabase rheology. The resulting effective elastic thickness generally correlates with the depth of the LAB and increases from below the western Barents Sea ($\sim$40 km) to the eastern Barents Sea and the Kara Sea (60-120 km). The crystalline crust and the mantle lithosphere are mostly decoupled except in areas characterized by a thick lower crust.

Dynamic Data for a Dynamic Planet

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Oral in Session C3

The discovery of plate tectonics can be seen as an early example of data driven science. It is a story of combining evidence from many fields of geosciences into a coherent theory. It was the combination of data from fields ranging from palaeontology to geophysics that supplied the leads and the evidence to the idea that the continents and oceans had not always been in their present day conformation. Further data acquisition and analysis helped us unravel the processes that drive plate tectonics. The emergence of new measurement technologies, such as very long baseline interferometry and global navigation systems, today allow us to actually measure the movement of the lithospheric plates. Taking into account the northward movement of 7 cm/year of the Australian Plate, Australia will introduce a dynamic datum for its geodetic reference system. Over the period of 100 years, the once disputed idea of moving continents has become an accepted fact and has even entered legislation. Data driven research has been called a new paradigm in the scientific method. And because data in geoscience are often difficult to come by, geosciences can be both data rich and data sparse, which raises the question in which circumstances data driven approaches can be used, and in which they will fail. A wealth of legacy data and new data coming from sensor systems today combine with advances in information technology. This combination of high-performance computing with high-performance data gives us a new set of tools for analysis, simulation and hypothesis testing to study the processes shaping planet Earth. Taking discovery of plate tectonics as an example, this presentation will examine how data driven research in the geosciences can contribute to our understanding of the processes that shape Earth as a dynamic planet.

The geological and tectonic structure of the Krka river estuary - integrated coastal zone management issues of the Adriatic Sea

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The Krka River is a medium sized water course in the Dalmatian karst area. It has formed in a typical karstic area, - however, some characteristics and features make this river unique among other rivers belonging to the Adriatic watershed. Its canyon-like appearance is a consequence of the geological setting of the entire catchment area with its suite of tectonically formed faults and crevices within limestone of Cretaceous and Paleogene age.The geological setting of the Krka river catchment area is the outer Dinaride formation, whose tectonic evolution is closely associated with the recent and historical seismicity of the circum-Adriatic region. The Adriatic microplate lies within a collisional environment caused by the northward motion of the African tectonic plate and its subduction under the Eurasian plate. A key question is whether the Adriatic microplate is a rigid promontory of the African plate mirroring its behaviour, or if it is moving independently, either rigidly in one or more parts, or with some distributed deformation. This movement is thought to have begun in Createceous time and has built the present Alpine mountain belt. Recent data on lower seismicity levels in the Adriatic sea and eastern Italy relative to their surroundings implies that the Adriatic microplate rotates with respect to Eurasia around a pole in the northern Po plain. Hence, neotectonic processes in the Apennines, showing dominantly but not exclusively normal faulting, reflect extensions between western Italy south of the Po plain (presently considered to part of Eurasia) and Adria, whereas the thrust faulting mechanisms in the Dinarides and Venetian Alps reflect Adria-Eurasia convergence. Complex integrated coastal zone management (ICZM) issues are dealt with through strategic environmental impact assessment approaches.

Evaluating the in-situ produced cosmogenic nuclide inventory of longshore transported sand, Fischland-Darss-Zingst peninsula, southern Baltic Sea

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The Fischland-Darss-Zingst peninsula, located in the southern Baltic Sea, was formed in the context of late Pleistocene and Holocene sea-level variations and comprises marine-coastal, glacial, fluvial and aeolian deposits. A known phenomenon is the longshore sand-transport, mainly driven by westerly winds, that transports sand from the west (Rostocker Heide, Fischland) towards the north and later eastward. A counter-player to this is a strong easterly wind, causing sand transport towards the west. Additionally, cliff retreat occurs in the Fischland-Altdarss region. Aside from these natural coastal processes, anthropogenic off-shore dredging for costal protection has influenced the sediment dynamics. Here we investigate sand transport dynamics and sand sources by analyzing in-situ produced cosmogenic nuclides in quartz sand. The approach is based on the largely divergent half-lives of 10Be (1.4 Ma) and 14C (5.7 ka) that cause a much faster drop of the 14C concentration (compared to 10Be) when the sand is shielded from cosmic rays. Shielding can be envisioned due to "sea-water coverage" or by burial on land in older highlands. Additional analysis of the heavy mineral content in the sand samples indicates some moderate mixture of sand from different sources. Cosmogenic nuclide concentrations obtained for 10Be are equivalent to 8-12 ka of exposure. In contrast, concentrations for 14C translate to only 1-2 ka of exposure resulting in apparent burial ages of 11-12 ka. A longshore trend is not obvious. The preliminary interpretation suggests an identical exposure and burial history for all analyzed sand samples prior to its deposition at today's shoreline. We will discuss possible exposure-burial scenarios in the context of the Late Pleistocene-Holocene evolution of the source and deposition areas, particularly with regard to influences from sea-level fluctuations, sand transport and erosion mechanisms.

The LArge Scale MOnitoring (LASMO) Project at the Grimsel Test Site (GTS) – monitoring the impact of regional perturbations on a URL

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Surface exploration or the characterization from underground of geological structures which determine a geological repository has to be designed in a way that the integrity of the host rock is not jeopardized through use of intrusive characterization techniques. A non-destructive approach to characterize the host rock and the emplacement tunnels could be based on the monitoring of signals induced by tunnel excavations or other regional anthropogenic perturbations and the impact on geological, hydraulic, hydrogeochemical and mechanical parameters. Such data and appropriate monitoring time-series would enable to better constrain the site descriptive models and reduce model uncertainties. It also

permits to test and develop monitoring strategies and techniques at different phases of repository implementation. In order to test the capabilities of existing approaches (measurements, analytics, modeling), the long-term (5 yr) LASMO project at the Grimsel Test Site (Switzerland) is taking advantage of the extension works of the local hydro power plant (constructions, lake drainages), which cause significant hydraulic changes or seismic signals. These can be compared with an existing 30yr long base-line, which can be used to distinguish between natural and anthropogenic perturbations. First results obtained by an interdisciplinary approach (nano-seismic, extensometer network, hydraulic and strain monitoring, structural mapping, hydrogeochemical sampling, modelling) utilising a dense time-series of observations, show that the activities to date have had limited impact. By using the existing hydrogeological and rock formation model of GTS, the project aims to predict, continuously update and validate the models. In addition the LASMO project provides the platform to test and develop monitoring strategies and techniques at different phases of repository implementation (baseline, construction, operation), at a large scale and under realistic boundary conditions.

Shallow magmatism during subduction-zone initiation: Constraints from the Oman ophiolite and related experiments

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The Semail Ophiolite in the Sultanate Oman was formed during the initiation of a subduction zone in the Cretaceous and is characterized by two different magmatic phases: The first shows typical MOR-type character with a small subduction zone component (extrusives composition similar to modern MORB, but with slight Nb-Ta anomaly and elevated primary water content), the second magmatic phase is completely different with the presence of typical lithologies not known from mid-ocean ridges: wehrlites, depleted gabbronorites, boninites, large plagiogranite bodies. Based on crystallization and melting experiments in different systems, we present here a coherent model that all these lithologies of the second magmatic phase can be formed under shallow pressure conditions in a typical spreading environment, just by adding small amounts of water to the magmatic systems. Partial melting of typical Oman harzburgites at 2 kbar at temperatures between 1050 and 1100°C produces melts with the composition of high-Ca-boninites, very similar to those known from the Oman ophiolite. Early mineral accumulation in these melts may result in depleted gabbronorites, well known from typical late-stage intrusions observed in the Oman ophiolite. The addition of small amounts of water into the gabbroic mushes at 2 kbar at temperatures between 1040 and 1080°C has the potential to destabilize plagioclase crystallization in the mushes, leading to the production of typical wehrlites, which can often be observed in the lower crust of the Oman ophiolite as late intrusions in the layered gabbros. Finally, partial melting of gabbros at temperatures between 870 and 980°C may produce SiO_2-rich lithologies, which are a typical component of the so-called late-stage magmatism in the Oman ophiolite. Our experiments on partial melting of gabbro show that this process produces characteristic features in the residue, which were recently discovered in natural gabbros from the Oman ophiolite.

Münchberg metamorphic complex: nature and ages of the nappe protoliths

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Oral in Session A1-05

The Münchberg metamorphic complex, part of the Variscan basement in NE Bavaria, is interpreted as remnant of a large Variscan nappe complex and is superposed onto very low-grade Paleozoic sedimentary sequences. The complex consists of four tectonic units, which are from top to bottom Hangend-, Liegend-, Randamphibolit- and Prasinit-Phyllit-Serie. Detailed information about formation ages and trace element geochemistry of the protoliths of the metamorphic nappes are still missing and the role of the different units within the Cadomian-Variscan plate tectonic evolution is so far unknown. To fill the gap, U-Pb isotope analyses on zircons and whole-rock trace element analyses were done by LA-ICP-MS. The Hangend-Serie consists of bimodal metavolcanic rocks of volcanic-arc signature, which show magmatic U-Pb ages of 550 Ma. The volcanic activity can most likely be correlated to the Cadomian arc – back arc system at the northern margin of Gondwana[1,2]. The Liegend-Serie is composed of metasediments and calc-alkaline metagranitoids. U-Pb zircon ages indicate a main intrusive phase at 500 Ma for the granitoids and maximum sedimentation ages between 545 and 500 Ma for the metasediments. This nappe can be interpreted either as Cambrian part of the continental margin of Gondwana or of the Cadomian arc. Amphibolites of the Randamphibolit-Serie show MORB character and yield U-Pb zircon ages of near 400 Ma. Our preferred interpretation is that they represent an Emsian part of the Rheic oceanic crust. The Prasinit-Phyllit-Serie consists of metabasaltic ($\pm$ gabbroic) rocks, intercalated with metasediments. Mafic rocks have oceanic island-arc signatures and show U-Pb zircon ages of 400 Ma, which is in good agreement with the youngest U-Pb zircon age of 393 Ma of the metasediments. This series can be interpreted as part of an Emsian-Eifelian island arc of the Rheic Ocean.

[1]Linnemann et al. 2014: Prec Res 244:236-278
[2]Szczepański, Ilnicki 2014: Int J Earth Sci 103:627-647

Thermokinematic evolution of the passive continental margin in NE-Argentina and SE-Uruguay, constrained by fission-track ages and (U-Th-Sm)/He ages and 2D-modelling

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Poster in Session A2-02

Passive continental margins are extraordinary geo-archives, that result from processes related to continental rifting, breakup, sea-floor spreading, post-breakup, and climate changes. Whereas the South Atlantic passive continental margins (SAPCM's) in Brazil, Namibia, and South Africa are represented by high-elevated margins (~2,000m a.s.l.), the SAPCMs in Argentina and Uruguay is of low elevation. The northern part of the Argentinean passive margin is represented by the Pampas plains with the lower mountain ranges of the Sierras Septentrionales (Tandil Hills or Sierras Tandil) and the Sierras Australes (Ventana Hills or Sierra de la Ventana). They are key areas to unravel the thermal and exhumation history of the low-elevation SAPCM as they provide many outcrops. In addition, this area has been part of the Gondwanides Orogeny. During the Permo-Triassic both areas were influenced by compressive deformation and diagenetic to low grade metamorphism. Thermochronological data from the Sierras Australes, the Sierras Septentrionales and Uruguay reveal that all measured ages are younger than the corresponding intrusion-, sedimentation- or formation-age. The Time-Temperature models from the Sierras Australes lead to a differentiated thermal evolution throughout the region., whereas the thermal history in the Sierras Septentrionales, seems to be very homogeneous. A thermal overprint due to Jurassic volcanism is very reasonable and supported by the thermokinematic models. This volcanic overburden is also revealed for the thermal history SE-Uruguay and based on modelling.

Deep-seated fluid ascent in mud volcanoes off Japan

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The Nankai accretionary margin, SW Japan, is one of the seismically most active regions with frequent M8+ earthquakes. It also hosts several deep-seated mud volcanoes which provide a window to depth. The transition along subduction zone plate boundary faults from a shallow aseismic region to the deeper seismogenic zone is thought to coincide with the onset of a "dry" fault zone, where compressive dewatering of the sedimentary layer and the dehydration and transformation of hydrous minerals such as smectite clay are essentially complete. Fluids primarily exit this region seaward along fault pathways, however, in case of the Nankai margin with more than a dozen recent drillholes in the frontal subduction system such deep fluid signatures have been absent. Recent sampling of mud volcanoes during cruise SO222 provides evidence for water sourced within the subducting igneous crust passing upward through the seismogenic zone and upper plate wedge and exiting through mud volcanoes 15 km above. Sr isotopes show input from primitive non-radiogenic igneous crust whereas B, and more so Li isotopes with signatures as low as 6‰, hint towards an origin from inside the oceanic crust as well. Other element concentrations, and the near complete removal of Mg, suggest the formation of serpentinite and brucite. Interestingly, the source region of the mud volcano fluids corresponds to a zone where seismicity is significantly lower than in any other location in cross sections of the Nankai margin. We propose that rapid fluid ascent may be an efficient mechanism to maintain low fluid pressure, this way hampering slip of the plate boundary fault stable at high effective stress and explaining low overall seismicity compared to regions up-dip or down-dip, or out-of-sequence faults above.

First-principles prediction of Ni partitioning between silicate and metal melts

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Poster in Session A7-02

Most geological processes are accompanied by a re-distribution of elements between different phases. Element partition coefficients between minerals, melts and fluids have been measured for many systems. The lattice strain model of Blundy and Wood (1994) has been very successful to explain mineral-melt partitioning of trace elements in terms of crystal chemistry. However, a more general theoretical framework for element partitioning is still missing. Here, we explore a first-principles simulation approach to predict element partition coefficients between metal melts and silicate melts, which may be considered a model system for metal-silicate segregation during the early evolution of the

Earth, which eventually lead to core formation. The simulations provide simultaneous access to the atomic structure and to thermodynamic state variables. Using the alchemical transmutation method of thermodynamic integration, the equilibrium constants of exchange reactions, e.g., of Ni and Fe between metal and silicate melts are estimated. Structurally, Ni and Fe have a very similar coordination environment in the metal melt, whereas Ni-O bonds in silicate melts are considerably longer than Fe-O bonds. The derived Ni partition coefficients agree rather well with experimental data, which provides confidence in the computational method used here. Relations between melt structure and partitioning behavior and the potential of predicting other partition coefficients from first-principles will be discussed. Blundy and Wood (1994) Nature 372, 452-454.

Quantification of temperature impacts on the dissolution of chlorinated hydrocarbons into groundwater

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ATES has great potential for energy storage especially in urban and industrial areas. However, frequently existing organic ground water contaminations in such areas were currently seen as exclusion criteria for ATES, since increased contaminant discharge is feared as consequence of heating. Contaminant discharge is influenced by a complex interaction of processes and boundary conditions as e.g. degradation, solubility, dispersion, viscosity and there is still a lack of experimental evidence of the temperature dependent interaction. Even existing studies on basic influencing factors as e.g. temperature dependent solubilities show contradictory results. Such knowledge gaps should be reduced to improve the basis and liability of numerical model simulations and the knowledge base to enable a more differentiated and optimized use of resources. For this purpose two exemplary experimental studies concerning the temperature dependent release of TCE (trichloroethylene) from a NAPL (non aqueous phase liquid) source are presented and discussed. Firstly, temperature dependent TCE solubility data were collected using enhanced batch experiments with significantly better temperature resolution compared to earlier studies, showing a distinct minimum at 35°C and increased solubility towards 5°C and 70°C. Secondly, heatable 2D-tanks (40 cm x 25 cm x 10 cm) homogenously filled with quartz sand and percolated by H_2O were used to investigate the dissolution behavior and plume development of TCE from a residual source zone at 10-70°C. TCE outflow concentrations were similar between 10°C and 40°C, but increased significantly at 70°C. Vertically upward displacement of the TCE plume indicated a significant role of TCE gas phase formation for the increased TCE release at 70°C. Both effects can have far-reaching effects for ATES applications in contaminated aquifers and for combinations of aquifer remediation with energy storage, which are discussed within the presentation. Acknowledgments: The presented work is part of the ANGUS+ project (03EK3022) funded by the German Ministry of Education and Research (BMBF).

Crustal structure of the Southern Pamir - insights from the TIPTIMON magnetotelluric experiment

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Poster in Session A1-02

The Pamir is a high plateau located north of the western syntaxis of the Himalaya. Pamir's present-day geometry is a result of Cenozoic indentation of India into Asia during which it was displaced northward by about 600-900 km with respect to the Tarim basin. Although the Pamir shares many geodynamic aspects with Tibet, it has several unique features, such as: 55-64% N-S internal shortening, exposure of middle-lower crustal crystalline rocks with Cenozoic metamorphism, and occurrence of intermediate depth seismicity caused by intracontinental subduction. Models of Pamir plateau formation and its present day kinematics propose crustal thickening and orogenic material flow whereby the ductile middle or lower crust is dragging the middle-upper crust NNW-to WNW. To investigate the structure of the lithosphere, particularly the extent and the depth range of the ductile crust, a magnetotelluric survey was conducted in the Southern Pamir as a part of the interdisciplinary TIPTIMON (Tien-Shan-Pamir Monitoring Program) project. Overall, we installed 85 wideband magnetotelluric stations covering a 200 km x 100 km wide region between Murghab and Chorog in Tajikistan, with a site spacing of approximately 8km. Results of 3D inversion show a resistive upper crust for the entire southern Pamir. Starting at around 10km depth, a prominent low-resistivity zone (below 10 Ωm) appears in the SE part. The conductive zone extends towards the center of the southern Pamirs but does not reach to the west. The conductive channel can be explained with interconnected partial melt of 3-10%. Low seismic velocities and high heat flow support this interpretation. In the southwestern part of the survey area a resistive core extends to larger depths (>30 km) and a few conductive regions appear as isolated structures with limited extension. We interpret these zones of high conductivity as faults which can provide pathways for fluids and which partly seem to coincide with hot springs at surface.

Drill core mineral analysis by means of the hyperspectral imaging spectrometer HySPEX, XRD and ASD in proximity of the Mytina Maar, Czech Republic

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Poster in Session A2-04

This study's purpose is the comparative analysis of drill core samples from the recently discovered maar system in Mytina, Czech Republic. It aims to create a surface cover map which includes the volcano-clastic overprint of the area around the maar in the Eger graben system and focuses on using remote sensing techniques to accomplish this goal. Hyperspectral images are increasingly used for surface mapping purposes and a range of different expert systems are being established to identify surface cover materials, their perfomances have to be qualified and verified. For this purpose several steps were taken: 1) samples from 7 drill cores from the adjacent area of the maar were analyzed by X-Ray diffractometry (XRD) and the hyperspectral imaging spectrometer HySpex. 2) Soil samples from the area were measured in the laboratory by HySpex and in-situ by an analytical spectral device (ASD). 3) The measured data was analyzed by a material characterization algorithm (MICA) and the results were compared to the results from the XRD-analysis. The XRD-analysis provides a basis of validation for the remote sensing results. 4) The MICA-results of the in-situ measured spectra of the soil samples were compared to the MICA-results of the soil sample results measured in the laboratory by HySpex. This provides the possibility to create a volcanic map on the basis of the in-situ soil in the surrounding area of Mytina. The comparison of the XRD- and solaroptic remote sensing results showed a good correlation of the minerals found. The comparison of the in-situ and laboratory-measurements of the soil samples showed a lack of mineral detection and instead a detection of vegetation or no detection at all,

which can be explained by the analysis method. This work developed an operable process chain which simplyfies the analysis of drill cores, drill core samples and soil samples and provides the basis for a spatially extensive analysis of hyperspectral remote sensing data of the area.

Natural analogue investigation for CCS in the Southern Caucasus

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Poster in Session B5-02

The present study aims to gain deeper insights into the geochemical processes of interaction between CO_2 and different rock types associated with natural CO_2 seeps in order to provide information on the long-term effects of geological CO_2 storage. In a joint project with geoscientists from Armenia and Georgia we investigated fluids and rocks as natural analogues for carbon capture and storage sites and we also carry out laboratory experiment. Fluids and rock samples were collected in 2012/ 2013 in both countries. The experiments were performed to mimic and evaluate natural analogue fluid and/or rock reactions. In the field we measured the pH, temperature, TDS, conductivity and alkalinity of water samples. In the laboratory we used ICP-MS, IC, OES and a DLT-100 Liquid-Water Isotope Analyser for water sample analysis. The analysis of rocks included XRD, optical microscopy, and XRF techniques. To investigate reactions between caprock and CO_2-fluid, batch experiments are being carried out in order to gain insights into the alteration processes. The rock samples were loaded into batch reactors and reacted with CO_2-saturated fluid, comprising 1g NaCl/L, at 5 bar and 100 °C for up to 6 months. The pH value varies between 5.6 and 9.1, temperature between 6 °C and 42 °C. Alkalinity varies from 1 to >80 mmol L-1 and TDS from 1500 mg/L up to 5000 mg/L. Due to the inaccessibility of rocks inside some wells, country rocks were sampled as close as possible to them. Although the sites in Armenia and Georgia are mostly characterized by andesitic to dacitic volcanic rocks, the fluids fall close to the meteoric water line and show little evidence of a magmatic contribution. We expect that our current laboratory experiments will provide detailed insights into the effects of CO_2-induced rock alteration on a mineralogical as well as chemical basis. We anticipate that this alteration will permit us to calculate mass balances for a number of elements between rock and fluid.

Seamount Phosphorites as Potential Resources for Rare Earth Elements and Fluoride

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Many seamounts in the oceans host phosphorite deposits that form primarily through early diagenetic processes replacing carbonates and precipitating in pore space. Rare earth elements plus yttrium (REY) and other trace metals are known to accumulate in marine phosphorite deposits during formation, however, there are few systematic studies. Phosphorite deposits found on seamounts have been the subject of far less research than deposits found in continental shelve/slope and plateau environments. To better address the influence of the depositional environment on the REY content of seamount phosphorites, we investigated 39 samples collected throughout the global ocean. Compared to other types of sedimentary phosphorite deposits, the REY concentrations were found to be lower, but generally with higher heavy REY (HREY) percentages, which have the highest economic value. In the Pacific Ocean phosphorites sampled between 9.9°S and 36.1°N at 1588 to 4850 m water depth, we measured concentrations for REY ranging from 98.9 to 1022 ppm (median ΣREY: 392 ppm), with high percentages of heavy REY (45-75%, median: 56%). Also fluorine up to 3% was measured, which shows that the major mineral in these deposits is carbonate fluorapatite (CFA). Shale-normalized REY patterns with negative Ce anomaly, positive La, Gd, and Y anomalies, and HREE enrichment over middle and light REE (MREE and LREE; Pr(SN)/Yb(SN) = 0.16-0.61) closely reflect the seawater REY pattern, pointing to seawater as the primary REY source in these deposits. Preliminary results indicate that the over one order of magnitude variation of ΣREY is not directly correlated with latitude or depth.

Opening of the Drake Passage: due to Mantle Anchoring and Absolute Plate Motions?

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Continental breakup of Gondwana 125 million years ago lead to a divergent plate boundary system between the South America, Antarctica and Africa with a R-R-R triple junction in the Southern Ocean that is still active today. For previously undefined reasons, a second phase of oceanisation opened the Scotia Sea within the South American passive margin. We show a kinematic restoration of the oceanic basins and surrounding continental fragments of the Scotia Sea, built in GPlates software. It shows that the Scotia Sea forms seemingly spontaneously from a within-South American-plate spreading system, balanced by a contemporaneous within-plate subduction zone that consumed South American lithosphere. Restoring the Nazca-Phoenix-Antarctic plate R-R-R triple junction in the SE Pacific shows that ∼55 Ma, a new ridge broke the Farallon plate into the Nazca and Phoenix plate. This ridge must have subducted below South America. We propose the following for the Scotia Sea development. The initial driving force is the stress transfer of active spreading across a highly coupled subduction plate contact. This causes rifting and thrusting in the overriding plate. The latter leads to a small mantle anchor at the base of the overriding plate, which resists strong westwards absolute plate motion of South America, stagnating the incipient trench relative to the mantle. To the NW of the anchor, South America moves away, opening the West Scotia Sea. Simultaneously, to the SE, it pushes the southeastern part of the South American plate into the mantle, causing full subduction. As the system develops, the subduction becomes self-sustaining. Roll back and trench lengthening cause the opening of multiple other basins. Arrival of the Weddell Sea ridge in the trench leads to the arrest of subduction at the southern part of the trench and isolation of the South Sandwich subduction zone, whose roll-back dominates the opening of the only currently active spreading center in the East Scotia Sea.

Numerical modelling of heat flows in Black Sea

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Poster in Session A4-01

Numerical modelling of heat flows is of great significance for the creation of structural models of the Black Sea lihtosphere. The formation of the heat flows at the bottom of the Black Sea is significantly influenced by the following: the radiogenic heat of the crust and the mantle; the conditions of heat transfer which depend on the temperature and vary in space and in time ; the heat arising from depths that is connected with the global cooling of certain horizonts in the tectonosphere. The heat flow measured at

the bottom at tha Black Sea is a major input parameter in calculating the temperature and heat flow in depth. The purpose of this paper is a more detailed study of the distribution in depth of the thermal field in the light of the latest geological and geophysical data concerning the age and structure of the sedimentary rocks and the Black Sea basement. Specified seismic and tomographic data about sedimentary formation and the region basement were obtained and employed in order to precise the results obtained from the previous studies. Calculations were carried out along three profiles and they have shown that the heat flow along the Moho plane varies from 15-20 to 29-41 mW/m2. Tha part of heat flow that is caused by radiogenic sources amounts to 17-30 mW/m2. The modelling results are presented as sections that illustrate the distribution of temperature and heat flow in depth. One characteristic feature of the Black Sea depression is the low heat flows measured at the sea bottom. Of all geological and geographic factors deforming temperature and heat flows at the bottom of Black Sea, the ones causing maximum field deformations are following: 1. The penetration of warm and sally waters from the Mediterranean. 2. The deposition of Neogene- Quaternary sediments. It is proved that the heat flows that have not been disturbed by sedimentation amount 45-60 mW/m2.

Porosity, A Catalyst For Formation Of Shock Deformation Features In The Low-shock Pressure Regime (2.5-20 Gpa)

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Despite extensive shock metamorphic investigation especially of the SiO_2 system, there is still a lack of diagnostic shock features for the low-shock pressure regime that represents a major proportion of the volume of impact structures. This issue is the focus of our research within the framework of the MEMIN research group, through studies of shock deformation experimentally generated in different target materials – particularly aiming at establishing a shock classification scheme for porous, quartz-bearing rocks that are strongly affected by porosity. Four series of shock recovery experiments (impedance method) have been conducted in the shock pressure range 2.5 to 20 GPa with dry and water-saturated Seeberger sandstone, and quartzite (porosities: 0 - ~30 vol.%). The number of shock-induced fractures generally increases with increasing pressure; increasing porosity results in stronger fracturing but also in fracture saturation at relatively lower shock pressure. This can be directly related to the increase in diaplectic quartz glass and SiO_2 melt development at moderate pressures [1, 2]. That means that fracturing is replaced by melting and an increase in porosity results in an increasing amount of diaplectic quartz glass and SiO_2 melt (e.g. at 17.5 GPa ~90 % in dry sandstone, ~0 % in quartzite). Shock compression of porous sandstone results in distinctly different effects from those observed in non-porous rocks, especially at low shock pressures. The formation of diaplectic quartz glass and SiO_2 melt was observed already at pressure as low as 5 GPa (dry sandstone) and increases with increasing pressures [2]. The amount of glass and melt decreases significantly with decreasing porosity because the crushing mechanism is strongly dependent on porosity and leads to a distinctly heterogeneous shock pressure and temperature amplification in the target [2]. References:
[1] Kowitz et al. (2013), MAPS 48:99-114;
[2]: Kowitz A. et al. (2013), EPSL 384:17–26.

Investigating New Biogeochemical Approaches for Prospection of Concealed Metal Deposits: Enhanced Release and Fractionation of ‚Immobile' High Field Strength Elements (REY, Zr, Hf, Th, U) by Leaching in Presence of Biogenic Ligands (Siderophores)

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Oral in Session B2-02

We conducted batch leaching experiments on different rocks and ores in the presence of the biogenic reagent desferrioxamine B (DFOB). DFOB belongs to a group of organic molecules known as siderophores which are exuded by a range of microorganisms, plants and fungi to cope with the scarcity of bioavailable iron in their habitat and which constitute one of the most important groups of biogenic ligands in many natural environments. Besides a high affinity for Fe(III), DFOB is also very efficient in binding metal ions with high ionic potentials, i.e. high field strength elements (HFSE). HFSE such as the rare earths and yttrium (REY), the geochemical twins Zr-Hf and the element pair Th and U are considered rather immobile during low-temperature water rock interaction. We investigated the impact of DFOB on the mobilization of these HFSE during low-temperature water-rock interaction and show that DFOB significantly enhances the mobility of REY, Mo, Zr, Hf, Th and U. We also show that Ce is decoupled from its light REY neighbors and that U is strongly fractionated from Th. The REY patterns obtained in the leachates are apparently characteristic for leaching in presence of siderophores. Our data shows that biogenic compounds such as siderophores are actively promoting the mobilization of 'immobile' trace elements. Metal-siderophore complexes are enzymatically reduced at the cell membranes and the metal may be incorporated into the organism and/or plant. Due to the misbelief of strictly 'immobile' HFSE, many studies on geochemical exploration involving plants and fungi as indicator plants/organisms lack the consideration of HFSE. However, biological activity is apparently able to bind and mobilize these elements – even from igneous rocks with rather low HFSE concentrations. This gives rise to the question whether the HFSE signature of plants and fungi is able to indicate the occurrence of concealed ore deposits like those of REY, Sc, Zr, Hf, Mo, U and others.

Marine Minerals Database and Information System at GEOMAR

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Poster in Session C3

Marine minerals and marine mining are an ongoing and current topic in many research fields, as nations begin looking to the oceans for future raw materials. These resources include not only manganese nodules and crusts, but also deep-sea polymetallic sulfides, phosphorites, diamonds, rare earth elements, and other nonmetallic resources found both in the Area beyond the limits of national jurisdiction and in the national jurisdictions of developed and developing nations. Future management of these resources requires new analytical tools and spatial information systems to interrogate complex and overlapping datasets. At the Marine Mineral Resources group at GEOMAR we are in the process of developing such a continuous integrative Marine Minerals database (MMIS). In this presentation we will give an overview of the MMIS and the use of GIS in the crucial question of the abundance and distribution of Seafloor Massive Sulfide deposits. We will show our approach of combining and analyzing public open-source and proprietary in-house data. These data sets include global to small-scale geophysical data and marine data (heat flow, magnetics, marine gravity, multibeam swath bathymetry, AUV bathymetry, bioproductivity) as well as diverse geological information layers (sediment thickness, age of the ocean crust, lithology) and data regarding spatial planning information (e.g. areas under national jurisdiction, marine protected areas, license area for different uses). Information on the mineralogy, geochemistry, and physical properties of known mineral occurrences and their surrounding host rocks will also be included. We will further discuss the implications for decision making in marine resource management.

Borehole seismic in the ICDP borehole COSC-1

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As support for the COSC drilling project (Collisional Orogeny in the Scandinavian Caledonides), an extensive seismic survey took place during September and October 2014 in and around the newly drilled borehole COSC-1. The main aim of the COSC project is to better understand orogenic processes in past and recently active mountain belts. For this, the Scandinavien Caledonides provide a well preserved example of Paleozoic plate collision. Surface geology and geophysical data provide knowledge about the geometry of the Caledonian structure. The COSC project will investigate the Scandinavian Caledonides with two approximately 2.5 km deep boreholes, located near Åre and Mörsil, in western Jämtland. The approximately 2.5 km deep borehole COSC-1 was drilled close to the town of Åre between May and August 2014. The borehole has diameters between 96 mm (102 m – 1616 m) and 75.7 mm (below 1616 m) and is open hole, except for the first 102 m. The seismic survey consisted of a high resolution zero-offset VSP (vertical seismic profiling) and a multi-azimuthal walkaway VSP (MSP) experiment with receivers at the surface and in the borehole. The wavefield, excited by impulse sources, was recorded in the borehole by 15 three-component receivers using a Sercel Slimwave geophone string. The zero-offset VSP (ZVSP) was designed to result in a geophone spacing of 2 m over the whole borehole length. The MSP experiment was recorded in the borehole at various depths and covered about 40% of the borehole with 10 m geophone spacing. The ZVSP-data show a high signal-to-noise ratio and good data quality. On the vertical component, clear direct P-wave arrivals are visible. Several P-wave reflections occur below 1600 meters logging depth. On both horizontal components, clear direct S-wave arrivals are visible. Additionally, several horizons can be identified from downgoing PS-converted waves. The ZVSP-data will provide a link between laboratory measurements, logging and surface seismic results.

Contrasting subduction modes in the Variscan collisional orogen

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Oral in Session A1-06

The Variscides of Europe and N-Africa represents a classical collisional orogen (400-300 Ma) caused by the prolonged convergence of the continents of Gondwana and Laurussia. Orogen wide exposures of continental (ultra) high pressure units proves the presence of subduction processes concomitant with the accretion of unsubductable microcontinental blocks following the closure of the Rheic Ocean. This different orogenic modes are the result of the distribution of crustal domains of contrasting rheological properties caused by pre-orogenic heterogeneous extensional tectonics. Moderately thinned continental blocks behave as unsubductable crust, whereas the interjacent continental crust was extremely thinned and thus subductable. The variable interplay between both crustal types in space and time is seen as the principal cause for the observed sequence of subduction/accretion processes. We distinguish three subduction

zone systems (VSZS 1-3). The first collisional contact between Brittany of Gondwana and the Midland microcraton of Laurussia caused the early Devonian deformation along the Anglo-Brabant Fold Belt. This process is coeval with the initiation of continental subduction along the Armorican Spur of Gondwana (VSZS 1). As further subduction along this collision zone is blocked, the plate boundary zone is reorganized, leading to a flip of the subduction polarity as well as subduction jump outboard of the already accreted blocks. The following Devonian–Early Carboniferous subduction accretion process (VSZS 2) is responsible for the juxtaposition of additional Cadomian blocks against Laurussia and a second suite of high-pressure rocks. The final collision between Gondwana and Laurussia is marked by an intracontinental subduction event (VSZS 3) affecting the entire internal zone of the orogen. Subduction stopped at 340 Ma and was followed by orogenwide high-temperature metamorphism caused by the rapid exhumation of deeply buried continental crust.

Structural Uplift And Ejecta Thickness Of Layered Lunar Mare Craters: New Insights Into The Formation Of Complex Crater Rims

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Poster in Session A3-02

Most complex impact craters exhibit elevated crater rims. This uplift is largest at the rim crest and gets rapidly smaller with increasing distance to the crater center [1]. For simple craters the elevated crater rim is due to two factors: (i) Ballistic emplaced coherent proximal ejecta material at the transient cavity (overturned flap) [1]. (ii) Structural uplift of the pre-impact surface in the proximity of the transient cavity [1, 2]. The amount of structural uplift is achieved by bulk plastic thickening of the target rock adjacent to the cavity, the emplacement of interthrust wedges and the injection of dike material into the cavity walls [1, 2, 3]. Because simple and complex impact craters have fundamental differences in morphology and structure, the elevation of complex crater rims is less well understood [1, 4,]. The crater rim of complex craters is no more situated adjacent to the transient cavity rim but further outward where the ejecta thickness and the structural uplift is presumably less developed. To evaluate the cause of rim formation in complex craters we investigated five lunar craters. Their mean structural uplift amounts to 70.56% and the ejecta thickness to 29.44 % of the total rim height. The radial distance between the transient and the final crater diameter ranges between 250 m to about 6 km. We discuss possible mechanisms for structural uplift: A structural uplift by dike injection or emplacement of interthrust wedges seems implausible at distances of more than 1 km from the transient crater cavity. Other mechanisms, like reverse faulting, beginning in the excavation stage of crater formation, could be responsible for additional structural uplift of the crater rim.

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Coupled ^{182}W–^{142}Nd constraints on the early differentiation history of Mars

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Poster in Session A3-01

Investigating the early evolution of Mars is useful, not only because it is the only other terrestrial planet than Earth that we have samples of, but also because Mars may be a planetary embryo that accreted very early in solar system history [e.g., 1,2]. To unravel the early differentiation history of Mars, we applied the short-lived Hf-W and Sm-Nd isotope systems to a suite of martian meteorites. These data provide insights into the nature of Martian mantle domains, and may help to distinguish between isotopic variability caused by core formation, silicate differentiation, and late accretion. Here we report new ^{182}W data obtained by MC-ICPMS [3] with an external reproducibility of 5-10 ppm (2.s.d.) for samples from different groups of shergottites and for NWA7034, the only polymict breccia from Mars [4]. The four enriched and two intermediate shergottites analysed here define a uniform ^{182}W excess of ca. +40 ppm relative to the present-day bulk silicate Earth, while a depleted shergottite exhibits a slightly larger ^{182}W excess. Modelling shows that the coupled ^{142}Nd-^{182}W variations within the shergottite suite may have been established ~50-60 Ma after CAI formation, consistent with the ^{142}Nd-^{143}Nd model age for shergottites [5]. NWA 7034 shows the least radiogenic ^{182}W composition yet measured for martian meteorites, consistent with the idea that this breccia derives from early-formed martian crust [6]. If this crust formed by partial melting of a primitive mantle, then the ^{182}W data suggest crust formation on Mars at ca. 20-30 Ma after CAI formation.

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Tectonic and edaphic constraints on early hominin strategic landscape use in the Kenya Rift

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Poster in Session A6-01

We present a detailed landscape reconstruction of Olorgesailie, a key site in the East African Rift with a long history of use between ~1.2 and ~0.5 Ma and abundant evidence of large-mammal butchery. We show how it was strategically located to exploit the complex and tectonically active landscape for ambush hunting. We suggest this as the earliest known example of strategic landscape use. We introduce new methods in support of this hypothesis, using tools developed to study earthquake faults, and the mapping of trace nutrients in soils critical to the health of large mammals. These techniques allow us to identify the limited routes of movement and grazing areas available to large mammals in the Olorgesailie region during the Lower to Middle Pleistocene and show the strategic location of the site as a base for their exploitation. These features explain the importance of Olorgesailie as a preferred location of repeated hominin activity that maintained its attractions despite multiple changes in climate and local environmental conditions.

comparable with detailed facies maps and sequencestratigraphic interpretations like those established in adjacent areas in Poland.

Early Jurassic lithology and facies distribution in the eastern part of the North German Basin revisited from litho-facies maps and borehole descriptions

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Poster in Session B5-02

To estimate geological storage potentials, the spatial and temporal distribution of porous rock units acting as reservoirs and tight rocks acting as seal layers has to be known. Therefore, knowledge about facies variations and changes in lithology is essential for an evaluation of the usage of the subsurface. These variations are dependent on the development of depositional environments and thus on sea-level changes and tectonic activities. To enhance our insight into changing environments, sequencestratigraphic interpretations, borehole investigations, mapping, and geological modeling are commonly used methods. In this study we reinvestigated existing lithological and facies maps together with borehole descriptions for the Early Jurassic time interval for the eastern part of the North German Basin. The original maps cover four time slices, i.e. Hettangian to Lower Sinemurian, Upper Sinemurian to Lower Pliensbachian, Upper Pliensbachian, and Toarcian. These maps have been digitized and interpreted with ArcGIS software. Each of these maps has been spliced into five separate maps, each for lithologies and facies. As a result, the detailed development of Early Jurassic transgressions and regressions together with its changing lithologies is visible. In combination with lithological borehole descriptions and facies interpretations, our results can be implemented into 3D geological models and used for further property and dynamic modeling. Furthermore, these maps are now

Indonesian Throughflow and Indo-Australian Climate History through the last glacial cycle

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Keynote in Session A6-03

The transfer of surface and intermediate waters from the northern Pacific Ocean to the Indian Ocean through the Indonesian Gateway (Indonesian Throughflow: ITF) strongly influences the heat and freshwater budgets of tropical water masses and regional monsoonal climate. The ITF also contributes to the renewal of thermocline water in the tropical Indian Ocean, leading to freshening of the central Indian Ocean and exerting a strong influence within the main source area of the Asian monsoon. Key areas for monitoring past ITF variations are the narrow passages through the Makassar and Timor Straits and the main outflow area into the Eastern Indian Ocean. High-resolution sea surface temperature and salinity reconstructions, grain size analyses and XRF-scanner derived runoff data from an array of sediment cores reveal that high-latitude climate variability influenced ITF intensity on different timescales. Declines in ITF strength occurred during Heinrich events and the Younger Dryas, most likely related to slowdown of the global thermohaline circulation during colder northern hemisphere climate spells. Sea level additionally exerted a major control on ITF properties through the last glacial termination by altering pathway configuration and regional precipitation-evaporation budgets. Runoff

estimates indicate that the development of the tropical convection at the southern margin of the Indonesian Throughflow was intricately linked to latitudinal shifts in the seasonal position of the Intertropical Convergence Zone (ITCZ). A massive intensification of the Australian summer monsoon through the Younger Dryas and earliest Holocene (12.9-10 ka) coincided with a southward shift of the ITCZ during a major deglacial atmospheric CO_2 rise coupled to southern hemisphere warming and enhanced greenhouse forcing over the Australian continent.

The effect of iron and aluminium incorporation on the single-crystal elasticity of bridgmanite at high pressure

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$MgSiO_3$ bridgmanite constitutes about 70% by volume of the Earth's lower mantle and likely governs the physical behavior of this region. Chemical substitutions in $MgSiO_3$ bridgmanite involving Al and Fe may explain seismic velocity anomalies observed in the Earth's lower mantle [1-3]. However, the effects of these substitutions on the anisotropic elastic properties of bridgmanite at high pressure and temperature are experimentally unconstrained. Here, we present first data of an internally consistent measurement of the single-crystal elastic properties of $Mg_{0.88}Fe_{0.12}Si_{0.09}Al_{0.11}O_3$ bridgmanite at high-pressures. Two differently oriented single-crystals of brigmanite have been double-side polished and cut as two semi-disks using a FEI Scios Focused Ion Beam (FIB) machine. Semi-disks of each crystallographic orientation were loaded together in the pressure chamber of a single diamond anvil cell with helium as a pressure-transmitting medium. Simultaneous measurements of density and sound velocities have been made on both crystals at high pressures using single-crystal X-ray diffraction and Brillouin spectroscopy in order to obtain self-consistent data, which do not depend on a secondary pressure scale. The data at each pressure were fitted for both crystals simultaneously in order to reduce correlations among the elastic constants Cij. Our approach allows for determining the single-crystal elastic properties of bridgmanite as a function of pressure, derived independently of a secondary pressure. We will use our results for Al-Fe-bearing bridgmanite to discuss the effects of chemical substitution on the high-pressure elasticity of bridgmanite and potential implications for the interpretation of seismic heterogeneities in Earth's lower mantle.

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Triaxial testing of marine sediments from offshore Costa Rica (Costa Rica Seismogenesis Project – IODP Expeditions 334 and 344)

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Poster in Session A1-06

Two major endeavors of the International Ocean Discovery Program (IODP), the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) and the Costa Rica Seismogenesis Project (CRISP), investigate the processes and controlling factors of deformation and seismogenesis at accretionary and erosive active continental margins including the incidence of large magnitude earthquakes and related tsunamis. Here we focus on the marine sediments from the Costa Rica erosive margin. Triaxial testing of these sediments may allow to shed light on the material properties promoting either distributed and continuous deformation or localized and discontinuous deformation in the forearc wedge and the subduction

channel. Results will also be compared to similar investigations on sediments from the Nankai trench (Stipp et al., 2013). Whole-round core samples recovered during IODP Expeditions 334 and 344 from a depth range of 7–125 m below sea floor were experimentally deformed in a triaxial cell under consolidated and undrained conditions at confining pressures of 400–1000 kPa, room temperature, axial displacement rates of 0.01–0.1 mm/min, and up to axial compressive strains of $\sim$ 45%. Experimental data show great differences in the consolidation state and the related mechanical behaviour of upper plate and incoming plate sediments. Similar to previous findings from the Nankai trench, structurally weak and structurally strong samples can be distinguished. One sample from the incoming plate shows a transition from structurally strong to structurally weak behaviour at elevated confining pressure of 1000 kPa that has not been observed for Nankai trench samples. The observed differences in mechanical behavior may hold a key for understanding strain localization and brittle faulting in forearc regions.

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Using apatite as a fluid probe for halogens to decipher fluid-rock interaction

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Oral in Session A7-01

Apatite is the main host of halogens in magmatic and metamorphic rocks and plays a unique role during fluid-rock interaction as it incorporates halogens (i.e. F, Cl, Br, I) and OH from fluids to form a ternary solid solution of the endmembers F-Apt, Cl-Apt, and OH-Apt. The distribution of halogens between fluid and apatite relies on a complex interplay of mainly compositional factors (i.e., activity of halogens, pH) and processes underlying the formation of hydrothermal apatite. Results of distribution experiments between apatite and fluids allow the calculation of halogen activities in natural hydrothermal fluids from the halogen concentrations of coexisting apatite. Here, we present spatially resolved halogen data for different apatite generations of two metasomatized gabbro samples adjacent to shear zones from different localities (i.e., Bamble Sector, SE Norway and Krakeneset, Western Gneiss Complex, W Norway). We use these sample sets to constrain the fluid composition and a possible compositional evolution of the fluid as fluid-rock interaction proceeded. Samples of both localities represent alteration sequences with an increasing fluid influence going from unaltered gabbro (no fluid present) via pervasively altered gabbro (moderate fluid flux) to shear zone (high fluid flux). Apatite from the Bamble sector shows a evolution in F and Br, with relatively high F/ low Br concentrations in samples close to the shear zone and low F/ high Br in least altered gabbro samples. In Krakeneset metagabbro the newly formed hydrothermal apatite from the shear zone is highest in Cl and Br and lowest in F, whereas least altered gabbro contains low Cl/Br and high F apatite. In both localities the halogen behavior is a result of an evolving fluid that changes its composition due to ongoing fluid-rock interaction. Both examples show the ability to use apatite as a fluid probe for halogens during fluid-rock interaction that can record compositional changes in hydrothermal fluids.

The effect of tetrahedral B on the B isotope fractionation between tourmaline and fluid

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Tourmaline is the most important carrier of B in crustal rocks and its $^{11}B/^{10}B$ ratio is a powerful tracer for geological mass transfer [1]. Δ^{11}B(tur-fluid) mostly depends on temperature and the bonding environment of B [3]. Most tourmalines contain 3 B pfu in trigonal planar coordination ($^{(3)}$B), but at ultrahigh pressure additional B can be incorporated as $^{(4)}$B substituting for Si on the tetrahedral site. Here, we present first results of the effect of $^{(4)}$B in tourmaline on Δ^{11}B(tur-fluid). We synthesized large (up to 30 x 150 μm), olenitic tourmaline, containing up to 2.53 $^{(4)}$B pfu together with coesite (12 wt%), and traces of AlBO3 (1 wt%) in presence of 300 mol% excess boric acid in a piston-cylinder press at 700°C/4.0 GPa. MC-ICP MS analyses of the experimental fluids proved that the difference of δ^{11}B of the starting (-5.88(5)‰) and the final fluid (-5.21(7)‰) is small. Thus, Rayleigh fractionation during tourmaline growth is negligible. SIMS analyses of the experimental tourmalines have been performed with spot sizes of 2-3 μm at an external precision of ±1‰. Preliminary results from a single, chemically homogenous grain with 1.18(15) $^{(4)}$B pfu) give δ^{11}B = -7.1‰ in the outermost rim. We interpret this value to derive from equilibrium fractionation with Δ^{11}B(tur-fluid) = -1.9±1.1‰ at 700°C/4.0GPa. B isotope fractionation between $^{(4)}$B-free tourmaline and fluid is significantly smaller (-0.8±0.5‰) at 700°C/0.2GPa [2], indicating that the lighter ^{10}B strongly fractionates into the tetrahedral site. Given the measured $^{[3]}$B pfu/ $^{(4)}$B pfu ratio of 2.5, at 700°C/4.0GPa, the estimated Δ^{11}B(tur-fluid) is -4.5‰ for $^{(4)}$B and -0.8‰ for $^{(3)}$B with the latter value taken from [2]. Assuming that pressure has no significant influence on Δ^{11}B(tur-fluid) we can give an estimate for the intracrystalline fractionation at 700°C with Δ^{11}B($^{(3)}$B-$^{(4)}$B) = 3.7‰. Ref.:

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Evolution of Andean orogeny, feedbacks between tectonics and global climate

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The Andean subduction margin, largest tectonic relief on the Earth (13 km vertically) has a stepped morphology, dominated by the Atacama Bench, a giant uplifted terrace at 1-2km asl. The stepped morphology is due to concomitant evolution of W-vergent thrusts parallel to the subduction interface and increasing aridity in the Atacama Desert, which keeps a large-scale record of interplaying tectonics and Cenozoic climate change. Geomorphic, climatic data, and numerical experiments of drainage incision are consistent with the development of a flat Atacama morphology, close to sea level, interrupted at ≤10 Ma by tectonic uplift prevailing to the present. This suggests recent trench-ward relief growth by incorporation of the Atacama Bench to the Andes mountain belt. Combining those results with published geological knowledge at the scale of the Central Andes, demonstrates that Andean orogeny results from protracted processes of bivergent crustal shortening in a wide region squeezed between the rigid Marginal Block and the S America Plate. The overall growth curve of Andean orogeny over the past 50 Myr appears synchronous with onset of the "ramp-shaped" temperature decrease since the Early Eocene climatic optimum. Andean growth and global cooling may have operated under the same forcing mechanism at plate-scale, involving viscous flow in the mantle. But Andean growth appears modulated by climatic feedbacks causative of stepwise reductions of erosive power over the Andean margin. The first of such events is coeval with Late Eocene cooling and promoted the eastward propagation of deformation from the W Cordillera to the E Cordillera-Interandean belt wedge. The second one, coeval with Late Miocene cooling, is associated with establishment of hyper-aridity in the Atacama Desert, and is responsible of a tectonic "freezing" which promoted since the triggering of subduction of the Brazilian craton, the Andean bivergent growth, and rapid uplift throughout the Andes–Altiplano.

Shale Gas and Fracking in Germany - Resources and Environmental Risks

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The pros and cons of unconventional gas and oil development and production are heavily debated in the public. In light of this controversial debate the German Federal Institute for Geosciences and Natural Resources (BGR) conducted a comprehensive resource assesment of shale gas and light tight oil in Germany and also studied the environmental impacts of shale gas development and hydraulic fracturing from a geoscientific perspective. In an interim report in 2012 of this project called "NiKo" („Nicht-konventionelle Kohlenwasserstoffe") a preliminary assessment of shale gas-in-place (GIP) was published and gave figures between 7 -23 x trillion cubic meters GIP. In place shale gas resources therefore are considered as significant. The interim assessment was mainly based on a desktop study of three possibly prolific shale formations: the Lower Carboniferous, the Jurassic Posidonia Shale, and the Wealden of the Lower Cretaceous. Here we present our final assessment, incorporating further prolific shale formations and employing several different assessment methods. Besides shale gas also light tight oil is incoporated in the assessment and this now relies on detailed laboratory analysis of petrophysical, mineralogical and geochemical parameters of the investigated shales. Additionally, the technically recoverable resources also are statistically modelled using a Monte-Carlo simulation. Furthermore an overview of employed modelling approaches concerning environmental impacts of the hydraulic fracturing is given. These models are based on a representative lithostratigraphy of the North-German basin. Hydrogeological modelling of frac fluid migration in the subsurface has been conducted, as well as stress modelling to estimate frac dimensions, magnitudes and frequency of induced seismity.

Geological 3D modeling of the deep underground in Schleswig-Holstein and Hamburg (north german basin). – A part of the joint project TUNB (Tieferer Untergrund Norddeutsches Becken)

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Poster in Session B5-02

In 2014 the joint project TUNB started its 6-year program. Within the project the partners (the Federal Institute for Geosciences and Natural Resources and the Geological Surveys of Northern Germany) will develop a national coherent geological 3D-model of the deep underground of the North German Basin. This large 3D-model will be constructed on the databases of the Tectonic Atlas of Northwest Germany and the German North Sea Sector (GTA) and the Geophysical Map Series of the former GDR (GPK). The experiences of the Geological Survey of Schleswig Holstein in 3D-modeling and related workflows are based on prior and current project works. Within the framework of these projects a geological 3D-model showing the base surfaces of the deep subsurface structures of Schleswig-Holstein was continuously developed, and several small-scaled but detailed models were built in different areas. Starting from the current stage of development, within the project TUNB the existing 3D-model will be verified, updated and further improved by means of wells, logs and seismic data. In a later stage, a parametrization of special volumes of interest with petrophysical properties is planned. This shall give a deeper insight in the usability of the deep underground for the different and competing demands, e.g. the extraction of geothermal energy from deep seated aquifers or gas storage in caverns within salt structures. By co-operating with project partners, the overall aim is to achieve cross-border consistency of the 3D-model. Since the Geological Survey of Schleswig-Holstein has just started to participate in the TUNB-project, the poster will give an overview of the existing 3D-Models, and a brief outline of the future works.

A valley over the course of time: Detailed geomagnetic mapping of two lava flows as base for a morphological reconstruction of the Alf valley, Quaternary Westeifel Volcanic Field (Germany).

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Poster in Session A6-01

The Alf valley at Gillenfeld and Strohn differs in its morphological and conspicuous structure from its neighboring valleys. The reason for the present course and shape of the valley is volcanic activity during the Late Weichselian glaciation. The recent Alf valley has a maximum width of 500 m and a slope of less than one percent between the Mehrener Maar and Strohn. About 30,000 years ago the so called Wartgesberg-volcano complex was formed in the southern part of the village Strohn. The ejected material piled up to a natural dam at the center of the Alf valley. Subsequently, the river was impounded for several thousand years. Due to the effusive activity two lava flows were promoted, one northwards (Strohn lava flow) and one southwards (Sprink Lava flow). These followed the route of the former valley and created a fingerprint of the paleo-surface. Total magnetic field intensity data were evaluated with the application of ArcGIS. In addition, the past route of the Alf valley, before volcanic activity had started, was reconstructed.

Unravelling processes of ore formation in porphyry Cu deposit with chalcopyrite Cu isotope compositions

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The Veliki Krivelj porphyry Cu deposit belongs to the Bor metallogenic zone, East Serbia. This zone characterized by numerous porphyry copper deposit, is part of the Late-Cretaceous Timok magmatic complex. The Veliki Krivelj copper deposit is formed in the domain of dyke systems above the quartz diorite plutonic intrusion. Chalcopyrite - pyrite veins or disseminated fine grain mineralization is located in hydrothermal altered late andesites and volcanoclastic sedimentary rocks. A vertical profile of around 200 m of chalcopyrite mineralization was sampled from the open mining pit. Sulphur isotope composition indicates magmatic origin of the ore sulphides. Copper isotope compositions of Veliki Krivelj chalcopyrite have been measured by (194 nm) deep UV-fsLA-MC-ICP-MS. For correction of instrumental mass bias, a Ni NIST SRM 986 standard solution has been introduced simultaneously to LA analyses. The δ65Cu values have been determined relative to the NIST SRM 976 Cu standard. A long-term reproducibility of better than 0.08‰ and 0.1‰ (2SD) on the NIST SRM 976 Cu-metal and chalcopyrite in-hause standard respectively, has been achieved with this technique. Analysed chalcopyrite veins have homogeneous δ65Cu, while disseminated grains present up to 0.3‰ difference within the sample. This may indicate secondary alteration. Although all chalcopyrites are mineralogically primary minerals they exhibit a range of more than 1.2‰ in δ65Cu between individual samples. Samples with southwest-northeast orientations have mostly positive and those with northwest-southeast orientation mostly negative δ65Cu. These two major orientations in chalcopyrite δ65Cu are likely related to the directions of mineralization. Furthermore, Cu isotope fractionation along vertical profile is observed for both directions of mineralisation which may indicate changes in the composition of the source of the hydrothermal fluids.

Kinematic reconstructions and possible driving forces of the Adriatic microplate

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The Adriatic microplate (Adria) is a key player in the geodynamics of the Western Mediterranean area. This microplate is caught between two major plates, Africa and Europe, that have been converging since Late Cretaceous time. Today, Adria comprises only continental lithosphere and is completely surrounded by highly deformable convergent boundaries (Apennines, Alps, Dinarides-Hellenides, Calabrian Arc) and distributed deformation in back-arc basins (Tyrrhenian and Algero-Provencal). Thus, kinematic reconstructions of this microplate and of the tectonic evolution of this area are a big challenge. We compare existing kinematic models for Africa, Adria and the Corsica-Sardinia block relative to a stationary European plate and select a combination of models that optimize consistency between geological and geophysical data. We also improve models for Adria motion by incorporating new shortening estimates from the Northern Apennines, the Alps and the Dinarides. The calculated motion rates for Adria and Africa relative to Europe indicate that Adria moved faster than and independently of Africa after the onset of Alpine subduction (from c. 84 Ma to c. 20 Ma). This raises the question of what drives the motion of Adria. Slab pull due to the subduction of part of Adria beneath Europe in the Dinarides is viable until c. 67 Ma when continental subduction/collision started and therefore slab-pull must have considerably decreased or stopped altogether. In the Alps, slab-pull cannot explain Adria-Europe convergence because Adria was the upper plate. A push from Africa is unlikely due to Adria's higher convergence rate with Europe and changes in direction of motion relative to Africa. Thus, viscous drag of upper mantle flow due to trench suction most likely drove motion of Adria between 84 and 20 Ma. After 20 Ma, indentation of Adria is compatible with a push of Africa if Adria is assumed to rotate counter-clockwise by 10°.

Wesersandstein: Building, dimension and ornamental stone, used yesterday and today

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Oral in Session B6-02

Since more than 1000 years the Lower Triassic Weser Sandstone (Solling-Formation, Buntsandstein) is used as dimension and ornamental stone: masoned as well as rough quarry stone. Todays use requires specific raw stone qualities primarily controlled by the depositional environment and the fracture system. Recent microscopic, geochemical and petrophysical investigations combined with fracture system analysis defines three sandstone varieties of different usage: The mainly fine grained reddish subarkosic wackes of the "Roter Wesersandstein" (Red Weser Sandstone) comprises two facies: (a) laminated flagstone to be split manually in thin slabs used for façade cladding and roofing (b) the contrasting massiv sandstone may masoned and sculptured and is used as well for machine-processed massiv components. (c) Due to the comparibly high quartz cement content the mainly medium grained greyish subarkose of the "Grauer Wesersandstein" (Grey Weser Sandstone) was historically used for weather resistant purposes like massiv quoins and socles. Today it is used also for paving stones and machine-processed massiv products. Interrelations between the depositional environment, mineralogical composition, geochemical characteristics and petrophysical properties controlling the usage of these sandstones up today have been investigated and will be presented in detail. References:

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Influence of iron- and sulfur-oxidizing bacteria on the operation of a geothermal cold storage system in the North German Basin: impact on well injectivity and filter lifetime

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Shallow aquifers are increasingly being used to store thermal energy for building climate control. An aquifer thermal energy storage system, located in Berlin in 30-60 m depth, was monitored for 21 months, including a phase of decreased filter lifetimes at the topside facility. The microbial biocenosis in fluid and filter samples collected from the topside facility was characterized using molecular biological methods under consideration of geochemical and mineralogical analyses. The genetic fingerprints revealed a biocenosis dominated by iron- and sulfur-oxidizing bacteria related to the genera Gallionella, Ferribacterium, and Thiothrix. SEM analyses indicated iron hydroxide precipitation in the filter of the topside facility and the well, corresponding to the detection of iron-oxidizing bacteria. Besides oxidizing bacteria, sulfate-reducing bacteria were detected as well, indicating the formation of micro-habitats with divergent redox zones. During a phase of plant failure caused by filter clogging, an increased abundance of sulfur-oxidizing bacteria (SOB) related to the genus Thiothrix was detected. Thiothrix related species are filamentous and tend to form biofilms. In addition to biofilms, precipitated iron sulfides, iron hydroxides, and carbonates caused the filter clogging, whereas the isotopic signatures of the sulfides (34S) and carbonates (13C) indicated microbial induced formation. The detection of SOB indicated a changed availability of electron acceptors; however, oxygen and nitrate concentrations were below the detection limit. Thus, the detection of SOB indicated a temporarily ingress of oxygen into the well more sensitively compared with chemical measures. Mechanical cleaning and a disinfection treatment successfully re-established normal filter lifetimes and well injectivity. Finally, technical adjustments are required to sufficiently maintain the pressure in the wells during phases of higher fluid production rates to prevent oxygen ingress.

Operational Earthquake Loss Forecasting: a Retrospective Analysis of some Italian Seismic Sequences

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Operational earthquake forecasting (OEF) is receiving increasing attention as potential tool for short-term management of seismic risk. Relying on real-time monitoring of seismic activity in a geographic area of interest, OEF provides constantly (e.g., daily) updates of the mean number of events exceeding a certain magnitude threshold in a given time window. In fact, magnitude exceedance rates cannot be directly used for risk management, which requires estimations in terms of seismic losses. If suitable information about vulnerability and exposure is available for the area of interest, it can be demonstrated that rates from OEF can be converted into expected values of loss in the same time period OEF refers to. This is a procedure recently defined as Operational Earthquake Loss Forecasting (OELF). In Italy an OEF system exists: it provides rates of earthquakes exceeding magnitude (M) 4 in a time-window of one week; these rates are updated, at least once a day, or right after the occurrence of a M 3.5+ earthquake. Moreover, at a national scale, structural vulnerability (i.e., the probability of building damage given a seismic intensity measure and the probability of injury or fatality for a given damage state) and exposure (i.e., the number of buildings and inhabitants per municipality), is also available information. Based on these data, OELF can be applied and losses can be estimated in terms of expected number of (i) collapsed buildings, (ii) displaced persons, (iii) injuries and (iv) fatalities in one week time horizon after the OEF data release. An experimental system for OELF has been set up and these indices of seismic risk have been computed referring to significant Italian seismic sequences of the last decade for a retrospective analysis of OELF potentialities. Analysed sequences are those of L'Aquila, Emilia and Garfagnana that featured a mainshock on 06/04/2009 (M 6.3), 20/05/2012 (M 5.9) and 21/06/2013 (M 5.1), respectively.

Alluvial Fans of the Oman Mountains: Morphometry and Hydrodynamic Characteristics

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The sedimentary record and morphologic characteristics of alluvial fans are mainly controlled by environmental factors, such as the overall climatic regime, hydrodynamic conditions, source lithology, relief factors, rates and style of tectonic activity, and other geomorphologic parameters of the overall area. Our study describes and evaluates the influence of environmental factors on the evolution and morphology of alluvial fans at the northern limit of the Oman Mountains, an area which is defined by a hot-desert climate (Bwh). This mountain range had formed in a continent–ocean zone during the Late Cretaceous and was affected by further compression and uplift during the Cenozoic. We derived quantitative morphological parameters from spatial analysis of remote-sensing satellite imagery based on Landsat and digital elevation models based on ASTER and SRTM using manual and semi-automatic algorithms. Our data record of alluvial fans confirms general shape characteristics described by Blair and McPherson (1994) from other locations. Surface areas of alluvial fans are in the range of 0.1–10 sqkm and generally increase with the size of the source area (1–100 sqkm). While fan areas increase fan slopes usually decrease and are below 10°. Fan slopes decrease in downstream direction forming a concave-upward profile. When comparing results to data from other locations in different climate zones we see a distinct trend towards debris-flow dominated fan genesis for most of the features in Oman. Our analysis will be used to constrain environmental boundary conditions in a quantitative way and assess their potential influence on morphology and shape of alluvial fans.

Sluggish homogenization of the late accreted materials in the Earth's mantle: Constraints from S, Se, Te, Ag and Cu in Archean komatiites

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Differences in the abundances of highly siderophile elements in komatiites that formed prior to and after 3 Ga have been interpreted to reflect progressive homogenization of the late accreted materials into the Earth's mantle (Maier et al., 2009). Alternatively, these variations may reflect sluggish mixing of deep mantle domains formed during differentiation of a terrestrial magma ocean (Touboul et al., 2012; Puchtel et al., 2013, 2014). Here, we evaluated these hypotheses by using abundances of incompatible chalcophile elements in well-preserved komatiites from the 3.5 Ga Barberton and the 2.7 Ga Belingwe greenstone belt. Belingwe komatiites display negative correlations of Cu and Ag abundances with MgO. The majority of the Barberton samples plot on the lower end of these correlations. Abundances of S, Se and Te in Belingwe komatiites show similar negative correlations with MgO, however, Barberton komatiites are systematically offset to low concentrations of S, Se and Te. With the exception of a sample from the boundary of the spinifex zone to the cumulate zone, S/Se, Se/Te and Cu/Ag of Barberton komatiites overlap ratios in Belingwe komatiites and Phanerozoic peridotites. In contrast, because of the low concentrations of S, Se and Te in Barberton komatiites, ratios of Cu and Ag relative to S, Se and Te are considerably higher than in Belingwe komatiites and Phanerozoic peridotites. It is unlikely that substantial mobilization of these elements would result in (or retain) near-chondritic S/Se, Se/Te and mantle-like Cu/Ag. Thus, because of their incompatible behavior, element ratios likely represent those of their mantle source. The chondritic ratios provide independent evidence that S, Se and Te in the Bulk Silicate Earth were delivered by a late veneer. Low abundances of S, Se and Te relative to Cu and Ag and near-chondritic S/Se and Se/Te in Barberton komatiites are consistent with incomplete mixing of the late accreted materials in the 3.5Ga terrestrial mantle.

Analysis of the Dynamic Mechanism of Continental Drift and Plate Motion

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The dynamic mechanism of continental drift and plate motion is a foundamental geodynamic issue that has long been argued and needs to be addressed in the sphere of human geosciences. This study shows that under the earth isostatic pressure, whether the material ascending or descending motions will all give rise to the horizontal converging movement of the surrounding material to the space portion with material deficit. Therefore, the ascending movement of lighter material (e.g., The magma rising results in the volcanic arc.) or the descending movement of heavier material (e.g., The delamination of lower crust and lithosphere mantle results in the sinking mantle current.) in the course of the ocean floor plate subduction, melting and vertical differentiation (below the continent) both generate the subcrustal horizontal sucking force. The mutual sucking movement of the American Plate and the East Pacific Plate is in essence the mutual sucking movement caused by the subcrustal horizontal sucking force produced by the subduction, melting and vertical differentiation of the East Pacific Plate below the American continent. The oceanward drift of the continent and the landward subduction of the ocean floor plate are the two mutually contradictory aspects, which are interdependent and mutually based. The hauling action of the stronger subcrustal horizontal sucking force below the continent results in the subduction of the ocean floor plate below the continent. The continental crust oceanwaord drifting force as a result of the subducted ocean floor plate melting and vertical differentiation caused the volcanic island arc or the continent to drift toward the ocean, giving rise to the continent marginal pull-apart and the formation of marginal sea basins, results in the coninental pull-apart and the formation of neogenic ocean. In November 2011, China Geological Press published the monograph—≪Theory of Crust-Mantle Differentiation and Sucking≫.

Evolution of the Baiyun Slide Complex and stability of the unfailed slopes on the northern margins of the South China Sea

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Poster in Session B3-03

The Baiyun Slide Complex (BSC) in the northern South China Sea (SCS) ranges among the largest slide complexes at passive continental margins, comparable in size with giant slides offshore Norway and Northwest Africa with a total area of 10,000 km2. The description of the BSC morphology, the seismic characterization of its structural elements and the analysis of the slide evolution are based on high-quality seismic reflection and multi-beam bathymetry data. The BSC has three major slide scar zones (termed A, B and C) that clearly differ in terms of morphology and underlying mass movement process. Headwalls, sidewalls, internal architecture and basal shear surfaces are well presented in the seismic profiles. The BSC consists of several slide phases and we propose a four-phase emplacement model. An extrapolation of the post-slide drape thickness (60 m) gives a very rough age estimate for the mass transport events of 0.3 Ma. Calculations using porosity measurements at ODP site 1146, ~50 km away show that excess pore pressure in the slope sediments is anomalously high at a depth around 93 m, which may be caused by a dramatic increase in sedimentation rates over the past 1.8 Ma. This increase is believed to be the major preconditioning factor for mass wasting related to the BSC, possibly aided by volcano-tectonic activity and gas hydrate dissociation. We conducted pseudo-static slope stability analysis which shows that the unfailed slope around the BSC is stable under static conditions. However, the preliminary calculations indicate that a near-field earthquake of Mw ~ 6 could induce a slope instability at a depth of ~93 mbsf. This alarming result calls for more sophisticated geotechnical investigations on the stability of the submarine slopes that are offshore of one of the most densely populated coastal stretches of the world.

Neoproterozoic-Phanerozoic tectonic evolution, magmatic pulses and metallogenic concentric period in East Asia: relation to the cycle of a self-organizing superheat-dissipation in the Earth

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Oral in Session A2-03

The change of mantle temperature and the corresponding time of accumulated deep-seated overheat are very active and important factors that powerful drive the evolutionary processes of the Planet-Earth, because the heat energy with the evolution of the planet is final out. In fact, the evo-lutionary history of the Earth is a recording of self-organizing superheat-dissipation in the Earth. Its mechanism can be simple description: Te=E1+E2+E3+E4+...+En, If the dissipating-heat (Te) is big as some value, namely turn into a superheat, then begins to drive a self-organizing superheat-dissipa-tion in the Earth. Sr isotope composition in the sea water is a useful geochemical signature that is connected with Bio-Sedimentary System and Tectono-Thermal System in the Earth system. On the base of the antiformal and synformal changes of the ratio of 87Sr/86Sr of sea water in geological history, and linking with regional tectono-sedimentary interface, tectono-thermal events and metallogenic geochronology, it may be given 5 gigantic cycles of the self-organizing superheat-dissipation after the assembly of Rodinia, and each one includes two processes with different nature (namely, one continent breaks up and a new continent is assembling), but parallel to evolve each other: I. 943-685Ma, Early-Middle Neoproterozoic Rodinia breaks-up and Middle-Late Neoproterozoic Sino-Kazakhstan-Siberia continent assembly; II. 685-550Ma, Late Neoproterozoic Sino-Kazakhstan-Siberia continent breaks-up and Late Neoproterozoic-Early Paleozoic Sino-Pannotia assembly; III. 550-500 Ma, Early Paleozoic Sino-Pannotia breaks-up and Early Paleozoic Gondwanaland accretion Orogeny; IIII. 500-280Ma, Early-Late Paleozoic Gondwana breaks-up and Late Paleozoic Pangea assembly; V. 280-60Ma, Late Paleozoic-Mesozoic Pangea breaks-up and Late Mesozoic-Cenozoic Afca-Eurasia assembly.

Coastal storm surge flooding impact under different climate scenarios in Pearl River Delta

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We apply a sophistic hydraulic model called D-Flow Flexible Mesh, to analyse the hydraulic processes between River Estuaries and the Marine System in Pearl River Delta, in order to better understand the tide and flooding inundation on the coastal areas. Pearl River Delta is one of the most complicated river networks and the most developed megalopolises worldwide. The coastal area of the Pearl River delta is more vulnerable to the natural disasters, such as flooding, landslides and weather extremes. This latest model is the first application in such a big domain and such a complicated river network in the worldwide. We have set up the D-Flow model for the Pearl River Delta, covering the domain between 15.54 -23.94oN and 108.95 -117.07 o E. Our domain includes the Pearl River distributaries and approximately 100 km sea area. We simulate the hydraulic interaction process in wet and dry season of the year 1999, 2002 and 2009. We choose different roughness scenarios as the sensitive test of the model in order to calibrate the model performance. This research shows that the discharge distributions depend strongly on temporal hydrodynamic processes influenced by seasons. We could see the model performance differently in the upstream for different roughness as well. Regarding the subtidal discharge in the upstream part of the Pearl River Delta, the discharge from West River is more than North River, which affect the flow direction at cross section to eastwards. Influencing tidal propagation can also have an effect on floods in the Delta. Wet season has much influence on the subtidal discharge in the upstream part of the Pearl River Delta and in case of relative high lateral sources of river discharge on the downstream bays.

SEM-EDX-based mineralogical, paragenetic and geochemical characterization of Nb-Ta-minerals in granites and greisen of the Sn-W-Li-deposit Zinnwald, Erzgebirge, Germany

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Poster in Session B1-04

A variety of accessory Nb-Ta-oxide minerals of the greisen deposit Zinnwald, eastern Erzgebirge, Germany have been studied using light and electron microscopy (SEM) as well as energy dispersive X-ray spectrometry (EDX). The analyzed samples were taken from recently obtained exploration drill cores, which intersected greisen mineralization and greisenized granites in the uppermost part of a geochemically evolved and pipe-shaped granitic intrusion. About 100 mineral grains from nine samples of different drill holes and depths have been characterized and analyzed. Primarily, Nb-Ta-oxides form grains of euhedral to subhedral shape, but due to intense alteration processes the majority was corroded leaving anhedral grains with sieve-like textures. Grain sizes range from 50–300 μm. The vast majority of analyzed mineral grains reveal chemical compositions close to W-rich columbites. Some of them show enrichment in Ti up to 50 wt.% and are considered as Nb-rutiles. Manifold and complex zonation patterns, including regular growth zoning, apparently disorganized, patchy zoning as well as the combination of both are visible in BSE images. These zones reflect variations in Nb/Ta ratio from 1 to 10 with dark areas corresponding to the enrichment in Nb. The type of zoning is not related to a distinct paragenetic relationship, depth or lithological type. In addition, an increasing Fe/Mn ratio over depth has been interpreted as hint for pathways of uprising F-rich fluids. Moreover, we can distinguish the main paragenesis minerals (quartz, zinnwaldite, cassiterite and fluorite-topaz) by diagnostic trends of Fe/Mn-ratio in the mineral chemistry of columbite, which also shows lower Fe/Mn-ratios in altered compared to unaltered rocks. Finally, slight variations of W/Ti-ratio have been observed, but could not be quantified sufficiently with EDX technique. For this purpose and the potential impact of trace element distribution on zonation further analysis with EMPA is needed.

Photonic structures in natural amorphous silica - Sedimentation and Replacement

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The synthesis of amorphous silica nanoparticles ($SiO_2 \times nH_2O$) from simple electrolyte solutions is of great importance in industrial applications as it allows to generate photonic crystals. Opalescent structures obtained from close-packed monodisperse nanoparticles are expected to display complete 3D band-gaps in the optical regime. Nanocolloidal silica is also a major component of environmental aqueous solutions and consists of spherical particles that are approximately a thousand times larger than the atoms in molecular crystals. We analyzed a wide range of samples from the Australian precious opal fields using petrographic microscopy, XRPD, SEM, and EPMA to characterize opaline silica, the mineral assemblage, and the host rock. The samples studied represent two formation regimes: (1) sedimentation in pore water, (2) layer-by-layer patterning after a crystal template. The opals in this study consist of spheres with a diameter of 80 to 450 nm and often show a prominent core-shell structure. Large spheres consist of 35 nm-sized subparticles proving growth by aggregation rather than monomer addition. Two groups are separated by their relative standard deviation: monodisperse spheres (RSD<6%) and polydisperse spheres (RSD>10%). This size contrast is reflected by the Na/K ratio (monodisperse <1.2; polydisperse >3). We suggest that the Na/K ratio represents significant differences in the overall solution characteristics (pH, salinity) that can be deduced from the associated minerals (e.g., alunite, kaolinite, K-feldspar). Mollusk shells replaced by amorphous silica spheres are a unique example for the transformation of an ionic to a photonic crystal. Preservation of polysynthetic twinning planes of calcite indicates that silicification proceeds via an interface-coupled dissolution-aggregation-precipitation mechanism which involves a fluid-filled gap in the μm-range. We assume that the face-specific rate constant replacement proceeds via layer-by-layer deposition.

Experimental studies on low calcian magnesite growth

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Oral in Session A6-04

Mg, after Ca, is the second most abundant cation in sedimentary carbonates (Lippmann, 1973). Therefore, the influence of Mg on Ca-carbonate growth has been studied extensively. But virtually nothing is known about the influence of Ca on the growth of Mg-carbonates. Yet knowledge about the behavior of Ca in a Mg-carbonate environment can considerably contribute to a better understanding of mineral growth within the entire Ca-Mg-carbonate system in general and provide crucial information regarding the dolomite problem in particular. Here we combined hydrothermal atomic force microscopy (HAFM), Raman spectroscopy and hydrothermal mixed-flow reactors (HMFR) to investigate the effect of aqueous Ca on magnesite growth. Experiments were performed at 100 °C, pH ~7.7 and at 0.1 M ionic strength. HAFM measurements of obtuse step velocities at Ω ~100, showed that only Ca concentrations above $1{\cdot}10^4$ M reduce step advancements. HMFR experiments confirmed that there is no significant kinetic influence of Ca on magnesite growth rates below $1{\cdot}10^4$ M and further revealed that up to 8 mol% of Ca are incorporated into the magnesite. Raman spectra of the growth layers were collected by vertical line mapping using a confocal Raman spectrometer. A Ca-impact on carbonate vibration modes was confirmed for translational T and librational L bands of magnesite. Subtraction of reference spectra indicates the presence of secondary bands at frequencies ~8 cm^{-1} lower than the T and L bands. This contradicts a linear interpolation of frequency shifts between magnesite and dolomite as proposed by Bischoff et al. (1985). Assuming that the secondary bands are caused by carbonate groups with a Mg-Ca-coordination ratio of 5, our observations indicate no agglomeration of Ca and point to a statistical Ca-Mg distribution within a given cation layer.

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Investigations of the System $\mathbf{Me^{2+}_{x1}Me^{3+}_{x2}[(OH^-)\frac{1}{2}CO_3^{2-}]_{x1+x2} \cdot nH_2O}$ with different di- and trivalent metal cations

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Poster in Session B6-03

Many layered double hydroxides are known and used for different applications, e.g. chemical catalysis, agriculture, medicine or for waste decontamination. In this study synthesized LDHs should be candidates for battery material applications and catalysts. Solid phases with the general formula $[M^{ii}_{1-x}M^{iii}_{x}(OH)_2]x^+[(CO_3)x/2$ • $nH_2O]x^-$ were synthesized. Different di- and trivalent cations, such as Ni^{2+}, Cu^{2+}, Co^{2+}, Al^{3+}, Mn^{2+}/ Mn^{3+} and Fe^{2+}/Fe^{3+}, were used for the preparation of the layered double hydroxides. The solid phases were prepared by co-precipitation from corresponding metal nitrate solutions at alkaline pH-values. The pH-value is set by sodium carbonate Na_2CO_3 and adjusted by the addition of sodium hydroxide solution NaOH. The mixtures were aged for 7 days at a temperature of 45 °C during constant agitation. The composition and structure of the precipitates were determined by chemical analysis, thermogravimetric analysis (TG/DTA), and X-ray diffraction (XRD). The lattice parameters were refined and the residual solutions were measured for the specific metal ions using ICP-OES. Because of the addition of Na_2CO_3 the solid phases should contain carbonate anions and water in the interlayers. Investigations of different hydration levels were made by XRD and thermogravimetric analysis.

Well-logs beneath Messel penetrating the post-Variscan unconformity (Sprendlinger Horst)

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The post-Variscan unconformity constitutes a significant horizon which is relevant for diverse geological questions in Europe. Locally-dependant sediments and volcanic rocks are unconformably overlying the basement of Variscan age which was more or less extensively exposed to weathering processes. Petrophysical, mineralogical and geochemical properties change abruptly within a short interval. Hence, this horizon controls geological issues significantly e.g. in groundwater or geothermal models, disposal sites or engineering-geological questions. Although prominently developed over Europe and exposed widespread, weathering and sedimentary processes are rarely studied at the post-Variscan unconformity so far. This contribution presents first studies on the drilling core "Forschungsbohrung Messel GA 1" which is penetrating the post-Variscan unconformity on the Sprendlinger Horst. 20 meters of sedimentary and volcanic rocks are unconformably overlying the Variscan plutonic basement. Twelve sedimentary and three magmatic lithofacies can be distinguished. The sedimentary lithofacies were classified with the help of sedimentary structures like massive, planar cross, trough cross and horizontal bedding or lamination. The grain sizes of the sedimentary rocks vary from clay/fine silt up to medium gravel. Afterwards, detailed profiles and a lithofacies catalog of the sedimentary rocks were generated, supplemented and interpreted with the help of porosity and permeability data. At this stage, the sedimentary rocks were interpreted as continental medial alluvial-fan deposits in a semi-arid environment with ephemeral streams and mudflows. The magmatic bed rock represents quartz monzodiorite which shows only weak weathering/alteration at the surface. Other studies of drilling cores and in an active quarry, where the post-Variscan unconformity is well exposed, will be done to analyze the spatial heterogeneity of weathering and sedimentation.

Metal-silicate trace element partitioning at reducing conditions: Implications for Mercury's differentiation

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Mercury is the smallest terrestrial planet of our solar system. It has probably differentiated through the crystallization of a magma ocean and has a very high density (5.43 ± 0.01 g/cm^3) indicative of a large metallic core. The surface of Mercury is ultramafic but very low in FeO. The combination of high metal fraction and low FeO content in the silicate portion is explained by highly reducing conditions during the differentiation of Mercury (IW-3 to IW-6.5). The surface lavas on Mercury were produced by partial melting of a lherzolitic to harzburgitic mantle source at 1-2 GPa and 1350-1550°C. Mantle melting is usually assumed to have resulted from isentropic decompression but heat release from radioactive elements (U, Th and K) may have also played a key role. Lavas at the surface of the planet have low Th/U ratios compared to chondrites, possibly suggesting early fractionation of these elements with U preferentially incorporated in sulfur-rich melts. However, the partitioning of U, Th, K and other trace elements between the metal core and the bulk silicate shell is largely unknown at pressure ($\sim$ 3-4 GPa) and oxygen fugacity (IW-4 to IW-7) conditions relevant to Mercury. In this study, we performed high-temperature (1500-1700°C) and medium- to high-pressure (0.1-3 GPa) experiments using a composition of an enstatite-chondrite, usually considered as representative of Mercury's mantle. In our experiments, we changed the SiO_2/Si ratio to reach oxygen fugacity conditions between IW-4 and IW-8. Experimental phases obtained at these conditions are dominated by 3 different melts: (1) a silicate melt; (2) a sulfide melt and (3) a metallic FeSi melt . In this poster, we will use our experimental data to show how U, Th and K partition between the silicate shell and metal melts. We will then discuss the effect of oxygen fugacity and pressure on trace element partitioning and determine the likely trace element distribution between Mercury's mantle and Mercury's core.

Multiple causes, multiple effects: Forensic hydrology approaches to elucidate complex relations between drivers and effects in landscape hydrology and biogeochemistry

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Oral in Session B4-03

Geosciences have identified a plethora of single processes which affect hydrological and biogeochemical processes in our environment. Joint effects of multiple processes can be assessed using coupled models. However, these models are in practice often substantially restricted by the available data, limiting their use for environmental authorities and water resources management. Thus inverse approaches are urgently needed to identify the causes of observed harmful effects, to check the effectiveness of taken management measures, or to identify hitherto unexpected threats to landscape hydrology and water quality. A single cause usually affects more than one single property of the environmental system under observation, and a single observable usually is affected by more than a single cause. In addition, environmental systems are usually far from stationarity. Climatic conditions are rarely really stationary. In addition, landscapes in many parts of the world have been shaped by human activities for centuries. We suggest approaches based on dimensionality reduction methods, e.g., principal component analyses. Single processes impose characteristic patterns on multivariate sets of observables in time or space. That information can be used to inversely assess or even identify the key processes in the system under observation. These approaches become effective only for large and high-dimensional data sets that are now increasingly available, opening a new avenue for forensic approaches. Examples to be presented include differentiating between natural and human effects on time series of groundwater head and lake water levels, differentiating between effects of crop rotation and tillage on soil water dynamics in arable fields, on extracting information about hydrological dynamics from water quality data from small streams, and on using information provided by time series of nitrate concentration in groundwater wells to identify the prevailing processes.

Exhumation and uplift of the Terra Nova Bay segment of the Transantarctic Mountains

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Poster in Session A2-02

Uplift and exhumation of the Transantarctic Mountains have been studied for more than three decades by means of apatite fission track (FT) data that were traditionally interpreted in terms of several exhumation and uplift stages since the Early Cretaceous. However, recent evaluation of geological and geomorphological observations require a thorough reinterpretation of the regional thermochronological data base. New apatite FT and U-Th-Sm/He data were obtained from vertical profiles of basement rocks from Eisenhower and Deep Freeze Ranges (Terra Nova Bay). FT ages of 32±2 Ma – 259±18 Ma and associated proxies, and U-Th-Sm/He ages of 35±4 – 238±28 Ma correlate with altitudes between 220 and 2620 m. Thermal history modeling of the thermochronological data from both mountain ranges and recently published data from the adjacent Prince Albert Mountains indicates Jurassic to Late Eocene heating of the studied crustal sections, and final cooling commencing at ~35 Ma. This requires burial, and therefore the existence of a Mesozoic sedimentary basin on basement and volcanic rocks in the Terra Nova Bay region. The correlation of sample paleotemperatures versus elevation indicates an increased Jurassic (~44°C/km) and a moderate Cretaceous – Eocene (~24°C/km) geothermal gradient. Paleotemperatures and gradients infer basement burial varying from ~2 km in Deep Freeze and Eisenhower Ranges to ~3.4 km in the Prince Albert Mountains. Basin inversion and fast erosion of the sediments initiated at the Late Eocene is linked with right lateral strike-slip and transtensional faulting attributed to Ross Sea rifting. Subsequent final exhumation with deepest incision at the coast is explained by a change of exhumation style from downwearing to backstepping incision from the coast towards the interior obviously caused by a combination of glacial incision, climate cooling, and isostatic surface rebound in response to sediment removal at ~30 Ma.

Ancient Shuangfeng-Bijia collisional orogenic belt in the South China Sea, a "witness" to processes of drifting of fragments from Gondwana, subduction of Tethys and accretion of southeastern Asia

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Oral in Session A2-01

In order to probe into late Mesozoic tectonic framework of South China Sea (SCS) region, "the ancient Shuangfeng-Bijia subduction-collision orogenic belt" (SOB), which was built in late Mesozoic before open of SCS, was found by the authors through structural analysis in seismic profiles. Combined with the results of comprehensive analysis on the data of Mesozoic stratum lithology-lithofacies of the SCS and adjacent areas, paleontology, gravity, magnetism and paleomagnetism, using the method of tectonic analysis,the authors put forward a new plan for late Mesozoic tectonic unit division of the research area: from north to south, there were geotectonic units such as South China plate, southern Guangdong back-arc area (including Qiongzhong block in west), Dongsha Island volcano arc, Chaoshan forearc basin, the SOB, ancient north Liyue ocean basin (ANLB) (remnant of Paleo-Tethyan ocean basin in early Mesozoic), Liyue block, and ancient SCS (Meso-Tethys), in turn. Then, the authors elaborated formation and evolution of the SOB and its relationship with splitting-drift of fragments from northern margin of Gondwana, subduction of Tethys, accretion of SE Asia in Mesozoic, and splitting of South China continental margin in Cenozoic. Evidences from fauna and flora fossils indicate there are possibility for the blocks sourced from Gondwana in Early Carboniferous. The subduction and disappearing of the ANLB resulted in building of the SOB, collosion of the blocks with South China plate, and accretion of SE Asia in late Mesozoic. Since the Cenozoic, extension and collapse of the SOB and delamination of the SOB root caused open of the SCS, and subduction of the ancient SCS beneath the northern Kalimantan arc. This study was funded by the State Fund for Natural Science of China (No. 41276048, 91328205, and 41476039), and State Key Laboratory Breeding Base of Nuclear Resources and Environment, East China Institute of Technology (No. NRE1302).

Paleosedimentological reconstruction of amphibolite facies metasediments: a holistic approach

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Poster in Session A1-03

Reconstruction of pre-orogenic sedimentary lithologies and paleogeographic environments from metamorphic rock units in collision orogens is as challenging as it is important for a complete understanding of orogenic and metamorphic processes. Medium to high grade metamorphism of metasediments destroys most features that can be used to determine the origins and history of sedimentary rocks such as grain shape, layering or mineralgogical composition. To complicate things even further, metamorphic processes are not necessarily strictly isochemical for all elements. Highly soluble ions such as the alkalis are easily lost from sediments that loose water as a result of clay mineral breakdown and also during metamorphism in shear zones with high fluid flux, impeding the interpretation of whole rock chemical analyses for paleosedimentological reconstructions. These complications can be partially circumvented by interpreting metasedimentary basins as a whole in their plate tectonic context instead of individual rock units. The Pfitsch-Mörchner Basin in the Western Tauern Window (Alps) provides an exceptionally well suited study area for reconstruction of the depositional environments of Permian-Mesozoic metasediments, based on detailed mapping, petrography and whole-rock chemistry. All units, from paleosoils and metaconglomerates to different coastal and marine sediments, can be explained with a coherent model of basin development if orogenic overprinting is taken into account. This allows a more reliable interpretation of the unusually boron or phosphate rich units in the sequence than characterizing them independently. Based on the paleo-environmental reconstruction, we present a model for the metamorphic history of the basin, including two major shear zones and the associated effects of element transport by fluids as well as metasomatic reactions of the metasediments with the underlying Variscan basement.

Observations and models of seismic anisotropy in the deep mantle and implications for mantle flow

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The delineation, characterization, and interpretation of seismic anisotropy has become a commonly used tool to understand patterns of (past and present) deformation in the upper mantle. However, our understanding of seismic anisotropy and its interpretation in the deeper mantle (transition zone, uppermost lower mantle, and the D" region at the base of the mantle) is considerably poorer. I will describe a number of recent studies that constrain seismic anisotropy in the deep mantle, and discuss the implications of these observations for our understanding of mantle flow near key boundary layers. In particular, we have documented seismic anisotropy at mid-mantle depths (transition zone and uppermost lower mantle) in a number of subduction systems worldwide, with evidence for laterally variable anisotropy whose geometry is likely influenced by the morphology and kinematics of slabs in the mid-mantle. New observations of lowermost mantle anisotropy using differential SKS-SKKS and S-ScS splitting reveal evidence for complex anisotropy in several regions; these observations are not generally compatible with the simplest models for anisotropy (e.g., vertical transverse isotropy). We have documented anisotropy at the edges of slow velocity provinces such as the African LLSVP and the Perm Anomaly, as well as near fast anomalies in the lowermost mantle that may correspond to paleoslab material. Forward modeling of lowermost mantle anisotropy observations using constraints from mineral physics and geodynamical models provides quantitative testing of different mantle flow scenarios.

Blötberget Iron Ore Project - From Resource and Mining History to Present

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This presentation gives an overview of the Blötberget Iron Ore Project, located in Dalarna in central Sweden. The project is situated in central Sweden, approximately 500 m south east of the village of Blötberget, and near the town of Ludvika. The project region is known as the Bergslagen District, famous for its very long mining and steelmaking history, with notable former and current production . In 2014, DMT Consulting Ltd. was retained by Nordic Iron Ore to prepare an independent Mineral Resource Estimate for the Blötberget Iron Ore Project. NIO is a mining company aiming to reopen the main Ludvika mines - Blötberget and Håksberg, and resume iron ore production. Mining and exploration in the Ludvika area has been active since the 1600's. The majority of this small scale mining was focused on iron production. Blötberget originally operated as two separate mines from the early 1900s, the German owned Vulcanus "original" mine and the Swedish owned Blötberget "new" mine. Blötberget started operations in 1944. Airborne and ground-based geophysical surveys over the project area were carried out in the 1950s and 1960s respectively. From 1942 until 1977, the deposits were systematically diamond drilled for resource definition and extension. The mineralisation at Blötberget is a so-called "apatite lake ore" which, besides the iron minerals magnetite and hematite, also contains apatite. The Blötberget deposit is referred to as a Kiruna type deposit although the exact origin is still disputed.
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Nitrogen and Carbon elemental and isotope chemistry in guano deposits – Pacific margin of Northern Chile

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Seabird excreta (guano) are preserved along the Pacific coastline in the hyperarid climate of N Chile and Peru at least since the Pliocene. The transfer of marine N and P from fish consumed by seabirds and finally deposited on land as guano is an important nutrient transfer path that generates economically relevant nitrogen and phosphor deposits. The exploitation of this renewable resource of fertilizer continued since Pre-Columbian times with extensive mining of fossil deposits in the 19th century. We studied modern and fossil deposits for mineralogy, major- and selected trace elements, and N and C elemental and isotopic makeup. Modern guano of ∼50 mm in-situ deposit beneath a nesting site reveals a decrease of N and C contents with depth from ∼30 and 32 wt% to ∼7 and 17 wt% accompanied by a systematic change of δ^{15}N from +19‰ to +23‰ (reported to air) and δ^{13}C from -16‰ to -13‰ (reported to vpdb). Nitrogen and C become isotopically heavier by degassing of NH_3 and CO_2. Other non-volatile major and trace elements are passively enriched during N and C loss as indicated by elemental analyses and the mineralogy changes from uric acid as the dominant mineral in fresh guano to oxalate compounds, e.g. whewellite, containing the remaining C and a passive enrichment of the phosphate minerals, mainly whitlockite. We consider these diagenetic alterations as a quick process even under fully arid climate conditions. In fossil guano, N contents are <1-2 wt%. Carbon contents are slightly more variable but <5 wt%. The δ^{13}C values of fossil guano remain in the range of modern guano whereas the δ15N further evolves to very heavy compositions mainly between 30‰ and 40‰. The δ^{15}N in guano in general and especially the high δ^{15}N in fossil guano exceeds ^{15}N enrichment in most natural materials, including plants. Therefore, N isotopes provide a good tracer for the use of such fertilizers in the food chain or for distinguishing them from synthetic fertilizers with δ^{15}N close to 0.

The role of volcanic deposits related to the destructive Bantul Earthquake 2006

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Volcanic hazards are multifaceted, and can be primary or secondary. Secondary hazards include flank collapses, lahars or even ground water contamination. New findings from Merapi volcano show that also very distal apron of a volcano, faraway from summit and steep flanks, may also be exposed to specific hazard during earthquakes. On May 26, 2006 (UTC) a destructive earthquake hit the southernmost apron of Merapi, hosting the urban regions of Bantul, Yogyakarta, with ∼1,000 pers./km^2. The quake damaged not only profane houses but also historical buildings, such as the Hindu temple of Prambanan (9th century) and the Sultans cemetery in Imogiri (17th century). The event costs ∼5,750 victims, destroyed > 127,000 houses, and left > 450,000 people homeless. The shallow hypocentre of this strike slip event was detected close to the south coast of Java, in 10 km depth. Largest destructions were concentrated parallel to the river Opak between Parangtritis at the shore line of the Indian Ocean up to Klaten, east of Yogyakarta. The same region was found to be the site of thick volcanoclastic sediments. Analyses of aftershock data collected by a local seismic network during a rapid response mission clarified the location of the ruptured fault to be located more than 10 km away from this zone. Beside destructions related to unsafe constructions, and topographic effects in the Gunung Kidul region, a more detailed view reveals that strong ground acceleration and site amplification on unconsolidated volcanoclastic sediments have enhanced the shaking. These deposits were transported as lahars and by rivers down the volcano, and accumulated along the river Opak. On these sediments earthquake damage was largest. Therefore, risk assessment at cities located on and around volcanoes requires consideration of earthquake site effects and ground amplification, even in areas tens of kilometres far from the summit of volcanoes at locations were unconsolidated alluvial sediments are deposited.

Quantifying permeability and modelling fluid and heat flow in an evolving sedimentary basin

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Fluid flow and permeability in sedimentary basins are difficult to constrain due to geological heterogeneity and because permeability data tends to be scarce and confined to relatively permeable drinking water, geothermal or hydrocarbon reservoirs. Basin-scale fluid flow models tend to use single permeability values for large geological units, which may underestimate the effect of subsurface heterogeneity and thin low permeability sediments. We use recently published permeability equations for mixtures of sand, silt and clay to quantify the basin-scale variability and distribution of permeability. Permeability was calculated as a function of porosity, grain size distribution and clay content, which were estimated from core and well-log data. We use the calculated permeability field to simulate fluid flow during the late Cenozoic evolution of the Roer Valley Graben in the southern Netherlands. The fluid flow model simulates compaction and porosity change and its effect on permeability. We take into account small-scale variability using a simple and computationally efficient upscaling algorithm that uses statistics on the subgrid distribution of clay content and porosity as an input. Model results were compared with data on subsurface temperatures and groundwater salinity as well as thermal history data from apatite fission track analysis. The results show that the permeability and upscaling algorithms provide a much improved representation of the effect of lithological heterogeneity on fluid and heat flow in sedimentary basins.

Production of climatically active gases during the Chicxulub impact event

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The Chicxulub impact event is thought to have caused the large mass extinction at the K-T boundary that led to the demise of the dinosaurs [1,2]. Although the actual chain of impact-induced consequences is still under discussion, it is assumed that the production of a large amount of climatically active gases from the shallow sea at the impact site and the underlying carbonate and anhydrite platform had caused substantial climatic effects giving rise to global environmental consequences [e.g. 3,4]. In previous studies, Pope et al. [3] and Pierazzo et al. [4] (i.a.) used impact simulations to estimate the amount of gases released as a consequence of high impact shock pressures. While in these early studies computer resources did not allow for resolving the relatively shallow water explicitly, in more recent studies a 1km deep ocean was considered in impact simulations [5]. However, at the time of impact the water depth varied between only 260m-650m or less [summarized in 5]. In our study, we use the iSALE hydrocode [e.g. 6] and the ANEOS package [7] to set up a model with a ten times higher resolution. Such high-resolution models enable to consider a shallow water layer with a depth of 100 m (13 cells). Following the approach of Pierazzo et al. [4], we evaluate the gas production from the carbonate and anhydrite layer and from water vaporization by determining the volume of target rocks/water that has experienced critical peak pressures for shock-vaporization varying the initial impactor masses and velocities at constant impact energy according to Ivanov [8].

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Snow Funnel Creation Due To Chelyabinsk Meteorite Fragments

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Poster in Session A3-02

After the Chelyabinsk meteorite fall, many small fragments were found in the snow in the surrounding area. The fragments created funnels with walls of denser coarse-grained snow. Larger fragments penetrated through the 70-cm-thick snow layer and reached the frozen ground surface. Smaller fragments got stuck in the snow, showing a special characteristic: at the bottom, 15–25 cm in depth, the funnels narrow into a cone shape, forming so-called "snow car-rots" [1]. In our study, we describe the deceleration and the thermal evolution of those fragments during their traverse of the atmos-phere in order to constrain the initial conditions (velocity, tempera-ture) at impact onto the snow. We then model the penetration of the fragments into the highly prous snow using the iSALE 2D hydrocode [2,3,4] combined with a porosity compaction model [3]. We observe the creation of funnels in the snow with funnel walls that show an increased density. Densities reach up to 380 kg/m^3. During the snow compaction due to the passing projectile, no temperature increase can be seen. Next, we also measure the decceleration and the final depth of the fragments in the snow. Our modelled terminal depth of the fragements is in good agreement with the observed Chelyabinsk funnels. By means of the Chelyabinsk snow funnels, we demonstrate the capability of the applied material models to describe the penetration of projectiles into highly porous materials (~70 % in this study). Such studies are of particular interest for the analysis of impact funnels in aerogel catchers of the Stardust experiments [5] and for impact cratering on highly porous targets as the recently visited comet Churyumov-Gerasimenko by the Rosetta mission.

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Triassic source rocks in the Barents Sea – Input for hydrocarbon assessment of the European Arctic

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Poster in Session B1-04

The Barents Sea region and its margins are key areas for the understanding of the geological evolution of the European Arctic. Information on the geological setting of the southern Norwegian Barents Sea is available from around 130 hydrocarbon exploration boreholes and ample 2D and 3D seismic data. The northern Norwegian Barents Sea, north of Bear Island (Bjørnøya) is excluded from commercial hydrocarbon exploration, thus no deep boreholes exist there. On the conjugate eastern Greenland continental margin even less data is available due to the long or even whole year ice coverage there. The Barents Sea itself is situated in an intra-cratonic basin, which consists of several basins, platforms and highs. During the Triassic this basin was filled from the south and south-east with sediments derived from the rising Uralian Mountains, Kola Peninsula and Norway. In the northwestern Barents Sea at the west coast of Svalbard a western sediment source is suggested for the Early and Middle Triassic. Deposition of organic-rich shales occurred in front of the prograding delta system in a prodelta to deep restricted shelf environment starting in the southern Barents Sea during Late Olenekian (Steinkobbe Fm.) and on Svalbard during the Anisian (Botneheia Fm. and Bravaisberget Fm.). The Late Triassic is characterized by deposition of sandstones and thick deltaic units of the advancing delta which exhibit excellent reservoir properties. The position of the advancing shoreline from south east to north west determines how much space was available for sedimentation of organic rich source rocks. This information is an important parameter for the assessment of the hydrocarbon potential in the PANORAMA project (Potenzialanalyse des Europäischen Nordmeeres und angrenzender Randmeere der Arktis) of BGR.

On the uplift anomaly of the Arica Bend, Western Central Andes.

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Oral in Session A6-01

Keywords: northern Chile, southern Peru, interplate coupling, coastal uplift, stream profile, incision, radiocarbon. The architecture of the Western Andes is remarkably constant between southern Peru and northern Chile. An exception, however, is present near Arica at 18°S, where the Andes change their strike direction by ca. 50° and the Coastal Cordillera is absent over a lateral width of 50 km. Here, we propose a large-scale model to explain the Ma-long low uplift rate of the Arica Bend in connection with interplate coupling and continental wedge-top basin evolution. Geomorphic, sedimentologic, and 14C-geochronologic data are integrated with stream profile analysis and seismic and structural data from the literature to interpret long term (post-Oligocene) and short term (Holocene) patterns of uplift, erosion, and sediment transport to the trench. Results show that both the absence of a sediment barrier and the amphitheater-shaped topography at the Arica Bend have conditioned a relatively high sediment discharge to the corresponding trench segment since Miocene time. However, the ^{14}C-ages and the river profile analyses yield contradicting high coastal uplift rates for the past 10 ka. It appears that, at the large scale, higher sediment supply likely reduced the friction at the interplate boundary, keeping the uplift push at lower levels and the Coastal Cordillera submerged below Arica, thereby explaining also the lower frequency of large subduction earthquakes and the absence of mappable deformation in the area. Nonetheless, at a shorter time scale, the prominent post-glacial sea level rise induced a landward shift of the interseismic elastic deformation, which in turn has perturbed the trunk stream's profile.

Prolonged tectonic history of a thin crustal lid on top of a subduction zone: The polygenetic mélange on Crete

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Oral in Session A1-06

The island of Crete represents a horst in the fore-arc of the present Hellenic subduction zone with internal structures, resulting from collision of the microcontinent Apulia with the Eurasian active margin in Oligocene-Miocene times. The high pressure metamorphic sedimentary cover of the subducted microcontinent forms the Lower Units of the Cretan nappe pile, exhumed beneath an extensional detachment. The Upper Units consist of Mesozoic-Tertiary sedimentary rocks. At the top, a polygenetic mélange of crustal slices with Mesozoic metamorphism, the "Uppermost Tectonic Unit" (UMU) is preserved in graben structures. It comprises km-sized slices of oceanic and continental provenance with differing type and age of metamorphism: (1) various very low grade metamorphic sedimentary rocks, (2) sedimentary and magmatic rocks with HP-LT metamorphism of Jurassic age, (3) extensive crustal slices with Late Cretaceous HT-LP metamorphism, and (4) dismembered ophiolites. Zircon fission track (FT) ages indicate that all UMU subunits resided at temperatures below about 300°C since Early Eocene times, at the latest, hence represent upper crust of the overriding continent during Oligocene-Miocene collision. Apatite FT ages up to 50 Ma indicate preservation of even very shallow crust, indicating little uplift and erosion related to collision. The UMU on Crete represents crust assembled at the active Eurasian margin in Mesozoic times. It developed into a thin lid of the upper plate during later subduction of the Pindos ocean, which finally terminated by collision of Apulia with the Eurasian margin in Oligocene-Miocene times. While metamorphism and internal structures of the subunits still reveal their individual subduction-related history in the Mesozoic, their Tertiary tectonic overprint is governed by localized deformation in the shallow crust during horizontal extension, driven by roll-back. New aspects based on structural relations and limitations of restoration will be discussed.

U-Pb and Lu-Hf isotope systematics of Nb-Ta mineralization

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Poster in Session C1

Rare element pegmatites are supposed to be the product of igneous fractionation of diverse felsic magmas. In many cases, a genetic relation between granite plutons and bodies of pegmatite is assumed on the basis of spatial proximity. If the “parental” granite is not exposed, the origin of a given pegmatite is unknown. The combination of high-spatial resolution Sm-Nd and Lu-Hf isotope systematics with U-Pb geochronology could be used to characterize the origin and source of the parental magma. We studied columbite group (CGM) minerals from the Tanco pegmatite (LCT) in southeastern Manitoba (Canada) and from different pegmatite fields of Kibaran age from Central Africa. LA-SF-ICP-MS U-Pb ages of CGM from the Tanco pegmatites show quasi concordant ages between 2.67 – 2.50 Ga as well as strongly discordant analyses with $^{206}Pb/^{238}U$ ages of 0.35 to 1.6 Ga. The association of the pegmatite to their “parent” magmas is still unknown. U-Pb ages of CGM samples from the Kibaran pegmatites vary between ~975 and ~930 Ma and are interpreted to be associated to the G4-Granite which formed at 986 ±10 Ma[1]. The U-Pb system shows a clear age variation for the Tanco and Kibaran CGM as well as some discordant ages. Sm-Nd and Lu-Hf isotopes of specific domains in CGM were analysed by isotope dilution technique using a Neptune MC-ICP-MS after dissolution in acid and subsequent separation of the isotope fraction by ion exchange chromatography. Samples of

0.5 to 50 mg were collected from thick section guided by BSE images using a microdrill and Resolution Excimer Laser, respectively. Nd and Sm concentration vary from 0.1 to 107 ppm with Sm/Nd of 0.1 to 0.9; Hf concentration vary from 8 to 740 ppm with Lu/Hf of 0.001 to 0.21. The CGM of the Tanco pegmatite fall in an ϵHf(t) range of 0.4 to 2.2. The ϵHf(t) data from Kibaran pegmatites show considerable variation from -2.9 to -23.9.

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The response of subducting slabs to a strength increase in the shallow lower mantle constrained by numerical modelling

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Poster in Session A4-01

Recent high-pressure experiments using synchrotron radial x-ray diffraction methods have revealed an increase of the strength of (Mg,Fe)O ferropericlase by a factor of three at pressures corresponding to the uppermost lower mantle (1). In a lower mantle scenario, where ferropericlase dominates the bulk deformation behavior through the formation of an interconnected weak layer network, the increase of ferropericlase strength can lead to increasing mantle viscosities with depth in the shallow part of the lower mantle and thereby affect the descent of subducting slabs. However, the effects of the strength increase on global mantle flow will depend on a number of variables and their quantification requires the incorporation in large-scale numerical modelling. Here, we present results from numerical modelling experiments designed to understand and quantify the effects of the increase of ferropericlase strength on the behaviour of subducting slabs and the implications for the structure and dynamics of Earth's lower mantle. For this purpose we perform numerical calculations in 2D geometry using the finite-difference code I2VIS (2) employing a viscoplastic rheology. In this model setup we simulate the upper 1400 km of the Earth's mantle and incorporate the strength profile of ferropericlase suggested by the previous experimental study (1). We will discuss the effects of the strength increase by comparing the outcome of subduction models with and without the presence of a viscosity hill in the upper part of the lower mantle.

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Deformation of (Mg,Fe)O ferropericlase at high-pressures and high-temperatures and slab stagnation in the shallow lower mantle

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Poster in Session A4-03

The Earth's lower mantle constitutes more than 50% of Earth's volume and is the largest geochemical reservoir for many elements. Material transport from Earth's surface into the deep mantle occurs by subduction of oceanic lithosphere. Seismic observations indicate stagnation and broadening of subducting slabs in the shallow lower mantle, but the underlying principle is unclear. Ferropericlase (Mg,Fe)O is thought to be the second most abundant mineral in Earth's lower mantle. Due to its potentially weak rheological behavior it may play a key role in controlling rheology, particularly in high strain areas in the Earth's mantle such as around subducting slabs. Here, we present results from synchrotron radial x-ray diffraction measurements

on the deformation behavior of (Mg,Fe)O at high-pressures and high-temperatures. One set of experiments was performed on $(Mg_{0.8}Fe_{0.2})O$ at the Advanced Light Source (Lawrence Berkeley National Laboratory) up to 96 GPa at 300 K and at the Extreme Conditions Beamline of PETRA III (DESY) to 70 GPa at 850 K and 40 GPa at 1150 K. From our data, we calculate the flow strength of ferropericlase, which we find to increase by a factor of 3 at pressures from 20 to 65 GPa at 300 K. Modelling based on our experimental data indicates a 2.3 orders of magnitude increase of viscosity around subducting slabs in the upper 900 km of the lower mantle [1]. Such a strong viscosity increase can lead to stagnation of sinking slabs in the shallow lower mantle as observed by seismic tomography.

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Structure-property relations in chalcopyrite based intermediate band solar absorber materials

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Poster in Session B6-03

By now, the progress in manufacturing $Cu(Ga,In)Se_2$ absorbers used for thin film solar cells led to conversion efficiencies of more than 21% [1]. In general, compound semiconductors own the advantage of adjusting the band gap by changing the composition of the solid solution, as in $CuIn_{1-x}Ga_xSe_2$. To optimize the utilization of solar energy we try to establish an intermediate band. The Shockley-Queisser limit for chalcopyrite semiconductors is at 32% [2], with an intermediate band gap it is proposed, that the efficiency can be raised up to 63.3%, in ideal conditions [3]. Therefore we use pure $CuGaS_2$ which has the widest band gap in the solid solution series of these two ternary system. Martì et al. proposed different transition elements, such as $Ti^{4+/3+}$ and $Fe^{3+/2+}$ which may cause an intermediate band within the energy band gap of $CuGaS_2$ [4]. In this study we focused at first on Cr^{3+} instead of Ti, because of better solubility proposed from thermodynamic calculations and Mn as analogue [5]. Powder samples have been synthesized by solid state reaction at 850°C. The products of this synthesis were grounded and annealed two times for 100h at 900°C with a heating rate of 10K/h. After that the powder samples were analyzed in terms of crystal structure as well as phase content by X-ray diffraction and chemical composition by electron microprobe (WDX). We will show the first results from our synthesized ternary standard $CuMS_2$ (M=Cr, Mn) and quaternary compounds $CuGa_{1-x}MxS_2$ (M=Cr, Mn).

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Apatite as a recorder of crustal and planetary evolution

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Oral in Session A7-01

Apatite has been utilized as a recorder of the physico-chemical evolution of its host rocks. This includes thermometry in magmatic rocks, provenance studies in sediments and volatile probes in planetary materials. The formation rates and mechanisms of the earliest continental crust is still largely unknown, mostly due to the sparsity of the rock record. Hadean zircon is the most reliable recorder of early crustal processes, but it has a restricted chemical variability. Detrital apatite and apatite inclusions in zircon form a versatile archive that could potentially supplement the zircon record. The chemical variability of apatite includes changes in the halogen ratios, its hydroxyl content, and a range of trace elements. The composition of apatite and apatite inclusions in zircon in magmatic rocks can be linked to magmatic differentiation. It can be used as a diagnostic tool to distinguish primitive, intermediate and felsic magmatic rocks, the relative abundances of which are of central importance to models of early continental crust formation. The distribution of hydrogen in the early solar system and during planetary accretion is still enigmatic, mostly due to a lack of reliable recorders. Apatite is a notable exception, and OH-bearing apatite has been discovered in Lunar rocks, and in primitive and differentiated meteorites. The earliest record of hydrogen from a differentiated planetary body comes from apatite in eucrites. It provides an archive of the isotopic composition of hydrogen in the early inner solar system at a time of major planetary accretion. The H isotopic composition of eucrite apatite shows a very narrow range and is indistinguishable from the bulk Earth and from the best estimate for chondrites. It is, however, grossly different from the composition of cometary water. This is strong evidence for the accretion of the bulk of the H present in the terrestrial planets during planet formation, and argues against a late-stage delivery of H by comets.

Plate tectonic and bryozoans: Biological response during times of extreme environmental changes (Devonian and Upper Cretaceous)

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Poster in Session A5-02

The Devonian and the Upper Cretaceous are major periods in the evolution of bryozoans, a phylum of marine invertebrate animals. The Devonian marks the transition of the Lower Palaeozoic fauna to the Upper Palaeozoic fauna, while the Upper Cretaceous marks the transition of the Mesozoic to the modern fauna. Both periods are a time of extreme climate warmth marked by eustatic sea level rise. Bryozoans represent prominent components of both the shallow-water communities of the Devonian Rheic Ocean and the Upper Cretaceous Boreal Chalk Sea. A comparison of the evolution of bryozoans during the Devonian and Upper Cretaceous shows many similarities. Radiation of bryozoans during both periods occurred fast, showing that bryozoans specialized and adapted rapidly to the environments they colonized. New modifications were developed to better protect the animals and to improve feeding and/or reproduction. Both the older and the newer fauna profited from radiation in the beginning, the newer fauna, however, faster radiating and steadily replacing the older fauna. Significant differences between both periods are recognized when looking to the response of bryozoan communities to mass extinction events, which occurred in the Upper Devonian and at the end of the Upper Cretaceous, respectively. During the Upper Devonian all bryozoan groups were affected, but to varying degrees, the older fauna getting extinct in the end. On the other hand, the K-Pg mass extinction event had only

little effect on bryozoan communities, both the newer and the older fauna surviving into the Cenozoic and soon recovering. Financial support of the DFG (projects ER 278/4-1 and 2 and SCHO 581/12-1) is gratefully acknowledged.

The Asterousia Crystalline Complex in the Aegean region: insights from structural analyses and U-Pb zircon dating on Anafi Island (Cyclades, Greece)

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Oral in Session A1-05

The Asterousia Crystalline Complex (ACC) belongs to the Uppermost Unit and consists of HT–LP metamorphic rocks and associated granitoids, both of which are Upper Cretaceous in age and attributed to the Pelagonian domain of the Internal Hellenides. The ACC is exposed on Crete and the Cyclades. We present geochronological, petrological and structural data obtained from crystalline rocks of Anafi Island attributed to the ACC. These rocks rest on top of Eocene flysch and comprise from bottom to top: a) LT–LP-metamorphosed rocks (Greenschist Unit); b) HT–LP metamorphosed rocks (Axina Group); c) tectonic mélange of HT–LP metamorphosed metasedimentary rocks, serpentinite, and marble intruded by granitoids (Chalepa Complex). Concordant U-Pb (TIMS) ages of zircons separated from granodiorite reflect multiple emplacement of magma into the marble (73.95±0.13 Ma in NE Anafi; 72.62 +0.03/–0.23 Ma in S Anafi). Thin section analyses of granodiorite and hornblende diorite reveal the granitoids of Anafi to have faced HT–LP metamorphism along with the rocks of the Axina Group and the Chalepa Complex. Metagranodiorite of NE Anafi is cut by synmetamorphic monzogranitic dykes, zircons of which yield a concordant age at 63.01+0.08/–0.03 Ma. The Axina Group and the Chalepa Complex are considered as subunits of the ACC formed in the back-arc domain of the Cretaceous Hellenic subduction zone. The Greenschist Unit is considered as a separate unit of the lower plate, which underwent Middle Palaeocene greenschist-facies metamorphism inside the same subduction zone. Thrusting of the different units occurred during continuous shortening with top-to-the SE tectonic transport and uplift of the high grade rocks from lower to higher structural levels, starting with ductile shearing of the Axina Group on top of the Greenschist Unit, followed by semibrittle shearing of the Chalepa Complex on both units and ceasing with thrusting of the crystalline rocks onto the Eocene flysch under brittle conditions.

Scaling of maximum observed magnitudes with geometrical and stress properties of strike-slip faults

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Poster in Session A2-01

Providing constraints for maximum magnitude earthquake on major continental strike-slip faults is important for seismic hazard estimates of populated areas near these faults. We test the potential scaling of the observed maximum earthquake magnitude with measurable geometrical properties such as cumulative displacement, mapped fault length and thickness of the seismogenic crust, as well as stress parameters (e.g. orientation between the fault trace and the maximum horizontal stress and the stress drop) using data from thirty major strike-slip fault sections worldwide. For all faults with cumulative displacement larger than 10 km (70-80% of the dataset depending of which parameter is used), the maximum magnitude scales logarithmically with the product of seismogenic thickness and cumulative displacement or fault length. These

faults are oriented at angles with respect of the regional maximum horizontal stress, suggesting low coefficients of friction and relatively low resolved shear stress onto those faults. Earthquakes larger than expected from these parameters on faults with cumulative displacements <10 km (20 – 30%) appear to be associated with fault orientation from 30 to 40° from the regional stress field. Earthquakes on these faults have comparatively larger stress drops, and typically affected multiple multiple fault segments.

New developments in microanalytical techniques for sulfur isotope analysis

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Keynote in Session C1

Sulfur stable isotope ratios provide key information about the redox state of the atmosphere and oceans through time. The study of multiple S isotopes (^{32}S, ^{33}S, ^{34}S, ^{36}S) represents one of the most exciting fields in geochemistry over the last 15 years, and has only been made possible by developments in analytical geochemistry. In this talk I will review the analytical instrumentation and methodology that is available for the stable isotope microanalysis of minerals and other geological materials. I will focus on data obtained by Laser ablation multiple collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) and Secondary Ionization Mass spectrometry (SIMS). Many of the problems encountered with these techniques for trace element analysis are magnified when attempting to obtain the high levels of accuracy and precision required for geologically-meaningful stable isotope measurements. Sulfur is a special case that due to its relatively light atomic mass, chemistry and proximity to other elements in the periodic table can be particularly challenging to measure. I will discuss instrumental mass fractionation, sampling bias, matrix (in)tolerance, drift and the numerous spectral interferences that limit our current capabilities. I will highlight some recent data for Archean rocks and discuss some of the remaining challenges that lie ahead.

Rapid cooling of the IIIAB iron meteorite parent body inferred from Pd-Ag systematics

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Oral in Session A3-01

We applied the short-lived ^{107}Pd-^{107}Ag system (t1/2 = 6.5 Ma) to a suite of early- to late-crystallized IIIAB iron meteorites to constrain the cooling history of their parent body. Because exposure of the iron meteoroids to galactic cosmic rays can modify the Ag isotopic composition, we used Pt isotopes as an independent neutron-dose proxy and developed a model linking this to the effects on $^{107}Ag/^{109}Ag$. The IIIAB irons investigated for this study are Boxhole, Cape York (Agpalilik), Grant and Henbury. After dissolution, three different aliquots were taken for the determination of Pd and Ag concentrations and Pt isotope compositions. Ion exchange procedures were adopted and slightly modified from. All measurements were performed on the Thermo Scientific® Neptune Plus MC-ICPMS in Münster. With the exception of Cape York, all samples exhibit well-resolved Pt isotope anomalies, indicating significant neutron capture effects. After correction for these effects, Pd-Ag isochrons are obtained for all investigated irons. The initial $^{107}Pd/^{108}Pd$ inferred from the isochrons are indistinguishable from each other and correspond to Pd-Ag ages between ~3 and ~5 Ma relative to an inferred solar system initial of (3.1±0.5)x10-5. The Pd-Ag ages thus obtained indicate cooling of the IIIAB metal core below the Pd-Ag closure temperature at ~4 Ma after CAI formation. Assuming the core was surrounded by an insulating mantle, such rapid cooling would indicate a small parent body with a radius of ~10 km. However, large variations in metallographic cooling rates appear inconsistent with this scenario. They were interpreted to indicate removal of the mantle in a hit-and-run collision, which would have exposed the IIIAB metal core to space, facilitating a rapid and simultaneously heterogenous cooling of a much larger metal core. If the cooling history of the IIIAB irons reflects mantle removal by such a collision, then the Pd-Ag ages date this event at ~4 Ma after CAI formation.

The Gardnos Impact Structure, Norway: Analysis of the autochthonous lithic Gardnos Breccia

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Poster in Session A3-02

The Gardnos impact crater is located on the western slope of the Hallingdal valley approximately 150 km NW of Oslo, Norway. The present rim-to-rim diameter of this complex crater is approximately 5 km and it is characterized by a circular area comprising numerous outcrops of autochthonous lithic breccias, allochthonous melt-bearing (suevite) impactites as well as post-impact sediments. The impact event of a non-magmatic iron meteorite occurred ~546 Ma ago into a crystalline target covered by a thin sedimentary layer in a shallow marine environment. Caledonian burial and erosion since the Tertiary have exposed different levels of the crater subsurface and thus give us an excellent opportunity to study the degree of brittle deformation at different levels beneath the crater floor. In order to shed light on the transport paths of blocks and fragments during the modification phase detailed measurements of the foliation in banded gneisses have been performed inside of the crater along of a W-E oriented profile. Outside of the crater the foliation is dipping towards W / NW with a gentle dip angle of 30-45°. In contrast inside of the crater the foliation dips either towards NE or SW and generally shows steep dip angles between 70 and 90°. Interestingly this orientation relationship is present in both the eastern and the western part of the crater. This indicates complex rotation directions of foliated blocks during the modification phase and on the first sight contradicts a flow field which is supposed to be oriented towards the crater center at every point of the transient cavity. These findings might be explained by effects of acoustic fluidization or very low impact angles but further studies are needed.

The deformation record of olivine in mylonitic peridotites from the Finero Complex, Ivrea Zone - separate deformation cycles during exhumation

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Poster in Session A1-04

Shear zone peridotites from the Finero complex show characteristic overprinting microfabrics indicating separate deformation events at different metamorphic conditions. The host rock is characterized by a bimodal grain size distribution with coarse isometric recrystallized grains (RG1). Broad deformation bands parallel (100) and a CPO indicating [100] dislocation glide are consistent with upper mantle flow by dislocation creep. Shear zones are characterized by a core-and-mantle microstructure with large deformed elongate porphyroclasts (PC, >500 μm) which are surrounded by recrystallized grains (RG2, 50-500μm). Intracrystalline deformation microstructures, such as deformation lamellae, deformation bands and kink bands reflect inhomogeneous high-stress crystal plastic deformation with [001] and [100] dislocation glide. Subsequent grain growth during a stage of annealing is indicated by a locally present well-developed foam structure of RG2. A new deformation cycle is indicated by deformed RG2 and a latest generation of recrystallized grains (RG3, <50 μm) which are not annealed but characterized by sutured grain boundaries and elongate shapes. A weak CPO of recrystallized

grains is inherited from the original CPO of the host rock. These microfabrics are interpreted to represent several (at least two) cycles of localized deformation at transient high stress with dynamic recrystallization at decreasing stress. Repeated deformation did not only result in re-activation of pre-existing shear zones but also affected the surrounding rocks as indicated by the presence of strongly deformed PC with sutured grain and kink band boundaries which are associated with not-annealed aggregates of recrystallized grains. These microstructures must have formed after the last annealing event. The inferred stress cycles can result from sudden increases in differential stress imposed by seismic events, i.e. high stress-loading rates and may be related to the exhumation of the Finero complex.

Evolution and Consequences of Magma Ocean Solidification

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Energy sources involved in the early stages of planetary formation can cause partial or even entire melting of the mantle of terrestrial bodies leading to the formation of magma oceans [1]. Upon planetary cooling, solidification from the bottom upwards of such a liquid magma ocean can exert a significant impact on the differentiation of the interior of terrestrial bodies. Initial compositional stratification of the solid mantle, resulting from fractional crystallization can play an important role for the subsequent planetary evolution and surface tectonics [2, 3]. In this study, we investigate the cooling and crystallization of a whole-mantle magma ocean and in particular the conditions for the onset of solid-state convection before complete mantle solidification. To this end, we run 2D simulations using the finite-volume code GAIA [4]. We treat the liquid magma ocean in a parameterized way while we self-consistently solve the conservation equations in the continuously growing solidified part with cooling boundary conditions. We consider two end-member cases: 1) "batch" crystallization, where melt remains in suspension in the silicate matrix until total solidification, and 2) efficient melt extraction, where melt is extracted towards the magma ocean. We test the effects of different magma ocean cooling rates (chosen according to coupled magma ocean-atmosphere models [5, 6]) and Rayleigh numbers between 106 and 109. We show that, even for a rapidly decreasing surface temperature, a sufficiently high Rayleigh number guarantees the onset of solid-state convection prior to complete mantle crystallization. This finding can have important consequences for the initial distribution of compositional heterogeneities generated through the magma ocean fractional crystallization.

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Late Quaternary landscape dynamics along the Subandean ranges of NW Argentina

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The piedmont in NW Argentina represents the transition between the Andean mountain ranges and their foreland basins, and is built from a series of coalescent alluvial fans. These fans receive their sediment from small local catchments in the Subandean ranges. Consequently, past geomorphic and environmental changes are potentially stored in their extensive stratigraphic record. Here, we present new chronological data

(^{14}C, OSL) from the Riacho Seco - a profoundly incised stream valley which provides insights into alluvial fan architecture, and temporal or spatial variations in paleosol types. Interpretation of these data is complemented by new isotopic data from soil organic matter. In combination, the results indicate (i) changes in sediment supply and transport capacities at Riacho Seco since Marine Isotope Stage (MIS) 3, and reveal (ii) significant paleoenvironmental variability during this period. Our results show that alluvial fans in NW Argentina represent valuable archives for the detailed reconstruction of regional-scale fluvial and environmental dynamics. Particularly when compared to existing and similar records from Bolivia and Central Argentina, they may thus help to clarify the varying influence of geological versus environmental controls on landscape evolution over different late Quaternary timescales.

Geomorphic and chronological constraints on the mid- to late Holocene evolution of the Río Grande megafan (Bolivia)

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Poster in Session A6-02

The Río Grande (Guapay) catchment in the Central Andes of eastern Bolivia constitutes the southernmost extension of the Amazonian drainage system and feeds one of the largest megafans in South America. Downstream, the confluence between the Río Grande and the Río Mamoré marks the transition from a distributive to tributive channel network. A rich record of preserved paleochannels is detectable in remote sensing imagery, reflecting the dynamic history of large-scale avulsive channel shifts across the >55.000 km2 large Grande system. So far, virtually no chronological information exists with regard to the temporal and spatial scales of these processes, limiting our ability of reconstructing late Quaternary fluvial dynamics, and complicating the interpretation of controls on longer-term megafan evolution in general. Here, we present stratigraphic and chronological data from four transects across the Río Grande megafan between ∼19°S and ∼13°S. Our study demonstrates rapid and impulsive channel shifts along the proximal Río Grande megafan during the mid- to late Holocene. These shifts establish the connection between the Grande and the Mamoré system along the distal megafan, and thus represent a major reorganization in the drainage network of the Bolivian Amazon. The corresponding increase in discharge and sediment load is expressed in paleochannel and channel geometry on the distal fan, and may also provide an explanation for a major, late Holocene avulsion of the Río Mamoré meander-belt. Thereby, the effects of major avulsions on the proximal and medial Río Grande megafan could successively propagate downstream, exerting an important control on the type and rate of drainage network re-organization across the large foreland fluvial system in the Bolivian Amazon.

How can environmental monitoring date be used in the Risk Management of CO_2 storage sites?

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Poster in Session B5-02

Environmental agencies and organizations argue for establishing tolerance thresholds for the environmental impact of CO_2 storage, e.g. concentrations of chemical species in the environment. Fixed values are appropriate for health and safety precautions focused on exposed organisms, e.g. maximum concentrations in air, water or food, based on the physiological response of the affected organisms. For environmental impact assessment and leakage monitoring however, the specification of fixed thresholds is less useful, because of often highly variable background signals, changing in space and with time. Thus, it is recommended to use baseline measurements to establish local base functions. Base functions enhance the detectability of anomalies, compared to linear trends or set constant values. Numerical simulations calibrated to baseline measurements can be used to supplement measurements, e.g. simulating the natural variability over longer time scales. Rather than defining single threshold values, a stepped tolerance approach is suggested that allows an optimization of the monitoring strategy. Lowering discriminator levels generally increases the rates of false alarms. Depending on the risks that have to be monitored and consequences resulting from detecting or missing an incident, there is a trade off between efforts and costs, maximizing the detectability and minimizing false alarms. Stepped tolerance levels can be linked to gradual response plans. The response to the observed anomalies depends on the risks which are monitored. For risks not associated with immediate health and safety consequences, the response could be gradual and linked to the tolerance level exceeded. The higher the tolerance levels that are exceeded, the more stringent can be the necessary measures to be taken. The concept of linking, base functions and stepped tolerance levels with gradual response plans can facilitates appropriate environmental monitoring and a balanced safety management.

Ohre rift related volcanism in Silesia (Poland): Insights from mineral micro-chemistry

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Cenozoic alkaline volcanism in SW Poland (Lower Silesia) is related to a Cenozoic Rift System, the Ohre rift in the NW part of the Bohemian Massif. Magmatic rocks from this province vary mostly from silica poor (basalts, basanites, nephelinites) to more differentiated rock types trachytes, rhyolites and latites. An overall porphyritic granular texture of the rocks, consisting of Olivine and Pyroxene phenocrysts and microphenocrysts is revealed. Olivines frequently show skeletal or elongated growing.Some of the olivine phenocrysts are highly resorbed;in the chilled margins partly altered olivine phenocrysts have been overgrown at the rims by skeletal feldspar aggregates growing inwards towards the core, enclosing clino-pyroxene halos.Two groups of Olivines can be distinguished : the more frequent unzoned or homogeneous olivine crystals and the less frequent zoned ones which have richer Mg cores compared to the rims where there is more concentration of iron. The trace element plots vs Mg numbers show a rather uniform positive linear correlation for Ni in most cases and negative correlation for Ca and Mn. Mg-values vary between 70-93 ; the overall higher Mg values denoting rather primary magmas as compared to occurrences of more differentiated ones, and very low crustal contamination. Pyroxenes show a wide variety of chemical zoning and its color changes from brownish and greenish at the centre to pinkish brown at the edges. Zonation is more dominant at the edges, being in some cases oscillatory.Several typologies of core are: slightly-pleochroic green cores, brown cores and pinkish brown cores. Cores can be either intact or present some degree of corrosion (sieve texture).The commonest pyroxene zoning sequence is cores of greenish augite mantled by diopsode which in turn may be rimmed by augite.Such mineral and textural analysis and data interpretation gives us valuable insights on mineral chemistry for magmatic evolution in the area.

Pervasive drought during the fall of the Classic Maya Civilization: are we better prepared?

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Keynote in Session B4-01

The development and collapse of the ancient Mayan civilization during the Terminal Classic Period (TCP, C.E. ∼800-1000) is thought to be linked to the climate history of the Yucatan Peninsula (YP) and northern Central American Lowlands. Climate archives as diverse as marine

sediments, lacustrine sediments and speleothems have all been found to support the hypothesis that climate change created hydrological conditions that were unfavorable for cultural development during the TCP. Alternatively, some studies suggest that societal events of the TCP, including endemic inter-state warfare, dynastic and trade-related conflicts are unrelated to climate change (Demarest, 2004). The YP climatology is characterized by a marked dry season (March-May) that results in an annual deficit of precipitation. However, because the YP is a Karst environment with high permeability, freshwater from precipitation still flows as "rivers" underground that can only be accessed from the surface via sinkholes. Existing lakes in the YP, on the other hand, are salty and inadequate for drinking. With the exception of lowland areas or bajos the soil layer in the YP is generally thin and prompt to erosion. Despite the fact that the Classic Maya civilization accumulated sufficient knowledge to progress under these challenging environmental and climatic conditions, the lack of unlimited freshwater and forest resources to sustain the civilization in the long run, could have determined its eventual demise. In fact, speleothem and lacustrine hydrological records reveal that during the TCP, the Maya Lowlands experienced a series of droughts with enough intensity to have severely reduced the carrying capacity of the environment and thus to have catalyzed the decline of the civilization. Yet a crucial question still remains: to what extent did climate change trigger Classic Period socio-political instabilities and ultimately the disintegration of the Maya civilization? Over the last few decades, the Yucatan Peninsula has been one of the fastest population and urban growing regions in Mexico. Technology has made this urban development possible by making freshwater resources available. Even though the YP is currently not considered under hydrological stress, freshwater availability and quality to sustain human populations and ecosystems, depend almost exclusively on precipitation fluxes. Global Circulation Models suggest that the mean climate state of the YP and northern Central America by the end of this century due to global warming could be similar to the mean climate state during the fall of the Maya civilization. In light of information revealed by historical records and model climate forecasts, ongoing population growth accompanied by severe reductions in freshwater availability, could result in the Yucatan Peninsula region to be the stage once again of dire societal disruption, possibly even before the end of this century.

Memory of the LAB for melt generation in Central European intraplate volcanic fields

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Oral in Session A2-04

The chemical compositions of intraplate lavas in central Europe allow to test results from lab experiments on the genesis of basaltic melts if correlated with known depths for the the lithosphere-asthenosphere-boundary (LAB). The data indicate that the source of European intraplate magmas is by no means the European Asthenosphere but rather the subcontinental lithospheric mantle whose Nd- and Sr-isotope characteristics are inherited from times when western Europe was still part of Gondwana. Based on this conclusive data set we are able to suggest presumable depths of the LAB for any volcanic field. Our map of the seismic tomography of the LAB based on S-wave velocities in Europe indicates that shallow positions correlate with Neogene volcanic fields. We thus can assume that slow mantle velocities within lithospheric depths don't necessarily have to be indications for upwelling mantle but may rather be inherited patterns from its Cenozoic melting history. The data indicate that the position of the LAB is readjusted (healed) after less than 70-80 Ma. The recent velocities have thus no memory

for pre-Upper Cretaceous intraplate volcanic activitiy in Europe such as in the volcanic fields of Bitterfeld-Delitzsch and Lausitz (Germany), Scania (Sweden), Zuidwal (Netherlands) or Forties in the Central North Sea.

Sr and Li isotope distribution in space and time - Salar de Pozuelos, NW Argentina

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The salt lakes (salares) of the Central Andes are known for hosting large amounts of lithium, but the source rocks and enrichment processes of Li are still under discussion. The brines and evaporates of the Salar de Pozuelos (Puna region, NW Argentina) together with potential source rocks were studied for key element-contents and Li and Sr isotope signature in order to trace and understand the path of Li from the source to the deposit in the enclosed salar. Brines and salts from near surface of the salar represent the composition of water soluble input usually delivered by runoff from weathered source rocks or hydrothermal springs. Their chemistry and isotope signatures are highly variable: $^{87}Sr/^{86}Sr$ and δ^7Li of brines vary between ~0.710 to 0.720 and +12 to +19‰ respectively, related salts show a similar 87Sr/86Sr range and slightly lower δ^7Li (ΔSalt-Fluid ≤0.3‰), Li concentration of the brines is highest close to the depocenter of the salar. The variability of $^{87}Sr/^{86}S$ is dominated by the composition of different source rocks in the feeder areas whereas δ^7Li may reflect source rock compositions and/or fractionation during weathering and transport of the water soluble fraction. The second sample set is from a 100 m drill core in the centre of the salar and gives insight into the formation and evolution of the salar. The salts show a uniform signature with δ^7Li of 16.5 ± 0.5 ‰ and $^{87}Sr/^{86}S$ between 0.713 and 0.715. This requires homogenization of the isotopically heterogeneous fluids and evaporates near the borders of the salar. The rock types in the catchment areas did not change substantially during the lifetime of the salar and the Sr isotope composition is not influenced by isotope fractionation during weathering or hydrothermal leaching. Hence, homogenization towards the centre of the salar occurred relatively uniformly through time and driving force of mixing of the soluble materials was water, i.e. seasonal rain as the main water supply in this arid region.

Zircon chemistry of granitoids from the Wilson Terrane of northern Victoria Land (Antarctica): evidence for an immature Andean-type continental margin

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Oral in Session A1-03

Here we present U-Pb, trace-element and Ti-in-zircon data from zircons of 15 granitoid samples of the Granite Harbour Intrusive (GHI) Complex in northern Victoria Land, Antarctica. It has been interpreted to represent a typical continental margin arc magmatic system, associated with a west-dipping subduction beneath the continental crust of the East Antarctic craton with compositions ranging from I- to S-type. Samples were taken by the BGR Hannover in the course of GANOVEX expeditions in 1992/93 and 1999/2000. Sampled intrusions cover a region of about 400 km along the former active margin with sample localities at: Lanterman Range (n=4), around the Terra Nova Bay (n=8), Anderson Ridge, Black Ridge, Szanto-, and Daniels Range (DR), which is furthest to the

west, craton wards. Obtained ages span a range from 480 to up to 560 to 580 Ma, over a distance of c. 400 km along an active margin, which is in agreement with previously reported syn- to post-kinematic magmatic activity in the Nimrod Glacier area (Goodge et al. 2012). However, inherited ages from around 1-1.4 Ga and between 1.7 and 2.8 Ga were obtained in almost all samples, suggesting clear I-type granitoids to be scarce. The DR sample shows particularly strong inheritance, (545 $\pm$26 Ma, 1082 $\pm$79 Ma, 2220 $\pm$280 Ma, and a single grain with a concordant age of 3.4 Ga). Many zircons from this site also show strong alteration and fluid induced recrystallization structures. Only 75% of its zircon population (n=50) contain inclusions, none of those apatite. This is in stark contrast to all other sampled granitoids, which have a near 100 % inclusion rate with apatite making up either 50 to 60% or around 80% of all inclusions. Instead the leading inclusion type in DR zircons is monazite followed by xenotime. These analyses confirm the applicability of apatite inclusions in zircon as indicators for magmatic origin. Regionally, indications for potential long term convergence related magmatism are observed.

Estimating the contribution of GIA to the present-day uplift of the European Alps considering post-glacial sediment redistribution and variations in lithospheric strength

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Present-day vertical movements of the Earth's surface are mostly due to tectonic deformation volcanic processes, and crustal unloading. In tectonically stable regions of North America and Scandinavia, the vertical movements are almost entirely attributable to crustal rebound after the melting of the Laurentide and Fennoscandian ice sheets. The Alpine icecap on the other hand grew on a relatively young mountain belt that has formed by collision of the European and African plates and which is still thought to be subjected to tectonic deformation. Therefore, the measured uplift is potentially a composite signal of tectonic shortening and unloading due to deglaciation and erosion. Deciphering the contribution of tectonics and crustal unloading with regards to present-day uplift rates in formerly glaciated mountain belts, is crucial for estimating the viscosity structure of the Earth's mantle and a variety of geodynamical problems. We evaluate the post-LGM glacial-isostatic rebound of the Alps following a 4-tiered procedure. First we estimate the thickness distribution of sedimentary valley fills to create a bedrock map of the entire mountain belt. Secondly, this map is used as topographic basis for the reconstruction of the Alpine icecap using a numerical ice-flow model. In a third step we estimate the equilibrium deflection of the Alpine lithosphere due to the combined loads of ice and sediments using a variable effective elastic thickness. Fourth, we use an exponential decay function to infer the residual deflection and the present-day uplift rate for a range of upper mantle viscosities. So far, our experiment shows that virtually all of the geodetically measured surface uplift in the Swiss Alps can be explained by glacial unloading and redistribution of sediments under the assumption of an upper mantle viscosity lower than that assumed for an old craton (Fennoscandia), but higher than that for a region with recent extension and volcanism (Basin and Range province).

Convective regimes in the Tiberias Basin, Israel/Jordan, and their consequences on relic brine migration

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The Tiberias Basin (TB), Israel/Jordan, is characterized by upsurge of deep-seated hot waters along the faulted shores of Lake Tiberias and high temperature gradient that can locally reach 46 C/km, as in the Lower Yarmouk Gorge (LYG). 3D simulations show that buoyant flow ascend in permeable faults which hydraulic conductivity is estimated to vary between 30 m/yr and 140 m/yr. Convection starts respectively at 46 and 200 kyrs and generate temperature anomalies in agreement with observations. It turned out that delayed convective cells are transient. Cellular patterns that initially develop in permeable units surrounding the faults can trigger convection also within the fault plane. The combination of these two convective modes lead to helicoidal-like flow patterns. This complex flow can explain the location of springs along different fault traces of the TB and have consequences on relic brines that saturate most of the aquifers of the area. Besides being of importance for understanding the hydrogeological processes of the TB (Magri et al., 2015), the presented simulations provide a scenario illustrating fault-induced 3D cells that could develop in any geothermal system References Magri, F., Inbar, N., Siebert, C., Rosenthal, E., Guttman, J., Möller, P., 2015. Transient simulations of large-scale hydrogeological processes causing temperature and salinity anomalies in the Tiberias Basin. Journal of Hydrology, 520(0), 342-355.

Late Cretaceous eclogite in the Eastern Rhodopes (Bulgaria): a link between the Rhodope Metamorphic Complex and the Stredna Gora volcanic arc

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The Rhodope Metamorphic Complex in Bulgaria and Greece is a stack of nappes comprising continental and oceanic fragments and assembled along the European continental margin during the Alpine orogeny. It is subdivided into four groups of tectonic units, the Lower, Middle, Upper and Uppermost Allochthon. Previous Lu-Hf garnet geochronology yielded Lower Cretaceous ages for eclogite in the Upper Allochthon in the Eastern Rhodopes and Eocene ages for eclogite at the base of the Middle Allochthon in the Central Rhodopes (Kirchenbaur et al. 2012). Furthermore, zircon and monazite dating suggest end-Triassic to Jurassic UHP metamorphism of diamond-bearing gneisses. Here we report new Lu-Hf geochronological data from eclogite of the Upper Allochthon exposed at Kazak in the Byala

Reka Dome, Eastern Rhodopes. The eclogites occur as lenses and blocks within metapelites. A well-defined isochron based on two omphacite and three garnet separates yields an age of 81.6 ± 3.5 Ma. The distributions of Mn and Lu in garnet show high concentrations in the core that decrease towards the rims, which indicates prograde growth of garnet during P and T increase. Therefore, this age is interpreted as the age of pressure increase during subduction. This new data provides another evidence for multiple subduction events in the Rhodopes. The Late Cretaceous subduction zone dipped north under the Sredna Gora arc where subduction-related, calcalkaline melts reached the surface at the same time. Top-North extensional detachment faulting unroofed the subducted rocks, including the Kazak eclogite, during the Late Eocene.

Kirchenbaur, M., Pleuger, J., Jahn-Awe, S., Nagel, T.J., Froitzheim, N., Fonseca, R.O.K.,Münker, C. (2012): Timing of high-pressure metamorphic events in the Bulgarian Rhodopes from Lu-Hf garnet geochronology. Contrib Mineral Petr, 163:897-921.

Reactions between mantle xenoliths and trachyandesite host melt from Pigroot, New Zealand

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Poster in Session A2-04

Phonolites and related rocks typically form by differentiation processes within crustal levels. In recent years increased evidence has been collected for phonolite melt formation at mantle depths based on P-T estimations from the Heldburg phonolite (Germany) and the experimental replication of reaction rims between mafic mantle xenoliths and evolved sialic melt [1, 2, 3]. Reaction rims around mantle olivine and orthopyroxene also provide a tool to reconstruct the timing of their interaction with the melt. Here we provide results from the mantle rock-bearing trachyandesite (benmoreite) from Pigroot NZL. This mostly aphyric volcanic rock with phonolite affinity consists of a groundmass of sodic alk-fsp, cpx, sodalite, nepheline and either aenigmatite or titanomagnetite with cpx microphenocrysts (dio-hed). Apart from mantle fragments various xenocrysts and micro xenoliths of unknown origin are present. Mantle rock fragments are lherzolites and harzburgites. Olivine is enriched in Fe toward the rims in contact with the melt, but no secondary minerals have formed. Opx is rimmed by zoned intergrowths of diopsidic cpx, Fe-rich olivine and magnetite. The rims are disequilibrium structures often consisting of a sandwich-type cpx dominated layer between two oivinel dominated layers, where the outer layer is enriched in fayalite component. Precise experimental studies are needed to constrain the P-T-X conditions suited for the formation of the observed reaction rims. Ref.:

[1] Grant et al. (2013) Lithos 182-183, 86-101;
[2] Grant et al. (2014a) CMP 168:1073;
[3] Grant et al. (2014b) Amer Min 99, 2211-2226

Diopside-Quartz-Glass thermometer: Temperature regime estimation of synthesized millstones from Iran

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Oral in Session B6-02

Historical shortage of beneficial materials and techniques led humans to invent new technologies or synthesize new materials. Some historical texts mentioned the production of artificial millstones in Sistan, southeastern Iran. Several broken pieces of an unknown type of vesicular millstones from Islamic era (14th-17th. C) have been found in an archaeological survey in that region. Lack of any kind of poriferous basaltic stone in that area fortified the assumption of an artificial origin of these materials. Initially, we studied the nature of the millstones by thin section, SEM, EMPA and XRF. This multi-approach analysis

shows an amorphous microstructure including unmelted quartz, associated with dendretic to hollow-euhedral crystals of diopsidic clinopyroxene. They result from the usage of calcareous clay mixed with sand and melted at high temperature; then brought to super-cooling condition from around the eutectic point of the SiO_2-Al_2O_3-CaO system that is very close to the composition of that calcareous clay. Further studies focused on the probable heating-cooling regime of this forgotten technology. Experimental samples with the same composition of regional clay and sand have been molten in the lab-furnace and cooled at controlled ramps to below the liquidus either to room temperature or by quenching in water. The maximum temperature was 1170° C, where the system (excluding quartz in surplus) exists of 98% melt and 2% blocky Cpx crystals; further Cpx crystallizes during the cooling process. The amount of remnant quartz and the morphology of Cpx are used as a tool to identify the heating regime.

Airborne hyperspectral and geochemical mineral exploration – challenges and opportunities

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Airborne hyperspectal surveys have been utilized for mineral exploration over the last decades. Particularly in arid regions with good exposure and sparse vegetation (e.g. Australia) hyperspectral information can be used to identify new target areas (Bierwirth et al. 2002). With continuously increasing ability to handle large data sets using modern computers the resolution of airborne hyperspectral data is also increasing. Within the scope of the research project GMES4Mining, where DMT has participated in as a consortium partner, an airborne hyperspectral survey was conducted during April 2015 with a spatial resolution of 1 m2. The 52 km2 large test site was located approximately 90 km south-west of Newman, Western Australia. In the field of geological research hyperspectral remote sensing has focused on identifying lithologies, alteration zones and the link between surface mineralogy and the spectral signatures (van der Meer et al. 2012). Investigations linking hyperspectral and geochemical data (element and whole rock geochemistry) are currently lacking. In order to provide data and close this gap, results from the GMES4Mining project will be utilized. Possible implications of combining airborne hyperspectral survey and geochemical data lie within the establishment of comparatively cost and time effective exploration methods for large and remote areas. Phil Bierwirth, David Huston & Richard Blewett (2002): Hyperspectral mapping of Mineral Assemblages Associated with Gold Mineralization in the Central Pilbara, Western Australia. Economic Geology, Vol. 97, 2002, pp 819-826. Freek D. van der Meer, Harald M.A. van der Werff, Frank J.A. van Ruitenbeek, Chris A. Hecker, Wim H. Bakker, Marleen F. Noomen, Mark van der Meijde, E. John M. Carranza, J. Boudewijn de Smeth & Tsehaie Woldai (2012): Multi- and hyperspectral geologic remote sensing: A review – International Journal of Applied Earth Observation and Geoinformation, Vol. 14, pp. 112-128.

Electron channeling contrast imaging of dislocations in geological materials using a scanning electron microscope

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Poster in Session A4-03

Imaging of individual dislocations in a scanning electron microscope (SEM) is currently under spotlight. Characterization of types of dislocations and its density are commonly measured by the diffraction contrast method, bright field and dark filed imaging in a transmission electron microscope. Also, dislocation density can be measured by direct methods such as dislocation oxidation and etching techniques in optical microscope and a SEM. Here, we report electron channeling contrast imaging (ECCI) of dislocations in a deformed (Mg,Fe)O ferropericlase. Under optimal diffraction conditions, ECCI can provide dislocation density and its microstructures in the bulk specimen.

PGE signature of Archean spherule layers in the Barberton Greenstone Belt, South Africa

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Archean spherule layers in the Barberton Greenstone Belt (BGB) are amongst the oldest known impact deposits known on Earth. Primary signatures in the spherule layers may elucidate impact processes, target material, and the projectiles involved. A comprehensive petrographic and geochemical study of Archean spherule layer material in drill core CT3 from Fig Tree Group strata of the north-eastern part of the BGB is being carried out and aimed at identification and localization of phases potentially hosting an extraterrestrial PGE signature. This follows on the recent discovery of sub-μm PGE micronuggets in spherule layers in ICDP drill core BARB 5 from the BGB [1]. In this study we identified the assemblage Ni-rich chromium-spinel/PGE phases as the long-sought carrier phases for the extraterrestrial signature in one BGB spherule layer. Primary PGE+Ni,Fe alloys are hosted by Ni-Cr-spinel. This nugget effect appears to be responsible for the local, anomalous enrichment of the siderophile elements (especially the PGE) in excess of meteoritic abundances. Using CT3 core material, some of the main questions to be pursued include: (1) Are the observations from the current BARB 5 project applicable to other spherule layer intersections with respect to the composition of PGE micronuggets and the occurrence of such nuggets within and between Ni-Cr-spinels? (2) Are PGE micronuggets primary meteoritic phases of the impacting body or the product of impact melting or condensation from the vapor plume, or have they been affected by postimpact secondary overprint? Further petrographic and textural analysis as well as quantitative microanalysis by SEM and EMPA of PGE phases and host material is being carried out to understand the distribution of the PGEs and how they fractionate within the vapor or melt system. This could lead to a better understanding of the behavior of extraterrestrial phases under extreme conditions. Ref.:

[1] Mohr-Westheide et al. (2015), Geology 43, 299-302.

Continental breakup and passive margin evolution based on plate tectonic concepts developed from the South Atlantic and the Red Sea

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Oral in Session A2-02

The results of regional deep seismic acquisition in the South Atlantic continental margins provide new constraints on the birth and development of sedimentary basins formed during the Gondwana breakup. The interpretation of these seismic profiles integrated with gravity and magnetic potential field data suggest alternative models for the birth of oceanic basins that evolve from an earlier phase of intracontinental rift. The Iberian model of mantle exhumation has been applied extensively to the interpretation of several basins in the Eastern Brazilian and West African conjugate margins. However, in this lecture we emphasize the contrasts from the tectono-sedimentary features imaged in deep-penetrating seismic profiles that extend from the platform towards the oceanic crust, which indicate that the Red Sea constitutes a better analogue for the development of divergent continental margins. An overview of the geological concepts that evolved rapidly during the last three decades brings new lights on the challenges of petroleum exploration in the ultradeep water provinces of divergent continental margins. This talk also shares with the scientific community the methods and results from the application of modern geological and geophysical tools that help in the interpretation of the crustal architecture, rift structures and the salt tectonics elements that are crucial to basin analysis studies.

Groundwater as transport pathway in biogeochemical cycles: from local observations to global estimates

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Material fluxes from chemical rock weathering are a major part of global biogeochemical cycles. Weathering is a sink for atmospheric CO_2 and a source of nutrients for terrestrial and marine ecosystems. Traditionally, rivers are regarded as the only link between the terrestrial and marine realm in studies assessing land-ocean matter fluxes. However, many local studies now point to the importance of submarine groundwater discharge (SGD) as a transport pathway for dissolved constituents from land to sea. Here, we present results from a review of the available literature, analyze major controls on SGD, and discuss the provenance of the identified dissolved constituents. Upscaling SGD-related matter fluxes from local studies to regional or global scale is complicated, because high local variability of SGD inhibits extrapolation to a stretch of coast. Model-based understanding of the controls of the groundwater discharge will help to improve the extrapolation. Among other, natural, controls (e.g. aquifer permeability), one major control of SGD-associated matter flux is the anthropogenic influence, which on the one hand can increase fluxes by increasing concentrations, but on the other it can decrease fluxes by reducing water discharge. Here, we present hypotheses and ideas to inspire a discussion about the relevance of submarine groundwater discharge as pathway between land and ocean in biogeochemical cycles at local to global scale.

TUNB: A 3D Model of the North German Basin – Project Overview

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The deep subsurface in Germany is receiving increased attention as a valuable commodity, not least due to discussions on new technologies such as carbon dioxide capture and storage, storage of renewable energy (e.g. compressed air or hydrogen), and an increasing demand for geothermal energy. Today's options related to production and storage of conventional as well as renewable energy involve potential conflicts of use and necessarily trigger the discussion on the need of a subsurface planning policy. This growing focus on the deep subsurface raises the need for more detailed geological information, also in 3D. In 2014, BGR and the state geological survey organisations (GSO) of the north German federal states started the project "Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB)". The primary intention is the construction of a 3D model of the entire North German Basin (NGB) within a period of six years. The GSOs of the north German federal states construct 3D geological models of their areas of responsibility as components for the NGB 3D model. BGR constructs 3D component models of the exclusive economic zone in the German North Sea and the Baltic Sea sectors. All models will be harmonised across national and as far as possible across international borders. BGR coordinates all efforts and will finally merge the individual component models into one consistent model of the entire NGB. As a starting point, modelling concepts and approaches will be tested in and applied to a pilot-region, where five federal states lie in close proximity to each other at the former inner German border. After completion of the 3D structure model of the entire NGB 3D model, submodels will be selected for parameterization. Parameterized volume models provide a basis for further studies including e.g. dynamic modeling of fluid flow.

Topography of mountain belts as a key element in the evolution of landscapes and life

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The past 10 years have witnessed rapidly expanding progress in stable isotope paleoaltimetry that resulted in a broad array of tectonic studies mainly focused on continental plateau regions. Stable isotope based topography reconstructions, therefore, have greatly expanded what used to be very sparse global paleoaltimetric data, partly through the advent of novel geochemical tools including plant biomarkers or clumped isotope thermometry. The topography of mountain ranges and plateaus, however, not only reflects the geodynamic processes that shape the Earth's surface; it also represents a key element in controlling continental moisture transport, atmospheric circulation and the distribution of biomes and biodiversity. The challenge now lies in disentangling the surface uplift component from the inevitable impact of climate change on long-term records of δ^{18}O and δD in precipitation that accompanies surface uplift. Here, we present examples where innovative approaches in stable isotope paleoaltimetry successfully track topographic thresholds to changes in atmospheric circulation and precipitation with a particular focus on the role of plateau-bounding ranges in western North America and Central Anatolia. We document a) how differences in δ18O between high and low-elevation sites enhance the robustness of stable isotope paleoaltimetry and b) clumped isotope thermometry may allow to trace composition and origin of precipitation-derived meteoric fluids into deep(er) basin systems. Future advances in stable isotope paleoaltimetry will greatly benefit from addressing topographically-induced teleconnections in the global climate system that affect δ^{18}O or δD of precipitation with a particular focus on plateau bounding ranges and from interfacing with phylogenetic techniques to evaluate competing hypotheses with respect to the timing of surface uplift and species development.

Continental inter-superswell travel and landscape evolution

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Australia is unique amongst continents formed during the breakup of Pangaea in that it has travelled from the edge of the African superswell in the Late Jurassic to the edge of the Pacific superswell in the Cenozoic, crossing the East Gondwanaland slab burial ground. The plate tectonic history has had major consequences for the evolution of Australia's topography. In the Late Jurassic at 150 Ma, Australia was tilted to the east, while the western part of the continent was proximal to the African superswell and the continent's eastern border was marked by long-lived subduction. Around 100 Ma subduction became extinct while

Australia had migrated east to a position far way from large upwellings. Eastern Australia's rebound from being drawn down by sinking Gondwanaland slab material followed subduction cessation and slab breakoff, leading to pronounced uplift of the eastern highlands of Australia, erosion and formation of the Ceduna Delta. After some period of absolute plate motion stagnation, Australia's fast Cenozoic north-northeastward brought its eastern perimeter into the reach of the Pacific superswell, leading to renewed uplift of the eastern highlands, and a second pulse of sediment deposition in the Ceduna Delta. We couple these dynamic topography predictions with a continental-scale surface process model that we use to compute 150 Myr of landscape evolution from a history of varying climate, sea level and mantle flow-driven dynamic topography. The model predicts the time dependence of erosion and drainage patterns that we compare to denudation rates and paleo-drainage from paleogeography and the sedimentary record in key basins. We find that the motion of the Australian plate from the African to the Pacific superswell has resulted in significant shifts in river drainage, intracontinental erosion and sedimentation as a result of the interplay between large-scale tectonic forces and surface processes.

Late Cretaceous vertebrate faunas from northeastern Gondwana: regional endemism, vicariance, and continental break-up.

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Oral in Session A5-01

The Late Cretaceous (Campanian/?Maastrichtian) deposits of northcentral Sudan are known to yield a diverse assemblage of micro- and macrovertebrates, which represent one of the few Late Mesozoic faunal records from the northeastern margin of Gondwana. Next to its exceptional diversity, the Cretaceous faunas from Sudan emphasize the complexity and problems of vicariance-induced (paleo-)biogeography and the idea that evolutionary diversification and regional (or continental) endemism of terrestrial vertebrates are primarily generated through continental break-up. We illustrate our point by several examples from the Sudanese fossils vertebrate fauna including taxa from several major clades of amphibians and reptiles, which constitute the results of novel fieldwork activities and a reassessment of previous paleontological surveys. In particular we show that a) propositions of vicariance-induced biogeograpic patterns may be the result of insufficient sampling activities, and b) continental endemism may not necessarily be evidence of in-situ evolutionary diversification after continental fragmentation, but can also be the consequence of major extinction patterns in a clade's ancestral global geographic range. Overly simplistic assumptions about the underlying processes that shape biogeographic patterns represent a major problem, and careful consideration of the fossil record is not only necessary for explaining the distributions of extinct organisms, but also for understanding those of modern day's biota.

In-situ Raman and infra red spectroscopy on siderite up to 60 GPa and maximum 1000 K

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Oral in Session A4-03

Carbonates are the most abundant carbon-bearing minerals on Earth. Through subduction processes carbonates can be transported into the Earth up to depths of the lower mantle. Magnesite-siderite solid solutions are the main carbon carriers in the deep Earth and therefore, understanding their stability may help understanding the long term carbon cycle Iron bearing minerals may undergo pressure induced electronic and structural phase transitions. In case of the magnesite-siderite solid solutions series, however, the high-pressure behavior is controversially discussed. Spivak et al. (2014), report a phase transition of the siderite at approximately 40 GPa and ambient temperature, which they assign to the pressure induced spin-pairing transition of the d-orbital electrons of Fe2+ from high spin (HS) to low spin (LS). However, Lavina et al. (2010) report the spin transition to be at ca. 44 to 45 GPa and ambient temperature. Liu et al. (2015) present the phase diagram of siderite from 20 to 120 GPa and 300 to 2700 K, which lacks data regarding the spin transition of siderite between 40 and 60 GPa and higher temperatures between 300 and 1200 K. But they assign the spin transition to 42 GPa and 300 K. With the spin transition a large collapse of the unit cell volume is reported (Lavina et al., 2010). Therefore, vibrational spectroscopy in combination with diamond-anvil cell experiments is especially suited to map such phase diagrams. Here we present in-situ Raman and infrared spectroscopic data of siderite up to ca. 60 GPa, showing the phase transition in dependence of pressure and temperature of maximum 1000 K.

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Modeling Microbialite Growth

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Poster in Session A4-05

Microbialites are sedimentary deposits formed in benthic environments under the influence of a surficial microbial community and were the dominant reef builders during most of the Precambrian. Their large-scale morphology (e.g. domes versus columns) and small-scale internal texture (e.g. stromatolitic versus thrombolytic) is governed by the nature of the associated microbial community as well as the physicochemical environment they thrive in. Many studies investigating modern microbialite occurrences have shown distinct correlations between environment, the type microbial community, and the associated microbialite morphology. However, due to the extremely slow growth rates of microbialites (<1 mm/year) and the additional inability to grow them in the laboratory, it has remained difficult to clearly understand what controls microbialite morphogenesis. We here present a numerical microbialite growth model that considers subaqueous surface illumination, water agitation-dependent sediment deposition, and growth properties of the microbial mat. Our simulation result show that large-scale morphologies are mainly controlled by the depositional pattern of sediment, whereas the internal texture is largely governed by the growth properties of the microbial mat. The ability to simulate microbialite growth with numerical methods will advance our abilities to decipher what controls microbialite morphogenesis and therefor open new avenues for using fossil microbialites to better reconstruct paleoenvironments and the former nature of microbialite-associated biota.

Correlation of shallow gas indicators and seismic stratigraphic units in the German North Sea

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Shallow gas is generally defined as natural gas with biogenic or thermogenic origin occurring in the upper 1000 m of the sediment column. Bright spots are seismic reflections with anomalously high amplitudes that exhibit a reversed phase in relation to the seabed reflection, which can be an indicator for hydrocarbons. In the past, shallow gas in the North Sea was entirely considered uneconomic and at its best of interest only as a potential drilling hazard. But since 2007 shallow gas is produced in the Dutch North Sea from three reservoirs. Nevertheless, the potential for shallow gas in the German part of the Southern North Sea has so far been barely investigated. A first interpretation of all amplitude anomalies identified in seismic data in the uppermost ∼1.000 m was published by Trampe et al. (2014). The dataset, consisting of more than 25.000 km of 2D seismic data and about 4.000 km2 of 3D seismic data, is used to analyze bright spots as a direct hydrocarbon indicator (DHI). The occurrences of shallow gas are linked to a detailed seismic stratigraphic model (Thöle et al. 2014) for the Neogene delta system that forms most of the uppermost 1.000 m of sediments in the German Bight. Most of the mapped DHIs lie above the prominent seismic reflector of the Mid-Miocene Unconformity within generally only poorly consolidated clastic sediments of the delta system. Correlation of the mapped bright spots with individual seismic units and other features reflecting the Neogene delta evolution indicate that potential shallow gas reservoirs are not randomly distributed but linked to several different key units. References:

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Petrophysical, mineralogical, and geochemical investigations of a Li-Sn-W deposit – A contribution to develop a borehole probe for quantitative element determination in ores of natural deposits

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Many resources needed for key technologies originate from natural deposits that have to be explored and evaluated with regard to economic exploitation. Interest in exploration and exploitation of ore deposits has increased worldwide over the last years. For economic exploration of ore deposits, an increased need of an efficient and universally applicable exploration technique exists, to explore resources of low concentrations using exploration boreholes or during exploitation. To bridge this gap in the market, a geophysical probe is developed which can detect a range of elements of economic interest, which has previously only been possible using costly rock cores. The probe is based on multiactivation analysis (combined radiometric principles such as neutron activation or gamma spectrometry). In addition, magnetic measurements are conducted. The aim is to provide a technique which comprehensively characterizes the penetrated ore-bearing formations and reduces exploration time and costs. To support the development of the probe and establish a calibration facility, an extensive geophysical, mineralogical and chemical investigation program aimed at characterizing a

Li-Sn-W ore body was realized. Grain density, porosity, compressional wave velocity, magnetic susceptibility, gamma spectrometry, electrical resistivity and magnetic resonance properties were determined in addition to ICP mass spectrometry, X-ray fluorescence spectroscopy and diffractometry. The investigations show that the ore-bearing rocks can clearly be differentiated from the neighboring rock based on elevated grain density, magnetic susceptibility and mostly high Th/K ratios. The chemical analyses indicate high contents of Li (>5.000 ppm), Rb (>3.000 ppm), F (>10.000 ppm), as well as W contents of >1.000 ppm and Sn contents ranging from 50 to >100 ppm. A logging dataset confirms the good correlation between field and laboratory results so that they can be used for calibration of the new borehole probe.

The Hf-W age of Mars revisited

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Based on the ^{182}W composition of Martian samples, recent studies have suggested rapid accretion and an old age for core formation for Mars, within a few Myrs after solar system formation. The Hf/W ratio of the Martian mantle is a key input parameter for this dating approach, but previous estimates of this ratio relied on literature compilations using ratios of W to lithophile Th and U, both considered to behave similar to W. A drawback of this approach is that W-Th-U concentrations were taken from different studies on different meteorite specimens. In order to improve the Martian Hf/W estimate, we measured the concentrations of W and similarly incompatible elements (e.g., Th,U,Nb,Ta) on the same meteorite specimen, mostly by employing isotope dilution. Our results indicate that Th-U behaved more incompatible than W during Martian silicate differentiation, whereas Nb and Ta behave most similar to W. This is in marked contrast to the Earth, where Nb-Ta behave more compatibly. The different behaviour of W on Mars can be explained by recent experimental studies, indicating a more compatible behaviour of W during silicate melting at reduced condition and suggesting more reducing conditions during the early history of Mars. Nakhlites yield a Ta/W and a calculated source Hf/W that is resolvably higher than that of shergottites, in line with the more radiogenic ^{182}W compositions of nakhlites. For the shergottite source, a single stage Hf-W model age of up to 4.5 Ma after solar system formation is obtained. For the nakhlite source, a model age older than the solar system age is obtained. This finding is in line with ^{142}Nd evidence and a more complex history of the nakhlite source, involving a combination of metal segregation and early silicate melting during the lifetime of ^{182}Hf.

Ionic mobility in lithium silicate glass powder during compaction

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A new cell was developed to study the behavior of powders during axial compactions at temperatures up to 950 K and pressures up to 1 GPa. The apparatus allows recording of impedance spectra in situ during compaction. Linear variable differential transducers attached to the pistons allow simultaneous monitoring of changes in sample volume. By flushing the cell with gases the material surfaces can be pre-equilibrated before compaction. Experiments were made with different grain size fractions of lithium trisilicate glass (ranging from 60 to 250 μm) in the brittle deformation range (315-443 K) and in the partially plastic deformation range (ca. 660 K). Results show that DC conductivity increases linearly with pressure up to 750 MPa at about

660 K. Lower conductivity for the smaller grain size fraction under these conditions is attributed to higher shares of pores between the grains, acting as resistors. Variations in the grain size fraction range cause a deviation of the linear behavior. Analysis of the recorded impedance spectra indicates ionic mobility along multiple pathways.

Palynology and micropalaeontology of Holocene lacustrine sediments of the Layla Lakes in central Saudia Arabia and implications for palaeoenvironment and palaeoclimate

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Poster in Session C4

The Layla Lakes in central Saudi Arabia, located 300 km south of Riyadh, are fed by groundwater, but dried up in the late 1980's due to extensive groundwater use, revealing a series of 23 sinkholes in the Jurassic Hith formation. In one of them with a size of 400x100 m and a depth of 10 m several samples were taken during a field campaign in 2011. Furthermore a sediment core was drilled near the sinkhole, revealing a lacustrine succession of 10.8 m. Mineralogical and geochemical analyzes show two distinct types of sedimentation: Sediments with an average content of 85% calcite (carbonates) and sediments, which consist almost entirely of gypsum and anhydrite (sulfates). The carbonates precipitated when the exchange between groundwater and lake water was too large to achieve supersaturation of gypsum, while the sulfates mark periods of strong evaporation with limited rates of water exchange. First radiocarbon ages of mollusc shells and U/Th dating of carbonates indicate that the sedimentary succession covers 6000 years. Autochthonous microfossil assemblages comprise pollen, spores, diatoms, freshwater algae, testate amoebae, phytoliths and other non-pollen palynomorphs and offer the application of various multi-proxy methods to reconstruct palaeoclimate and palaeoenvironment in the center of Saudi Arabia in detail, a region, where such a complete sedimentary record is unknown so far. First XRF and visual analyses of sediment composition show at least four changes between arid and more humid phases based on the frequency of carbonate and sulfate sediments. A first palynological analyses show that during the humid phases the groundwater inflow was higher than the loss of lake water by evaporation. With increasing lake level large floodplain environments evolved, which were covered by a vegetation mainly composed of grasses and sedges. During dry phases the lake level decreased significantly and the vegetation was replaced by plants that were adapted to arid conditions.

Climatic and geochemical implications of Archean pedogenic gypsum of the Moodies Group (∼3.2 Ga), Barberton Greenstone Belt, South Africa

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Lithic sandstones of braided-fluvial to supratidal facies in the Paleoarchean Moodies Group (∼3.22 Ga, Barberton Greenstone Belt, South Africa) include several regionally traceable units with common to abundant, in places rock-forming, nodular concretions of megaquartz pseudomorphs after gypsum, barite and calcite. Concretionary accumulations are stratiform and commonly associated with aqueously reworked, fine-grained tuffaceous sediment of originally rhyodacitic composition and can grow to fist-sized agglomerates in crusts tens of m in lateral extent. Weathering of tuffaceous material and feldspar delivered alkali cations such as Ca, Ba, and K while carbonates were likely supplied by silicate weathering of mafic to ultramafic volcanic rocks during exposure to a CO_2–rich atmosphere. Sulfate ions were partly delivered by oxidative pyrite dissolution which may have included microbial and abiotic disproportionation of volcanic S or SO_2. Concretionary growth apparently took place under pedogenic to early diagenetic conditions within unconsolidated granular sediment in the vadose zone, dominated by seasonal fluctuations of the groundwater level under evaporitic conditions. The concretions likely represent the oldest terrestrial evaporites known to date and form part of the oldest known compound paleosols. Their formation and composition constrain the local occurrence of sulfate in the Archean atmo- and hydrosphere, their interaction with the emerging biosphere, Archean weathering regime, local climate, and vadose-zone hydrodynamics.

Biogenic overgrowth on detrital pyrite in Archean paleosols in the ~3.2 Ga old Moodies Group, BGB, South Africa.

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Pyrite is a common mineral in the braided-fluvial to supratidal sandstones of the lower Moodies Group of the Barberton Greenstone Belt (~3.22 Ga). Regionally traceable paleosols within these strata contain locally abundant silicified concretions originally composed of pedogenic carbonates and sulfates, interbedded with heavy-mineral laminae dominated by chromite and pyrite. A large proportion of this pyrite is of metamorphic origin and associated with hydrothermal gold mineralization. A second type of pyrite, however, shows rounded, partly dissolved detrital cores affected by a slightly oxidizing pore fluid during or shortly after their deposition. This fluid may have been related to the formation of the pedogenic sulfate and carbonate concretions. Secondary idiomorphic rims grew under reducing conditions and have clearly different trace elemental compositions, particularly Ni and Cr, than the cores, indicating an ultramafic provenance for their formation. Bulk sulfur isotope analyses of detrital pyrite have δ^{34}SVCDT values as negative as -8.2 but no Δ^{33}S anomaly. The lack of a Δ^{33}S anomaly shows that sulfur was not delivered from the atmosphere while the negative δ^{34}SVCDT values suggest a biogenic fractionation of sulfur. The close spatial association and nearly contemporaneous formation of pedogenic sulfate concretions and secondary pyrite rims is consistent with the activity of sulfate-reducing bacteria (SRB) in the paleosols which produced secondary sulfide rims around the detrital pyrite grains. This indicates that vadose-zone soil processes in the Archean involved not only physical and chemical modification of unconsolidated sediment but also biological modification. Microbial life was already present in the moist vadose zone of terrestrial environments about 3.2 Ga ago.

Hard discharge of rivers and supply by wind in south Caspian Sea

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Poster in Session A6-05

Beaches are part of land system while most of the people choose to live there about 60% of the people societies live on beaches (Krak Nel1999).in other words beyond half of the population of the world live on beach ,sand beach are originated from rivers and according to dynamic movement of the water and waves they distnbrted across the beaches . Some rivers like Haraze,Tagan,sefidrood,Babolrood and make precipitation in Caspian sea and its south beaches. Coast of the Caspian Sea is bordered at south by mountain system of Alborz, slopes of which come down rather abruptly to coastal lowland. Altitude is 4,5-5,6km in distance 50-100km (peaks of mountains rise to these notes). It is clear, that rivers springing from slopes of Alborz, have great

potential and kinetic energy and can transfer a great quantity of friable material as discharge flow. Latter is deposited then in their deltas and at foot of slopes as alluvial fans. Numerous rivers (65) of various sizes-from large River Sefidrud, collecting its water from huge territory- off spurs of Zagros, slopes of volcano Heremdag (3707m) and range Bothkush to short rivers Tajan, Neka, Babol etc., draining the northern slopes of Alborz. They annually supply around 40 million tons of sediments to the shoreline. Main portion of coarse sediments are brought to the coast by rivers, especially in central coast, where gradients are steep and coarse-grained material is readily transported by floods. Data of sediment load of rivers Sorkh, Babol, Talar and Tajan show, that these even small rivers bring to the Caspian sea about 50 000 ton of sediment in year.

Systematic imaging of bimaterial interfaces at the at the Karadere-Düzce segment of the North Anatolian Fault Zone, Turkey

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Poster in Session A2-01

We investigate the presence and properties of bimaterial interfaces at the Karadere-Düzce segment of the North Anatolian Fault Zone (NAFZ) in NW Turkey with observations of fault zone head waves and direct P body phases. The tectonic loading on the NAFZ produces major (M7+) strike-slip earthquakes. The two most recent major earthquakes in the study region were the 1999 Mw 7.4 Izmit and Mw 7.1 Dücze events. In the present study we use waveform recordings from near-fault stations along the broader Karadere-Düzce area operating during the Izmit and Duzce aftershock periods. We analyze the data using automatic detection of direct P and fault zone head waves along with the manual inspections and particle motion analysis. Preliminary results indicate abundant early arrivals before the direct P at many stations that appear to be head waves, but show no moveout with different source-receiver distances. These phases may reflect local bimaterial interfaces near the stations that may be associated with fault zone-related basin structures. We also observe at some stations head wave type signals before the direct P waves that show systematic moveout with increasing propagation distance along the fault and may indicate a deep velocity contrast across the NAFZ in the area. Updated results will be presented in the meeting.

Sulfur solubility in mafic silicate melts at reducing conditions: Implications for Mercury's differentiation

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Mercury's surface is represented by mafic to ultra-mafic lavas with high SiO_2 and MgO content, variable Al_2O_3 and CaO content and extremely low FeO. All lavas are significantly enriched in sulfur. The solubility of sulfur in such silicate melts is poorly known but is critical to understand the mechanisms of mantle melting and the differentiation of the planet. We investigated the sulfur solubility in silicate melts with compositions relevant to surface compositions of Mercury at low oxygen fugacity conditions (IW-2 to IW-6, where IW is the iron-wustite buffer), in the temperature range of 1200-1500°C and in the pressure range from 0.1 to 2 GPa. The S content of the melt saturated with a sulphide phase shows a linear correlation with log f_{o2}. The sulfur solubility is relatively low ($\sim$ 0.5 wt.%) at oxygen fugacity conditions near the IW buffer, but increases significantly with reducing conditions (2-4 wt.%; IW-4 to IW-6). The experimental results can be compared with the sulfur content observed in Mercury's surface lavas, containing 0.5-3 wt.% S. This range is relatively similar to the values of sulfur solubility in the silicate melt observed in the experiments. This indicates that the sub-solidus mantle of Mercury was probably sulfide-saturated. During melting, sulfides are progressively exhausted and the sulfide melt dissolves into the silicate melt. If all sulfides present in the source are dissolved in silicate melts, magmas ascending from the mantle to the surface of the planet may be sulfide-undersaturated and the sulfur observed at Mercury's surface may therefore be entirely comprised in quenched silicate melt. On the other hand, if solidification occurred in a sub-surface environment, progressive cooling together with silicate liquid differentiation may have lead to sulfide saturation, therefore producing immiscible sulfide melts that further crystallized as sulfide minerals.

On the virtue and wickedness of modern Rb-Sr dating

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Keynote in Session A1-05

The Rb-Sr dating technique has been a prominent and widely used dating tool, and has been successfully applied to rocks and minerals ranging in age from early solar system processes to geologically young volcanic events. However, over the last three decades, advances in other dating techniques, as e.g., U-Pb and Ar-Ar, have almost "outdated" so-called conventional Rb-Sr dating, being more precise, and for specific (high-temperature) rocks also more accurate. The former primarily relates to analytical difficulties, in particular mass spectrometric techniques, whereas the latter is a function of (1) a possible decay constant bias and (2) the susceptibility of Rb-Sr to low temperature and fluid overprinting. Recent joint-efforts in the community have led to a substantial improvement of Rb-Sr dating, so that it is now possible to date rocks with a precision comparable to e.g., Ar-Ar dating. In addition, convincing re-calibrations of the Rb decay constant yield coherent results so that this matter is plausibly settled. The question now remains: where does this leave us with respect to geologic pitfalls – or what is a Rb-Sr age worth? Here I will show a number of high-precision Rb-Sr ages, placed into a geochronologic context and explore their value for geologic interpretations. Examples from southern Sweden reveal the scale of igneous cooling. Samples from the Ilimaussaq intrusion in Greenland show high-precision magmatic ages and reveal two distinct magmatic pulses. Rocks from the Bushveld and Great Dyke complex show the (possible) effect of fluid overprinting. Finally, I re-assess the matter of decay constant in light of two Wenlock-aged bentonite layers from Gotland.

These confirm the new Rb decay constant but also highlight the danger of isotope disturbance in seemingly well preserved volcanic ash layers.

Phase content and neutron diffraction analysis of off-stoichiometric Cu_2ZnSnS_4 (CZTS)

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Oral in Session B6-03

Quaternary chalcogenides have seen rapid development in recent years leading to a world record efficiency for thin film solar cells based on $Cu_2ZnSn(S,Se)_4$ (CZTSSe) of 12.6% [1]. CZTS belongs to the $A^{I}_2B^{II}C^{IV}X^{IV}_4$ compound family and crystallizes in the tetragonal kesterite type structure, the certain ordering of the Cu and Zn cation layers results in the space group $I\bar{4}$ [2]. According to literature [3] the stability field of single phase CZTS is assumed to be quite narrow. In literature [4] four off-stoichiometric CZTS compounds, named A-, B-, C- and D-type, have been proposed. The number of publications on intrinsic point defects in kesterites is very limited. Further studies on deviation from stoichiometry, distribution of the cations and formation of intrinsic point defects are of great importance to understand solar cell performance. Therefore, our experiments focus on the synthesis of off-stoichiometric CZTS reference powder samples with cation ratios Zn/Sn and Cu/(Zn+Sn) $\neq 1$. All powder samples were synthesized by solid state. The obtained samples have been well characterized regarding chemistry, phase composition and trends in lattice parameters using wavelength-dispersive X-ray spectroscopy (WDX) on an electron microprobe system and X-ray diffraction (XRD). Furthermore neutron diffraction was used to obtain the site occupation of the Cu and Zn sites in the kesterite structure. The results of the XRD and WDX analysis show that CZTS is the main phase in all synthesized samples. Also 8 of these samples are single phase off-stoichiometric kesterite. Furthermore the neutron diffraction results of the off-stoichiometric kesterite samples correspond well with the postulated cation substitution processes from literature [4].

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Middle and lower passive margin crust preserved in mountain belts and its correlation with upper crust: significance for rifting models and tectonic reconstructions

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Oral in Session A2-02

The poorly studied middle and lower crust (MLC) of passive continental margins, a key plate tectonic element, is often preserved in thick-skinned tectonic wedges of mountain belts. We studied the Permian to early Norian Meliata Ocean-related rift-characteristics of MLC and detached upper crust (UC) of the Austroalpine nappes of Eastern Alps with the aim to assess rift models, composition and temporal and spatial distribution of magmatism. There, the response of LMC to rifting includes acidic and subordinate, mostly earlier mafic magmatism, high-temperature/low-pressure metamorphism (ca. 0.46 GPa, 540 °C), and pure and simple shear deformation in shallow parts of MLC. In UC, the poorly dated rift-onset unconformity formed in Early or Middle Permian and resulted in N-S to NE-SW striking halfgrabens filled with up to 1.5 km thick terrestrial clastics. First marine ingressions occurred during latest Permian, since Anisian carbonate deposition dominated (loss of the clastic hinterland). We recently detected a break-up angular unconformity in central Northern Calcareous Alps (NCA) on top of tilted Lower Anisian Gutenstein Limestone and wedge-shaped Middle Triassic carbonates covered by Norian Dachstein Reef Limestone. In Permian evaporites, polyhalite veins and grains crystallized between 235 and 225 Ma and at ca. 210 Ma testifying intense fluid flow along normal faults similar as Anisian/Ladinian strata-bound iron and Pb-Zn-Ba-F mineralizations do. In the underlying basement, we detected similar Permian to Triassic ductile shear zones with Ar-Ar sericite ages of 239 and 267 Ma. Age, type and distribution of LMC magmatism allow correlation with UC rift basin infill and therefore correlation of detached pieces within the Austroalpine thrust wedge. A continent-ward, ca. NW-ward progression of initiation of magmatism is constrained during the initial extension mode. This model also allows a new tectonic reconstruction of the Cretaceous-aged Austroalpine nappe stack.

Study of the evolution of the intra-plate magma plumbing system beneath Fogo

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Poster in Session A2-04

Intra-plate magma plumbing systems are still not fully understood. Key questions are whether such a system is dominantly affected by the depth of the magma chamber, degree of melting and magma supply rate. Fogo is one of the most active oceanic intra-plate volcanoes on Earth and belongs to the Cape Verde Archipelago. Till today it is not clarified if the chamber supplying Fogo is differentiated in layers or just an evolutionary process forming different eruptions with varying compositions or else there are different plumbing systems under the Cape Verde. Different eruptions can be sampled as ash layers in off shore drill cores. There is a high potential to correlate this ashes with tephra samples taken on shore by geochemical, petrological and volcanological characterization of the mafic, felsic and sometimes compositionally zoned, highly alkaline tephra. Therefore 9 ash layers are analyzed taken from a drill core drilled off shore south-west of Fogo. Optical microscope was used for a better understanding of the compositional differences in the ashes. All layers were differentiated in their different particle sizes to correlate mineral size with mineral assemblages and mineral chemical data. The ashes are composed of Clinopyroxenes, Amphibole, Olivine, Feldspar and Fe-Ti-Oxides and their coexisting glasses. By using different thermobarometers for alkaline differentiated magmas on the main components it is possible to get an inside into the evolution of the magma. Furthermore the electron microprobe was applied to investigate the chemical changes of the minerals and to look for compositionally zoned minerals. The analyses are used to determine the Kds of melt mineral pairs for thermobarometric calculations to decipher the depth of the magma chamber and the related temperature conditions. Therefore the analyses are used to understand temporal and regional changes of the magma evolution as well as the different temperatures in the magma chamber.

The Diversity Of Asteroid Differentiation As Derived From Numerical Studies

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Poster in Session A3-01

The early Solar system produced a vast variety of objects with different properties. Among those, small bodies are of particular interest due to their importance as building blocks of planets and as parent bodies of meteorites. Their properties are greatly diverse, as are compositions of meteorites that provide strong evidence that partial melting and differentiation were ubiquitous in the early Solar System. With respect to the degree of differentiation, two classes can be defined: chondrites originating from primitive, undifferentiated parent bodies and achondrites originating from bodies layered into (at least) a silicate mantle and a metallic core. Achondrites' compositions deviate moderately to strongly from chondrites: metal separated partially or completely from silicates and silicates fractionated from each other. To understand planetary evolution and differentiation, it is essential to know, by which mechanism, how, and when this diversity emerged. Numerical modelling of the evolution of meteorite parent bodies provides an effective tool that allows putting the information recovered into a more general context. The insights gained from such models bring us closer to the understanding of the evolution of the Solar system as a whole and of the planets in particular. We use a spherical 1D model of an ordinary chondritic body which considers accretion as radial growth. Our model includes compaction, melting (with the associated changes of material properties and partitioning of 26Al), latent heat, differentiation by porous flow, advective heat transport, and convection along with the associated effective cooling in a potential magma ocean. We will present results of our investigations on the differentiation of rocky asteroids, show models that lead to both partial and complete differentiation, and discuss parameters that are crucial for these events. As a particularly interesting example we will consider the parent body of acapulcoite-lodranite meteorites.

Performance oriented durability testing of eco-concrete for the precast industry

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Poster in Session B6-01

To slow down climate change many measure are taken to cut greenhouse gas emissions. For the building industry – responsible for approx. 24% - large reduction for GWP and PEI are lying in the production of Ordinary Portland Cement (OPC) and by the optimization of concrete in general. The approach to the latter is by partly substituting OPC clinker in normal concrete by properly selected, more eco-friendly micro- and "eco-fillers". This can be achieved by mix design optimization and an extended durability performance design. New standards (EN206-1:2014) allow for designing innovative concretes in a more performance oriented way by the so-called equivalent concrete performance concept. Within this study two new methods to test durability performance regarding acid attack and chloride ingress into concrete are presented. Based on the equivalent concrete performance concept both newly developed eco-concretes and normal concrete as a references are tested. The resistances of concrete mixes against carbonic acid attack were investigated in a newly developed flow-through reactor over time period of about 6 weeks. The experimental setup allows for in-situ measurements of the reactive solution i.e. pH and electric conductivity as well as monitoring the chemical composition of the solution. The leached samples were analyzed by X-ray diffraction and electron microprobe. Results indicate that portlandite dissolved within $\sim$100 hours, followed by carbonate mineral dissolution and alteration of C-S-H phases originally present in the cementitious matrix. These processes resulted in the formation of a few mm-thick, mechanically weakened leached layer on the exterior of the concrete. Chloride diffusion was performed in 3 & 10% NaCl-solutions for 2 months. For both concentrations the chloride penetration was less developed in the eco-concrete vs. the reference standard concrete. Besides a lower effect on the environment also the durability was enhanced in the investigated samples.

How minor changes in a geological model can affect simulation results: An example of a geothermal reservoir in Tuscany, Italy

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Oral in Session B5-01

Structural geological models are often the basis for further exploration for resources, be it mineral, oil and gas or geothermal. While the input data for geological models is uncertain, the final result usually comprises one geometric model, which is then further used, e.g. for numerical simulations. In this work we assess how changing a particular layer in a geothermal reservoir model influences the results of hydrothermal simulations, and in turn predictions of the geothermal potential of the reservoir. The primary heat source of the majority of geothermal reservoirs in Tuscany seems to be young granitic intrusions. Connected to those intrusions seems to be a prominent seismic reflector, the so called K Horizon. It is usually regarded as an isotherm of about 450 °C. Despite of its reflectivity, depth and shape of the K Horizon is uncertain and may vary significantly. For example, uncertainty connected to its depth has been estimated to be around 300 m. Changes in temperature, depth and shape of the K Horizon within intervals of confidence significantly change heat transport in the model. Varying its temperature yields greater uncertainty w.r.t. temperature distribution than when its depth is varied. Considering these uncertainties evidently influcences decisionmaking in prospecting this geothermal reservoir, as uncertainty-evaluation is important for the success of a good model.

Modelling magma ocean evolution and volatile outgassing using a 1-D atmosphere-interior coupled model for the early earth.

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Poster in Session A4-01

The early phases of the evolution of the Earth and terrestrial planets likely included a state characterized by one or multiple vigorously convecting magma oceans. Even super earths at a close distance to their host star can presently be in a similar hot state. Understanding magma ocean's evolution can serve to better characterise terrestrial planets that have passed through such a state in their history and possibly constrain that state in our planet. However, the temporal evolution of a vigorously convecting magma ocean is poorly known due to missing constraints on the mechanical and thermal properties of the molten material and on the blanketing effect of the overlying atmosphere, which can strongly influence the heat flowing out of the planet and retard its cooling and solidification. The outgassing of volatiles with greenhouse potential is a key process that affects both aforementioned factors. Using a simple 1D model we simulate the evolution of a primitive magma ocean coupled with a grey atmosphere. The evolution of the potential temperature dictates the rate of mantle crystallization, which proceeds from the bottom upwards because of the steeper slope of the mantle adiabat compared to the solidus. This model allows us to represent the complex physical state of simultaneous regimes of liquid and solid convection in the mantle. In future steps we are going to replace the grey atmosphere model with a more sophisticated 1D model of radiative-convective equilibrium to better represent the emissivity of the atmosphere generated by magma ocean outgassing.

Synthesis and characterization of a $[Li_{0+x}Mg_{2-2x}Al_{1+x}(OH)_6]Cl \cdot mH_2O$ solid solution LDH

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Layered double hydroxides (LDHs) consist of alternate positively charged mixed metal hydroxide layers and negative charged interlayer anions. An application is for example the use as ionic conductor. Two known LDHs are $[Mg_2Al(OH)_6]Cl \cdot mH_2O$ and $[LiAl_2(OH)_6]Cl \cdot mH_2O$ [1], which are the end members in this mixed crystal series. Due to the diagonal relationship in the periodic system between Li and Mg and the chemical similarities, there is a possibility to produce a LDH, containing Al, Li and Mg in the positively charged main layer. The syntheses were done by mixing solutions of LiCl, $MgCl_2 \cdot 6H_2O$ and $AlCl_3 \cdot 6H_2O$, adding NaOH until a pH of 9,5 was reached and heating it up to 140°C in an autoclave for 20h. The products were filtered, washed and dried (RH 30%). Starting with the Mg end member the amount of Li was raised and the amount of Mg was reduced in 10mol% steps until 100mol% Li was reached. XRD investigations showed two different coexisting mineral phases in the area of 10mol% - 80mol% Li. The Synthesis with 90mol% Li showed a single mineral phase and a different lattice parameter (a) (5,11Å) compared to the Li end member (5,08Å). This difference matched with calculated theoretical lattice parameter (a) (5,11Å) for a Li and Mg containing LDH with 10mol% Mg. Syntheses between 90 mol% and 100 mol% Li were done and the results showing a straight raising lattice parameter from 5,08Å to 5,11Å like calculated. Analysis by ICP-OES showed that all Mg was bound to the solid solution. The amount of interlayer water was investigated by TGA and is 1,9mol. Therefore the solid solution with the highest Mg content is $[Li_{0,9}Mg_{0,2}Al_{1,9}(OH)_6]Cl \cdot 1,9H_2O$ at 140°C. References:

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Subsurface Spatial Planning: Development of a 3-D online tool for the evaluation of potential underground energy storage sites

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Oral in Session C6

Since the share of renewable energies like wind and solar power in Germany is growing, the underground storing of superfluously produced electricity (such as during a heavy wind event) in the form of compressed air, gas, or heated water will become increasingly important. However, the identification of suitable sites for such future underground storages is a complex task. Site identification requires a combination of geological information and surface energy infrastructure related data. Regarding the underground, needed data includes geological features such as rock layers and salt formations enriched with attribute data about e.g. rock porosity and permeability. This information then needs to be combined with surface data on the existing energy infrastructure, such as locations of wind, solar and bio-gas power plants, power line arrangements and substation sites. For planning purposes, not only the current situation needs to be incorporated into the system, but also prospective scenarios such as expected growth in produced amount of energy, as far as possible. Furthermore protected areas on the surface and current surface spatial planning influence the selection of potential underground storage sites. A 3-D spatial planning online tool could help stakeholders to identify sites potentially suited for underground energy storages. Its aim is to provide a basis for a pre-selection of possible sites for thermal, electrical, and substantial underground energy storages. The primary task of the presented tool is to assist local authorities in the process of combining surface and subsurface spatial planning with a focus on energy storage in the German state of Schleswig-Holstein. Taking into account as many of the relevant input factors as possible, the tool aims to suggest appropriate sites for setting up a selected kind of underground energy storage.

Plumes, piles or puddings? Testing hypotheses of lowermost mantle dynamics with geodynamic and seismic calculations

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Two regions at the base of the Earth's mantle—the Large Low-Shear Velocity Provinces (LLSVPs)—pose a fundamental problem in understanding large-scale mantle dynamics and history: are they dense piles of (possibly primordial) material separated from mantle circulation, or large-scale thermal features which are part of global mantle convection? Or some combination of the two? We address this by simulating mantle convection with Earth-like parameters in a 3D spherical geometry, for three endmember cases: (i) an isochemical (T) mantle; (ii) a thermochemical (TC) case where a global, dense layer exists initially at the base of the mantle, and is focussed into two piles; and (iii) a TC mantle where dense material is created naturally through time by melting and differentiation at mid-ocean ridges. For case (iii), we begin with pyrolite, which differentiates into depleted (harzburgite) and enriched (basalt) material. Using 200 Ma of plate motion history, we impose an Earth-like pattern of convection at the surface, and track the location of the three compositions as dense material accumulates throughout the mantle. Conversion from pressure, temperature and composition to seismic velocities is done with a thermodynamical database (Stixrude & Lithgow-Bertelloni, GJI, 2005, 2011), allowing us to compare the model with previous observations of triplications and waveform complexity near the margins of the LLSVPs. These observations have been taken as proof that strong chemical variations are present; our simulations can be used to show whether this is true, or if purely thermal convection can also cause these features. We simulate finite-frequency, 3D seismograms at ∼5 s period and compare these with previous studies.

TUNB-Projekt (TP3): Recherche geologischer und geophysikalischer Daten und digitale Aufbereitung für ein 3D-Landesmodell Mecklenburg-Vorpommern

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Poster in Session B5-02

Im Rahmen des von der BGR Hannover initiierten TUNB-Projektes erarbeiten die Staatlichen Geologischen Dienste der norddeutschen Bundesländer ein abgestimmtes 3D-Modell, um die „Potenziale des unterirdischen Speicher- und Wirtschaftsraumes im Norddeutschen Becken" zu veranschaulichen. Die Arbeiten im Teilprojekt 3 (TP 3) Mecklenburg-Vorpommern werden vom Geologischen Dienst im LUNG M-V übernommen. Dafür wurden im November 2014 zwei Geowissenschaftler befristet für max. 6 Jahre eingestellt. Zu den ersten Arbeitsschritten gehört eine umfangreiche Recherche der verfügbaren Daten geologischer und geophysikalischer Erkundungen, die das Landesgebiet von M-V (plus ca. 20 km Umkreis) betreffen. Insbesondere werden dabei Archivbestände, die bei der BGR Berlin, im Bergamt Stralsund und vor allem bei GDF SUEZ E&P GmbH in Lingen vorhanden sind, gesichtet und fehlende Dokumente (Erkundungsberichte, Bohrprofile, Schichten- und Kernmarschverzeichnisse, geophysikalische Bohrlochmessungen, geologische Karten und Schnitte, seismische

Profile etc.) gescannt sowie digitale Datensätze in das landeseigene FIS „Tieferer Untergrund" integriert. Zu den wichtigsten Unterlagen gehören Ergebnisberichte reprozessierter 2D-Seismikdaten und weiterer geologischer oder petrophysikalischer Untersuchungen in den nach 1990 beantragten bergrechtlichen Erlaubnisfeldern der ehemaligen EEG GmbH „Anklam", „Bergen", „Ludwigslust", „Stralsund", „Wismar" und „Wolgast", die bisher im Archiv des LUNG M-V nicht verfügbar waren. Die neuen Datensätze wurden zusammen mit den Altdatenbeständen in GIS-Projekten aufbereitet. Insgesamt liegen zur Zeit für ca. 750 relevante Tiefbohrungen etwa 120 „Bohrlogs" als Digitalkopie vor, von denen ein Viertel auch im LAS-Dateiformat verfügbar sind. Weiterhin sind für 85 Bohrungen Vertikalprofilierungen vorhanden, die für eine genaue Korrelation mit seismischen Profilen unabdingbar sind. In der Datenbank zur 2D-Seismik sind bereits Metadaten für über 4250 seismische Linien erfasst.

Genesis of chert nodules in Ediacaran black shales: implications from micro scale Si isotope analyses using fs-laser ablation MC-ICP-MS

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Poster in Session A5-02

Chert nodules hosted in carbonatic, organic-rich mudstones from the Lower Ediacaran Doushantuo Formation formed rapidly during early diagenesis and led to the exceptional preservation of microfossils1. They also potentially hold a record of past seawater Si isotope composition and the silicification process. These records we access by analysis of the micro-scale Si isotope composition of Ediacaran chert nodules and their surrounding host rock at the 100 μm scale using state-of-the-art fs-laser ablation multicollector inductively coupled plasma mass spectrometry (fsLA-MC-ICP-MS). In all three analyzed chert nodules Si isotope ratios steadily decrease from ca. 1.1‰ δ^{30}Si (relative to NBS-28) at the rims to ca. -0.5‰ at the center which typically contains a microbial mat fragment. The host rocks δ^{30}Si is 0.66 $\pm$ 0.25‰ (1SD, n= 34), where authigenic alkali feldspar is the only silicate mineral. The concentric pattern of Si isotope fractionation within the nodules suggests a rapid initial adsorption of silica onto an organic nucleus. This process leads to the precipitation of light Si isotopes and to their enrichment in the center. We infer subsequently decreasing rates of net solid formation accompanied by decreasing magnitudes of kinetic isotope fractionation during precipitation (Δsolid-solution approaching zero)2. This fractionation behavior implies Ediacaran seawater δ^{30}Si at ca. 1.1 ‰, in agreement with inorganically formed chert3. Based on the Si isotope data and the mineralogical composition (XRD, EDX), we further constrain the recent model for the genesis of chert nodules in carbonatic host rocks1. We identify early diagenetically formed, authigenic feldspar as Si source where further nodule growth must be supported by Si from seawater.

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Sector zoned tourmalines as a thermometer in blackwall sequences, southwestern Tauern Window (Austria)

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Oral in Session A1-03

Tourmaline is a common accessory mineral in the metamorphosed rocks of the Lower Schieferhülle in the southwestern Tauern Window, where Palaeozoic basement rocks are squeezed in between the Tux and Zillertal Gneiss and covered by Permo-Mesozoic sediments. Tourmaline occurs in many rock types ranging from Al-phosphate-bearing quartzites to meta-pelites, tourmalinite veins and blackwall sequences. Depending on its host rock, the tourmalines differ in size, ranging from a few millimeters to more than five centimeters in the blackwall sequences. We use the well established Zr-in-rutile thermometer to calibrate the empirical geothermometer based on the partitioning of Ca and Ti and to reconstruct the complete T-histories of individual tourmaline grains and the genesis of their related mineral inclusions from prograde to peak as well as retrograde growth in blackwall sequences in the southwestern Tauern Window. We analyzed chemistry and structure of sector zoned tourmalines from contact bands between ultramafic serpentinites and the surrounding felsic rocks (i.e. blackwall sequence). Metasomatic exchange involving Mg transfer from the serpentinites to the country rock and Si, Ca, K, Al vice versa in conjunction with mineral breakdown during prograde Alpine metamorphism and external fluids caused the contemporaneous growth of tourmaline and rutile in this highly reactive B- and Ti-saturated zone. Temperature and charge dependent incorporation of elements resulted in preferential enrichment of higher charged cations at the tourmalines analogous (c^-) and of the less charged cations at the antilogous (c^+) pole with compositional differences most distinct for Ca and Ti amongst the different sites. Preliminary evaluation showed a pro- and retrograde growth of the dravitic tourmalines (XMg from 0.58 to 0.85) with the predominant exchange vector between the distinct sectors being $CaMg_{-1}\square Al_{-2}$.

Vegetation impacts on Himalayan denudation and landscape

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The Himalaya hosts a broad range of vegetation, both across and along strike. Across strike, vegetation transitions from agriculture and dense forest in the Lesser Himalaya to sparse alpine and arid regions at high elevation and in the rain shadow of the Higher Himalaya. Along-strike vegetation densities also differ significantly and show a pronounced E-W gradient. We quantify the along-strike vegetation gradient, using 14 years of MODIS 13C1 enhanced vegetation index (EVI) data. To evaluate the effect of vegetation on denudation and landscape evolution, we combine EVI, topographic analysis, and a compilation of >100 previously published and unpublished 10-Be terrestrial cosmogenic nuclide catchment-mean denudation rates from across the Himalaya. We calculate the relationship between various topographic metrics and catchment-mean denudation rates of fluvial watersheds and find that vegetation density in each study site correlates with the relationship between topography and denudation in each region. In sparsely vegetated areas, denudation increases in a rapid, non-linear fashion as topographic metrics such as normalized channel steepness or hillslope angle increase. Where vegetation cover is denser, the relationship between denudation and topography becomes increasingly linear, such that lower denudation rates are maintained as hillslopes and channels steepen. Additionally, more sparsely vegetated regions appear to reach a maximum steepness lower than that observed in

densely vegetated regions. We therefore observe a negative correlation between increasing annual, summer, and winter EVI and the power-law exponent p of the relationship denudation $\sim$ (topographic metric)p. In contrast to recent studies arguing that Himalayan denudation is primarily forced by tectonics, our study emphasizes how vegetation density, as a climatic agent, modulates erosional style and landscape development along strike across the Himalaya.

Modeling the burial and maturation history of the Haynesville Shale in the East Texas Salt Basin and the Sabine Uplift area

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The study area located in E-Texas, NW-Louisiana and southern Arkansas is a region of extensive hydrocarbon exploration. A rift-margin basin developed in the Late Triassic to Middle Jurassic related to the opening of the Gulf of Mexico. Subsequent cooling of the crust resulted in gradual subsidence and deposition of more than 5 km Mesozoic and Cenozoic sediments. Structural styles within the area are mostly characterized by rift margin basin structures and salt tectonics such as widely spaced normal faults with small displacement and a variety of structures related to salt diapirism. The geological model is constructed from stratigraphic well-log picks obtained from a data base containing several thousand exploration wells. Additional information comes from published profiles, maps and publications. Digitized isolines of the top of salt model from the E-Texas Basin salt tectonic atlas and the picks of 12 formation tops provided the base for the construction of the geological model. Formation tops were interpolated, corrected for intersections and refined manually. Patchy distribution of well picks, salt tectonics and not well documented tectonic displacement impeded horizon interpolation and model construction. The resulting geological model provides the base for a 3D basin model. The model incorporates facies dependent lithology variations to consider lithology dependent variations of thermal conductivities. Two major erosion events are reconstructed mainly in and around the Sabine Uplift area. Effort is taken to incorporate salt migration and the resulting formation of diapirs. Model calibration with vitrinite reflectance data from the Sabine Uplift area is good. The modeled burial and maturation distribution shows overmature, deeply buried parts of the Haynesville in the E-Texas Salt Basin while the Haynesville on and around Sabine Uplift is mainly in the dry gas window. This puts the most favorable areas for shale-gas potential in the area of the Sabine Uplift.

Linking global mantle dynamics with lithosphere considering the effect of visco-elasto-plastic rheology in the upper 300 km

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Poster in Session A4-01

Over the past decades rheological properties of the Earth's mantle and lithosphere have been extensively studied using numerical models calibrated versus a range of surface observations (e.g., free-air-gravity anomaly/geoid, dynamic topography, plate velocity). The quality of model predictions however strongly depends on the simplifying assumptions, spatial resolution and parameterizations adopted by numerical models. The geoid is largely (Hager & Richards, 1989) determined by both the density anomalies driving the mantle flow and the dynamic topography at the Earth surface and the core-mantle boundary. This is the effect of the convective processes within the Earth's mantle. The remainder is mostly due to strong heterogeneities in the lithospheric mantle and the crust, which also need to be taken into account. The surface

topography caused by density anomalies both in the sub-lithospheric mantle and within the lithosphere also depends on the lithosphere rheology. Here we investigate the effects of complex lithosphere rheology on the modelled dynamic topography, geoid and plate motion using a fully coupled code of the lithosphere and mantle accounting for strong heterogeneities in the upper mantle rheology in the 300 km depths (Popov & Sobolev, 2008). This study is the first step towards linking global mantle dynamics with lithosphere dynamics using the observed geoid as a major constraint. Here we present the results and compare them with the observed geoid, dynamic topography and plate velocities from GPS measurements. This method allows us to evaluate the effects of plate rheology (e.g., strong plate interiors and weak plate margins) and stiff subducted lithosphere on these observables (i.e. geoid, topography, plate boundary stresses) as well as on plate motion. Finally, given significant dispersion of geodynamic predictions from various seismic tomography models, we further look for seismic models that provide better predictions at global and regional scales.

Rockslide dams in the European Alps

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A number of catastrophic events associated with rockslide dam formation and failure have occurred in the mountain regions of the world in the last century, even in the European Alps. Whereas most catastrophic dam failures occur within less than one year, some dams form stable elements in the landscape that may persist for millennia – a potential risk often forgotten. Furthermore, multiple partial dam breaks have received little scientific attention. An inventory of past and present natural dams, their distribution and formation processes, and the state of their impounded lakes does not exist for the European Alps. Improved knowledge about the temporal evolution of slope failures is essential for understanding the causes and triggering mechanisms of deep-seated collapse and runout-processes. With respect to rockslide dam lakes in the European Alps and worldwide, three major questions are: (1) where and in which geological environment the damming occurs, (2) when the catastrophic event took place, and (3) how stable the rockslide dam was/is and what happened with the backwater lake.

Multiphase flow and unstable calcite-dissolution patterns from the core to reservoir scale

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Injection of acids into carbonate formations can lead to unstable calcite dissolution fronts. For single-phase flow this has been extensively studied in the context of well stimulation. Dissolution patterns, such as wormholes, are governed by the relative rates of convection to dispersion, and dissolution to diffusion, the Péclet (Pe) and Dahmköhler (Da) number, respectively. With the present knowledge, well-stimulation operations can be designed and dissolution patterns can be controlled. The topic has now received significant interest in the context of CO_2 storage. Several groups experimentally observed wormhole formation and fully coupled Reactive Transport Modelling reproduces these results. Most of the experiments were conducted in single phase mode, using carbonic acid. However, there are remaining questions about how these results relate to CO_2 injection, which is in general a two-phase flow problem, and how do we translate experimental results to field relevant scales. Here through time-lapse computed tomography of injection experiments, we present the first dynamic data on wormhole formation and the fluid flow therein. We show that dissolution during single-phase flow produces wormholes, as found previously, but that two-phase flow during CO_2-brine injection leads to compact dissolution. The results also suggest that initial Pe and Da numbers for single-phase flow process would fail to describe the dynamic process of whether compact or wormhole dissolution would ensue. We modeled core flood experiments using a fully coupled approach, both for single- and two-phase flow. We then formulated an upscaled description, based on existing models but generalized to two-phase flow and validated both approaches on the core scale. We applied the upscaled description to semi-quantitatively predict the timing and spatial distribution of dissolution patterns, including their effect on injectivity and the CO_2 plume shape.

Phase properties and chemical rock-fluid interactions in-situ and under reservoir conditions investigated by Raman spectroscopy

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Contaminated gas reservoirs contain substantial amounts of CO_2 and H_2S. Re-injection of these contaminants is a sustainable solution for disposal. In order to re-inject in a safe manner, knowledge about subsurface reactions and physicochemical behavior is of vital importance; a disturbance of chemical and physical equilibria in a target reservoir might ultimately result in a change of the fluid-flow field and of mechanical rock properties. In order to predict the performance of injection operations, reservoir engineering aims to integrate flow physics and chemical reactions in reactive-transport modeling by coupling a geochemical modeling module to a classical reservoir simulator solving the transport equations. Predictive modeling of reactive-transport regimes and resulting consequences require good knowledge of reaction mechanisms, kinetic and equilibrium data at in-situ conditions. Here, we present a Raman-based method to quantify chemical mineral/fluid interactions in-situ and under reservoir pressures and temperatures. For this we combined a confocal Raman microscope with a set of optical translucent and chemically inert high pressure and temperature reactors to run experiments at conditions of up to 350°C and 400 bar. The system is customized to gain a high degree of automation and quantification in order to effectively map the parameters space. The Raman energy shift is used to detect solid surfaces, aqueous and gaseous chemical species in their chemical environment and their transformation in situ. The direct access provides complementary advantage over analytical methods that require the transition to ambient conditions and a back calculation to in-situ conditions. In the presentation we will discuss Raman scattering as a method, the design and the possibilities of the experimental unit. As example, we will show results on CO_2-brine phase properties and on carbonate dissolution kinetics under sequestration conditions.

Thermo-mechanical simulations of rock behavior in underground coal gasification show negligible impact of temperature-dependent parameters on permeability changes

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Underground coal gasification (UCG) can increase the world-wide coal reserves by utilization of coal deposits not mineable by conventional methods. The UCG process involves combusting coal in situ to produce a high-calorific synthesis gas which can be applied for electricity generation or chemical feedstock production. Apart from its high economic potentials, UCG may induce environmental impacts such as ground subsidence associated with groundwater pollution due to generation of hydraulic connectivities between the UCG reactor and adjacent aquifers. These changes overburden conductivity may introduce potential

migration pathways for UCG contaminants such as organic and inorganic pollutants. Mitigation of potential environmental UCG impacts can be achieved by improving the understanding of coupled thermo-hydro-mechanical processes in the rocks surrounding the UCG reactor. In the present study, a coupled thermo-mechanical (TM) model has been developed to carry out a parameter sensitivity analysis and assess permeability changes derived from volumetric strain increments in the UCG reactor overburden. Our simulation results demonstrate that TM rock behavior is mainly influenced by the thermal expansion coefficient, tensile strength and elastic modulus of the surrounding rock. A comparison of temperature-dependent and -independent simulation results indicates high variations in the distribution of total displacements in the UCG reactor vicinity related to thermal stress, but only negligible differences in permeability changes. Hence, temperature-dependent TM parameters have to be considered in the assessment of near-field UCG impacts, while far-field models can achieve a higher computational efficiency by using temperature-independent TM parameters. Considering the findings of the present study in the large-scale assessment of potential environmental impacts of UCG, representative coupled simulations based on complex 3D large-scale models become feasible.

Quaternary tectonics, regional structure and of reverse fault N100° of Djebel Kellal mount, Constantine area (north-east of Algeria)

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Djebel Kellal is one of Constantine cretaceous mount limiting the basin of HammaBouziane (Northern Constantine).On the geological map and satellite photo, this monocline Cretaceous series is a transverse structure (East-West), this particular structure (perfect linearity of carbonate series, and implementation of Triassic formations) gives a deep neotectonic structure appearance limiting Constantine neritic. Nearly 4km long, This carbonated series showed a variation of dips from 0 ° to 90 °, collapses shoals, quaternary formations instabilities, geotechnical anomalies (the thickness of neritic carbonates observed during the excavation of the tunnel), it pushed us to apply the model of a system of reverse fault dipping slope (M.Mattawer, 1973) which is in contradiction with the classical structural diagram presented by JM, Vila (1974) in this region. To the east of this mount, the Plio-Quaternary travertines of HammaBouziaine is bounded by vertical faults N100°.At the regional level, this structure is identified in a morphostructural map (from aerial photo) made on the Constantine region, it is a segment of transversal structure limiting Constantine's shelf. Keywords: neotectonic Jebel Kellal neritic Constantine, seismic structure, reverse fault.

Current Status and Future Plans of re3data.org - Registry of Research Data Repositories

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In 2012 re3data.org – the Registry of Research Data Repositories [1] went online with 23 entries. Three years later the registry provides researchers, funding organizations, libraries and publishers with over 1,200 listed research data repositories from all over the world making it the largest and most comprehensive online catalog of research data repositories on the web. re3data.org provides detailed information about research data repositories, and its distinctive icons help researchers easily identify relevant repositories for accessing and depositing data sets. Funders like the European Commission [2] and research institutions like the University of Bielefeld [3] recommend the use of re3data.org in their guidelines and policies. Project partners in re3data.org are the Library and Information

Services department (LIS) of the GFZ German Research Centre for Geosciences, the Computer and Media Service at the Humboldt-Universität zu Berlin, the Purdue University Libraries and the KIT Library at the Karlsruhe Institute of Technology (KIT). re3data.org will be included in DataCite's suite of services by the end of 2015. The poster describes the current status and the future plans of re3data.org - Registry of Research Data Repositories.

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Activities of the Centre for Early Warning Systems, GFZ Potsdam

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The Centre for Early Warning Systems of GFZ Potsdam is setting out develop and implement methodologies for the early warning of various types of natural hazards, with a focus currently on earthquakes and tsunami. Of particular interest is the feasibility of alarm systems that accommodate multi-risk aspects of natural disasters. One avenue pursued in this direction is the development of low-cost units that can incorporate a variety of sensors, and may be used in activities ranging from long-to-short term environmental monitoring and the assessment of structural response of buildings to different loading. The centre's research is also directed towards the assessment of the vulnerability of exposed assets through advanced methods, mainly based on remote sensing, and the possibility of computing reliable real-time single- and multi-type risk scenarios that can be provided to end users in order to help in the decision making process within disaster prevention and for disaster management. An example of the activities being undertaking is the SIBYL (SeIsmic monitoring and vulneraBilitY framework for civiL protection) project, supported by EC-ECHO, which is setting out to develop an operational framework for Civil protection authorizes to rapidly and cost-effectively assess the built environment's seismic vulnerability. This includes short-notice vulnerability assessment in a pre-event situation (instrumentation, in situ and space-based damaging) and monitoring the built environment during a seismic sequence. Another example of a so-called "end-to-end" system approach is the successful operating tsunami early warning system in the Indian Ocean, GITEWS (German Indonesian Tsunami Early Warning System).

Petrophysical and geoeletrical investigations on analogue outcrops of the South German Malm

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Poster in Session B5-02

Since 2008 a lot of drilling campaigns in the hydraulic porous eastern part of the Upper Jurassic limestones occurred. In the low quality rocks of the western part of the Bavarian foreland Molasse much less drillings to understand geologic controls on parameters which are important for reservoir evaluation were implemented. Nonetheless, outcrop analogues present the opportunity to investigate potential reservoir rocks at the surface prior to drilling. The analogue outcrops of carbonates of the Franconian Alps with their endless variations of textures, fossil components and diagenetic overprint show strong facial-diagenetic specifications and petrophysical heterogeneities. To get an exact knowledge of the geometric pore space structure to characterize the hydraulic potential the specimens were analysed with different petrophysical and geoelectrical methods. Samples of the banked limestones of Malm Zeta 6 show the highest porosities and permeabilities with values around 20 % and 1 mD with pore size of 77 % above 0,06 μm. In other samples porosities and pore size distributions have no direct dependency to their permeablity values. Hysteresis curves of mercury porosimetry indicate the existence of ink bottle pores with small pore throats. Additionally, Spectral Induced Polarization (SIP), which measures the complex electrical conductivity in a frequency range of 1 mHz to 1 kHz, was performed for the geoelectrical characterization of some outcrop samples. The parameters of the pore space (e.g. porosity, pore size and specific surface) determine some of the characteristics of the measured spectra, which is in agreement with our measurements. Therefore SIP data can also be used to estimate the permeability of the rock. We compare our estimated values from SIP to measured permeability.

The influence of CO_2-charged brine on mineralogy and pore space of caprocks: An XRD and FIB-SEM study on Toarcian claystones

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The integrity of the caprock plays a major role for the long-term safety of CCS projects. Salt-induced anticline structures in Western Pomerania, NE Germany that are capped by Toarcian claystones could store up to 1,5 Gt CO_2. This study focused on the interaction between Lower Jurassic claystones and CO_2-charged brine in an attempt to identify pathways within the caprock. Batch reactor experiments with claystone, a modelled brine and supercritical CO_2 were conducted at 172 bar, 100 °C and a solid:solution ratio of 1:10. XRD analyses were employed to determine the mineralogy before and after the experiments and Rietveld calculations were used to quantify mineral phases. AAS and IEC analyses were run on collected brine samples before and after the experiment. FIB-SEM was used to obtain information from a milled volume of 12 x 10 x 10 μm3 with a voxel size of about 253 nm3. This data was used to reconstruct 3D microstructures using AVIZO. The connectivity, orientation and size distribution of the pores was analysed and compared between the reacted and unreacted sample. EDX was used to create elemental mappings of selected slices. The mineralogical and geochemical investigations revealed that the reactivity of the caprock is low in an acidic CCS environment likely due to the absence of carbonates. No changes in the mineralogy were observed. Increases in fluid concentrations were related to minor dissolution of chlorite, Fe-rich illite and pyrite. Analyses of the connectivity and the pore path orientation of the reacted sample point to a horizontal orientation and connectivity of the pores developed parallel to the bedding plane. However, a stronger vertical orientation was observed for larger pores. Results indicate that pathways through the caprock exist that may be sufficient for the transport of CO_2 and brine, although the degree of connectivity of the pores measured may be exaggerated by some minor shrinkage of smectite phases in the vacuum of the microscope.

Synthesis of nanoscale iron, for waste water treatment, using red mud as an iron precursor

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Sustainable development, a concept that has been widely adopted by governments, businesses and environmental interest organizations, relies strongly, among others, on recycling and environmental remediation. The aims of the present study were to prepare nanoscale zero valent iron (nZVI) particles, using red mud as the iron source and to test the performance of these particles for cadmium removal from aqueous solutions. Investigating, thus, the possibility of reusing a metallurgical waste to synthesize an effective sorbent for waste water treatment. Red mud is a waste product generated in the industrial production of alumina by the Bayer process while nZVI has been widely proposed as an effective sorbent for waste water treatment. For comparison reasons along with iron solution produced by the red mud treatment, an iron solution prepared by FeCl3 was used and the two synthesized materials were compared. The nanoscale iron was synthesized by reductive precipitation with sodium borohydride. The synthesized sorbent was characterized by powder X Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM-EDX) while its sorption efficiency, for Cd removal, was investigated with kinetic and equilibrium studies performed in batch conditions. The experiments showed that with the described procedure, using red mud as the iron precursor, an efficient sorbent for the removal of cadmium from contaminated water systems can be synthesized. Sorption equilibrium was achieved within 24 h and maximum adsorption capacity of nZVI for Cd was 70 mg/g. Data proved to fit better to the pseudo second-order kinetic model and the Langmuir equation.

Mantle temperature and the time scale of extensional basin subsidence

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Poster in Session A1-02

Subsidence of extensional basins is commonly regarded as an isostatic response due to crustal thinning and a subsequent and/or coeval phase of thermal relaxation and contraction. The time scale of thermal subsidence in the oceans is $\sim$100 Myr whereas basins of the continental interior often subside continuously for more than 200 Myr after rifting. Oceanic subsidence is consistent with the plate-model that predicts an exponential time-subsidence pattern, but basins of the continental interior typically display long-term rates of subsidence that do not seem to decay as would be predicted by the plate model. Using thermo-mechanical models of both the rift process as well as the thermo-mechanical boundary layer at the lithosphere/asthenosphere boundary, we show how these diverse rifting scenarios are unified when accounting for varying mantle potential temperature. At 1200°C, subsidence is almost linear and continues for more than 800 Myr. The longevity of basin subsidence in the continental interior can therefore be explained by variation of mantle temperature. An additional cause of the longevity of subsidence is related to the equilibrium thickness of the lithosphere which is increased by the local reduction of heat producing elements due to crustal thinning. Consequently, the thermally mature lithosphere of an extensional basin can be thicker than the surrounding lithosphere. This mechanism contributes to additional thermal subsidence compared to the case where the base of the lithosphere is assumed held at a constant depth.

The Global Resource Potential of Seafloor Massive Sulfides in Various Tectonic Settings

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Increasing commercial interest in mining of seafloor massive sulfides and the political need to secure metal supply for western industries led to an ongoing debate about their possible resource potential. The need for such assessments is now more urgent, as a number of countries and international consortia have begun to invest in intensive exploration campaigns. A growing database of global SMS occurrences is providing clues to the likely distribution, size and grade of the deposits. More than 335 sites of seafloor mineralization are now known on the ocean floor; about 220 of these are sites of confirmed high-temperature venting (black smokers) and associated polymetallic sulfide deposits. More than 5,000 samples have now been collected from 140 of the best-studied deposits, and preliminary estimates of the sizes of the deposits have been made at 63 sites. The largest deposits, excluding the Atlantis II Deep in the Red Sea, are on the order of 10 million tonnes in size. However, the median deposit size is less than 100,000 tonnes and closer to 50,000 tonnes. The median concentrations of metals based on analyses of surface samples from those deposits are 3.1 wt.% Cu, 8.6 wt.% Zn, 0.1 wt.% Pb, 2.4 g/t Au, and 109 g/t Ag, although comparisons with drill core indicate that grades can be significantly less below the seafloor in many deposits. These metals are highly heterogeneously distributed on a regional and local scale. Estimates of the total numbers of deposits range from 500 to 1,000 along the neovolcanic zones of the mid-ocean ridges, with up to 500 additional sites on submarine volcanic arcs and in back-arc basins hosting on the order of 600 million tonnes of sulfides. This does not include long extinct deposits that may be located far off-axis. If present-day rates of massive sulfide formation on the ridges are extrapolated to older crust, significant tonnages of massive sulfide may be expected beneath off-axis sediments.

Fracking and potential risks for fresh water aquifers – Numerical modeling of fluid flow due to hydraulic fracturing of shale formations in the North German Basin

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The production of gas from shale formations by horizontal drilling and hydraulic fracturing has raised many environmental concerns regarding the effects of additives and flowback water on the quality of groundwater. Studying these potential impacts is part of the NIKO project on unconventional resources carried out by the Federal Institute for Geosciences and Natural Resources (BGR). Based on a geological model that represents a typical lithology of the North German Basin a potential migration of injected fracking fluids through the geological underground toward the surface was simulated. We modeled several geological settings, including natural migration pathways (permeable fault zones and fracture networks) connecting the shale gas formation with shallower layers. We simulated a fluid and mass transport from a shale formation (Posidonia) triggered by a high pressure boundary condition of up to 50 MPa excess pressure. The results show no significant fluid migration for a case with undisturbed cap rocks and a maximum of 41 m vertical transport within a permeable fault zone during pressurization. Open fractures, if present, strongly control the flow field and migration. In that case vertical transport of fracking fluids reaches up to 215 m during hydraulic fracturing simulation. Long term transport of the injected treatment water was simulated for 300 years (without recirculation). The fresh water plume, representing injected fracking fluid (slick water), rises vertically within the fault zone up to 485 m due to buoyancy. Progressively, it is transported into horizontal sand stone layers, following the natural direction of groundwater flow. In the course of the long term simulations, the injected fracking fluids are diluted to minor concentrations, mostly less than 5 %. In spite of the presence of permeable pathways, the fracking fluids in our model were far from reaching vulnerable aquifers, neither in the process of hydraulic fracturing nor in the long run.

Evaluation of Portland Cement CLINKER with optical microscopy – Case Studies

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Optical microscopy on polished sections has been a crucial method for the investigation of the phase assemblage and the burning conditions of Portland cement clinker for decades. With upcoming X-ray analytical methods and their automation in the production laboratories it has lost its widespread application. In times of the increasing use of alternative fuels and raw material (AFR), and of more and more complex burning conditions, the microscopic clinker investigation experiences a kind of renaissance. It has to be accepted that even the fasted bulk analytical method like quantitative XRD could not yield such detailed information on raw meal grinding performance, homogeneity, the impact of fuel ashes or the cooling conditions. Two case studies on the application of clinker microscopy are presented here. First, microscopical investigations on a technical clinker revealed minor signs of local reducing burning conditions, caused by an AFR, rich in CaO, but containing a certain amount of organic compounds. Particles of this compound had caused reducing conditions in the immediate vicinity of free lime clusters. The second case study, performed on laboratory clinker samples within a research project, shows the uncommon effect of inhomogeneous Al_2O_3 distribution on the formation of belite clusters. These are usually attributed to local enrichments of SiO_2, mostly caused by large grains of quartz or other silicate phases in the raw meal. However, the emulation of Al_2O_3 resulted in belite accumulations in the vicinity of the former Al_2O_3-enrichments. The analytical method of optical microscopy of the clinker microstructure is complex and time consuming, and it requires laboratory staff with experience in preparation and evaluation of the findings. Nevertheless, if information can be obtained that helps to enhance the quality of a product mass flow of up to 10,000 tons per day, the effort will be worthwile. Usually it is not necessary to have the expertise available in each cement plant. Consulting a central laboratory or research centre could be the most efficient strategy.

Automated quantitative XRD in the quality control of the cement production process

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Quantitative X-ray diffraction analyses with Rietveld refinement (QXRD) on clinker and cement samples are well established in the cement producing industry since the 1990. But due to the huge variability in choosing crystalline structures and structural parameters the results of such an analysis could vary in wide ranges. So it is necessary to have a critical review on the evaluation results by an experienced staff. To implement the method to a production quality control process in a cement plant effectively, analyses in a fully automated analytical system including the sampling, preparation, measurement and evaluation are necessary. The results of a research project are presented which deals with the options and limits of the automated QXRD in the cement quality control. The precision and reproducibility of the clinker phase examination is reflected as well as the measurements of cement compositions, both with crystalline or X-ray amorphous main constituents. The main focal point is the so called robustness of the evaluation files. After the definition of such useful evaluation procedures they were adopted to XRD raw data coming from technical production processes. Long term production periods are observed as well as short term effects, e. g. changing cement types in the in- and outlet from ball mills. It could be shown how accurate the method indicates changes in the product composition. When adjusted to results of standardised analytical reference methods the QXRD could allow for the internal quality control of the production processes.

A multistage volcanic and tectonic formation history of the Manihiki Plateau, central Pacific

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The Manihiki Plateau, a Large Igneous Province (LIP), is the proposed center piece of Ontong Java Nui, a so called Super Large Igneous Province in the central Pacific. For the Manihiki Plateau, a multistage volcanic and tectonic emplacement history is revealed in new, multi-channel high resolution seismic reflection data. Gathered during cruise So224 (2012), the profiles are distributed to study the initial emplacement and tectonic related processes at the margins of the High Plateau (HP), and the Western Plateaus, two subprovinces of the Manihiki Plateau. Improved data quality has allowed for an identification of an intra-basement reflection sequence, which was formed by volcanism prior to the major emplacement during the early Cretaceous. Restricted to the southern part of the High Plateau, we suggest that it represents the nucleus of the HP's formation and conclude that the Manihiki Plateau is older than the proposed $\sim$125 Ma. We have identified evidence that the plateau was extended to the east during that stage and later broke-up along the Manihiki Scarp during the main emplacement period (125-110 Ma). Further break-up occurred between the Hikurangi and Manihiki Plateaus and resulted in stretched and rifted structures at the south-western margin. The Western Plateaus were separated at the Danger Islands troughs, an en enchelon depression system, which resulted in different morphologies and seismic facies. Secondary volcanism lasted until $\sim$65 Ma with a spatial distribution that hint on a shift of the emplacement mechanism from sources related to initial emplacement to tectonic induced volcanism at the margins. The south-western part of the High Plateau has still been tectonically active after the end of the secondary volcanic period. These findings contribute to a detailed

understanding of the evolution of a Large Igneous Province including multiple distinct volcanic and tectonic stages.

On-demand and near-real-time earthquake impact forecasting for Central Asia: the CARAVAN tool

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Central Asia, considered here Kyrgyzstan, Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan, is one of the parts of the world with the highest levels of seismic hazard. It is also a region undergoing major social changes, which results in a highly dynamic riskscape, in terms of both exposure and vulnerability. As part of efforts to mitigate against the negative effects of earthquakes, the GFZ German Research Centre for Geosciences is developing the Central Asian Risk And Vulnerability Analysis Tool (CARAVAN). CARAVAN is a web-based application for on-demand, near real-time scenario-based risk assessment in Central Asia. The role of CARAVAN is twofold: (1) to compute and display in near real-time impact assessments from earthquake events, and (2) to provide to regional partners and end-users (e.g., Ministry of Emergency Situations) a simple, reliable tool to simulate the consequences of damaging earthquakes (both historical and those compatible with recent hazard models). CARAVAN is incorporating state of the art shake map computations in terms of expected ground motion, is multi-scale, meaning it is exploitable for regional and local scales, is compatible with de-facto standards for exposure modelling, and implements a fully probabilistic damage and loss assessment. The web-based platform considers a flexible architecture based on free, open-source technologies, and is being designed to be expanded to other natural hazards relevant for the considered region, as for instance landslides.

Thermal evolution and heat-pipe melt transport: implications for one-plate planets

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Poster in Session A3-03

During the early evolution of terrestrial bodies, a large amount of mantle melting is expected to affect significantly the energy budget of the interior. As a consequence of upward migration of magma through volcanic vents, a large amount of heat is expected to be transferred from the melt region to the planetary surface. This so-called heat-pipe mechanism may have shaped the Earth's earliest evolution by controlling interior heat loss until the onset of plate tectonics [1] and is likely the primary process through which Jupiter's moon Io loses its tidally generated heat, leading to massive volcanism able to cause a present-day heat-flux about 40 times higher than the Earth's average heat-flux [2]. Heat-piping, however, is often neglected in mantle convection models because of its additional complexity and vaguely defined parameterization. We investigate heat-piping effects using the mantle convection code Gaia [3] and consider either 1) complete melt extraction to the surface similar to [1] or 2) assuming that a significant amount of melt remains trapped into the stagnant lid, while the rest is instantaneously extracted to the surface. In both cases, melting regions are refilled by downward advection of cold mantle material to ensure mass conservation. We run thermal evolution models using Mars, Moon and Mercury-like parameters. Our results are consistent with [1], showing that in stagnant-lid bodies the heat-pipe mechanism results in a decreased average mantle temperature and an increased lid thickness compared to cases where heat-piping is neglected. Such effect is prominent during the early thermal evolution and levels off in the later stages when the amount of mantle melting is significantly reduced due to planetary cooling. Nevertheless, this mechanism can have major implications for the planetary evolution by significantly reducing the amount of produced crust.

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Measurements of planar deformation features in quartz using EBSD: A new method to prevent false recognition of craters

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Oral in Session A3-02

A number of recent publications have suggested finds of new impact craters on Earth. These include the Maniitsoq structure in Greenland (Garde et al. 2012), the Tunguska stucture in Siberia (Vannucchi et al. 2015), and the Warburton West structure in Australia (Glikson et al. 2015). All of these publications use poor methodology in recognizing and measuring the classic planar deformation features in quartz, or "PDFs" used for confirmation of shock metamorphism. When PDFs are confirmed or "indexed" with the use of a universal stage, "false positives" can occur if Boehm lamellae or microfractures are measured, as appears to be the case in the references above. Poelchau (2015) suggested that when using the standard u-stage method, less than ~16% of measured PDFs should remain unindexed for a rock sample to be considered "shocked". While this threshold value excludes the structures above, it is regretably not fail-safe and could be abused if authors chose to exclude bad measurements. Here, we used EBSD to determine the full orientation of both c- and a-axes. Intial results show that on a shocked gneis sample from the Nördlinger Ries, ~25% of PDFs remain unindexed. In comparison, the indexing template from Ferriere et al. (2009) covers 23% of the Wulff net, meaning that for randomly distributed planes, ~77% should remain unindexed. This is in good agreement with results from Voorn (2010), who showed ~90% unindexed planes in unshocked quartzites, also using the EBSD method for crystallographic orientation. We intend to apply this method to a number of shocked and unshocked samples and see great potential for its use in avoiding false positives in unshocked samples. References:

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Tracking the retention, mobilization and chemical evolution of major NSO compound classes in petroleum systems

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It is widely accepted that petroleum expulsion from mature organic-rich source rocks is highly efficient [1]. The free organic matter remaining in the source is enriched in NSO compounds [2]. While the basic mechanisms of the fractionation process are established, our knowledge about NSO compound partition behaviour is essentially restricted to low molecular weight compounds [3]. A more detailed characterization of the whole petroleum NSO fraction is afforded by ultrahigh resolution mass spectrometry (Fourier transform ion cyclotron resonance mass spectrometry, FT-ICR MS) [4]. The kerogen type of the source rock has a strong impact on the composition of retained and expelled NSO compounds. Here we present new insights into the chemical evolution of solvent extractable NSO compounds during maturation of the classical kerogen types I (Wealden Shale, Germany/Shahejie, China), II (Posidonia Shale, Germany/Barnett Shale, USA/Bakken Shale, USA) and III (Coal Band, New Zealand). Changes in the relative abundance of compound classes, in their aromaticity as well as in the aliphatic carbon chain length of typical core structures are elucidated. We go into most detail for the Posidonia Shale, gathering equivalent data for kerogen pyrolysates as well as solvent extractable organic matter over the maturity range Ro = 0.48–1.45%, and for petroleums (offshore Netherlands) generated in and expelled from the stratigraphic equivalent of our Posidonia Shale series. Chain length distributions from pyrolysis gas chromatography are utilised in the interpretation of the FT-ICR MS data for the kerogen pyrolysates. References:

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Structural of Silicate-Carbonate Melts: An EXAFS Study on Y and Sr Properties

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Carbonate-bearing silicate melts play a crucial role during mantle melting, in diamond formation and as metasomatic agents. At low pressures, silicate and carbonate melts are immiscible, invoking a distinct trace element partitioning. By using extended X-ray absorption fine structure (EXAFS) spectroscopy, we investigate the influence of carbonate concentration on the structural incorporation of the geochemically important trace elements Y and Sr in silicate and carbonate melts in the system Na_2O-CaO-Al_2O_3-SiO_2-CO_2. This system resembles the composition of the only active carbonatite volcano, the Oldoinyo Lengai, TZ. Data of silicate glasses with up to 10 wt% CO_2, quenched from melts under high pressure/temperature (HP/HT), indicate no or only a slight effect of CO_2 on the local structure of Y and Sr. Compositions with higher CO_2 contents could not be quenched to glasses. In-situ data along the join from silicate to carbonate composition were collected under HP/HT using the Paris Edinburgh-Press. The in-situ experiments reveal shorter Y-O-bond lengths ($\sim$2.2 instead of $\sim$2.3 Å) as well as a higher degree of disorder (σ^2 of $\sim$0.02 instead of $\sim$0.005 Å^{22}) compared to the glasses. Furthermore, there is a slight increase in Y-O bond length along the join silicate – carbonate composition from $\sim$2.2 to $\sim$2.3 Å. The XANES region of the spectra shows distinct differences between the glass and in-situ data as well along the join silicate – carbonate, which may imply a change in the average site symmetry. Information derived from the trace elements' local structure is used to develop a structural model for carbonate-silicate melts. The ultimate goal is to gain insight into the structural control on chemical fractionation processes in carbonate-bearing magmatic systems in the deep Earth.

Convergent plate margin processes in the Archean Craton of West Greenland between 3.8 and 2.5 Ga: Evidence for the operation of plate tectonics in the early Earth

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Structural, magmatic, sedimentary and metamorphic processes taking place at modern plate boundaries are used to unravel the histories of Phanerozoic orogenic belts (e.g., the Appalachians, the Rockies, the Himalayas, the Altaids). Given the multiple phases of deformation and metamorphism, and post-Archean tectonic overprint, recognition of plate boundary processes in the Archean rock record is not an easy task. Because the Wilson cycle processes destroy nearly all oceanic crust (divergent and transform plate boundaries), the manifestation of ancient plate tectonic processes is mostly preserved in orogenic belts where convergent plate boundary processes produced strongly deformed and metamorphosed rocks and arc magmatism, resulting in the formation of continental crust. The style of deformation and the nature of magmatism in Archean cratons are similar to those of Phanerozoic orogenic belts and present-day convergent plate boundaries (e.g., the Andes, the Canadian Cordillera), suggesting that continental crust has mainly been generated above subduction zones throughout Earth's history. The Archean craton of West Greenland composed of many fault-bounded Eoarchean to Neoarchean tectonic blocks that provide clear evidence for the operation plate tectonic processes between 3.8 and 2.5 Ga. These tectonic blocks consist mainly of TTGs, granites, volcanic rock-dominated supracrustal belts, and layered anorthositic complexes. Rock assemblages and geochemical signatures in these tectonic blocks suggest that they represent fragments of deformed oceanic island arcs. The structural characteristics of the boundaries between tectonic blocks are consistent with the assembly of these island arcs through modern style of horizontal tectonics, suggesting that the Archean craton of West Greenland grew at convergent plate margins. Melting of metamorphosed volcanic rocks during tectonic thickening in the arcs played an important role in the generation of Archean continental crust.

Project InSpEE: Storage Potential for Renewable Energies (CAES & H2) in Northern Germany's Salt Structures

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With Germany's progressive transition to energy production from fluctuating renewable energy sources large scale energy storages will be required. In this context, storage power plants, which generate, store and withdraw electricity on demand from excess wind or solar energy converted to compressed air (CAES) or hydrogen, play an essential role. However, large volumes of these media can only be accommodated in the geological subsurface. Salt caverns represent the preferred storage option, because of their high flexibility in operation mode, their thermomechanical stability and their low tendency to react chemically with the stored medium. The main aim of the InSpEE project is to provide basic geological and geotechnical data and to compile criteria for the establishment of salt caverns. Combined with site selection criteria the total renewable energy storage potential of salt structures in the North German Basin will be estimated. In this collaborative project, existing expertise in salt geology, rock mechanics and cavern design are brought together by the Federal

Institute for Geosciences and Natural Resources (BGR), Leibniz University of Hannover – Institute of Geotechnical Engineering/Department of Underground Construction (IGtH), and KBB Underground Technologies GmbH. We present both an overview and criteria-based evaluation process of salt structures in the North German Basin. Because establishment of salt caverns and storage volume of each salt structure are closely related to their internal structure, methods will be demonstrated to predict spatial distribution of specific salt structure types with varying economic potentials. The project's results will be integrated into a publicly accessible geo information system called "Salt", allowing licensing authorities, industry and interested public to gain extensive information and to use it for preliminary cavern planning.

The Eoalpine High Pressure Event in the western Eastern Alps

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The Alps are the result of two orogenic cycles, a Cretaceous one followed by a Tertiary one. The metamorphism in the Western Alps is predominantly related to the Tertiary event, the subduction of the Alpine Tethys. The Eastern Alps, excepting the tectonic Engadin and Tauern windows, on the other hand are characterised by a Cretaceous tectonometamorphic imprint related to subduction of the Neotethys ocean. In the course of this event an Eoalpine High Pressure belt (EHB) was formed, taking a key position in the Austroalpine nappe stack. East of the Tauern window the EHB forms part of a Cretaceous south(east) dipping subduction/collision zone as visible in today's geometries. On the other hand west of the Tauern window the EHB is generally interpreted as to represent an intracontinental HP shear zone and the entire nappe stack displays a northwest dip. This important change along strike of the EHB gives rise for discussion on the general setting. Based on own observations and literature data we present a new and coherent tectonic model for the western part of the EHB that can explain this apparent contradiction: Despite at present the major structures dip to northwest the intracontinental shearzone was originally directed to south(east). Due to the special situation of this area at the tip of the Southalpine indenter the originally south(east) dipping structures became overturned during Neoalpine collision and former thrusts appear as normal faults (e.g. Schneeberg fault zone) while former normal faults presently display thrust geometries (e.g. Jaufen fault).

Petrological characterization of the seismic low-velocity anomaly beneath the Eifel volcanic field (West Germany) using major and trace element compositions of olivine macrocrysts

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The Eifel volcanic field is part of the Central European Cenozoic Magmatic Province and was periodically active from the mid-Cretaceous until the latest Pleistocene. It is widely accepted that the Pleistocene volcanism is related to plume-type thermal upwelling in the asthenosphere. This model is strongly supported by seismic tomography modelling which yields a low-velocity anomaly beneath the Eifel volcanic field. The seismic data were interpreted to represent a small-scale upper mantle plume buoyantly upwelling from the transition zone with excess mantle temperature causing sub-lithospheric melt generation. Alternatively, the seismic anomaly may be related to compositional differences in the mantle similar to those suggested for some "wet plumes". Based on a comprehensive dataset of high-precision electron microprobe data for major and minor elements as well as on laser ablation ICP-MS data for trace elements in olivine from several primitive Pleistocene Eifel lavas, we challenge the hypothesis of a hot plume origin for the Eifel volcanism. Olivine is the most reliable mineral for the estimation of crystallization temperature that may be translated into the mantle potential temperature – a parameter decisive for the ultimate confirmation of the presence of a thermally induced plume. Our estimation of the olivine-liquid equilibria using compositions of the most Mg-rich phenocrysts indicates temperatures not considerably higher than 1300 oC. The trace element composition of olivine phenocrysts shows several important characteristics: they are considerably enriched in Li, and depleted in Ti, deflecting from an equilibrium line on Li vs Ti diagram. The data together may be interpreted in the way that the Eifel plume does not consist of the material considerably hotter that the ambient mantle, but it needs to be more enriched in fluid-mobile (LILE) elements like Li. This supports the notion that Eifel represents a compositional or wet plume, and not a hot plume.

Sand bodies in the Frimmersdorf Lignite Seam, Garzweiler open-cast mine, Lower Rhine Basin

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The Cenozoic-age Lower Rhine Basin is located in the SE part of the Dutch-German Central Graben. During the Miocene up to 100 m of lignite (Main Seam) was deposited within the basin. This seam can be subdivided into the Morken, Frimmersdorf and Garzweiler seams which are separated by bodies of transgressive sands deposited in a tide-dominated estuary system (Frimmersdorf & Neurath Sand). In the Garzweiler open-cast mine, the 3 lignite seams are worked by RWE Power AG. The presence of small-scale sand bodies within the Frimmersdorf Seam, together with their irregular occurrence affects the working of the seams. Characterisation of these sand bodies, both individually as well as in terms of their occurrence within particular seam profiles, allows the origin of these sand bodies to be reconstructed. Initial classification was based on six properties (position within the seam, shape, orientation, composition, grain size, sedimentary structures). The sand bodies may be isolated or extensive, be concentrated at the seam base (Frimmersdorf Sand), top (Neurath Sand) or distributed throughout, or indeed absent. Sand bodies range in shape from small circular blebs or balls (up to 60 cms diameter) through to lenticular (up to 100 cms) or channel-like units (up to 200 cms). They may also be concordant or discordant to bedding. The sands, which are rich in dark humic substances, are generally well sorted and fine- to medium-grained and may contain clasts of lignite, gravel or clay. Internally, the sand bodies may be structureless or graded, with planar or trough cross lamination. The high degree of variability within the sand bodies would suggest that a variety of pre- and post-depositional causal mechanisms were responsible for their genesis. These range from deposition within the marginal marine environment through to fracture fillings and injection features, providing evidence of an extremely complex sedimentation and post-sedimentation system.

Coastal high-energy Neurath Sand in Cenozoic-age Lower Rhine Basin (W Germany)

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The Lower Rhine Basin, comprising the SE end of the Dutch-German Central Graben, formed as a result of extension and subsidence within the NW Schiefergebirge. By early Neogene times, marginal marine conditions had developed, and tidal-dominated estuarine environments were established within the basin. The relatively mild (warm & moist) climate facilitated the development of shrublands and forests onshore, thus providing favourable conditions for peat development. Indeed, substantial thicknesses (up to 100 m) of lignite were deposited in parts of the basin. The Neurath Sand (Serravallian, late middle Miocene), excellently exposed in the Garzweiler open-cast mine, up to 60 m thick and interdigitating with the Rhenish Main Lignite Seam, is one of several marine sands in the basin which were deposited as a result of transgressive activity. Detailed examination of the profile extending from the Frimmersdorf Seam through to the Garzweiler Seam, and integrating sedimentological and palaeontological data was used to reconstruct the depositional setting of the area. Five subenvironments were recognised. The basal units were deposited in an upper shoreface setting. These sediments were overlain by silt-rich sands (transitional subenvironment) which graded up to an upper shoreface subenvironment characterised by evidence of tidal activity and an extensive biota (Ophiomorpha and Skolithos). The overlying beach setting (including ridges and runnels, high-energy parallel lamination) was capped by aeolian sediments (dune subenvironment). Within this latter setting, extensive root traces reflect the development of the overlying peatland (i.e. Garzweiler Seam). Additionally, this seam contains extensive sand-rich lenses (including tidal bundles) providing evidence of lagoonal subenvironments. Regional correlation with adjacent wells would suggest that marine conditions were widespread at this time within the Lower Rhine Basin.

The origin of deep geothermal anomalies in the German Molasse Basin assessed by 3D numerical model of coupled fluid flow and heat transport

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Poster in Session B5-01

The Molasse Basin is a foreland basin in the northern front of the European Alps. The clastic sediments filling the basin are underlain by Mesozoic sediments successions which are characterized by pronounced positive and negative thermal anomalies. Since the basin and the underlying karstified Malm aquifer are intensively used for geothermal energy production, a better understanding of the heat driving processes in the basin would reduce the risk of geothermal explorations. To improve this understanding we have simulated the coupled fluid flow and heat transport in the German part of the basin using a three-dimensional basin-scale numerical model. The lower thermal boundary conditions have been extracted from an earlier 3D lithospheric-scale conductive thermal model of the German Molasse Basin and the adjoining Alps. Our results show that the long wavelength thermal field of the basin is dominated by conductive heat transport which in turn is mostly influenced by the structure of the crystalline crust and the Alps. The fit of the thermal anomalies with observed temperatures could be improved considering fluid flow in the sedimentary parts of the model compared to the too hot predictions derived from the purely conductive approach. The coupled fluid and heat transport simulations were able to reproduce the measured temperatures in the Molasse Basin area including the pronounced thermal anomalies. Additional consideration of permeable faults had only a minor influence on the thermal anomalies by further cooling down the system, but did not lead to changes in the general temperature trend. Summarizing, our results show that the thermal anomalies in the Molasse Basin are triggered by conductive heat transport, but reinforced by fluid flow. Thus, the geological structure, and in particular the configuration of the underlying crystalline crust and the facies distribution in the Malm, appear to be the major influencing factors of the deep thermal field.

An experimental investigation of the fluid-rock reaction of Bowland Shale with a shale gas injection fluid.

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Poster in Session B1-02

Shale gas exploration within the UK is in its infancy. The principle target horizon is the Mid-Carboniferous Bowland Shale Formation, similar in both age and depositional style to the producing Barnett shale in the USA. During a shale gas operation, water is injected, along with sand that acts as a proppant, into the shale formation until the rock fractures, releasing hydrocarbons (gas) into the fluid. The injected water returns to the surface (flowback) usually within the first few days. The produced water will contain the hydrocarbon gas resource and is a mixture of the formation water and injection fluid. Changes in chemistry may result from the interaction of the mixed water with the shale minerals. Scientific studies and industry production data have been able to predict and demonstrate the composition of the produced water from sites in the USA. However, the likely composition of the produced water for the Bowland Shale in the UK is currently uncertain. Batch reactor experiments containing crushed Bowland Shale (500 μm – 2000 μm fraction) from the Roosecote-1 Borehole, south Cumbria were reacted with injection water (local tap water) at 40°C and 150 bar to simulate likely in-situ conditions. The experimental fluids were sampled periodically over 6 months. Fluid-rock reactions resulted in an increased fluid salinity. An initial decrease of Eh was observed possibly due to the oxidation of the accessible pyrite (total pyrite 1.3%) in the shale. There was a slight increase in fluid pH from 7.45 to 8.30 which stabilised after two weeks. The increase in pH was probably driven by significant carbonate (calcite/dolomite) dissolution followed by a possible minor re-precipitation as Ca, Mg and HCO^{3-} concentrations all decreased over time. Concentrations of Sb, As, Mo, known impurities of pyrite, were found to continually increase over 6 months, tracking sulphate concentrations. Zn, Cu and Ba were rapidly removed from the injection water whilst cations such as Al, Mn, Co, Se, V and U all showed a steady decrease in concentration. Geochemical modelling of the experimental fluid using PHREEQC suggests saturation of aluminosilicate phases and some metal hydroxides as a result of the shale reactions. Further experiments are currently ongoing, to investigate the longer term interactions of the injected fluid with the Bowland Shale Formation.

A synthetic fluid inclusion study of copper solubility in NaCl-H_2O fluids at 800°C and 200 MPa

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Transport and deposition of copper in the Earth's crust are mainly controlled by the speciation of Cu and solubility of Cu-bearing phases in magmatic/hydrothermal fluids. Especially the stability of Cu-complexes with ligands such as chlorine is considered to be of particular importance. In order to quantify the relationship between salinity and Cu content in the fluids under controlled Cu activity, we conducted experiments in Cu capsules (aCu=1) filled with aqueous Na-chloride solution at 800°C and 200 MPa. The experiments were conducted in a rapid heat/rapid quench argon-cold seal pressure vessels at logfO2 = NNO+2. The volatile phase was sampled at run conditions by the entrapment of synthetic fluid inclusions in quartz. To test if the volatile phase had reached equilibrium before the isolation of the inclusions by fracture healing, we used two types of quartz chips, one was initially pre-cracked before experiment and the other one was cracked in-situ by an intermediate quench. Fluid inclusions were subsequently analyzed by laser ablation ICP-MS. Insitu cracked quartz chips show the inclusions with higher Cu content , indicating that sampling in the pre-cracked quartz may be affected by disequilibrium conditions. Results of these experiments show that the solubility of Cu in the fluid phase increases as a function of chloride concentration. When salinity changes from 0.173m Cl to 1.488m Cl and to 4.278m Cl, concomitantly the Cu solubility rises from 0.63 wt% to 5.44 wt% and to 19.07 wt%, respectively. This positive tendency between the concentration of Cl and the Cu solubility suggests the presence of Cu chloride complexes. Surprisingly, the results demonstrate also a large excess of Na+Cu(I) over Cl in the equilibrated fluids on a molar basis. If Na is subtracted, molar copper(I) – chlorine ratio is below 1:1, which indicates the presence of Cu(II) in addition to Cu(I). To unequivocally resolve this discrepancy, further experimental efforts are required.

Depositional environment of ferruginous sediment in the Moodies Group, Barberton Greenstone Belt, South Africa

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Poster in Session A4-05

Ferruginous strata in the Moodies Group of the Barberton Greenstone Belt (BGB, ca. 3.57-3.22 Ga) are, in contrast to those of the underlying Fig Tree Group, thin and occur in moderately-deep-water facies rather than on submarine slopes. They dominantly consist of jaspilite (made of quartz, hematite, and magnetite) and subordinate BIF, are fine-grained and reach a few mm to >1m thick. Jaspilite beds are generally over- and underlain by thick, repetitive, thin-bedded, fine-grained Tde turbidites. In addition, some jaspilite beds occur in close proximity to thick muddy debris flows, slumped rafts of shaly sediment, and lenticular beds of cross-bedded, well-sorted sandstones. Eight correlated stratigraphic measured sections at four sites throughout the northern BGB and interpretation of common soft-sedimentary structures, such as fluid-escape structures, slumps and slump folds, extended and undulatory bedding from two locations in the Eureka Syncline (Clutha Creek, Elephant's Kloof), the Moodies Hills Block (Devil's Staircase Road), and the eastern Stolzburg Syncline collectively suggest that ferruginous sediment was deposited in upper prodelta and lower delta-front facies of one or several tidal-dominated deltas. At least two jaspilitic units (MdI1 and MdI2) are regionally traceable over >30 km strike length; this is possibly true also for MdI3. The jaspilites are the only chemical sediment in the Moodies Group and approximately mark its most distal and deepest-water facies. They thus approximate maximum-flooding surfaces and may serve as sequence-stratigraphic time markers.

The Holocene cold-water coral reef phenomena off Norway: insights from a multi proxy approach

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The current rise in atmospheric pCO_2 is a serious threat for marine calcifiers with high-latitude cold-water coral (CWC) reefs being particularly susceptible due to enhanced CO_2 uptake in these regions. Thus, although CWCs are currently flourishing offshore Norway (71°N) this maybe an especially critical region to assess their longer-term viability. During research cruise POS 391 with RV POSEIDON we retrieved sediment cores from a CWC reef of Norway, Lopphavet at ~71°N. Based on well-dated (U/Th) CWCs we use a multi proxy approach combining boron isotope systematics (δ11B) with elemental ratios (U/Ca, Ba/Ca) to reconstruct the environmental boundary conditions and response mechanism of CWC reef growth during the Holocene. Interestingly, the sedimentary record from these CWC reefs reveals a significant gap during the Holocene. The question remains if this phenomenon is related to changes of the carbonate system or other causes? Our U/Th ages indicate a start of the CWC reef growth at 10 ka and a Mid-Holocene CWC demise starting at around 7 ka. The initial postglacial setting with high Ba/Ca ratios tend to show a decreasing trend towards the cease at 7 ka, probably indicating changes in nutrient supply and terrigenous input. On the contrary the U/Ca ratios reveal an increasing trend towards 7 ka indicating a change of the carbonate system (decreasing pH and/or carbonate ion concentrations) of the ambient seawater near 7 ka, probably due to advances of CO_2 rich arctic waters. The corresponding shift of 2 ‰ from ~725.0 to ~727.0 ‰ in the δ^{11}B record may therefore imply a stronger pH-up regulation of the CWCs due to higher CO_2 concentrations in the ambient seawater, which in turn may have amplified the Mid-Holocene CWC reef collapse on the Norwegian Margin.

Study of coastline changes in south Caspian sea by geochronology of ancient sites during Holocene (Iran)

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Current geoarchaeological research encompasses a wide range of paleoenvironment studies, from the paleoclimatic, to the paleogeomorphic. This research deals exclusively with the latter type of study, especially Holocene coastal change in regions of important archaeological sites. Factors and environmental conditions played a major role in the human settlement in the past, and in this way many civilized societies have emerged that it remains to be sites ancient in modern times. The settlements and ancient sites are essential to study, which places a strip along the southern coastline of the Caspian Sea are determined at regular intervals. With ages from these settlements can be drawn shoreline changes in the Holocene. However, geologists and archaeologists still need to work together more closely to appreciate and understand the contributions each field has to offer. Only when this fact is fully appreciated by archaeologists and geologists alike will it be possible to forge a new synthesis of the relationship between the dynamic sea oscillations and its human settlements.

Analysis of near-surface properties using waveform recordings from the GONAF-Tuzla vertical array, SE Istanbul

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Poster in Session A2-01

The knowledge of near surface velocity structure and ground motion amplification and attenuation is a pre-requisite for many seismology studies. We estimate site effects for selected locations in the Istanbul – Eastern Sea of Marmara Region where vertical geophone arrays in 300 m deep boreholes were installed as part of the ICDP-GONAF project (Geophysical Observatory at the North Anatolian Fault). Here we use recordings from the first GONAF borehole on the Tuzla peninsula in eastern Istanbul. The array consists of one 1 Hz 3C seismometer at the surface, three 1 Hz vertical seismometers at 75 m depth-spacing, and one 2 Hz and one 15 Hz 3C seismometers at 288 m depth. 26 local microseismic earthquakes are used to analyze the near-surface properties of the Tuzla site. Seismic interferometry based on deconvolution is used to extract the Green's functions between different depth levels of the borehole. After deconvolution they are free of the source and path effects and only depend on local site effects. By modeling the observed Green's functions we derive the near surface properties such as the quality factor Q and the seismic velocity structure. By matching the amplitude ratios between up going direct waves and their corresponding down going surface reflections we determined average quality factors for P- and S-waves for the depth intervals of the seismometer array for the upper 288 m. Matching of the arrival times yields a P- and S-wave velocity model.

Challenges and chances of geological 3D-modelling – a case study for the northeastern part of Estonia

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As part of the collaboration between the Estonian Land Board Maa-amet and the Department of Geoinformation of the Institute of Applied Geosciences at Technische Universität Darmstadt, addressing the evaluation of geo-potentials in North-East Estonia, several 3D-models of pre-Quaternary strata have been developed. As these models are the first attempt of GOCAD and SKUA based 3D modelling in Estonia the opportunity is offered to discuss the challenges and chances of geological 3D-modelling and the benefit for the involved parties. Based on a set of input data (wells, LiDAR, cross sections, maps) provided by different institutions, the geometry of the major pre-Quaternary horizons was depicted in a structural model. Furthermore, two smaller and more detailed models, covering potential oil shale mining sites have been derived. In combination with an inevitable quality control of the input data and expert knowledge, different stakeholders like governmental institutions, universities and industry can achieve great benefits by pooling their resources and competences. Lacks or inconsistencies in data become more obvious in a combined model as it would in separated approaches. Areas of interest can be easily extracted and processed for any purpose, thus bringing together working groups from different disciplines. The smaller models, for example, show the advantages of the three-dimensional visualization and processing of target horizons for the mining industry, as it allows calculation of thicknesses, volumes and, in the present case, oil shale reserves for every required section as well as for the entire model. Furthermore geological 3D-modelling serves users with continuously updated state of the art technologies and content and supports daily business.

Geological 3D-Modelling as a perspective for mining planning in open pit mines

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Introduction The mining planning process in open pit mines is mostly based on visual monitoring and quality control in addition to exploration boreholes and geological surveys. All information exist as 2D-Information, mostly on paper. The geological investigations usually spread over a wide lapse of time and depend on several geologists reflecting different standards of knowledge and terminology. Knowledge gained during daily business often can´t be considered in the consultancy process sufficiently. Geological 3D-modelling therefor is a promising approach to improve mine planning. Workflow First all types of data about the quarry and its vicinity need to be gathered. The compilation leads to a GIS-Project including all the information. The sum of the input data is used to check each dataset for plausibility. During the validation of positional information accuracy of positioning needs to be considered. Precisely measured positions such as bore holes have paid off as fix points. Modelling then mainly is based on direct interpolation from markers and control points, but also the construction of bedding planes from outcrop lines and geological measurements. The geological surfaces are used to derive 3D-volumes and the results are made available as reports as well as in 2D through maps and cross sections. 3D data can be provided as GOCAD-project, PDF3D or via web-based applications. Conclusion The combination of expert knowledge, 3D-technologies and ongoing implementation of new data for further development of the model is a promising approach for decision making regarding mining planning. Detailed data on special areas can be extracted easily as statistical data, cross sections and virtual wells, providing a profound base for decisions. Considering the fact that new data is gained continuously due to mining progress and quality management, a geological model of a quarry should never be considered as finished. It gets more detailed and reliable with every verification.

Water, the other network modifier in borate glasses

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Boron oxide glasses usually show low glass transition temperature Tg due to the three-fold oxygen coordination of boron. Adding of alkali and alkaline earth oxides to the glass composition will not decrease but increase Tg due to a change in boron coordination from trigonal to tetrahedral, known as the boron anomaly. Only for higher fractions of alkali oxides, non-bridging oxygens (NBO) are progressively formed in competition with tetrahedrally coordinated boron, which leads to a decrease in viscosity. In contrast to this well-known behavior of alkali oxides (R_2O), there is little known about adding H_2O to borate glasses. The present work therefore aims in shedding light on the rheological properties of hydrous soda lime borate glasses with particular focus on the role of water. For doing so, we determined Tg as a function of Na_2O and H_2O content using differential thermal analysis (DTA) backed up by micropenetration viscosity measurements. Results show that water decreases Tg for all glasses and water concentrations under study (<8 wt% total water). Obviously, water mostly causes the formation of NBO having no significant influence on boron coordination as seen for alkaline.

Late Devonian subduction and ocean closure: Evidence from zircon ages from the northern Böllsteiner Odenwald

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Oral in Session A1-05

The Odenwald is part of the Mid-German Crystalline Rise (MGCR) at the northern margin of the Saxothuringian Zone of the Variscan orogen. The exposed crystalline basement is divided into the Bergsträsser Odenwald in the West and the Böllsteiner Odenwald in the East, separated by the Otzberg fault zone. The Böllsteiner part is composed of various gneisses in the core of the anticline and mainly schists in the outer regions. We used samples from drilling sites for geochronological and geochemical studies in the northern part of Böllstein, the deepest of which reached 775 m near Heubach. For comparison we analyzed gneisses from the region of Neustadt as well. The zircon ages were dated by U/Pb analyses with LA-ICPMS. The ages of the orthogneisses of the Heubach drilling site as well as those from Neustadt cluster between 361 and 368 Ma. The zircons of this age indicate an igneous origin. Sphene and some metamorphic rims from zircons are between 330 and 339 Ma old, giving evidence for a metamorphic overprint during the peak of the Variscan orogeny. Paragneisses and a quartzite additionally contain 400-600 Ma old inherited zircon grains. The major igneous event is younger than that of the 410 Ma old gneisses of the southern Böllsteiner Odenwald and the ca. 420 Ma old core gneisses of the neighboring crystalline Spessart. Furthermore, it is significantly older than the majority of Variscan plutonic rocks of the Bergsträsser Odenwald. The only similar ages are known from the Frankenstein Massiv with 361 Ma and from the Albersweiler gneiss with 365 Ma. Analog to those rocks, the geochemistry of the investigated samples indicates a subduction-related origin. Therefore, the zircon ages obtained in this study provide evidence for at least one late Devonian subduction zone in the realm of the MGCR. Subduction of the Rhenohercynian ocean from the North or the Rheic ocean from the South are a plausible settings for such a scenario.

Plio-Pleistocene evolution of the north Alpine drainage system: constraints from detrital thermochronology of foreland deposits

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Poster in Session A6-02

The evolution of drainage systems in and around active orogens may be strongly affected by climatic or tectonic processes. Information on the drainage evolution is stored in the sediments of the foreland depocenters. We investigated the provenance of two key deposits adjacent to the Central Alps, the Pliocene Sundgau gravels and the Pleistocene Höhere Deckenschotter by applying detrital thermochronology. Combined with provenance information from Rhine Graben deposits, we propose a reconstruction of the north-Alpine drainage system since the middle Pliocene, and discuss potential controlling mechanisms. Our data show that the Rhine Graben received detritus from the Alpine realm already during the Pliocene, indicating two different river systems – the proto-Rhine and the Aare-Doubs – draining the Alpine realm towards the North Sea and Mediterranean Sea. The investigated sediments contain detritus from two central-Alpine sources, one showing a regional exhumational equilibrium, and the other characterized by increasing exhumation rates. Discharge of the latter source ceased after ~2 Ma, reflecting a northward shift of the main Alpine drainage divide. Between ~2.0 and 1.2 Ma, the drainage system was affected by a major change, which we explain as resulting from a change of the Alpine stress field leading to tectonic exhumation and topography reduction in the area of the southern Aar massif. Generally, it seems that between ~4 and 1.2 Ma, the drainage system was mainly controlled by tectonic processes, despite first glaciations that already affected the north-Alpine foreland by ∼2 Ma. The drainage system only seems to have reacted to the late Cenozoic climate changes after ∼1.2 Ma, i.e., at the time of the most intense Alpine glaciation. At that time, the course of the Rhine river shifted towards the area of the Hegau volcanics, and the size of the Rhine river catchment became strongly reduced.

Bioflumology: Cyanobacterial biomat morphologies under flow conditions

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Poster in Session A4-05

The Precambrian world was dominated by microorganisms that were able to organize into macroscopic communities that have been preserved in the geologic rock record as biolaminites or microbialites. However, there remains much uncertainty regarding the nature of these former microbial communities with respect to their metabolism (chemo- or phototrophic), species composition, morphological adaptation, or cohesiveness. We here present the results of month-long laboratory experiments conducted in several sterilized circular flumes designed to allow single cyanobacterial species to growth into biomats under adjustable fluid flow conditions and protected from contamination. Depending on the cyanobacterial species (e.g. coccoidal versus filamentous) and the boundary shear stress at the sediment-water interface the microbial mats develop a range of morphologies (e.g. reticulate structures, streamers, intra-mat gas-bubbles) and protect the sandy substrate differently against erosion. A better understanding of the relationship between microbial species, mat morphologies, and the physicochemical growth conditions will advance our abilities of using fossil specimens for assessing paeloenvironments and nature of the former biota.

X-ray powder diffraction, electron microscopy and magnetic properties of shocked magnetite: a useful geobarometer for cratering processes?

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This study investigates on the effect of shock waves on the magnetic and structural behavior of magnetite, and it's usage for shock pressure barometry in terrestrial rocks and meteorites. The extreme conditions during hypervelocity collisions results in variation of the magnetic behavior of magnetite. These changes are associated with a wide range of transformations including particle fragmentation, phase transformations and coordination distortion of iron and oxygen atoms. These geophysical and mineralogical changes were studied in magnetite-bearing ore samples experimentally shocked to pressures ranging from 5 to 30 GPa at the Ernst-Mach Institute in Freiburg. The magnetic properties were characterized by low-temperature saturation isothermal remanent magnetization (SIRM), susceptibility measurements around the Verwey transition as well as by hysteresis properties extracted from Day plots and first-order reversal curve distributions. Structural behavior was investigated using a combination of transmission electron microscopy and X-ray powder diffraction. For the geophysical properties we found that, the increasing shock pressure correlates with an increasing SIRM, decreasing specific magnetic susceptibility, increasing width and temperature of the Verwey transition as well as with the development of multi-domain to single domain grain size transition. For the mineralogical properties we found that, increasing the shock pressures results in the decrease in apparent crystallite size, cell parameter reduction and the development of planar defects containing micro-twins.
The presented results suggest that the magnetic strain memory can be associated with the presence

of lattice defects and distorted tetrahedral and octahedral iron-oxygen sites.

Stable carbon isotopic composition of fluid inclusions from the Archean Bikita LCT pegmatite field

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On-line simultaneous measurements of stable carbon isotope ratios of CO_2 within quartz- and pollucite-hosted fluid inclusions were carried out on a continuous-flow isotope ratio mass-spectrometer. The aim of the study was to decipher the source(s) of the mineral-forming fluids of the Archean lithium-cesium-tantalum (LCT) pegmatites at Bikita, located within southeastern part of the Zimbabwe Craton. The Bikita pegmatites represent one of the most important sources for the rare metals cesium and lithium worldwide. The pegmatites are hosted by metavolcanic and metasedimentary rocks as part of the Masvingo greenstone-belt. Fluid inclusions were studied in quartz, pollucite, petalite and apatite from the Bikita main quarry (BQ) and surrounding pegmatites (SP). Primary and pseudosecondary inclusions hosted in quartz and pollucite contain aqueous two-phase H_2O-NaCl and H_2O-CO_2-CH_4-NaCl inclusions. Total homogenization temperatures in quartz-hosted, CO_2-bearing inclusions range from 280 to 355 $^\circ$C with salinities between 3.9 and 14.2 wt.-% NaCl equiv. Pollucite-hosted inclusions containing CO_2 homogenize between 230 and 285 $^\circ$C (BQ) and 330 and 380 $^\circ$C (SP) with salinity ranges from 2.9 to 13 wt.-% NaCl equiv. Stable carbon isotope ratios of CO_2, released by crushing of quartz- and pollucite-hosted fluid inclusions, lie between -4.5 and -3.2 ‰VPDB. The δ13C (CO_2) values either indicate degassing of the mantle or devolatilization of greenstone-belt rocks, as suggested for CO_2-rich fluids in some Archean Au deposits in Zimbabwe (Lüders et al., 2015). Whether these results can be generalized for other Archean LCT pegmatites, especially those containing pollucite, needs further research. Nevertheless, this method is an advantage in characterizing paleofluids and can contribute to the research of early mantle-to-crust processes and fluid evolution.

2D Seismic-Reflection Analysis and 3D Reconstruction of the Development of Cenozoic Carbonate Systems along the Lynher-Lombardina Structure, Browse Basin, Northwest Australia

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Tropical reef structures in the Browse Basin, Northwest Australia, formed a major barrier reef during the Cenozoic. In the Barcoo Subbasin these systems are located along the Lynher-Lombardina structural high, which is partly of anticlinal shape but changes significantly in appearance on a local scale. This study analyses the influence of tectonic activity along the Lynher-Lombardina Structure on the formation of the Cenozoic carbonate systems using 2D seismic-reflection data and borehole information in an area of approximately 10000 km2. Seismic interpretation and seismic-to-well correlation enabled the construction of a 3D structural framework model, which was depth-converted using a dynamic conversion approach based on the assignment of interval velocities for each stratigraphic layer interpreted. The tectonic and stratigraphic development of the study area was analysed by applying an incremental structural restoration (backstripping) complemented by decompaction and isostatic compensation.
The key aim of this research is to comprehend the growth of the tropical reef systems and the underlying non-tropical carbonates under tectonically controlled topography changes along the Lynher-Lombardina trend, and to discuss the controlling

factors in general for the Cenozoic carbonate development in this region.

Impact of olivine-spinel phase change kinetics on the deformation of the Mariana Slab

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Oral in Session A4-03

Recent studies of high pressure and high temperature experiments indicate that metastable olivine might persist in a cold core of a slab due to the low rate of reaction of olivine to wadsleyite phase transformation. These experimental results correlate with recent seismological observations that a metastable olivine wedge may survive up to a depth of 630 km in the Mariana slab. We study this problem using a 2D Cartesian numerical code which incorporates self-consistently transition kinetic effects into a thermo-mechanical convection model. The kinetics of the 410-km olivine to wadsleyite and the 660-km ringwoodite to Pv+Mw phase transformations, including effects of water content at the 410-km phase boundary and latent heat, are all taken into account. The detailed results (1) show a positive correlation for some of the controlling parameter with respect to the size of the metastable olivine wedge. With increasing depth of the phase transformation, the effect of latent heat release is enhanced; heating of about 100 °C occurs when olivine transforms into wadsleyite at depths deeper than 550 km. Temperature increase due to the latent heat release stimulates further phase transformation, resulting in further temperature increase, therefore acting as a positive feedback effect. The main conclusion from our results, comparing the calculated temperature and phase structures in the Mariana slab with seismological observations, is that the deeper portion of the Mariana slab should be relatively dry.

(1) S. Yoshioka, Y. Torii, M.R. Riedel (2015), PEPI 240, 70-81, doi:10.1016/j.pepi.2014.12.001

Provenance and characteristics of rocks from the Yermak Plateau, Arctic Ocean: Petrographic, geochemical and geochronological constraints

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The Yermak Plateau is a prominent bathymetric feature of the Arctic Ocean, bordered by the Fram Strait, which forms the only deep-water connection between the Arctic and the other global oceans. Origin, crustal nature and age of the Yermak Plateau are largely unknown. For this study, we investigated dredged rocks of two sites from the Yermak Plateau. Based on petrography, geochemistry, and geochronology, we distinguished between ice-transported and in-situ rocks. Ice-transported material was most likely derived from outcrops of the High Arctic Large Igneous Province on Franz Josef Land, the Siberian trap province, and from northern Svalbard. Our data from the in-situ rocks, in conjunction with previously published geophysical data, show that the investigated parts of the Yermak Plateau are composed of stretched continental crust strongly affected by alkaline magmatism. The continental rocks represent a direct continuation of the exposures on northern Svalbard. Alkaline magmatism took place at ~51 Ma and was related to continental rifting in an extensional setting. The melts were formed by low degrees of partial melting of the sub-continental lithospheric mantle and are probably associated with the high amplitude magnetic anomalies described for the northeastern Yermak Plateau. Extension of the Yermak Plateau was contemporaneous with spreading of the adjacent young Eurasian Basin, and occurred during the peak of compressional deformation affecting North

Greenland, Svalbard, and Ellesmere Island. These contrasting regimes were probably compensated by transpression and strike-slip movements along the DeGeer and Wegener Faults. The date of ∼51 Ma for extension-related magmatism also provides age constraints for the extension-related formation of the Sophia Basin (and thus for water exchange between the Eurasian Basin, the area of the DeGeer Fault and the young Norwegian-Greenland Sea), and for the sediments covering the horst-and-graben structures of the Yermak Plateau.

The vertical surface-deformation pattern of Crete (Greece) from Persistent Scatterer Interferometry

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The island of Crete is situated above the Hellenic subduction zone, which allows to observe the vertical surface-deformation pattern. Crete is approximately rectangular on the first order, but segmented into individual blocks by upper crustal faults. The most prominent recent surface deformation affected SW Crete, where the shoreline has been uplifted by 9 m related to the 365 A.D. earthquake. An important question is whether this earthquake occurred along the subduction interface, or on upper-crustal faults, such as the Hellenic Trench, which is a major revers fault in the overriding plate. In order to address this question, and to better evaluate the tectonic processes responsible for the regional-scale segmentation, we have analysed the contemporary vertical deformation pattern across the island. We used Persistent Scatterer Interferometry (PSI) measurements over eight years (1992 to 2000) to determine the vertical deformation pattern, with mm-accuracy and a wide spatial coverage of hundreds of kilometers. We applied the observational PSI system for wide areas, which was developed at the German Aerospace Center (DLR). Our PSI results show significant differential vertical surface-deformation across Crete during the observation time. SW Crete is characterized by uplift of up to 5 mm/yr predominantly along the SW coastline. This strong uplift signal reduces towards the NW coastline, which is relatively stable. The observed PSI deformation pattern is similar to the coseismic displacement field related to the 365 A.D. earthquake (Pirazzoli et al., 1996). This deformation pattern is opposite to that expected by interseismic loading above a locked subduction zone, which implies slow aseismic creep along the subduction interface, or motion related to upper-crustal faults. Based on our analysis, the vertical deformation of SW Crete is not dominated by strain accumulation along the Hellenic subduction zone, but rather by active faulting within the overriding plate.

New constraints on the metamorphic evolution of metabasites of the Central Schwarzwald Gneiss Complex, Germany

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Poster in Session A1-03

The Central Schwarzwald Gneiss Complex (CSGC) is part of the Moldanubian Zone of the Variscan orogen. Paragneisses and migmatites of the CSGC contain lenses of metabasites which display relics of eclogite and/or granulite facies mineral assemblages (e.g. Kalt et al., 1994). In order to constrain the metamorphic history of these metabasites, which today exist almost exclusively as amphibolites, petrological studies have been carried out on samples from the northern (Bad Peterstal area), central (Kinzigtal), and southern part (Kappler-Tal) of the CSGC. The observed mineral reaction history of the metabasites combined with geothermobarometry and calculated P–T pseudosections in the

NCKFMASH-Ti system, point to a clockwise retrograde P-T evolution of samples from the Kinzigtal and Kappler-Tal. Their relict peak-metamorphic assemblage of Omp-Grt-Rt-Ky is stable at P-T conditions of >23 kbar and >800°C. These P-T estimates are substantiated by Grt-Cpx thermometry and jadeite barometry. Near-isothermal decompression to 8-10 kbar at still high temperatures of >800°C is evidenced by the pseudomorphic replacement of kyanite by Pl-Spl symplectites, of rutile by ilmenite, of garnet by Opx-Pl symplectites, and of omphacite by Cpx-Pl symplectites. Subsequent decompression and cooling into the amphibolite facies (6.5-7.5 kbar, 700-750°C) is reflected by the replacement of Grt-Cpx-Rt/Ilm by Hbl-Pl-Ttn. This MT/LP overprint is dominant in foliated amphibolites of the Bad Peterstal area, which contain only rare clinopyroxene, formed at P-T conditions of c. 4-5 kbar / 800-850°C Metabasites of the Kinzigtal and Kappler-Tal frequently preserve their original igneous textures, pronounced by accumulations of cm-sized, euhedral apatite. The abundance of zircon in these samples indicates their crustal origin or at least a major contribution of crustal material during their early metamorphic evolution.
Kalt et al., 1994, J. Met. Geol. 12, 667-680.

How to improve a large-scale geological 3D model? -The TUNB3D-NI project-

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Poster in Session B5-02

Geological 3D model building is an important tool to better understand geological settings. All relevant subsurface and field data can be combined and visualized. This allows for comprehensive representation of geological data and is increasingly used by Geological Survey Organizations (GSOs). But how does one include additional data in an existing 3D model? The State Authority for Mining, Energy and Geology (LBEG) of Lower Saxony (Germany) has compiled a regional 3D model (Bombien et al. 2012) of most of Lower Saxony, based on the Geotectonic Atlas of Northwest-Germany (GTA) (Baldschuhn et al. 1996, 2001). Analogue structural maps, as well as digitized depth lines of the GTA, were imported into the software GOCAD®. 14 lithostratigraphic horizons from upper Permian to Quaternary and almost 300 salt-structures could be constructed. Due to the lack of detailed information, faults were modelled separately for each horizon as vertical offsets. Also, geometric inconsistencies were revealed, e.g. horizon surfaces intersect each other. In addition, some areas of the model could not be constructed because of data was missing. The project TUNB3D-NI focuses on the Lower Saxony part of the North German Basin. Within this project a large quantity of new data, e.g. boreholes, 2D and 3D seismic reflection data will be implemented to improve and extend the existing 3D model. Challenges include the selection of data, the development of effective workflows, and the time-to-depth conversion of seismic data.

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Vibrational spectroscopic investigations of heated concrete

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Oral in Session B6-01

The measurement of the IR spectra enable to detect small changes in the structure of the concrete within the amorphous faces responsible for the mechanical strength development. In a first step we used the most common sampling technique ATR (Attenuated total reflection) to analyse samples treated at different temperatures. The development of ATR devices like the Golden Gate Bridge has greatly simplified sampling for FT-IR spectroscopy. Sampling time for one sample is reduced to <2 minutes. With the micro technique one could measure with reasonable local resolution in order to measure profiles through fired samples, too. It is observed that the position of the peak maximum (PPM) of the Si-O-stretching mode is a function of the temperature. The PPM decreases with increasing temperature. This correlation is independent from the time the sample was exposed to temperature. The decrease of the PPM is explained by a shortening of Si-O-Si-chains of the CSH phases which depolymerise into monosilicate ß-C2S. It can be suggested that the compressive strength of concrete at high temperatures correlates with the depolymerisation of the Si-O-Si-chains of the CSH phases. For comparison we used the transmission sample technique, too (KBr method). This method reveal similar trends in peak position depending on heating temperature. However, there are significant differences in peak positions and intensities compared to the ATR derived spectra. Even the use of conversion algorithm of ATR spectra to transmission does lead to unsatisfactory improvements. Since both methods are broadly used possible consequences and explanations will be discussed.

Lithosphere structure in the southern Madagascar from receiver function and ambient noise surface wave dispersion analysis.

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The geology of the western part of Madagascar is very different from that of the eastern part of Madagascar. The eastern part is dominated by Precambrian rocks; whereas the western part is characterized by sedimentary formations. The Precambrian rocks in Madagascar have several tectono-methamorphic units with age ranging from Archean to Neoproterozoic. Between 2012 and 2014, 25 broadband stations were operated in Southern Madagascar extending from the East coast (Mananjary) to the West coast (Toliary). In addition, between 2013 and 2014, 23 short period stations were installed in the southeastern part of Madagascar. These stations cross different domains and are thus suitable for investigating the evolution of the Precambrian lithosphere and the effect of the Cenozoic and the recent igneous activity. We will present results regarding the lithosphere structure in the southern part of Madagascar based on receiver functions and surface wave dispersion measurements from ambient noise analysis. Our interpretation focuses mostly on the contrast between the lithosphere structure in the Precambrian rocks and the basin formation in Madagascar and the local seismicity in Madagascar. Beneath the sedimentary formation, crustal thickness varies between 23 km and 30 km and the Vp/Vs ratio ranges from 1.79 to 1.85. In the Precambrian rocks, the Moho depth ranges from 30 km to 40 km, and the Vp/Vs' ratio of the crust varies between 1.69 and 1.79. The crustal thickness in the western part of the Precambrian rocks is relatively thin (average 35 km) compared to those in the eastern part (average 39 km). The obtained results from the joint inversion

of receiver function and Rayleigh surface wave dispersion indicate sediment thickness ranges from 4 km to 12 km in the Morondava basin.

Biotic and abiotic $^{238}U/^{235}U$ fractionation – applications to bioremediation and U ore roll-front deposits

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Poster in Session B5-02

Decades of U mining and processing left a legacy of contaminated sites around the world. Strategies for remediation are commonly based on the reduction of the mobile U(VI) to more immobile U(IV), either by stimulated bio-reduction or after adsorption onto mineral surfaces. The ratio of the most abundant uranium isotopes, $^{238}U/^{235}U$, was suggested as indicator for the progress of U reduction [1] and according to recent results it may be used to even distinguish between biotic and abiotic reduction [1, 2]. While enzymatic U reduction results in an enrichment of the heavier U isotope, ^{238}U, in the reduction product, abiotic U reduction apparently does not produce U isotope fractionation, or in some cases, as for magnetite (Fe_2O_3) and aqueous Fe(II), appears to preferentially reduce light U isotopes. Here, we examined in more detail this potential kinetic effect, performing U reduction experiments with varying magnetite to U concentration ratios. Initial results show that magnetite-mediated uranium reduction does not result in light isotope signatures in the reduced product, but rather, in no detectable isotope fractionation, as observed for other abiotic reduction mechanisms [2]. Furthermore, we tested the application of the U isotope proxy to gain information on the formation of a sandstone-hosted U roll front deposit in Wyoming, to elucidate the reduction mechanism(s), particularly the role of biotic versus abiotic U reduction. The deposit samples that were analyzed exhibited predominantly ^{238}U-enriched isotope signatures, indicating that biotic reduction of U(VI) was significant during deposit formation. Findings from these two studies support the conclusion that U isotopes and their fractionation is a powerful tool to unravel processes driving U deposit formation as well as remediation of uranium contaminated sites.

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East Greenland copper exploration: Geological features and the application of field methods around the Jameson Land basin, Greenland

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First geological investigations and systematic mapping of central East Greenland have been carried out by the "Lauge Koch Expeditions" from 1926 to 1958. Several surveys, including first mineral exploration programs (1956-82 by Nordisk Mineselskab A/S) followed over the last decades. The Danish mineral exploration company Avannaa Resources Ltd. started first reconnaissance of the Jameson Land area in 2011. A full field season in 2012 lead to the claim of a license that covered roughly 900 km2, which was further extended in 2013. As part of a joint-venture with Anglo-American plc a prospect was drilled, which lead to the license being dropped in 2014. The most promising target of the exploration campaign was the sediment-hosted copper mineralization in the Permo-Triassic sedimentary sequences on the margins of the Jameson Land basin. The central

East Greenland geology is dominated by a N-S trending Caledonian Fold Belt. The Jameson Land area represents part of a Late Palaeozoic to Mesozoic post-orogenic rift basin. It is bordered by Caledonian crystalline rocks of Liverpool Land on the eastern margin and the Stauning Alps to the west. The sedimentary rock units of interest consist of shallow marine sediments in the Upper Permian to the lowermost Triassic and continental lacustrine sediments during the main part of the Triassic. The Upper Permian sediments represent the first marine transgression with similarities to the European Zechstein. The exploration program included detailed prospecting, ground geophysics, geological mapping and stream sediment sampling, soil sampling, and talus sampling campaigns. This presentation will give an overview on the geology that is host to the copper mineralization. Additionally, experiences from and challenges for planning, layout, logistics and development of an exploration program in an arctic environment will be pointed out. Hands-on experiences can give a detailed insight into such a three-year exploration campaign.

Rapid hydrological response to central Andean Plateau uplift revealed by leaf wax stable isotopes

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Plateaus and their flanking ranges excerpt a strong impact on regional and global hydrology, vegetation, and erosion. During the last decade topographic evolutions have increasingly been derived from stable isotopes. However, several factors (e.g. moisture source changes) can impact the isotopic composition of precipitation during the multi million year timescales of uplift. We use a multi-isotope-proxy approach with δDwax and δ^{13}Cwax, soil-carbonate δ^{18}O and δ^{13}C and δD volcanic glass shards to better separate potential influences and obtain a picture of the paleohydrologic and environmental changes that occur during topographic growth. We reconstructed paleohydrological changes from a sedimentary sequence (9-2 Ma) exposed in the intermontane Angastaco Basin of NW Argentina (25°45 S, 66° W). Throughout the record δDwax values ranged between -160 to -98 ‰ and δ^{13}Cwax between -36 to -24 ‰. In addition, by analyzing δ18O and δ^{13}C values from coeval soil-carbonate and δD values of volcanic glass shards, we were able to reconstruct the (eco)hydrological regime during orogenic uplift. These isotope proxies record different components of the hydrological cycle: while δDwax records the leaf water isotopic composition (a function of plant transpiration) and soil-carbonate δ^{18}O records soil water (a function of soil evaporation), whereas volcanic glass δD values record precipitation δD values. Combined, these proxies provide a unique high-resolution (60 to 100 ka) precipitation - evapotranspiration record that revealed the onset of a monsoonal precipitation regime at this latitude at 8.5 Ma, accompanied by protracted, seasonal humid foreland conditions with a dominant C3 vegetation until 6.5 Ma. Subsequent orographic barrier formation upwind of the basin resulted in intermontane aridification and a changeover to C4 vegetation. Our multi-proxy-isotope approach is capable of capturing the complex paleoenvironmental and elevation changes that occur during topographic uplift.

Dynamic characteristics of plate motions and continental drift in global mantle flow

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It is now widely accepted that plate tectonics is a surface expression of mantle convection and that both are dynamically linked. Hence, plate motions can be used to constrain the dynamics of the deep interior. While those motions are directly observable only for the present-day, they can be reconstructed for Earth's recent history. However, this is limited by the preservation of seafloor of which the oldest is ~200 Myr. Thus, periods of supercontinent assembly (pre-Pangea) are not captured. Moreover, reconstructions rely on the kinematic principles of plate tectonics only and can thus not explain plate motions dynamically, thus, the link between surface observations and deep mantle processes is missing. We use global models of mantle convection including tectonic plates self-consistently evolving from mantle flow as well as Earth-like continental drift, which allow us to investigate plate motion evolution dynamically fully consistent and over long time scales. We observe fluctuations in global plate motion rates of a factor of 2-3, in agreement with kinematic reconstructions since 200 Ma. Fluctuations are mainly driven by the onset of new subduction, indicating the strong role of slab-related driving forces. Using simple proxies for driving and resisting plate forces (e.g. subduction flux, sub-lithospheric viscosity, convective wavelength), we discuss the effects of different rheological parameters on global plate motion rates. For regional plate motions (individual plates) we focus on the continents and their drift. Clustering of continents is favored by longer-wavelength flow, which is controlled by e.g. lithospheric strength. Cases with an intermediate characteristic wavelength may be prone to episodic assembly and dispersal of continents, although these processes do not seem to have clearly identifiable time scales. Continental drift is fastest after break-up during dispersal, when single blocks may reach velocities comparable to India at ~50 Ma.

On the dynamic origin of Venus' unusual gravity spectrum

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Venus is Earth´s neighbor in the Solar System and quite similar to it in terms of size, mass, and bulk density. Thus, it is often popularized as Earth's sister planet. On closer inspection, however, this similarity disappears: for instance, Venus has a much thicker atmosphere, no strong magnetic field, and most fundamentally, no plate tectonics. It is more moreover exotic in terms of its gravity field, since it is the only one under the terrestrial planetary bodies whose gravitational figure is not dominated by a spherical harmonic degree 2. This observation is not well understood and may be interesting because it can possibly tell us more about Venus's internal structure and evolution, and its differences to Earth. Taking this as motivation, we analyze Venus's gravity spectrum in more detail by using dynamic forward models of mantle convection in the stagnant lid tectonic regime to predict synthetic gravity spectra for a Venus-like planet. By comparison to the observed spectrum, we are able to make constraints on the (viscosity) structure of the Venusian mantle. In contrast to Earth, our results indicate that Venus' mantle is unlikely to have a strong viscosity stratification between upper and lower mantle. The presence and properties of solid-solid phase transitions are important to match the amplitude of the observed spectrum and lateral viscosity variations do not strongly affects the long-wavelength geoid. Moreover, we will address the question of how representative

Venus presently unusual (in terms of dominant length scales) gravity spectrum is for its evolution by modeling tectonic scenarios that feature catastrophic resurfacing events that are likely to have occurred during Venus' history. We model them by including a viscoplastic lithosphere whose strength leads to a transitional (episodic) regime between plate-like and stagnant lid behavior and analyze their effects on the geoid spectrum and the recovery time of the spectrum.

Gondwana-links of Phanerozoic magmatic tin and tungsten mineralization

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Poster in Session B2-02

The formation of major granite-related Sn and/or W deposits involves source enrichment, source accumulation, and metal mobilization from the source by partial melting, followed by fractional crystallization (Romer and Kroner, 2015). Source enrichment is related to intense chemical weathering on a stable craton, with loss of Ca, Na, Sr, and Pb and residual enrichment of K, Rb, Cs, Li, and Sn and W in and on clay minerals. Source accumulation refers to the redistribution of the chemically weathered material from the continent interior to the continent margins and may result in particularly voluminous packages at the discharge of major rivers. Later tectonic overprint of these sedimentary deposits may result in additional tectonic accumulation of enriched source rocks. Metal mobilization involves heat input from the mantle, to achieve high-temperature melting, and may be due to input of mantle-derived melts subduction and extensional settings or to ultra-high temperature metamorphic units in collisional settings. Thus, the occurrence of Sn and/or W deposits is spatially controlled by the distribution of voluminous packages of enriched source rocks at the margin of continents and is temporally controlled by the availability of a high-temperature heat source at a plate margin. Most Phanerozoic Sn and W mineralization occur in belts that border to former fragments of Gondwana (Sn and W belts of South America, eastern Australia, Southeast Asia, southern China, and possibly also Central Asia and Korea). Common to these belts is that the source rocks have weathered on stable Gondwana and have been redistributed during Gondwana fragmentation. Formation of the deposits is restricted to former continent margins that were reworked by processes operating at plate margins.
Romer, R.L. and Kroner, U. (2015) Sediment and weathering control on the distribution of Paleozoic magmatic tin–tungsten mineralization. Mineralium Deposita, 50: 327–338.

Contrasting tectonic setting of magmatic Acadian-Variscan-Appalachian tin and tungsten mineralization

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Granite-hosted Sn and/or W mineralization and lithium-cesium-tantalum (LCT) type pegmatites in the Acadian, Variscan, and Alleghanian orogenic belts of Europe and Atlantic Northern America have in common that they occur in areas with voluminous sedimentary rocks that have chemically intensely weathered on stable Gondwana and have been redeposited at continent margins during Gondwana breakup and the formation of the Rheic. Deposits that define a single tin belt are highly variable in that they (i) formed diachronously over a period of more than 120 Ma, (ii) occur on both sides of the Rheic suture, (iii) occur in subduction, collision, and extension settings, and (iv) may be related to multiple mineralization events within a single area, but in different tectonic settings. Whereas the occurrence of mineralization in belts reflects the distribution of enriched source rocks, the age distribution and the range of contrasting

tectonic settings reflects the availability of heat sources favoring high-temperature melting (>850°C) at a time, when the source rocks were at depth. Such high melting temperatures require heat input from the mantle and occur in the following tectonic settings: (i) extension of the upper plate above subduction zones with mantle upwelling and crustal melting (e.g., Nova Scota); (ii) advective heat input from exhumed ultra-high–temperature metamorphic units after continental collision (e.g., Erzgebirge); and (iii) post-orogenic crustal extension in the orogenic foreland with mantle upwelling (e.g., Cornwall). Crust-internal heating may reach temperatures sufficient for LCT-tpye pegmatites, but not for Sn and/or W mineralization.

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Romer, R.L. and Kroner, U. (2015) Sediment and weathering control on the distribution of Paleozoic magmatic tin–tungsten mineralization. Mineralium Deposita, 50: 327–338.

The Wilson cycle revisited

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Deep seismic profiles, mantle tomographies and thermomechanical models coupling mantle convection and lithosphere dynamics have provided new means to investigate the current architecture and geodynamic processes operating at passive margins from the initial stages of rifting until more mature stages of the modern conjugate margins of the Red Sea, Atlantic, Indian, Arctic and Southern oceans. In the meantime, improvements in crustal imagery along both sides of North America and Western Europe and radiometric dating of lower crustal bodies remobilized in Cordilleran and Aegean metamorphic core complexes or in tectonically uplifted and unroofed segments of formerly hyperextended continental crust in the Alps have demonstrated the temporal and tectonic controls exerted by the post-orogenic collapse of the Caledonian, Appalachians, Variscan, Cordilleran and Alpine-Carpathian orogens on the localization of subsequent extensional provinces of the North Sea, Paris Basin, Atlantic margins, as well as in the Basin and Range province and in the Pannonian, Tyrrhenian and Aegean basins. Ultimately, modern geodynamical settings such as the Gulf of California-Salton Sea and Read Sea-Dead Sea systems can help understanting the pre-orogenic architecture of former Mesozoic extensional basins currently located in transpressionaly inverted domains of the Iberian Chain and Pyrenees, Saharan Atlas and Eastern Mediterranean Basin, whereas the China Sea, the Japan Sea and other barck-arc and marginal seas from the Western Pacific realm can be used as modern analogues for the Paleozoic and Mesozoic ophiolites currently accreted within the North American Cordillera.

Evolutionary models of the Earth with a grain size-dependent rheology

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We present a set of numerical simulations of mantle convection in which the rheology is grain size-dependent. We use the models of grain size evolution proposed in the past years [Austin and Evans (2007), Ricard and Bercovici (2009), Rozel et al. (2011), Bercovici and Ricard (2012a,2012b)]. Zener pinning, phase transitions and dynamic recrystallization are implemented in these very non-linear simulations solved with the convection code StagYY [Hernlund and Tackley (2008)]. Equilibrium situations are presented in 2D spherical annulus models and compared to a grain size-dependent 1D reference profile of the mantle. Our preliminary results have shown that out of equilibrium grain size dynamics leads to localization of deformation below the

lithosphere rather than subduction initiation. Yet this result was obtained assuming idealized conditions. We study here the evolution of grain size in the mantle and lithosphere in evolutionary models. For this purpose, we consider melting, visco-plasticity, phase transitions, compressible convection, and different composite rheologies (diffusion and dislocation creep) in upper and lower mantles.

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Effects of impacts on the thermochemical evolution of Mars

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Poster in Session A4-01

The early history of the terrestrial planets was strongly shaped by the occurrence of several large meteorite impacts. A large impact causes not only severe effects on geologically short timescales (i.e., on the order of seconds to centuries), but may also disturb the thermal structure of the mantle and core of a planet for millions of years. Numerical models have shown that even a single large impact can potentially suppress convection on a large scale and extinguish a core dynamo (e.g., Roberts and Arkani-Hamed, 2012; Arkani-Hamed and Olsen, 2010). We combine numerical mantle convection models that include a detailed model of mantle mineralogy and chemistry and are coupled with a simple model of core energetics (e.g., Ruedas et al., 2013) with a detailed parameterization of the effects of an impact in order to improve existing models in terms of applicability to the real planet Mars. We study the effects of single and multiple giant impacts on the long-term evolution of the mantle and core of Mars and investigate to which extent traces of the early giant impacts - apart from the obvious craters - may have survived to the present day and could be observable by geochemical or geophysical methods. References:

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Geopolymers, additions to Portland-cement and hosting hydrogen storage materials

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A geopolymer could be described as a hardened, charge balanced aluminosilicate gel made from a suspension of metakaolin ($Al_2O_3 \bullet 2SiO_2$) and some water glass formulations (an alkali meta-silicate solution, M = Na, K). A standard composition could be given as $M_2O \bullet Al_2O_3 \bullet 4SiO_2 \bullet 11H_2O$. The resulting microstructure is impervious, nanoporous, contains up to 40% porosity by volume, and is nanoparticulate (5-40 nm diameter depending on composition). Generally geopolymers are a class of alkali activated materials that have applications within the wide range from the building and construction materials to advanced ceramic type materials. The production of 1 kg of Portland cement releases almost 1 kg of carbon dioxide into the atmosphere, whereas the synthesis of geopolymer liberates less than 1/4th of that. Thus geopolymers could present a viable pathway to retard the effects of global warming. Another advantage is the direct consumption of industrial wastes (fly ash, pond ashes, slag) or for example rice husk ash for the production geopolymers, too. The mechanical properties of geopolymer concretes could gain about twice the compressive strength and three times the flexural strength of Portland-cement concretes. Some long term investigations extending over five years showed the positive impact of Ca ions with the addition of slag and fly ash as some structure directing agent in the formation of CSH-chain type structures versus network formation in pure metakaolin/waterglas based geopolymer formulations. Some new applications in geopolymer research like hosting hydrogen storage materials will be considered, too. Boronhydrides like tetrahydroborates (MBH4) and aminoborane (NH3BH3) have attracted some attention due to their remarkable gravimetric and volumetric hydrogen contents. This has enforced the development of scenarios for an easy handling of such hydrides like the enclosure in geopolymers.

Pre-Messinian Salinity Crisis sedimentary successions of the southern Vera Basin, SE Spain

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The Vera Basin, one of several interlinked basins within the internal Zone of the Betic Cordillera, is a NNE-SSW-elongated Neogene-age basin. The tectonic regime is characterized by transform activity as well as the ongoing orogeny of the Betic Cordillera. This latter has resulted in the uplift of metamorphic domes (Sierra Amagro, Sierra Almagrera & Sierra Cabrera) which form the basin margins. The sedimentary succession within the Vera Basin comprises Burdigalian- to Pliocene-age deposits and includes the Messinian Salinity Crisis (MSC), and can be broadly subdivided in pre- and post-MSC units. The pre-MSC succession contains continental to deep-marine sediments, cropping out in the southern and central parts of the basin. Initial sedimentation (Burdigalian) is poorly understood but would appear to comprise shallow marine marls and limestones overlain by up to 500 m of alluvial fan sediments deposited in Serravallian times. The subsequent succession comprises mixed clastic-carbonate coastal units. These units vary both in terms of their carbonate content as well as the origin of the sediments (Sierra Cabrera vs Sierra Bedar). Tectonic activity centred around these latter highs acted as a control on the development of progradational systems into the basin. Coevally, the basin centre was dominated by extensive marine marls and thin sandstones. The presence of a classical Nereites ichnofacies (e.g. Cosmorhaphe, Nereites, Paleodictyon & Spirorhaphe), as well as the recognition of Bouma sequences within the thin sandstones would suggest a deep-marine system. However, the relationship between these two very different depositional systems (deep marine vs coastal/shelf) is unclear, since they would appear to be coeval and yet there are no direct links – in terms of intervening systems – between them. The focus of this present study, therefore, is the precise mapping and correlation of these two systems, together with more detailed descriptions of the main environments.

An overview of Neogene-age deposition within the Vera Basin, SE Spain

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Poster in Session C4

The Vera Basin is one of a series of interlinked Neogene-age basins which formed within the Internal Zone of the Betic Cordillera, SE Spain. These basins were open to the Mediterranean Sea, with the Vera Basin being immediately adjacent. Deposition within the basin commenced in the Burdigalian extending up to the Pliocene, thus encompassing the Messinian Salinity Crisis (MSC). The sediments within the basin, therefore, can be subdivided into pre- and a post-MSC successions, although the precise subdivision is not always clear. While a broad stratigraphic framework exists for the basin, there are significant lithological variations across the basin. The precise implications of these variations are not always clear. Additionally, the evolution of the basin both in terms of its formation as well as in terms of the basin fill history was interlinked with transform activity along the Palomares Fault Zone. Thus, the precise stratigraphy varies considerably across the basin. It would appear that the post-MSC stratigraphy is broadly sound, whereas the pre-MSC stratigraphy is more problematic. The present study has concentrated on high-resolution analysis of the pre- and post-MSC successions. Detailed mapping, together with petrological, geochemical and micropalaeontological analysis have been used to reconstruct the tectono-sedimentary evolution of the basin. A new stratigraphic framework for the basin is proposed, incorporating existing work, as well as the results of the new mapping. Additionally, the new work facilitates more detailed comparisons with the adjacent Sorbas, Nijar & Pulpi basins thus providing a better understanding of the regional evolution during this crucial period.

The impact of Andes tectonics on hydrocarbon generation in the northern Austral Basin, southern Argentina, South America

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Oral in Session B1-01

The Austral (or Magallanes) Basin in southern Argentina was affected by many tectonic phases during the Mesozoic and Cenozoic. Especially the eastward subduction of the Nazca and Antartic plates under eastern South America, which trigger the rise to the southern Andes, had a major influence on the Austral Basin evolution. Despite the numerous currently-producing oil and gas fields, first order controlling factors of hydrocarbon generation and accumulation, in time and space, in this basin remain not completely understood. Therefore we carried out a multi-scale integrated analysis including 1D subsidence and sedimentary rates analysis, long-distance onshore-offshore correlations, identification of main tectonic events and their link to depocenter migration, and a basin-wide 3D modeling of the petroleum system. Seismo-stratigraphic interpretation provided the input maps on basin geometry for the 3D basin model. The Jurassic Tobifera Formation represents the earliest basin fill, overlied by Cretaceous, Paleogene, Neogene and Quaternary sediments. Burial history reconstruction allowed estimation of eroded thicknesses. Information about source rocks, reservoirs and seals were included into the 3D petroleum system modelling. The source rock properties were assigned to the Lower Cretaceous Springhill Formation, Lower Inoceramus and Margas Verdes Formation. The Springhill Formation was defined as the main reservoir. The heat flow was initially set to 60mW/m2 over time and then adjusted to account for known times of volcanic activity until the model reached an acceptable thermal calibration. Our results indicates that hydrocarbon generation is triggered by Andes-uplift related volcanic activities as spatiotemporal impact of tectonic activity on maturity - and thus timing of petroleum generation- was observed.

depositional environments, including open marine, patch reef, lagoon, and semi-restricted lagoon settings.

Biostratigraphy and Lithostratigraphy of the Qom Formation in the Navab Anticline section, southeast of Kashan area, Iran

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Poster in Session A5-01

The Qom Formation was deposited in the central Iranian back-arc basin during the Oligocene-Miocene and documents the closure of the Tethyan Seaway. In this study, foraminiferal faunas and carbonate microfacies were studied based on a total of 43 samples from the Navab Anticline section, which is located southeast of Kashan area. The section mainly consists of limestone, calcareous marl, marl, and gypsum-bearing marl with a total thickness of 318 meters. The Qom Formation is deposited on top of the gypsiferous and evaporitic red beds (Lower Red Formation) and is unconformably overlain by evaporitic red beds of Middle-Late Miocene age (Upper Red Formation). The studied sediments contain a variety of red algae, bryozoans, benthic and planktonic foraminifers. The distribution of index larger benthic formaminifers suggests a late Oligocene (Chattian) to early Miocene (Aquitanian-Burdigalian) age. The studied section contains a complete succession of all members of the Qom Formation and based on index foraminifera represents assemblage zones 1 & 2 introduced by Adams & Bourgeois (1967). The foraminiferal fauna is characterized by benthic taxa, including Rotalia viennoti, Operculina complanata, Elphidium sp.14 and Eulepidina dilatata as most dominant species. Microfacies analyses from Navab section suggest a range of

Bioflumology: Cyanobacterial biomat morphologies under tidal conditions

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Poster in Session A4-05

The evolution of oxygenic photosynthesis only occurred once in cyanobacteria and has resulted in a transformational change of earth‘s geochemical cycles and the subsequent evolutionary path of life. Despite decades of studying Precambrian microfossils, biomarkers, and isotopic signatures, the timing of the emergence of oxygenic photosynthesis has remained ambiguous. We here present the results of month-long laboratory experiments conducted in several sterilized tidal flumes designed to allow single cyanobacterial species to growth into biomats under adjustable tidal conditions and protected from contamination. Our results show that the formation gas-bubbles trapped within or below a microbial mat can originate from photosynthetic oxygen production or the tidal pumping of the ambient air through the sediment pore space. The ability to morphologically distinguish different types of microbial mat associated gas-bubbles and relate them to a specific formation mechanism (e.g. through in-situ oxygen formation versus subsurface air migration) will advance our abilities to better confine the former metabolic attributes of fossil microbial communities.

Petrography and Geochemistry of rift-related dykes in northern Indian plate, north-west Pakistan

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Dykes of basic composition cut across the pre-Permian rock suites in the northern margin of Indian plate in north-western Pakistan. On the basis of their textural and mineralogical characteristics, these dykes are further divided into two: a) dolerite and b) altered/ metamorphosed basic dykes. Dolerites essentially consist of plagioclase and clinopyroxene and display ophitic texture. Plagioclase composition ranges between An75 Ab25 to An55 Ab45 with some grain display zoning from anorthite rich core to labradorite rich margins. The clinopyroxene falls mostly in field of augite with pink/violet in plane light indicating its titaniferous signature. Altered dykes mostly have certain degree of preferred orientation and consist of plagioclase and hornblende. Clinopyroxene is very subtle and present as relics enclosed within or totally pseudomorphed by green amphibole and chlorite. Appreciable amounts of epidote and clinozoisite also occur and their mode of occurrence and association suggest that it formed by the alteration of amphibole and plagioclase. This feature and formation of amphibole and chlorite at the expense of clinopyroxene suggest metamorphism of the dykes under green schist to epidote-amphibolite facies conditions. The major elements geochemical characteristics are also supported by the modal mineralogical compositions. Discrimination diagrams using trace elements including Zr, Y, Nb, Hf, Th, and Ta suggest within-plate tectonic setting for these rocks. All the mentioned features suggest the association of these dykes with Permian rift activity mostly marked by presence of felsic alkaline magmatism occurred in northern Indian plate. Cross cut relation of these dykes within alkaline granite further points towards its younger nature than the main alkaline episodes.

Textural characteristics as an efficient indicator towards rock strength: Insights from studies on Granites from north Pakistan

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The size, shape and mutual arrangement of mineral grains in a rock, collectively called as its texture, is an effective pointer towards the various evolutionary and deformational/ tectonic stages during its creation history. An attempt has been made to use this important feature in formulating the mechanical nature of rock. Granite, a one of the common rock types used in various engineering operations throughout the world, has been selected because of its broader applications and steadiness in diversity of conditions relative to other rock types. Four different granites with range in their texture features from the lower Himalayas in north western Pakistan are used for analysis. Detailed petrographic examination and subsequent QEMScan analysis provide better understanding on the difference between their textures. Post-tests petrography has also been conducted to observe the propagation of newly formed fractures and its relation to grain boundaries. The variation in strength values of these rocks give some interesting perceptions relating to their differences in texture. The important textural features controlling strength of rocks include grain size and shape, nature of the grain boundaries, arrangement of grains, preferred alignments and recrystallization features. Fractures generally propagate through connecting grain boundaries of minerals in coarse grained rock. However, recrystallization of minerals along boundaries has a pronounced positive effect on strength of granites. It expressively opposes the applied stress for a longer period which eventually raised the strength of rocks. All the mentioned features collectively contribute to govern rock strength and none of them is

independently recommended to apply. Degree of alteration is another limitation which needs to be considered as it is having strong negative correlation with rock strength; however, textures are more significant in describing the variation in strength of rocks with similar alteration grade.

Mantle convective dynamics and mixing processes across scales

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The diversity of basalt samples collected at the surface of the Earth suggests that the underlying mantle rocks are heterogeneous at all scales. While part of these heterogeneities can be attributed to the constant processes of differentiation and recycling, several geochemical signatures indicate the preservation of primordial material over several billions of years. The survival of different types of heterogeneities in a vigorously convecting mantle is directly related to the efficiency of convective mixing over geological times. Such a link highlights the importance of understanding the mixing process for the interpretation of geochemical data. It is generally accepted that the large-scale motions of tectonic plates is the main mechanism of mantle homogenisation. Yet, the chemistry of lavas from different mid-ocean ridges vary considerably. This variability is often small in areas where plate velocities are high (10 to 20 centimeters per year), which is explained by an efficient mixing due to plate motion. However, slow spreading centers such as the Southwest Indian ridge, are also associated with a homogeneous geochemistry, which is incompatible with mixing induced purely by tectonic plate motion. To elucidate this paradox I will present a series of numerical experiments that systematically study the influence of mantle dynamics, controlled by the size and the speed of tectonic plates, on mixing efficiency in the vicinity of mid-ocean ridges. These experiments reveal the central role of the so-called "small-scale" convective motions, which gradually develop underneath ageing tectonic plates, on the mixing of mantle heterogeneities.

Deglaciation-induced reactivation of deep-seated faults in southern Denmark – an example of temporary tectonic instability in the early Holocene

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Denmark is today a tectonically stable area with earthquakes rarely exceeding magnitude 4. However, using high-detail LiDAR data we have found evidence of an early Holocene tectonic event that created large surface deformations of a Late Weichselian outwash plain in southern Denmark. This tectonic event appears to have been of a significantly larger scale. We have found pronounced elevation changes along km-scale lineaments, frequent changes in slope orientation and magnitude, and we have also found areas lying higher and lower than the expected. In addition to this, borehole data and geophysical data show depressions of up to 16 m below the expected surface level of the outwash plain. The deformations are found above the Tønder Graben structure, leading us to conclude that deep-seated faults were reactivated after the formation of the outwash plain. Dating of samples from an 8-m depression showed that sedimentation did not start before early Holocene; 9,000 years after the ice sheet had retreated from the area. We interpret the tectonic deformations to be related to the deglaciation phase, and as the present-day streams show highly angular patterns we interpret the tectonic event to have been short-lived. We interpret the tectonic event as the result of a combination of release of tectonic stress (plate motion) suppressed by the weight of the ice sheet, and glacio-isostatic recovery involving elastic flexing of the lithosphere and viscous flow in the

mantle. The weight relief from the ice during the deglaciation phase thus temporarily induced unstable tectonic conditions, causing reactivation of pre-existing fault zones. Although the vertical deformations related to deglaciation-induced tectonics are rather small, the impact on the erosion and sedimentation patterns may be larger than previously thought. Deglaciation-induced tectonics has probably been recurrent throughout the Quaternary and is therefore likely to have affected the same areas more than once.

Late Pliocene–to–early Pleistocene Mediterranean Outflow Waters in the N.E. Atlantic: Where? When? Forcings and Implications of Change?

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Late Pliocene changes in the advection of distal derivates of Mediterranean Outflow Waters (MOW) were reconstructed on orbital timescales for Northeast Atlantic DSDP/ODP Sites 548 off Brittany and 982 on Rockall Plateau and compared to West Mediterranean deep-water records of Alboran Sea Site 978 (Khélifi et al., 2014). Neodymium isotope (ϵNd) values more positive than -10.5/-11 reflect diluted MOW that spread almost continuously into the Northeast Atlantic between 3.7 and 2.55 Ma, reaching Rockall Plateau from 3.63–2.75 Ma. Minima in MOW occurred at 3.7–3.64 and 2.75–2.67 Ma, short-lasting maxima near 3.63, 3.15–3.1, and 2.8 Ma. On the basis of Mg/Ca and δ18O of epibenthic foraminifers we estimated changes in MOW temperature, salinity, and density. Oscillations of five-point running average records from 3.6–2.9 Ma are closely coherent at more proximal Site 548 and distal Site 982, thereby lending major support for the significance and robustness of these records. From 3.4–3.3 Ma they increased by 2°–4°C, $\sim$1 psu, and >1.5 kg m-3, resp¬ectively, in harmony with a coeval increase in sea surface salinity and deep-water density at Mediterranean Site 978 and increased summer aridity (Fauquette et al., 1998). The origin might be linked to a major switch in the Indonesian subsurface throughflow culminating at 3.4–3.27 Ma and resulting in a slight cooling of the equatorial Indian Ocean (Karas et al., 2009). The rise in Mediterranean salt export may have led to rising Upper North Atlantic Deepwater formation. With the onset of major Northern Hemisph¬ere Glaciation after 2.95 Ma (MIS 17) bottom water temperature, salinity, and dens¬ity records of sites 548 and 982 followed independent trends, since the MOW signal at Rockall Plateau was increasingly suppressed by that of Upper North Atlantic Deep Water.

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New techniques to create a 3D structural model of the deeper underground in the North German Basin in Lower Saxony

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A nearly statewide 3D structural model (GTA3D, Bombien et al. 2012), based on the Geotectonic Atlas of Northwest Germany (GTA, Baldschuhn et al. 1996, 2001), exists for Lower Saxony. As described in Bombien et al. (2012), the GTA3D is an implementation of digitized data from the GTA, modeled with Paradigm® GOCAD® and stored as triangulated surfaces. In the final GTA3D model, there are inconsistencies originating from either the digitized contour maps of the GTA or the modelling process itself.

As advancements in 3D modelling technology take place, existing modelling techniques and workflows are examined and adapted to the new options available, when appropriate. In the TUNB3D-NI project we intend to use state of the art modelling technology to enhance the existing model. We will include two additional horizons and complete the model for the missing regions. To achieve this, we study how to make good use of the functionalities provided by the latest version of Paradigm® SKUA-GOCAD® 14.1 to build a consistent 3D structural model for the project area. This includes testing the Structure & Stratigraphy Workflow to create volume models using input data taken directly from GTA3D. Later on we will incorporate seismic and borehole data in the model. The ultimate goal is to obtain topologically correct triangulated surfaces for each geological layer.

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Three-dimensional analysis of highly porous building and ceramic materials with computed tomography (CT) on laboratory X-ray diffractometers

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Poster in Session B6-01

The amount of porosity as well as the type, size, connectivity and three-dimensional distribution of pores are among the most important features in building and ceramic materials. They determine their properties (e.g. surface area, permeability, heat transport or strength), their field of application and also their quality and have to be observed and adjusted throughout the development and manufacturing process. Computed tomography (CT) offers the possibility to analyze and visualize these features in a fast and non-destructive way through three-dimensional virtual reconstructions of the samples. To show the capabilities and advantages of high-resolution CT on laboratory X-ray diffractometers for highly porous building and ceramic materials, various kinds of samples, including autoclaved aerated concrete and Al_2O_3 ceramic foams for catalyst support with different pore sizes were investigated and partly compared to conventional imaging analysis techniques based on thin sections. A PANalytical Empyrean X-ray diffraction instrument in CT mode, equipped with a GaliPIX3D detector, was used for the measurements and Volume Graphics VGStudio MAX for reconstruction and analysis tasks. The results show that the parameters mentioned at the beginning can be determined, analyzed and visualized through CT measurements done on a laboratory X-ray diffractometer. Additionally, it is possible to obtain information about the material itself, like thickness of the cell boundaries or variations in the composition of the material within a three-dimensional context. These results, that are exemplary for a wide range of materials, can be achieved by a trained individual in less than three hours per measurement / sample with the described method and clearly show the potential for many fields, ranging from materials research and development to quality control during the production process.

Understanding the effect of seismic uncertainty on geological models

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Seismic information is a common and yet important source of information about spatial continuity at depth. We discuss here general sources of uncertainties in seismic data, especially with respect to the construction of 3-D structural geological models, which are then a basis for subsequent process simulations. Several methods to estimate uncertainties in geological models have been developed in recent studies, often combining implicit geological modeling with Monte Carlo simulations of error propagation. In this study we investigate the effect of uncertainties in geological contact and orientation data points taken from seismic sections. This is of interest for all cases where legacy data has to be considered, as often in the construction of regional scale models. We consider here specifically uncertainties in the time-depth conversion step and present a method to investigate the propagation of these types of structural uncertainties. As a test of feasibility, we apply our workflow to study a regional-scale geological model of the Gippsland Basin, Australia. We perform an analysis for a previously constructed 3-D geological model and re-evaluate model uncertainties. This model contains limited local information about layers at depth in wells, but deep structures are mainly interpreted on the basis of two regional-scale seismic sections. We investigate here how uncertainties in these seismic sections affect the overall model uncertainty and compare our results to a previous estimation of spatial uncertainty using information theoretic measures. We show how, and where, our approach helps to identify areas of uncertainty in better detail than a pure random sampling. Our results suggest that it is possible to consider the effect of seismic uncertainties in regional-scale geological models. Future work will incorporate the effect of additional types of seismic uncertainties to provide a more complete estimate of the effect of seismic uncertainties on geological models.

Testing causes of Andean flat slab subduction in an absolute plate motion frame

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Oral in Session A1-06

The Andes is the longest continental mountain range on Earth with a length of ~7500 km extending through seven countries. It formed through shortening of the overriding South American Plate, which is coupled to the subducting Nazca plate due to the westward absolute plate motion of South America since the Eocene. Below the Andes, the Peruvian and Pampean flat slab segments are subducting under South America over a ~300 km distance since ~11 Ma. The cause of flatslab subduction is hotly debated. Most infer positive buoyancy of a locally thickened oceanic crust that resists subduction as the main cause. Formation of the Andes has been regarded in the light of absolute plate motions but flat slab subduction in combination with rollback has not. To investigate the cause of flat slab subduction in an absolute plate motion context, we have kinematically restored the Andes and reconstructed relative motions between the downgoing plate, overriding plate, trench, slab bend and mantle in a moving hotspot reference frame. Assuming that at the onset of formation of the Andes no flat slabs were present, a minimum amount of absolute westward motion of the slab bend (i.e. rollback) and the trench (i.e. trench-retreat) has been estimated. We show that the Nazca slab has rolled back ~800 km in the flat slab segments, and ~1100 km elsewhere. We further show that since onset of flat slab formation, the amount of subduction was thrice as much as the width of the flat slab, thus, a

positive buoyancy of oceanic crust cannot be the direct cause for flat slabs. Rather, we infer that during the formation of flat slabs the slab rollback rate was lower than the trench migration rate. We therefore suggest that flat slab subduction is the result of resistance against slab rollback rather than resistance against subduction. Our study highlights the role of absolute plate motion and mantle flow in forming the Andean flat slabs, with likely a subordinate role for subducting lithosphere structure.

Climate-change versus landslide origin of fill terraces in an arid bedrock landscape: San Gabriel River, CA

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Fill terraces along rivers represent the legacy of aggradation periods that are most commonly attributed to climate change. In the North Fork of the San Gabriel River, an arid bedrock landscape in the San Gabriel Mountains, CA, a series of prominent fill terraces were previously related to climate-change-induced pulses of hillslope sediment supply that temporarily and repeatedly overwhelmed river transport capacity during the Quaternary. Based on field observations, digital topographic analysis, and dating of Quaternary deposits, we suggest instead that valley aggradation was spatially confined to the North Fork San Gabriel Canyon and a consequence of the sudden supply of unconsolidated material to upstream reaches by one of the largest known landslides in the San Gabriel Mountains. New 10Be-derived surface exposure ages from the landslide deposits, previously assumed to be early to middle Pleistocene in age, indicate at least three Holocene events at ~8-9 ka, ~4-5 ka, and ~0.5-1 ka. The oldest and presumably most extensive landslide predates the valley aggradation period, which is constrained by existing ^{14}C ages and new luminescence ages to ~7-8 ka. The spatial distribution, morphology, and sedimentology of the river terraces are consistent with deposition from far-travelling debris flows that originated within and mined the landslide deposits. Valley aggradation in the North Fork San Gabriel Canyon therefore resulted from locally enhanced sediment supply that temporarily overwhelmed river transport capacity but the lack of similar deposits in other parts of the San Gabriel Mountains argues against a regional climatic signal. Our study highlights the potential for valley aggradation by debris flows in arid bedrock landscapes, provided sufficient supply of loose material, such as downstream of landslides that occupy headwater areas.

A numerical and analogue study of dike ascent in asymmetric continental rift zones

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In continental rift zones, tectonic extension generates deep topographic depressions, typically graben or half-graben structures, confined by large border faults. Volcanism may be distributed within, at the border and outside of the depressions, and the mechanisms controlling this distribution are debated. Recently, Maccaferri et al. (2014) proposed that the reorientation of the principal stresses linked to crustal thinning and overall crustal mass redistribution in rift zones modifies the expected trajectory of ascending magma pockets and plays a fundamental role in the distribution of volcanism at the surface. However, the model does not explain why volcanism is asymmetric in most continental rift zones. The goal of this study is to investigate the relation between the characteristic distribution of volcanism at the surface, the distribution and geometry of magma storage at depth, and the observed geometric asymmetry of the grabens at most rift zones. By using a boundary element model for dike propagation and analogue laboratory experiments we evaluate the ascent path of magmatic dikes in asymmetric continental rifts. Introducing asymmetry of various degrees into the models has a large impact on the modeled location of the surface volcanic activity. A density distribution investigation lets us conclude that shallow and narrow graben as well as deep and wide graben lead to more scattered volcanism than a mix of the mentioned scenarios. This is true for both sides of the rift. We also investigate the decompression due to mass redistribution and see that below the deep side of the graben a strong decompression is generated, which coincides with the expected region of sill formation. Thus, we expect melt accumulation at exactly that location. By incorporating this result with the expected trajectories, we conclude that volcanic activity is expected at the deep side of the half-graben.

Landscape response to millennial-scale climate forcing from fluvial fill terraces: Humahuaca Basin, NW Argentina

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Oral in Session A6-02

Millenial-scale climate shifts have been linked to fill terrace formation, making them promising features for recording landscape responses to climate change. Within the southern Central Andes, periods of high insolation on precessional timescales have been characterized by increased precipitation, and in some places also increased landslide activity. The Humahuaca intermontane basin parallels the eastern margin of the Puna Plateau. Fill terraces along tributaries to the trunk stream yield OSL dates between $\sim$30 and 120 ka. Curiously, aggradation on the west side of the basin correlates with periods of increasing precipitation, while on the east side, it correlates with decreasing precipitation. Yearly rainfall and lithology across the basin are similar, but the tributary geometries differ, with the east side containing perched sedimentary basins and narrow bedrock gorges, while the west side has a simpler morphology. From modern tributary sediments, cosmogenic 10Be-derived denudation rates from pebbles are 1.2 to 4x higher than those from sand, reflecting the importance of landslides today. From terraces on the west side of the valley, paleo-denudation rates are higher than those from modern streams with very high scatter, which may reflect a greater importance of landslides during aggradation. In contrast, on the east side, paleo-denudation rates overlap with modern rates. We suggest that landslides are triggered throughout the landscape when precipitation increases, inducing aggradation on the west side. But, along the east side, landslides block the narrow gorges, causing sediment to remain in the perched basins. During drier periods with reduced landslide frequency, the gorges are cleared of their blockages and sediment exits the eastern tributaries. Such behavior at an orogen-scale could attenuate or mask landscape responses to climate forcing in sedimentary archives.

Decorative Stones in Berlin: Monument Conservation and Public Education

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In the architecture of Berlin decorative stones are essential and very diverse. In the course of history various rulers had their attractive residences built and citizens added their houses, more modest, yet collectively also rich and varied in stones. Since there are only very few natural deposits in the surroundings of Berlin, from early on increasingly more types of stone were imported from various regions depending on the respective means of transport and several other factors including politics. For conservation and reconstruction of historical monuments geoscientific assistance is needed with identification of the stones originally used, with information on their availability and/or advice with respect to suitable alternative material where necessary. While more often large-sized building elements are concerned, occasionally even mm-scaled pieces require attention, as in the case of terrazzo floors in the "Neues Museum". Further, identification of stones is prerequisite for activating their potential in public geoeducation. In a field guide to decorative stones along the central east-west axis of Berlin 233 types listed by trade names are located (Schroeder, ed., 2006); meanwhile developing further routes in Berlin more types were added to the list. Guided tours successfully draw interest and communicate the knowledge about the stones to a broad audience, from children to senior citizens, from persons professionally concerned such as architects or stonemasons to enthusiastic laypersons. Since 1996 more than 7000 participants joined stone-tours along 30 separate routes in various parts of Berlin.

A novel sediment coring instrument combining classical piston corer with hydraulic downhole hammer

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Poster in Session C5

The recovery of several 10 to several 100 m long, high-resolution records of excellent core quality through ocean and continental scientific drilling has played a very important role in advancing our knowledge in climate and environmental dynamics. There is an urgent need to further develop drilling and sampling capabilities and to acquire and analyze (ultra-)high resolution geological records of past environmental conditions and changes. A striking gap in drilling technology exists for the recovery of especially lacustrine sediments from ∼20 to 100 plus meters depth. Standard piston coring techniques have provided sediment cores down to 30 m whereas longer sediment cores can only be recovered by deploying very cost intensive mining-style wireline diamond coring or similar techniques. A new coring device has been designed and tested that combines state of the art high quality, continuous piston coring with a downhole hydraulic percussion system. The latter is utilized to provide impact force directly atop the coring system and therefore minimizes losses of energy over longer coring/rod distances. The coring device has a small footprint and is mounted on a highly mobile barge providing floatation. The system is modular and highly flexible. Lake environments, shallow estuaries or other drillsites with limited accessibility and no infrastructure can be drilled/sampled with this lightweight, yet powerful equipment. The sediment archives recovered with this tool will allow researchers to better understand why and how the climate system has been responding rapidly to external and internal forces and how the various high frequency oscillations of the climate system interact over longer time intervals.

Mico-CT analysis of Archean microbial mats

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Poster in Session A4-05

The biological formation of free oxygen during the Late Archean followed by the Great Oxidation Event (GOE) resulted in a transformational change of earth's geochemistry and life's evolution. Although it is undisputed that cyanobacteria were the first and only organisms that evolved oxygenic photosynthesis, it remains unclear when this metabolic ability emerged. The study of microfossils, biomarkers, and isotopic signatures, all in the context of their paleoenvironments, suggests that free oxygen was produced long before the GOE. In order to substantiate the notion of an early evolution of oxygenic photosynthesis, we compared the three-dimensional morphology of the 3.2 Ga-old fossil microbial mats from the Moodies Group, Barberton Greenstone Belt, South Africa with modern photosynthetic microbial mats from Bahar Alouane, Tunisia. Here we present micro-CT analysis of the tufted Archean microbial mats and demonstrate their high degree of morphological similarity with their modern counterparts from Tunisia. If, as is frequently suggested, morphological attributes of microbial mats correlate with their metabolism, such as tufts being indicative of phototropism, further morphometric studies of Archean mat communities may hold the key for unlocking their ancient metabolisms.

Cryo-BIB-SEM and Wood's Metal Injection to image pore morphology, pore connectivity, and fluid distribution in hydrocarbon bearing rocks

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Imaging of the pore space by using Broad Ion Beam (BIB) milling and Scanning Electron Microscopy (SEM) allows accurately imaging of the pores at nanometer scale resolution on a relatively large area in mudstones. From the mm2 size sample area we can obtain the mineral porosity by combining the SE, BSE and EDX detectors using various image processing techniques. It is found that the pore sizes follow a power-law behaviour from the micrometer down to the nanopore scale range (Houben et al. 2013). Combining BIB-SEM with Wood's Metal Injection (WMI) enables to visualize the preferred transport pathways and determine the controlling pore throat diameter. The WMI experiments followed by BIB-SEM illustrated the significant effect of fractures on transport pathways and the low connectivity of the clay-rich matrix in mudstones (Klaver et al. 2015). BIB-SEM under cryogenic conditions allows direct study of the oil-water-mineral system in hydrocarbon-bearing reservoirs, at resolutions of 10 nm. We quenched sandstone reservoir samples, equilibrated with oil and brine, to liquid nitrogen temperature and subsequently sectioned them using BIB-cutting under cryogenic conditions (Schmatz et al. 2013). The flat cross-sections with dimensions of 1 mm^2 allow cryo-SEM imaging of oil-brine-mineral interfaces, with high-resolution EDX-mapping for phase identification. 3D-reconstruction of capillary contact angles is done using serial sectioning with a distance of 1 μm. Our results call for improvements in models of multiphase pore-scale flow in digital rocks. Further anticipated applications of the method are i. a. the investigation of pore-level mechanisms of EOR or aging processes; the investigation of oil-sands,

gas-hydrates, and other sensitive or wet materials; or the investigation of in-situ fluid distribution reservoir- sandstones and carbonates.

Raman spectroscopic determination of sulfur species concentrations in aqueous solutions

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Raman spectroscopy is one of the few techniques that can be applied to determine the speciation of sulfur in aqueous solutions, including in situ experiments at the pressure-temperature conditions of subduction zones. This requires knowledge of relative scattering cross sections of Raman bands of sulfur species and water. Very little information can be found in the literature on relative cross sections of Raman bands of the reduced species S_3^-(aq), other polysulfides, H_2S(aq), and HS^-(aq), and such information on oxidized sulfur species is often only applicable at specific instrumental and analytic conditions. We determined ratios of relative molar scattering factors at 22 °C and 0.1 MPa for the Raman bands of H_2S(aq) at ~2590/cm, HS^-(aq) at ~2570/cm, SO_2(aq) at ~1150/cm, HSO_4^-(aq) at ~1050/cm, $S_2O_3^{--}$(aq) at ~445/cm, the bending mode of H_2O at ~1640/cm and the O–H stretching band of water at ~3400/cm to the relative molar scattering factor for the Raman band of SO_4^{--}(aq) at ~980/cm. In addition, we assessed this ratio for the Raman band of the high-temperature species S_3^-(aq) at ~535/cm from experiments up to 600 °C and 1.36 GPa using a hydrothermal diamond-anvil cell. The ratios were obtained for the excitation wavelengths 473 and 532 nm. To facilitate applicability in other laboratories, the ratios were based on spectra corrected for the response function of the spectrometer, the frequency and scattering factor, and the Bose-Einstein factor plus one. In addition, the spectra were normalized to fluid density, accumulation time and laser power. Experimental data for a H_2SO_4 solution suggested a significant decrease in the Raman scattering cross section of the band of HSO_4^-(aq) at ~1050/cm with temperature at elevated pressure, which still needs verification. Our results permit quantification of the sulfur speciation in aqueous geological fluids by Raman spectroscopy.

The Impactite collection at Museum für Naturkunde Berlin

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The Museum für Naturkunde Berlin houses more than 30 million collection items in its zoological, paleontological, and mineralogical-petrological research collections. Petrographic samples are stored mainly in the Rock and Ore Collection with about 70.000 samples subdivided into several specific sub-collections. One of these is the Impactite collection, which comprises shocked rocks, impact breccias, suevites, impact melt rocks, tektites, and other distal impact ejecta, as well as unshocked target rocks from impact structures around the world. The collection is strongly associated with the section "Global Catastrophes" within the Science Program "Evolution and Geoprocesses" of the Museum. The Impactite collection was established in 1994 by Dieter Stöffler, and combines samples from his personal research collection build up during his work at the universities of Tübingen and Münster, with samples already available in the petrographic collections of the Museum, especially tektites. There is a continual growth of this collection due to research projects at several impact structures. The Impactite collection hosts around 4,500 samples arranged in geographical order, contains samples from 72 of the worldwide known 186 impact structures, and is among the largest collection of its kind worldwide. The main focus is on European impact craters, and especially the Nördlinger Ries in southern Germany, which is represented by 1,138 samples. Nevertheless, there are also numerous samples from American, Asian, African, and Australian impact craters available. Notable are the samples from the Araguainha impact structure in Brazil (mainly collected by Wolf von Engelhardt in 1984 and 1988, and donated by the University of Tübingen in 2012). The samples of the Impactite collection are completely databased, which allows fast access for dealing with inquiries. The collection serves as a research and public outreach tool, and samples can be leant for research and/or exhibition purposes.

Are mafic and ultramafic rocks from the lower Onverwacht Group (Barberton Greenstone Belt) crustally contaminated?

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Mafic to ultramafic rocks in the lower Onverwacht Group of the Barberton Greenstone Belt (South Africa) have been considered to be representative of typical early Archaean oceanic crust. However, it is proposed that older felsic crustal material was involved in their petrogenesis, which is based on heterogeneous Hf-in-zircon isotopic compositions in felsic volcanic rocks interlayered with mafic units of the Onverwacht Group [1]. Likewise, the Hf-in-zircon isotopic compositions of some adjacent Eoarchean rocks of the Ancient Gneiss Complex (Swaziland), possibly representing a basement to the lower Onverwacht Group, also show significant input of older crustal material in their genesis [2]. Hf-Nd isotope and trace element analyses, performed on the oldest rocks of the lower Onverwacht Group, namely the Theespruit, Sandspruit and Komati Formations (3.46 to 3.53 Ga. Our first results show that initial Hf isotope compositions are near chondritic to slightly depleted (ϵHf(t) = 0 to +3.5). The results for the Sm-Nd isotope compositions are somewhat different. Initial Nd isotope compositions are also near chondritic, but slightly enriched (ϵNd(t) = -2.2 to +1.8) which is in agreement with previous studies. Additionally, a Hf errorchron constrained based on combined own and published data for the Theespruit Fm. yield a much older age of 3749 $\pm$ 88 Ma, also hinting towards contamination of the unit. Our results either imply that (1) the oldest mafic rocks of the BGB were generated from a near-primitive mantle source without crustal contamination and the errorchron reflect disturbance, (2) melts from a depleted mantle source were homogeneously mixed with older crust of unradiogenic Hf-Nd composition, or (3) the assimilated crust was juvenile and also had a near-chondritic Hf-Nd isotopic composition.

[1] Kröner et al. (2013), EPSL 381, 188-197.
[2] Kröner et al. (2014), Precamb.Res. 258, 823-846.

Orogenetically driven weathering as major control of atmospheric oxygen during the Phanerozoic

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Atmospheric oxygen, along with carbon-dioxide, directly influences biological and geological processes on Earth. Building upon prior efforts to reconstruct paleo-atmospheric pO_2, using stable carbon isotopic ratios (δ^{13}C) of plant resins and amber, we here extend the record to 450 million years (Ma) by utilizing the δ13C of terrestrial organic matter from >4000 literature data. This new reconstruc-

tion of atmospheric oxygen indicates that pO_2 varied considerably, but has never been higher than present at any time during the Phanerozoic, including the Permo-Carboniferous for which hyperoxic conditions (~30% O_2) have been previously inferred. Most importantly, throughout much of the Phanerozoic, variations in pO_2 closely follow variations in 87Sr/86Sr of marine carbonates, implying that the processes of O_2 generation and removal are associated with those that drive Sr isotopic variability in the world oceans e.g. orogenetically driven weathering and water-rock interaction at mid ocean ridges. Therefore, the main conclusion of the observed co-variation is that pO_2 in the atmosphere is primarily influenced by the rates of continental weathering that obviously trigger the burial of organic carbon and pyrite. During episodes of increased weathering, i.e., during orogenetic cycles, more sedimentary carbon and sulfur is deposited (possibly enhanced by increased nutrient supply to the world oceans), causing a rise in pO_2. Episodes of declining pO_2, on the other hand, are primarily the result of reduced continental weathering and a reduced nutrient supply to the oceans at times of tectonic quiescence. During these episodes, seafloor alteration results in a continual removal of oxygen through oxidation and hydration processes at mid-ocean ridges. We conclude that geodynamics exert a first-order control over atmospheric oxygen during the Phanerozoic whereby the interactions of Lithosphere, Ocean and Atmosphere were the driving forces for atmospheric oxygen (LOA model).

A New Atmospheric pO_2 record allows the assessment of quantities of organic carbon deposited in episodic organic carbon burial events (OBE) during the Phanerozoic

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Poster in Session B2-03

A new reconstruction of Phanerozoic atmospheric pO_2, which is based on the $\delta^{13}C$ of terrestrial organic matter, indicates that at least four major episodes of continuous pO_2 increase occurred over the last 450 million years. Because increase of oxygen in the atmosphere must be stoichiometrically balanced by burial of carbon, the episodes of pO_2 increase indicate massive organic carbon burial events (OBE). Therefore, we can estimate the amount of organic carbon (OC) that needed to be buried in order to account for the pO_2 increases. The combined total for all four burial episodes is ~4.4x1019 moles of OC. Using the amount of bitumen in the Athabasca tar sands deposit as a measure of scale (1 AE ~1.8 x1012 barrels), we estimate the amount of OC burial during all burial events to be equivalent to ~2600 Athabasca deposits. Specifically we identify a Tertiary OBE1 (678 AE), a Cretaceous OBE2 (775 AE), a Triassic/Lower Jurassic OBE3 (484 AE) and a Carboniferous OBE4 (678 AE). The timing of the four inferred burial events coincides with the formation of economically important coal, oil, and gas deposits. However, the amount of carbon stored in known deposits is ~2-3 orders of magnitude smaller than the amount of OC burial required to account for the pO_2 changes. This suggests that the vast majority of OC buried during the Phanerozoic still remains within its sedimentary host rocks, either as dispersed material, or as undiscovered resources.

Attributes of Subducting Lower Plate Relief that Hinder (Through Roughness) and Promote (Through Smoothness) the Rupturing of High-Magnitude (≥Mw8.0) Megathrust Earthquakes

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INTRODUCTION: Wonderments have long been expressed about the influence geologic factors might have on the occurrence and non-occurrence areas of high-magnitude or great (≥Mw8.0) megathrust earthquakes. A large base of field observations, one that grew rapidly in the past 11 years, now identifies two significant factors, both involving attributes of the surface relief of the subducting oceanic plate: (1) underthrusting bathymetric roughness inhibits rupture continuation and the generation of great megathrust earthquakes (see, for example, Wang, K., and Bilek, S.L., 2014, Fault creep caused by subduction of rough seafloor relief: Tectonophysics, v. 610, p. 1–24), and, (2) underthrusting bathymetric smoothness, which favors a laterally even distribution of interplate coupling, promotes rupture continuation and the generation of great megathrust earthquakes. This 2nd factor, a conjecture first explored by Ruff (1989, Do trench sediments affect great earthquake occurrence in subduction zones?: Pure and Applied Geophysics, v. 129, p. 263–282), was un-compellingly supported by the limited number of megathrust earthquakes and accurate sediment-thickness measurements then available. SMOOTHNESS FACTOR A newly compiled, much larger base of data of thickness vs magnitude now compellingly supports the posit that great megathrusts are statistically linked to where the underthrusting seafloor is bathymetrically smooth (Scholl et al., 2015. Great (≥Mw8.0) megathrust earthquakes and the subduction of excess sediment and bathymetrically smooth seafloor, Geosphere: v. 11, no. 2, p. 236–265). Smoothing is effected, perhaps dominantly, by the subduction of a thick, (i.e., ≥1.0 km), laterally continuous (≥250-300 km) section of relief-smothering trench sediment. Where the thickness is much thinner, smoothing can be produced by the underthrusting of low basement relief and where the subduction channel containing the megathrust is significantly thickened by subduction erosion.

Progress in code development for calibration of tectonically coupled surface evolution

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While observations clearly show the influence of tectonic deformation to river networks and erosion rates, the influence of surface processes to tectonics could not be observed yet. Nevertheless, such a two-way coupling is expected and intensively studied with the aid of numerical modelling. For a proper numerical study, a calibrated surface evolution code (SEC) needs to be coupled to a (thermo-)mechanical code. This presentation focusses on the challenges faced by surface evolution calibration techniques and the consequences for the code development. In order to enhance the calibration of the SEC DANSER, changes to common SECs have been made, using empirical equations and nearing the code to observations. Wide valleys constitute a major challenge for calibration when applying a SEC to a digital elevation model. Such valleys may develop from braided streams, meanders or forth and back drifting riverbeds. Usually, SECs incise channels of exactly one cell width. Working with low resolution, small tributaries get wider, working with high resolution, just a narrow channel within a wide valley gets incised. DANSER's lateral incision routine solves this task. It spreads the channelled water discharge over the entire valley width and forces incision there. The resulting channel gets laterally smoothed and its width gets preserved. Under the influence of tectonic deformation, flooding may cause river capturing events. The coupled models in this study underline the importance of flooding events for the development of river networks. With lateral incision simulating flooding, capturing events are significantly more likely than without. In fact, without lateral incision almost no capturing events happen. To summarize, we highlight the progress for model calibration as well as for coupling results on the example of the Pamir orogen. Especially DANSER's lateral incision pushes the code development further in applying SECs to real data and in modelling geomorphological features.

The dissolution-precipitation reactions and the role of aqueous fluids in the transformation of corundum to kyanite - three natural examples on a metamorphic cycle

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Poster in Session A1-04

Aluminum-silicate minerals forming reaction rims around corundum (α-Al_2O_3) are common features in alumina-rich rocks. Mica, sapphirine, feldspar and cordierite coronae are reported in the literature, replacing corundum whenever the rock provides free silica and fluid to induce a dissolution-precipitation reaction. However, coronae of kyanite, sillimanite or andalusite around corundum are comparably rare reaction features. We investigated three samples of kyanite growth on corundum from (a) Mysuru (India), (b) Morogoro (Tanzania), and (c) Naxos (Greece) in order to understand how these structures formed under different p-T conditions. The coronae from (a) and (b) are monomineralic and display a very particular growth mechanism dependent of the precursor crystallography and the fluid pathways through the corundum host into the corona structure. Kyanite grains are elongated parallel to the basal plane of the corundum and show tabular shape perpendicular to it. The incorporation of corundum fragments into corona crystals demonstrates that the kyanite crystals grow preferentially along the fluid transport ways, such as Ky-Ky-grain boundaries and corundum twinning-glide planes. The kyanite corona from India formed during a prograde metamorphic stage and the one from Tanzania during a retrograde stage, but growth mechanism is similar. Both samples represent a fluid mediated transformation from oxide to silicate mineral in the chemically simplified system K_2O-Al_2O_3-SiO_2-H_2O. Sample (c) from Greece on the other hand demonstrates why Al2SiO5-reaction rims in this system are rarely preserved. The fluid mediating the dissolution-precipitation reaction corundum $\rightarrow$ kyanite also replaces kyanite in favor of muscovite and corundum as soon as the muscovite stability field is reached. Using the three samples a hypothetical metamorphic cycle for corundum bearing rocks interacting with silica- and alkali-bearing fluids was constructed.

Resolving the complex structure in Mediterranean microplates: The evolution of the Austroalpine Basement in the Eastern Alps

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The northern part of the Adriatic-Apulian microplate is exposed as the Austroalpine Basement (AB). It was involved in movements of Gondwana, Laurussia and Pangea continents and their disappeared oceans. The AB started its geological evolution in the northern Gondwanan periphery. Detrital zircon U-Pb-dating by LA-SF-ICP-MS in meta-siliclastic units revealed a dominant population at 600 - 700 Ma, probably delivered from the eroding Avalonian-Cadomian Belt and/or the Pan-African belts. A prominent „Grenvillian" 950 - 1050 Ma population is interpreted to have been supplied from Eastern Gondwanan source regions. Following other studies in peri-Gondwanan units, the Saharan Metacraton and the West-African craton can be considered as the sources for subpopulations at 1700 - 2300 Ma, 2550 Ma and 2750 Ma. By protolith Pb–Pb zircon ages, Ta/Yb - Th/Yb and Sr and Nd WR isotope data one can define an older active margin magmatic evolution at elevated Th/Yb. It started by 590 Ma N-MORB-type and 550 -530 Ma volcanic arc basalt type mafic suites, and finished with 470 - 450 Ma acid magmatites. A younger passive margin type magmatic evolution with 430 Ma alkaline within-plate and tholeiitic basalt-type suites could have been related to Paleo-Tethys opening. The polymetamorphic evolution in the AB has been resolved by electron-microprobe Th-U-Pb dating of monazite and geothermobarometry. A 360 - 300 Ma amphibolite to eclogite facies event was related to the Variscan continental collision. Intrusion of pegmatites accompanied a Permian thermal event at 260 Ma. The Early-Alpine collision was recorded by 100 - 80 Ma monazite, partly in eclogite facies rocks. During the Oligocene Late-Alpine collision event, the AB was thrusted upon the Penninic units belonging to the European Plate. Such detailed reconstructions of the multistage evolution in dismembered microplates are prerequisites for understanding the plate tectonic processes at larger spatial and chronological scales.

The ilmenite-pseudorutile-leucoxene alteration sequence in placer sediments in the view of automated SEM mineral liberation analysis

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The alteration of ilmenite ($FeTiO_3$) is a near-surface process which controls the economic value of Ti placer sediments, as it has an important influence on their benefication by magnetic and gravity separation. The process is characterised by in situ leaching with continuous loss of Fe and gain of OH that finally leads to leucoxene (Mücke & Bhadra Chaudhuri 1991). The alteration sequence has been established by XRD as ilmenite - leached ilmenite pseudorutile - leached pseudorutile - leucoxene. It was addressed by automated mineralogical methods based on a combination of SEM with BSE imageing and EDX analysis. Placer samples with pseudorutile were used to establish a list of typical spectra which cover the Ti-Fe compositions of ilmenite s. str. (Ti 31, Fe 36 wt%), pseudorutile (Ti 36, Fe 28 wt%), leached pseudorutile (Ti 40, Fe 18 wt%) and leucoxene (Ti 60, Fe <5 wt%). By GXMAP measurement mode with a FEI Quanta 650 FEG instrument, about 30.000 particles in polished grain mounts were analysed by narrow grids ($\sim$10 x 10 μm) of single EDX spectra. This measurement mode allows to resolve chemical heterogeneities within particles. The ilmenite alteration features are visualised in detail by relating distinct colours to the pixel areas defined by Ti-Fe spectra. Core-mantle structures with ilmenite in the cores and several successive coronas of pseudorutile followed by leached pseudorutile and then leucoxene Ti-Fe compositions toward the rims are abundant. Leucoxene $(TiFe)_3O_6(OH)_6$ cannot be properly distinguished from rutile (TiO_2) by EDX and XRD. As a consequence, particles with leucoxene/rutile cores mantled by pseudorutile or ilmenite-typical Ti-Fe compositions should be interpreted as preserved relics of initial magmatic or metamorphic origin. Summarising the alteration features in all Ti-Fe particles in combination with virtual particle size classing then gives indications for beneficiation concepts.

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The effect of iron content and hydration on the high-pressure single-crystal elasticity of ringwoodite derived from an internally consistent approach

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Oral in Session A4-03

Ringwoodite is the most abundant mineral in the lower transition zone. As such, its physical properties, which are a function of iron-content and hydration state, largely affect the properties of this boundary layer and its role for material flow through Earth's mantle. For example, regional variations in H_2O-content may affect mantle viscosity and thereby impact on the fate of subducting slabs. To derive information about the abundance of ringwoodite in Earth's transition zone, including potential regional variations in major chemistry and H_20-content, from seismic observations, a quantitative knowledge about the individual effects of iron content and hydration state on the high-pressure/high-temperature elasticity of ringwoodite is necessary. However, these effects are relatively small, for parameter variations as expected in the transition zone, and it is thus difficult to constrain their influence by comparing data collected in different laboratories and/or using different techniques. Here, we will discuss first results of a single-crystal elasticity study using an internally consistent approach for combined Brillouin spectroscopy and single-crystal x-ray diffraction to constrain the influence of iron concentration and hydration state on the high-pressure elasticity of ringwoodite. Single-crystals were synthesized in multi-anvil presses from either natural olivine or forsterite powders. The syntheses vary in composition from Mg_2SiO_4 to $(Mg_{0.89},Fe_{0.11})_2SiO_4$ and contain between about 0.4 wt.%H_20 and more than 2 wt.%H_20. A FEI Scios Focused Ion Beam (FIB) machine was used to precisely cut selected crystals with different compositions into 1/4-circles, which were loaded together into a single diamond-anvil cell (DAC). This approach allows to measure the full elastic tensors of ringwoodite crystals with varying compositions in a single experimental run and thereby directly quantify effects of pressure, temperature, iron-content and hydrogen-incorporation.

PANGAEA® - more than 20 years serving the Earth science community with data archiving and publication

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Oral in Session C3

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new collections, a favourite tool for modeling and synthesis. PANGAEA is a recommended repository for supplements in some hundred journals related to earth system research. Elsevier was the first publisher providing an automatic data-integration and visualization functionality that is shown next to the article on ScienceDirect. Any author can submit data via a ticket system. An editor then prepares the submitted data for import including an editorial review and check for completeness of metadata and consistency. After the import and formatting the supplement, the editor sends the DOI to the author for a proofread. Communication during the publication process is fully documented and archived. The data-DOI is used by the author in the article to point to its data supplement. An established workflow for data publications is still under an international discussion – the final step in the data publishing service of PANGAEA, provided to the scientific community since 2 decades.

Stable Vanadium isotope analyses by femtosecond LA-ICP-MS, and solution MC-ICP-MS

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Oral in Session C1

Vanadium (V) is a very redox-sensitive trace metal that occurs in nature as V^{III}, V^{IV}, and V^{V}, e.g. in a variety of ore-forming minerals like vanadates (hosting V^{V}), sulfides (e.g., patrónite: $V^{IV}S_4$), silicates (e.g., roscoelite, hosting V^{III}), and hematite, but it could also be enriched in black shales and magmatic rocks [1, 2]. Hence, V isotope compositions may provide valuable information for source fingerprinting and redox-controled processes during formation of V-rich hosts. This, however, has not yet been constrained. We present the first in situ V isotope analyses of several natural V minerals conducted with both femtosecond-laser ablation-high resolution and solution-HR-MC-ICP-MS. Analyses of V isotopes are challenging because of a very high $^{51}V/^{50}V$ (~400), and isobaric interferences of ^{50}Cr, ^{50}Ti, and $^{36}Ar^{14}N+$ on the low-abundant ^{50}V during ICP-MS analyses. Thus, laser ablation-ICP-MS analyses are limited to minerals with high V and low Ti and Cr contents. For mass bias control, a Fe standard was employed. For solution-ICP-MS, the V fraction was purified with a slightly modified method after [3], quantitatively removing isobaric interferences of Cr and Ti. The $\delta^{51}V$ values were determined via standard-sample bracketing, using pure V metal as standard. First results indicate a significant variation of $\delta^{51}V$ values between the analyzed minerals, ranging from –0.1 to –1.1‰ (2s.d.: 0.2‰). This spread is significantly larger than reported for peridotites and MORBs, and also exceeds the difference for $\delta^{51}V$ between the bulk silicate Earth and the meteorite average [see 3]. The extended range of $\delta^{51}V$ values suggests dissolution and/or reprecipitation processes due to redox variations, and demonstrates that V isotopes provide a new means for research in low-temperature environments.

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First steps towards a 3D structural model of the Southern Baltic Sea, Northeast of Rügen Island

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Poster in Session C6

The development of a 3D structural model of the subsurface of the southern Baltic Sea area is the target of the research project USO ("Untergrundmodell Südliche Ostsee"), which started in 2012 as corporation between the University of Greifswald and the Geological Survey of Mecklenburg-Western Pomerania, financially supported by Central European Petroleum Ltd. (CEP). In the NE of Rügen Island, numerous offshore seismic profiles have been measured by the joined research group "Petrobaltic" (1970ies-1980ies). A partial re-processing was done during the research project SASO ("Strukturatlas südliche Ostsee") in the 1990ies, and recently by CEP. The north-eastern working area comprises complex geological successions since the Proterozoic whose deposition was among others influenced by the Caledonian Orogeny, represented by the Rügen Caledonides (an accretionary wedge between Baltica and Avalonia) or the Tornquist Fan. Permian to Cretaceous strata represent the evolution at the north-eastern margin of the North German Basin. Tectonical movements triggered the generation and re-activation of faults during the Mesozoic, which led to the formation of complex fault systems, like the Adler-Kamien Fault System (western faults of the Tornquist-Teisseyre Zone) or the West Pomeranian Fault System. All the available seismic and borehole data were integrated and illustrated within a GIS project. 150 re-processed profiles (about 3120 km length) and the offshore wells with logs G14, H2, H9 and K5 could be analyzed with the "SeisWare™" software package. Important marker horizons and tectonic structures like fault systems were picked along the 2D-lines with regard to the well informations. The triangulated faults crosscutting gridded marker horizons were firstly imaged using the "SeisWare - 3D Visualizer". In a next step the program MOVE™ (Midland Valley) was used to restore single 2D-cross-sections and continue modeling.

Comparison between the Marienberg-Pobershau, Seiffen-Hora Sv. Kateřiny and Ehrenfriedersdorf-Geyer Sn-polymetallic districts and their potential for tin resources

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Poster in Session B1-04

The Erzgebirge-Krušné hory is one of the most important rare metal provinces in Europe with an 800 years history of mining and a wide spectrum of commodities (Sn, W, Li, Mo, Ag, Cu, Co, Bi, Pb, Zn, Au, fluorite, barite, U, and In and Ge as byproducts). The old mining districts Marienberg-Pobershau (MBG-POB), Seiffen-Hora Sv. Kateřiny (SEIF-KTY) and Ehrenfriedersdorf-Geyer (ED-GEY), located in the central Erzgebirge, were important Sn, Ag, and Cu producers until the end of the 19th century and have a significant potential for tin, tungsten and indium resources. Two main sub-stages of the Sn-W-polymetallic mineralization can be distinguished: (1) Li-mica-bearing Sn-greisen-/vein-type with quartz, topaz, protolithionite, fluorite, apatite, cassiterite (with columbite inclusions), wolframite, arsenopyrite/löllingite, and molybdenite (Pobershau, Marienberg/SW, ED-GEY); (2) chlorite- and sulfide-bearing Sn-greisen with chlorite, fluorite, topaz, quartz, cassiterite, arsenopyrite, and In-Cd-enriched sphalerite with chalcopyrite and stannite diseases (SEIF-KTY, northern MBG-POB, northwestern ED-GEY). The Sn-B-As succession is probably the oldest stage of late-Variscan Sn-polymetallic association. In the central part of ED-GEY the tourmaline-chlorite-sulfide veinlets crosscut LD1-type lamprophyres. Two generations of F-enriched aplites and microgranites with post-LD1 age show pre- and post-Sn-B-As ages. In MBG-POB the tourmaline-quarz-chlorite-arsenopyrite-cassiterite-wolframite mineralization (Sn-B-As) show a maximum in the Wolkenstein-Lauta area and indicate possibly hidden Sn-polymetallic mineralization below the deepest mining and exploration levels. The high potential for Sn resources in

MBG-POB is indicated by significant similarities of different mineralization stages (Sn-B-As, W-As-Sn, Sn-Li-F) in geological, structural, mineralogical, geochemical, and fluid inclusion characteristics and in relative and absolute ages to the Sn-W-polymetallic association of ED-GEY.

Thermal Treatment of Ultra-High Performance Concrete

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Oral in Session B6-01

Ultra-high performance concrete (UHPC) is characterized by outstanding compressive strength of more than 150 MPa, double of normal concrete. Furthermore UHPC has a very dense structure which leads to an extremely low permeability for fluids resulting in with a very high durability. Further structural improvement can be achieved with thermal treatment of UHPC. Recent studies have shown that an increase in compressive strength of more than 50% is possible. Nevertheless, the accurate conditions for an optimal thermal treatment are still not determined. A multitude of parameters can be varied: Temperature, pressure, water saturation, duration of the process steps. Primary object of this study is the optimization of the conditions for thermal treatment focused to the treatment duration at a defined temperature and pressure (185°C / 1,1MPa). Therefore, the thermally treated UHPC samples are analysed by mean of mechanical properties and phase composition. The development of phases and strength at higher temperature differs fundamentally from other cementitious systems (like normal concrete or autoclaved aerated concrete), although the chemical composition is similar. Because of the very dense structure and the low water/cement ratio the availability of water is low. This influences the hydration process. As a consequence tobermorite is absent in thermal treated UHPC in contrast to thermally treated normal concrete or predictions based on thermodynamic modelling.

Brandenburg 3D - delivering geological information to the public

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Poster in Session C6

To foster the public discussion on topics like geothermal energy, underground storage or fracking, it is indispensable to present geological information comprehensible to the public. For this, geological 3D-models are one possibility. In addition they can be used as a basis for decision-making on questions concerning the utilization of the subsurface. Within in the project Brandenburg 3D (B3D) the geological survey of Brandenburg started digitizing its predominantly analog archive inventory and developing a new 3D model as well as an infrastructure node to integrate all geological and spatial data within the Spatial Data Infrastructure Brandenburg and provide it to the public through an interactive 2D/3D web application. The geological 3D model of Brandenburg includes the most important regional seismic horizons, along with a large-scale fault-network and a detailed Zechstein-salt surface as well as the basing data inventory i.e. more than 20.000 km seismic profiles und 880 stratigraphic well logs. All data are stored in a new data infrastructure build of Free and Open Source Software, including databases and customized interfaces. A publishing tool allows the publication of approved 2D and 3D data sets to a web server that in turn provides it through OGC services to the web. To make the results of B3D available to external users, the web portal "Brandenburg 3D" provides a 2D- and a 3D-viewer (based on WebGL) with components typical of a WebGIS like an overview-map and a layertree. Within the 3D-Viewer it is possible to move freely within the model and to interact with the data. A central feature is the possibility to create hypothetical boreholes or cross-sections at any arbitrary position within the model and also at the map. All data can be exported as KML, X3D or PDF. Due to a legal dispute, the web application is currently not available for the public, but is still used by our employees. The project was funded by the European Fund for Regional Development.

A new sample holder for fast xrd investigation on uhpc

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Poster in Session B6-01

Powder X-ray diffraction (XRD) is a time consuming and challenging task, in particular if a comprehensive series of experiments have to be investigated. The quality and significance of the resulting diffractogram is strongly dependent on the kind of preparation, e.g. type of mill, grain size, packing or ordering of the grains, besides the technical issues of XRD. In principle, preparing a fine grained powder is required to achieve good statistics of every crystal orientation, if the starting material is a coarse aggregate concrete. Fine grained concrete like ultra-high performance concrete (UHPC) with average grain size <50 μm could be investigated straightly without milling. In this study, small UHPC cylinders were investigated with different preparations methods (milling and cutting or grinding with water or petroleum). Powders were measured in the conventional manner, while solid cylinders were investigated with the new designed sample holder. The results show a significant influence of the preparation on the susceptible phases like portlandite and ettringite. Besides difference in phase content, good counting statistics and a low signal to noise ratio were achieved. Finally, the new designed sample holder provides a reliable and fast method of investigation fine grained concrete without time consuming preparation.

Lithospheric strength variations across the Kenya Rift region as constrained by data-driven 3D gravity and thermal modelling

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Tectonic deformation is largely controlled by the strength of the lithospheric plate. Predictions on the rheology of the lithosphere, in turn, require knowledge about lithological variations and the thermal configuration of the plate. To better understand the relationships between strength variations and tectonic observables (seismicity, volcanism, fault distribution etc.), we investigate the present-day thermal and mechanical state of the lithosphere in a tectonically active region, the Kenya Rift. To assess lateral strength variations in the lithosphere of Kenya, we follow a stepwise data-driven approach. The lithospheric density configuration is constrained by 3D gravity modelling and a simultaneous integration of multi-disciplinary data such as surface geology, borehole, reflection and refraction seismic data, and seismological observations. According to differences in lithology, compaction state, and hence density configuration, we differentiate the sedimentary and volcanic cover of the crystalline crust into six depositional domains. P-wave velocities and gravity-constrained densities indicate that both the upper and the lower crustal units show a general west-to-east trend towards denser and more mafic rocks. We interpret these results in terms of lithologies and assign corresponding thermal properties (heat production and thermal conductivity) to calculate the lithosphere-scale 3D conductive thermal field across the region. Finally, we discuss how far the assessed variations in lithology and temperature find their expression in the integrated strength of the lithosphere.

Big Data Analytics Research at the GFZ German Research Center for GeoSciences

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Oral in Session C3

Variety, velocity, volume, value, and veracity define the specific characteristics of big data (5V). Geo-scientific data comprise all 5V, thus, it is difficult to support the analysis of this data using existing information technologies. Our close collaborations with the geo-scientists at the German Research Center for Geosciences GFZ have shown us that many geo-scientists struggle with two technological challenges of geo-scientific data: the integration and extraction of relevant information from big geo-scientific data. Big Data Analytics is a new earth science informatics research field at the GFZ German Research Center for GeoSciences. The aim of this coordinated approach is to achieve a broad and deep understanding of the analytical requirements of heterogeneous geo-scientific data to future information technology. Big Data Analytics focuses on the development of novel methods in three research areas: (a) intelligent data preparation and integration of geo-scientific data (b) scalable data analysis methods for big geo-scientific data and (c) the combination of interactive visualization and knowledge discovery methods to support interpretation of data and analytical results. Big Data Analytics research at GFZ combines the domain expert knowledge with novel information technology from computer science such as cloud computing, knowledge discovery and data mining, and visual analytics. It identifies capes between domain expert knowledge and current information technologies, addresses these challenges in interdisciplinary projects, and translates novel methods and concepts into field-ready scientific prototypes. In my talk, I will argue that Big Data Analytics is a key technology to transform the way research is conducted in a data-rich environment. I will present how Big Data Analytics supports geo-scientists to better understand land-use processes in the context of our BMBF-project "GeoMultiSens – Scalable Multi-Sensory Analysis of Remote Sensing Data".

Managing the risk from natural perils

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Keynote in Session B3-03

Great natural disasters have always played a key role for progress in risk assessment and risk management for natural perils. An example is the Great Lisbon Earthquake of 1755 which led to a well planned reconstruction of the city center. More recently the Managua earthquake in 1972 and Cyclone Tracy in Northern Australia in 1974 led to the establishment of specialized research units in companies like Munich Re and Swiss Re, and of consulting companies like AIR, RMS and EQECAT. Hurricane Andrew 1992, the Northridge and Kobe earthquakes 1994/95, the South Asian tsunami 2004, hurricane Katrina 2005 and the string of natural disasters since 2010 starting with the Haiti earthquake have marked records either in financial losses or in the number of victims. These recent disasters have provoked a re-consideration of several aspects of natural disaster risk management, such as the globalisation of risk and complex event chains, the significance of rare worst-case events and of event clusters on the other hand. The 3WCDRR in Sendai in March 2015 has called for accessibility to open and transparent data and tools to understand the risk from natural perils. New financial regulatory regimes as Solvency II confirm this need for more transparency in risk management processes. The Global Earthquake Model (GEM) project initiated by the OECD in 2006 is a public private partnership whose primary goal is to provide an independent, open and transparent standard for earthquake hazard and risk assessment. After six years of collaborative development with partners all over the world, GEM has released the OpenQuake platform in January 2015. The final intention behind this effort is to use the tools and data developed for risk reduction. GEM has already found one follower, the Global Volcano Model. Similar initiatives are desirable for other perils such as tsunami, flood and windstorm in order to enable more holistic approaches to disaster risk reduction worldwide.

Apatite fission-track dating reveals post-Variscan history of the Orlica-Śnieżnik Dome, Eastern Sudetes Mts. (Bohemian Massif, SW Poland)

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Poster in Session A6-01

The aim of this project is to find a time-relative linkage between the Late Cretaceous-Paleogene geodynamic history of the eastern Bohemian Massif and its present-day structure by applying the apatite fission-track (AFT) dating technique. The easternmost part of the Variscan orogeny, represented by the Bohemian Massif, has primarily been studied in the north; the central and southern flanks have received much less attention. We analysed 18 samples representing Palaeozoic crystalline basement from the Orlica-Śnieżnik Dome, Carboniferous Kudowa granitoids and Turonian to Coniacian/Santonian sedimentary rocks deposited within the Upper Nysa Kłodzka Graben. AFT data from crystalline rocks are dominated by Palaeocene-Eocene pooled ages, clustering between ~48-61 Ma. Apatites from Cretaceous strata (deposition age ~94-84 Ma) yield post-depositional pooled ages ranging between 46 and 58 Ma, implying that the samples have experienced significant Cenozoic burial or/and re-heating. One basement sample collected from a remnant of a high-elevation planation surface (ca. 1400 a.s.l.) yielded an older, Cretaceous pooled age (84 Ma). Together, these results suggest that both basement and cover experienced an early Cenozoic tectono-thermal event. Our results provide also new information about the Upper Nysa Kłodzka Graben, giving for the first time geochronological constraints for its formation and latter evolution.

Oligocene - Miocene exhumation of the Tian Shan

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Oral in Session A6-01

The Cenozoic deformation of the Tian Shan is driven by north-vergent compression from India. East of the Talas-Fergana fault (TFF), the width of the range decreases eastward, suggesting that the magnitude of shortening decreases in the same manner. The geometry is more complex to the west but width generally decreases westward. Numerous studies in the past decade have begun to clarify the exhumation and deformation evolution of the range. We synthesize published AFT, apatite (U-Th-Sm)/He and magnetostratigraphic data and our own recent work in order to show spatial patterns of exhumation and thereby constrain geodynamic models. Prior to middle Cenozoic deformation, the area of the present range was characterized by low relief; adjacent sedimentary basins record very low accumulation rates or a hiatus. Localized Eocene deformation events have been proposed in several areas, but do not appear to reflect significant shortening. The first large pulse of deformation commenced in the Late Oligocene or Early Miocene. These are represented by isolated range uplifts, often related to reactivation of older structures, and pulses of clastic sedimentation.

Perhaps the most significant deformation at this time occurred north of the Pamir along the NW-SE trending dextral Talas-Fergana fault (TFF), and the Chatkal ranges, at the NW end, and the Kokshaal and At-Bashi ranges, at the SE end of the fault. The Fergana basin, to the west of the TFF, underwent significant counter-clockwise rotation that was accommodated by these structures. Relatively rapid slip along the TFF persisted from ca. 25 Ma until at least 13.5 Ma. A second, larger deformation episode commenced in the Middle-Late Miocene along the length of the Tian Shan. Similar-aged deformation is reported from the Tadjik depression and within the Pamir. Important questions to address include whether the drivers for the two episodes were the same, and the roles of the rigid Tarim block and the indentation of the Pamir.

Can batholithic structures influence the seismogenic behavior of the North Chile Seismic Gap?

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Poster in Session A1-01

The analysis of the gravity field in Northern Chile has shown that the North Chile Seismic Gap (NCSG) is characterized by a well established chain of gravity isostatic residual anomalies (IRA) along both sides of the coast line. With respect to this anomaly distribution, the NCSG is divided in a southern and northern part with a pronounced IRA in amplitude in the region around the city of Iquique, opposite of the recent Mw 8.1 2014 Iquique earthquake. According to former studies on the Mw 8.0 1995 Antofagasta earthquake we were able to develop a hypothesis which postulates that these IRA anomalies are proxies for dense bodies of Jurassic-Early Cretaceous coastal batholiths with contact to the seismogenic part of the subduction zone interface where they influence asperity generation as documented by several seismological parameters. In case of the northern part of the NCSG we were able to observe an interesting relation between areas of largest slip on the rupture plane of the Iquique earthquake and its largest aftershock and the distribution of batholithic structures derived from gravity data and density modeling. However, the congruence of batholithic thicknesses and IRA gradients let us suggest that in the northern case the batholiths act as barriers to seismic slip instead of rupture fortifying asperities. This is supported by results from back projection of seismic energy at the borders of the batholithic structures. To quantify the influence on the interface, we calculated the vertical stress component of the dense bodies to come up with a vertical stress anomaly distribution with striking similarity to seismic slip, batholithic thickness and the locking coefficient from GPS data. We present these first results in our poster to hypothesize that massive batholithic structures influence propagation of seismic rupture.

Modelling Seismic Cycle of a Megathrust Earthquake across the Scales

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Oral in Session A1-01

Being the key process of the plate tectonics, the subduction is an essentially multi-scale process with the time-scales spanning from geological (>10**6 yr) to earthquake scale (10**-6 yr) with the seismic cycle in between. Here we present a cross-scale modelling approach capable to simulate the entire subduction process from rupture to geological time. We use the finite element thermomechanical modeling technique employing elasto-visco-plastic rheology with strongly non-linear temperature and stress-dependent viscosity constrained by laboratory-experiments and mineral physics considerations. First we generate a 2D thermo-mechanical model of subduction zone including a narrow subduction channel with “wet-quartz” visco-elasto-plastic rheology and low static friction. We next introduce in the same model classic rate-and state friction law in subduction channel, leading to stick-slip instability. The adaptive time-step algorithm recognizes moment of instability and drops the integration time step to its minimum value of 10-6yr during the earthquake. The time step is then gradually increased to its maximal value of 5 yr, following decreasing displacement rates during the postseismic relaxation, until next instability. We apply our model to seismic cycles of earthquakes with M>9. We demonstrate that most of the postseismic slip process can be explained by visco-elastic relaxation taking place in the mantle wedge and in the lower crust with viscosity that strongly varies in time and space in internally consistent way. Interestingly, in this model an average slip velocity at the fault in the time range from days to few years closely follows hyperbolic decay law usually interpreted as an afterslip although it has completely different physical mechanism. We also demonstrate implication of our model for the short-term and long-term deformation of the upper plate and will compare modeling results with the recent GPS observations for the Great Tohoku Earthquake.

Models of the Earth’s largest inter-plate magmatic events- Siberian Traps and Ontong Java Plateau

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Oral in Session A2-03

The Earth’s biggest magmatic events, Large Igneous Provinces (LIPs), are believed to originate from massive melting when hot mantle plumes rising from the lowermost mantle reach the base of the lithosphere. Two largest continental and oceanic LIPs that are Siberian Traps (ST, 252 Ma) and Ontong-Java Plateau (OJP, 120 Ma) shear common features that make their origin apparently controversial. Extreme volcanic production at large areas and high potential temperature of the magma sources of both LIPs indeed support classical model of melting of a large starting plume head. However, contrary to the prediction of the classical plume-head model there were no pre-magmatic uplift associated with ST, and OJP remained at about 1 km depth below the sea level despite of exceptionally thick (30 km) oceanic crust produced during OJP event. Moreover, average seismic velocities of the OJP crust (<7.3 km/s) are much lower than velocities expected for the high-Mg basalts derived from the hot mantle plume (about 7.4 km/s). Here we present a combined thermomechanical-geochemical model that explains controversial observations for both ST and OJP as well as compositions of basalts in both LIPs. The model implies that both LIPs originate from decompression melting of a similar low-buoyancy mantle plume head with potential temperature of about 1600°C that contained about 15 wt% of the dense recycled oceanic crust. Differences in volume of melts and their composition were solely caused by difference in the initial thickness of the lithosphere that was thicker than 130 km in the case of ST and thinner than 50 km in the case of OJP. We will also discuss implications of the mode of the melt transfer in the lithosphere, which appears to be crucial to determine the style of the interaction of mantle plume and lithosphere.

Eclogite xenoliths from post-collisional mafic dykes in the Variscan Odenwald (Germany)

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In the Bergsträßer Odenwald we recently discovered retrograded eclogites occurring as cm-sized xenoliths in post-collisional Variscan mafic dykes (lamprophyres). The eclogite facies mineral assemblage with omphacite I (Jd_{51-32}), kyanite, high-Si phengite (3.35-3.73 Si a.p.f.u.), quartz, epidote, rutile and apatite is well preserved as inclusions in garnet crystals. Garnets are up to 5 mm large and compositionally heterogeneous with concentric zoning in Ca (Grs_{27-22}) and strong sector zoning in Mg, Fe and Mn (Prp_{25-35}, Alm_{44-41}, Sps_{3-1}). Fluid-mediated recrystallization at granulite facies *P*-*T* conditions is indicated by patchy zonation patterns in marginally to completely replaced garnets (Prp_{36-39}, Alm_{44-41}, Grs_{18-16}, Sps_1) and by the appearance of plagioclase (An_{19-27}) and omphacite II (Jd_{27-32}). Locally, replacement textures like reaction rims, symplectites and kelyphites with diopsidic pyroxene, pigeonite, feldspars, spinel, Si-rich sapphirine, corundum, ilmenite and minor biotite and amphibole developed, presumably during eclogite incorporation into the lamprophyric melts. The presence of sector zoning hampers thermobarometric calculations of the eclogite facies stage. Preliminary *P*-*T* data comprise temperatures in the range of 800 – 900 °C (Grt-Cpx Fe^{2+}-Mg exchange), while the H*P* granulite facies overprint occurred at 800 – 850 °C and 1.50 – 1.65 GPa (GADS), indicating near isothermal decompression from the eclogite facies stage. Sector zoning can be caused by fast growth rates due to reaction overstepping, which, in our case, may be related to heat supply by mantle-derived intrusions. Preservation of this zonation demands a rapid exhumation process, with only a short-lived, fluid-mediated overprint under H*P*granulite facies conditions, right before the pick-up by the lamprophyre melts. This overprint may be linked to the development of shear-zones, which are necessary for the lithosphere-scale uprise of the volatile-rich lamprophyres.

Emergence of plate tectonics from magma ocean

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Rephrasing Saslaw's statement about galaxies one can say that if plate tectonics did not exist we would have no difficulty in explaining the fact. From the observational point of view, Earth is the only planet that has plate tectonics. Space exploration in the past several decades found no convincing evidence for plate tectonics elsewhere, either at present or in the past. From the theoretical point of view, the lack of plate tectonics is much easier to explain than its presence. There are at least two major obstacles in the emergence of plate tectonics. One is that crust or other types of compositional layering can easily suppress plate tectonics. The other is lithospheric strength. Due to high strength of rocks the very first episode of subduction on a planet which does not already have a well-developed plate tectonics system, is extremely difficult if not impossible. One solution is that plate tectonics never had a beginning but instead was an evolutionary product of convection in the magma ocean. Depending on various factors, including the development of compositional stratification, magma ocean can produce a planet which cannot sustain plate tectonics as well as a planet which can. In the latter case, convection in the magma ocean can evolve into plate tectonics. From a fluid dynamical point of view, convection in a magma ocean is already similar to plate tectonics in that it involves the planetary surface and is driven by the cold thermal boundary layers. The emergence of plate tectonics from convection can then be viewed as slowing down the convective motions from meters per second to meters per year as the magma ocean gradually freezes and the dynamics magma ocean undergoes a transition to a predominantly subsolidus dynamics. This eliminates an apparently unsolvable problem of starting plate tectonics on a one-plate planet by replacing it with a solvable problem of how convection in the magma ocean evolved into plate tectonics.

Seismic constraint of a dry, basalt-rich transition zone near a stagnant slab region beneath China

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Plate tectonic processes operating over much of the Earth's history induce long-term mantle mixing of chemical heterogeneities, recycling of volatiles into the mantle and regulate basalt geochemistry. Through frequency-dependent analysis of P-wave receiver function conversions and topside reflections, we are able to, for the first time, simultaneously determine shear velocity and density jumps, the sharpness of the boundary as well as the gradient immediately above/below the boundary. Within the thermodynamic framework, HeFESTo, we explore these observations with respect to seismic properties predicted in a volatile/melt free mantle, where harzburgite and basalt rock assemblages are either fully equilibrated or are mechanically mixed. We find that observed shear velocity (5-6%) and density jumps (1.5-2%) across the 410 are both too low to be consistent with the olivine-wadsleyite phase transition in a pyrolitic mantle; the width of the 410 is very narrow ($\sim$ 2-3 km) and it is inconsistent with the prediction from a dry mantle peridotite with Mg# of 0.89. The harzburgite assemblage near the 410 could be at least as depleted as Archean cratonic peridotites. The mantle is likely not wet but is basalt rich ($\sim$40%). On the other hand, the 660 not only consists of a sharp boundary ($\sim$2-3 km), but it also involves a substantial velocity/density gradient near the boundary. These observations coincide very well with the post-spinel and post-garnet phase transitions if the mantle near the 660 consists of about 75% harzburgite fully equilibrated with about 25% basalt. Alternatively, if the mantle is mechanically well mixed, the basalt fraction is probably high in the lower transition zone, but ecreases rapidly toward the uppermost lower mantle.

Slab dragging and the recent geodynamic evolution of the Africa-Iberia plate boundary region

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The Tortonian-Present geodynamic evolution of the plate boundary between North Africa and Iberia is characterized by first-order enigmas. Iberian and North-African lithosphere are moving in different directions but what is the nature of the boundary between the plates? What explains the observed crustal-motion patterns and what is driving the present-day tectonic activity with its destructive earthquakes? What closed the marine gateways through northern Morocco and southern Iberia prior to the Messinian Salinity Crisis? What drives the puzzling left-lateral fault systems of the Trans Alboran Shear Zone and Eastern Betic Shear Zone that became active since the Tortonian? Invariably these and other questions were addressed in the classical plate tectonic context of the NW-SE relative plate convergence between Iberia and northern Africa since the Tortonian, independent of possible effects of mantle processes underlying the region. From combining observations and predictions from seismology, geology, geodesy, and numerical crust-mantle dynamics modelling, we developed a new and promising geodynamic framework for addressing many of these questions. We suggest that regionally the major plates are both connected to the Rif-Gibraltar-Betic slab such that at depth there is no clear plate boundary between the African and Eurasian plates. This may cause the diffuse nature of the plate boundary as exhibited by the strongly distributed crustal seismicity. As the slab is connected to both plates it is dragged through the mantle and experiences mantle resistance due to the viscous coupling between slab and mantle. The resulting differential lateral motion between the slab and surrounding plates drives the crustal deformation that so far was difficult to explain. We suggest a key role of lateral dragging of slab by the subducting plates for understanding crustal deformation in the region.

Compression of $(Mg_{0.9}Fe_{0.1})_2SiO_4$ olivine at ambient temperature to lower mantle pressures

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Mg-rich olivine with average formula $(Mg_{0.9}Fe_{0.1})_2SiO_4$ is the most abundant mineral of the upper mantle down to a depth of about 410 km, at which it transforms into its high pressure polymorph wadsleyite. The presence of metastable olivine in the peridotitic component of oceanic lithosphere subducted below 410 km depth may explain velocity anomalies reported in local seismological studies (Kawakatsu and Yoshioka, 2011). Olivine's delayed transformation is probably related to the mechanism which generates deep earthquakes (e.g. Green and Houston, 1995). In our experiments we investigated the behavior under compression of the typical mantle olivine $(Mg_{0.9}Fe_{0.1})_2SiO_4$. We have performed multiple x-ray diffraction experiments in the diamond anvil cell both in quasi-hydrostatic conditions (in Ne pressure medium) and in strongly non-hydrostatic conditions (without any pressure transmitting medium). The quasi-hydrostatic compression experiments show a first structural transition to triclinic forsterite II (FoII) at 48+/-2 GPa and a second transition to orthorhombic forsterite III (FoIII) at 55+/-2 GPa. The high pressure polymorph FoIII was preserved in decompression to 12+/-3 GPa. These results are confirming the results obtained recently by single-crystal x-ray diffraction on Mg_2SiO_4 forsterite (Finkelstein et al, 2014). The high-pressure behavior of Fe-bearing olivine subject to non-hydrostatic compression is qualitatively different. We observe a first transition to FoII at 48+/-3 GPa but we do not observe FoIII phase up to 81 GPa, the maximum experimental pressure. The FoII phase is preserved in decompression to 10 GPa. This suggests that the presence of large uniaxial stress components seems to prevent the transformation of the intermediate phase FoII to the post-spinel FoIII. References:

Finkelstein, G.J., et al., Am. Mineral., 99, 35-43, 2014 Green H.W., H. Houston, Annu. Rev. Earth Planet Sci, 23, 169, 1995.

Kawakatsu H., S. Yoshioka, Earth Planet. Sci. Lett., 303

elevated above sea level. Since the formation of a continental ice sheet requires a significant area of emergent land, our data imply that initiation of extensive glaciation of this part of West Antarctica may have only started since the early Miocene.

Activity of the West Antarctic Rift System along Marie Byrd Land and the Amundsen Sea area

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The West Antarctic Rift System is one of the largest continental rifts on Earth. Its evolution is of global importance, because it forms the "underbelly" of the West Antarctic Ice Sheet, which is currently undergoing rapid destabilization and retreat. Because of the glacial cover, rift evolution and interaction with the overlying ice sheet is still poorly understood. We present the first low-temperature thermochronology data from eastern Marie Byrd Land, an area that stretches $\sim$1000 km along the rift system, in order to shed light on its development. Our data provide information about the tectonic and morphologic history of the rift system. Rifting occurred in two episodes. The earlier took place between $\sim$100 and 60 Ma and led to widespread tectonic denudation and block faulting over large areas of Marie Byrd Land. The later episode started during the Early Oligocene and was confined to western Pine Island Bay area, indicating rift activity that connects the continental interior of Antarctica with the Amundsen Sea. This Oligocene tectonic activity may be linked kinematically to previously described rift structures reaching into Bellingshausen Sea and beneath Pine Island Glacier, all assumed to be of Cenozoic age. However, our data provide the first direct evidence for Cenozoic tectonic activity along the rift system outside the Ross Sea area. Furthermore, our data suggest that uplift of the Marie Byrd Land dome within the rift system only started at $\sim$20 Ma; that is, nearly 10 Ma later than previously assumed. The Marie Byrd Land dome is the only extensive part of continental West Antarctica

Evolution of northwest Greenland margin along Baffin Bay

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The geomorphic evolution of high-standing passive continental margins is still controversially discussed. This is particularly true for the elevated margins of Greenland. They have alternatively been explained by resulting from prolonged very slow erosion following Paleozoic orogeny, resulting from rifting and opening of ocean basins adjacent to the Greenland margins, or as young geomorphic features formed during the Cenozoic. This study focuses on the northwestern margin of Greenland, north of the Melville Bugt at the northern end of Baffin Bay, using low-temperature thermochronology. Opening and formation of oceanic crust of Baffin Bay took place during the Late Cretaceous. The study area is also situated at the southern termination of the postulated Wegener Fault, a controversially discussed large-scale strike-slip fault system supposedly active during the Paleogene, which has been described as one of the last problems of global plate tectonic reconstructions. Our data show that several normal faults dissecting the northwest Greenland margin were active during or after the Cretaceous, presumably related to extension associated with the opening of Baffin Bay. Also, our data show a clear – although not very pronounced – cooling signal at the end of the Cretaceous, which we interpret as reflecting initial formation of an elevated margin during and after continental breakup. Margin formation was followed by subsidence, with maximum burial at c.

30 Ma, again followed by a period of relatively rapid exhumation associated with net denudation of 2 – 3 km. This post-30 Ma denudation period may be related to tectonic activity associated with ongoing northward movement of Greenland, or to climatic changes such as early glaciation of the Arctic realm. In any case, our data imply that the present morphologic expression of the northwest Greenland margin results from young Cenozoic processes unrelated to earlier orogenies or continental breakup.

The evolution of the infant Moon

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In the absence of lunar plate tectonics, geochemical signatures of even relatively young lunar rocks can originate directly from the early global differentiation of the Moon. The most established hypothesis of the initial differentiaiton of the Moon is that of a global lunar magma ocean (LMO), which unites numerous aspects of lunar geology and geochemistry. Recent evidence for a 'young' LMO crystallization at ca. 4.4 Ga and 'young' Sr-Nd age constraints for lunar crustal rocks including anorthosites as presumed LMO flotation cumulates were held against the LMO hypothesis. In contrast, a multitude of studies found that model LMO cumulates most aptly provide the sources of key geochemical signatures of major lunar rock units, for instance the characteristic trace element and radiogenic Nd and Hf isotope compositions of low- and high-Ti mare basalts. Furthermore, the fractionated U/W and Th/W in KREEP (the residual LMO liquid) is now understood as a vestige of the much more reducing nature of the Moon which rendered W to behave less incompatibly than on Earth. We discuss our recent findings and possible scenarios to reconcile the pros and cons of the LMO hypothesis. Either 1) the Moon formed relatively late, 2) the accessible lunar samples offer an incomplete picture and the LMO was no global lunar feature, 3) tidal heating by the early Earth and cumulate overturn prolonged LMO crystallization and prevented isotopic closure, or 4) KREEP formation, the ^{146}Sm-^{142}Nd mantle isochron, and anorthosite age data reflect a global thermal perturbation that postdated LMO solidification but did not erase the elemental properties of previously formed LMO products. Possibly, the recently discovered small ^{182}W excesses in lunar rocks as well as excesses and deficits in radiogenic ^{182}W in ancient terrestrial rocks may place the Moon-forming giant impact event within the first 60 Myr of the solar system, thus excluding scenario 1).

Provenance Analysis of the Laga Formation (Messinian, Central Apennines)

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The Messinian Laga turbidites represent a complete submarine fan complex deposited in the Adriatic foredeep of the growing Apenninic chain. Although the stratigraphy and physiography of the basin were extensively studied, a recycled Apenninic source still competes with a direct linkage to the Alpine realm. Furthermore, a shift in paleocurrent is interpreted to indicate a provenance change at ∼6 Ma. By combining detrital zircon fission-track and U-Pb dating with compositional analyses, differences between the proximal channelized and distal lobe facies and the sedimentary provenance of the fan complex are addressed. Due to sediment sorting processes, the lobe facies shows a reduced heavy mineral spectrum compared to the channelized facies. Hence, proximal deposits reflect their source better than their distal counterpart and should be preferred in provenance analyses. The petrographic composition implies a major

amphibolite-facies metamorphic origin with an additional dolomite source. The fission-track data reveals three main age populations peaking at ∼16-17 Ma, 34 Ma, and 100-138 Ma, revealing lag times of ∼9 and ∼11 Ma for the youngest peaks at the base and top of the sequence. The $^{238}U/^{206}Pb$ ages show two major peaks around 37.5 Ma and 277.5 Ma, and broad minor peaks recording the main magmatic-metamorphic events observed in European basement. Since modern fission-track ages similar to the lag times are only observed in the Central Alps, and U-Pb ages between 33–42 Ma are unequivocally associated with the Adamello complex (Southern Alps), these areas are inferred as major source for the Laga arenites. Furthermore, no compositional difference is observed in the stratigraphic profile. The change in paleocurrents thus likely reflects only reorganization of the basin topography due to syn-sedimentary tectonics. A large axial foredeep, extending from the Central Alps to the Central Apennines, was still maintained just before and during the Messinian salinity crisis.

From exoplanets to the importance of shear stresses for plate tectonics on Earth-like planets

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For almost ten years, there has been a great disagreement as to whether plate tectonics is likely to occur on rocky planets more massive than the Earth or not. We show that the nature of the stress (normal or shear) responsible for leading into plate failure and mantle overturn is one of the main reasons leading to such debate. To specifically study the nature of stresses driving plate tectonics, we use a 3D spherical shell mantle convection history model to explore an episodic mode of plate tectonics. The time evolution of shear and normal stresses is tracked to determine how the stress levels vary coming into a global lithospheric failure event. The results indicate that an increase in convective mantle shear stress initiates lithosphere failure and an associated period were the lithosphere actively participates in convective mantle overturn. Normal stresses remain large only close to the surface in a thin stress skin and are not causally correlated to the initiation of plate failure and mantle overturn. In a second step, we study the implications of shear stresses leading to and maintaining plate failure with 1D interior thermal history models. We specifically focus on how water and surface temperatures affect plate tectonics. We discover that high surface temperatures favor the initiation but not the maintenance of plate failure - allowing an unstable tectonic mode for Venus. And last but not least, we observe that dry planet formation with a belated delivery of surface water is ideal for initiating and maintaining plate tectonics – connecting planet formation to the basic stresses driving plate failure and to the discussion of plate tectonics on Earth-like planets.

Tipping point in North Atlantic-Arctic circulation controlled by the Oligocene-Miocene subsidence of the Greenland-Scotland Ridge

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Changes in high latitude ocean gateways and atmospheric CO_2 are thought to be main drivers of Cenozoic climate evolution during the last 65 million years. However as yet, especially the link between climate changes and the opening history of the North Polar Seas via the subsidence of the Greenland-Scotland Ridge is poorly understood. Here we use a coupled ocean–atmosphere general circulation model for early Miocene boundary conditions to reveal a threshold behaviour for the ventilation of the North Polar Seas controlled

by the Greenland-Scotland Ridge subsidence. Our model simulations show that a deepening of the ridge from 200 to 300 meters below sea-level induces major reorganizations in North Atlantic-Arctic Ocean circulation with an abrupt regime shift from restricted estuarine conditions to a bi-directional flow regime similar to today. Close to critical gateway depths, additional scenarios with different atmospheric CO_2 concentrations indicate that realistic Oligocene-Miocene CO_2 changes actively modulate the transition between the two circulation regimes via the impact of the atmospheric hydrological cycle. Taking uncertainties in timing into account this suggest that tectonic changes starting at ~33-30 Myrs controlled the circulation of the Nordic Seas. Thereafter superposed changes in CO_2 delayed an abrupt transition to a modern prototype North Atlantic-Arctic exchange by millions of years until CO_2-levels finally dropped to preindustrial levels at ~25-24 Myrs. This concept and the associated mechanism bridges tectonic processes with much shorter time-scales in the coupled atmosphere-ocean system that differ by three orders of magnitude, which provides an unanticipated new perspective on abrupt climate changes during the Cenozoic era.

Microbial lipid distributions and substrate potential of the organic matter in Siberian permafrost deposits: Impact on climate evolution

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Poster in Session A6-05

In this study, a terrestrial permafrost core from the Bour Khaya coast in Siberia is investigated to reveal the role of the microbial ecosystems in the organic matter transformation for past and future climate changes. The microbial life markers (intact phospholipids, PLs) prove the presence of currently living microorganisms in the entire permafrost sequence. The adaptation of their cell membranes to cold environmental conditions is regulated by specific branched and unsaturated fatty acids. The PL profile indicates abundant microbial life in the active layer and a decrease in the underlying permafrost deposits. Other microbial markers, already partly degraded and, therefore, not indicating microbial life, reveal similarities with the TOC content especially in Late Pleistocene deposits. This suggests increased microbial activity during the Late Pleistocene presumably caused by periods of warmer temperature conditions. Pore water analysis reveals the presence of low molecular weight organic acids (LMWOA) such as acetate, being an excellent substrate for methanogenesis. In the Late Pleistocene deposits the LMWOA depth profiles show significant similarities to the TOC content. This points to a link between the organic matter and the unbound LMWOA concentrations and to the potential of these permafrost layers to provide the substrates for microbial greenhouse gas production. In contrast in the active layer the LMWOA concentrations are low, reflecting an active microbial turnover in the surface layers. Overall this suggests that the organic matter stored in the permafrost deposits and, therefore, removed from the surface carbon cycle is not much different in terms of organic matter quality than the fresh surface organic material. Considering the discussed increase of permafrost thawing, this might imply a strong impact on the generation of greenhouse gases from permafrost areas in future with its feedback on climate evolution.

Decoding Magma Plumbing and Geochemical Evolution Beneath the Lastarria Volcanic Complex (Northern Chile) - Evidence for Multiple Magma Storage Regions

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Lastarria is a part of the Lazufre Volcanic Complex, a ~30 km long chain of overlapping Quaternary volcanic centers located on the border between Chile and Argentina. Recent GPS and InSAR observations have shown that this volcanic area is one of the largest volcano systems on earth, comparable in size with Yellowstone or Long Valley, which is recently undergoing an active inflation of up to 3 cm/yr. The petrology of quaternary andesites and dacites from Lastarria volcano is investigated to reconstruct magma plumbing and storage beneath the volcano. The mineral phase compositions and whole-rock major and trace element compositions were used to constrain temperature, pressure and possible mechanisms for magma differentiation. The applied thermobarometric models include two-pyroxene thermobarometry, pyroxene-melt thermobarometry, plagioclase-melt thermometry, amphibole composition thermobarometry, and Fe-Ti oxide thermo- oxybarometry. The overall temperature range gained by several geo- thermometers is between 840 and 1060°C. Calculated oxygen fugacity for all samples corresponds to a range between NNO to NNO+1. Results of the geo-barometric calculations reveal multiple magma storage regions, with a distinct storage level in the uppermost crust (~6.5-8 km depth), a broad zone at mid-crustal levels (~10-18 km depth), and a potential deeper zone at intermediate to lower crustal levels (>20km depth), which is difficult to define from petrological information only. The highest temperatures are recorded in minerals stored in the mid-crustal levels (~10-18 km depth). The whole-rock compositions clearly indicate that magma mixing is the main parameter controlling the general differentiation trends. Complex zoning patterns and textures in the plagioclase phenocrysts is interpreted as a reheating and remobilization remnant of the resident magma by an intrusion of hotter more mafic magma rising from depth into shallow reservoirs.

Initiative „Research Assignments in the Field of Ore Deposit Research" – what has been achieved?

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Original research at BGR includes the participation in and contributions for the security of Germany's raw material supply. This aim is achieved by ore deposit and raw material research projects in the forefront of potential economic activities, established in 1989 and based on an initiative by F.-W. Wellmer. The scientific projects cover a wide range from the evaluation of raw material potential, supply and demand, ore deposit districts and regional metal and mineral assessments, and the derivation of metallogenetic concepts as a base for new exploration targets. Research assignments are contracted to qualified universities and research centers in order to benefit from their advanced and special expertises in the fields of all relevant metallogenetic aspects. In the first years after 1989, the thematic topics focused on gold metallogenesis flanking scientific projects on African gold deposits at BGR in those years. New technological developments and conceivable shortage in raw material supplies shifted the focus in BGR research assignments to metals with so-called short lifetime reserves, in anticipation of the fast-growing significance of strategic metals and minerals. Metals and metalloids like indium, germanium, platinum group elements, tantalum and antimony were covered in great detail and enabled BGR and her partners to comment and serve the political and economic knowledge requirements. The significance of early and today's BGR's research assignments is affirmed by the annual definition of metals and minerals considered strategic by the European raw materials group. Most raw materials from this group have been covered since the start of BGR's assignments in the field of ore deposit research. This program is well established and of high notification even outside Germany. A number of other Geological Surveys in as well as outside Europe established similar programs; to some extent a demonstration of the significance of BGR's and F.-W. Wellmer's initiative.

Understanding hail damage of External Thermal Insulation Composite System (ETICS)

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External Thermal Insulation Composite Systems (ETICS) are one of the most common technologies in facade insulation in central Europe. The multi-layer system consists of an insulation board (expanded polystyrene) attached to the external wall. This board is covered by a base coat, reinforced by a glass fibre mesh, and a textured top coat. Storm events in recent years have shown that hail can cause severe damages to ETICS. Our project investigates hail impacts on ETICS in order to understand and prevent future damage, using a combination of detailed microstructural analyses of the damaged mortar layers (depressions and fractures), high speed camera recordings of impact experiments, and impact simulations (finite element modeling). This combination of analytics allows us to identify the different steps in damage evolution (strain and stress distribution) and to link these steps to the internal fracture pattern. We conducted both steel ball (ETAG 004) and ice sphere (VKF Prüfbestimmung No. 8) impact tests. Mi-crostructures were analyzed using micro-computer tomography 3D imaging and thin sections of the impact areas. High speed camera recordings provided information about the reaction of the ETICS specimen as well as the internal deformation in the impacting ice sphere. Recordings show that the soft insulation plate is depressed up to 2 cm during impact. The covering mortar layers have to follow these movements and tend to crack in regions of extension. In an advanced stage, further fractures propagate along the reinforcement mesh as the mesh tightens. As the fracture density in the cementitious base coat is much higher than in the organic-based top coat, the majority of fractures remain hidden and can lead to delayed damages.

ETAG 004 (2011): Guideline for European Technical Approval of External Thermal Insulation Composite Systems with Rendering, EOTA, Brüssel.

VKF (2011): Prüfbestimmung Nr. 08 Putz auf Aussendämmung, Schweizerisches Hagelschutzregister, Bern

Inferring mantle flow and dynamic topography from seismic tomography

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Oral in Session A4-01

Dynamic topography is the vertical displacement of the surface in response to flow driven by density anomalies in the mantle and influences which continental regions are above or below sea level. In developing a dynamic topography model based on seismic tomography, a major challenge is to determine the thickness of the lithosphere and hence to exclude seismic anomalies unrelated to density anomalies causing dynamic topography: The lithosphere thickness model derived here is also based on tomography, and calibrated such that average thickness as a function of sea

floor age visually matches the theoretical curve for half-space cooling. It is quite variable on continents, with thick lithosphere up to ∼350 km inferred for many cratons. In order to focus on contributions originating in the sublithospheric mantle, topography inferred from seafloor ages is subtracted. Using an optimization to fit a number of constraints, a best-fit mantle viscosity structure is obtained, for which dynamic topography is compared to "residual" topography (corrected for crustal isostasy and sea-floor ages). Best-fitting models feature a density anomaly ∼0.2% in the continental lithosphere - far less than inferred from thermal anomalies. With recent tomography models, computed root mean square (rms) amplitudes of dynamic topography are <∼30% larger than residual topography, and correlation is ∼0.6. Density anomalies in the lithosphere do not cause "dynamic" topography in the proper sense, but because amplitudes of the nearly isostatic topography they cause are very similar, it can be formally included in it. Comparison of results with different lithosphere thicknesses and asthenosphere viscosities indicates that lateral viscosity variations lead to variations in dynamic topography amplitude of a factor <∼2, partly explaining that modelled dynamic topography amplitudes are too low on continents and too high in oceans.

Mantle dynamics models of the gravity spectrum of Mercury

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Poster in Session A3-03

The MESSENGER mission has provided gravity data for Mercury. Like on the Earth and Mars, but notably different from Venus, the non-equilibrium equipotential shape of Mercury is dominated by very long wavelengths, in particular spherical harmonic degree two. Here we conduct simple convection models in an isochemical 460-km thick mantle to test for which parameters (if any) the low-degree gravity and topography spectrum (up to degree 20) can be explained as a consequence of density anomalies in a convecting mantle, overlain by an elastic lithosphere. We find the best results for relatively thin lithosphere (∼100 km thermal thickness, 60 km elastic thickness), and mantle viscosities similar to Earth's upper manlte (∼2*10^{20} Pas) yield better results than higher viscosities . In this case the maximum amplitude occurs for degree ∼7, but degree amplitudes stay within ∼30% of observed amplitudes for the whole degree range 3-20. Also, the geoid-topography ratio is matched well for degrees 2-20. Models run for 4.5 Gyr, and results get closer to observed values with modelling time, but most changes occur during the first 1 Gyr. A latitude-dependent surface temperature condition (corresponding to variable insolation) only changes results in a minor way, and results are also relatively insensitive to the amount of core heat flux (and hence core-mantle boundary temperature). The main discrepany remains always degree 2 amplitude which is a factor ∼3 too low, and difficult to explain with simple thermal mantle convection models.

A Wegenerian Approach to Understanding When Plate Tectonics Began

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Oral in Session A4-04

Understanding when and how Plate Tectonics (PT) began is profoundly important for constraining a wide range of Earth science problems, from how much water exists in the mantle transition zone to whether continental crust volume is growing or shrinking. We can imagine how Alfred Wegener would attack this problem; above all he would want to understand the geologic evidence and draw conclusions from this. Isotopic evidence indicates that surface materials (including water) sunk to become sources of some modern OIB early in Earth history and most geoscientists

accept that PT began in Archean and Late Hadean times. In contrast, most geologic lines of evidence (ophiolites, blueschists, UHP terranes, collision gemstone Ruby and subduction gemstone Jadeitite) indicate Neoproterozoic onset. Three other major Neoproterozoic transitions - wild climate and C isotopic swings and accelerated biological evolution - are also explained by a major tectonic transition. Earth's first tectonic regime was magma ocean, which cooled from the top down to form increasingly thick, stable lithosphere. Stagnant lid with heat pipes slowly stabilized into crust and mantle lithosphere, with komatiite plumes, Rayleigh-Taylor instabilities (drips) delivering surface materials to depth and formation of tonalite-trondhjemite-granodiorite plutons by melting of eclogitic drips and lower crust. By the end of Archean time, the lithosphere stabilized and lithospheric recycling transitioned to edgewise delamination, and something approaching PT occurred during Paleoproterozoic time, 2.0 – 1.8 Ga. After this, the 'boring billion' of stable stagnant lid tectonics persisted until ∼1000 - 800 Ma when the appearance of ophiolites, blueschists, UHP terranes, Ruby, Jadeitite, rapid climate change, C isotopic swings, and accelerated evolution indicate the onset of true PT. It is not too ridiculous to imagine that Wegener would conclude that modern-style PT began in Neoproterozoic time.

Are you sure? – Visualizing geological uncertainties in structural 3D models

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Poster in Session B5-02

Before using 3D models geologists had to rely on 2D illustrations (maps, sections, profiles) to visualize 3D concepts of the underground space. On maps it is quite straightforward to highlight uncertain or unknown areas, from the blank space and the writing "hic sunt leones" (still a problem for the mapping geologist) in ancient maps to shaded areas with the description "assumed" and dashed formation boundaries. To visualize uncertainties in geometry or geological parameters in 3D is more difficult. A modeled geologic horizon or volume is either present or not. But how is it possible to apply uncertainty to them? Here we focus on uncertainties that emerge from geological interpretation and generalization rather than those caused by sparse or unclear data or by the modeling algorithms themselves. Especially for regional scale models the level of detail has to be reduced. This generalization inevitably leads to a loss of information and an increase of uncertainty. We will give examples how we tackle the problem in the German North Sea. The simplest way of displaying uncertain areas is by applying a color code to the modeled surface (also usable for volume cells underneath it), similar to the methods used in maps. For generalized faults it is more complex. The main fault structures of grabens, for example, are mostly not a singular fault, but a set of faults running more or less parallel within a short distance. In a regional model this fault zone is generally generalized to one single fault. So a method has to be defined to visualize this generalization. One way would be to develop a certain type of generalization catalogue. E.g. in the model "fault type 1" would represent a set of normal faults at the edge of a graben. Such a concept will not affect the model, but will point out areas in which information got lost during the modeling process. Such additional information to geological 3D models can increase the usability for advanced studies and analyses.

Analysis of oils from the Lower Saxony Basin and the Gifhorn Trough – Oil quality and biodegradation as related to reservoir depth and source rock maturity

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Poster in Session B1-03

The Lower Saxony Basin as well as the Gifhorn Trough are among the most important oil and gas producing regions in Northern Germany. Oil production in this region started in the late 19th century and is still continuous today. Due to the progressive advance in technology, especially older, currently non-operative fields start to be of interest again. 24 oils samples, out of the inventory of the Oil Museum Wietze, from in the past producing oil fields located in the Lower Saxony Basin and the Gifhorn Trough were subject to geochemical analysis, including analysis by GC-FID, GC-MS, Iatroscan, as well as density measurements to determine API-values. The results were then used to determine the oil quality and the degree of degradation. Methylphenantrenes and Methyldibenzothiophenes (Radke et al., 1986) were analysed and the ratios MPI (Methylphenantrene-index) and MDR (Methyldibenzothiophene-ratio) were applied to determine the maturity of the samples. The results were then compared to maturity maps of the Posidonia Shale, which is the most likely source for the oil samples within the study area. The degree of biodegradation (Wenger et al., 2002) is low in most samples, but severe in a few samples from reservoirs located at shallower depths. References:

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Mantle Plume Impingement During Break-up Of The Gondwana Supercontinent

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Oral in Session A2-03

Earth history has been punctuated by episodes of short-lived (<10 Ma), high-volume magmatism, often associated with plate-tectonic reconfiguration and biosphere mass-extinction. The origins of these events, and their resultant manifestations as large igneous provinces and associated continental flood basalts (CFB), are difficult to comprehend within the current plate-tectonic paradigm. Upper mantle processes have been invoked for some CFB, whereas the origin of other CFB appears to be rooted in the deep mantle. The lack of consensus hampers the development of robust models for this fundamental geological process. The Cretaceous Paraná-Etendeka CFB, which crops out in modern-day Namibia and Brazil, has been a particular challenge for models, as this event of episodic, short-lived, large-scale melting has had no obvious connection with a deep mantle origin. Here we provide the first direct indication for a deep mantle signature for this province, based on isotopic (He, O, Sr, Nd, Pb, Os) and trace-element abundance evidence from primitive mafic dykes from north-western Namibia. The combined data define mixing trends documenting the presence of a deep, relatively undegassed mantle plume source that mixed at shallow depths with ambient asthenospheric mantle before ascent through the crust. The results confirm that the break-up of Gondwana and formation of the Atlantic Ocean basin was directly affected by deep mantle upwelling that has occurred persistently from the Cretaceous to the present-day.

Regional comparison of the syn- and post-rift tectono-stratigraphic evolution of megasequences in salt and salt-free basins offshore Brazil and Africa, South Atlantic

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Poster in Session A2-02

The large South Atlantic basins offshore South America and Africa record a highly variable syn- to post-breakup tectonic-stratigraphic development. The present-day diversity in the structural and sedimentary architecture of the conjugate margins offshore southern Brazil and Namibia/Angola reflects variations in a number of controlling factors, of which the most important are rift geometries, the structural configuration of each margin segment at the time of break-up, the post break-up geodynamic history, and variations in sediment input to the respective margin segment. Particularly the highly asymmetric, conjugated Santos and Namibe/Angola basins show pronounced differences. Only a few attempts exist to establish a regional tectono-stratigraphic correlation framework across the South Atlantic Ocean (e.g., Mohriak et al., 2008). This was mainly due to lack of data across entire margin segments, limited resolution of basin wide geophysics, and only medium-resolution data hampering comparison of the major stratigraphic differences. There are consequently still many unresolved issues, which particularly concern the explanation of the basin-specific geological development of each margin segment in comparison to the neighbouring ones on the same continental margin as well as a correlation of the geological development of conjugate basins and margin segments across the Atlantic Ocean. In our study we present interpretations of megasequences and their first-pass restorations based on regional 2D seismic-reflectivity data from the large basins offshore Brazil (Pelotas Basin, Santos Basin, Campos Basin, Espirito Santo Basin), and offshore Namibia and Angola (Walvis Basin, Namibe Basin, Benguela Basin, Kwanza Basin), which represent four adjacent pairs of conjugate basins on both sides of the South Atlantic. Results are used to document and compare the contrasting styles of rift and post-rift settings during and after the continental breakup.

Quantifying sediment transport time and burial duration in central Australian low-gradient landscapes using ^{10}Be and ^{26}Al

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Poster in Session A6-05

Landscape evolution is in large part governed by erosion and sediment routing. Many studies have investigated these processes in steep mountain regions, while neglecting the low-gradient landscapes that lie beyond. Yet, transport timescales are commonly thought to be much longer in flat regions relative to steeplands. Here we use cosmogenic nuclides to examine sediment transport and storage along two low-gradient catchments (Neales and Macumba Rivers) in arid central Australia. The combined catchments cover ~65,000 km^2 with a mean slope of 30 ± 28 m/km (mean ± 1σ, calculated from 1 arc-sec SRTM). Previous studies have identified the slow-erosion character of the continental interior via nuclide measurements in bedrock outcrops; however, to better understand the processes shaping these landscapes we adopt a source-to-sink approach coupling bedrock and hillslope colluvium measurements with basin-wide measurements in fluvial sediment. Variation in concentrations and ratios of ^{10}Be and ^{26}Al in sediment provides insights to residence times and burial history as grains are transmitted through the bedrock-hillslope-stream sediment conveyor. Our preliminary results reveal model burial signals

in hillslope gravels and river sediment of ∼0.4-1.2 Myr, which implies that using a single nuclide alone will yield erroneous basin-wide denudation rates in low-gradient landscapes.

Shale gas assessments - Comparison of performance-based vs. gas in place approach

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The recent worldwide interest in shale gas resources increases the demand for reliable and comparable resource assessments. Often, several assessments of the same shale play using different methods lead to inconsistent and contradictory results. The present study aims to investigate possible reasons for these discrepancies for two well established methods: the performance-based and the volumetric Gas-In Place (GIP) assessment. This is carried out using two case studies for developed and undeveloped shale plays: the Woodford shale (US) with active production and the underexplored shale play of Alaska North Slope. The assessments are accomplished by using identical geological framework conditions (lithology, organic matter type, organic carbon content, depth, net thickness, and thermal maturity). Within the performance-method we used populations of well production data to establish quantitative, probabilistic estimates of volumes of technically recoverable oil and gas resources. Contrary, with the GIP method we estimated the recent volume of a source rock that is filled with gas. Our results show, that both methods provide compatible results, when considering the identical assessment units, based on similar geological data, and using a recovery factor of 10% for the GIP-method. This reveals that differences in input data and differing geological evaluation of the basins, rather than methodology, are the principal cause of differing assessment results. The greatest uncertainty and key parameter between these methods is presented by the estimated recovery factor. Moreover, our results indicate that initial estimations, generally done by the volumetric in-place approach, should be based on identical screening criteria, to guarantee compatible results of assessments in different countries.

Shale Gas and Shale Oil in Germany: In-Place assessment and technically recoverable resources

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Poster in Session B1-03

In light of the shale gas boom in North America in the last decade, the German Federal Institute for Geosciences and Natural Resources (BGR) has conducted a shale oil and gas assessment for Germany. Here we present our final assessment of the five year project, incorporating the majority of potential shale source rock formations in Germany. Organic-rich shale formations were characterized as potentially prolific for shale oil or shale gas, if meeting following criteria: thermal maturity 0.6-1.2 %VR (oil) and >1.2 %VR (gas) respectively, organic carbon content >2%, depth between 500/1000 m and 5000 m as well as a net thickness >20 m. The shale formations of Lower Carboniferous, Upper Triassic (Rhaetian), Lower Jurassic (Posidonia Shale), Lower Cretaceous (Wealden) and Tertiary (Fish Shale) have both shale oil and shale gas potential, while the Permo-Carboniferous and Lower Cretaceous (Paper Shale) are characterized by only shale oil potential. The resource assessment of these formations was carried out using a volumetric in-place approach. Variability inherent in the input parameters was considered using Monte-Carlo simulations. A cross-check of the volumetric approach was performed for two

study areas with a higher data density using two additional assessment methods: a i) 1-D initial hydrocarbon-potential-modeling and ii) 3-D petroleum system modeling. These cross-checks reveal similar and consistent results and hence support our general volumetric assessment of German shale oil and gas resources. Technically recoverable resources were evaluated using recent, production-based recovery factors of North American shales. As the factor is controlled by several parameters, varying within one play and over production time, a Monte-Carlo simulation is used to catch the range of variation. Additionally, the influence of brittleness and fracture networks, both controlling the frackability, as well as the geological complexity is evaluated qualitatively.

Characterizing Precambrian lakes as unique habitats for the early evolution of life

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Precambrian lakes are relatively unexplored, although they may have been important habitats for early life. Especially in volcanic terrains and during the wake of atmospheric oxygenation, the alkalinity, nutrient supply and redox state of lakes may have differed markedly from marine settings. These conditions may thus have hosted unique microbial ecosystems with potentially important implications for biological evolution and global biogeochemical cycles. Sedimentary deposits of the late Archean Fortescue Group, Western Australia, are used to test this hypothesis. Three fluvio-lacustrine units within this succession, including the Mt. Roe Fm (2.78 Ga), the Hardey Fm (2.76 Ga) and the Tumbiana Fm (2.72 Ga), were investigated with regard to elemental compositions, iron speciation, carbon and nitrogen isotopes, and petrography. Unusually high δ^{15}N values in the Tumbiana and Mt. Roe Fms are interpreted as evidence of alkaline conditions during the time of deposition. In contrast, lakes in the Hardey Fm display low δ^{15}N values, consistent with pH-neutral but anoxic nitrogen cycling. Organic δ13C is systematically lighter in the Tumbiana and Mt. Roe Fms relative to the Hardey Fm and most contemporary marine sediments, indicating significant microbial methanogenesis and methanotrophy in these alkaline settings. In light of trace element data, iron speciation and sedimentological features, the low carbon isotope ratios are best explained by localized methanotrophy, favored by in-situ O_2 production. The relatively higher solubility of some nutrients at high pH, such as molybdenum or phosphate, may have enhanced microbial activity. In conclusion, these data support the idea of local production and consumption of biogenic O_2 at favorable sites on Archean continents. Such processes may have contributed to low levels of oxidative weathering long before the Paleoproterozoic oxygenation event.

Experimental constraints on Fe isotope fractionation between silicate and carbonate immiscible melts

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Carbonatite magmatism provides a highly efficient mechanism for transport from mantle to crust, allowing for insights into the chemistry and dynamics of the Earth's mantle [1]. Iron isotope data from natural carbonatite rocks show the largest variability found in igneous rock to date [2]. As such, Fe stable isotopes are a promising tracer for interaction of carbonate and silicate magmas in the mantle, particularly because Fe isotope fractionation is controlled by oxidation state and bonding environment [3]. To date, the partitioning behavior of Fe between immiscible silicate melt and carbonate melt is largely unknown, and the Fe isotope fractionation between these compartments is assessed by theoretical calculations only [4], lacking experimental constraints. We performed equilibration experiments between silicate and carbonate melts at 1200°C and 0.7 GPa in an internally heated gas pressure vessel at intrinsic redox conditions (log f_{o2} = NNO+2). The silicate and carbonate run products were separated chemically by sequential extraction and mechanically by picking. Fe isotope compositions were then analysed by solution MC-ICP-MS. First experimental results demonstrate that in an alkali rich carbonatite system Fe is partitioned in nearly equal shares between silicate and carbonate immiscible melts. The Fe isotopes show a remarkable fractionation of Δ^{56}Fe_sil.melt-carb.melt = 0.41 ±0.07 ‰. The enrichment of the heavier isotope in the silicate melt is corresponding to a high Fe^{3+}/Fe^{2+} ratio [4]. These findings provide experimental support for a previously published model for carbonatite genesis, where extremely negative δ^{56}Fe values in carbonatite rocks were produced by crystal fractionation and liquid immiscibility[2].

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Structural rim uplift and ejecta thickness measurements of martian complex impact craters: Rim formation of complex impact craters

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Martian complex impact craters show elevated crater rims like their simple counterparts. While the raised rim in simple craters is the result to one half of (a) the deposition of a coherent proximal ejecta blanket at the edge of the transient crater and to the other half of (b) a structural uplift of pre-impact target material near the transient cavity [1, 2, 3], the cause of elevated topographies of final crater rims [4] in complex craters is less obvious. The radial distance between the transient cavity rim and the final crater rim can amount to several kilometers depending on the final crater size. The thick, proximal ejecta in such complex craters is then situated well inside the final crater [2, 5, 6]. This work is aimed to understand the crater formation process, especially the crater rim formation. We determined the structural rim uplift and ejecta thickness along the final crater rim of eleven complex martian impact craters to understand the cause of their elevated rims. Our study of these complex impact craters indicates that the structural rim uplift at the final crater rim makes 56-88% of the total rim elevation while the ejecta thickness contributes 12-44%. To constrain the size of the transient crater and hence the radial distance between the transient cavity rim and the final crater rim balanced profile reconstuctions along the terraced zones were carried out. These calculations suggest smaller transient crater sizes than previously assumed [7, 8].

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Geomorphological response of a landscape to long-term tectonic and glacial processes: the upper Rhône basin, Central Swiss Alps

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The susceptibility of the Alpine landscape to erosion is controlled by a combination of surface uplift, climate, glaciers, lithology, seismic activity and short-term variables including anthropogenic impact. At a basin-scale, the spatial and temporal variability of erosion regulates the basin's sediment budget and is an important mechanism controlling material fluxes from source to sink. In this this study we will conclude on litho-tectonic and glacial conditioning on patterns of erosional fluxes inferred from landscape morphometries in the upper Rhône basin, which drains an area of ca. 5400 km2 in the Central Swiss Alps. We extract geomorphological parameters such as river profiles, hypsometry and slope gradients along the channels of ca. 50 tributary basins of various sizes. Their catchments are located in either granitic basement rocks (External Massifs), oceanic meta-sedimentary and ophiolitic rocks (Penninic nappes) or fine-grained continental-margin sediments (Helvetic nappes). Although the entire Rhône basin shows a strong glacial inheritance (and is still partly glaciated) and some of the highest uplift rates recently measured in the Alps, the river network responds differently to those perturbations. We found that tributary basins in the Helvetic nappes are the most equilibrated (concave river profiles, overall lower elevations and slope gradients), whereas the tributaries located in the External massifs are least equilibrated, which is expressed by convex river profiles, the highest elevations and the steepest slope gradients. We interpret this pattern by highly variable response times of the rivers towards glacial and tectonic perturbation, with the response time being strongly dependant on the lithology and therefore on erosion potential. In order to investigate the significance of this variability for the sediment budget, we combine our findings from geomorphology with erosion rates derived from ^{10}Be dating and petrographical analysis of river sands.

Deltaic progradation under high tidal range: the lower Moodies Group, Barberton Greenstone Belt, South Africa

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The Moodies Group, uppermost stratigraphic unit of the Barberton Greenstone Belt, South Africa, comprises well preserved shallow-water siliciclastic lithologies deposited ca. 3.22 Ga ago in one or several basins on one of the world's oldest crustal fragments. Strata are preserved in several complex folded synclines and range from alluvial and fluvial to prodelta depositional settings in an overall deepening-upward trend. The lack of detailed mapping, structural complexity and uneven exposure has to-date prevented a detailed understanding of lateral and vertical facies transitions within the individual basins as well as between them. A potential key locality in addressing this problem exists in the western Saddleback Syncline in unit MdS1, where an up to 250 m-thick, well-exposed, resistant sandstone unit (the incorrectly named Lomati 'Quartzite') with abundant shallow-water sedimentary structures gradually wedges out north-eastwards over ca. 4 km to grade into thick but poorly exposed fine-grained sandstones and siltstones of a prodelta facies. Mapping, facies analysis, paleocurrent measurements and sedimentary petrography identified (1) a delta geometry in cross section, (2) seven mappable high-energy and shallow-water lithofacies, (3) a transition from fluvial to tidal deposits in an overall progradational geometry, (4) three laterally extensive horizons with abundant mudcracks and mud-chip conglomerates, indicating episodic

desiccation and flooding events with intense reworking, and (5) a change from arkosic to lithic sandstone petrography. These findings suggest that unit MdS1 was deposited in a tide-dominated basin that recorded changes in basin geometry, source region uplift and sediment supply.

Facies analysis of lowermost Cambrian carbonate platform in East Yunnan, South China: An implication of the importance of depositional hiatus

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Poster in Session A5-02

The Precambrian (Pc) to Cambrian (C) interval is a key as well as a mystery in Earth history. The origin of many animal phyla can be traced to within ca. 20 Ma of the Pc-C boundary which marks the major radiative evolutionary event of life on Earth, the so-called "Cambrian explosion". The Terreneuvian (542-521 Ma) strata in east Yunnan Province in South China preserve an excellent record of the lowermost Cambrian bioradiation and global biogeochemical changes. Carbonate carbon isotope values reveal a noisy transition with extreme δ13C oscillations until about 521 Ma, after which a modern marine ecosystem became firmly established. However, as subaerial exposure and depositional hiati on carbonate platforms are common due to sea level fluctuations, detailed sedimentological work is needed to link geochemical perturbations to fossil zones. This work provides an improved understanding about the spatial and temporal development of a carbonate platform in the lowermost Cambrian of east Yunnan. Two units consist of stacked, northeastward-thickening, shallowing-upward phosphorite-carbonate sequences interlaced by a karsted surface which forms a third-order sequence boundary. The arrangement of 16 recorded lithofacies in 5 detailed measured sections along a S-N traverse document an inner-platform depositional setting characterized by commonly changing tidal flat, protected lagoon and shallow subtidal / sandy shore paleoenvironments. Hardgrounds are common especially near the sequence boundary in an intertidal to shallow subtidal environment. The interval of common hardgrounds affects δ13C values and a new small shelly fossil zone. It would be valuable, therefore, to study the Pc-C interval in an interdisciplinary way rather than focusing on individual factors.

High-resolution magnetics reveal the deep structure of a volcanic-arc related basalt-hosted hydrothermal site (Palinuro, Tyrrhenian Sea)

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High-resolution magnetic surveys have been acquired over the partially sedimented Palinuro massive sulfide deposits in the Aeolian volcanic arc, Tyrrhenian Sea. Surveys flown close to the seafloor using an autonomous underwater vehicle (AUV) show that the volcanic arc-related basalt-hosted hydrothermal site is associated with zones of lower magnetization. This observation reflects the alteration of basalt affected by hydrothermal circulation and/or the progressive accumulation of a non-magnetic deposit made of hydrothermal and volcaniclastic material and/or a thermal demagnetization of titanomagnetite due to the upwelling of hot fluids. To discriminate among these inferences, estimate the shape of the non-magnetic deposit and the characteristics of the underlying altered area – the stockwork – we use high-resolution vector magnetic data acquired by the AUV Abyss (GEOMAR) above a crater-shaped depression hosting a weakly active hydrothermal site. Our study unveils a relatively small non-magnetic deposit accumulated

at the bottom of the depression and locked between the surrounding volcanic cones. Thermal demagnetization is unlikely but the stockwork extends beyond the limits of the non-magnetic deposit, forming lobe-shaped zones believed to be a consequence of older volcanic episodes having contributed in generating the cones.

Distribution and properties of ejecta deposits in the region of Morasko meteorite impact craters (Poznań, Poland)

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Oral in Session A3-02

Morasko in the northern part of Poznań (western Poland) has witnessed the largest known iron meteorite shower in the Central Europe. Apart from the thousands of iron meteorite pieces, the impact has left also at least 7 meteorite impact craters with maximum diameter of about 100 m. The craters are in the region of terminal moraine of the last glaciation. The age of the impact has been assessed to be older than about 5500 years BP. The previous geological studies in the region failed to identify impact ejecta layer around the craters and the documented deposits were interpreted to be of glacigenic origin. The objective of the present study is to reinterpret earlier observations and provide new evidences of ejecta layer from meteorite impact in unconsolidated sediments. The studies focuses on the biggest crater and included detail topographical mapping, georadar survey, field investigations of the sediments in trenches and collection of 52 cores with the maximum length of 9.5 m. The sediments were subjected to sedimentological and mineralogical studies and samples of likely paleosoil were dated with AMS 14C. The studies revealed a complex pattern of surface and subsurface sediments in the region. It's partly due to complicated stratigraphy left by the last glaciation, when a push moraine was formed, which composed of a mixture of glacial till, sand and gravels as well as deformed clay of Neogene age. Thus, it's often difficult to recognize the ejecta layer. In the sediment cores where a likely paleosoil is preserved the ejecta deposits reflect reversed stratigraphy. At sites with less distinct variability it was found that presence of angular clay clasts help in identification of the ejecta layer. The most commonly, distance from the crater rim where the recognizable ejecta is visible reaches only few tens of meters. These results were financed from the project, which is funded by National Sci¬ence Center (Poland) grant No. 2013/09/B/ST10/01666.

The key influence of magmatism on the thermo-chemical-tectonic evolution of terrestrial planets

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Oral in Session A3-03

Melting and resulting differentiation play a large role, starting from the magma ocean phase and contin-uing through long-term evolution with the production of different types of crust (oceanic and continental on Earth). We can now numerically model the evolution of a terrestrial planet from the magma ocean stage to the present day using a 2D or 3D model of the mantle-lithosphere system couped to a parameterized model of the core (and sometimes, atmosphere), including the effects of magmatism and variations in tectonic mode. Such models will be presented here. Our recent models find that melting has several key effects on planetary evolution. Firstly, it produces compositional heteroge-neity in the lithosphere, including continental cratons [Rolf & Tackley, 2011 GRL] and basaltic crust [Lourenco et al. submitted], which facilitate plate tec-tonics by focussing or producing stresses, making it 'easier' for the lid to break. Thus, scaling laws that are based on purely thermal convection cannot be literally applied to planetary evolution. Secondly, magmatism acts as a thermostat on mantle temperature, losing large amounts of heat when the mantle is hot, when internal heat production is high such as early in a plan-et's evolution [Nakagawa & Tackley, 2012 EPSL] or in a stagnant-lid mode – [Armann & Tackley, 2012 JGR] showed that in a stagnant-lid Venus-like planet most of the heat loss is accommodated by magmatic heat pipe volcanism. Thirdly, it can produce composi-tional stratification in the deep mantle, which modules heat flux from the core, determining geodynamo evo-lution [Nakagawa and Tackley, 2010 GCubed]. On Earth most magmatism is intrusive rather than extru-sive. This tends to warm and weaken the crust, result-ing in substantial surface deformation even if modern-day plate tectonics did not operate (e.g. Gerya, 2014 EPSL).

Glacial structures revealed in County Kerry, Ireland, by detailed 3D geophysical investigation

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Poster in Session A6-07

Glacial topographic structures formed by processes close to the ice front are rarely preserved because of subsequent ice-advance. On the northern coast of Kerry Head in County Kerry, Ireland, the coastal outcrop shows that the basal surface of the Quaternary glacial deposits is offset by two, 2-4 m high, near vertical, topographic scarps. We investigated the inland unexposed extension of these structures using closely spaced ground-penetrating radar (GPR), within a 50 x 60 m grid, using 80 and 200 MHz antennae, and 2D electrical resistivity tomography (ERT) using 12 2D profiles with 0.3-1 m electrode-spacing. ERT is capable of determining the depth of the Quaternary sediments while GPR can also image the bedding in the underlying sandstones. We show that the scarps propagate inland at an oblique angle to the strike measured in outcrop. The scarps are formed by a combination of the two joint sets present in the sandstones that accommodated the collapse of the scarp by erosion of a shale layer between the sandstones. Preservation of the near-vertical scarps attests to the speed in which the structure was buried.

Kinematic analysis of syn-sedimentary normal faults in the Otway Basin, Australia

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Poster in Session B1-01

The Otway Basin formed during the Cretaceous passive breakup of the southern margin of Australia. We have analysed an approximately 8 km x 7 km x 4 km depth 3-D reflection seismic dataset, especially the faults. Some faults extend from the lowest recognizable stratigraphic horizons at 2.4 km depth up to the highest seismically-visible horizons at ca. 400 m depth. They were interpreted in fault plane-normal and custom-line sections, at 40-60 m intervals. All analysed faults have normal displacements; they are partly listric in the south of the area, but planar in the northern part. The major faults dip by 60° southwest on average; some minor antithetic faults are apparent, particularly in the south. We performed two kinds of fault analysis: fault plane attributes, such as cylindricity and curvature, were calculated and juxtaposition throw maps were constructed to show the lateral change in throw along fault strike for each horizon. The former demonstrate that long axes of the fault plane curvature maxima are not always parallel to the dip direction, rather a number are oblique, with a clockwise rotation of ca. 15° with regards to the dip direction. Juxtaposition

maps of different faults have some similarities; for instance vertical displacement and fault strike length always decreases stratigraphically upwards. However, two different groups of faults exist with different tip-line migrations: symmetrical and asymmetrical. The juxtaposition maps support the attribute analysis of the faults in that the symmetrical convergence is due to pure dip-slip movement on the faults, whereas the asymmetrical tip-line convergence is due to normal and right-lateral movement of the faults. There is no particular distribution pattern of the different faults; rather their mixture suggests strain partitioning occurred during the the development of the passive margin.

Prediction geodynamic safety in the disposal of high-level radioactive waste in geological formations

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Poster in Session B5-02

The possibility of using deep geological formations to dispose of high-level radioactive waste (HLRW) is a subject raising heated debate among scientists. In Russia, the idea of constructing HLRW repository in the Niznekansky granitoid massif in Krasnoyarsk area is widely discussed. To solve this problem we are elaborating a technology associated with time – space stability prediction of the geological environment, which is subject to geodynamic processes evolutionary effects. It is based on the prediction of isolation properties stability in a structural tectonic block of the Earth's crust for a given time. The danger is in the possibility that the selected structural block may be broken by new tectonic faults or movements on a passive fault may be activated and thus underground water may penetrate to HLRW containers. The technology comprises the following complex of research methods. 1. Structural geology, engineering geology and geomorphology methods of fault block tectonics. 2. Heterogeneous finite-element modeling of stress fields distribution in structural blocks. 3. Paleotectonic reconstruction of stress – strain state of the areas under investigation for a period of time of up to 1 million years. 4. Zoning of the area and separation of deep linear zones from geological and geophysical data that can be potential zones of tectonic faults on the basis of artificial intelligence methods. 5. GPS-observations of modern movements of the Earth's crust. 6. The method of rock destruction time calculation on the basis of the kinetic theory of solid bodies strength.

Responding to anthropogenic climate change and ocean acidification: insights from a global weathering model

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Oral in Session A6-04

High-magnesium olivine is a particularly fast-weathering silicate mineral found in basic and ultrabasic rocks. Because mineral weathering is a sink for atmospheric CO_2, it has been suggested that climate change could be ameliorated by applying crushed olivine to the humid tropics so that weathering fluxes could be increased, thereby drawing down more CO_2. As weathering is also a source of alkalinity delivered to the oceans by rivers, this type of intervention could potentially also address the "other" climate change problem, ocean acidification. We present a new global weathering model which, driven by climate, runoff and primary productivity projections from five general circulation models and a dynamic global vegetation model, predicts the CO_2 consumption due to weathering under two Representative Concentration Pathways. By forcing an Earth Systems model with net emissions curves, we test the hypotheses that enhanced weathering can ameliorate climate change and ocean acidification for application scenarios encompassing both natural ecosystems and agricultural lands. Finally, we consider the ethics and possible adverse

consequences of enhanced weathering, and whether any of our idealized scenarios could or should be implemented at any scale.

Atlantic inflow and the erosional input into the Nordic Seas during the late Plio- and Pleistocene

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Deep and intermediate waters formed in the Labrador Sea, Nordic Seas and North Atlantic Ocean have strongly affected the Atlantic Meridional Overturning Circulation (AMOC), which not only ventilates much of the Atlantic Ocean, but also exerts controls on global climate. In this study we reconstruct past intermediate and deep water mass mixing and erosional inputs in the Nordic Seas and the North Atlantic Ocean over the past 3 million years based on neodymium (Nd), lead (Pb) and strontium (Sr) isotope compositions of seawater-derived ferromanganese coatings on bulk sediment particles, as well as from the detrital fraction itself, which serves as a sediment provenance indicator. Data were obtained from ODP/IODP sites in the Nordic Seas on the Svalbard shelf (Site 986), on the Vøring Plateau (Site 644), and in the North Atlantic Ocean on the Rockall Plateau (Site 982). At the two sites in the Nordic Seas we observe a very strong influence of changes in local erosional inputs on the water mass isotopic compositions linked to the onset of Northern Hemisphere Glaciation (NHG). These Nordic Seas sites have for most of the time been influenced by Norwegian Sea Deep Water and Arctic Intermediate Water, whereas the Rockall Plateau Site has been dominated by overflow waters from the Nordic Seas and the Labrador Sea. Furthermore, we were able to identify periods of distinct change in Atlantic inflow into the Nordic Seas. For instance, between 2.2 and 1.5 Ma a warmer climate and moderate glacial conditions prevailed, resulting in enhanced inflow of warm Atlantic waters reflected by similar Nd isotope compositions of deep waters at all sites. In contrast, at the beginning of the Mid-Pleistocene Transition (1.5 – 1.2 Ma) a significant reduction in Atlantic inflow occurred, expressed in markedly distinct deep water Nd isotope compositions in the Nordic Seas and the North Atlantic Ocean.

The Case of the Arctic Wegener Fault -Postulations and present state of knowledge

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Alfred Wegener organized several expeditions to Greenland. But although the area played a major role in his revolutionary hypothesis on the drift of continents, he never did geological field investigations there. Wegener's only example of major-strike-slip movements between drifting continents is the case of Nares Strait between Arctic North America and Greenland. His general figure on this case (see below) was possibly based on a publication by TAYLOR (1910). This general figure was accompanied by two small geological maps of the area, in the first edition by Willis (1912), in the second edition replaced by a map of Lauge Koch (1922), whom Wegener had joined on an expedition to East Greenland. Both geological sketch maps are largely wrong and cannot be used for any reconstructive purposes in support of the hypothesis. Yet the general idea of strike-slip through Nares Strait has survived, although not accepted by all geologists.The question of strike-slip movements in the area became even a major geological debate between mobilistic and fixistic views (Dawes & Kerr, 1982). Independently of this debate, J.Tuzo Wilson, one of the fathers of plate tectonics, gave credit to Wegener's early considerations, when he christened a postulated transform fault through Nares Strait "Wegener Fault" (Wilson, 1985). Since 1998, the structure of the Wegener Fault was the subject of detailed investigations of the German Arctic program CASE. Several onshore expeditions, one marine seismic cruise in Nares Strait and several linking aeromagnetic surveys provided new insights into the problem. The present state of knowledge and interpretation is presented in this contribution. Wegener, 1915, Fig. 1 (colours added)

Extension and thermal evolution at the Mid-Norwegian Margin – Insights from basin modelling between Greenland and the Møre Margin

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The Norway-Greenland rift system experienced multiple stretching episodes since the collapse of the Caledonides, eventually leading to break-up in the Early Eocene, seafloor spreading at the now extinct Aegir Ridge and the formation of the Norwegian continental margin. Rifting continued during the Cenozoic finally yielding the second break-up in the North Atlantic in the Late Oligocene and the formation of the Jan Mayen Microcontinent (JMMC). Information on the tectonic development at continental margins is documented in the stratigraphic record of sedimentary basins. The Møre Basin is one of the deep sedimentary basins at the Norwegian Margin that developed during these successive episodes of stretching. We present new geophysical data of the Møre Basin, which have been integrated with existing deep seismic reflection and refraction data. The structural and thermal evolution along a profile across the Møre Basin has been reconstructed using different basin modelling approaches and verified by borehole data and gravity measurements. The local transect could be further extended until the East Greenland margin using a modified interpretation of published crustal transects (Breivik et al 2009, Mjelde et al. 2008). The resulting transect crosses the North Atlantic from the Møre margin across the JMMC to East Greenland. The reconstruction of this transect includes both break-up events and the formation of oceanic crust between the Møre Basin and East Greenland and therefore allows us to explore the feedbacks of break-up related magmatic events on the evolution of the adjacent sedimentary basins. The resulting stretching factors and estimated extension coincide well with estimations resulting from global plate reconstruction models (Torsvik et al. 2008).

Anhydrite precipitation in hydrothermal systems

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Seafloor hydrothermal systems have been studied intensively since the discovery of the first black smokers in the 1980s. The composition and metal concentration of hydrothermal fluids venting at the seafloor is strongly temperature-dependent and fluids above 300°C are required to transport metals to the seafloor (Hannington et al. 2010). Previous studies have shown that permeability seems to be a key factor controlling the style and temperature of hydrothermal venting (Jupp and Schultz, 2000; Andersen et al. 2015). In general, a too high permeability results in high fluid fluxes and mixing with cold seawater as well as short residence times of the fluid near the heat source. Both processes result in low fluid temperatures. However, ore-forming hydrothermal systems and high temperature vents in general are often associated with zones of enhanced permeability.

Faults or fractures are, in fact, used to determine possible locations of ore deposits (Heinrich & Candela, 2014). In addition, numerical models of hydrothermal convection along the ridge axis of mid-ocean ridges so far could not resolve the observed irregular spacing of vent fields, but show a certain wavelength of convection cells due to the applied homogenous permeability structure. Mineral precipitation has been suggested to clog the pores and thereby to reduce the permeability leading to focused high temperature fluid flow. Anhydrite for example precipitates from seawater if it is heated to temperatures above ~150°C or due to mixing of a hot Ca-rich hydrothermal fluids with cold seawater. We implemented anhydrite reactions (precipitation and dissolution) in our numerical models of hydrothermal circulation. The initial results show that the precipitation of anhydrite efficiently alters the permeability field and affects the spacing of hydrothermal convection cells as well as the resulting vent temperatures.

West Eifel xenolith analyses via multiple isotopic systems

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The Quaternary West Eifel's mantle xenoliths may provide insights into the composition and evolution of the regional continental lithospheric mantle. Previous studies of anhydrous Dreiser Weiher (DW) lherzolite nodules have recorded a Paleoproterozoic depletion age. Isochronous Rb-Sr and Sm-Nd relations amongst nodules, in turn, led to inference of an early Cambrian second partial melting event. Association of some xenoliths' isotopic signatures with European lower crustal signatures may hint at a Variscan episode of fluid metasomatism. Two younger — early cretaceous and quaternary — episodes of melt infiltration have been concluded from textural and Sr-Nd isotopic observations. Focusing on anhydrous lherzolites from the DW locality, we present the first Rb-Sr, Sm-Nd, and Lu-Hf mineral isochron study of Eifel xenoliths. Mineral separates of olivine, ortho- and clinopyroxene, and bulk fractions were digested at low pressure. All analyses were conducted on the Cologne/Bonn Neptune MC-ICP-MS. Initial results indicate Lu-Hf resetting after 200 Ma, coinciding with the two youngest metasomatic episodes. Preliminary Sm-Nd data provide concurring observations. As our sample was a vein-free, anhydrous lherzolite, we infer that it recorded the older of the two young episodes episodes of melt infiltration. We discuss the age and initial isotopic data data obtained from our Rb-Sr, Sm-Nd, and Lu-Hf isochron study and possible implications for lithospheric mantle modifying events, as well as possibly distinct responses of the different dating tools to these events.

Zircon dating compared by different methods (SHRIMP/SIM, evaporation, high-precision CA-ID-TIMS) - how accurate and precise can we date zircons?

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Several samples from Variscan granites were dated in different laboratories and by different methods: i) SHRIMP/SIM: in St. Petersburg and Stockholm, ii) evaporation: in Freiberg, iii) high-precision CA-ID-TIMS: in Geneve, Freiberg and Zürich. Zircon dating results will be presented and discussed for several samples from different granitic complexes. In conclusion, the accuracy and precision of these zircon dating methods will be assessed and compared to recent statements of "1-3% (2s) laboratory reproducibility" for SHRIMP/SIM-ages (Schaltegger et al., 2015).

Ref: Schaltegger U., Schmitt A.K., Hortswood M.S.A. (2015): U-Th-Pb-zircon geochronology by ID-TIMS, SIMS, and laser ablation ICP-MS: Recipes, interpretations, and opportunities. Chem. Geol. 402, 89-110.

Quantification of neotectonic movements after volcanic edifices and Quaternary deposits – an example from the Lausitz block-faulted area (Germany)

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Three Cenozoic volcano remnants (Baruth, Landeskrone, Sonnenberg) and adjacent Quaternary sediments were investigated in the Lausitz Volcano Field (climax 32–29 Ma) for the reconstruction of the uplift and denudation history for the Lausitz Block, a Cadomian-Variscan consolidated block-faulted area. The Baruth Complex Volcano consists of three deeply eroded scoria cones. Only in glaciofluviatile Saalian-1-Glaciation sediments appear greater amounts of scoria pebbles at this place. This suggests greater scoria bodies for the 33–27 Ma old volcanoes at the time about 250 ka ago. Such observation implies a young uplift of the Lausitz Block. The Landeskrone Volcano gives also indications for neotectonic movements. The reconstruction of this large monogenetic scoria cone allows in connection to adjacent volcano edifices the estimation of an average denudation rate from 3 mm/ka for the last 34 Ma. This uplift and denudation rate increased in the Middle Pleistocene. Otherwise, the recent 200 m high basaltic hill would destroyed by the influence of two Elster glacial ice streams between 400–320 ka ago and basaltic pebbles should have been found in the connected glaciofluviatile deposits in the upstream of the volcano hill. The Sonnenberg Volcano is situated in Zittau Mountains 1.3 km southward the Lausitz Block. The tectonical uplifted area overtops the Lausitz Block by 200 m. In contrast, the Sonnenberg Volcano (approx. 30 Ma) and the adjacent volcanic edifices show little erosion. Therefore, the maximal 100 m deep erosion of the Zittau Mountains – determined after the Sonnenberg Volcano – should be induced by a young uplift with a rate of 10 mm/ka since volcanic time too. Today, glacigenic deposits at the top of the Zittau Mountains occur 40–60 m above the glaciation limit at the foot of the Lausitz Highland and Zittau Mountains. This indicates a neotectonic uplift of the Zittau Mountains from 100–150 mm/ka after the Elsterian-1 period of glaciation before 400 ka.

Comparison between one-way and two-way hydro-mechanical coupling for assessment of fault fluid flow by numerical simulations

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Fluid injection into saturated porous media triggers pressure elevation and volume changes in the host rocks and adjacent fault zones due to volumetric strains. Consequently, the hydraulic conductivity of faults can increase by several orders of magnitude, and thus induce upward migration of fluids resulting in the salinization of shallower aquifers. Since interaction between hydraulic and mechanical processes is significant in this context, we applied coupled hydro-mechanical simulations to assess the impacts of geological underground storage on stress state alterations and fluid flow at a prospective onshore CO_2 storage site in the Northeast German Basin. A Lower Triassic saline sandstone aquifer, sealed by several caprocks from the Triassic to Tertiary, was chosen as target horizon for CO_2 injection. The Upper Tertiary Rupelian clay forms the main regional barrier separating salt water bearing aquifers from Tertiary and Quaternary freshwater reservoirs. However, glacial erosion resulted in thinning or a complete absence of the Rupelian clay in some areas that also meet parts of regional fault zones. Therefore, a structural geological model was used in our coupled hydro-mechanical simulations, considering hydro-mechanical one-way and two-way coupling procedures. One-way coupling considers pore pressure calculated by the multiphase flow simulator as input to the hydro-mechanical simulator, while feedback from the mechanical simulator to the multiphase flow simulator is not taken into account. In contrast, the two-way coupling procedure includes that feedback to account for changes in hydraulic properties. Our simulation results outline that a two-way coupling is required when fault fluid flow is assessed in numerical simulations exhibiting significant volumetric strain increments, since hydraulic flow properties change by several orders of magnitudes enhancing pre-existing fluid migration pathways.

Observing the Iquique aftershock sequence: the HART deployment

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The Northern Chile margin has long been identified as a seismic gap (Iquique gap), which could give rise to a M∼9 megathrust earthquake if it ruptured all at once. This area was thus selected for a European-South American operated plate boundary observatory (IPOC – Integrated Plate boundary Observatory of Chile). Following the M 8.1 and M 7.6 earthquakes from April 1st and 3rd 2014 in the Iquique gap, several field teams quickly went to Northern Chile in the framework of the HART (Hazard and Risk Team) initiative in order to install new seismic instruments, retrieve data from offline-instruments, and re-measure GPS monuments in order to gain a better and more detailed understanding of the rupture process and the rupture surface based on the aftershocks and their distribution. In total, 25 seismometers (19 Trillium Compact, and 6 short-period) were deployed in April 2014, 70 GPS points re-measured, and two new cGPS stations. Finally, in December 2014, 15 ocean bottom seismometers were installed in the offshore region of this earthquake. In this poster we provide a summary of these activities.

Replacement of uraniferous opal by chalcedony and disturbance of the U-Pb system

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Poster in Session C1

U-Pb geochronology of hydrous silica potentially provides age constraints on near-surface, low temperature processes, such as fluid migration during weathering or hydrothermal activity. Reliable application of the opal geochronometer requires an understanding of the processes that could cause complications for its U-Pb systematics. We studied a natural sample of petrified wood from the Siebengebirge, where uraniferous opal-CT was replaced by chalcedony. The petrified wood occurs within quartzous sand and gravels of Upper Oligocene stratigraphic age. These sediments were covered by an extended trachyte tuff around 25 Ma and document a protracted history of silica indurations. Results from ionprobe and LA-ICPMS opal U-Pb measurements indicate that the dominant silicification event clearly postdates active volcanism and clastic sedimentation by about ∼8 Myr. Fluorescence microscopy and Raman analyses revealed that some domains of Siebengebirge wood opal are characterized by well-preserved tracheid cell structures and thus represent the texturally oldest silica generation. At a later stage, the early wood opal was partially transformed to chalcedony. Across the reaction front between both silica domains the inherited wood structure fades out and secondary μm-sized inclusions accumulated and pertruded as inclusion trails into the opal matrix. Carnotite and likely vanadinite (U- and Pb-vanadates, respectively) were identified as the primary inclusion phases.

LA-ICPMS U-Pb analyses of the uraniferous, tracheid-textured wood opal returned a highly dispersed pattern within time-resolved spot segments. Measured isotopic ratios spread close to the concordia with apparent ^{206}Pb-^{238}U ages spanning from 10 to 200 Ma. The pattern suggests a heterogeneous redistribution of radiogenic lead (and less pronounced of uranium) within the analytical volumes. Probable hot spots are the secondary vanadate phases that readily recognized along a replacement front.

Mercury's Low-Degree Geoid and Topography from Insolation-Driven Elastic Deformation

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Poster in Session A3-03

Because of its high eccentricity, nearly zero obliquity, and 3:2 spin-orbit resonance, Mercury experiences an uneven insolation that leads to significant latitudinal and longitudinal variations of its surface temperature. Such variations, which can be expressed in terms of degree-2 and 4 spherical harmonics, propagate at depth imposing a long-wavelength thermal perturbation throughout the mantle. Using a 3-D mantle convection model of thermal evolution, we computed the accompanying mantle density distribution and used it to calculate the mechanical and gravitational response of a 3-D compressible and self-gravitating elastic shell. We then compared the resulting surface deformation and geoid at degree 2 and 4 against Mercury's topography and geoid derived from MESSENGER data. For an elastic thickness between 110 and 180 km - mainly dependent on the mantle thermal expansivity and representative of the time at which the pattern of surface temperature developed through the mantle - we obtain a variance reduction of more than 95% for the joint prediction of topography and geoid. The predicted range of elastic thickness can be also reconciled with independent estimates based on the mantle temperature distribution and the strength-envelope formalism. The insolation pattern thus explains Mercury's low-degree shape and geoid.

Controls on intramontane 'cool'-spring limestones, Austria (Eastern Alps): Implications of a quantitative approach.

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Oral in Session C4

Limestone precipitated from non-thermal springs (<20°C) is often considered as a warm-climatic feature. To test this, we compiled 186 geological maps (1:25000-1:50000) of the Austrian Geological Survey for parameters relevant to spring-associated limestone (SAL). Our data show that the distribution of 376 SAL deposits is mainly controlled by geological substrate and structure. Below the present permafrost limit in the Eastern Alps (∼2600–3000 m), mean annual air temperature (MAAT) exerts little influence on SAL density (number of SAL per 100-m altitude increment). The altitudinal density of SAL instead roughly correlates with the hypsometric curve. SAL prevail on: (a) flysch-type terrains, (b) terrains of calcphyllites, (c) units telescoped between the Penninic and Austroalpine domains, and (d) domains with rock cataclasis. The Northern Calcareous Alps, in contrast, are poor in SAL. Limestone spring seems to be favoured by: (a) dissolution of fine-grained carbonate (e.g. in marls, phyllites, tills), (b) presence of sulfate (e.g., evaporite dissolution, pyrite oxidation), and (c) slope deformation and rock cataclasis. Locally, anoxic spring with Fe^{2+}, or spring with

Mg/Ca $\geq$ 3, may result from sulfide oxidation and rock leaching. 'Climate', if understood as MAAT, and as long as MAAT is above the threshold for permanent snow cover or buildup of ice, seems to be of minor significance in controlling intramontane SAL deposition. Instead, spring-water chemistry as a function of rock type and ground preparation (e.g. faulting) and hydrology most significantly control intramontane SAL. Our database is used to develop a predictive model of SAL deposition.

grains. The shear zones document at least two different deformation stages: A first stage is characterized mainly by dissolution-precipitation creep generating the scaly cleavage, representing low-stress viscous flow in the subduction zone. A second stage is recorded by the shear bands and associated quartz veins, indicating localized and episodic deformation at transient high stresses. This stage is interpreted to represent deformation triggered by seismic activity during detachment and exhumation.

Deformation and stress history during burial and exhumation – the quartz microstructural record of rocks from the Talea Ori, Crete, Greece

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Oral in Session A1-04

Quartz microfabrics from HP-LT metamorphic rocks at the base of the lowermost known level of the Cretan nappe pile in the Talea Ori Mountains are presented with the aim to provide information on the deformation and stress history during burial and exhumation. In components of low-strain metaconglomerates, deformation microstructures originating from the source rocks of the pre-Alpine basement are preserved or quasi-statically overprinted during the later geological history. A gradual transition from these low-strain metaconglomerates, associated black shales and metacherts, to shear zones is observed. The shear zones are characterized by a scaly foliation, shear bands and associated quartz veins. The shear bands generally indicate down-faulting of the northern block. Associated quartz veins taper wedge-shaped at a high angle to the foliation, decorating the shear band boundaries and showing shear offsets. Microfabrics from these shear bands and related vein quartz show indication of dislocation glide-controlled deformation of quartz by the presence of deformation lamellae, deformation bands, short-wavelength undulatory extinction and localized strings of recrystallized

Experimental study of the carbonation process in natural hydraulic lime binders

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Poster in Session B6-01

Alternative cements, such as natural hydraulic limes, represent excellent compatible binders for the conservation of the building heritage. Using a marly limestone as raw material, a series of calcination experiments were performed at 850, 900 and 950°C for 12 hours, respectively. The reactivity of the produced binders, strongly related to the quicklime content, was evaluated by wet slaking rate tests. The resulted natural hydraulic limes putties were exposed to carbonate in the presence of atmospheric carbon dioxide, under constant conditions of relative humidity and temperature (75% and 25°C, respectively). Studies monitoring the carbonation process of the binders via X-ray diffraction and thermogravimetric (DTG-TG) analysis after 20, 40, 60, 120, 180 and 365 days of curing, are described. Based on the mineralogy and especially on the β-Ca_2SiO_4/$Ca(OH)_2$ ratio, the examined samples represent hydraulic lime binders with different degree of hydraulicity (moderately and eminently hydraulic). Significant carbonation evolution differences have been observed among the binders, depending strongly on the calcination temperature. The conversion of portlandite ($Ca(OH)_2$) to calcite is almost completed throughout the samples, after 20 days of curing. After 40 days the presence of aragonite and vaterite was detected, with their percentage in the binders increasing with the evolution of the carbonation. Based on the results of the quantitative mineralogical analysis is indicated, that the presence of aragonite and vaterite on the carbonation profiles of the binders is due not only to the decomposition of the metastable phase of larnite (β-Ca_2SiO_4), but also to a solid state transformation of a part of calcite to the other two polymorphic modifications of calcium carbonate. Thermal analysis patterns display that, both temperatures and rates of reaction of the decomposition of the calcium carbonate minerals present in the binders, decreases as the carbonation process proceeds.

CLIP - Chile Large-slip: Initiation and Propagation mechanisms

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The great 1960 Chile subduction thrust earthquake (EQ) was the largest, ever instrumentally recorded EQ with a rupture length >1500 km (37 - 43°S). In 2010, the plate-boundary segment to the north ruptured during the Maule EQ. Apparently, the subducted sediment exerts a major control on the mechanical behavior of the seismogenic zone. Mineralogical investigations indicate a strong northward increase in feldspar (fsp) and decrease in quartz (qtz) contents, suggesting a deep brittle-ductile transition at 37°S, where the EQ originated. Geotechnical experiments on Holocene trench sediments, which are close analogues of sediments presently subducted to seismogenic zone depths, show a southward drop in shear strength and friction coefficients (μ). This suggests that the rupture nucleated in an asperity zone defined by mechanically stronger (μ = 0.4-0.5), fsp-rich sediment and then propagated southward into weaker deposits (μ<=0.15) with abundant mica and chlorite. At the southern end of the 1960 rupture area, materials become stronger again (μ = 0.3-0.5), caused by elevated qtz rather than fsp content. A common hypothesis is that the position of the interplate seismogenic zone is not only controlled by frictional properties, but also by temperature. In order to account for this effect, we employ thermal models of the subduction zone. Two simulated PT dependent subduction pathways as end members - one on very young, hot oceanic crust (46°S) and one colder, 35 Ma-old crust further north (36°S) - predict a latitudinal shift of the onset depth seismicity. Based on the along-strike variations of temperature conditions and mineralogical composition of the incoming sediment we conducted high PT (up to 250 MPa and 250°C) shear experiments. These serve to examine the potential for coseismic slip of the seismogenic zone as well as how the tendency for frictional instability, that result in earthquake nucleation, varies along strike. Tentative results will be subject of the paper.

Sensitivity of active continental margin evolution to different surface process models

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Tectonics and surface processes reshape the crust in regions of deformation and topography development. They create a potentially powerful surface signature of deeper processes, such as slab break-off or delamination. Mass redistribution and stress changes also affect deformation and tectonic evolution. In studying plate boundaries, the resulting challenge for dynamic models is the choice of an appropriate recipe for surface treatment. Applied surface process models (SPM) range from simple, spatially continuous height changes on the grid, to coupling with non-continuous, dynamically reorganizing SPMs that model multiple physical processes. Gross rate changes are an established solution that has provided first-order insights into continental-scale system response. Models with diffusion SPMs reproduce the fundamental transition of foreland basins from underfilled to overfilled, by coupling local process efficiency to the elevation relative to sea-level. Sophisticated SPMs dissect the surface in connected co-evolving elements, hillslopes and channels. These SPMs are applied in studies of orogenic wedges, such as fold-and-thrust belts. Yet, for a given tectonic setting, the appropriate choice of SPM and its impact is not known. We subject a 3D collision model to different SPMs to study the effect on trench, topography, and orogen evolution. To research the interaction at a smaller, crustal scale, where the interaction of tectonic and surface process modes of mass redistribution is strong, we also single out the orogenic wedge area. On this scale, the influence of surface process efficiency on spacing and morphology of structures is corroborated. Results with a non-continuous SPM, featuring hillslopes and logically reorganizing fluvial networks, show surface control on shear zone localization, and the formation of evolving relief and basins.

Reading the Record: Understanding heterogeneity in macrofossil geochemistry

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Macrofossil shells provide one of the most reliable substrates for constraining palaeoenvironmental conditions in deep time using geochemical proxies. Fast growth rates and metabolic control on element and isotope incorporation into their shells, however, lead to a substantial compositional variability, which may impede straightforward interpretation of macrofossil-derived datasets. This data heterogeneity does not necessarily represent only unwanted noise but can be partially utilized for assessing palaeoenvironmental parameters, when the processes governing element and isotope partitioning into biogenic shell materials can be disentangled. Here we present results of multiple geochemical profiles through a single Early Jurassic belemnite rostrum, allowing assessment of the effects on calcite composition of diagenesis, crystal morphology, growth rate, metabolism and environmental parameters. Our results indicate that carbon and oxygen isotope ratios show systematic ontogenetic fluctuations but are uniform within single growth bands. Sr/Ca and Mg/Ca ratios, however, are heterogeneous within single growth increments. Within coeval calcite close to the apical line of the rostrum the dominant control on this variability can be attributed to effects of crystal morphology, leading to significant enrichments (up to >50 %) of Sr and Mg. In intermediate growth bands and towards the rims of the rostrum, calcite precipitation rate can account for enrichment of Sr and depletion of Mg reaching 15 %. Taking these effects into account, residual trace element variability in the data set is greatly reduced, which allows for derivation of more robust average element/Ca ratios for past environmental interpretation.

Hydro-mechanical simulations demonstrate wellbore system integrity during entire lifecycle at the Ketzin pilot site

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Poster in Session B5-01

In geological underground utilization, operating and abandoned wells have been identified as main potential leakage pathways for reservoir fluids. In the scope of the well abandonment procedure currently carried out at the Ketzin pilot site for CO_2 storage in Germany, we implemented a hydro-mechanical wellbore model based on drilling and site operation data. The implemented numerical model comprises all major geological formations and wellbore system components such as cement sheaths, steel casings, tubing and packer elements as well as wellbore annuli for a detailed representation of the entire wellbore system. To assess the wellbore integrity, we investigated the impacts of stress changes on the cement-casing and cement-rock interfaces, occurring during the entire wellbore lifecycle. The simulations were accomplished in three steps including the calculation of the static hydro-mechanical equilibrium, the operational phase and cement backfilling undertaken in the scope of the abandonment procedure. Our simulation results indicate that failure of the wellbore system is highly unlikely to occur during any phase in the wellbore lifecycle. This is strongly supported by site-specific data and observations that do not provide any evidence on the failure of specific wellbore system components. Normal and shear displacements at the cement-casing and rock-cement interfaces exhibit such low magnitudes that formation of potential fluid leakage pathways due to hydro-mechanical processes does not have to be expected. The implemented hydro-mechanical model can be further employed for investigation of different hypothetical failure scenarios and their impacts on reactive fluid flow by a hydro- mechanical-chemical process coupling, which is currently under development.

Synthesis and structural characterization of off-stoichiometric $Cu_2ZnSnSe_4$

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CZTSe is a promising absorber material for solar cells. Record efficiency reported for CZTSSe thin film solar cell [1] exhibits an off-stoichiometric composition because causes intrinsic point defects which determine the electronic properties significantly. This work focuses on the synthesis and characterization of off-stoichiometric CZTSe. In literature [2] A,B,C and D-types have been suggested. We synthesized powder samples of these types by solid state reaction from pure elements. Reaction took place at 750°C with several temperature steps (250°C, 450°C, 600°C) in between. After reaction all samples were ground, pressed in pellets and annealed again at 750°C. Phase content and chemical composition were determined by an electron microprobe system equipped with WDX analysis. Measurements proved the presence of CZTSe as main phase within all samples. Lattice parameters of main phase were determined by Rietveld analysis from XRD data. Refinements were performed using FullProf [3] with kesterite model, because stoichiometric CZTSe crystallizes in the kesterite type structure [4]. Neutron powder diffraction was performed at the Berlin Research Reactor BERII/HZB. Neutron scattering length of Cu and Zn is different, therefore is possible to distinguish between Cu^+ and $Zn^{2}+$ site occupation in the crystal structure. Rietveld refinements of neutron data additionally with the average neutron

scattering length method lead the determination of cation distribution, the Cu/Zn order-disorder defect and the formation of intrinsic point defects related to the according off-stoichiometric cation substitution type. A comparative study in the crystal structure of CZTSe main phase concerning the different off-stoichiometry types will be presented. Acknowledgments: KESTCELLS 316488

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Eoarchean peridotites from southern West Greenland: remnants of Eoarchean mantle or ultramafic cumulates?

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In order to gain new insights into the evolution and isotopic composition of the Eoarchean mantle, several well preserved >3.8 Ga ultramafic samples from the Itsaq gneiss complex (IGC; SW Greenland) were investigated for major and trace elements as well as Hf-Nd isotope systematics. Moreover, we investigated the petrology and mineral chemistry to place constrains on their origin. Some of the samples show similarities to modern mantle peridotites (e.g. Mg/Si vs. Al/Si, Fo# ~90, high Ni and low Ca content). EMP analyses of fresh olivine and spinel reveal that some samples with Fo#<89 clearly have a cumulate origin. REE abundances in the peridotites are near chondritic, but compared to modern peridotites less LREE-depleted (LaN/YbN from 0.31 to 1.37) and in some cases somewhat similar to cumulates reported from Isua (Szilas et al., 2014). These peridotites exhibit small negative Nb-Ta anomalies, consistent with compositions of Isua metabasalts that are interpreted to have a subduction related origin. First Hf-Nd isotope analyses by MC-ICP-MS yielded positive ϵHf(3.85) from +1.5 to +6.0 and ϵNd(3.85) from +1.1 to +4.7. In ϵHf(t)-ϵNd(t) space, the initial eHf and eNd values overlap with those reported for tholeiitic metabasalts and TTGs of the Isua region (Hoffmann et al., 2011). Both Lu-Hf and Sm-Nd data plot on an errorchron close to the minimum age of 3.81 Ga as defined by crosscutting tonalites. This pattern confirms only minor isotopic disturbance of both Hf and Nd isotope systems.2012

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Tectonics, Climate, Relief and Erosion: disentangling driving forces within a complex system

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Keynote in Session A6-01

Tectonics, climate and erosion interact through a number of couplings and feedbacks; the relief of the Earth's surface is both an indicator of state and a central element in this complex coupled system. Topography and relief are generated by tectonics and drive erosion. The spatial distribution of erosion is influenced by climate, in particular the amount, phase and spatio-temporal distribution of precipitation. Feedbacks between erosion, relief and both tectonics and climate have also been identified. The question of what fundamentally drives erosion rates in this coupled system has been around for at least three decades, but has still not been satisfactorily answered. I present an analysis of recently constituted global databases of relief (1) and denudation rates on different time-scales (2,3). These are related to various potential climatic and tectonic control parameters. Initial results suggest a strong primary control of tectonics on erosion rates, with climate playing a secondary role. Various measures of relief appear surprisingly decoupled from erosion rates; I explore different potential explanations for this decoupling. Both physical models and initial analysis of global datasets of sediment flux suggest that relief has a first-order control on erosion rates. However, this control breaks down at high rock-uplift/erosion rates when landsliding becomes the dominant erosional process. It is also modulated by lithology and rock fracturing in ways that are insufficiently understood. Finally, relief appears to be strongly influenced by climate change, in particular through the strong imprint of glacial processes on relief. Late-Cainozoic climate change, characterized by overall cooling and increased climatic variability, appears to be responsible for both increased overall erosion rate and relief in glaciated mountain belts.

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3. Herman et al., Nature 2013

Silicate liquid immiscibility in magmatic systems

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Oral in Session A7-02

Interest in silicate liquid immiscibility between ferrobasaltic and silica-rich melts and its role in natural volcanic and plutonic systems has been on a rise in the last decade. The research on immiscibility has strongly benefited from recent progress in experimental and analytical techniques. Kinetics studies have revealed the importance of nucleation barriers to unmixing, coarsening and spatial separation of immiscible liquids. The improvement of analytical tools has enabled detailed studies of major and trace liquid-liquid element partitioning. Studies of immiscible emulsions in volcanic glasses bring important information on the evolution of plutonic systems and on the potential formation of compositional gaps along liquid lines of descent. Much work has been carried out on revealing traces of silicate liquid immiscibility in layered mafic intrusions, especially in Skaergaard (Greenland), Sept Iles (Canada), intrusions of the Emeishan province in China and the Bushveld Complex in South Africa. At Skaergaard, immiscibility is believed to be responsible for specific intrecumulus reactions and redistribution of Pd, Pt and Au in mineralized horizons of the Plationva reef. At Bushveld, immiscibility has been discussed in connection with the formation of nelsonite layers at the top of the Upper Zone and iron-rich ultramafic permatites (IRUP) in and above the Upper Critical Zone. It appears that the petrogenetic role of immisciblity in large, slowly cooling plutonic magma chambers, which give rise to layered mafic intrusions, can be significant.

Quantifying melting and mobilisation of interstitial melts in crystal mushes

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Poster in Session A7-02

The deformation of crystals mushes and separation of melts and crystals in is critical to understanding the development of physical and chemical heterogeneity in magma chambers and has been invoked as an eruption trigger mechanism. Here we investigate the behaviour of the melt in the well characterised, classic crystal mush system of the Skaergaard Igenous Complex by combining experimental petrology and the non-destructive 3D imaging methods. Our experiments raise a suite of samples from the X Series to temperatures of X-Y C and hold them isothermally for between 24 hours and one week. We then use spatially registered 3D x-ray computed tomography images, collected before and after the experiment, to determine the volume and distribution of the crystal framework and interstitial phases, and the volume, distribution and connectivity the interstitial phases that undergo melting and extraction while at elevated temperature. Image analysis has allowed us to quantify these physical changes with high spatial resolution. Our work is a first step towards quantitative understanding of the melt mobilisation and migration processes operating in magmatic systems.

Triggering and remote triggering of the Atacama Fault System monitored with the IPOC Creepmeter Array (N-Chile)

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The Atacama Fault System (AFS) is an active trench-parallel fault, located in the forearc of N-Chile directly above the subduction zone interface. About 3 M=7 Earthquakes in the past 10 ky have been documented in the paleoseismological record, demonstrating the potential of large events in the future. To investigate the current surface creep rate and to deduce the mode of strain accumulation, we deployed an array of 11 creepmeters along four segments of the AFS. This array monitors the interaction of earthquake activity on the subduction zone and fault activity in the overriding forearc. The displacement across the fault is monitored with 2 samples/min with a resolution of 1μm. Collocated seismometers record the seismicity at two of the creepmeters, whereas the regional seismicity is provided by the IPOC Seismological Networks. Continuous time series of the creepmeter stations since 2009 show that the shallow segments of the fault do not creep permanently. Instead the accumulation of permanent deformation occurs by triggered slip caused by local or remote earthquakes. The 2014 Mw=8.2 Pisagua Earthquake, located close to the creepmeter array, triggered large displacement events on all stations. Another event recorded on all stations was the 2010 Mw=8.8 Maule earthquake located 1500km south of the array. This points to a dynamic triggering process caused by transient stresses during passage of the seismic wave. Investigation of seismic events with Magnitudes <6 show displacement events triggered during P and S wave passage, pointing to static as well as dynamic stress changes for proximal events. Analyzing the causative earthquakes we find that the most effective way to trigger displacement events on the AFS are deep (>100km) earthquakes on the subduction zone interface up to 300 km east of the array.

Water input and water release from the subducting Nazca Plate along southern Central Chile (33°S-46°S)

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The fixation of water in the oceanic crust and upper mantle, the flux of stored water into subduction zones and the partial liberation of those fluids underneath the forearc and arc are mechanisms that impact on most aspects of subduction zone processes, e.g. volcanism, ore deposition and seismicity. Offshore Chile, the age of the subducting Nazca Plate varies between 0 Ma at the Chile Triple Junction (46°S) and ~38 Ma at the latitude of Valparaíso (32°S). Age-related variations in the thermal state of the subducting Nazca Plate impact on the water influx to the subduction zone, as well as the volumes of water that are released under the continental forearc or, alternatively, carried into the deeper mantle. Southern Central Chile is an ideal setting to study this effect, because other factors important for the subduction zone water budget appear constant. We determine the water influx by calculating the crustal water uptake and by modeling the upper mantle serpentinization at the outer rise of the Chile Trench. The water release under forearc and arc is determined by

coupling FEM thermal models of the subducting plate with stability fields of water-releasing mineral reactions for upper and lower crust and hydrated mantle. Results show that both the influx and the release of water vary drastically over a length of 1500 km. In particular, the oldest and coldest segments carry roughly twice as much water into the subduction zone as the youngest and hottest segments, but their release flux to the forearc is only about one fourth of the latter. This high variability over a subduction zone of $\sim$ 1500 km length shows that it is insufficient to consider subduction zones as uniform entities in global estimates of subduction zone fluxes.

Coseismic seafloor displacement by the 2010 Maule Earthquake offshore Central Chile - relation to fault activity and fault strength

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Poster in Session A1-06

Mega-thrust earthquakes at subduction zones can displace the seafloor above the seismogenic zone horizontally as well as vertically by tens of meters, such as in the case of the 2011 Tohoku-oki earthquake, where the frontal prism was shifted landwards by 50 m. Displacement can be expected at the toe of the continental prism, if the coseismic slip propagates updip along the decollement and reaches the seafloor and on the continental slope, if a part of the slip is accommodated along splay faults. The Mw 8.8 Maule earthquake hit Chile on the 27 Feb 2010. The event caused vertical on-land level changes of up to 2.5 m and had a coseismic slip maximum of 17 m at 18 km depth. Within the rupture area, three prominent trench-parallel fault systems crop on the continental slope and express as trench-parallel escarpments that extend over $\sim$250 km at water depths of 1000-2500 m. Two of the features are seen as splay faults that connect the zone of maximum slip on the subduction fault to the seafloor. In order to substantiate if the splay faults were coseimically active, or if the slip reached the trench, we check if systematic seafloor deformation patterns exist around the fault outcrops and at the frontal-most prism. We use three bathymetric data sets to employ cross-correlations techniques between the bathymetry prior to the Maule earthquake, and shortly after the event. The datasets do not overlap systematically but sufficiently over areas of the fault outcrops and the toe of the slope. Cross-correlation is done by systematically shifting and tilting small panes of the "new map" one on top of the "old map", and by quantifying the match. The results are presented as high resolution trajectory maps of seafloor displacement. The method bears the potential to show (1) if, and (2) where deformation at the seismogenic zone has been passed to the surface. In addition, results should offer insights into the relative frictional properties of the faults.

The Reloca Slide offshore Central Chile - a revision based on geotechnical sliding plane characterization and tsunami modeling

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Reloca Landslide is a $\sim$ 24 km3 volume failure at the lower continental slope of the active continental margin of Central Chile. The slide event appears to of post-Last Glacial Maximum (LGM) age. The evacuation site is characterized by a 30° steep and 2000 m high failure plane, while slide deposits are characterized by little disintegration of the failed material and are preserved in the Chile Trench as scattered slide blocks and a debris cone. The particular combination of a steep and high drop and cohesiveness of failed

material makes Reloca Slide a likely local tsunami source. Our numerical simulations show that a similar event would create waves of >8m height that would impact the Chilean coast within 30 minutes. Much of the unfailed lower slope of Southern Central Chile paralleling a coastal stretch of 1500 km shares general morphology, tectonic situation and sedimentary properties with the source region of Reloca Slide. It is therefore of high relevance for risk mitigation to understand preconditioning factors and triggering mechanisms of Reloca Slide as critical boundary conditions for similar potential future events. Geological samples that were cored directly from the failure plane ,are used to run geotechnical experiments for a thorough understanding of the mechanics of the failure process. We are particularly interested in the question of whether failure of the lowermost slope is a continuing process linked to the subduction of the Nazca Plate (e.g. a process needed to re-establish a critically tapered accretionary wedge), or, alternatively, if it is related to particular local conditions or an exceptional triggering event. We report on results from direct and rotary shear experiments to characterize the frictional properties and weakness of the materials at the detachment surface of the Reloca Slide, showing that both shear and cohesive strengths are low in this zone.

Stable weathering fluxes into the oceans over glacial-interglacial cycles from $^{10}Be/^{9}Be$ records and global runoff-weathering models

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Throughout the Quaternary, biogeochemical cycles at the Earth surface responded to large oscillations in temperature and precipitation. Weathering fluxes in modern rivers show that silicate weathering is controlled by such measures of climate. To resolve the extent to which the supply of dissolved elements to oceans was altered by glacial-interglacial oscillations, we present a new weathering proxy [1] that uses the ratio of cosmogenic beryllium-10, produced in the atmosphere, to the stable isotope beryllium-9, introduced into the oceans by the riverine silicate weathering flux. Using sedimentary Be records previously used for reconstructing changes in Earth's magnetic field strength, we show that over multiple glacial-interglacial cycles, and over the last 2 Myr, shifts in global silicate weathering inputs are not detectable [2]. Combining climate model simulations of the Last Glacial Maximum [3] with a new model for silicate weathering [4], we show how large regional variability in runoff between glacial and interglacial periods was insufficient to shift global weathering fluxes into the oceans. The observed and modeled stability explains why removal of atmospheric CO_2 by silicate weathering has been balanced to within 2% of net CO_2 degassing over the last 600 kyr [5].

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Project TUNB - a 3D Model of the North German Basin

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Germany has a long tradition in utilizing the deep subsurface, e.g. as a source of raw materials, as storage space for fossil fuels, and for the disposal of waste. In recent years, the discussion of new technologies such as carbon dioxide capture and storage, the storage of re-newable energy (e.g. compressed air, hydrogen), and an increasing demand for geothermal energy production results in a growing focus on the deep subsurface and raises the need for more detailed geological information. Geology is inherently a 3-dimensional issue and todays computing technology allows the development of large scale 3D geological models. In 2014, BGR and the state geological survey organisations (GSO) of the north German federal states started the project "Subsurface Potentials for Storage and Economic Use in the North German Basin (TUNB)" with the primary intention to construct a 3D model of the entire North German Basin (NGB) within a period of six years. Within the project the GSOs of the north German federal states construct 3D geological models of their areas of responsibility as components for the NGB 3D model. BGR constructs 3D models of the exclusive economic zone in the German North Sea and the Baltic Sea sec-tors. All models need to be harmonised across national and international borders. BGR coordinates these efforts and will finally merge the individual models into one consis-tent model of the NGB. In order to ensure that the individual models fit to a harmonised 3D model, permanent exchange and agreements on a common set of workflows is essential: Concepts for the interpretation and generalisation of horizons, faults, and salt structures are developed, and specific technical issues concerning the modelling software are discussed. As a starting point, these concepts will be tested and applied to a small region, the so-called "pilot-region", where five federal states lie in close proximity to each other at the former inner German border.

Lack of correlation between relief and exhumation in the North Alpine Foreland Basin revealed by thermochronometry and a new thermal model

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The North Alpine Foreland Basin has experienced an enigmatic phase of late-stage exhumation that has been linked to changes in orogenic activity, climate changes and drainage reorganization. Consequently, it has been shown to be a natural laboratory for understanding the influence of climatic forcing on mountain building. Several thermochronological and vitrinite reflectance studies have quantified the amount of exhumation in both the flat lying Plateau Molasse, as well as in the part of the basin that was incorporated into the orogenic wedge after deposition, the Subalpine Molasse. We present an unprecedented data compilation, including new and previously published thermochronological and vitrinite reflectance data from boreholes and surface outcrops. We interpret these data using a new 1-D thermal model that includes a rigorous uncertainty analysis and is used to explore all plausible thermal history scenarios. We use the model to estimate the amount of cooling using during the late Cenozoic. Surprisingly, we find that overall the data show the same amount of cooling in the Plateau and Subalpine Molasse, in spite of the differences in relief, elevation and deformation. Our models show that when all uncertainties, including provenance history of sediments, are taken into account, it is difficult to constrain timing of cooling. Therefore, if climate influenced exhumation rates within the basin, it might have done so already during the late Miocene, or as late as the Pleistocene. However, in the Subalpine Molasse there are large variations in cooling rates along strike of the orogenic front. These data can only be explained either by lateral kinematic variations that have not been described in the literature or by variations in temperatures induced by fluid flow. This study shows that in order to isolate any climate signal from the inferred exhumation rates, a large dataset of single thermochronometric data on sedimentary rocks is not enough. We argue that multiple thermochronometers on the same samples, combined with high resolution field mapping of target areas identified with our models may provide new insights.

Modeling the convective heat transfer in solid planets

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The internal dynamics and thermal evolution of planets is governed by the efficiency of convective heat transfer in the mantle. However, it is computationally challenging to investigate large parameter spaces while precisely modeling the full convective heat flow. Therefore, parameterized descriptions of mantle convection in planetary bodies are essential and have been widely used in the past. For this study, we choose to deploy the mixing-length theory because it uses only local values of physical quantities. Thus, it should yield a better spatial resolution when compared to common parameterized convection models. Originally obtained solely for fluids characterized by the combination of low Prandtl and high Rayleigh numbers, Sasaki & Nakazawa [1] extended the mixing-length theory by reformulating it for highly viscous fluids. This extension is based upon the estimation of the convective velocity by considering the balance between the buoyancy force operating on thermal parcels and the viscous drag instead of the free-fall velocity. We aim at calibrating the mixing length to accurately reproduce temperature profiles and heat-flow relationships obtained from three-dimensional convection experiments. To realize this, we use the finite-volume code Gaia [2] to carry out basally and internally heated numerical simulations with viscosity contrasts of up to 10^6 across the convective fluid. The resulting mixing-length scaling for convection of viscous fluids will be presented. Furthermore, the usefulness of the mixing-length approach as a reliable tool for modeling the thermal state of planetary interiors is demonstrated. [1] Sasaki, S. & Nakazawa, K. (1986): Metal-silicate fractionation in the growing Earth: Energy source for the terrestrial magma ocean. J. Geophys. Res., 91, 9231. [2] Plesa, A.-C., Hüttig, C., Tosi, N., & Breuer, D. (2015): Thermo-chemical mantle convection simulations using Gaia. In: High Performance Computing in Science and Engineering '14. Springer.

Y and La compatibility in silicate melts and its dependence on melt structure: A first principles simulation study

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Knowledge of trace element partition coefficients is crucial for our understanding of global element cycles. While a great number of experimental studies on mineral-melt partitioning have been performed in the past, the influence of melt structure in this matter has at most been considered empirically. One of the major challenges is the

lack of reliable structure models for typical melts at the relevant P/T conditions. First-principles molecular dynamics simulations are predictive and provide a unique approach to structure and thermodynamic properties of both minerals and melts. In this contribution, we employ a two-step computer simulation strategy to access information about structural environment and partitioning behaviour of the trace elements Y and La in a variety of silicate melts. At first we explore the local structure around these two elements at similar P/T conditions and varying compositional and structural parameters of the melt. Our starting compositions comprise a granitic and basaltic melt (low and high NBO/T) as well as two titanite bearing melts with varying alkali contents. Experimental data for all these systems are readily available to verify our results. All systems are doped with one or several Y/La on different sites in the target melt and equilibrated at 3000 K and ambient pressure for the structural analysis. In a second step we employ this structural knowledge in a thermodynamic integration approach to quantify the compatibility of Y and La in various silicate melts. Here we use an alchemical transmutation by which the identity of a major element (e.g. Al) is gradually changed from 100% Al to 100% Y or La. From this integration we derive the free energy of the exchange reactions and thus the preferred phase. We will discuss the results of this approach as compared to experimental findings and how the data can be related to structural parameters of the involved melts.

3D-Mapping of sedimentary and tectonic structures applying "Terrestrial LIDAR" and "Structure from Motion (SfM)" in view of developing multi-scale digital geologic models

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The advanced numerical 3D-modeling of geological processes at nanometer to global scales need digital models of real rocks and structures as starting situations. While at small scales e.g. X-ray-, Synchrotron- and neutron-tomography as well as combined Electron Backscatter Scatter Diffraction (EBSD) with focused ion beam techniques (FIB) are applied, at large scales e.g. seismic tomography is used. At hand specimen and outcrop scale one approach is the combination of 3D-surface acquisition and the following structure construction. Such methods have been evolving and expanding rapidly in many disciplines (e.g. architecture, archeology). We selected two of the most promising techniques – "Terrestrial LIDAR" and "Structure from Motion (SfM)" – to figure out advantages and disadvantages for the documentation and analysis of different outcrop situations. We focused on spatial resolution, costs, amount of time, data accuracy and user knowledge. Furthermore, we tested different methods for the analysis of the generated 3D model that can be a point cloud or a mesh. Both techniques were applied on three dimensionally-exposed fold-structures of Mesozoic limestones in the Leinetalgraben structure close to Göttingen and of Paleozoic cherts, greywackes and limestones in the Variscan Harz mountains. Additionally, the methods were applied on the walls of construction sites in Göttingen which are made up of aeolian and fluvial sediments. Both methods provide excellent results in view of capturing complex outcrop situations and structures of cm to mm size. While the terrestrial LIDAR has advantages in view of geometric accuracy and light-independence, the main advantages of SfM are the low costs and the small expenditure of acquisition time.

Related to the embedding of this outcrop-related measurements in a wide range of scales, we will demonstrate first approaches to multi-scale digital models as input models e.g. for the exploration and development of geothermal resoources.

Induced stress in stiff lithosphere by melt emplacement

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Transport of melt through and into the lithosphere has an essential influence on it's state, properties and evolution. Mantle circulation, physically often seen as viscous flow, acts on a long time scale compared with the rapid ascent of melt originating in the asthenosphere. Due to this large scaling contrast the short time scale transfer of melt is replaced by melt extraction and emplacement at a given depth zone above the source region in our numerical approach. Applying a full compaction formulation new findings reveal probably consequential stresses in the high viscous lithosphere. Thermo-mechanical physics of visco-plastic flow is approximated by Finite Difference Method with markers in an Eulerian formulation in two dimensions. The equations of conservation of mass, momentum and energy are solved for a multi component and two phase system: melt and solid matrix in a full compaction formulation. The high Prandtl number approximation is applied, elasticity is neglected, and viscosity is temperature-, stress- and depth-dependent. Taking in account depletion and enrichment melting and solidification are controlled by a simplified linear binary solid solution model under consideration of extraction and emplacement of melt. A continental rift scenario serves to define a model comprising asthenosphere and lithosphere under extensional conditions. A temperature anomaly generates deep melt intruding the lithosphere on its way up. Above a fraction limit melt extraction induces underpressure at its origin region attracting ambient melt and contracting the matrix. A melt fraction minimum develops in the initial batch. In the emplacement zone above sudden dilatation, immediate freezing, increase of enrichment and heating takes place. The dilatation of the rock matrix generates relative high stresses if it's viscosity is high. The behaviour is not intuitively comprehensible.

Numerical modeling of fluid migration in subduction zones

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It is well known that fluids play a crucial role in subduction evolution. For example, excess mechanical weakening along tectonic interfaces, due to excess fluid pressure, may enable oceanic subduction. Hence, the fluid content seems to be a critical parameter for subduction initiation. Studies have also shown a correlation between the location of slab dehydration and intermediate seismic activity. Furthermore, expelled fluids from the subduction slab affect the melting temperature, consequently, contributing to partial melting in the wedge above the down-going plate and extensive volcanism. In summary, fluids have a great impact on tectonic processes and therefore should be incorporated into geodynamic numerical models. Here we use existing approaches to couple and solve fluid flow equations in the SLIM-3D thermo-mechanical code. SLIM-3D is a three-dimensional thermo-mechanical code capable of simulating lithospheric deformation with elasto-visco-plastic rheology. It has been successfully applied to model geodynamic processes at different tectonic settings, including subduction zones. However, although SLIM-3D already includes many features, fluid migration has not been incorporated into the model yet. To this end, we coupled solid and fluid flow assuming that fluids flow through a porous and deformable solid. Thereby, we introduce a two-phase flow into the model, in which the Stokes flow is coupled with the Darcy law for fluid flow. Ultimately, the evolution of porosity is governed by a compaction pressure and the advection of the porous solid. We show the details of our implementation of the fluid flow into the existing thermo-mechanical finite element code and present first results of benchmarks and experiments. We are especially interested in the coupling of subduction processes and the evolution of the magmatic arc. Thereby, we focus on the key factors controlling magma emplacement and its influence on subduction processes.

River-sand ^{10}Be Concentration after 2008 Wenchuan Earthquake: Tracing the Transportation of Landslide Debris

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In high-relief mountain ranges bounded by reverse faults, large-magnitude earthquake can contribute to topographic growth by co- and inter-seismic surface uplift on the hanging wall; meanwhile, this can also lower relief by causing extensive landslides. How fast can those landslide debris materials be evacuated out of the mountain range? The 2008 Mw 7.9 Wenchuan earthquake at Longmen Shan of eastern Tibet provides a valuable opportunity to evaluate such direct impact of large-magnitude earthquakes on topographic evolution. The consmogeinc nuclide concentration in river sand are believed to get diluted by the input of landslide debris materials (Niemi et al., 2005), and accordingly we attempt to use ^{10}Be concentration in river sand at various years after the Wenchuan earthquake to trace the routing process of debris flow. During the past six years of 2008-2013, we collected river sand samples at 19 locations annually along the rivers that traverse the fault rupture zones. Compared with published pre-earthquake data (Godard et al, 2009), our results show the 10Be concentration in river sand declined dramatically after this earthquake at all sampling sites. Meanwhile, multi-year time series of 10Be concentration at single site present roughly constant level of dilution with moderate fluctuation. Further analysis indicates the dilution extent is closely controlled by both local catchment slope and the connectivity between landslides and sampling locations. The moderate variation of ^{10}Be concentration implies the effect of landslide debris on the river has no significant change during the six years after the earthquake. In conclusion, our results indicate 1) river suspended load will respond quickly to the input of landslide debris materials; 2) the speed of debris flow evacuated out of the mountain range is dramatically controlled by local tomography and landslides locations; 3) in landslide-rich areas, the amount of debris materials transported by river display no obvious decrease, which might be related to their sufficient landslide debris sources.

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Magmatic fractionation of chalcophile elements on Earth and Mars

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Oral in Session A3-01

The stability of sulfide and the partitioning of chalcophile elements in basic and ultrabasic igneous rocks on Earth and Mars are affected by the different FeO contents of basic magmas on these planets. The sulfur concentration at sulfide saturation in Martian magmas is much higher than for terrestrial basaltic magmas, however, it is unclear if other chalcophile elements also behave differently. Partial melts derived from low to moderate degrees of melting of Earth's upper

mantle are commonly sulfur saturated. Sulfide segregation from such ascending melts during reactive infiltration into peridotites and fractional crystallization leads to significant decrease in abundances of platinum group elements and Te in evolving melts and strong fractionation from less chalcophile S, Se and Re. Peridotites, mid-ocean ridge basalt (MORB) glasses and MORB sulfide droplets on Earth display similar ranges of Cu/Ag ratios (3000-4000), indicating limited fractionation of Cu and Ag during magmatic fractionation. New data on different groups of Martian meteorites show that Cu and Ag abundances are a factor of 5-15 lower than in MORB, but Cu/Ag ratios are also constant (~1000). This indicates similar sulfide melt-silicate melt partitioning of Cu and Ag on Earth and Mars, although their contents in Martian magma source are lower because of a stronger depletion by core formation. Abundance ranges of S, Se and Te and S/Se in Martian meteorites are similar to MORB, however, Se/Te are significantly higher. As for Cu-Ag, the S-Se-Te data on Martian meteorites predominantly reflects a combination of magmatic fractionation and segregation of cumulative phases and fractionations inherited from core formation.

Pattern-based analysis of subsurface heterogeneities and its application to generate spatial property distributions for process simulations

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Inferring the spatial distribution of physical properties in the subsurface conditional on sparse data and prior knowledge plays a significant role for accurate simulations of thermo-hydro-mechanical-chemical processes. Heterogeneities are dominated by different patterns on different scales of subsurface structures (i.e. configuration of relevant geological layers, facies distribution, and stochastic variability of properties). Robust statistical methods are required in order to recognize and extract underlying patterns of subsurface heterogeneities from multiple geophysical data sets. We test here a different approach to the commonly used geostatistical methods based on a combination of clustering analysis for pattern descriptions in the subsurface using multiple geophysical data sets and random field models for a characterization of patterns in terms of statistical moments and estimated spatial correlations. We then apply a pattern-based random field generation process to initialize the spatial distribution of physical properties so that the geophysical information will exert significant constraints on the uniqueness of the solution in subsequent process simulations. We test our approach with the application to the pattern-based analysis of multiple geophysical data sets. Information reflecting the subsurface heterogeneity is locally available from geophysical observations (e.g. electrical impedance tomography (EIT), ground penetrating radar (GPR) and electromagnetic induction (EMI)). We derive the spatial distribution of hydraulic properties as an input for subsurface flow simulations. In addition, as we apply a probabilistic method, we obtain a measure of uncertainty about the property distribution. First results suggest that our proposed method provides benefits for the combination of multiple geophysical data sets with prior geological knowledge, especially when heterogeneities are distributed in spatial patterns in the subsurface.

Provenance and dispersal of terrigenous sediments in the North Pacific: Implications for late glacial land-ocean linkages

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Clay mineralogy and grain-size properties of 39 surface samples and one sediment core, collected in the temperate to sub-Arctic North Pacific, are used to decipher spatial-temporal variations of provenance and transport paths of terrigenous detritus. The area south of 45° latitude today is dominated by terrigenous sediment components that reveal a characteristic quartz-illite assemblage in the clay fraction and include abundant fine silt (70%), indicating the importance of westerly jet-streams in carrying dust particles from the dry areas of the East Asian interior. In the southeastern Gulf of Alaska, a zonal region of increased chlorite contents stretches along the Aleutian Trench, tracing the westward flow paths of the Alaska Coastal Current and Alaskan Stream bringing suspended sediments from offshore of southern Alaska. The Bering Sea has a variety of sediment sources and is affected by ice-rafting, as indicated by increased terrigenous sand concentrations. Sediment core $SO_2$02-18 taken from the western Alaskan continental slope documents glacial to Holocene changes in sediment provenance and sedimentary transport, mainly driven by the interplay of postglacial sea-level rise, changes in fluvial runoff, and ocean circulation. During the last glacial maximum, the depositional environment was characterized by hemipelagic background sedimentation with overregional sediment sources. By the end of Heinrich Event 1 through the Bølling/Allerød Interstadial, clay-laden meltwaters from Alaska entered the study site, pointing to a strong meltwater pulse. The fresh-water lid might have eased local overturning ventilation in the Bering Sea water that promoted the deposition of laminated sediments at the same time. During Holocene sea-level rise the shore line moved far away from the site and reduced the terrigenous sediment influx. Strong contour currents possibly led to the winnowing of sediments and caused residual sand enrichment.

Understanding salt structure evolution in the Central Glueckstadt Graben (Northern Germany) by means of restoration of minibasins

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The Glueckstadt Graben (GG) is one of the most prominent extensional basins in the Central European Basins system. The evolution of the subsidence and sedimentation patterns in the GG was crucially affected by salt flow and formation of up to 6000 m high salt walls. By means of reconstruction of one representative geological cross-section, we investigated the spatial and temporal evolution of salt structures and adjacent minibasins, which are filled with post-Permian sediments. 2D-restoration of post-salt layers was conducted in order to derive subsidence rates and to determine phases of fastest growth of the salt structures. 1D-backstripping was performed in the most characteristic minibasins of the GG to distinguish between tectonic subsidence and subsidence due to salt expulsion. The structural restoration reveals that subsidence of minibasins and growth of the salt structures were initiated in Early to Middle Triassic time by regional extension. At the beginning of the Late Triassic, subsidence rates and tectonic subsidence were highest indicating strong salt flow and fast growth of the salt walls in the centre of the GG. From the Late Triassic to Middle Jurassic salt movement and salt structure growth was continuous. During this period, main depocentres in the minibasins gradually migrated from the basin centre towards the graben flanks reflecting continuous salt expulsion due to differential loading. Three specific types of salt structures can be distinguished in the GG: (1) Graben centre salt walls possessing deep asymmetric minibasins flanking the sides facing away from the basin centre, (2) Platform salt walls, whose neighbouring minibasins switched multiple times from one side of the salt wall to the other, and (3) graben edge pillows, which are characterised by only one minibasin on the side facing the basin centre.

Toward better exploitation of satellite multi-temporal interferometry in landslide hazard research

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In situ investigations and monitoring of areas prone to landslides are expensive and limited in terms of spatial and temporal coverage. Therefore, the use of complementary cost-effective remote sensing approaches to slope hazard detection and assessment is an important issue. We solicit a widespread application of satellite multi-temporal interferometry (MTI), an advanced technique that can enhance our capabilities of detecting and monitoring slope hazards. MTI provides long-term (years), regular (weekly-monthly), precise (mm) measurements of ground displacements over large areas (thousands of km2), combined with high spatial resolution (up to 1-3 m) and a possibility of multi-scale (regional to site-specific) investigations using the same series of radar images. Further, the initial reconnaissance approaches relying on medium resolution MTI (e.g. ENVISAT, RADARSAT) can now be suitably integrated with high resolution MTI relying on the new generation radar sensors (e.g. COSMO-SkyMed, TerraSAR-X), thereby providing most valuable information for the spatial and temporal analyses of slope deformation and landslide activity. To highlight the great potential of MTI we present application examples from two seismically active regions prone to land instability. We also stress that MTI results have yet to be fully explored, in particular those based on high spatio-temporal resolution data. Some of the landslide research and application areas that may particularly benefit from MTI include: - Long-term behavior and climatic controls of large, long-lived very slow deep landslides and deep-seated gravitational slope deformations - Post-earthquake landslide activity and evolution of slopes - Early detection and warning of slope instability hazards via long-term monitoring. Acknowledgements COSMO-SkyMed and TSX data provided, respectively, by the Italian Spatial Agency (ASI) within the COSMO-SkyMed AO Project ID 1820, and by DLR under TerraSAR-X General AO Project ID MTH0432.

Uncertainties in city greenhouse gas inventories

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In 1993 mayors from 50 cities in 20 countries gathered at the UN in New York under the umbrella of the International Council for Local Environmental Initiatives (ICLEI) to issue a declaration aimed at cutting carbon dioxide emissions from cities. By today 465 cities report their GHG emissions in ICLEIs carbonn Cities Climate Registry (cCR) . Many cities worldwide are on the route to implement the combined new standard for city-based GHG accounting and reporting, named the Global Protocol for Community-Scale GHG Emissions (GPC). These extensive data sources offer the unique chance to better understand, manage and reduce city GHG emissions. However, many cities are already reporting or have reported their GHG emission in non GPC conform tools. This heterogeneous data source raises the question on how these data could be potentially transferred to a GPC

conform level. For the transfer process it is very important to understand and quantify the potential losses of information and increase or decrease in uncertainty due to class conversions and associated recalculations of GHG data. Here we compare existing GHG reports from different sources based on the use of different tools used . We look at data from carbonn Registry by ICLEI, the CDP, C40 and the Ecoregion tool. Using examples of existing data form cities in Europe we demonstrate potential information losses and inconsistencies leading to increased uncertainty. We also illustrate the potential mapping schemes for the data structures and identify uncertainties from using alternative mappings. In conclusion it is essential to develop consistent data structures in order to allow the use of city GHG for time serial analysis and city intercomparison.

Scientific drilling in the deep sea with the sea floor drill rig MARUM-MeBo

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The MeBo-sea bed drilling technology was developed within the last decade by MARUM in cooperation with several companies including Prakla Bohrtechnik and Bauer Maschinen. The MARUM-MeBo drill rigs can be deployed from multipurpose research vessel like, RV MARIA S. MERIAN, RV METEOR, RV SONNE and RV POLARSTERN and are used for getting long cores both in soft sediments as well as hard rocks in the deep sea. The first generation drill rig, the MARUM-MeBo70 is dedicated for a drilling depth of more than 70 m (Freudenthal and Wefer, 2013). Between 2005 and 2014 it was deployed on 15 research expeditions and drilled more than 2 km into different types of geology including carbonate and crystalline rocks, gas hydrates, glacial tills, sands and gravel, glacial till and hemipelagic mud with an average recovery rate of 72 %. Further developments for the MeBo-drilling technology are bore hole logging (since 2010) and bore hole instrumentation (MeBo-CORK, since 2012). Based on the development and operational experiences with the MeBo70 we started in 2011 with the development of the MARUM-MeBo200. This drill rig is dedicated for conducting core drilling down to 200 m below sea floor. It was successfully tested on the new research vessel RV SONNE in October 2014 in the North Sea. The first scientific expedition with the MeBo200 is planned in 2016 off New Zealand. In this presentation we show examples and scientific results for the use of MeBo70 for different research targets including slope stability in the Gela basin south of Sicily, paleoceanographic reconstructions off Chile and in the South China Sea, gas hydrate distribution in a pockmark field off Nigeria, and cold water coral mounds in the Alboran Sea and in the Gulf of Cadiz. References: Freudenthal, T and Wefer, G (2013) Drilling cores on the sea floor with the remote-controlled sea floor drilling rig MeBo. Geoscientific Instrumentation, Methods and Data Systems, 2(2). 329-337. doi:10.5194/gi-2-329-2013

The physical hydrology of porphyry copper systems

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Porphyry copper deposits form by fluids expelled from cooling hydrous magma chambers in the upper crust. Simulation results from a numerical process model describe the physical hydrology of these systems and demonstrate that chemical enrichment of metals to economic grades is controlled by a hydrological divide between areas of ductile and brittle rock behaviour. The hydrological model incorporates a dynamic permeability model, which describes hydraulic fracturing and the transition from brittle to ductile rock behaviour in a geologically realistic way. In response, the hydrothermal system stabilises a temperature-pressure front along an inner part dominated by near-lithostatically pressured hot magmatic fluids that is cooled from the outside by meteoric fluids under hydrostatic conditions. With inward crystallization of the pluton, fluid production decreases and the front gradually retreats to greater depths. As a consequence, earlier intense but barren quartz veins are overprinted by later copper-bearing veins. The simulation results are in good agreement with observations that are typical for porphyry copper systems, such as the distribution of fluid phase states, vein densities as well as location, shape, timing and grade distribution of the ore shells. The simulations also provide a physical explanation for the transition to epithermal conditions at shallower levels where pulses of magmatic fluids mixing with convecting ambient fluids.

The magmatic roots of Tristan da Cunha - A thermobarometric approach from melt inclusions and phenocrysts

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Tristan da Cunha island is an active stratovolano located at the seaward end of the Walvis Ridge in the South Atlantic. The island is thought to reflect the present-day location of a mantle plume that was responsible for generation of the Paraná-Etendeka large igneous province and the Walvis Ridge, an aseismic ridge showing systematic age progression from its landfall at the Namibian continental margin towards the Tristan da Cunha archipelago. We present the results of olivine-hosted melt inclusion analyses and of mineral-melt geothermobarometry and their implications for the conditions and location of magma storage and crystallization below the island. Clinopyroxene-melt equilibrium thermobarometry yielded an overall range of pressures from 4 to 14 kbar, corresponding to depths of 12-42 km, but most results are in two depth ranges of 18-24 km and 28-38 km. The most primitive, basanitic samples gave the highest pressures, suggesting crystallization at 42 km, whereas the shallowest (12 km) was determined on trachyandesite from the 1962 eruption. Given a Moho depth of 12-14 km derived from seismological studies, these results imply that the phenocrysts last equilibrated in the uppermost mantle; no evidence for crustal magma chambers was found. Temperatures estimated from phenocryst-melt geothermometry, using bulk rock compositions as proxies for the melt, range from 1080° to 1100°C for the evolved trachyandesite, and 1130° to 1280°C for the ankaramite-basanite samples. Slightly higher temperatures were calculated from melt inclusions and their olivine host (1180° - 1320°C). The variations in P-T estimates and their correspondence with the chemical composition of the different rock types and eruption styles suggest that the Tristan magmas erupted from different storage depths in the shallow mantle, rather than from one large magma chamber.

Is a Road to Sustainable Use of Non-Renewable Mineral Raw Materials possible?

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The principle of inter-generational fairness is generally accepted as a base for achieving a sustainable development: a path allowing every future generation the option of being as well off as its predecessors. Concerning non-agricultural resources we can distinguish two systems on Earth: an open system, our energy system, and a closed system of all other non-renewable resources. We receive continuously solar energy input which is the base of all renewable energies except geothermal energy. Thus it is reasonable to use an unlimited source to help to reach the path of sustainability for other non-renewable resources. How can energy help to achieve the goal of sustainability? Fossil energy resources are totally consumed and cannot be recycled. However all other non-renewable resources are only transferred from the geosphere to the technosphere in one form or the other and are available for recycling. This is especially true for metals which are used and not consumed. Although a 100% recycling efficiency is thermodynamically impossible, a stage can be envisioned when most of the material for our industrial requirements can be secured from the technosphere. For the remaining portion which we would require from the geosphere the principle has to be applied that we do not need a raw material as such but only its intrinsic property to fulfil a function. Thus with man's creativity solutions of functions have to be found with all the available resources in the geosphere and the technosphere. The concept of finding different solutions for functions does not work for the essential agricultural fertilizers N, K, and P. There is no replacement for them. The plants need them as such. For N and K there are unlimited resources in air, resp. seawater. For P, however, there is no unlimited reservoir. But possibilities exist to create a closed loop for P.

Mobility of Lithium in borate glass networks

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This study focuses on investigating characteristics of lithium mobility in borate glass network, by means of impedance spectroscopy, IS, isotope exchange experiments and Raman analysis of the glass network aspect. For this purpose binary $Li_2O \bullet xB_2O_3$ (x = 2,3,6) glasses were synthesized with different Li-isotopies, i.e. with ^{6}Li-enriched glasses (94 % ^{6}Li) or natural content (92.58 % ^{7}Li) for each composition. The chemistry of synthesized glass was confirmed using inductively coupled plasma optical emission spectroscopy (ICP-OES) analyses. For each glass density and the glass transition temperature, Tg, was determined, impedance spectra collected and the diffusion couples were made for each composition to be used for isotope exchange experiments. The annealing temperatures for developing isotope exchange profiles were determined based on the IS data. The stability of the borate glass network before and after the high-temperature annealing was tested using Raman spectroscopy. Moreover, Raman spectroscopic analyses provided a valuable insight into the arrangement of the planar BO_3 and tetrahedral BO_4 units in the glass network. The isotope exchange profiles were measured with fs laser ablation ICP mass spectrometry and the results in combination with ionic diffusivity indicate drastic drop in long-range Li-migration in glasses with lower Li-content. The drop is more pronounced than in silicate-based Li-containing glasses. The low mobility cannot be attributed only to the low concentration of mobile particles. It can be concluded that in addition to chemistry, particularly strong impact on mobility of lithium ions has the ratio between BO_3 and BO_4 units as it shapes the potential landscape for long-range movements. It is very probable, based on the overall data that is locally enriched and strongly constrained by the local arrangement of BO_3 and BO_4 units.

Hydrodynamics: a key to exploration success in the South Caspian Sea

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The South Caspian basin (SCB) started as a back-arc basin during the Mesozoic in response to the subduction of the Neo-Tethys. The convergence of the Arabian and Eurasian plates during Plio-Pleistocene created structures that are the exploration targets of the basin. The continued subsidence of the SCB lead to up to 10 km of Plio-Pleistocene sediments, derived mainly from the Paleo-Volga system prograding from the North. Such high deposition rates of very young sediments create large pressure gradients that are indicated by regional pressure data, triggering a strong hydrodynamic flow that is directed northwards from the basin center to the outcrops of the Apsheron peninsula. The reservoirs, also called Productive Series, are laterally continuous thus providing excellent regional transfer for pressures. HC charge occurs concomitantly from the underlying Mio-Oligocene organic rich Maikop shales. In 2011, Total and its partners discovered the giant Absheron gas field which is estimated to contain 350 BCM of gas and 40 MT of condensate. The discovery well was located close to a previously drilled dry hole that had targeted the same structure on the southern side of a crestal fault. Seismic data indicated an amplitude anomaly on the northern side of the anticline which was however not structurally conform. Hydrodynamic closure modeling indicated that the observed seismic anomaly is compatible with the regional hydrodynamic flow field, with the presence of a crestal fault system as a complicating factor. Observed pressures in the discovery well were compatible with the model predictions, substantiating the hydrodynamic trapping hypothesis.

Implications for landscape evolution in the Zittau Mountains (Eastern Saxony) inferred from the low erosion level of the Lausche Volcano (Lusatian Volcanic Field)

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The research on volcano edifices in the Lusatian Volcanic Field (LVF, eastern Saxony, southwestern Lower Silesia, northernmost Bohemia) provides information about the landscape evolution of this region since the Neogene (e.g. TIETZ et al. 2011, BÜCHNER & TIETZ 2012). Volcanoes of subaerial origin, preserved as residual scoria cones or lava flows, mark a pre-volcanic paleosurface which is considered to have been relatively flat. Tectonic activity in post-volcanic times is therefore indicated by the occurrence of this paleosurfaces in different recent altitudes. Although this superficial volcanoes are of upper oligocene to lower miocene age their erosion level is relatively low, what points to tectonic events in "younger" geological times (TIETZ et al. submitted). Geological mapping and reconstruction of the Lausche Volcano, situated in centre of the LVF (BÜCHNER et al. 2015), allows additional implications for landscape evolution in the Zittau Mountains (Eastern Saxony) by two facts (WENGER 2015): First, sediments that are preserved at the base of the volcano mark a pre-volcanic paleosurface. Second, the recent geology shows a relatively low erosion of the volcano. The source area of the pre-volcanic deposites, reflected by their petrographic composition, reveal the general relief inclination of a broader area for the time preceding tertiary volcanism. They might be correlated to a stage of tectonic development of the Lusatian Overthrust, a geological fault active since the Upper Cretaceous and running in the vicinity of the Lausche Volcano. The low erosion of the volcano can be explained by a "young" uplift of the surrounding Zittau

Mountains due to neotectonic since the Middle Pleistocene. This is also supported by, e.g., sporadically preserved nordic erratics on the southern side of the mountain ridge what indicates that the Zittau Mountains didn't terminate the Elsterian-1-glacier in the way generally assumed. The uplift was possibly induced by glacial rebound.

Arctic petroleum source rocks - Development of an open-system, non-isothermal pyrolysis system to investigate stable isotope specific kinetics of hydrocarbon generation

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The arctic region is one of the main frontier areas for hydrocarbon exploration. An accurate assessment of the arctic petroleum systems requires detailed knowledge of the regional occurrences of source rocks and their hydrocarbon generation potential, which can be investigated with samples from outcrops in the area. Source rocks in the Arctic comprise diverse coals and organic-rich shales of Paleozoic to Cenozoic age. Amount and type of generated hydrocarbons as well as timing of petroleum generation are influenced by the composition of source rock organic matter. Kinetic parameters, describing the transformation of organic matter into hydrocarbons, are commonly derived from open-system pyrolysis experiments using different heating rates. Especially the hydrogen-rich, oil-prone composition reported for some arctic coals contrasts with the usually mostly gas-prone nature of terrestrial source rocks, emphasizing the need for specific kinetic parameters for these arctic source rocks. Knowledge of isotope fractionation associated with petroleum generation from different source rocks may support gas- source rock correlations. To obtain kinetic parameters of petroleum generation and to investigate stable isotope specific kinetics of selected arctic source rocks, an open-system, non-isothermal pyrolysis coupled to gas chromatography and online isotope ratio mass spectrometry is used, which is based on previous work by Krooss et al. (1995) and Gaschnitz et al. (2001). The pyrolysis system is improved for investigation of low-TOC source rocks and modified enabling stable hydrogen isotope analysis. An overview of the pyrolysis system and its performance as well as first results on hydrocarbon generation characteristics of arctic source rocks will be presented. References:
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Spin crossover in ferropericlase and velocity heterogeneities in the lower mantle

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Deciphering the origin of seismic velocity heterogeneities in the mantle is crucial to understanding internal structures and processes at work in the Earth. The spin crossover in iron in ferropericlase (Fp) [1], the second most abundant phase in the lower mantle, introduces unfamiliar effects on seismic velocities [2,3]. First principles calculations indicate that anti-correlation between shear velocity (VS) and bulk sound velocity (V_ϕ) in the mantle, usually interpreted as compositional heterogeneity, can also be produced in homogeneous aggregates containing Fp [4]. The spin crossover also suppresses thermally induced heterogeneity in longitudinal velocity (Vp) at certain depths but not in Vs. This effect is observed in tomography models at conditions where the spin crossover in Fp is expected in

the lower mantle. In addition, the one-of-a-kind signature of this spin crossover in the Rs/p (∂lnVs/∂lnVp) heterogeneity ratio is a useful fingerprint to detect the presence of Fp in the lower mantle. References:

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The damage potential of alkali-silica reaction by using sand and fine gravel grain sizes for various reactive aggregates

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The alkali-silica reaction (ASR) is a worldwide problem in concrete technology. Mainly, hydraulic structures and high-ways show cases of ASR. It is associated with the formation of expansive alkali-silica gel due to the reaction of alkali-susceptible siliceous aggregates with alkalis and water. This leads to pressure build-up followed by cracking of the concrete. In modern concrete, a variety of aggregates are used with diverse grain sizes. Recent studies have shown that with decreasing size, the ASR potential increases. But there is a specific size limit below which the particles reverse their damaging behaviour and act like a pozzolan, forming non-swellable calcium-silicate-hydrate-phases. However, as yet no uniform size limit has been established. It is highly likely this is because it is aggregate-specific and the results by using numerous test methods will differ greatly. This project is focused on the relationship between the aggregate properties of various aggregate types and the ASR mechanism for different grain sizes. Differences in the amount and chemical composition of the reaction products, based on mineralogical and microstructural characterisation, are the major concern. Five grain size fractions within sand and fine gravel range are considered. One test method will be applied to measure the expansion resulting from the swelling capacity of the gel. Preliminary results have shown that greywacke aggregates only in the size of 0.125-0.25 mm reduce the ASR potential significantly compared to quasi-non-reactive quartz sand. A maximum ASR potential for greywacke was reached for the size of 0.5-1 mm. Artificial borosilicate glass acts quite different in fact that the ASR potential increases constantly with decreasing sizes. In all samples gel formation could be proved via thin section petrography. For further chemical analyses SEM-EDX will be used and a second test method will be performed to control the dissolution of the major oxides constituting the gel.

Microscopic and microchemical investigation of building materials affected by alkali-silica reaction

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The alkali-silica reaction (ASR) is a harmful process, which can occur in concrete. Above all, hydraulic structures and highways made of concrete worldwide show cases of ASR. As product of this chemical reaction a swellable alkali-silica gel can exert pressure leading to cracking of the material. The damages induced by ASR can differ in their magnitude, and to assign certainly that ASR is the main damage mechanism a combined investigation of microscopic and microchemical analyses is necessary. For texture analysis thin section petrography is the major tool. Optical microscopy offers the best way to analyse ASR-affected concrete samples for damage classification by visualising the potentially reactive aggregates, the gel and the crack formation. In particular, the amount of gel inside cracks and pores as well as the dimension and orientation of cracks, are the major concern. The chemical investigation of the gel enables a precise determination of the involved amounts of the major oxides SiO_2, CaO, Na_2O and K_2O. The proportions of these components of the gel are decisive with regard to its ability to swell. For this analysis scanning electron microscopy coupled with energy dispersive X-ray spectroscopy is the first choice. In addition, it allows a high-resolution observation to detect microscopic features of ASR-affected areas, for example inhomogeneity's of the gel. Furthermore micro X-ray fluorescence analysis gives an insight into the elemental distribution of an ASR-affected sample. By mapping a bigger segment of the concrete sample, the depletion or enrichment of elements, especially in the matrix of the cement stone but also inside the aggregates, can be obtained. The combined use of the above mentioned analyses achieves an assessment of the type and origin of the damage along with the evaluation of various alkali-susceptible aggregates.

Causes and Consequences of Spherical Harmonic Models of Observed Dynamic Topography

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Mantle convective simulations are often used to predict present-day dynamic topography on Earth. Most of these models suggest that dynamic topography is dominated by degree 2 and 3 patterns which have peak amplitudes of 1-2 km. In order to test the applicability of these results, it is useful to construct an accurate global observational database. We have collated about 1000 seismic reflection profiles and about 500 wide-angle refraction experiments from the oceanic realm. This dataset can be used to calculate residual depth anomalies with respect to the well-known age-depth cooling relationship by carefully taking sedimentary and crustal loading effects into account. Resulting anomalies have wavelengths of 1000 to 10,000 km with amplitudes of typically plus/minus 1 km. Average uncertainties are plus/minus 150 meters. We have combined these oceanic residual depth anomalies with onshore estimates from GRACE gravity anomalies to generate a spherical harmonic map of present-day dynamic topography. The resultant power spectrum is significantly less red than most predictive models. In other words, there is significantly less power at degrees 2 and 3 and much greater power at degrees 20 to 30 (i.e. wavelengths of 2000-1300 km). This mismatch is significant and implies that predictive models are compromised by limited resolution of mantle density structure and weak constraints of viscosity variation. Inclusion of shallow mantle structure, which is the likely source of degrees 20-30 dynamic topography, is particularly important.

Coupling μ-XRD2 & DTA: Advantages using large 2D-detectors for the real-time monitoring of temperature dependent processes

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Coupling time- and temperature-resolved 2-dimensional X-ray diffraction (XRD2) with differential thermal analysis (DTA) is a powerful tool for a more detailed understanding of many temperature-dependent processes like phase transitions, recrystallization phenomena and decomposition reactions with or without structural changes [1]. In our study we used the combination of an in house designed DTA-system (up to 600°C) integrated into a commercially available BRUKER D8 microdiffractometer equipped with a large 2-dimensional detector with 135mm diameter active area (VÅNTEC-500) which covers in our setup 40° in 2Θ- and psi simultaneously in one measurement shot (μ-XRD2). This large detector avoids a drawback when analyzing phase transformations by X-ray diffraction during a typical DTA-experiment with its small sample amounts. Crystallite ripening processes or recrystallization effects lead to a coarsening of the crystallites which causes bad crystallite statistics and, therefore, strongly influences the measured intensities and hampers the interpretation of the diffraction pattern. Additional replacement of commonly used pinhole collimator systems in such a setup by a polycapillary lens providing a spot size of 200 μm allows measurement times down to a few seconds per diffraction pattern with such a system as shown in [2]. The typically used heating and cooling-rates of 10 K/min for DTA-experiments can be realized by these short XRD measurement times without any problems. In our contribution we will show typical examples demonstrating the potential of our coupled setup especially regarding temperatur dependent texture and crystallinity changes of the samples during heating and cooling which are directly visible and therefore interpretable only using such a large 2D-detector.

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Evolution of the Lake Victoria basin in the context of coeval rift initiation in East Africa: a 3D numerical model approach

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Poster in Session A2-01

Over the last five years sedimentologic and thermochronologic studies in the eastern and western branch of the Cenozoic East African Rift System (EARS) have supported the notion of a broadly contemporaneous onset of normal faulting and rift-basin formation in both segments. In the light of these studies we explore the evolution of the Lake Victoria basin, a shallow, unfaulted sedimentary basin ontop of the deep rooted Tanzania Craton and centered between both branches of the EARS in the interior of the East African Plateau. We quantify the fluvial catchment evolution of the Lake Victoria basin and assess the topographic response of African crust to the onset of rifting in both branches. Furthermore, we evaluate and localize the nature of strain and flexural rift-flank uplift in both branches. By using a 3-D thermo-mechanical forward model, which is able to reproduce the flexural response to variably thick lithosphere, we assess the topographic changes in both rift branches and the plateau interior caused solely by extension. The model domain covers the entire EAP and integrates extensional processes in a heterogeneous, yet cold and thick cratonic block (Archean Tanzania craton), which is surrounded by mechanically weaker Proterozoic mobile belts, which are characterized by thinner

lithosphere. The lower limits of the craton (170 km) and the mobile belts (120 km) are simulated by different depths of the 1300 $^\circ$ C lithosphere-asthenosphere boundary. We assume a constant extension rate of 4 mm/a throughout the entire simulation of 30 Ma. The model shows that elevation differences of 120 to 180 m between the plateau interior and bordering rift shoulders are pronounced enough to form a closed basin after 6.5 Ma of extension and dates the existence of the basin back into Early Miocene.

A tale of a whale: How does a ziphiid fossil pinpoint the onset of uplift in East Africa?

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Deciphering the timing and magnitude of surface uplift is key to understanding the impact of crustal deformation on changes in atmospheric circulation, environmental conditions, and surface processes. Uplift of the East African Plateau (EAP) has been linked to mantle processes, but palaeoaltimetry data are too scarce to constrain unambiguously plateau evolution and subsequent vertical motions associated with rifting. Here we assess the fossil remains and palaeotopographic implications of a beaked whale (Ziphiidae) from the Turkana region of Kenya, found 740 km inland from the present-day coastline of the Indian Ocean at an elevation of 620 m. The Kenyan ziphiid was discovered in fluvio-lacustrine sediments of the extensional Oligo-Miocene Lokichar basin (Mead, 1975) along with terrestrial mammals and freshwater mollusks below a basalt dated at 17.1 $\pm$ 1.0 Ma (Boschetto et al., 1992). The unifying characteristics of riverine occurrences of modern marine mammals include sufficient discharge in low-gradient rivers to maintain pathways deep enough to facilitate migration, and the absence of shallow bedrock, rapids, and waterfalls. The whale travelled from the Indian Ocean inland along an eastward-directed Miocene drainage system, which may have been controlled by protracted regional subsidence associated with the Cretaceous Anza Graben. The fossil locality and analogies with present-day occurrences of marine mammals in terrestrial realms suggest that the ziphiid stranded slightly above sea level and therefore provides the older of only two empirical palaeoelevation points that document approximately 520 m of uplift of the EAP between 17 and 13.5 million years ago. Surface uplift of the EAP from near sea level coincides with a palaeoclimatic change from a humid environment to highly variable and much drier conditions, which altered biotic communities and appears to have driven evolution in East Africa, including that of primates.

Magma mixing enhanced by bubble segregation

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That rising bubbles may significantly affect magma mixing paths has already been demonstrated by analogue experiments. Here, for the first time, bubble-advection experiments are performed employing volcanic melts at magmatic temperatures. The formation of plume-like filaments of advected basalt within the rhyolite was characterized by microCT and subsequent high-resolution EMP analyses. Melt entrainment by bubble ascent appears to be an efficient mechanism for mingling volcanic melts of highly contrasting compositions and prop-

erties. MicroCT imaging reveals bubbles trailing each other and multiple filaments coalescing into bigger ones. Rheological modelling of the filaments yields viscosities of up to 2 orders of magnitude lower than for the surrounding rhyolitic liquid. Such a viscosity contrast implies that bubbles rising successively are likely to follow this pathway of low resistance that previously ascending bubbles have generated. Filaments formed by multiple bubbles would thus experience episodic replenishment with mafic material. Inevitable implications for the concept of bubble advection in magma mixing include thereby both an acceleration of mixing because of decreased viscous resistance for bubbles inside filaments and non-conventional diffusion systematics because of intermittent supply of mafic material inside the filament. The mafic material was variably hybridised to andesitic-rhyolitic composition. Compositional profiles across filaments to distinguish single or multiple bubble origins of filaments. Statistical analysis, employing concentration variance as measure of homogenisation, demonstrates that most filaments are likely to have experienced multiple bubbles passages. In cases where bubbles have been essential for magma mixing, standard diffusion analysis may thus be inadequate for constraining timescales. Data analysis employing concentration variance relaxation thus permits the distinction of bubble advection in natural samples.

Patterns and timing of post-rift denudation across the southwest African continental margin and interior plateau as revealed by apatite fission track and (U-Th-Sm)/He thermochronology

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Poster in Session A2-02

Our understanding of the thermal and structural processes of continental rifting has developed to a point that the "passive" continental margin classification may be considered somewhat misleading. It is becoming clear that it does not reflect the complex tectonic and geomorphological evolution a margin may experience during the post-break up phase. Geodynamic numerical models have provided new insights into the interaction of the mantle with the overlying lithosphere, while surface process models reveal how the landscape responds to deformation of the lithosphere over different length scales. However, these models require empirical quantitative data to help constrain and validate their predictions. Low temperature thermochronology is ideally suited to obtain these constraints by providing information on the temperature-time history of samples as they cool through the upper kilometres of the crust. Here we present an extensive suite of apatite fission track data from the western continental margin of South Africa alongside the first apatite (U-Th)/He data from the Namaqualand region of the margin. The data have been inverted using a Bayesian approach to resolve the thermal history of the margin and reveal two discrete episodes of cooling linked to onshore denudation. The first episode is synchronous with the onset of rifting between southern Africa and South America (150-130Ma) and is attributed to erosion of syn-rift topography. The second occurs during the Late Cretaceous (100-80Ma) and is proposed to have been induced by regional uplift of southern Africa coupled with localised reactivation of basement structures at the continental margin and interior craton boundary. The occurrence of modest surface uplift occurring during the Cenozoic remains a possibility, but thermal histories presented here restrict the depth of regional Cenozoic erosion on the western margin to less than c. 1 km.

New insights into the Kaali meteorite crater - an update based on the development in crater research from Wegner to today

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The Kaali meteorite strewn field on Saaremaa Island in Estonia was formed by the impact of a Tscheljabinsk sized IAB type iron meteorite which supposedly hit Saaremaa Island in the Holocene when it was already inhabited [1]. It is a small set of nine structures including the 110 m sized Kaali Main Impact Crater. Its impact origin was suggested already in 1922 by Kalkun and eventually confirmed 1938 by Reinvaldt [2]. However the small craters drew little attention outside of Estonia in the past decades and documentation of the crater structure has been limited. So far few strike and dip measurements are documented, key features such as the overturned flap are not reported and the actual age is still very controversially debated [3,4]. With a fresh view on the crater formation, we started out an expedition in August 2014 to map the crater in unprecedented detail using 3D laser scanning tools, 380 strike and dip measurements [5]. Additional measurements using ground penetrating radar and electro-resistivity tomography and a trench transect of the ejecta blanket, which provided a new best-estimate of the crater formation of 3237+-10 14C yr BP based on the dating of charcoal fragments with in the proximal impact ejecta [6]. We hope to refine the formation model of a crater at the strength-gravity boundary with our thorough investigation.

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The surface structure of shatter cones in experimental impact craters

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Oral in Session A3-02

Shatter cones are an important feature for the discovery and verification of impact structures. They are easily identifiable in the field and are the only macroscopic feature considered as evidence for shock metamorphism. However, their occurrence is heterogeneous throughout the crater record and the precise mechanism of shatter cone formation is still enigmatic. The development of shatter cones is supposedly taking place in a pressure regime of 2 to 25 GPa and evidently bound to further boundary conditions and material parameters. We recovered several fragments from the MEMIN cratering experiments, showing slightly curved and conical to hyperboloid geometries marked by fine striations typical for shatter cones, which is along with the hierarchical horsetailing of the striation patterns distinctive for shatter cones. The shatter cone fragments where found in experiments with 20 to 80 cm sized target cubes of sandstone, quartzite and limestone which were impacted with velocities from 4.6 to 7.8 km/s with aluminum, steel and iron meteorite projectiles with a diameter of 2.5 to 5 mm. SEM analysis of the recovered fragments showed vesicular melt films alternating with smooth polished surfaces. We hypothesize the vesicular melt films predominantly form at strain releasing steps and suggest that shatter cones are probably mixed mode fractures. We believe a thorough description of the shatter cone geometry offers critical tests for the debated shatter cone formation models. We made μm to nm accurate 3D scans with white light interferometry and extracted geometric parameters from the millimeter to half centimeter sized fragments and from shatter cones of various terrestrial impact craters. The thorough morphometric analysis of the experimental and natural shatter cones will enable us to extract specific surfaces parameters characteristic for shatter cones.

Experimental calibration of a new geobarometer for rhyolitic melts based on cotectic melt compositions

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The phase relationships in water-undersaturated rhyolitic systems have been determined systematically to calibrate a geobarometer based on the composition (mainly SiO_2 content) of cotectic melts saturated with respect to quartz (Qtz) and Na- (Ab) and/or K-rich (Or) feldspar(s). In the system Qtz-Ab-Or, the melt normative Qtz content (QtzL) increases with decreasing pressure but this effect is obscured by the presence of CaO in the melt (expressed as normative anorthite ; An). We performed a series of near-liquidus crystallization experiments (870 to 1050°C) in internally heated pressure vessels to calibrate the position of the cotectic curve separating the Qtz and Fsp primary fields at 200 and 500 MPa for two melt water contents (H_2Omelt of 1.3 and 3 wt% H_2O) and for two AnL contents (3.5 and 7 wt% AnL). The QtzL content of cotectic compositions was estimated as a function of pressure, H_2Omelt and AnL. Preliminary results indicate that at identical H_2O and An contents the QtzL content decreases by ~5.3 wt% when increasing P from 200 to 500 MPa. When compared to a Ca-free system, the effect of 7 wt% AnL results in an increase of the QtzL content up to ~9.2 wt%. These results confirm the general trend proposed by [1] to predict the influence of AnL on cotectic compositions. However our experimental results indicate that the shift of the position of the eutectic point is distinctly more pronounced than expected from the approach of [1], even for small amounts of AnL. Our new data are applied to track changes of magma storage depths of rhyolitic magmas from the Twin Falls eruptive center (Snake River Plain, Yellowstone volcanic province) in space and time. Preliminary results indicate that the main magma chamber(s) of one eruptive center may become deeper with time (from 130 to 425 MPa) and match values derived from the TitaniQ Geobarometer.

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Subsurface deformation induced by experimental hypervelocity impacts in different target materials

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Introduction: The study of deformation processes that occur in the crater subsurface during hypervelocity impact has multiple implications e.g., for the geophysical signatures of impacts. Deformation mechanisms vary with porosity in common tectonic fragmentation regimes on earth. We are currently analyzing whether, and how, impact-induced deformation is similar to deformation mechanisms from other fracturing regimes. Methods: In four hypervelocity impact experiments into Quarzite, Sandstone, Tuff and Marble we discovered different deformation features in the subsurface. In all impact experiments the projectile was a 2.5 mm steel or iron meteorite sphere with a density of 8 g/cm3 and impact velocities were between 4.8 – 5.6 km/s. Thin section analysis was used to map the deformation. Orientations of the deformation features were analyzed to infer the deformation mechanisms. Results: All target materials exhibit tensile fractures directly beneath the crater floor due to dilatancy upon pressure release. However, the depth of tensile failure below the crater floor varies with target material: Tuff: 0.2 proj. diam. (dp) & ca. 0.5 dp in ca. 2 dp depth, Sandstone 0.36 dp, Quartzite 0.6 dp, Marble 1.2 dp. The low porosity targets quartzite and marble reveal localized deformation along discrete narrow zones with strong grain size reduction. Higher porosity sandstones developed a proximal zone of grain crushing and compaction and a distal zone of localized shear deformation [1]. High porosity volcanic tuffs show intensive compaction with proximal zones of localized deformation. In all four targets, shear deformation seems to be a dominant mechanism in subsurface deformation. Conclusions: First results of SEM microscopy of all targets reveal great similarities between impact-induced deformation mechanisms and deformation occuring in other dynamic fracturing environments. References:

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Deformation band analysis at the Upheaval Dome impact crater

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Introdution : Deformation bands (DB) are a common phenomenon in tectonically deformed sandstone. In 2007 Okubo and Schultz [1] were the frist authors who proved impact-related deformation band formation at a natural impact site. The found compactinal shear bands were showed to form by failure along a yield strength envelope. Buhl et al. (2014) [2] showed the development of volume neutral shear bands in impact experiments. The long axes of the DBs were shown to form ± radially around the impact point source. The question arose, wheather or not DBs at the Upheaval Dome impact site are also arranged in a radial pattern around the impact point. Methods: DBs were measured and sampled in three successive sandstone formations, neighboring the central uplift. In total 920 DB orientations at 94 outcrops were measured. The orientations were analyzed using the freeware software Stereo32. Thins sections with blue resin were prepared of all 15 samples. Results: First results of deformation band orientations reveal that not all DBs were formed under the stress regime related to the impact event. Shear deformation seems to be the most abundant deformation mode in all three units. Aside from shear deformation, DB orientations of the outer units show a radial pattern. Interestingly, in the innermost unit the orientaions indicate compaction as prominent formation process. First microscopic analysis confirm localized cataclastic flow as dominant deformation mechanism.

Conclusion & Outlook : Among the DB at Upheaval Dome shear deformation seems to be the most common response during DB formation. Further investigations including the impact induced tilt of the layers, general DB orientations of the whole region and relative formation depth related to the estimated original impact point will be performed to validate these preliminary results.

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Terrace styles and timing of fluvial terrace formation in the Weser and Leine valleys, northern Germany

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Although the Pleistocene terrace record of major river systems in northwestern Europe has been investigated by many authors, relatively little attention has been paid to base-level changes related to glacier advance–retreat cycles and how these regional changes in base-level interacted with river catchment processes. The drainage system of the study area developed during the Early Miocene. During the Pleistocene up to 170 m of fluvial incision took place. A major change in terrace style from strath terraces to cut-and-fill terraces occurred during the Middle Pleistocene at around Marine Isotope Stage MIS 12, which correlates with the onset of glaciation in northern central Europe. During this time a stable buffer zone was established within which channels avulsed and cut and filled freely without leaving these vertical confines. Climate was the dominant driver for river incision and aggradation, whereas the terrace style was controlled by base-level changes during ice-sheet growth and decay. The late Middle Pleistocene fluvial terraces are vertically stacked, indicating a high aggradation to degradation ratio, corresponding with a regional base-level rise during glacier advance. At the beginning of the Late Pleistocene the terrace style changed from a vertical to a lateral stacking pattern, which is attributed to a decrease in accommodation space during glacier retreat. Major incision phases took place during MIS 7, 5e, 5c, and probably early MIS 4, early MIS 3 and MIS 2. During interglacials (MIS 7, 5e, Lateglacial to Holocene) the braided river systems changed into meandering river systems, as is indicated by thick organic-rich flood-plain and point bar deposits. The Late Pleistocene braided river systems (MIS 5d to MIS 3) are characterized by a high sinuosity, which may be a direct effect of an increased downstream gradient after deglaciation when the channel lengthened and the river adjusted to the increased gradient by increasing sinuosity.

CO_2-Storage – from Site Assessment to the Post-Closure Phase

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In 2004, the GFZ German Research Centre for Geosciences started the EU-project CO_2SINK which aimed at testing the geological storage of CO_2 into a saline aquifer at a depth of approximately 630 m below ground surface. It has been the initial CCS-project (Carbon Capture and Storage) onshore in Europe. Several other national and international scientific projects were carried out at the same site, each with a different set of questions. In the meantime, scientific and industrial partners throughout the world have contributed to the investigations. All those efforts led to a comprehensive understanding of CO_2-storage in saline aquifers like the Ketzin site. The COMPLETE project, which started in 2014, will now "complete" the CO_2 storage life cycle phases. These phases were originally defined by the European Commission in 2011. After the injection of 67 kt of CO_2 between 2008 and 2013, the project is now in the so-called Post-Closure/Pre-Transfer Phase, which belongs to the final part of the chain. The work mainly focuses on stepwise site abandonment and monitoring of the stored CO_2. Field experiments such as a CO_2 back production or the reinjection of brine into the reservoir are important experimental parts of the project. Moreover, modelling and simulations were applied in nearly all studies and are indispensable. Computer models are the only tool to predict the behaviour of the storage site over thousands of years and therefore play an important part for the long-term integrity and post-closure safety of the reservoir. This in turn is also the prerequisite for a transfer of responsibility from the operator to the Competent Authority.

Dampened Holocene sediment fluxes across the lowlands of the Amazon and Ganga basins

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Quantifying sediment production in source areas and its comparison with sediment transport in large lowland basins is indispensable for understanding source-sink connectivity, how rivers transmit signals of climate cycles and to estimate the fluvial preservation potential. Cosmogenic nuclides are now an established tool of Earth surface science, but their application to lowland basins, where sediment undergoes storage and deposition, are still rare. In such settings, additional nuclide production during surficial floodplain storage, or radioactive decay during deep and long storage might proceed. Recent findings however detect no significant changes in long-lived in situ 10Be concentrations from the source to the sink, or the change can be corrected for [1]. Uniform 10Be concentrations across lowland basins thus result in the possibility to determine long-term denudation rates. From the first available in situ 10Be datasets from source to sink for the large Amazon and Ganga basins [2,3], we show that denudation rates measured from lowland sediment are well-representative of a mean orogenic denudation rate such that small-scale variability is averaged out. When converted to sediment fluxes, these longer-term erosion signals, integrating over several kyr, compare well with modern decadal-scale estimates of sediment fluxes from gauging. Sustaining source-area erosion at the same rate over time scales encompassed by the two methods is one explanation for this similarity, but is not one for the observed decrease in variability. On the largest possible terrestrial scale, the lowland floodplain, the ability of the floodplain to buffer changes in sediment supply most likely drives these averaging effects, such that temporally dampened Holocene sediment fluxes are exported from the Amazon and Ganga basins, in spite of changing climate over the same period.

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Seismo-stratigraphic subdivision of the Triassic in the Central German North Sea

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A coherent seismo-stratigraphic concept has been developed for the Central German North Sea sector. This concept defines the relationship between particular seismic reflectors and sedimentary sucessions. In the German North Sea, especially the rim synclines along salt structures preserve thick Triassic sediments which are eroded elsewhere. These local deposits are seperated from each other by salt structures as well as unconformities and are rarely exposed in wells. Therefore, a direct correlation between wells is usually not possible. In consequence, the geological interpretation often depends on seismic data only. Seismic attributes and changes in the reflectivity pattern especially due to facies or rock property changes will enable additional regional characterization of the reflector characteristics. Similar seismic interpretation concepts have already been conducted successfully in nearby areas (Arfai et al. 2014). The transition between Zechstein and Buntsandstein is an examplary challenge. The stratigraphical unit at the Top of Zechstein is called "Bröckelschiefer". Both Bröckelschiefer and Calvörde Formation (Lower Buntsandstein) consist of fine-clastic sediments with minor evaporite content. This low contrast in lithology results in small reflectivity contrasts at the stratigraphic boundary. As an additional difficulty, the Upper Zechstein anhydrites produce several strong reflections that may further mask the low-amplitude reflectors occuring at the stratigraphic boundary. References:

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Reactivity vs. transport: Geochemical impact of SO_2 in CO_2 flue gas and its spatial dissolution pattern in the reservoir system

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Poster in Session B5-02

CO_2 flue gas captured from industrial sources contains impurities like N_2, O_2, NO_x and SO_2. These impurities exhibit physical as well as chemical impacts on the geological reservoir system, for instance concerning injectivity issues. Chemical impacts mainly involve perturbation of the local redox state or the pH in the formation water due to the formation of acidic species, e.g. sulfuric acid (H_2SO_4). For SO_2 in particular chemical rates for H_2SO_4 formation under geological p-, T- and salinity conditions are largely unknown. This is an important factor as these rates relative to CO_2 fluid migration influence the spatial dissolution pattern and thus the amount and concentration of dissolved sulfur acids in the formation water. Subsequently, the rate of sulfuric acid formation furthermore determines the extent of acidic attack on minerals. In order to elucidate the possible range of the chemical impact of SO_2 on the geochemical reservoir system reactive transport simulations using the numerical TOUGHREACT code were performed. The results highlight the differences in qualitative and quantitative predictions of mineral reactions depending on the applied model setup. The comparison of simulations with infinitely fast chemical SO_2 speciation by equilibrium computation and kinetically delayed aqueous speciation suggests that, because the classical equilibrium approach neglects any transport related impact, it overestimates the acidic dissolution potential of SO_2 [CRANDELL et al., 2010]. More experimental evaluation of the reactive dynamics of SO_2 is urgently needed for

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Kinematics of the Marmara segment of the North Anatolian Fault Zone from fault-plane solutions derived from a refined high precision hypocenter catalogue (2007-2010)

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The North Anatolian Fault Zone (NAFZ) represents a right-lateral transform plate boundary that slips at an average rate of 20-30 mm/yr separating the Eurasian and Anatolian plates. During the last seismic cycle the NAFZ has produced a series of large earthquakes that started in 1939 in Eastern Anatolia and has propagated westward towards the Istanbul-Marmara region. Here an up to 150km long segment below the Sea of Marmara represents the only NAFZ segment that was not activated since 1766 representing a seismic gap believed being capable of generating a magnitude up to 7.5 earthquake within the next decades. Using recent advancements in automatic picking of P- and S-onset times and first-motion polarities we consistently analyze extensive waveform data provided by permanent seismic broadband stations of the KOERI network and short period stations of the PIRES network and present a refined hypocenter catalog for the seismicity M>2.2 throughout the Sea of Marmara region in northwestern Turkey for the time period 2007-2010. The quality of automatically determined travel times is carefully examined by comparing them to manual reference picks which were determined with a scheme emphasizing highest possible consistency and precision. The high accuracy obtained for the travel times results in an improved hypocenter catalog with fewer but well-located events that allow to image the major fault branches of the NAFZ below the Sea of Marmara. The large network aperture with lacking stations immediately above the seismicity and insufficient azimuthal station density prevents inversion for focal mechanisms of single events. Therefore we aim at calculating composite focal mechanisms for spatial event clusters. Despite considerable uncertainties the resulting focal mechanisms are in good agreement with the regional tectonic setting and with results from previous studies analyzing the same area but earlier time intervals.

Variations in timing of plate tectonics initiation on Earth-like planets due to chaotic nature of mantle convection

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Subduction initiation on a planet which does not already have an ongoing plate tectonics is difficult due to the high strength of the lithosphere and is believed to be one of the major issues in the origin of plate tectonics. We investigate the very first episode of subduction initiation on a planet which is initially in the stagnant lid convection regime using a yield stress approach. We find that the lithospheric stresses generated by thermal thinning of lithosphere may cause subduction provided the convective subcells are sufficiently wide. Moreover, we find that subduction may take a geologically long time. We investigate the timing of subduction initiation as a function of the yield stress. In a chaotically convective system, the behavior of the system is further complicated by the extreme sensitivity to the initial conditions. For a given set of parameters but slightly different initial states, the time of subduction initiation can vary by several orders of magnitude. Since the variations in initial conditions are random, the timing of subduction initiation and thus the timing of plate tectonics

initiation are random too. Our results suggest that plate tectonics on an Earth-like planet may start either very early in planetary history or after billions of years of evolution depending on small variations in the early state of the planet.

Sea level and climate change at the southern Cape coast, South Africa, as inferred from coastal lake sediments from Groenvlei

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Within the RAIN project (Regional Archives for Integrated iNvestigations) interdisciplinary investigations on environmental change in southern Africa during the Late Quaternary are being conducted. For this purpose, marine and terrestrial archives from the three major rainfall zones covering South Africa (winter-, summer- and year-round rainfall zone) are being studied. Here we present results inferred from a sediment record from the coastal lake Groenvlei located on the southern Cape coast within the year-round rainfall zone. Both 14C and 210Pb dating techniques were applied to create a robust age-depth model, revealing a basal age of ∼4200 cal BP as well as two hiatuses (from 2710 to 1860 cal BP and 1640 to 1230 cal BP). Sediments are predominantly composed of autochthonous carbonates. During the period from 4200 to 2710 cal BP aragonite and dolomite were the main forms of carbonates indicating a greater connectivity to the ocean, probably due to a higher sea level. A drier climate than at present was contemporaneously leading to the evaporitic modification of the lake water. Thereafter, the marine influence decreased and the lake was entirely desiccating twice as reflected by the hiatuses. During the period from 1230 cal BP to the present Groenvlei was a freshwater system mainly precipitating Mg-calcites. Climate was probably more humid and comparable to the present conditions. High TOC values and smaller particle sizes of the allochthonous sediment fraction indicate an expansion of the vegetation around the lake. High δ^{13}C values of the carbonate fraction suggest a different environmental setting during the period from 610 to 140 cal BP which might temporally be linked to the Little Ice Age (LIA). A comparison of these data with other palaeoclimatic studies points to an increased winter rainfall seasonality at the southern Cape coast prior to ∼2700 cal BP and an increased influence of the summer rainfall zone and hence a more humid climate thereafter.

How to communicate 3d geological models to public

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During the last years different geological 3d-models have been developed by the working group and as a result of the increasing complexity of models and modeling techniques, new questions regarding their visualization, as well as the communication of their technical and scientific content became a challangeing task. The models under discussion cover the entire subsurface of the cities e.g. Halle, Magdeburg and Berlin. The challenge here was to apply visualization methods which would be also suitable for people beyond the geoscientific community. This also includes common problems of nearly every digital presentation mode: the absence of a real visual 3d perception and the ability to interact physically with the model. Lenticular 2-phases flip, which combines image information of e.g. aerial

photograph and 3D-geological subsurface modeled section. The lenses filter the image information, depending on the viewing angle. The interactive approach in the internet was introduced as "3D Geo-stripping" in 2012 (www.3d-geology.de). True color hologram (i-Lumogram images) is a new technique of GEOLIA Ltd. (Vilnus) which allows a colored presentation of the complex structural information and gives a very impressive 3D-view. However to create lenticular images or a hologram, a lot of single rendered images are necessary. This can be a very challenging task, depending on the complexity and the size of the model since the common rendering software is designed for low-poly models. Glass laser engraving models – Here the entire information of the 3D geological model are transferred by green lasers into a polished crystal glass block of optical (lens) quality, technically limited up to a depth of 10 cm. The recently used glass blocks have a format of app. 27x30x12 cm and a weight of 25 kg. The largest one – the mining infrastructure of Staßfurt - has a size of 27x60x12 cm and 52 kg! This presentation technique allows a detailed and fascinating insight view of the entire model area.

Glass laser engraving 3d-models – Innovative techniques of visualization

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Using the innovative technique of glass laser engraving, the entire information of the digital 3d geological model has to be transferred pointwise by green lasers into a polished crystal glass block of optical (lens) quality. Until now, this technology is limited up to 10 cm depth. This presentation technique allows a very detailed and fascinating transparent view of the entire model area. The presented glass laser models have been realized in technical cooperation with STARGLAS GmbH, Bünde, Germany. The structural model of Halle (Saale) city shows the fault system and the distribution of the consolidated rocks in the deeper underground of the city of Halle (Saale). This model was created with 3D MOVE by MLU in cooperation with the LAGB based on seismic and drilling data down to a depth of about 1000 m. The geological model of Magdeburg City covers an area of about 195 km^2. It shows the geological basement with its typical fault system as well as the unconsolidated rocks of Tertiary and Quaternary age. The resulting glass laser engraving depicts the geology with 52 Mio laser points. For visualization purposes the lower part of the model consisting of consolidated sediments which are effected by an extended fault system, was presented without any exaggeration, while the above following highly differentiated unconsolidated rocks of Tertiary and Quaternary age have an exaggeration to 15-fold and are presented in a "flying carped" mode. The third presented model shows Staßfurt City, with the detailed salt mining infrastructure in the subsurface. Modeling work was done by BGR, the glass model was realized in cooperation with MLU. The model shows the base plane of the potassium layer "Kaliflöz Staßfurt" (Zechstein 2) and the detailed mining infrastructure with shafts, drifts and chambers. The model is assumed as the largest geological model (4.9 x 2.2 km^2) of a laser engraved glass block of 52 kg weight. For more information visit www.3d-geology.de/ausstellung.

Petrography, Provenance and Diagenetic study of sandstone from Murree Formation, Peshawar Basin, NW Pakistan.

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The Jena Kor section of the Murree Formation is a part of the Miocene molasse sequence of the Peshawar Basin and consists of a series of alternating beds of sandstone, siltstone and shale with subordinate marls and conglomerates. Samples representing the sandstone unit of the formation were studied in terms of their petrographic characteristics. The sandstone is predominantly fine to medium-grained and moderately sorted to well-sorted. The framework grains are angular to sub-angular to sub-rounded and mostly consist of quartz, feldspar and rock fragments. Their relative modal abundance and petrographic features reflect the Murree Sandstone to be mineralogically submature, but texturally immature. The monocrystalline quartz, which mostly shows uniform to weakly undulose extinction, is more abundant than the polycrystalline type. The feldspar consists of orthoclase, albite and alkali feldspar, while the rock fragments include volcanic, low-grade metamorphic and sedimentary (mudstone, shale and siltstone). The observed heavy minerals include chlorite, zircon, epidote, rutile, illmenite, chromite, sphene, apatite and tourmaline. The crystals of zircon, epidote and rutile mostly occur as tiny inclusions in quartz grains. With an average matrix abundance of 36 %, the sandstone is classified as wacke, while relative proportion of frameworks makes most of them fall in the range of arkosic wacke-lithic arkosic wacke. The petrographic characteristics of quartz, feldspars, lithic fragments and heavy minerals indicate that the source lithologies for the Murree Sandstone consisted of acidic plutonic, volcanic, low-grade metamorphic and sedimentary rocks. The observed diagenetic features, e.g. replacement of quartz and feldspar by calcite and stylolitic boundaries between some of the quartz grains indicate that the Murree Formation underwent deep burial.

Sedimentary Dynamics And Structural Evolution Of The Constantinois Platform During The Cretaceous

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Poster in Session C4

The synthesis of stratigraphic and structural data of Constantinois limestone massifs has allowed the refining of the southern Tellian series at nummilites stratigraphy and proposing a structural model. The most significant sites and less disturbed by tectonics, are the Taxas syncline and southern flank of Guerioun massif, exactly at the Djebel Ras Rihane. Also, at the level of Taxas syncline, and surmounting the hard ground which ended the Aptian neritic limestone, the marly levels had provided Cenomanian microfauna: Favusella washitensis, Rotalipora appenninica, R. cushmani, R. brotzeni, Hedbergella sp., and Praeglobotruncana stephani. On the southern reverse of Djebel Ras Rihane, at the level of Chaabet Ras Chiboub notch, we can observe, on the hard ground that terminates the Aptian neritic limestones, a clayey Cenomonian over one hundred meters of thickness. The samples from these clays have provided many Hedbergella, Rotalipora brotzeni, R. cushmani, R. globotruncanoides and Praeglobotruncana gr. Stephani. The top of these clays has provided Coniacian foraminifera and revamped Cenomanian rotalipora. The study of the stratigraphic series of s neritic massifs allowed the refining of our predecessor's results. Also the yellow marls stratigraphically surmounting the terminal Aptian- basal Albian through a hard

ground, represents the Cenomanian-Turonian. Microscopic analysis of samples from this hard ground highlights sedimentological phenomena that attest the emersion of Constantinois platform during the terminal Aptian- basal Albian. In the Constantinois limestone massifs, ''the southern Tellian units at Nummilites '' represent the normal marly cover of neritic limestones. Keywords: Constantinois limestone massifs, Albo-Aptian, southern Tellian units, eastern Algeria.

Shock Microdeformation In A Shatter Cone From Serra Da Cangalha, Brazil

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Poster in Session A3-02

Shatter cones (Strahlenkegel, SC) were first reported from the Steinheim impact basin in 1905; they have since been described from many impact structures and are widely accepted to represent the only meso- or macroscopic impact-diagnostic impact deformation feature. Numerous authors have attempted to solve the enigma about the genesis of SC; however, a coherent hypothesis accounting for all observed effects has not been established yet. We have investigated shock microdeformation and the internal fracture pattern observed in a shatter-coned sandstone sample from the Serra da Cangalha impact structure, Brazil, with μComputer Tomography (μCT) and polarizing microscopy, in order to constrain the timing of SC formation. After CT-scanning, 47 thin sections oriented parallel to three perpendicular axes (x, y and z) of an arbitrary coordinate system were prepared of this sample. Even with high resolution scans (13 μm voxel volume) only major fractures could be detected in the CT slices. Petrographic investigation revealed a high degree of irregular to subplanar microfracturing, as well as shock-induced planar fractures (PF), planar deformation features (PDF), and feather features (FF). Of these, only PDF are recognized as distinct indicators for shock metamorphism. FF formation by rock-shock wave interaction is still debated. PF are not impact-diagnostic but where highly abundant - as in this sample - and in combination with the occurrence of PDF, a strong indicator for shock deformation. We determined that subplanar fractures, PF, and PF belonging to FF are formed prior to PDF. FF lamellae may overprint PDF; thus, FF lamellae form after PDF. FF and PDF that are displaced by a SC 'surface' were observed. Accordingly, SC must form after PDF or, at least, they are coeval. As PDF are constrained to form during the pressure increase of the compressional phase, the earliest possible timing for SC formation is the late compressional phase of an impact event.

Sedimentology and Sea level changes of the offshore deposits South of Caspian Sea (Noshahr-Tonekabon)

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Poster in Session A5-01

The Caspian Sea is the largest land loked water body on earth,containing 40% of the earth's continental water mass (Dumont, 1998) and is susceptible to environmental changes.The Caspian Sea has experienced different sea-level fluctuation (lahigani et al., 2009). In this survey, in order to sedimentological studies and determine the Caspian Sea level fluctuations by variations in magnetic susceptibilities of the Caspian bottom sediments, 7 cores with certain ditstances and depths have been taken by gravity corer method as well as surface samples from beach and river mouths of adjacent area were taken from southeastern basin in Noshahr-Tonekabon area of the Caspian Sea. These samples have been analyzed for grain size, total organic carbon content, carbonate content, mineral composition and magnetic susceptibility. The obtained results from physical and chemical analysis show that the sediments mainly composed of mud with homogenous texture. Grain size of the sediments decreas from the shoreline and carbonate and organic matter content also decreases. Camparing the mineralogy of marine sediments with fluvial inputs demonstrated that reverine source is the main supplier of the sediments. The results show a close relation between particle size distribution and magnetic susceptibility magnitude due to variation in detrital influx, caused by sea-level fluctuations in different time. This process is reflected in increasing particle size and magnitude of magnetic susceptibility simultaneously with sea-level rise and decreasing particle size and magnitude of magnetic susceptibility simultaneously with sea-level fall. References:

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Zircons of the Bushveld Complex – When and How did they form?

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Oral in Session A1-05

The Rustenburg Layered Suite (RLS) of the Bushveld Complex (BC) represents Earth's oldest large igneous province (>370 000 km^3), and contains the world's largest reserves of platinum-group elements, chromium and vanadium. However, its mode of formation, the exact timing and nature of magma emplacement, solidification and sub-solidus cooling history remain a matter of debate. In this paper we present new data from zircons recovered from nine (ultra)mafic rocks of different units throughout the ca. 8 km thick RLS. Our datasets comprise new results of high-precision U-Pb dating obtained by CA-ID-TIMS, detailed information about zircon compositions, textures, zoning, crystallization temperatures, and mineral/melt inclusions. These data in combination reveal that zircon throughout the RLS crystallised within 1.02 $\pm$ 0.63 Ma from highly fractionated intercumulus melts at temperatures between 940° and 670°C. Zircon in quenched Marginal Zone rocks crystallized at 2055.91 $\pm$ 0.26 Ma, and slightly later at 2054.89 $\pm$ 0.37 Ma in cumulus rocks in the centre of the RLS. This timing is in agreement with field observations and the results of thermal modelling, which require rapid accumulation of magma at a flux rate of >5 km^3/year over less than 100 ka, followed by crystallization and cooling to below 700°C within 300 to 950 ka. Zircon zoning patterns additionally indicate that zircon crystallisation in economically important units like the UG2 chromitite layer and Merensky reef occurred in "closed system", and/or "open system" intercumulus environments during cooling. Cooling is well supported by systematic decrease of Ti from zircon core to rim (formed in assemblage with quartz and rutile). Initially "closed system" zircon growth is indicated by a systematic decrease in U (from 150 to 10 ppm) at increasing Th/U (from 0.8 to 10), that can be explained by Rayleight fractionation, and subsequent open system zircon growth by late rims with high U (>150 ppm), and low Th/U and Ti.

Kinematics and low-temperature thermochronology of the Skutari-Pec-Fault in northern Albania: a combined structural and apatite fission-track study

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Poster in Session A1-05

The Skutari-Pec Line is an orogen-perpendicular structure separating the Dinarides to the north from the Hellenides to the south. It was initially interpreted as a transverse structure (the Skutari-Pec Transverse Zone, Auboin & Dercourt 1975), then more recently, as a normal fault that accommodated post-Eocene orogen parallel extension (Skutari-Pec Normal Fault, SPNF; Handy et al. 2014), possibly in conjunction with Cenozoic clockwise rotation of the Hellenides (Kissel et al. 1995). Structural mapping at its western end confirms the Skutari-Pec as a normal fault that dips to the south with 20 – 30° and accommodated top-to-SE downthrow (Zertani et al. 2014). In order to constrain its timing and displacement, we conducted apatite fission-track (AFT) analysis on clastic rocks from Maastrichtian to Eocene flysch in its footwall and from Jurassic mélange in its hangingwall. First results indicate post-depositional partial annealing of fission tracks in apatite. The apparent AFT ages from either side of the fault overlap within 2σ-error, hampering a determination of the age of faulting. However, a Mio-Pliocene age can be inferred from extensional basin sediments in Kosovo bounded by the E branch of the SPNF (Antonijevic 1969). Our AFT samples from the SPNF footwall have significantly lower age dispersion than in the hangingwall, suggesting either slightly higher maximum temperatures and/or a longer residence time of the footwall within the partial annealing zone. This is consistent with orogen-parallel normal faulting and suggests that displacement near the western termination of the SPNF is small, as corroborated by a minimum offset of stratigraphic markers of only 300 m in cross-sections perpendicular to the fault.

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Late Quaternary incision rates of the Lancang River (Upper Mekong) in southeastern Tibet

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Poster in Session A6-01

The SE margin of the Tibetan plateau is gently sloping southward with abundant high-elevation low-relief surfaces perched between deeply incised gorges, which is considered to reflect a transient topographic state. Thus, the SE Tibetan margin provides an excellent opportunity to explore the role of tectonics and climate changes on dynamic topographic evolution. In this study we focus on fluvial terraces preserved along the Lancang River to constrain main-trunk river incision rate and its spatial variation. Field investigations show that a series of levels of fluvial terrace are well preserved at three reaches, including Mangkang, Yanjing-Deqin, and Yunlong (26-30 N). Their strath surfaces have heights of ~220-250, ~140-170, ~100, ~35-60, and ~10-20 m, and are overlain by alluvial sediments of varying thickness. We systematically collected samples to date the aggradation and incision events, including CRN exposure dating, as well as CRN burial and OSL dating (CRN results not available). Along the Yanjing-Deqin reach (28.5-29.0 N), over 60-m thick alluvial sediments cover strath surfaces at 150-180 m. OSL dating of fine-sand at the base of this depositional sequence yields an age of ~89.1±6.3 ka, which constrains the subsequent incision rate of 1.74±0.12 mm/yr in the Late Pleistocene. Near the reach of Deqin (28.3 N), OSL dating of the silt lens above strath surface at 10 m high show an age of ~9.0±0.3 ka, suggesting an incision rate of

1.11±0.04 mm/yr in the Holocene. In summary, our preliminary results suggest that incision rates of the Lancang-Mekong River in our study area may vary, but are on the order of ~1 mm/yr during the late Quaternary, which is almost one order of magnitude higher than exhumation rates of ~0.15-0.25 mm/yr since 10-15 Ma from low-thermochronological data. In our future work, we will further assess whether there has been a recent increase in incision rate, and how this is related to the formation of the south-eastern Tibetan Plateau margin. Keyword: SE Tibetan plateau, Lancang-Mekong River, river incision rate, fluvial terraces

Numerical Modeling of the Ejecta Distribution and Crater Formation of the Orientale Basin on the Moon

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Oral in Session A3-02

The Orientale basin is located on the western limb of the lunar nearside, at the transition between the thinner nearside and the thicker farside crust. It was formed 3.80 billion years ago, making it the youngest multi-ring basin on the lunar surface. Due to its relatively young age, Orientale's morphology is well preserved; the basin has, therefore, been extensively studied and used as an archetype for investigating large-scale impact structure. However, attempts to estimate important impact parameters of Orientale basin such as the impactor size and velocity, the transient crater size, the excavation depth, and the ejecta volume deviate significantly among different studies. Here, we present a new numerical model to reinvestigate the formation and structure of the Orientale basin and to better constrain the impact parameters such as impact size and velocity. In contrast to previous modeling studies, the observed ejecta distribution and thickness was used as a main constraint in addition to crater morphology and morphometry, and subsurface structure derived from high-resolution remote sensing observations and gravity models based on GRAIL data. The model suggests that a 100-km diameter impactor with a velocity of ~ 12 km s^{-1} formed the Orientale basin on a relatively 'cold' Moon. In this impact scenario the transient crater would be ~ 460 km in diameter, similar in size to the Inner Rook Ring, and ~ 4.70 x 10^6 km^3 of crustal materials would be ejected. The latter is in agreement with recent estimates of the thickness of the ejecta blanket at Orientale from remote sensing studies. The model also confirms the remote sensing spectroscopic observations that no mantle material was excavated and deposited at Orientale's rim.

Investigating water-soluble organic compounds released from black shales and coals

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Knowing the composition of dissolved organic carbon (DOC) is prerequisite for a comprehensive understanding of the fluid-rock interactions taking place in shale and coal environments over both geological and human timescales. In this study, black shales and coals taken from five different geological settings and covering the full maturity range from immature and overmature were extracted with deionized water. The DOC yields were found to decrease rapidly during diagenesis and remain low throughout catagenesis. Different fractions of DOC have been qualitatively and quantitatively characterised in the study using size exclusion chromatography (SEC). The dominant fractions detected by SEC are humic substances and building blocks in the leachates of immature and mature samples and they are replaced by low molecular weight neutrals in the extracts of overmature samples. Acetate is the dominant low molecular weight organic acid (LMWOA) in all extracts of shales and coals of bituminous rank. The concentrations of individual LMWOAs also decrease with increasing maturity of the samples except for acetate released from the overmature Posidonia shale (Haddessen well), which was influenced by hydrothermal brines. The Oxygen Index values of the original shale samples show a positive correlation with respective LMWOA yields. The yields of individual organic compounds normalized to TOC are in the same order of magnitude for coals and shales at same maturity. However, the extracts of coal samples tend to contain more aromatic compounds and the maximum molecular masses of both humic substances and building blocks are higher compared to the shale extracts. Thus, both the origin of organic matter and the thermal maturation have a significant influence on leachate composition.

Metamorphism and melting of picritic crust and its contribution to continental crust formation in the early Earth

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There is evidence that half of the continental crust was formed before the end of the Archean and therefore prior to the onset of modern plate tectonics. A large proportion of the preserved Archean crust consists of rocks of the tonalite-trondhjemite-granodiorite (TTG) suite, but its generation is still debated. The hypothesis of a more magnesium-rich average composition of the early crust (picritic) in contrast to modern MORB, and its shifting to a lower magnesium content during the secular cooling of the early Earth is investigated via a forward modelling approach. The potential metabasic source rocks for the generation of TTG-like melts are garnet-amphibolites, whose assemblages were identified in picritic bulk rock compositions of up to at least 13.2 wt% MgO via mineral equilibria calculations using the software THERMOCALC. High-pressure partial melting experiments with models of Archean oceanic crust (MAOC) were then used to investigate the role of melting of MAOC with 11, 13 and 15 wt% MgO in the generation of TTG-like melts. The experiments were conducted at P–T conditions from 10–20 kbar and 900–1100 °C, and indicate a transition of melt compositions from aluminous basaltic melts in MAOC 15 to predominantly tonalitic melts in MAOC 11 at pressures $\geq$ 12.5 kbar. The presence of tonalitic melts in MAOC 11 and 13 reveals the potential for the generation of TTG-like continental crust in the early Archean from oceanic crust with a higher magnesium content than modern MORB. In contrast to today´s processes of continental crust formation, the viable tectonic settings for tonalitic melt generation at pressures up to 15 kbar could be either melting at the base of oceanic crust thicker than today, or slab melting in subduction zones. The tonalitic melts generated at 20 kbar may represent melting in deeper subduction zones that may have become more important during the progressive cooling of the Earth.

Glacial erosion, deposition and ice loading: Impact on structural development of the western Barents Sea sedimentary basins

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Lack of major hydrocarbon discoveries in the western Barents Sea shelf is often attributed to the consequences of the Pleistocene rapid glacial erosion, subsidence and ice loading. In the relatively small area contrasting sedimentation patterns and uneven ice thickness distribution occurred, leading to considerable structural changes. The structural changes include reactivation of faults, differential uplift, subsidence and tilting; potentially resulting in hydrocarbon re-migration and leakage. Although new Pleistocene erosion and deposition estimates exist, resulting uplift, subsidence and tilting has not been quantified yet. Similarly, modern and detailed ice topography models are available but their impact on structural changes has not been calculated yet. For these reasons it remains unclear whether the Pleistocene tectonic events could contribute in the hydrocarbon leakage. If so, which of the Pleistocene tectonic event had dominant effect on depletion of hydrocarbon traps? These questions can be answered by using modelling of isostatic effects of deposition/erosion and ice loading by using newly published data. Two different isostatic models are considered: Airy and flexural models. We will present effects of inhomogeneous erosion/deposition and ice loading on structural changes of underlying rocks with focus on reservoir units and hydrocarbon traps. In addition, reconstructed geometry of the trap structures prior to the glaciations will be shown. Also, we will demonstrate differences of the results between the used isostatic models in context of the Pleistocene tectonic events.

Mapping of the background-gamma-dose-rate in the urban area Erfurt, Thuringia – Germany

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In the professional fire department Erfurt is a so-called NBC Reconnaissance Vehicle stationed, as a part of the civil defense and disaster protection. This vehicle is equipped with radiation protection measuring technique, especially with a 2-liters plastic scintillator detector. Position-related data is generated by an on-board GPS. Because of weak dose rates in the environment, a spectroscopy is not possible. In order to create a map of the underlying background-gamma-dose-rate in the urban area of Erfurt, to calculate possible contaminations, the data were selected by numerous exercise runs from the last 10 years. The map of background gamma dose rate was created by more than 60,000 single measurement points. The map shows that the dose rate of 30-40 nSv h in rural areas rises to 50-70 nSv/h in peripheral neighborhoods and to 80-100 nSv/h in the historical city center. In the evaluation we saw, that the predominant component of detected radiation comes directly from the road surface and the substructure. The used materials for road construction differed significantly. We could demonstrate, that where slag stones were installed under an asphalt surface. A significant share of the radiation exposure have pavement stones of slag, with more than 300 nSv/h. To compare, granite shows only 80-90 nSv/h. We identified a significantly elevated gamma dose rate by 100-130 nSv/h were measured by some concrete structures. However this is not fully understood yet. Chemical analysis are still pending, currently. The measurements shows, in the narrow old town area, the overall activity is significantly increased. The emitted gamma dose rate of building materials outweighs the geogenous

background activity, sometimes by more than 10 times. A correlation between gamma dose rate values and the geological bedrock does not exist. Further fields of applications of the gamma dose rate mapping with scintillator technology is currently being examined, for example in geological mapping.

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Thermal annealing behaviour of radiation damaged pyrochlore

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Poster in Session B6-03

Radiation damaged minerals show structural disorder on different length scales –resulting from α-decay processes of built-in uranium and thorium atoms. These structural damages are metastable and influence the macroscopic properties. Upon thermal annealing the metastable structure reorganizes. This is of great interest for material sciences, for instance for the better understanding of embedding materials for actinides in radioactive waste. [1], [2] The analysis of pyrochlores exposed to different radiation doses on annealing using X-ray diffraction, Raman and IR spectroscopy gives insight into their structural damage and their recrystallization behaviour on different length scales. Recrystallization temperatures are sensitive to crystal chemistry, structural topology and disorder phenomena; hence pyrochlore properties differ considerably in partly crystalline and completely XRD amorphous pyrochlores. In our study we present the thermal annealing behaviour of three pyrochlores with different degrees of structural damage.

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Anorthositic dykes in Cyprus – precipitates of magmatic fluids?

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Poster in Session A2-04

The Upper Cretaceous ophiolite of Cyprus includes rare anorthositic dykes. Normative bulk compositions range around 90% plag. Melting experiments of such compositions show that even under fluid-saturated conditions, temperatures required for whole-sale melting are well above 1250 °C at 500 MPa, which is unrealistic for a derivative melt. The working hypothesis is that the dykes may represent the solute of a magmatic fluid that exsolved from an H_2O-saturated basaltic melt at shallow crustal levels. Fluids exsolving from a silicate liquid at magmatic temperature and medium pressure can be quite enriched in silicate and oxide solutes, comparable in composition to silicate melts. Controlled decompression-crystallization experiments are performed to test this proposition. A tholeiite glass from the upper pillow lavas of Cyprus is doped with excess H_2O (10 wt.%) and several trace elements whose partitioning behaviour may be diagnostic of fluid-melt equilibrium. The charges are equilibrated in Pt capsules at 1 GPa and 1150°C, decompressed isothermally to 250 MPa, slowly cooled at 250 MPa to 650°C (0.3 °C/min), then quenched. Experimental products return three pyx generations in an apparent glassy matrix; a low-Ca opx followed by a high-Ca cpx, and finally by a subcalcic pyx generation with XCaTs component as high as 15 %. The interstitial material, seemingly a glass, is greatly enriched in CaO and Al_2O_3, Na_2O-poor, almost

FeO-MgO free, and it is peppered with volatile bubbles. EPMA totals suggest a H_2O-content as high as 12 wt.%. In terms of composition, the glasses are very close to the compositions of the anorthosite dykes. We argue that the dykes may represent escape channels, of magmatic fluids that exsolved from basaltic melts at depth and precipitated their solute as calcic plag and potentially CaTs-enriched pyx during passage to the upper crust. The primary agent that triggered fluid saturation, may have escaped, or may have been consumed by alteration reactions.

Carbon-isotope chemostratigraphy and sedimentary characteristics of Kimmeridgian shallow-water deposits in the Lower Saxony Basin of northern German

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Poster in Session C4

Kimmeridgian successions of the Lower Saxony Basin are composed of alternating limestones, marls and claystones, which have been deposited under very shallow marine conditions. Stratigraphic uncertainties caused by the absence of open marine marker fossils and prevalence of sedimentary gaps hamper a precise age assignment and interbasinal correlation of these deposit. Here, we present new sedimentological and chemostratigraphic data of a Kimmeridgian section located in the uplifted zone of the Subhercynian basin (Langenberg-Oker quarry), focusing on sedimentology and microfacies analysis coupled with high-resolution carbon-isotope stratigraphy. Carbon isotope values obtained from 231 bulk rock samples vary between -5.4 and +3.0 ‰ and show some distinct long-term variations across the section. The observed chemostratigraphic pattern enables correlation with a previous established carbon-isotope record from the Eulenflucht drill core (Süntel area). The chemostratigraphic correlation reveals that (1) high-amplitude as well as rather subtle trends in the carbon isotope record are preserved at both localities and that (2) values in both curves gradually decrease with stratigraphic height. These results highlight the potential of carbonate-isotope stratigraphy for interbasinal stratigraphic correlation of Kimmeridgian shoal-water deposits. Besides, integrated sedimentology analysis, combining detailed logging and field observations and with data derived from thin-section analysis, and detailed carbonate microfacies analysis are used to better constrain depositional environment and obtain information on diagenetic alteration of investigated deposits. Moreover, strontium isotope data based on analysis of pristine low-Mg calcite shells (branchiopods and oysters) will be used to refine the stratigraphic age. Bulk geochemistry parameters including $CaCO_3$ content and TOC, as well as clay mineral data will provide additional information and complement the sedimentological data.

Appendix - Conference Programme

GeoBerlin 2015

4—7 October 2015 | Annual Meeting of DGGV · DMG

DYNAMIC EARTH ·
from Alfred Wegener to today and beyond

Programme

GFZ Helmholtz Centre Potsdam · Freie Universität Berlin · DGGV · DMG · DFG Deutsche Forschungsgemeinschaft · Geo.X

Content

Conference Office | Registration

Phone ++ 49 (0)30-838 – 51704

Sunday: 17:00 – 21:00 h | Tuesday: 08:00 – 19:00 h
Monday: 08:00 – 19:00 h | Wednesday: 08:00 – 16:00 h

WLAN Conference-Key:
uv5rt4x6 | Network "Conference" | Valid from 2015-10-04 until 2015-10-07

Coffee breaks
The catering is served in the foyers at the posters and exhibitors. The coffee breaks are included in the conference fee.

Lunch breaks
Lunch is not included in the conference fee but you will have the opportunity to buy soups, snacks, etc. at the conference venue in the foyers.
Examples from the price list: Soup € 3.00, Vegetarian soup € 2.50, Fruit € 1.00, Chocolate bars € 1.00, Wraps € 2.00, Rolls € 1.50

Greetings

Alfred Wegener revolutionized the way we see planet Earth. It has been exactly one hundred years since Wegener published his theory of continental drift and laid the groundwork for modern science and plate tectonics. Scientific experts today are still reaping the benefits of Wegener‘s research.
His research provides geoscientists the basis for gaining new ground from which future generations of researchers will in turn profit.

By exploring how human activities affect the earth system, the geosciences deliver crucial information for our daily life. Georesearch is also very important as we look ahead to future challenges – our demand for natural resources and energy, for example. The use of the geological subsurface to store energy and the exploration of the oceans as sources of mineral resources will play a major role in this regard.

Knowledge and experience in the geosciences will be more and more in demand in future. That knowledge and experience will also provide the basis for political decision-making processes. The Federal Ministry of Education and Research (BMBF) therefore supports activities in the entire geoscience spectrum. At the same time we also want to expand on Germany‘s strong international position in this field. The BMBF‘s future funding programme “Georesearch for Sustainability (GEO:N)” will move us nearer to achieving that goal.

In addition, conferences such as GeoBerlin 2015 provide the necessary forums for expert exchange. Through discussions about Alfred Wegener‘s achievements, GeoBerlin 2015 in particular encourages us to reflect on the successes of georesearch in the past and throughout time. This conference is also an opportunity to devote some thought to the potential of geosciences for the future.

May all the conference participants gain interesting input and inspiring new knowledge for their work in the geosciences.

Prof. Dr. Johanna Wanka
Federal Minister of Education and Research

Greetings

Dear Geoscientists,

Exactly 100 years ago the most outstanding German Geoscientist Alfred Wegener published the first edition of his seminal book “Die Enstehung der Kontinente und Ozeane” (“The Origin of Continents and Oceans”). Today we all know that his seminal hypothesis was only accepted once the pieces of the “plate tectonics” puzzle were put together in the 1960’s. Wegener was 50 years ahead of his time. We should never forget that Wegener was a metereologist and astronomist. He pursued his research on the thermodynamcis of the atmosphere and impact craters with as much energy as his development of “continental drift”.

In our meeting Dynamic Earth – from Alfred Wegener to today and beyond we will review how Wegener‘s findings evolved into to modern Earth system science including its impact on climate and the Earth surface, and how this system affects our daily life: where humans live, what risks we are exposed to, where we find our resources. In the meeting we will hold sessions that cover the entire geoscience spectrum (from mineral physics over solid earth geodynamics to the climate sciences) and that explore the consequences of Wegeners findings on how humans use our planet today (from energy and mineral resources over georisks to utilisation of the subsurface and materials for modern society). We have invited keynote speakers that are eminent international scientists in these fields. In events open to the general public we will get an account of Wegeners final trip to Greenland on the history of science of his hypothesis.

The conference takes place in the Henry Ford Bau of the FU Berlin, is staged by the FU Berlin and GFZ Potsdam, and is supported by the Potsdam-Berlin Geosciences coordination platform Geo.X. It is the joint annual meeting of the Deutsche Geologische Gesellschaft / Geologische Vereinigung (DGGV) and the Deutsche Mineralogische Gesellschaft (DMG).
We thank the DFG, GFZ Potsdam, and our sponsors and exhibitors for financial support.
The Potsdam-Berlin research platform Geo.X will stage the Geo.X School “Methods in Geosciences““in the week before the conference: 28th September – 1st October 2015.

Alfred Wegener was born in Berlin. Hence it is timely that we review his hypotheses and their impact for our lives today in a stimulating geoscience meeting in Berlin. We are looking forward to welcome you here!

With best regards · for the Organising Committee




Alessandro Airo
FU Berlin

Kirsten Elger
GFZ Potsdam

Friedhelm von Blanckenburg
GFZ Potsdam/ FU Berlin

Max Wilke
GFZ Potsdam/Uni Potsdam

Scientific Committee

Alessandro Airo · FU Berlin
Andreas Bergner · Potsdam University
Wilhelm Dominik · TU Berlin
Georg Dresen · GFZ Potsdam
Kirsten Elger · GFZ Potsdam
Christof Ellger · GeoUnion
Gerhard Franz · TU Berlin
Hildegard Gödde · Geo.X
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Lutz Hecht · Museum für Naturkunde Berlin
Brian Horsfield · GFZ Potsdam
Hans-Wolfgang Hubberten · AWI Potsdam
Timm John · FU Berlin
Jürgen Kropp · PIK
Axel Liebscher · GFZ Potsdam
Hauke Marquardt · Bayreuth University
Ralf Milke · FU Berlin
Johannes Müller · Museum für Naturkunde Berlin
Onno Oncken · GFZ Potsdam
Uwe Reimold · Museum für Naturkunde Berlin
Magdalena Scheck-Wenderoth · GFZ Potsdam
Taylor Schildgen · Potsdam University
Stephan V. Sobolev · GFZ Potsdam
Tilman Spohn · DLR
Manfred Strecker · Uni Potsdam
Friedhelm von Blanckenburg · GFZ Potsdam/FU Berlin
Michael Weber · GFZ Potsdam
Max Wilke · GFZ Potsdam/Uni Potsdam

Conference Organisation:
F&U confirm, Leipzig,
Susanne Lange
Ogarit Uhlmann MSc.

Prof. Dan McKenzie (University of Cambridge, GB)
"The lithospheric structure of Pangea and central Asia: The rules of craton assembly"
Dan McKenzie wrote the first paper defining the principles of plate tectonics, and his early work on mantle convection created the modern discussion of planetary interiors. He spent the majority of his academic career at the Cambridge University, UK. Here he worked on mantle convection and sedimentary basins, applying physical and mathematical techniques to geological problems, the melt generation in the lithospheric mantle, and the tectonic evolution of Mars and Venus. Dan McKenzie received the Crafoord Prize by the Royal Swedish Academy of Sciences in 2002.
| **Mon · 15:00 h** | 17:45 h · Award ceremony (see p. 9)

Prof. Maureen Raymo (Lamont Doherty Earth Observatory, USA)
"Sea Level During Past Warm Periods – Rethinking the Bathtub Model"
Maureen Raymo is a paleoceanographer/marine geologist who studies the history and causes of climate change in the Earth's past. In 1992 she published a seminal paper on the "uplift climate hypothesis" for late Cenozoic. Since then she has worked on the timing of the major climate terminations, sea level change, and co-compiled with Lorraine Liesiecki a Pliocene-Pleistocene stack of benthic foraminifera d18O. Maureen Raymo received the Milutan Milankovic Medal of the European Geosciences Union and the Wollaston medal of the Geological Society of America in 2014.
| **Mon · 18:00 h** | 17:45 h · Award ceremony (see p. 9)

Prof. Trond Torsvik (University of Oslo, Norway)
"Paleomagnetism and Plate Tectonics"
Trond Torsvik started his career in classic palaeomagnetism and rock magnetism. His interests range from the core-mantle-boundary to the surface of the entire Earth. Current research activities embrace plate tectonics, global palaeogeography, the nature of Wilson cycle tectonics, absolute plate motion reference frames, linking surface and deep mantle processes, hotspots, large igneous provinces, and supercontinental assembly and dispersal. He is engaged in software development linked to global databases. Trond Torsvik is member of the Academia Europea since 2005 and has will receive the Leopold von Buch medal of the DGGV at the GeoBerlin2015.
| **Tue · 13:45 h** | 17:45 h · Award ceremony (see p. 9)

Prof. Barbara Romanowicz (IPG Paris and Berkeley University, USA)
"Global mantle imaging in the age of high speed wavefield computations"
Barbara Romaniwicz explores deep Earth structure and dynamics. She pioneered seismic tomography and waveform modelling as pertaining to the determination of deep mantle, core mantle boundary and core structure. She studies Earthquake processes and scaling laws, and real time estimation of earthquake parameters. She developed modern seismic and geophysical observatories on land and on the ocean floor. Barbara Romanovicz received the Alfred Wegener Medal of the European Union of Geosciences in 1999 and is member of the Collège de France.
| **Wed · 10:45 h** | 17:45 h · Award ceremony (see p. 9)

Awards GeoBerlin 2015

Citation of awards will take place just before plenary lectures:

Monday 17:45 h
DGGV
- Serge-von-Bubnoff-Medaille: Hans-Joachim Franzke
- Gustav-Steinmann-Medaille: Onno Oncken

Tuesday 13:30 h
DGGV
- Leopold-von-Buch-Plakette: Trond H. Torsvik
- Teichmüller-Preis: Jop Klaver
- Bernd Rendel Preise der DFG: Eleanor Berryman & Benedikt Soja

Tuesday 11:30 h
DMG Goldschmidt Price 2014 Lecture
- Oliver Nebel in Session A1-05 in Hall "Max Kade Auditorium"

Wednesday 10:30 h
DMG Awards
- AG Werner in Silber: Al Hofmann
- Goldschmidt Preis: Eva Stüeken
- Ramdohr Preis 2014: Eleanor Berryman
- Beate-Mocek Preis: Doreen Turner & Sara Niedenzu

DGGV is awarding the honorary membership to Monika Dullo on Tuesday 18:00, General meeting of the DGGV, Hall B.

DMG and DGGV are awarding the following student awards,
Closing ceremony, Wednesday 16:00, Hall A.
- Outstanding DGGV Student Poster Award
  All first-author students presenting a poster are eligible to compete for this award.
  Please note that all (PhD/Master) students' posters have been marked with a green label.
  In case that you are a (PhD/Master) student but you cannot find a green label on your poster board, please ask our helpers to provide one.
  Successful students will be awarded financial support (1st place: € 600, 2nd: € 400, 3rd: € 200).

- Sediment Award: Awards will also be given to an outstanding talk and poster given within the SEDIMENT (Young Sedimentologist) sessions.

- DMG Paul Ramdohr Award: The DMG is awarding the Paul Ramdohr award (€ 1,000) to a young academic DMG-member for an outstanding presentation.

Public Events

Sonntag, 4. Oktober 2015, 15:30 Uhr · FU Berlin,
Henry-Ford-Bau, Max-Kade-Auditorium, Garystraße 35

GeoBerlin 2015-Auftaktveranstaltung – Eine Veranstaltung für Fachleute und Nicht-Fachleute, die unsere heutigen Vorstellungen über den Bau der Erde – und den Weg dahin – in spannender Weise präsentiert. · Öffentliche Veranstaltung · Eintritt gratis

Die Revolution der Geowissenschaften Alfred Wegener und der Umbruch in der Geologie im 20. Jahrhundert

Herzliche Einladung an Nichtfachleute und Fachleute.

- **Begrüßung und Moderation:**
  Präsident der GeoUnion Manfred Strecker
- **Kurt Stüwe (Graz):**
  Unterwegs in Grönland: Auf den Spuren von Alfred Wegener
- **Celâl Şengör (Istanbul):**
  Das Weltbild der Geowissenschaften –
  von Alfred Wegener bis heute

  Alfred Wegener hat mit seiner Hypothese der Kontinentalverschiebung die Erdwissenschaften revolutioniert, auch wenn die Revolution ein halbes Jahrhundert verzögert erfolgte. Die Antwort auf die Frage, warum diese Verzögerung stattfand, ist symptomatisch für die Erdwissenschaften im zwanzigsten Jahrhundert und darüber hinaus. Celâl Şengör spannt in seinem Vortrag den Bogen von Eduard Suess, dessen Beobachtungen z.B. in den Alpen wegweisende Grundlagen für Wegeners Theorie bildeten, über die breite Ablehnung seiner Theorie durch die damaligen Kollegen, bis in die heutige Zeit.

- **Gespräch zu Film und Vorträgen**
  mit Kurt Stüwe, Celal Sengör, Manfred Strecker, weiteren Gästen – und dem Publikum

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- **Prof. Celâl Şengör** · Universität Istanbul
  Celâl Şengör ist seit 1981 als Professor an der Technischen Universität Istanbul tätig. Durch seine wissenschaftliche Arbeit und seine vielfältige internationale Zusammenarbeit hat er enorm viel für die Entwicklung der Geowissenschaften in seinem Land bewirkt. In seiner Forschung versucht er, die von Alfred Wegener zuerst vermuteten Bewegungen der Kontinentalplatten für die Zeit seit dem Erdaltertum zu rekonstruieren.
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  Celâl Şengör's major research objective is the reconstruction of plate dynamics from the paleozoic to the present, using a genuinely historic approach with regard to both the analysis of the object matter and the study of the evolution of the discipline. He has immensely contributed to our knowledge of continental fragments, island arcs and oceanic residues of the Tethys. In search of the fundamentals of the tectonics of the Asian continent, his work covers predominantly the area from Turkey to south west China.

  Die Alfred-Wegener-Gedenkexpedition 2014 – mit Film (30 min)
  Sein hauptsächlicher Untersuchungsraum dabei ist Asien, von Südwest-China über Tibet bis in den Iran und die Türkei. Der wissenschaftlichen Tradition, der Geschichte der Geowissenschaften verpflichtet, stellt er seine geowissenschaftliche Arbeit stets in einen historischen Zusammenhang. Deswegen ist er für eine Würdigung des Werks Alfred Wegeners und für die Darstellung des heutigen Weltbilds der Geowissenschaften der hervorragend geeignete Experte.

- **Prof. Kurt Stüwe** · Universität Graz
  Kurt Stüwe hat sich als Geologe mit verschiedenen Subdisziplinen der Geowissenschaften beschäftigt: mit der Geologie der Metamorphite, Strukturgeologie, Geophysik und Geomorphologie. All dies nutzt er vor allem, um die Dynamik von Gebirgszügen zu erforschen, oft auch mit einem quantitativen Ansatz. Kurt Stüwe ist darüber hinaus ein begeisterter Bergsteiger; er hat erfolgreich Gipfel in allen Hochgebirgen der Welt bestiegen. 2014 leitete er eine die Alfred-Wegener-Gedächtnisexkursion nach Nordost-Grönland.
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  Kurt Stüwe has worked in many sub-disciplines of the Earth sciences including metamorphic geology, structural geology, geophysics and geomorphology. He has used all of these fields to study the dynamic evolution of mountain belts and has always had a focus on quantitative treatment of geological problems. He is also an avid mountaineer and has climbed in the highest mountain ranges of all continents. In 2014 he led the Alfred Wegener Memorial Expedition to North East Greenland.

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In German language:
Mittwoch, 7. Oktober 2015,
14:00–16:00 Uhr, Max Kade Auditorium

Öffentliche Vorträge über die unglaublichen Ideen von Alfred Wegener: Kontinente, die sich bewegen – so ein Unsinn!

- **Ulrich Wutzke (Berlin):**
  Alfred Wegener (1880–1930) – Eine Idee erobert die Welt
- **Prof. Dr. Wolfgang Jacoby (Univ. Mainz):**
  Wie dachte Alfred Wegener über die Ursachen der Kontinentalverschiebung?
- **Prof. Dr. Jörn Thiede (Univ. St. Petersburg):**
  Wladimir Köppen, Alfred Wegener und Milutin Milankovitch: Pioniere und Partner der Paläoklimaforschung
- **Günther Schönharting (Enkel von Alfred Wegener):**
  Die Wahrnehmung der Ideen von Alfred Wegener und Wladimir Köppen in der Öffentlichkeit: ein Stück Wissenschaftsgeschichte

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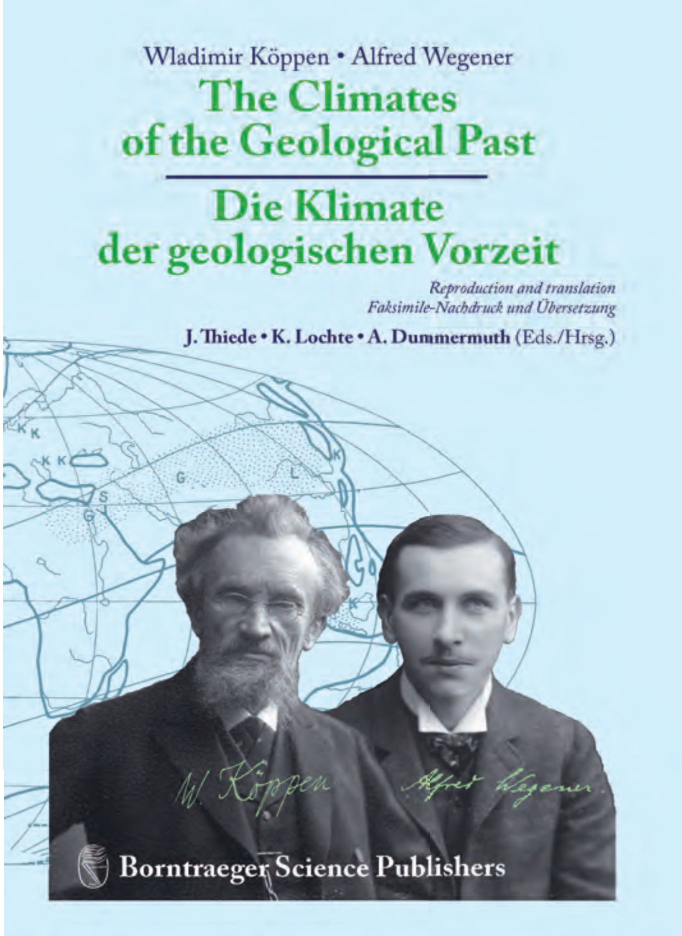
Wednesday, 7 October 2015, 11:45–12:30 h,
Foyer of the Henry Ford Building

Invitation to the Presentation of the reproduction and first English translation of Köppen & Wegener, 1924: "The Climates of the Geological Past"

with speeches and anecdotes by:

- **Karin Lochte (AWI Director, Editor)**.
- **Jörn Thiede (Editor)**.
- **Walter Obermiller (Bornträger, Publisher)**, and
- **Günther Schönhareng (Grandson of Alfred Wegener)**.

Public Events



ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Einladung zur Präsentation

des Faksimile-Nachdrucks
und der englischen Übersetzung

Köppen & Wegener, 1924: „Die Klimate der geologischen Vorzeit“

auf der Tagung GeoBerlin 2015
im Foyer des Henry-Ford-Baus*

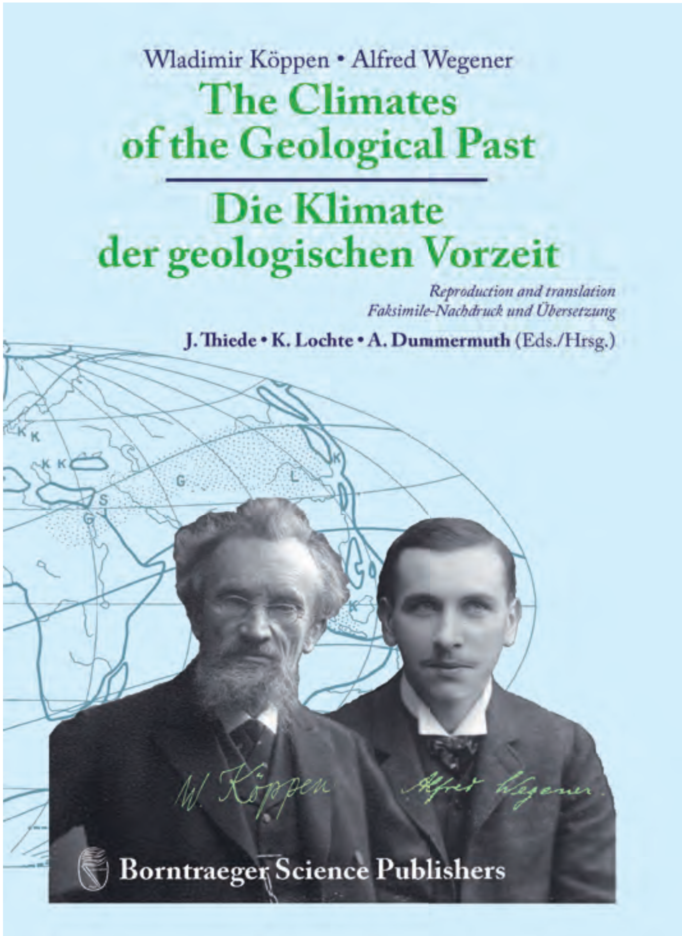
- 7. Oktober 2015, 11:45 – 12:30 Uhr

Mit Grußworten und Anekdoten von:

- Karin Lochte (AWI/Herausgeberin)
- Jörn Thiede (Herausgeber)
- Walter Obermiller (Bornträger, Verleger)
- Günther Schönharting (Enkel von Alfred Wegener)

*Freie Universität Berlin, Garystr. 35, 14195 Berlin-Dahlem. Bitte melden Sie sich bis zum 20.9.2015 per E-Mail an. Unsere Adresse lautet: <kontakt-potsdam@awi.de>

Infos zum Buch:
www.schweizerbart.com/koeppen-wegener



ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Invitation to the Presentation

of the reproduction and
first english translation of

Köppen & Wegener, 1924: „The Climates of the Geological Past“

at the GeoBerlin 2015 Congress
in the Foyer of the Henry Ford Building*

- 7th October 2015, 11:45 – 12:30 h

with speeches and anecdotes by:

- Karin Lochte (AWI Director, Editor)
- Jörn Thiede (Editor)
- Walter Obermiller (Bornträger, Publisher)
- Günther Schönharting (Grandson of Alfred Wegener)

*Freie Universität Berlin, Garystr. 35, 14195 Berlin-Dahlem. We kindly ask you to inform us about your participation until 20th September 2015: <kontakt-postdam@awi.de>

See also:
www.schweizerbart.com/koeppen-wegener

GeoBerlin 2015 4-7 October 2015 | Annual Meeting of DGGV • DMG
DYNAMIC EARTH – from Alfred Wegener to today and beyond
DYNAMISCHE ERDE – von Alfred Wegener bis heute und in die Zukunft

Öffentliche Vorträge über die unglaublichen Ideen von Alfred Wegener

Am Mittwoch, den 7.10.2015, 14:00-16:00 Uhr

„Kontinente, die sich bewegen - so ein Unsinn!"

Das dachten wohl die meisten Wissenschaftler, als Alfred Wegener am 6.1.1912 das erste Mal seine Idee, dass sich die Kontinente unserer Erde verschieben, vorstellte. Erst ca. 30 Jahre nach seinem Tod konnten meeresgeologische Expeditionen seine Theorie beweisen. Dies war der Beginn der modernen Plattentektonik.

Alfred Wegener (1880-1930) war ein deutscher Meteorologe, Polar- und Geowissenschaftler. Zu seinen Lebzeiten war er vor allem für seine neuen Erkenntnisse in der Meteorologie und als Pionier der Polarforschung, vor allem in Grönland, wo er auch 1930 während einer Expedition verstarb, anerkannt. Seine wissenschaftlichen Visionen sind heute noch ein Vorbild für nachhaltige naturwissenschaftliche Forschung.

Im Rahmen der GeoBerlin2015, der Jahrestagung der größten deutschen geowissenschaftlichen Fachgesellschaften, würdigen wir mit einem öffentlichen Symposium einen unvergessenen Wissenschaftler. Vortragende sind:

- **Ulrich Wutzke (Berlin):** ***Alfred Wegener (1880–1930) – Eine Idee erobert die Welt***
- **Prof. Dr. Wolfgang Jacoby (Uni Mainz):** ***Wie dachte Alfred Wegener über die Ursachen der Kontinentalverschiebung?***
- **Prof. Dr. Jörn Thiede (Uni, St. Petersburg):** ***Wladimir Köppen, Alfred Wegener und Milutin Milankovitch: Pioniere und Partner der Paläoklimaforschung***
- **Günther Schönharting (Enkel von Alfred Wegener):** ***Die Wahrnehmung der Ideen von Alfred Wegener und Wladimir Köppen in der Öffentlichkeit: ein Stück Wissenschaftsgeschichte***

Dieses Symposium ist vor allem an interessierte Schüler und Lehrer und die Öffentlichkeit gerichtet, die wir hiermit herzlich einladen. Der Eintritt ist kostenlos, eine Anmeldung über das Tagungssekretariat (geoberlin2015@fu-confirm.de, Frau Lange) ist wünschenswert**.**

Wo? Max Kade Auditorium, Henry Ford Bau der FU Berlin, Garystraße 35, 14195 Berlin-Dahlem, **Wann?** Mittwoch, den 7.10.2015, 14:00-16:00 Uhr. **www.geoberlin2015.de**

GFZ Freie Universität Berlin DGGV DMG GeoUnion Geo.X

Topics/Sessions

A GEOLOGICAL AND GEOPHYSICAL PROCESSES –100 years past Wegener: Plate tectonics, meteorite impacts, climatic evolution and sedimentation

A1 Subduction Processes and Continental Collision

A1-01: Monitoring Plate Boundary Systems and Observing Megathrust Earthquakes |
Bernd Schurr (GFZ Potsdam), Frederik Tilmann (GFZ Potsdam), Andreas Rietbrock (Uni Liverpool)
A1-02: Fluids in subduction zones – from a deformation to geochemistry perspective |
Ilona van Dinther (ETH Zürich), Matthias Konrad-Schmolke (Uni Potsdam), Matthias Rosenau (GFZ Potsdam)
A1-03: From oceanic subduction to continental collision: a metamorphic and magmatic geochemical perspective |
Chistoph Beier (Uni Erlangen), Ralf Halama (Keele University, UK)
A1-04: Mountain building on the scale of grains and atoms |
Claudia Trepmann (LMU München), Uwe Altenberger (Uni Potsdam), Rainer Abart (Uni Wien, Austria)
A1-05: Motion and time in orogenesis |
Johannes Glodny (GFZ Potsdam), Axel Gerdes (Uni Frankfurt), Armin Zeh (Uni Frankfurt)
A1-06: Subduction systems – missing link between Wegener's concept of continental drift and plate tectonics |
Jan H. Behrmann, Michael Stipp (both at GEOMAR, Kiel)

A2 Rifting / Continental Breakup / MORB / Transform Faults

A2-01/05: Plate tectonics, plate boundary deformation and intraplate tectonics: Observations and models on global, regional and basin scale |
Dietmar Müller (Sydney University), Sascha Brune (GFZ Potsdam), Christian Heine (Shell Intl. Expl. & Prod.), Mark Handy (FU Berlin), Anke Friedrich (Uni München), David Hindle (Uni Göttingen)
A2-02: Continental breakup and passive margin evolution |
Peter Kukla (RWTH Aachen), Sebastian Kollenz (Uni Heidelberg), Ulli Glasmacher (FU Berlin)
A2-03: Large Igneous Provinces: relation to continental breakup |
Eleonora Rivalta (GFZ Potsdam), Guillaume Jacques (Geomar), Gabriele Uenzelmann-Neben (AWI), Robert Trumbull (GFZ Potsdam)
A2-04: Magmatism in oceanic and continental intraplate environments |
Oliver Nebel (ANU Canberra), Christoph Beier (GeoZentrum Nordbayern), Lothar Viereck (Uni Jena), Michael Abratis (Uni Jena), Jörg Büchner (Senkenberg Museum Görlitz)

A3 Planetary Plate Tectonics and Impact Cratering Studies

A3-01: Meteorites and Early Planetary Evolution |
Harry Becker (FU Berlin), Ansgar Greshake (Museum für Naturkunde Berlin), Thomas Kruijer (Uni Münster), Vera Laurenz (Uni Bayreuth)
A3-02: Impact Cratering in the Planetary System |
Kai Wünnemann, Christopher Hamann (both Museum für Naturkunde Berlin)
A3-03: Earthlike Planets: Plate tectonics vs stagnant lid tectonics | Doris Breuer, Tilman Spohn (both DLR)

A4 Mantle Circulation / Driving Forces

A4-01/02: Mantle flow: geophysical imaging and large-scale geodynamic modelling |
Bernhard Steinberger (GFZ Potsdam), Nicola Tosi (DLR Berlin), Claudio Faccenna (Uni Roma Tre), Christine Thomas (Uni Münster), Andy Nowacki (University of Bristol)
A4-03: Properties of Earth Materials and Constraints on Mantle Flow |
Hauke Marquardt (Uni Bayreuth), Robert Farla (Uni Bayreuth), Patrick Cordier (Université Lille)
A4-04: When and How did Plate Tectonics Begin on Earth |
Robert Stern (Univ. Texas Dallas, USA), Taras Gerya (ETH Zürich), Stephan Sobolev (GFZ Potsdam)
A4-05: Archean environments and ecosystems | Alessando Airo (FU Berlin), Christoph Heubeck (Uni Jena)

A5 Evolution – Diversity as a Result of Plate Tectonics

A5-01: Palaeoenvironmental, sedimentological and biogeographic consequences of the formation and breakup of supercontinents |
Johannes Müller (Museum für Naturkunde Berlin), Robert Bussert (TU Berlin)
A5-02: Major environmental changes in Earth history: short- and long-term trends |
Christoph Korte (University of Copenhagen), Dieter Korn (Museum für Naturkunde Berlin), Clemens V. Ullmann (Uni Exeter)

A6 Climate and Plate Tectonics – Planetary Climate

A6-01: Tectonic and climatic imprints on the evolution of landscapes |
Taylor Schildgen (Uni Potsdam), Miriam Dühnforth (LMU München), Bodo Bookhagen (Uni Potsdam), Cornelia Spiegel (Uni Bremen)
A6-02: The Sediment Factory: Tectonic and Climatic Forcing of Erosional and Depositional Processes |
Kristen Cook (GFZ Potsdam), Paolo Ballato (Uni Potsdam), Hella Wittmann (GFZ Potsdam), Hilmar von Eynatten (Uni Göttingen), Dirk Scherler (GFZ Potsdam), Maria Giuditta Fellin (ETH Zürich)
A6-03: Ocean Gateways – Arteries of Tectonic-Climate Interaction |
Michael Sarnthein (Kiel University), Heidrun Kopp (Geomar), Silke Voigt (Uni Frankfurt), Gregor Knorr (AWI)
A6-04: Weathering and Global Biogeochemical Cycles – Crossing the Scales | Julien Bouchez (IPGP Paris), Cornelius Fischer (Marum), Jens Hartman (Uni Hamburg), F. v. Blanckenburg (GFZ Potsdam)
A6-05: Quaternary Environmental Changes and Sediment Dynamics |
Margot Böse (FU Berlin), Frank Preusser (Uni Freiburg)
A6-07: Glacial tectonics: from push moraines to glacial isostatic adjustment |
Christian Brandes (Uni Hannover), Christian Hübscher (CEN Uni Hamburg)

A7 Earth Materials in Geological Processes

A7-01: Geomaterials as indicators for Earth's light element cycles | Bernd Wunder (GFZ Potsdam), Eleanor Berryman (TU Berlin), Klaus-Dieter Grevel (Uni Jena), Andreas Ertl (Uni Wien)
A7-02: Structure, dynamics and properties of silicate melts and magmas |
Marcus Nowak (Uni Tübingen), Kai-Uwe Hess (LMU München)

B CONSEQUENCES FOR MANKIND

B1 Conventional and Non-Conventional Energy Ressources

B1-01: Multi-scale evolution of sedimentary basins |
Rolando diPrimio (Lindin, Norway), Johannes Wendebourg (Total Exploration Production, Paris)
B1-02: Rock and Fluids Properties and Interactions in Hydrocarbon Systems |
W. van Berk (TU Clausthal), H.M. Schulz (GFZ Potsdam)
B1-03: Shales and Coals:source and reservoir for oil and gas |
Ralf Littke (TWTH Aachen), Volker Wrede (Geol. Dienst NRW), M. Kosinowski (BGR)
B1-04: Exploration and development of natural resource projects | Bernd Teigler (DMT), B. Stribrny (BGR)

B2 Mineral Ressources and their Useage

B2-01: Marine ore deposits | U. Schwarz-Schampera (BGR Hannover), T. Kuhn (Geomar Kiel), M. Hannington (Geomar Kiel), S. Petersen (Geomar Kiel)
B2-02: Terrestrial ore deposits | Albert Gilg (TU München), Volker Steinbach (BGR Hannover)
B2-03: Scenarios for the Raw Material Supply of the Far Future |
Friedrich-Wilhelm Wellmer (Hannover), Wolfgang Jacoby (Mainz), Martin Schoell (Uni Mainz)

Topics/Sessions

B3 Risks (Tsunami, Earthquakes, Landslides)

B3-01: Operational Earthquake Forecasting, Early Warning and Real-Time Risk Reduction |
Jochen Zschau (GFZ Potsdam), Stefan Wiemer (ETH Zürich)
B3-03: Geological signatures of extreme events | H. Bahlburg (Uni Münster), M. Spiske (Uni Münster/Trier)

B4 Topography, Climate and Human Habitat

B4-01/02: Topography, Climate and Human Habitat | Diego Rybski (PIK/ GTK Finland), J. Kropp (PIK Potsdam)
B4-03: Transforming the Geo-Biosphere by Humanity: Agriculture and Water Management |
Bruno Merz (GFZ Potsdam)

B5 Utilisation of the Subsurface

B5-01: Numerical Simulation for geological underground utilization : Linking geological information to process modelling |
Mauro Cacace (GFZ Potsdam), Michael Kühn (GFZ Potsdam), Florian Wellmann (RWTH Aachen)
B5-02: Subsurface storage |
Christian Müller (BGR), Christian Ostertag-Henning (BGR), Axel Liebscher (GFZ Potsdam), Volkmar Bräuer (BGR), Guido Blöcher (GFZ Potsdam), Simona Regenspurg (GFZ Potsdam), Stefan Kranz (GFZ Potsdam), Frank Schilling (KIT)

B6 Materials for the Modern Society

B6-01: Cements, Ceramics and glasses |
B. Meng (BAM Berlin), H. Behrens (LU Hannover), Sebastian Simon (BAM Berlin)
B6-02: Archaeometry, monument conservation and dimension stones |
Klaus Bente (Uni Leipzig), Christoph Berthold (Uni Tübingen), Angela Ehling (BGR Hannover), Klaus Poschlod (Bayerisches Landesamt für Umwelt)
B6-03: Energy, materials, and minerals for technical applications |
Susan Schorr (Helmholtz-Zentrum Berlin), Christiane Stephan (FU Berlin), Stefan Stöber (Uni Halle), Herbert Pöllmann (Uni Halle), Melanie Keuper (Uni Tübingen)

C Additional Themes

C1/C2: Advances in material characterisation and analytical geochemistry |
Christoph Berthold (Uni Tübingen), Jörg Göttlicher (KIT Karlsruhe), Axel Gerdes (Uni Frankfurt), Geerke Floor (GFZ Potsdam)
C3: Earth Science Informatics for a Dynamic Planet |
Robert Huber (Marum), Roland Bertelmann (GFZ Potsdam)
C4: Young Sedimentologists |
Matthias Hinderer (TU Darmstadt), Robert Bussert (TU Berlin), Ulrich Heimhofer (Uni Hannover)
C5: Probing and Monitoring the Earth by Scientific Drilling |
Ursula Röhl (MARUM), Michael Stipp (Geomar), Ulrich Harms (GFZ Potsdam)
C6: 3D geology and geoinformation – modelling, data storage and distribution |
Rouwen Lehné (HLUG Wiesbaden, TU Darmstadt), Helmut Schaeben (TU Freiberg)

H HISTORICAL SYMPOSIUM: ALFRED WEGENER

H: Faszination Alfred Wegener: Leben, Aktivitäten und wissenschaftliche Leistungen (Public Session in German!)
Hans Hubberten (Berlin), Eva-Maria Pfeiffer (Deutsche Gesellschaft für Polarforschung DGP), Ulrich Wutzke (Berlin), Wolfgang Jacoby (Mainz)

Program at a glance | 4 – 7 October 2015

MONDAY, 5.10.2015					
	Foyer	Max Kade Audi 1.200 seats	Hall A 350 seats	Hall B 220 seats	Hall C 300 seats
8:00	**Registration**				
9:00		**A1-01 Monitoring Plate Boundary Systems and Observing Megathrust Earthquakes** (B. Schurr, F. Tilmann, A. Rietbrock)	**A2-02 Continental breakup and passive margin evolution** (P. Kukla, S. Kollenz, U. Glasmacher)	**A6-05 Quaternary Environmental Changes and Sediment Dynamics** (M. Böse, F. Preusser)	**B2-01 Marine ore deposits** (U. Schwarz-Schampera, T. Kuhn, M. Hannington, S. Petersen)
10:30	**Coffee break I poster session I exhibition**				
11:00		**A1-02 Fluids in subduction zones ...** (I. van Dinther, M. Konrad-Schmolke; M. Rosenau)	**A2-02 Continental breakup and passive margin evolution** (P. Kukla, S. Kollenz, U. Glasmacher)	**A6-05 Quaternary Environmental Changes and Sediment Dynamics** (M. Böse, F. Preusser)	**B2-03 Scenarios for the Raw Material Supply of the Far Future** (F.-W. Wellmer, W. Jacoby, M. Schoell)
12:30	**Lunch break I poster session I exhibition**				
14:00		Opening Ceremony: Greetings			
15:00		Plenary Lecture: Dan McKenzie (University of Cambridge, GB): The lithospheric structure of Pangea and central			
16:00	Poster Social for Posters of the following Sessions: A1-01, A1-02, A1-05, A2-01/-05, A2-02, A3-01, A3-02, A5-01, A5-02, A6-01,				
17:45		Awards: Serge-von-Bubnoff-Medaille and Gustav-Steinmann-Medaille			
18:00		Plenary Lecture: Maureen Raymo (Lamont Doherty Earth Observatory, USA): Sea Level During Past Warm Periods –			
19:00				Mitgliedervers.: DMG	

TUESDAY, 6.10.2015					
8:00	**Registration**				
8:30		**A1-05 Motion and time in orogenesis** (J. Glodny, A. Gerdes, A. Zeh)	**B2-02 Terrestrial ore deposits** (A. Gilg, V. Steinbach)	**A2-01 Plate tectonics, plate boundary def. & intraplate tectonics...** (M. Handy, A. Friedrich, D. Müller, D. Hindle, S. Brune, C. Heine)	**A6-01 Tectonic and climatic imprints on the evolution of landscapes** (T. Schildgen, M. Dühnforth, B. Bookhagen, C. Spiegel)
10:00	**Coffee break I poster session I exhibition**				
10:30		**A1-05 Motion and time in orogenesis** cont. + Goldschmidt Talk	**B2-02 Terrestrial ore deposits** cont.	**A2-01 Plate tectonics,...** cont.	**A6-01 Tectonic and climatic imprints on the evolution of landscapes** cont.
12:00	**Lunch break I poster session I exhibition**				
12:15			Information on DFG funding in Geosciences		
13:30		Awards: Leopold-von-Buch-Plakette, Teichmüller-Preis, Bernd Rendel Preise der DFG			
13:45		Plenary Lecture: Trond Torsvik (University of Oslo, Norway): Paleomagnetism and Plate Tectonics			
14:45	**Coffee break I poster session I exhibition**				
15:30		**A1-06 Subduction systems....** (J. H. Behrmann, M. Stipp)	**A6-03 Ocean Gateways – Arteries of Tectonic-Climate Interaction** (M. Sarnthein, H. Kopp, S. Voigt, G. Knorr)	**A2-01 Plate tectonics,...** cont.	**A6-01 Tectonic and climatic imprints on the evolution of landscapes** cont.
	Foyer	Max Kade Audi 1.200 seats	Hall A 350 seats	Hall B 220 seats	Hall C 300 seats
17:00	Poster Social for Posters of the following Sessions: A1-03, A1-04, A1-06, A2-01, A2-04, A3-03, A4-01, A4-03, A4-05, A6-03, A6-				
19:00				Mitgliedervers. DGGV	
20:00	Conference Dinner at the Mensa				

Hall D 250 seats	Senatssaal 60 seats	ZG 1 30 seats	RW 1 50 seats	RW 2 70 seats
A6-02 The Sediment Factory... (K. Cook, P. Ballato , H. Wittmann, H. von Eynatten, D. Scherler, M. G. Fellin)	**A7-01 Geomaterials as indicators for Earth's light element cycles** (B. Wunder, E. Berryman, K.-D. Grevel, A. Ertl)	**A5-01 Palaeoenvironmental, sedimentological and biogeographic consequences…** (J. Müller, R. Bussert)	**A3-01 Meteorites and Early Planetary Evolution** (H. Becker, A. Greshake, T. Kruijer, V. Laurenz)	**B4-01 Topography, Climate and Human Habitat** (D. Rybski, P. Schmidt-Thome, J. Kropp, N. Schwarz, G. Blöschl)
A6-02 The Sediment Factory... (K. Cook, P. Ballato , H. Wittmann, H. von Eynatten, D. Scherler, M. G. Fellin)	**A7-02 Structure, dynamics and properties of silicate melts and magmas** (M. Nowak; K.-U. Hess)	**A5-02 Major environmental changes in Earth history...** (C. Korte, D. Korn, C. V. Ullmann)	**A3-01 Meteorites and Early Planetary Evolution** (H. Becker, A. Greshake, T. Kruijer, V. Laurenz)	**B4-03: Transforming the Geo-Biosphere by Humanity: Agriculture and Water Management** (B. Merz)
Asia: The rules of craton assembly				
A6-02, A6-05, A7-01, A7-02, B2-01, B2-02, B2-03, B2-02, B4-01/-02, B4-03, B5-01, B6-01, C5, C6				
Rethinking the Bathtub Model				
A4-03 Properties of Earth Materials and Constraints on Mantle Flow (H. Marquardt, R. Farla, P. Cordier)	**B6-01 Cements, Ceramics and glasses** (B. Meng, H. Behrens)	**C6 3D geology and geoinformation – modelling, data storage and distribution** (R. Lehné, H. Schaeben)	**B5-01 Numerical Simulation for geological underground utilization...** (M. Cacace, M. Kühn, F. Wellmann)	**A3-02 Impact Cratering in the Planetary System** (K. Wünnemann, C. Hamann)
A4-03 Properties of Earth Materials and Constraints on Mantle Flow cont.	**B6-01 Cements, Ceramics and glasses** cont.	**C5 Probing and Monitoring the Earth by Scientific Drilling** (U. Röhl, M. Stipp, U. Harms)	**B5-01 Numerical Simulation for geological underground utilization…** cont.	**A3-02 Impact Cratering in the Planetary System** cont.
C4 Young Sedimentologists (M. Hinderer, R. Bussert, U. Heimhofer)	**B1-01 Multi-scale evolution of sedimentary basins** (R. di Primio, J. Wendebourg)	**B6-02 Archaeometry, monument conservation and dimension stones** (K. Bente, C. Berthold, A. Ehling, K. Poschlod)	**C3 Earth Science Informatics for a Dynamic Planet** (R. Huber, R. Bertelmann)	**A3-02 Impact Cratering in the Planetary System** cont.
Hall D 250 seats	Senatssaal 60 seats	ZG 1 30 seats	RW 1 50 seats	RW 2 70 seats
07, B1-01, B1-02, B1-03, B1-04, B3-03, B5-02/-03/-04, B6-02, B6-03/-04/-05, C1/C2, C3, C4				

Program at a glance | 4 – 7 October 2015

WEDNESDAY, 7.10.2015					
8:00	**Registration**				
8:30		**A1-04 Mountain building on the scale of grains and atoms** (C. Trepmann, U. Altenberger, R. Abart)	**A3-03 Earthlike Planets: Plate tectonics vs stagnant lid tectonics** (D. Breuer, T. Spohn)	**A4-04 When and How did Plate Tectonics Begin on Earth** (R. Stern, T. Gerya, S. Sobolev)	**A6-07 Glacial tectonics: from push moraines to glacial isostatic adjustment** (C. Brandes, C. Hübscher)
10:00	**Coffee break | poster session | exhibition**				
10:30		Awards: AG Werner in Silber, Goldschmidt Preis, Ramdohr Preis, Beate-Mocek Preis			
10:45		Plenary Lecture: Barbara Romanowicz (IPG Paris and Berkeley University, USA): Global mantle imaging in the age of			
11:45	**Lunch break | exhibition**				
12:30		**A4-05 Archean environments and ecosystems** (A. Airo, C. Heubeck)	**A2-04 Magmatism in oceanic and continental...** (O. Nebel, C. Beier, L. Viereck, M. Abratis, J. Büchner)	**A4-04 When and How did Plate Tectonics Begin on Earth** cont.	**A6-04 Weathering and Global Biogeochemical Cycles...** (J. Bouchez, C. Fischer, J. Hartman, F.v.Blanckenburg)
14:00	**Coffee break | poster session | exhibition**	**Historische Session: Faszination Alfred Wegener: Leben, Aktivitäten und wiss. Leistungen** (H. W. Hubberten, E.-M. Pfeiffer, U. Wutzke, W. Jacoby)	**Coffee break | poster session | exhibition**		
14:30			**A1-03 From oceanic subduction to continental collision: a metamorphic and magmatic geochemical perspective** (C. Beier, R. Halama)	**A4-04 When and How did Plate Tectonics Begin on Earth** cont.	**A6-04 Weathering and Global Biogeochemical Cycles…** cont.
16:00			Closing and Poster Awards and Paul Ramdohr Award		
16:30-18:30				Workshop BDG	

B6-03 Energy, materials, and minerals for technical applications (S. Schorr, C. Stephan / H. Pöllmann / S. Stöber, M. Keuper)	**B1-02 Rock and Fluids Properties and Interactions in Hydrocarbon Systems** (W. van Berk, H.M. Schulz)	**B3-01 Operational Earthquake Forecasting, Early Warning and Real-Time Risk Reduction** (J. Zschau, S. Wiemer)	**C1/C2 Advances in material characterisation and analytical geochemistry** (C. Berthold, J. Göttlicher, A. Gerdes, G. Floor)	**B5-02 Subsurface storage** (C. Müller, C. Ostertag-Henning / A. Liebscher, V. Bräuer / G. Blöcher, S. Regenspurg, S. Kranz, F. Schilling)
high speed wavefield computations				
A4-01 Mantle flow: geophysical imaging… (B. Steinberger, N. Tosi, C. Faccenna /C. Thomas, A. Nowacki)	**B1-03 Shales and Coals: Source and reservoir for oil and gas** (R. Littke, V. Wrede)	**B3-03 Geological signatures of extreme events** (H. Bahlburg, M. Spiske)	**A2-03 Large Igneous Provinces: relation to cont.…** (E. Rivalta, G. Jacques, G. Uenzelmann-Neben, R. Trumbull)	**B5-02 Subsurface storage** cont.
A4-01 Mantle flow: geophysical imaging cont.	**B1-04 Exploration and development of natural resource projects** (B. Teigler, B. Stribrny)	**B3-03 Geological signatures of extreme events** cont.	**A2-03 Large Igneous Provinces: relation to continental breakup** cont.	**B5-02 Subsurface storage** cont.

Information for oral presentations

You are allowed a maximum of 15 minutes for presenting your paper; each presentation shall not exceed 12 min and is followed by 3 minutes for questions from the audience.

Please bring your presentations latest in the coffee break before your session starts to your lecture hall.

Please give your file preferably on a memory stick to the technical assistant who is waiting in the breaks in your lecture hall for you in order to save your file to the presentation notebook and to check it together with you.

Monday | 5 October 2015

	Max Kade Audi 1.200 seats	Hall A 350 seats	Hall B 220 seats	Hall C 300 seats
8:00	**Registration**			
09:00-10:30	**A1-01 Monitoring Plate Boundary Syst. ...** | chair: B. Schurr, F. Tilmann, A. Rietbrock	**A2-02 Continental break-up & passive margin evol. ...** | chair: P. Kukla, S. Kollenz, U. Glasmacher	**A6-05 Quaternary Environ. Changes & Sediment Dyn. ...** | chair: M. Böse, F. Preusser	**B2-01 Marine ore deposits** | chair: U. Schwarz-Schampera, T. Kuhn, S. Petersen
9:00	Stephan V. Sobolev; Iskander Muldashev | **Modelling Seismic Cycle of a Megathrust Earthquake across the Scales**	**invited:** François Roure | **The Wilson cycle revisited**	**Keynote:** Philipp Gibbard | **The Anthropocene; a formal stratigraphical unit, an informal designation, or an interval of Holocene time?**	Peter E. Halbach, Andrea Koschinsky, Andreas Jahn | **The influence of water depth on concentration and fractionation of Rare Earth Elements in marine ferromanganese crusts**
9:15	P. Victor, B. Schurr, M. Sobiesiak, G. Gonzalez, O. Oncken | **Triggering and remote triggering of the Atacama Fault System monitored with the IPOC Creepmeter Array (N-Chile)**	**Keynote:** Webster Mohriak | **Continental breakup and passive margin evolution based on plate tectonic concepts developed from the South Atlantic and the Red Sea**		Andrea Koschinsky; James R. Hein; Katja Schmidt; Lydia Somers | **Seamount Phosphorites as Potential Resources for Rare Earth Elements and Fluoride**
9:30	**Keynote:** Jean-Philippe Avouac | **Seismic and Aseismic Fault Slip on Megathrust, application to the 2015 Gorkha earthquake, Nepal**		W.-C. Dullo, S. Flögel, M. Boxleitner, J. Raddaatz, C. Gudopp, A. Rüggeberg, V. Liebetrau | **Cold-Water Coral occurrences on the American Shelf**	S. Petersen, M. Hannington, T. Monecke, J. Jamieson | **The Global Resource Potential of Seafloor Massive Sulfides in Various Tectonic Settings**
9:45		Hans-Peter Bunge, Lorenzo Colli | **Spreading changes in the South Atlantic region: observations and geodynamic interpretations**	J. Raddatz; V. Liebetrau; J. Trotter; S. Flögel; A. Rüggeberg; A. Eisenhauer; Wolf-Christian Dullo; S. Voigt; M. McCulloch | **The Holocene cold-water coral reef phenomena off Norway: insights from a multi proxy approach**	Hannah Grant; Thomas Monecke; Sven Petersen; Mark Hannington | **Critical Metal Potential of Seafloor Massive Sulphide Deposits**
10:00	D. W. Scholl, S. H. Kirby, and R. von Huene | **Attributes of Subducting Lower Plate Relief that Hinder (Through Roughness) and Promote (Through Smoothness) the Rupturing of High-Magnitude (>Mw8.0) Megathrust Earthquakes**	Franz Neubauer | **Middle and lower passive margin crust preserved in mountain belts and its correlation with upper crust: significance for rifting models and tectonic reconstructions**	T. Haberzettl, M. Wündsch, T. Kasper, H. Cawthra, G. Daut, P. Frenzel, A. Hahn, K. Kirsten, S. Meschner, L. Quick, M. Zabel, J. Baade, M. Meadows, R. Mäusbacher | **The RAIN project and results from the terrestrial sites in South Africa**	M. Anderson; M. D. Hannington; T. F. McConachy | **Massive sulfide accumulation along a submarine scoria cone row at the Tinakula Deposit, New Hebrides Arc, Solomon Islands**
10:15	Stefanie Rieger, Nico Adam, Anke M. Friedrich | **The vertical surface-deformation pattern of Crete (Greece) from Persistent Scatterer Interferometry**	S. Brune, S. Williams, N. Butterworth, D. Müller | **Abrupt plate accelerations controlled by rift strength: A global analysis of Pangea fragmentation**	M. Wündsch; T. Haberzettl; K. L. Kirsten; S. Meschner; P. Frenzel; J. Baade; G. Daut; R. Mäusbacher; T. Kasper; L. J. Quick; M. E. Meadows; M. Zabel | **Sea level and climate change at the southern Cape coast, South Africa, as inferred from coastal lake sediments from Groenvlei**	J. Jamieson; S. Petersen; M. Hannington | **Exploration and Resource Potential of the Semyenov Vent Fields, on the 13°30' Oceanic Core Complex, Mid-Atlantic Ridge**
10:30	**Coffee break | poster session | exhibition**			

Hall D 250 seats	Senatssaal 60 seats	ZG 1 30 seats	RW 1 50 seats	RW 2 70 seats
A6-02 The Sediment Factory… I chair: K. Cook, P. Ballato , H. Wittmann, H. von Eynatten, D. Scherler, M. Giuditta Fellin	**A7-01 Geomaterials as indicators for Earth's light…** I chair: B. Wunder, E. Berryman, K.-D. Grevel, A. Ertl	**A5-01 Palaeoenvironmental, sedimentological…** I chair: J. Müller, R. Bussert	**A3-01 Meteorites and Early Planetary Evol. …** I chair: T. Kruijer, V. Laurenz	**B4-01 Topography, Climate and Human Habitat** I chair: J. Kropp
John Armitage I **Landscape response due to sediment transport and bed-rock detachment**	**Keynote:** Horst R. Marschall, Adam R. Sarafian I **Apatite as a recorder of crustal and planetary evolution**	J. Müller, R. Bussert, N. Klein, K. Allah Salih, D. Evans I **Late Cretaceous vertebrate faunas from northeastern Gondwana: regional endemism, vicariance, and continental break-up**	Gregory A. Brennecka; Lars E. Borg; Meenakshi Wadhwa I **Isotopic Fingerprints of Early Solar System Events**	**Keynote:** Martin Medina-Elizalde I **Pervasive drought during the fall of the Classic Maya Civilization: are we better prepared?**
Hella Wittmann; Friedhelm von Blanckenburg I **Dampened Holocene sediment fluxes across the lowlands of the Amazon and Ganga basins**		Annika Brüske; Stephan Schuth; Lingang Xu; Marie C. Arnold; Nadja Pierau; Stefan Weyer I **Stable vanadium isotopes – a potential new proxy for paleo-oceanography**	C. Burkhardt; L.E. Borg; G.A. Brennecka; Q. Shollenberger; N. Dauphas; T. Kleine I **The Sm and Nd isotopic composition of chondrites and their bearing on the composition and evolution of the Earth**	
Keynote: Matthias Hinderer I **Control on large-scale sediment fluxes**	Kusebauch C., John T., Whitehouse M. J. I **Using apatite as a fluid probe for halogens to decipher fluid-rock interaction**	Veit Höfler; Christine Wessollek; Pierre Karrasch I **Modelling prehistoric terrain Models using LiDAR-data – a geomorphological approach**	G. Budde; T. Kleine, T. S. Kruijer; K. Metzler I **Hf-W chronometry of Allende chondrules and matrix**	Martin Wattenbach, Richard Redweik, Stefan Luedtke, Ben Kuster I **Uncertainties in city greenhouse gas inventories**
	Andreas Ertl, Hans-Peter Meyer I **Pneumatolytic overgrowth of fluor-schorl on earlier formed schorl from Zschorlau, Erzgebirge, Germany**	Elahe Rahimi; Ali Mahfroozi I **Study of coastline changes in south Caspian sea by geochronology of ancient sites during Holocene (Iran)**	D. C. Hezel; P. Friend; D. Mucerschi; H. Palme I **Extensive Melt-Gas interaction between chondrules and surrounding protoplanetary disk**	Markus Böttle, S. Kriewald, L. Costa, D. Rybski, J. Kropp I **Coastal Floods Threatening European Cities: a Large Scale Damage Function Assessment**
T. Schildgen, R. Robinson, S. Savi, B. Bookhagen, S. Tofelde, D. Scherler, M. Strecker I **Landscape response to millennial-scale climate forcing from fluvial fill terraces: Humahuaca Basin, NW Argentina**	M. Kutzschbach, B. Wunder, R. Trumbull, A. Meixner, D. Rhede, W. Heinrich, G. Franz I **The effect of tetrahedral B on the B isotope fractionation between tourmaline and fluid**	Robert Bussert; Ali A.M. Eisawi I **Late Cretaceous tropical coastal wetlands at the southern shoreline of the Tethys in central Sudan**	A. Harbott, Y. Kadlag and H. Becker I **Chromium isotope heterogeneity in components and bulk rocks of carbonaceous chondrites.**	Steven Zierold, Lars Angler, Sven Dörfer, Lothar Viereck I **Mapping of the background-gamma-dose-rate in the urban area Erfurt, Thuringia – Germany**
Bodo Bookhagen; Manfred R. Strecker I **Evolution and erosional dynamics of intermontane basins on the Puna Plateau, NW Argentina**	E. Berryman; B. Wunder; A. Ertl; M. Koch-Müller; W. Heinrich; G. Franz I **Linking crystal structure to composition in tourmaline: A multi-method investigation of synthetic dravite, maruyamaite, magnesio-foitite, and oxyuvite**		Moritz I. F. Barth; Dennis Harries; Falko Langenhorst I **Polycrystalline Sulfide-Assemblages in Acfer 094 – Clues to Heterogeneous Nebular Conditions of Sulfide and Oxide Formation.**	Ramana Venkata Gudipudi, Till Fluschnik, Anselmo García Cantú Ros I **City Density and CO_2 Efficiency**

Monday | 5 October 2015

	Max Kade Audi	Hall A	Hall B	Hall C
11:00-12:30	**A1-02 Fluids in subduction zones…** I chairs: I. van Dinther, M. Konrad-Schmolke	**A2-02 Continental break-up & passive margin evol. … cont.** I chair: P. Kukla, S. Kollenz, U. Glasmacher	**A6-05 Quaternary Environ. Changes… cont.** I chair: M. Böse, Frank Preusser	**B2-03 Scenarios for the Raw Material…** I chair: F.-W. Wellmer, W. Jacoby, M. Schoell
11:00	W. Bloch, J. Kummerow, T. John, P. Wigger, S. Shapiro I **Evidence for Metamorphic Slab Dehydration in the Central Andean Subduction Zone, Derived from Volumetric Vp/Vs Measurements And Thermodynamical Modeling**	M. Kosters; D. van Hinsbergen; L. Boschman; G. Schepers; P. Bijl; W. Spakman I **Opening of the Drake Passage: due to Mantle Anchoring and Absolute Plate Motions?**	E. Gischler, A. Isaack, H. Hudson, F. Anselmetti, M. Humblet, J. C. Braga, A. Eisenhauer, G. Camoin I **Late Quaternary reef response to sea-level rise and subsidence in Bora Bora, Society Islands, South Pacific (French Polynesia)**	**Keynote:** Lawrence Cathles I **The Earth has the energy and mineral resources to indefinitely sustain 10.5 bn at an EU standard in an environmentally acceptable way**
11:15	S. Angiboust, J. Kirsch, O. Oncken, J. Glodny, P. Monié, E. Rybacki I **Probing the transition between seismically coupled and decoupled segments along an ancient subduction interface**	**invited:** François Guillocheau and the TopoAfrica working group I **Passive margins of austral Africa: long term evolution, mantle dynamics, erosion and sedimentation**	A. Bernhardt, M. R. Strecker I **Propagation of paleoclimatic perturbations to turbidite systems, Chile convergent margin**	
11:30	Achim Kopf, Michael Tryon, Simone Kasemann, Andre Hüpers I **Deep-seated fluid ascent in mud volcanoes off Japan**	**invited:** R. Brown, M. Wildman, R. Beucher I **The topographic evolution of southern Africa: what's all the fuss about and why are we still arguing about this?**	B. Diekmann, B. Biskaborn, O. Dirksen, V. Dirksen, U. Hoff, L. Nazarova, L. Pestryakova, D. Subetto, P. Tarasov I **Limnogeological Records of late Quaternary Palaeoenvironments in eastern Siberia**	Wolfgang Jacoby I **Limits of Earth**
11:45	Fatma Gülmez, Dejan Prelevic, Ş. Can Genç I **Can slab-rollback trigger ultrapotassic volcanism in an active arc setting: an example from Northern Anatolia, Turkey**	E. Duesterhoeft; H. Wichura; R. Bousquet; R. Oberhänsli I **Pre-rift topography of the East-African Plateau induced by metamorphic density changes in the lithosphere**	F. Kober, K. Hippe, M. Christl, L. Wacker, W. Winkler, R. Lampe I **Evaluating the in-situ produced cosmogenic nuclide inventory of longshore transported sand, Fischland-Darss-Zingst peninsula, southern Baltic Sea**	
12:00	T. John, O. Plümper, H. Vrijmoed, Y. Podladchikov, M. Scambelluri I **From porosity formation to permeability generation and the initiation of flow in dehydrating rocks: deciphering fluid flow mechanisms in subduction zones**	Jana Schierjott; Francesco Maccaferri, Valerio Acocella, Eleonora Rivalta I **A numerical and analogue study of dike ascent in asymmetric continental rift zones**	Michael Kenzler; Sumiko Tsukamoto;Stefan Meng; Manfred Frechen; Heiko Hüneke I **New results of OSL dating of Weichselian sediments from the German Baltic Sea coast**	Friedrich-W. Wellmer, Volker Steinbach I **Is a Road to Sustainable Use of Non-Renewable Mineral Raw Materials possible?**
12:15	S. Ferrero, P. J. O´Brien, L. Hecht, M. Ziemann, B. Wunder I **Primary carbonate-rich melt in stromatic migmatites of the Bohemian Massif as result of partial melting of metasediments in the middle-lower crust**	E. J. Rindraharisaona; F. Tilmann; X. Yuan; M. Reiss; G. Ruempker I **Lithosphere structure in the southern Madagascar from receiver function and ambient noise surface wave dispersion analysis**	J. Winsemann, J. Lang, J. Roskosch, U. Polom, U. Böhner, C. Brandes, C. Glotzbach, M. Frechen I **Terrace styles and timing of fluvial terrace formation in the Weser and Leine valleys, northern Germany**	Jens Gutzmer I **EIT Raw Materials - perspectives for research on raw materials in Europe**
12:30	**Lunch break I poster session I exhibition**			
14:00	Opening Ceremony: Greetings			
15:00	Plenary Lecture: Dan McKenzie (University of Cambridge, GB): The lithospheric structure of Pangea and central			
16:00	Poster Social for Posters of the following Sessions: A1-01, A1-02, A1-05, A2-01/-05, A2-02, A3-01, A3-02,			
17:45	Awards: Serge-von-Bubnoff-Medaille and Gustav-Steinmann-Medaille			
18:00	Plenary Lecture: Maureen Raymo (Lamont Doherty Earth Observatory, USA): Sea Level During Past Warm			
19:00			Mitgliedervers. der DMG	

Hall D	Senatssaal	ZG 1	RW 1	RW 2
A6-02 The Sediment Factory… cont. | chair: K. Cook, P. Ballato , H. Wittmann, H. von Eynatten, D. Scherler, M.G. Fellin	**A7-02 Structure, dynamics and properties…** | chair: M. Nowak; K.-U. Hess	**A5-02 Major environmental changes…** | chair: C. Korte, D. Korn, C. V. Ullmann	**A3-01 Meteorites and Early Planetary Evol. … cont.** | chair: T. Kruijer, V. Laurenz	**B4-03 Transforming the Geo-Biosphere by Humanity…** | chair: B. Merz
Sarah Schroeder; Richard Gloaguen | **Progress in code development for calibration of tectonically coupled surface evolution**	**Keynote:** Ilya Veksler | **Silicate liquid immiscibility in magmatic systems**	**Keynote:** Stephen P. Hesselbo | **New Developments in understanding Jurassic Earth History**	M. Matthes; M. Fischer-Gödde; T.S. Kruijer; I. Leya; T. Kleine | **Rapid cooling of the IIIAB iron meteorite parent body inferred from Pd-Ag systematics**	**Keynote:** Giuliano Di Baldassarre | **Socio-hydrology: capturing the interplay between societies and floods**
L. Stutenbecker, F. Schlunegger | **Geomorphological response of a landscape to long-term tectonic and glacial processes: the upper Rhône basin, Central Swiss Alps**			Zaicong Wang; Harry Becker | **Magmatic fractionation of chalcophile elements on Earth and Mars**	
C. von Hagke, E. Luijendijk, R. Ondrack, J. Lindow | **Lack of correlation between relief and exhumation in the North Alpine Foreland Basin revealed by thermochronometry and a new thermal model**	S. Wiesmaier; D. Morgavi; C. Renggli; D. Perugini; C. De Campos; K.-U. Hess; W. Ertel-Ingrisch; Y. Lavallée; D. B. Dingwell | **Magma mixing enhanced by bubble segregation**	Clemens V. Ullmann; Robert Frei: Christoph Korte, Stephen P. Hesselbo | **Reading the Record: Understanding heterogeneity in macrofossil geochemistry**	Olivier Namur; Bernard Charlier; Francois Holtz | **Sulfur solubility in mafic silicate melts at reducing conditions: Implications for Mercury's differentiation**	G. Lischeid, T. Hohenbrink, C. Lehr, S. Böttcher, J. Steidl, C. Merz, U. Schindler, R. Dannowski, T. Kalettka | **Multiple causes, multiple effects: Forensic hydrology approaches to elucidate complex relations between drivers and effects in landscape hydrology and biogeochemistry**
Martin Elsner | **Structure and Stratigraphy of the Upper Freshwater Molasse of the North Alpine Foreland Basin in Western Bavaria**	J. Wagner; S. Jahn | **Y and La compatibility in silicate melts and its dependence on melt structure: A first principles simulation study**	Leonid Anisimov | **Comparative Hydrogeochemistry in Global Perspective**	Thorsten Kleine; Thomas Kruijer; Mario Fischer-Gödde | **Tungsten isotopes and the origin of the Moon**	C. Conrad, F. Löw, J. P. A. Lamers | **Satellite remote sensing-based indicators for an improved understanding of irrigation water use, and agricultural area dynamics in the Aral Sea basin**
Alexander Bassis; Matthias Hinderer; Guido Meinhold | **Provenance of Saudi Arabian Palaeozoic sandstones using whole rock and single grain geochemistry**	Maria Stuff; Jan A. Schuessler; Max Wilke | **Experimental constraints on Fe isotope fractionation between silicate and carbonate immiscible melts**	S. Huck; U. Heimhofer | **Rudist bivalve versus bulk carbonate chemostrati-graphy: towards an improved chronostrati-graphy of Urgonian carbonate platform demise in the run-up to the Oceanic Anoxic Event 1a**	Peter Sprung, Raúl O. C. Fonseca, Maxwell M. Thiemens, Carsten Münker | **The evolution of the infant Moon**	C. Bismuth, H.-G. Frede, H. Kreutzmann, O. Bens, R.-F. Hüttl | **Major Water Engineering Projects as key driver for the transformation of landscapes: An analysis of case studies from the Fergana Valley and the Lower Jordan Valley**
Alexandra Hellwig; Silke Voigt; Andreas Mulch; Axel Gerdes; Thomas Voigt | **Paleoclimatic implications from Cenozoic terrestrial calcrete formation in the Ili Basin, SE Kazakhstan**	J. Pohlenz, S. Pascarelli, O. Mathon, S. Belin, A. Shiryaev, O. Safonov, A. Veligzhanin, V. Murzin, T. Irifune; M. Wilke | **Structural of Silicate-Carbonate Melts: An EXAFS Study on Y and Sr Properties**	K. Frisch; S. Voigt; S. Batenburg; S. Nigmatova | **Tectonic and climatic forcing of lake level and salinity in the Miocene lacustrine succession of the Aktau Hills, southeastern Kazakhstan, Central Asia**	Philipp Gleißner, Harry Becker | **Highly siderophile and chalcophile elements in lunar impact melt rocks: evidence for mixing of impactor compositions**	Abdullaev Iskandar | **Transformastions in water sector in Central Asia: from hydraulic mission to socio-political control**
Asia: The rules of craton assembly				
A5-01, A5-02, A6-01, A6-02, A6-05, A7-01, A7-02, B2-01, B2-02, B2-03, B2-02, B4-01/-02, B4-03, B5-01, B6-01, C5, C6				
Periods – Rethinking the Bathtub Model				

Tuesday | 6 October 2015

	Max Kade Audi 1.200 seats	Hall A 350 seats	Hall B 220 seats	Hall C 300 seats
8:00	**Registration**			
8:30	**A1-05 Motion and time in orogenesis** | chair: J. Glodny, A. Gerdes, A. Zeh	**B2-02 Terrestrial ore deposits** | chair: A. Gilg, V. Steinbach	**A2-01 Plate tectonics...** | chair: M. Handy, A. Friedrich	**A6-01 Tectonic and climatic imprints...** | chair: T. Schildgen, M. Dühnforth, B. Bookhagen, C. Spiegel
8:30	Armin Zeh; Allan H. Wilson; Maria Ovtcharova; Urs Schaltegger | **Zircons of the Bushveld Complex – When and How did they form?**	Philipp Weis | **The physical hydrology of porphyry copper systems**	M. Bohnhoff, P. Martínez-Garzón; F. Bulut; E. Stierle; Y. Ben-Zion | **Maximum earthquake magnitudes in relation to fault zone evolution: The case of the North Anatolian Fault Zone**	**Keynote:** Peter van der Beek | **Tectonics, Climate, Relief and Erosion: disentangling driving forces within a complex system**
8:45	F. Boekhout; J. Berndt; A. Gerdes; H. Bahlburg | **Geological bias in the provenance record: an example of Rodinia margin granites from the Seychelles**	Marina Lazarov; Aleksandar Pačevski, Stefan Weyer | **Unravelling processes of ore formation in porphyry Cu deposit with chalcopyrite Cu isotope compositions**	Eline Le Breton, Mark R. Handy, Kamil Ustaszewski | **Kinematic reconstructions and possible driving forces of the Adriatic microplate**	
9:00	N. Koglin, G. Franz, J. Glodny, U. Schüssler, A. Zeh, A. Gerdes, H. Brätz | **Münchberg metamorphic complex: nature and ages of the nappe protoliths**	Moritz Albrecht; Insa Theresa Derrey; Ingo Horn; Axel Müller; Francois Holtz; Stefan Weyer | **UV-fs-LA-ICP-MS analyses of fluid inclusions from tin ore deposits**	W. Spakman, M. Chertova, S. Mohammadi, A. van den Berg, C. Thieulot, D. van Hinsbergen | **Slab dragging and the recent geodynamic evolution of the Africa-Iberia plate boundary region**	J. D. Jansen, A. T. Codilean, D. L. Egholm, M. F. Knudsen, O. Korup, A. Stroeven, B. Goodfellow, J. L. Andersen, S. V. Ugelvig, J. Klein | **The cold-climate origins of Scandinavian mountain plateaux**
9:15	T. Reischmann, A. Gerdes, H.-G. Fritsche, H.-D. Nesbor | **Late Devonian subduction and ocean closure: Evidence from zircon ages from the northern Böllsteiner Odenwald**	M. Duchoslav; M. A. W. Marks; C. McCammon; H. Marschall; T. Wenzel; G. Markl | **Major-minor and trace element variations in tourmaline as monitors for magmatic differentiation, fluid un-mixing and associated ore precipitation**	Kosuke Ueda, Dave May, Taras Gerya, Sean Willett | **Sensitivity of active continental margin evolution to different surface process models**	P. Ballato, A. Landgraf, T. F. Schildgen, D. F. Stockli, M. Fox, M.R. Ghassemi, E. Kirby, M. Strecker | **The growth of a mountain belt forced by base-level fall: Tectonics and surface processes during the evolution of the Alborz Mountains, N Iran**
9:30	S.O. Martha; G. Zulauf; W. Dörr; P. Xypolias; R. Petschick; J. Schastok | **The Asterousia Crystalline Complex in the Aegean region: insights from structural analyses and U-Pb zircon dating on Anafi Island (Cyclades, Greece)**	**Keynote:** Hartwig E. Frimmel | **From early life to gold deposits**	Jonas Kley; Fabian Jähne-Klingberg, Alexander Malz, Frithjof Bense | **Mesozoic intraplate structures in Germany: trying to understand the crucial details**	R. Dietmar Müller, Tristan Salles, Nicolas Flament, and Michael Gurnis | **Continental inter-superswell travel and landscape evolution**
9:45	Andreas Gärtner, Michel Villeneuve, Ulf Linnemann, Nasrrddine Youbi, Axel Gerdes | **The Adrar Souttouf Massif (Moroccan Sahara) – a key to the Avalonia and Meguma conundrum?**		Anke M. Friedrich, Simon Kübler, Manfred Strecker | **Coseismic origin of transgranular gravel fractures in non-lithified deposits**	Edward R. Sobel; Alejandro Bande; Alexander Mikolaichuk; Euan Macaulay; Chen Jie | **Oligocene – Miocene exhumation of the Tian Shan**
10:00	**Coffee break | poster session | exhibition**			
10:30	**A1-05 Motion and time in orogenesis** | chair: J. Glodny, A. Gerdes, A. Zeh	**B2-02 Terrestrial ore deposits** | chair: A. Gilg, V. Steinbach	**A2-01 Plate tectonics....** | chair: D. Müller, D. Hindle	**A6-01 Tectonic & climatic imprints...** | chair: T. Schildgen, M. Dühnforth, B. Bookhagen, C. Spiegel

Hall D 250 seats	Senatssaal 60 seats	ZG 1 30 seats	RW 1 50 seats	RW 2 70 seats
A4-03 Properties of Earth Materials... | chair: H. Marquardt, R. Farla, P. Cordier	**B6-01 Cements, Ceramics & glasses** | chair: B. Meng, H. Behrens	**C6 3D geology and geoinformation** | chair: R. Lehné, H. Schaeben	**B5-01 Num. Simulation for geol. Undergr. ...** | chair: M. Cacace, M. Kühn, F. Wellmann	**A3-02 Impact Cratering in the Planetary System** | chair: K. Wünnemann, C. Hamann
Keynote: Ulrich Faul, Ian Jackson, Emmanuel David, Christopher Cline and Andrew Berry | **Experimental constraints on seismic properties and rheology of the upper mantle: Effects of water and melt**	**Keynote:** Georges Calas, Laurence Galoisy, Laurent Cormier & Gérald Lelong | **Linking optical and structural properties of glasses**	Humaad Ghani, Ehtisham Javed, Irum | **3D Structural modelling of Central Salt Range, Pakistan**	J. Freymark; J. Sippel; M. Scheck-Wenderoth; K. Bär; M. Stiller; J.-G. Fritsche; M. Kracht | **Structure and thermal field of the Upper Rhine Graben – a lithospheric-scale 3D model**	**Keynote:** Alex Deutsch | **Impact Processes: From Alfred Wegener to Chelyabinsk and beyond**
		M. Nolde, M. Schwanebeck, E. Biniyaz, R. Duttmann | **Subsurface Spatial Planning: Development of a 3-D online tool for the evaluation of potential underground energy storage sites**	Elco Luijendijk; Mark Person | **Quantifying permeability and modelling fluid and heat flow in an evolving sedimentary basin**	
H. Idrissi, C. Bollinger, P. Cordier, F. Boioli | **In situ deformation of olivine in the transmission electron microscope: from dislocation velocity measurements to stress-strain curves**	Dawid Murawski; Sebastian Roß; Harald Behrens; Martin Lerch | **Ionic mobility in lithium silicate glass powder during compaction**	Stefan Rautenberg, Thomas Schmitz, Rouwen Lehné, Ivo Sibul | **Challenges and chances of geological 3D-modelling – a case study for the northeastern part of Estonia**	J. Niederau; A. Ebigbo; G. Marquart; I. Dini; M. Thorwart; W. Rabbel; R. Pechnig; R. Bertani; C. Clauser | **How minor changes in a geological model can affect simulation results: An example of a geothermal reservoir in Tuscany, Italy**	Meng-Hua Zhu, Kai Wünnemann, Ross W. K. Potter | **Numerical Modeling of the Ejecta Distribution and Crater Formation of the Orientale Basin on the Moon**
R. Farla; A. Rosenthal; C. Bollinger; S. Petitgirard; T. Kawazoe; J. Guignard; D. Frost | **In situ deformation of eclogite and depleted peridotite compositions at high pressure and temperature**	S. Reinsch, C. Roessler, U. Bauer, R. Müller, J. Deubener, H. Behrens | **Water, the other network modifier in borate glasses**	Bianca Wagner; Bernd Leiss | **3D-Mapping of sedimentary and tectonic structures applying "Terrestrial LIDAR" and "Structure from Motion (SfM)" in view of developing multi-scale digital geologic models**	Hui Wang; J. Florian Wellmann | **Pattern-based analysis of subsurface heterogeneities and its application to generate spatial property distributions for process simulations**	S. Sturm; T. Krüger; T. Kenkmann | **Structural rim uplift and ejecta thickness measurements of martian complex impact craters: Rim formation of complex impact craters**
Herbert Wallner; Harro Schmeling | **Induced stress in stiff lithosphere by melt emplacement**	Anna-Maria Welsch, Harald Behrens, Franziska Fritsche, Ingo Horn | **Mobility of Lithium in borate glass networks**	Peter Wycisk; Lars Schimpf | **How to communicate 3d geological models to public**	A. Hassanzadegan, M. Cacace; J. Sippel; M. Scheck-Wenderoth, M. Frick | **Geological characterization and modeling of the Berlin sub-sedimentary basin**	R. Luther; A. Yener; K. Wünnemann | **Production of climatically active gases during the Chicxulub impact event**
N. Biedermann; H.-J. Reichmann, S. Speziale; M. Koch-Müller; G. Heide | **High-pressure phase transitions of strontianite**	V. Steinbauer; M. Herwegh; T. Bühler; R. Raso, J. Kaufmann, R. Zurbriggen | **Understanding hail damage of External Thermal Insulation Composite System (ETICS)**	H. Budde; C. Hoselmann; R. Lehné; G. Radtke; H. Heggemann; A. Hoppe | **3D Modelling of the Quaternary and Tertiary units as a key for sustainable groundwater management in an urban area (Frankfurt, Germany)**	T. Kempka; B. Nakaten; M. De Lucia; F. Magri; N. Nakaten; C. Otto; M. Pohl; E. Tillner; M. Kühn | **Flexible simulation framework to couple processes in complex 3D models for underground utilization assessment**	Julia Brugger; Georg Feulner | **Climatic effects of the Chicxulub impact**
A4-03 Properties of Earth Material... | chair: H. Marquardt, R. Farla, P. Cordier	**B6-01 Cements, Ceramics & glasses** | chair: B. Meng, H. Behrens	**C5 Probing & Monitoring the Earth by Sci. Drilling** | chair: U. Röhl, M. Stipp, U. Harms	**B5-01 Num. Simulation for geol. Undergr. ...** | chair: M. Cacace, M. Kühn, F. Wellmann	**A3-02 Impact Cratering in the Planetary System** | chair: K. Wünnemann, C. Hamann

	Max Kade Audi	Hall A	Hall B	Hall C
10:30	**A1-05 Motion and time in orogenesis** | chair: J. Glodny, A. Gerdes, A. Zeh	**B2-02 Terrestrial ore deposits** | chair: A. Gilg, V. Steinbach	**A2-01 Plate tectonics....** | chair: D. Müller, D. Hindle	**A6-01 Tectonic & climatic imprints...** | chair: T. Schildgen, M. Dühnforth, B. Bookhagen, C. Spiegel
10:30	K. Fassmer; G. Obermüller; T. Nagel; F. Kirst; N. Froitzheim; S. Sandmann; I. Miladinova; R. Fonseca; C. Münker | **Coherent vs. non-coherent subduction of ophiolite complexes – new insights from the Zermatt-Saas Zone (ZSZ) in the Western Alps**	H.-J. Kümpel und R. Gaupp | **Laudatio zu Prof. Wellmer**	Lydian M. Boschman; Douwe J. J. van Hinsbergen; Cedric Thieulot; Wim Spakman; Martha Kosters | **How the largest plate on Earth originated in a point**	Andreas Mulch, C. Page Chamberlain, Katharina Methner, Jens Fiebig, Maud Meijers | **Topography of mountain belts as a key element in the evolution of landscapes and life**
10:45	Axel Gerdes | **Dating shear zones, volcanism and ore mineralisation by insitu U-Pb small scale isochrones**	Volker Steinbach, Ulrich Schwarz-Schampera | **Initiative „Research Assignments in the Field of Ore Deposit Research" – what has been achieved?**	Marco Maffione, Cedric Thieulot, Douwe van Hisnbergen, Antony Morris, Oliver Plümper, Wim Spakman | **Subduction initiation at oceanic detachment faults and the origin of forearc ophiolites**	Alexander Rohrmann; Dirk Sachse; Andreas Mulch; Heiko Pingel; Ricardo Alonso; Manfred Strecker | **Rapid hydrological response to central Andean Plateau uplift revealed by leaf wax stable isotopes**
11:00	Shuyun Cao, Franz Neubauer, Manfred Bernroider, Johann Genser, Gertrude Friedl, Junlai Liu | **Low-grade retrogression of a high-temperature metamorphic core complex: Naxos, Cyclades, Greece**	E. Müller-Huber; K. Kühn; S. Schmidt; M. Maurer; F. Börner | **Petrophysical, mineralogical, and geochemical investigations of a Li-Sn-W deposit – A contribution to develop a borehole probe for quantitative element determination in ores of natural deposits**	D.J.J. van Hinsbergen, K. Peters, M. Maffione, W. Spakman, C. Guilmette, C. Thieulot, O. Plümper, D. Gürer, F.M. Brouwer, E. Aldanmaz, N. Kaymakci | **Dynamics of intra-oceanic subduction initiation, part 2: supra-subduction zone ophiolite formation and metamorphic sole exhumation in context of absolute plate motions**	Andrea Madella; Romain Delunel; Laurence Audin; Sönke Szidat; Fritz Schlunegger | **On the uplift anomaly of the Arica Bend, Western Central Andes**
11:15	I. Miladinova; S. Sandmann; N. Froitzheim; T. J. Nagel; M. Janák; N. Georgiev; C. Münker; R.O.K. Fonseca | **Late Cretaceous eclogite in the Eastern Rhodopes (Bulgaria): a link between the Rhodope Metamorphic Complex and the Stredna Gora volcanic arc**	Friedrich Lucassen, Wolfgang Pritzkow, Martin Rosner, Simone Kasemann | **Nitrogen and Carbon elemental and isotope chemistry in guano deposits – Pacific margin of Northern Chile**	Franz Tessensohn. Karsten Piepjohn, Detlev Damaske, Solveig Estrada | **The Case of the Arctic Wegener Fault.-Postulations and present state of knowledge.**	Robin Lacassin, Rolando Armijo, Aurélie Coudurier-Curveur, Daniel Carrizo | **Evolution of Andean orogeny, feedbacks between tectonics and global climate**
11:30	**AWARD WINNER – DMG Goldschmidt Preis 2014** Oliver Nebel | **On the virtue and wickedness of modern Rb-Sr dating**	D. Kraemer; M. Bau | **Investigating New Biogeochemical Approaches for Prospection of Concealed Metal Deposits: Enhanced Release and Fractionation of ‚Immobile' High Field Strength Elements (REY, Zr, Hf, Th, U) by Leaching in Presence of Biogenic Ligands (Siderophores)**	H. Liu, Y. Zhou, B. Shen, Y. Li, Y. Wang | **Ancient Shuangfeng-Bijia collisional orogenic belt in the South China Sea, a "witness" to processes of drifting of fragments from Gondwana, subduction of Tethys and accretion of southeastern Asia**	Jan-Hendrik May; Frank Preusser; Andreas Schellenberger; Roland Zech; Heinz Veit | **Late Quaternary landscape dynamics along the Subandean ranges of NW Argentina**
11:45		H. Albert Gilg, Adrian M. Hall, Anthony E. Fallick, Frank Friedrich, Ulf B. Andersson | **Hydrothermal clays in Fe oxide deposits of Norrbotten County, northern Sweden**	M.R. Handy; S. Cionoiu; J. Giese; P. Gross; E. Le Breton; K. Onuzi; J. Pleuger; S.M. Schmid; K. Ustaszewski; S. Zertani | **Orogen-parallel and orogen-normal extension related to ongoing clockwise rotation at the junction of the Dinarides and Hellenides (Northern Albania)**	Henry Wichura, Louis L. Jacobs, Manfred R. Strecker, Andrew Lin, Michael J. Polcyn, Fredrick K. Manthi, Dale A. Winkler, Clemens Matthew | **A tale of a whale: How does a ziphiid fossil pinpoint the onset of uplift in East Africa?**

Hall D	Senatssaal	ZG 1	RW 1	RW 2
A4-03 Properties of Earth Material... | chair: H. Marquardt, R. Farla, P. Cordier	**B6-01 Cements, Ceramics & glasses** | chair: B. Meng, H. Behrens	**C5 Probing & Monitoring the Earth by Sci. Drilling** | chair: U. Röhl, M. Stipp, U. Harms	**B5-01 Num. Simulation for geol. Undergr. ...** | chair: M. Cacace, M. Kühn, F. Wellmann	**A3-02 Impact Cratering in the Planetary System** | chair: K. Wünnemann, C. Hamann
Sergio Speziale; Hanns-Peter Liermann, Giacomo Lo Nigro, Hauke Marquardt, Hans-Josef Reichmann | **Compression of (Mg0.9Fe0.1)2SiO$_4$ olivine at ambient temperature to lower mantle pressures**	Roland Pierkes, Matthias Böhm | **Evaluation of Portland Cement Clinker with Optical Microscopy - Case Studies**	**Keynote:** Chris Juhlin | **Exploration of the Caledonian Mountain Belt in Scandinavia by Deep Drilling**	**Keynote:** Guillaume Caumon | **Accurate geological modeling for subsurface applications and the need for uncertainty assessment**	Anastasiia Dolgushina | **The Kara impact structure: general overview and particular features**
Michael Riedel, Shoichi Yoshioka | **Impact of olivine-spinel phase change kinetics on the deformation of the Mariana Slab**	Roland Pierkes | **Automated quantitative XRD in the quality control of the cement production process**	G. Bohrmann; T. Pape; T. Himmler; P. Geprägs; J. Wei; N. Sultan; L. Ruffine; T. Marsset; S. Garziglia; B. Dennielou | **Gas hydrate dynamics of pockmarks at continental margins – Results from MeBo sea floor drilling offshore Nigeria**		M. Szokaluk, W. Szczuciński, R. Jagodziński, A. Muszyński, G. Rachlewicz, W. Włodarski, M. Pisarska-Jamroży, A. Duczmal-Czernikiewicz | **Distribution and properties of ejecta deposits in the region of Morasko meteorite impact craters (Poznań, Poland)**
Johannes Buchen; Hauke Marquardt; Takaaki Kawazoe; Alexander Kurnosov; Tiziana Boffa Ballaran | **High-pressure single-crystal elasticity of wadsleyite: Constraints on seismic anisotropy in the transition zone**	Holger Kletti, Bernd Möser, Christiane Rößler | **Electron backscatter diffraction (EBSD) – an additional technique for a more reliable estimation of alkali reactivity potential of rock aggregates in concretes**	A. Hüpers; S. A. Kasemann; A. J. Kopf; A. Meixner; T. Toki; R. Shinjo; C.G. Wheat; C.-F. You | **Boron isotope geochemistry of pore water fluids sampled across the active Nankai Trough subduction zone forearc**	Mauro Cacace, Guido Blöcher, Johannes Aichele, Norihiro Watanabe, Florian Wellman, Antoine Jacquey | **Linking geology to numerical modelling: application for geothermal reservoir applications**	Malgorzata Bronikowska, Kai Wünnemann, Natasha Artemieva, Witold Szczucinski | **Modeling the Morasko strewn field**
K. Schulze, H. Marquardt, T. Kawazoe, M. Koch-Müller, A. Kurnosov, T. Boffa Ballaran | **The effect of iron content and hydration on the high-pressure single-crystal elasticity of ringwoodite derived from an internally consistent approach**	E. Rigo; K. Unterderweide; D.C.H. Rüscher | **Vibrational spectroscopic investigations of heated concrete**	Jörg Geldmacher; Maria Luisa G. Tejada; Folkmar Hauff; Kaj Hoernle; Dieter Garbe-Schönberg; Ken Heydolph | **Late stage evolution of Shatsky Rise volcanism and possible connection to Hess Rise (NW Pacific)**	A.B. Jacquey; M. Cacace; G. Blöcher; N. Watanabe; M. Scheck-Wenderoth | **Thermo-Hydro-Mechanical numerical modelling for faulted geothermal reservoir systems: case study of the Groß Schönebeck reservoir**	Michael H. Poelchau, Agnes Matysiak | **Measurements of planar deformation features in quartz using EBSD: A new method to prevent false recognition of craters**
Jan Müller, Monika Koch-Müller, Sandro Jahn | **In-situ Raman and infra red spectroscopy on siderite up to 60 GPa and maximum 1000 K**	Christian Selleng; Patrick Fontana; Birgit Meng | **Thermal Treatment of Ultra-High Performance Concrete**	M. Abratis; T. Wiersberg; M. Görlitz; W.A. Brand; L. Viereck; N. Kukowski; K. U. Totsche; INFLUINS Scientific Drilling Team | **Geochemistry of drilling mud gas from the INFLUINS Scientific Deep Drilling into the Thuringian Syncline, Germany**	Elena Tillner; Thomas Kempka | **Comparison between one-way and two-way hydro-mechanical coupling for assessment of fault fluid flow by numerical simulations**	Boris Reznik; Agnes Kontny; Jörg Fritz | **X-ray powder diffraction, electron microscopy and magnetic properties of shocked magnetite: a useful geobarometer for cratering processes?**
Zhongqing Wu; Renata Wentzcovitch | **Spin crossover in ferropericlase and velocity heterogeneities in the lower mantle**	C.H. Rüscher; W. M. Kriven; L. Schomborg; Z. Assi; H. Tchakoute; J. Temuujin; F. Jirasit; L. Lohaus; J. C. Buhl | **Geopolymers, additions to Portland-cement and hosting hydrogen storage materials**	G. Wefer, G. Bohrmann, D. Hebbeln, K. Huhn, G. Martinez-Mendez, M. Mohtadi, T. Freudenthal | **Scientific drilling in the deep sea with the sea floor drill rig MARUM-MeBo**	C. Otto, T. Kempka | **Thermo-mechanical simulations of rock behavior in underground coal gasification show negligible impact of temperature-dependent parameters on permeability changes**	Dennis Harries; Shogo Yakame; Masayuki Uesugi; Falko Langenhorst | **Sub-micrometer impact craters on a regolith grain of asteroid 25143 Itokawa**

	Max Kade Audi	Hall A	Hall B	Hall C
12:00	**Lunch break I poster session I exhibition**			
12:15		Information on DFG funding in Geosciences		
13:30	Awards: Leopold-von-Buch-Plakette, Teichmüller-Preis, Bernd Rendel Preise der DFG			
13:45	Plenary Lecture: Trond Torsvik (University of Oslo, Norway): Paleomagnetism and Plate Tectonics			
14:45	**Coffee break I poster session I exhibition**			
15:30	**A1-06 Subduction systems....** I chair: J. H. Behrmann, M. Stipp	**A6-03 Ocean Gateways – Arteries of...** I chair: M. Sarnthein, H. Kopp, S. Voigt, G. Knorr	**A2-01 Plate tectonics...** I chair: S. Brune, C. Heine	**A6-01 Tect. & climatic imprints...** I chair: T. Schildgen, M. Dühnforth, B. Bookhagen, C. Spiegel
15:30	Marzieh Baes, Stephan Sobolev I **A missing element in Wilson Cycle scenario**	**Keynote:** Yannick Donnadieu, Emmanuelle Puceat I **Late Cretaceous changes in continental configuration: toward a better-ventilated ocean?**	**Keynote:** Kenni Petersen I **Mantle temperature and the time scale of extensional basin subsidence**	Eric Deal; Gianluca Botter; Anne-Catherine Favre; Jean Braun I **Landscape evolution driven by an analytical stochastic hydrological model**
15:45	Uwe Kroner; Rolf L. Romer I **Contrasting subduction modes in the Variscan collisional orogen**	Keynote: Karsten Gohl, Graeme Eagles, Wilfried Jokat I **The challenge of polar ocean gateway reconstructions**		Stephanie M. Olen, Bodo Bookhagen, Manfred R. Strecker I **Vegetation impacts on Himalayan denudation and landscape**
16:00	Hannah Pomella, David Flöss, Romed Speckbacher, Peter Tropper, Bernhard Fügenschuh I **The Eoalpine High Pressure Event in the western Eastern Alps**	Michael Stärz; Wilfried Jokat; Gregor Knorr; Gerrit Lohmann I **Tipping point in North Atlantic-Arctic circulation controlled by the Oligocene-Miocene subsidence of the Greenland-Scotland Ridge**	M. Cacace, M. Scheck-Wenderoth I **Why intracontinental basins subside longer – 3D feedback effects of lithospheric cooling and sedimentation on the flexural strength of the lithosphere**	Dirk Scherler, Michael P. Lamb, Edward J. Rhodes, Jean-Philippe Avouac I **Climate-change versus landslide origin of fill terraces in an arid bedrock landscape: San Gabriel River, CA**
16:15	Caroline Mantey, Manfred R. Brix, Bernhard Stöckhert I **Prolonged tectonic history of a thin crustal lid on top of a subduction zone: The polygenetic mélange on Crete**	**Keynote:** Ann Holbourn; Wolfgang Kuhnt; Karlos G.D. Kochhann; Mitch Lyle; Nils Andersen I **Reconstructing Miocene climate history from Pacific deep sea sedimentary archives**	Ritske S. Huismans I **Depth-dependent extension, two-stage breakup and depleted lithospheric counterflow at rifted margins**	G. De Gelder, D. Fernández-Blanco, R. Lacassin, A. Delorme, R. Armijo, J. Jara-Muñoz, D. Melnick I **Pleistocene vertical movements along the Hellenic arc (S-Greece): analysis of marine terraces through high-resolution DEMs**
16:30	G. Schepers; D. J. J. van Hinsbergen; M. E. Kosters; L. M. Boschman; W. Spakman I **Testing causes of Andean flat slab subduction in an absolute plate motion frame**	**Keynote:** Wolfgang Kuhnt; Ann Holbourn; Jian Xu; J. Schröder; E. Lo Giudice Capelli; R. Zuraida; M. Henrizan I **Indonesian Throughflow and Indo-Australian Climate History through the last glacial cycle**	J. Sippel; C. Meeßen; M. Cacace; M. Scheck-Wenderoth; S. Fishwick; C. Heine; M.R. Strecker; J. Mechie I **Lithospheric strength variations across the Kenya Rift region as constrained by data-driven 3D gravity and thermal modelling**	Olaf Tietz; Jörg Büchner I **Quantification of neotectonic movements after volcanic edifices and Quaternary deposits – an example from the Lausitz block-faulted area (Germany)**
16:45	David Völker, Michael Stipp I **Water input and water release from the subducting Nazca Plate along southern Central Chile (33°S-46°S)**	M. Sarnthein, N. Khélifi, M. Frank, N. Andersen, D. Garbe-Schönberg I **Late Pliocene-to-early Pleistocene Mediterranean Outflow Waters in the N.E. Atlantic: Where? When? Forcings and Implications of Change?**	C. Spiegel, J. Lindow, P. Kamp, S. Mukasa, F. Lisker, G. Kuhn, K. Gohl I **Activity of the West Antarctic Rift System along Marie Byrd Land and the Amundsen Sea area**	E. Wenger, J. Büchner, O.Tietz, D. Sauer I **Implications for landscape evolution in the Zittau Mountains (Eastern Saxony) inferred from the low erosion level of the Lausche Volcano (Lusatian Volcanic Field)**
19:00	Poster Social for Posters of the following Sessions: A1-03, A1-04, A1-06, A2-01, A2-04, A3-03, A4-01, A4-03,			
19:00			Mitgliedervers. DGGV	
20:00	Conference Dinner			

Hall D	Senatssaal	ZG 1	RW 1	RW 2
C4 Young Sedimentologists | chair: M. Hinderer, R. Bussert, U. Heimhofer	**B1-01 Multi-scale evol. of sedimentary basins** | chair: R. di Primio, J. Wendebourg	**B6-02 Archaeometry, mon. conserv. & dim. stones** | chair: K. Bente, C. Berthold, A. Ehling, K. Poschlod	**C3 Earth Science Informatics for a Dynamic Planet** | chair: R. Huber, R. Bertelmann	**A3-02 Impact Cratering in the Planetary System** | chair: K. Wünnemann, C. Hamann
M. Yar, M. Arif, A. Khan Afridi, M. Saeed, A. Ali, M. Ziad | **Petrography, Provenance and Diagenetic study of sandstone from Murree Formation, Peshawar Basin, NW Pakistan**	Johannes Wendebourg, Frank Adler, François Lorant, Bertrand Chevallier | **Hydrodynamics: a key to exploration success in the South Caspian Sea**	**Keynote:** Gerda Schirrmeister | **Decorative Stones in Berlin: Monument Conservation and Public Education**	**Keynote:** Jens Klump | **Dynamic Data for a Dynamic Planet**	R. Winkler; M. H. Poelchau; T. Hoerth; T. Kenkmann | **Subsurface deformation induced by experimental hypervelocity impacts in different target materials**
H. T. Thi Hoang, J. Walde, E. Rott, D. Sanders | **Controls on intramontane ‚cool'-spring limestones, Austria (Eastern Alps): Implications of a quantitative approach**	S. Müller; R. Lutz; L. Reinhardt; C. Gaedicke; H. Thöle | **Correlation of shallow gas indicators and seismic stratigraphic units in the German North Sea**	K. Bente, R. Wirth, Ch. Berthold, A. Schreiber, M. Keuper | **Microstructural and chemical mechanisms of the transformation of red (corallium rubrum) to white corals**		A. Kowitz, W.U. Reimold, R.T. Schmitt | **Porosity, a catalyst for formation of shock deformation features in the low-shock pressure regime (2.5-20 GPa)**
Rong Wang, Bernhard Diekmann | **Provenance and dispersal of terrigenous sediments in the North Pacific: Implications for late glacial land-ocean linkages**	Peter Klitzke; Sebastien Gac; Jan Inge Faleide; Magdalena Scheck-Wenderoth | **Lithospheric Strength and elastic thickness of the Barents Sea and Kara Sea region**	Axel Gerdes, Klaus Bente, Christoph Berthold | **Origin of bead decorations of celtic fibulae: Constraints from in-situ Sr and B isotope composition**	P. Gerchow; R. Koppe; A. Macario; A. Haas; C. Schäfer-Neth; H. Pfeiffenberger | **O2A - supporting data managment from observation to enhanced data product**	N. Güldemeister; K. Wünnemann; M. Poelchau | **Scaling impact crater dimensions in cohesive rock by numerical modeling and laboratory experiments**
Adrian Linsel, Matthias Hinderer, Jens Hornung, Kristian Bär | **Well-logs beneath Messel penetrating the post-Variscan unconformity (Sprendlinger Horst)**	Heinrich Bahlburg | **On restoring sedimentary basins for post-depositional deformation – Paleozoic basins of the central Andes**	Jochen Lepper; Angela Ehling | **Wesersandstein: Building, dimension and ornamental stone, used yesterday and today**	Mike Sips; Doris Dransch; Patrick Köthur | **Big Data Analytics Research at the GFZ German Research Center for GeoSciences**	Jakob Wilk, Thomas Kenkmann | **The surface structure of shatter cones in experimental impact craters**
A. Isaack, E. Gischler, J. H. Hudson, F. S. Anselmetti, A. Lohner, G. Camoin | **Holocene sedimentation in the barrier reef lagoon of Bora Bora, Society Islands (French Polynesia), South Pacific**	Grobe Arne, Litte Ralf, Urai Janos | **Structural and thermal history of the Oman Mountains**	G. Buck; I. Zutterkirch; C. Lauer; C. Berthold; P. Schmidt; K.G. Nickel | **Materials Science of the Middle Stone Age: Heat treatment of flint and silcrete**	Stefanie Schumacher; Amelie Driemel, Hannes Grobe, Rainer Sieger | **PANGAEA® – more than 20 years serving the earth science community with data archiving and publication**	Matthias Ebert; Lutz Hecht; Christopher Hamann | **Simulation of impact melting processes: An experimantal approach using high-energy laser beam**
Ingmar Frese, Eckhardt Stein, Thomas Kenkmann | **Investigation of the Western Badenweiler-Lenzkirch-Zone with respect to sedimentological, structural and economical aspects**	V. Sachse, Z. Anka, J. F. Rodriguez, R. di Primio | **The impact of Andes tectonics on hydrocarbon generation in the northern Austral Basin, southern Argentina, South America**	M. Mishmastnehi; R. Milke Diopside-Quartz-Glass | **thermometer: Temperature regime estimation of synthesized millstones from Iran**	Kirsten Elger, Kerstin Lehnert, Roland Bertelmann | **Data Publication and Citation**	C. Hamann; L. Hecht; M. Ebert; A. Deutsch | **Formation of calcite melts in hypervelocity impact and laser melting experiments**
A4-05, A6-03, A6-07, B1-01, B1-02, B1-03, B1-04, B3-03, B5-02/-03/-04, B6-02, B6-03/-04/-05, C1/C2, C3, C4				

Wednesday | 7 October 2015

	Max Kade Audi 1.200 seats	Hall A 350 seats	Hall B 220 seats	Hall C 300 seats
8:00	**Registration**			
8:30	**A1-04 Mountain build. on the scale...** | chair: C. Trepmann, U. Altenberger, R. Abart	**A3-03 Earthlike Planets...** | chair: D. Breuer, T. Spohn	**A4-04 When and How did Plate Tectonics...** | chair: R. Stern, T. Gerya, S. Sobolev	**A6-07 Glacial tectonics...** | chair: C. Brandes, C. Hübscher
8:30	**Keynote:** Gerlinde Habler; Thomas Griffiths; Olga Ageeva; Rainer Abart | **Microfabrics of mineral host-inclusion systems: constraining formation mechanisms**	A. Rozel, G.J. Golabek, P. J. Tackley | **Evolutionary models of the Earth with a grain size-dependent rheology**	**Keynote:** Kent Condie; Cin-Ty Lee; Richard C Aster; Jeroen van Hunen | **Subductionless Archaean continental drift and implications for secular tectonic evolution on Earth**	A. Gehrmann, M. Meschede, H. Hüneke, S. A. Schack Pedersen, K. Obst | **Constructing Balanced Cross Sections from 2D Cliff Profiles of the Jasmund Glaciotectonic Complex (Rügen Island, NE Germany)**
8:45		Tobias Rolf; Bernhard Steinberger; Stephanie Werner | **On the dynamic origin of Venus' unusual gravity spectrum**		P. B.E. Sandersen, F. Jørgensen | **Deglaciation-induced reactivation of deep-seated faults in southern Denmark – an example of temporary tectonic instability in the early Holocene**
9:00	Florian Heidelbach | **Garnet formation in the CMAS system under deviatoric stress**	Lyal B. Harris; Jean H. Bédard | **Linked plume-related rifting, regional transcurrent faulting and indentation tectonics on Venus interpreted from Bouguer gravity and radar – a precursor to plate tectonics**	Robert J. Stern | **A Wegenerian Approach to Understanding When Plate Tectonics Began**	M. Al Hseinat, C. Hübscher, J. Lang, I. Ott, U. Polom, C. Brandes, A. Hampel, J. Winsemann | **Ice-load induced salt tectonics controlled crestal collapse graben evolution – Instances from the Southwestern Baltic Sea**
9:15	C. Soder; R. Ziergöbel; R. Altherr | **Eclogite xenoliths from post-collisional mafic dykes in the Variscan Odenwald (Germany)**	P. J. Tackley; D. Lourenco; A. Rozel; T. Nakagawa | **The key influence of magmatism on the thermo-chemical-tectonic evolution of terrestrial planets**	K. Ziaja; S. F. Foley; R. W. White, S. Buhre | **Metamorphism and melting of picritic crust and its contribution to continental crust formation in the early Earth**	M. Al Hseinat; C. Hübscher | **Ice-load Induced Tectonics Controlled Tunnel Valley Evolution – Instances from the Southwestern Baltic Sea**
9:30	C. Trepmann | **Deformation and stress history during burial and exhumation – the quartz microstructural record of rocks from the Talea Ori, Crete, Greece**	Dennis Höning; Tilman Spohn | **Feedback cycles in planetary evolution including continental growth and mantle hydration**	J. van de Löcht, C. Münker, J. E. Hoffmann, R. Kleinschrodt and M.T. Rosing | **Eoarchean peridotites from southern West Greenland: remnants of Eoarchean mantle or ultramafic cumulates?**	Christian Brandes; Holger Steffen; Rebekka Steffen; Patrick Wu | **Climate-change induced earthquakes in northern Central Europe**
9:45	Z. Hamimi; B. Zoheir | **East-West Gondwana collision: microstructural evidence for earlier timing**	**Keynote:** Vlada Stamenković; A. Lenardic; T. Höink; D. Breuer | **From exoplanets to the importance of shear stresses for plate tectonics on Earth-like planets**	K.P. Schneider; J. E. Hoffmann; C. Münker; A. Kröner | **Are mafic and ultramafic rocks from the lower Onverwacht Group (Barberton Greenstone Belt) crustally contaminated?**	
10:00	**Coffee break | poster session | exhibition**			
10:30	Awards: AG Werner in Silber, Goldschmidt Preis, Ramdohr Preis, Beate-Mocek Preis			
10:45	Plenary Lecture: Barbara Romanowicz (IPG Paris and Berkeley University, USA): Global mantle imaging in the			
11:45	**Lunch break | exhibition**			
12:30	**A4-05 Archean environments and ecosystems** | chair: A.Airo, C. Heubeck	**A2-04 Magmatism in oceanic...** | chair: O. Nebel, C. Beier, L. Viereck, M. Abratis, J. Büchner	**A4-04 When & How did Plate Tect...** | chair: R. Stern, T. Gerya, S. Sobolev	**A6-04 Weathering & Global Biogeochem. ...** | chair: J. Bouchez, C. Fischer, J. Hartman, F.v.Blanckenburg

Hall D 250 seats	Senatssaal 60 seats	ZG 1 30 seats	RW 1 50 seats	RW 2 70 seats
B6-03 Energy, materials & minerals ... | chair: S. Schorr, C. Stephan / H. Pöllmann / S. Stöber, M. Keuper	**B1-02 Rock & Fluids Properties...** | chair: W. van Berk, H.M. Schulz	**B3-01 Operational Earthqu. Forecasting...** | chair: J. Zschau, S. Wiemer	**C1/C2 Advances in mat. Character. ...** | chair: C. Berthold, J. Göttlicher, A. Gerdes, G. Floor	**B5-02 Subsurface storage** | chair: C. Müller, C. Ostertag-Henning
A.-L. Hansen; T. Dankwort; M. Winkler; L. Kienle; J. König; W. Bensch | **The Future of Thermo-electric Materials: High Efficiency vs. Earth abundance**	**Keynote:** Knut Bjørlykke | **Constraints on fluid flow and mass transport on diagenesis in sedimentary basins. Predicting physical properties of sandstones and shales**	S. Parolai, J. Lauterjung, D. Bindi, M. Pittore, M. Wieland, T. Boxberger, M. Pilz, A. Saponaro, S. Ullah, B. Petrovic, M. Haas, K. Fleming | **Activities of the Centre for Early Warning Systems, GFZ Potsdam**	**Keynote:** Paul R. D. Mason | **New developments in microanalytical techniques for sulfur isotope analysis**	**Keynote:** Gerold W. Diepolder | **Cross-border 3D geological modelling for subsurface potential assessment – lessons learned from the transnational GeoMol project**
K. Neldner, G. Gurieva, D. Többens, P. Whitfield, S. Schorr | **Phase content and neutron diffraction analysis of off-stoichiometric Cu2ZnSnS4 (CZTS)**		M. Pittore, M. Wieland, M. Haas, S. Parolai, K. Fleming | **On-demand and near-real-time earthquake impact forecasting for Central Asia: the CARAVAN tool**		
L. E. Valle-Rios, G. Gurieva, S. Schorr | **Synthesis and structural characterization of off-stoichiometric Cu2ZnSnSe4**	E.T. Arning; S. Häußler; Y. Fu; W. van Berk; H.-M. Schulz | **Integrated hydrogeochemical modelling of rock-water interactions in shallow marine sediments: implications for biogenic methane prediction**	P. Brondi, M. Picozzi, A. Emolo, A. Zollo, M. Mucciarelli | **Rapid Estimation of Macroseismic Intensity for On-site Earthquake Early Warning in Italy from Early Radiated Energy**	S. Schuth, A. Brüske, I. Horn, J. Ciążela, M. C. Arnold, S. Weyer | **Stable Vanadium isotope analyses by femtosecond LA-ICP-MS, and solution MC-ICP-MS**	Gabriela von Goerne, Christian Müller and Project Group | **Project TUNB – a 3D Model of the North German Basin**
Florian Kiesel, Anna-Maria Welsch, Hannes Krueger | **High-temperature studies on spodumene polymorphs**	M.-L. Grundtner; D. Groß; H.-G. Linzer; D. Misch; R. Sachsenhofer; L. Scheucher; R. Gratzer | **Diagenesis of Upper Eocene clastic reservoir rocks in the Alpine Foreland Basin (Austria)**	Lunio Lervolino, Eugenio Chioccarelli | **Operational Earthquake Loss Forecasting: a Retrospective Analysis of some Italian Seismic Sequences**	Axel Gerdes | **Direct insitu U-Pb dating of secondary carbonates by LA-SF-ICPMS**	Sabine Sattler, Julia Rienäcker | **New techniques to create a 3D structural model of the deeper underground in the North German Basin in Lower Saxony**
N. Gaida, N. Nishiyama, A. Holzheid, O. Beermann, C. Giehl, L. Kienle, A. Masuno | **Improvement of mechanical properties in poly-nanocrystalline composite ceramics**	J. Schmatz, J. Klaver, G. Desbois, J. L. Urai | **Cryo-BIB-SEM and Wood's Metal Injection to image pore morphology, pore connectivity, and fluid distribution in hydrocarbon bearing rocks**	R. Wang, Y. Zhang, J. Zschau, S. Parolai, F. Diao, T. Dahm | **Imaging finite-fault earthquake sources by iterative deconvolution and stacking (IDS) of near-field complete seismograms**	P. Asmussen; O. Conrad; A. Günther; M. Kirsch, U. Riller | **Semi-automatic segmentation of thin section images with an application to characterize subarkose sandstone**	F. Hese, K. Lademann, C. Thomsen | **Geological 3d modelling of the Northwest German Basin in Schleswig-Holstein for investigations of the geothermal potential of reservoirs and fault zones**
C. Fischer, I. Kurganskaya, A. Luttge | **Prediction of porosity evolution in polycrystalline material: A combined experimental and Kinetic Monte Carlo study using the rate spectra concept**	Yaling Zhu; Andrea Vieth-Hillebrand; Brian Horsfield | **Investigating water-soluble organic compounds released from black shales and coals**	J. Lauterjung and GITEWS Team | **The Tsunami Early Warning System for the Indian Ocean**	H. Ott; H. Peters; P. van den Bos; C. Peng | **Phase properties and chemical rock-fluid interactions in-situ and under reservoir conditions investigated by Raman spectroscopy**	L. Pollok et. al. | **Project InSpEE: Storage Potential for Renewable Energies (CAES & H$_2$) in Northern Germany's Salt Structures**
age of high speed wavefield computations				
A4-01 Mantle flow... | chair: B. Steinberger, N. Tosi, C. Faccenna /C. Thomas, A. Nowacki	**B1-03 Shales and Coals: Source and reservoir...** | chair: R. Littke, V. Wrede	**B3-03 Geological signatures of extreme e. ...** | chair: H. Bahlburg, M. Spiske	**A2-03 Large Igneous Provinces...** | chair: E. Rivalta, G. Jacques, G. Uenzelmann-Neben, R. Trumbull	**B5-02 Subsurface storage** | chair: C. Ostertag-Henning, A. Liebscher

	Max Kade Audi	Hall A	Hall B	Hall C
12:30	**A4-05 Archean environments and ecosystems** | chair: A.Airo, C. Heubeck	**A2-04 Magmatism in oceanic...** | chair: O. Nebel, C. Beier, L. Viereck, M. Abratis, J. Büchner	**A4-04 When & How did Plate Tect...** | chair: R. Stern, T. Gerya, S. Sobolev	**A6-04 Weathering & Global Biogeochem. ...** | chair: J. Bouchez, C. Fischer, J. Hartman, F.v.Blanckenburg
12:30	**Keynote:** Alessandro Airo, Martin Homann | Links between morphology and metabolism of modern and Archean microbial communities	**Keynote:** Albrecht Hofmann | Canonical Element Ratios as Tracers of Mantle Circulation – a Reassessment	**Keynote:** Jean H. Bédard, Lyal B. Harris | Subductionless Archaean continental drift and implications for secular tectonic evolution on Earth	**Keynote:** Jérôme Gaillardet, Julien Bouchez, Mathieu Dellinger | From plate tectonics to plate weathering
12:45	M. Homann, C. Heubeck, T. R. R. Bontognali, A. Airo | **Evidence for cavity-dwelling life in 3.2 Ga tidal deposits (Moodies Group, Barberton Greenstone Belt, South Africa)**			
13:00	L. Stutenbecker, C. Heubeck | **Deltaic progradation under high tidal range: the lower Moodies Group, Barberton Greenstone Belt, South Africa**	C. Beier, P. A. Brandl, K. M. Haase | **Implications from lateral zoning of plumes approaching ridges**	Ali Polat | **Convergent plate margin processes in the Archean Craton of West Greenland between 3.8 and 2.5 Ga: Evidence for the operation of plate tectonics in the early Earth**	Julien Bouchez, Jérôme Gaillardet | **Weathering of shales under a tropical climate in the Bolivian Andes**
13:15	S. Nabhan, T. Luber, C. Heubeck | **Climatic and geochemical implications of Archean pedogenic gypsum of the Moodies Group (~3.2 Ga), Barberton Greenstone Belt, South Africa**	D. Prelevic, R. Mertz-Kraus, S. Buhre, D. Mertz | **Petrological characterization of the seismic low-velocity anomaly beneath the Eifel volcanic field (West Germany) using major and trace element compositions of olivine macrocrysts**	L. B. Harris; J. H. Bédard | **Indentation and lateral escape in Western Ishtar Terra, Venus and the Archaean Superior Craton, Canada — "Wegenerean" continent-like drift without subduction and modern plate tectonics**	Lyla Taylor; Steve Banwart; David Beerling | **Responding to anthropogenic climate change and ocean acidification: insights from a global weathering model**
13:30	Christoph Heubeck | **Architecture of Moodies Group (Barberton Greenstone Belt, 3.22 Ga) suggests partial convective overturn of unstable lithosphere**	Maxwell Marzban Thiemens, Peter Sprung | **West Eifel xenolith analyses via multiple isotopic systems**	J. E. Hoffmann, E. Musese, A. Kröner, C. Münker | **Hf-Nd and trace element constraints on granitoid-greenstone relationships of the >3.46 Ga Dwalile Greenstone Belt, Ancient Gneiss Complex (Swaziland)**	F. von Blanckenburg, J. Bouchez, D. E. Ibarra, K. Maher | **Stable weathering fluxes into the oceans over glacial-interglacial cycles from 10Be/9Be records and global runoff-weathering models**
13:45		L. Viereck, T. Meier, R. Soomro, C. Weidle, L. Cristiano, M. Abratis, S. Lebedev, J. Büchner | **Memory of the LAB for melt generation in Central European intraplate volcanic fields**	T. Gerya, R. Stern, R. Fisher, E. Sizova, M. Baes, S. V. Sobolev, S. Whattam | **Plume tectonics and subduction in the early Earth**	M. Schoell, R. Tappert, K. Muehlenbachs, A. P. Wolfe, R. C. McKellar | **Orogenetically driven weathering as major control of atmospheric oxygen during the Phanerozoic**
14:00	**Historisches Sympsoium: Faszination Alfred Wegener: Leben, Aktivitäten und wissenschaftliche Leistungen** | chair: H. W. Hubberten, E.-M. Pfeiffer, U. Wutzke, W. Jacoby	**Coffee break | exhibition**		
	Keynote: Ulrich Wutzke | **Alfred Wegener (1880–1930) – Eine Idee erobert die Welt**			
14:30		**A1-03 From oceanic subd. to continental collision...** | chair: C. Beier, R. Halama	**A4-04 When & How did Plate Tect...** | chair: R. Stern, T. Gerya, S. Sobolev	**A6-04 Weathering & Global Biogeochem. ...** | chair: J. Bouchez, C. Fischer, J. Hartman, F. v. Blanckenburg

Hall D	Senatssaal	ZG 1	RW 1	RW 2
A4-01 Mantle flow... | chair: B. Steinberger, N. Tosi, C. Faccenna /C. Thomas, A. Nowacki	B1-03 Shales and Coals: Source and reservoir... | chair: R. Littke, V. Wrede	B3-03 Geological signatures of extreme e. ... | chair: H. Bahlburg, M. Spiske	A2-03 Large Igneous Provinces... | chair: E. Rivalta, G. Jacques, G. Uenzelmann-Neben, R. Trumbull	B5-02 Subsurface storage | chair: C. Ostertag-Henning, A. Liebscher
Andrew Fowler, Peter Howell, Tania Khaleque | **Convection of a fluid with strongly temperature and pressure dependent viscosity**	S. Poetz, N. Mahlstedt, H. Wilkes, B. Horsfield | **Tracking the retention, mobilization and chemical evolution of major NSO compound classes in petroleum systems**	Keynote: Anselm Smolka | **Managing the risk from natural perils**	D. Franke; H. Koopmann | **Large igneous provinces – a consequence of plate tectonics?**	H. Feldrappe, M. Stöwer, C. Arnold | **Dimensioning and optimizing of gas storage caverns in flat bedded salt formations using the example of storage site Bernburg (Central Germany)**
Tobias Rolf, Fabio A. Capitanio, Paul J. Tackley | **Dynamic characteristics of plate motions and continental drift in global mantle flow**	T. Gorka, E. B. Teigler, S. Peters | **Geological parameters for successful shale gas plays – why is testing so crucial?**		S. V. Sobolev, A. V. Sobolev | **Models of the Earth's largest inter-plate magmatic events- Siberian Traps and Ontong Java Plateau**	H. Ott, J. Snippe, S. Oedai | **Multiphase flow and unstable calcite-dissolution patterns from the core to reservoir scale**
Keynote: Henri Samuel, Scott King | **Mantle convective dynamics and mixing processes across scales**	J. Klaver, G. Desbois, R. Littke, J. L. Urai | **Pore space morphology and distribution in mature and post mature Posidonia Shale samples from the Hils area, Germany**	G. Hoffmann, K. Reicherter, C. Grützner, F. Preusser | **The geological signatures of extreme wave events within the archaeological record – examples from the coastline of the Arabian Sea**	Weiyuan Li | **Neoproterozoic-Phanerozoic tectonic evolution, magmatic pulses and metallogenic concentric period in East Asia: relation to the cycle of a self-organizing superheat-dissipation in the Earth**	S. Henkel, D. Pudlo, F. Enzmann, R. Gaupp | **A comparison of high resolution X-ray CT generated data with common analytical methods – Advantages of μ-CT analysis, models and numerical simulations**
	S. Bou Daher, F. H. Nader, R. Littke | **Source rocks potential and maturity modelling of the east Mediterranean Levant basin and its eastern margin**	H. Bahlburg, M. Spiske | **Styles of early diagenesis and the preservation potential of onshore tsunami deposits - a re-survey of Isla Mocha, Central Chile, two years after the February 27, 2010 Maule tsunami**	S. Estrada, F. Henjes-Kunst | **The Cretaceous High Arctic Large Igneous Province (HALIP): Temporal and geochemical variations of occurrences on the Canadian Arctic islands**	S. Fischer; J. L. Wolf; S. Waldmann; H. Rütters; A. Niemi; J. Bensabat; F. May; and D. Rebscher | **Implementing SO_2 as a CO_2 stream impurity in geochemical simulations of different sandstone formations potentially suitable for geological CO_2 storage**
Maxime Maurice, Nicola Tosi, Ana-Catalina Plesa, Doris Breuer, Christian Huettig | **Evolution and Consequences of Magma Ocean Solidification**	S. Ladage & Team BGR – NIKO Project | **Shale Gas and Fracking in Germany – Resources and Environmental Risks**	D. Völker, A. Kopf, M. Ikari, S. Trütner, J. Bialas | **The Reloca Slide offshore Central Chile – a revision based on geotechnical sliding plane characterization and tsunami modeling**	F. Riefstahl, S. Estrada, W. Geissler, W. Jokat, R. Stein, H. Kämpf, P. Dulski, R. Naumann, C. Spiegel | **Provenance and characteristics of rocks from the Yermak Plateau, Arctic Ocean: Petrographic, geochemical and geochronological constraints**	M. Berta, F. Dethlefsen, M. Ebert, C. Mascus, A. Dahmke | **Reductive biogeochemical sequence triggered by hydrogen in experiments using aquifer sediment and groundwater**
M. K. Kaban, W. D. Mooney, A. G. Petrunin | **Cratonic roots under North America are shifted by basal drag: new evidence from gravity and geodynamic modeling**	H. Pfunt; G. Houben; T. Himmelsbach | **Fracking and potential risks for fresh water aquifers – Numerical modeling of fluid flow due to hydraulic fracturing of shale formations in the North German Basin**		R. Pietsch; G. Uenzelmann-Neben | **A multistage volcanic and tectonic formation history of the Manihiki Plateau, central Pacific**	M. Wipki, A. Liebscher, F. Möller, B. Prevedel, S. Lüth, C. Schmidt-Hattenberger, M. Zimmer, R. Conze, T. Kempka, T. Kollersberger | **CO_2-Storage – from Site Assessment to the Post-Closure Phase**
A4-01 Mantle flow... | chair: B. Steinberger, N. Tosi, C. Faccenna / C. Thomas, A. Nowacki	B1-04 Exploration and development of natural resource projects | chair: B. Teigler	B3-03 Geological signatures of extreme e. ... | chair: H. Bahlburg, M. Spiske	A2-03 Large Igneous Provinces... | chair: E. Rivalta, G. Jacques, G. Uenzelmann-Neben, R. Trumbull	B5-02 Subsurface storage | chair: V. Bräuer, G. Blöcher

Wednesday | 7 October 2015

	Max Kade Audi	Hall A	Hall B	Hall C
	14:00 | Historisches Sympsoium: Faszination Alfred Wegener… | **Keynote:** Ulrich Wutzke	**14:30 | A1-03 From oceanic subd. to continental collision…** | chair: C. Beier, R. Halama	**14:30 | A4-04 When & How did Plate Tect…** | chair: R. Stern, T. Gerya, S. Sobolev	**14:30 | A6-04 Weathering & Global Biogeochem. …** | chair: J. Bouchez, C. Fischer, J. Hartman, F. v. Blanckenburg
14:30	**Keynote:** Wolfgang Jacoby | **Wie dachte Alfred Wegener über die Ursachen der Kontinentalverschiebung?**	J. Koepke, S. Feig, P. E. Wolff | **Shallow magmatism during subduction-zone initiation: Constraints from the Oman ophiolite and related experiments**	**Keynote:** David Bercovici; Yanick Ricard | **Origin of plate tectonics: Grain-damage, inheritance and hysteresis**	N. Moosdorf, M.-C. Hajati, K. Haßler | **Groundwater as transport pathway in biogeochemical cycles: from local observations to global estimates**
14:45		A. Stechern, T. Just, M. Banaszak, F. Holtz | **Decoding Magma Plumbing and Geochemical Evolution Beneath the Lastarria Volcanic Complex (Northern Chile) - Evidence for Multiple Magma Storage Regions**		Y. Godderis; Y. Donnadieu **The role of palaeogeography in the Phanerozoic history of atmospheric CO2 and climate**
15:00	**Keynote:** Jörn Thiede | **Wladimir Köppen, Alfred Wegener und Milutin Milankovitch: Pioniere und Partner der Paläoklimaforschung**	B. Schulz | **Resolving the complex structure in Mediterranean microplates: The evolution of the Austroalpine Basement in the Eastern Alps**	P. Chowdhury, T. Gerya, S. Chakraborty | **Continental crustal recycling by modern-day plate tectonics and its plausible nature in the early Earth: A numerical modeling approach**	Eva E. Stüeken | **Characterizing Precambrian lakes as unique habitats for the early evolution of life**
15:15		M. Menneken, T. John; A. Läufer, J. Berndt | **Zircon chemistry of granitoids from the Wilson Terrane of northern Victoria Land (Antarctica): evidence for an immature Andean-type continental margin**	R. Fischer, T. Gerya | **Early Earth tectonics: A high-resolution 3D numerical modelling approach**	M. Lindner, U.-N. Berninger, A. Reul, G. Jordan, E. H. Oelkers, J. Schott | **Experimental studies on low calcian magnesite growth**
15:30	**Keynote:** Günther Schönharting | **Die Wahrnehmung der Ideen von Alfred Wegener und Wladimir Köppen in der Öffentlichkeit: ein Stück Wissenschaftsgeschichte**	Ralf Oeser, Anselm Loges, Gerhard Franz, Dieter Rhede, Dina Schultze | **Sector zoned tourmalines as a thermometer in blackwall sequences, southwestern Tauern Window (Austria)**	**Keynote:** Viatcheslav S. Solomatov | **Emergence of plate tectonics from magma ocean**	
15:45				
16:00		Closing and Poster Awards and Paul Ramdhor Award		
16:30-18:30			Workshop BDG	

Hall D	Senatssaal	ZG 1	RW 1	RW 2
14:30 I A4-01 Mantle flow... I chair: B. Steinberger, N. Tosi, C. Faccenna / C. Thomas, A. Nowacki	**14:30 I B1-04 Exploration and development of natural resource projects** I chair: B. Teigler	**14:30 I B3-03 Geological signatures of extreme e. ...** I chair: H. Bahlburg, M. Spiske	**14:30 I A2-03 Large Igneous Provinces...** I chair: E. Rivalta, G. Jacques, G. Uenzelmann-Neben, R. Trumbull	**14:30 I B5-02 Subsurface storage** I chair: V. Bräuer, G. Blöcher
Bernhard Steinberger I **Inferring mantle flow and dynamic topography from seismic tomography**	B. Cramer, K. Kleeberg, U. Lehmann I **Ore Mountains reloaded – new exploration of ore and spar deposits in Saxony**	Li Li, J. Böhner I **Coastal storm surge flooding impact under different climate scenarios in Pearl River Delta**	K. Hochmuth, K. Gohl, G. Uenzelmann-Neben, R. Werner I How can a "Super-LIP" break apart? **– Indications from the crustal structure of the Manihiki Plateau, western Pacific**	F. Brandt, M. Klinkenberg, V. Vinograd, U. Breuer, J. Weber, D. Bosbach I **Radiogeochemistry of Radium in a nuclear waste repository system**
Roberto Agrusta; Jeroen van Hunen; Saskia Goes I **The influence of mantle phase transformations on the slab dynamics**	H. Gielisch I **Coal Fires of the Jharia Coal Field/ India – A national disaster endangered the Indian Coking Coal Production and the development of the most important natural resource of India**	M. Ostermann, A. Dufresne I **Morphology and sedimentology of a large carbonate rockslide – rock avalanche deposit (Tschirgant, Austrian Alps)**	M. Sajid, J. Andersen, M. Arif I **Petrography and Geochemistry of rift-related dykes in northern Indian plate, north-west Pakistan**	C. Fischer, S. Finkeldei, F. Brandt, D. Bosbach, A. Luttge I **Analysis of dissolution rate components in potential nuclear waste forms: The example of pyrochlore**
T.-R. Alex Song, X. Shen, L. Stixrude, C. Lithgow-Bertelloni I **Seismic constraint of a dry, basalt-rich transition zone near a stagnant slab region beneath China**	P. Mittelstädt, H. Gräßel, C. García Piña I **Airborne hyperspectral and geochemical mineral exploration – challenges and opportunities**	Janusz Wasowski, Fabio Bovenga I **Toward better exploitation of satellite multi-temporal interferometry in landslide hazard research**	Maximilian David Fischer, Gabriele Uenzelmann-Neben I **The magmatic structure of the Mozambique Ridge**	F. Kober, T. Spillmann, LASMO Team I **The LArge Scale MOnitoring (LASMO) Project at the Grimsel Test Site (GTS) – monitoring the impact of regional perturbations on a URL**
M. Hosseinpour, N. Flament, S. Williams, M. Seton. R. Hassan, R. D. Müller I **Fate of Mesozoic Tethyan slabs in the deep mantle**	Florian Lowicki; Tim Horner I **Blötberget Iron Ore Project – From Resource and Mining History to Present**	B.-G. Luehr, A. Anggraini, T. R. Walter, R. Wang, S. Parolai, J. Zschau, P. J. Prih Harjadi, Kirbani Sri Brotopuspito I **The role of volcanic deposits related to the destructive Bantul Earthquake 2006**	G. Jacques, R. Werner, F. Hauff, G. Uenzelmann-Neben, K. Hoernle I **First Petrological-Geochemical results from SO-232 (SLIP) at the Mozambique Ridge (SW Indian Ocean)**	Klas Hebbeln, Ralf Köber, Andreas Dahmke I **Gas phase formation during thermal energy storage in near surface aquifers**
Keynote: Maureen Long, Colton Lynner, Heather Ford, Anwar Mohiuddin, Neala Creasy, Xiaobo He I **Observations and models of seismic anisotropy in the deep mantle and implications for mantle flow**	T. Rödel, G. Borg I **East Greenland copper exploration: Geological features and the application of field methods around the Jameson Land basin, Greenland**		N. A. Stroncik, M.-S. Krienitz, S. Niedermann, R. L. Romer, C. Harris, R. B. Trumbull, J. M. D. Day I **Mantle plume impingement during break-up of the Gondwana supercontinent**	N. Koproch, R. Köber, A. Dahmke I **Quantification of temperature impacts on the dissolution of chlorinated hydrocarbons into groundwater**
	J. Grötsch, M.C. Pöppelreiter, H.-J. Kloosterman and E. van Zeeland I **Digital Geology – 'Flight Simulator' for the Subsurface**		A. Weit, I. V. Veksler, J. K. Keiding, R. B. Trumbull I **The magmatic roots of Tristan da Cunha – A thermobarometric approach from melt inclusions and phenocrysts**	S. Lerm, R. Miethling-Graff, M. Wolfgramm, K. Rauppach, A. Seibt, H. Würdemann I **Influence of iron- and sulfur-oxidizing bacteria on the operation of a geothermal cold storage system in the North German Basin: impact on well injectivity and filter lifetime**

Site Meetings & Special Events

Mitgliederversammlung / General meeting DMG
Monday, 5 October, 2015 · Henry Ford Building · Hall B · 19:00 h

DGGV Mitgliederversammlung / General meeting DGGV
Tuesday, 6 October 2015 · Henry Ford Building · Hall B · 19:00 h

V&B-Sitzung
Tuesday, 6 October 2015 · Henry Ford Building · Konferenzraum II · 9:00 – 17:00 h

GV-Sektion Sedimentologie/SEPM-CES Meeting
Tuesday, 6 October 2015 · Henry Ford Building · Konferenzraum III · 12:00 h

Arbeitskreis Lagerstätten
Tuesday, 6 October 2015 · Henry Ford Building · Senatssaal · 12:15 h

Information on DFG funding in Geosciences: DFG Geschäftsstelle, Gruppe Physik, Mathematik, Geowissenschaften
Tuesday, 6 October 2015 · Henry Ford Building · Hall A · 12:15 h

Öffentliche Vorträge über die unglaublichen Ideen von Alfred Wegener: Kontinente, die sich bewegen – so ein Unsinn!
Mittwoch, 7. Oktober 2015 · Henry-Ford-Bau · Max Kade Auditorium · 14:00–16:00 Uhr

Presentation of the reproduction and first English translation of Köppen & Wegener, 1924: „The Climates of the Geological Past"
Wednesday, 7 October 2015 · Henry Ford Building · Foyer · 11:45 h

BDG Workshop: „Karriere in den Geowissenschaften"
Mittwoch, 7. Oktober 2015 · Henry Ford Bau · Saal B · 16:30–18:30 Uhr

Oliver Paech (URS Essen) und Dr. Wolfgang Nachtmann (CEP Berlin) berichten aus ihrer Tätigkeit und stehen für Fragen und Diskussionen zur Verfügung.
Abgerundet wird der Workshop durch Informationen zum aktuellen Arbeitsmarkt und zum Mentoring-Programm BDG. Die Moderation übernimmt Frau Tamara Fahry-Seelig vom Berufsverband Deutscher Geowissenschaftler (BDG) aus Berlin.

Field Trips during and after the conference
Start & end for all field trips:
The conference venue -> Henry Ford Building (except 1 a & 1 b: Bahnhof Zoo)

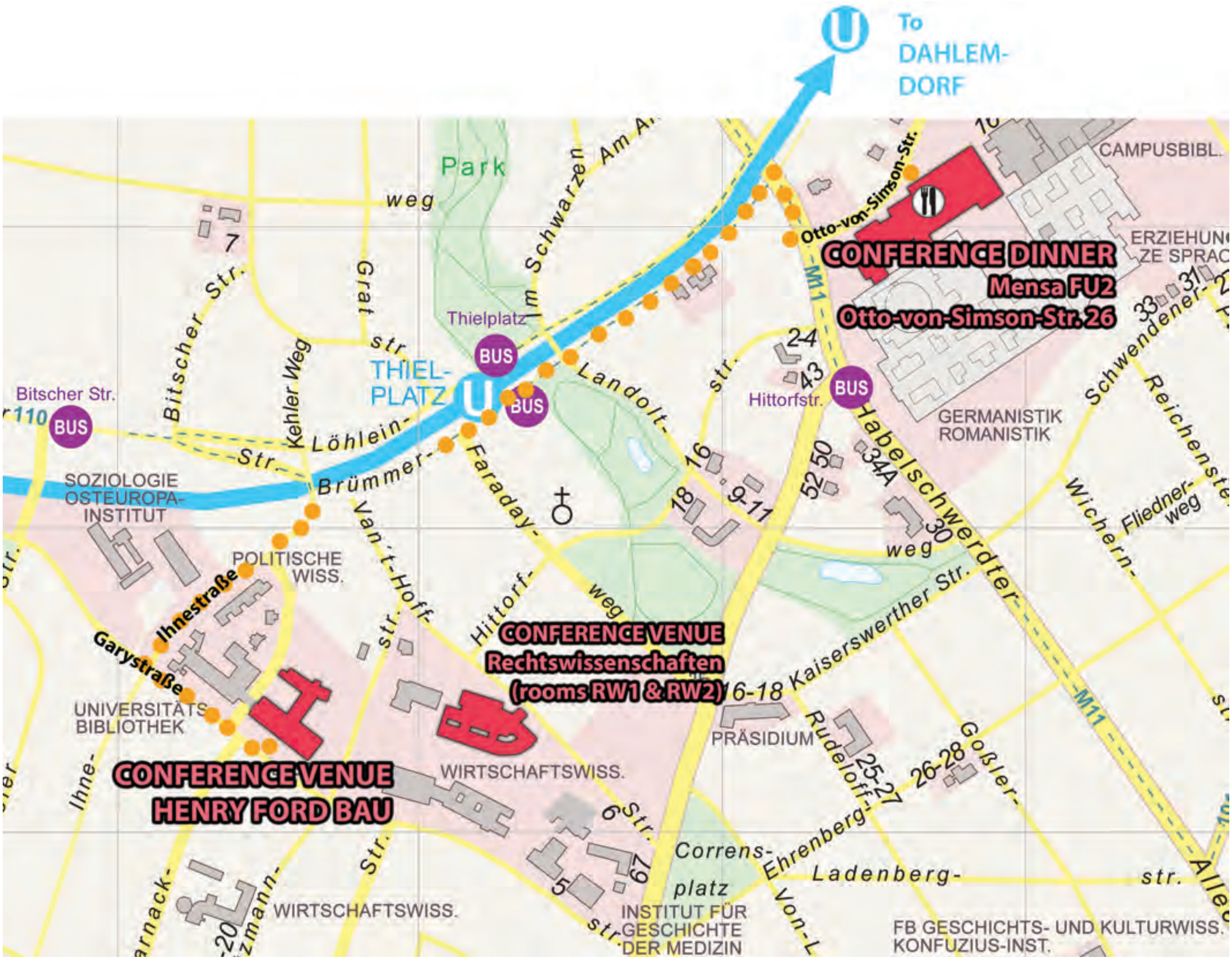
Conference Dinner

Conference Dinner at FU Berlin refectory "Mensa FU2"

Tuesday, 6 October 2015 · FU Berlin refectory "Mensa FU2"
20:00 h · EUR 10
Address: Mensa FU2, Otto-von-Simson-Str. 26, 14195 Berlin

How to get there (15 min walk from Henry Ford Building):
Please leave the Henry Ford Building at the entrance Garystraße, turn to the left and walk along Garystaße to cross junction Ihnestraße. There, please turn again to your left an walk along Ihnestraße (changes its name during your walk to "Brümmerstraße". At cross junction Thielallee, please turn to your right and walk along Thielallee until you get to Otto-von-Simson-Straße (please see map → orange dots).

Public Transport Station: Underground / U-Bahn: U 3 (Thielplatz or Dahlem Dorf)
On food from Henry Ford Building: approximately 20 min,
S-Bahn: S1 to Lichterfelde-West, from there Bus M11 (direction Dahlem Dorf),
exit at "Hittorfstr.", then on foot to Henry-Ford Building



Posters

Information for Poster Presenters

The poster unit size is A0 portrait. Materials for mounting your posters will be available in the poster hall and at the registration desk. Please do not use any other tapes or needles.

There will be two poster sessions. Please check the program to identify the time slot for your poster presentation. Posters shall be changed on Tuesday during lunch time, i.e. 11:00–13:30 h.

We kindly ask all Monday poster presenters to remove their posters before the beginning of Tuesday's lunch break, so that the Tuesday poster presenters can mount their posters during the Lunch break. Helpers will be around to assist you.

In order to foster vivid discussions in front of the posters, the poster social will be held without any other parallel events and will be featured with drinks and snacks.

Posters will be on display during our two poster socials as it follows:

Poster Social Monday for Sessions:

A1-01: Monitoring plate boundary systems…
A1-02: Fluids in subduction zones….
A1-05: Motion and time in orogenesis
A2-02: Continental breakup…
A2-01/05: Plate tectonics…
A3-01: Meteorites…
A3-02: Impact Cratering …
A5-01: Supercontinents…
A5-02: Major environmental changes…
A6-01: Tectonic and climatic imprints…
A6-02: The Sediment Factory…
A6-05: Quaternary Environmental Changes…
A7-01: Earth's light element cycles
A7-02: Silicate melts and magma
B2-01: Marine ore deposits
B2-02: Terrestrial ore deposits
B2-03: Material Supply
B4-01/02 Human habitat
B4-03: Agriculture…
B5-01: Numerical Simulation
B6-01: Cements, Ceramics
C5: Scientific Drilling
C6: 3D Geology and Geoinformation

Poster Social Tuesday for Sessions:

A1-06: Subduction systems
A1-03: Geochemistry
A1-04: Mountain building on atomic scale
A2-01: Plate tectonics…
A2-04: Magmatism
A3-03: Earthlike planets
A4-01: Mantle flow
A4-03: Earth materials
A4-05 Archean environments
A6-03: Tectonic-climate
A6-07: Glacial tectonics…
B1-01: Sedimentary basins
B1-02: Rocks and fluid
B1-03: Shales and coals
B1-04: Natural resource projects
B3-03: Extreme events
B5-02: Subsurface storage…
B6-02: Archaeometry…
B6-03: Energy and materials…
C1/C2: Material characterization…
C4: Young Sedimentologists
C3: Earth Science Informatics

List of Posters

4–7 October 2015

No.	Session	Presenter Last Name	All Authors	Abstract Title
M-T-1	H	Stuewe	Kurt Stüwe	The Wegener Memorial Expedition to the greenland Caledonides
M-T-2	H	Jacoby	Wolfgang Jacoby	Wegener's learning about the mechanism of continental drift
M-T-3	Regional Geology	Menning	Manfred Menning	Die Stratigraphische Tabelle von Deutschland 2015
M-T-4	Regional Geology	Schro-eder	Johannes H. Schroeder	Stones in Towns and Cities – Public Geo-Education
M-T-5	Regional Geology	Schro-eder	Johannes H. Schroeder	Field guides "Geology in Berlin and Brandenburg"
M-T-6	Regional Geology	Stacke-brandt	Werner Stackebrandt, Dietrich Franke	Newly published: The Geology of Brandenburg

This Posters will be present during the hole conference.

List of Posters

Monday, 5 October 2015

No.	Ses-sion	Pre-senter Last Name	All Authors	Abstract Title
Mon-1	A1-01	Bordbar	Zari Bordbar, Hadi Hoseini, Mohammad Reza Hatami	Earthquakes Depth Accuracy of the Zagros Continental Collision Zone using Nonlinear Probabilistic Method
Mon-2	A1-01	Sobie-siak	Monika Sobiesiak, Theresa Schaller, Benja-min Gutknecht, Hans-Jürgen Götze	Can batholithic structures influence the seismogenic behavior of the North Chile Seismic Gap?
Mon-3	A1-01	Tilmann	Frederik Tilmann, Bernd Schurr, Günter Asch, Ben Heit, Torsten Dahm, Patricio Raul Arias Ortiz, Dietrich Lange, Ingo Grevemey-er, Marcos Moreno, Jonathan Bedford	Observing the Iquique aftershock sequence: the HART deploy-ment
Mon-4	A1-02	Koepke	A.M. Currin, P.E. Wolff, J. Koepke, R. Al-meev, B. Ildefonse	Amphiboles extremely enriched in chlorine as evidence for interac-tion between rock and saline fluid
Mon-5	A1-02	Dietrich	Marcel Dietrich, Harald Behrens, Christian Schmidt, Max Wilke	In situ determination of sulfur speciation in fluids at high P-T and controlled redox conditions
Mon-6	A1-02	Schmidt	Christian Schmidt, Terry M. Seward	Raman spectroscopic determination of sulfur species concentra-tions in aqueous solutions
Mon-7	A1-02	Walter	Marius J. Walter, Javier Quinteros, and Stephan V. Sobolev	Numerical modeling of fluid migration in subduction zones
Mon-8	A1-02	Ko-rolevski	Walja Korolevski, Oliver Ritter, Ute Weck-mann, Anatoly Rybin, Vitali Matiukov	Crustal structure of the Southern Pamir - insights from the TIPTI-MON magnetotelluric experiment
Mon-9	A1-05	Ticho-mirowa	Marion Tichomirowa	Zircon dating compared by different methods (SHRIMP/SIM, evaporation, high-precision CA-ID-TIMS) - how accurate and precise can we date zircons?
Mon-10	A1-05	Halama	Ralf Halama, Johannes Glodny, Matthias Konrad-Schmolke, Masafumi Sudo	Episodic re-crystallization during subduction-related metamor-phism (Sesia Zone, Western Alps)
Mon-11	A1-05	Zertani	Sascha Zertani, Jörg Giese, Mark Handy	Kinematics and low-temperature thermochronology of the Skutari-Pec-Fault in northern Albania: a combined structural and apatite fission-track study
Mon-12	A2-01/05	Wollin	Christopher Wollin, Ludger Küperkoch, Marco Bohnhoff	Kinematics of the Marmara segment of the North Anatolian Fault Zone from fault-plane solutions derived from a refined high preci-sion hypocenter catalogue (2007-2010)
Mon-13	A2-01/05	Najdah-madi	Bita Najdahmadi, Marco Bohnhoff, Fatih Bulut, Zachary E. Ross, Yehuda Ben-Zion	Systematic imaging of bimaterial interfaces at the at the Karadere-Düzce segment of the North Anatolian Fault Zone, Turkey
Mon-14	A2-01/05	Gürer	Derya Gürer, Douwe van Hinsbergen, Liviu Matenco, Fernando Corfu, Murat Özkaptan, Cor Langereis, Nuretdin Kaymakcı	Subduction zone configuration of Central and Eastern Anatolia since the late Cretaceous reconstructed from sedimentary basins in the Neotethyan suture zone
Mon-15	A2-01/05	Bohnhoff	Christina Raub, Stefano Parolai, Peter Ma-lin, Marco Bohnhoff	Analysis of near-surface properties using waveform recordings from the GONAF-Tuzla vertical array, SE Istanbul
Mon-16	A2-01/05	Martínez-Garzón	Patricia Martínez-Garzón, Marco Bohnhoff, Yehuda Ben-Zion, Georg Dresen	Scaling of maximum observed magnitudes with geometrical and stress properties of strike-slip faults

List of Posters

Mon-17	A2-01/05	Hampel	Andrea Hampel, Ralf Hetzel	Three-dimensional finite-element modelling of horizontal surface velocity and strain patterns near thrust and normal faults during the earthquake cycle: implications for interpreting geological and geodetic data
Mon-18	A2-01/05	Chertova	M.V.Chertova, W.Spakman, A.P. van den Berg, D.J.J. van Hinsbergen	Rheological and kinematic control on the subduction evolution of the western Mediterranean region.
Mon-19	A2-01/05	Müller	Austin M. Gion, Simon E. Williams, R. Dietmar Müller	The Wegener Fault revisited: Building a deforming plate model for the Eurekan Orogeny
Mon-20	A2-01/05	Brune	Sascha Brune, Nathaniel Butterworth, Simon Williams, Dietmar Müller	Oblique Rifting during Pangea Dispersal: The Rule, not the Exception
Mon-21	A2-01/05	Wichura	Henry Wichura, Javier Quinteros, Daniel Melnick, Sascha Brune, Wolfgang Schwanghart, and Manfred R. Strecker	Evolution of the Lake Victoria basin in the context of coeval rift initiation in East Africa: a 3D numerical model approach
Mon-22	A2-01/05	Jähne-Klingberg	Fabian Jähne-Klingberg, Frithjof Bense, Jonas Kley	“Geological elevators”? – the example of a Muschelkalk block surrounded by Zechstein next to the Sontra Graben (NE Hesse)
Mon-23	A2-01/05	Ouided	Laziz Ouided, Boularak Moussa, Benabbas Chaouki	Quaternary tectonics, regional structure and of reverse fault N100° of Djebel Kellal mount, Constantine area (north-east of Algeria)
Mon-24	A2-01/05	Hawemann	Friedrich Hawemann, Neil Mancktelow, Sebastian Wex, Alfredo Camacho, Giorgio Pennacchioni	Intracontinental earthquakes – from 550 Ma to present day in the Musgrave Ranges of Central Australia
Mon-25	A2-02	Emmel	Friederike U. Bauer, Joachim Jacobs, Benjamin Emmel, Finlay M. Stuart, Matthijs C. van Soest	Tracing the evolution of an orogen passive margin system by apatite and titanite (U-Th)/He data
Mon-26	A2-02	Bousquet	Romain Bousquet, Thierry Nalpas, Ronny Lompa; Roman Chelalou, Abdeltif Lahfid	Consequences of HT metamorphism during sedimentary basins formation
Mon-27	A2-02	Bredow	Eva Bredow, Rene Gassmöller, Bernhard Steinberger, Juliane Dannberg, Trond Torsvik	Models and observations of plume-ridge interaction in the South Atlantic and their implications for crustal thickness variations
Mon-28	A2-02	Dressel	Ingo Dressel, Magdalena Scheck-Wenderoth, Mauro Cacace, Hans-Jürgen Götze, Dieter Franke, Hans-Peter Bunge	Subsidence history of the South Atlantic passive margins
Mon-29	A2-02	Kollenz	S. Kollenz, U. A. Glasmacher, S. Pfister, E. A. Rossello, C. Gaucher, T. Will	Thermokinematic evolution of the passive continental margin in NE-Argenina and SE-Uruguay, constrained by fission-track ages and (U-Th-Sm)/He ages and 2D-modelling
Mon-30	A2-02	Kukla	F. Strozyk, P. Kukla, S. Back	gional comparison of the syn- and post-rift tectono-stratigraphic evolution of megasequences in salt and salt-free basins offshore Brazil and Africa, South Atlantic
Mon-31	A2-02	Spiegel	F. Lisker, J. D. Prenzel, M.L. Balestrieri, A. Läufer, C. Spiegel	Exhumation and uplift of the Terra Nova Bay segment of the Transantarctic Mountains
Mon-32	A2-02	Spiegel	C. Spiegel, W. Reiter, F. Lisker, V. Damm	Evolution of northwest Greenland margin along Baffin Bay
Mon-33	A2-02	Wildman	M. Wildman, R. Brown, C. Persano, R. Beucher, F. Stuart	Patterns and timing of post-rift denudation across the southwest African continental margin and interior plateau as revealed by apatite fission track and (U-Th-Sm)/He thermochronology
Mon-34	A3-01	Fischer-Gödde	Mario Fischer-Gödde, Thomas Kruijer, Thorsten Kleine, John Wasson	Isotopic Evidence for the Origin of IIE Iron Meteorites
Mon-35	A3-01	Münker	C. Münker, B. M. Elfers, T. Schulz, D. Garbe-Schönberg	The Hf-W age of Mars revisited
Mon-36	A3-01	Kruijer	T.S. Kruijer, T. Kleine, L.E. Borg, M. Fischer-Gödde, G. Brennecka, A.J. Irving, A. Bischoff, C.B. Agee	Coupled 182W–142Nd constraints on the early differentiation history of Mars
Mon-37	A3-01	Li	Chunhui Li, Harry Becker, Igor S. Puchtel, Zaicong Wang, Elis J. Hoffmann	Sluggish homogenization of the late accreted materials in the Earth’s mantle: Constraints from S, Se, Te, Ag and Cu in Archean komatiites
Mon-38	A3-01	Linsler	Stefan Andreas Linsler, Olivier Namur, Moritz Albrecht, Bernard Charlier, Francois Holtz, Catherine McCammon	Metal-silicate trace element partitioning at reducing conditions: Implications for Mercury’s differentiation
Mon-39	A3-01	Neumann	Wladimir Neumann, Doris Breuer, Tilman Spohn	The Diversity Of Asteroid Differentiation As Derived From Numerical Studies
Mon-40	A3-02	Hasch	Maximilian Hasch, Patrice Tristan Zaag, Ulli Raschke, Wolf Uwe Reimold	Shatter cones of the Keurusselkä impact structure, Finland
Mon-41	A3-02	Sturm	T. Krüger, T. Kenkmann, S. Sturm	Structural uplift and ejecta thickness of layered lunar mare craters: new insights into the formation of complex crater rims
Mon-42	A3-02	Luther	R. Luther, A. Lukashin, N. Artemieva, V. Shuvalov, K. Wünnemann	Snow funnel creation due to Chelyabinsk meteorite fragments

Mon-43	A3-02	Matysiak	Agnes Matysiak, Rebecca Winkler, Thomas Kenkmann	The Gardnos Impact Structure, Norway: Analysis of the autochthonous lithic Gardnos Breccia
Mon-44	A3-02	Mohr-Westheide	Tanja Mohr-Westheide, Wolf Uwe Reimold, Desirée Hoehnel, Jörg Fritz, Ralf Thomas Schmitt, Tobias Salge, Ansgar Greshake, Axel Hofmann, Seda Oezdemir, Christian Koeberl	PGE signature of Archean spherule layers in the Barberton Greenstone Belt, South Africa
Mon-45	A3-02	Hoffmann	Marie Hoffmann, Stefanie Fischer, Johann Preuß, Wolf Uwe Reimold, Natalia Hauser, Alvaro Penteado Crósta, Ralf Thomas Schmitt, Uwe Altenberger, Lutz Hecht, Mariana Velzic Marivieiro	Investigating the genesis of impact-generated melt rocks of Araguainha, Brazil
Mon-46	A3-02	Schmitt	Ralf T. Schmitt	The Impactite collection at Museum für Naturkunde Berlin
Mon-47	A3-02	Wilk	Jakob Wilk, Anna Losiak, Michael Zanetti, Eva Maria Wild, Argo Joeleht, Rudolf Välja, Tomek Wisniowski, Matthew Huber, Kristiina Pavel, Aivar Kriiska, Antero Kukko, Harri Kaartinen, Jüri Plado, Wolf Dietrich Geppert	New insights into the Kaali meteorite crater - an update based on the development in crater research from Wegner to today
Mon-48	A3-02	Winkler	Rebecca Winkler, Elmar Buhl	Deformation band analysis at the Upheaval Dome impact crater
Mon-49	A3-02	Zaag	Patrice Tristan Zaag, Wolf Uwe Reimold, Kai-Uwe Hess, Kate Dobson	SHOCK MICRODEFORMATION IN A SHATTER CONE FROM SERRA DA CANGALHA, BRAZIL
Mon-50	A5-01	Brocke	Rainer Brocke, Robert Bussert, Dawit Lebenie	First discovery of Early Palaeozoic post-glacial (post-Hirnantian/latest Ordovician-early Silurian) mudstones and cryptospores in northern Ethiopia
Mon-51	A5-01	Darvishi Khatooni	Javad Darvishi khatuoni, Razyeh lak, Ali Mohammadi, Alireza salehipuor Milani	Verification of the important factors that causes of rapid falling of Urmia Lake water table (Northwestern of Iran)
Mon-52	A5-01	Darvishi Khatooni	Zahra Zandinasab, Javad Darvishi Khatooni, Behruz Rafiei	Sedimentology and Sea level changes of the offshore deposits South of Caspian Sea(Noshahr-Tonekabon)
Mon-53	A5-01	Sadr	Fatemeh Dabaghi Sadr, Gerhard Schmiedl, Christian Betzler, Mohammad Parandavar	Biostratigraphy and Lithostratigraphy of the Qom Formation in the Navab Anticline section, southeast of Kashan area, Iran
Mon-54	A5-02	Martha	Silviu O. Martha, Andrej Ernst, Joachim Scholz	Plate tectonic and bryozoans: Biological response during times of extreme environmental changes (Devonian and Upper Cretaceous)
Mon-55	A5-02	Oeser	Ralf Oeser, Michael Tatzel, Gerhard Franz, Jan A. Schuessler, Friedhelm von Blanckenburg	Genesis of chert nodules in Ediacaran black shales: implications from micro scale Si isotope analyses using fs-laser ablation MC-ICP-MS
Mon-56	A5-02	Sun	Xiaojuan Sun, Christoph Heubeck	Facies analysis of lowermost Cambrian carbonate platform in East Yunnan, South China: An implication of the importance of depositional hiatus.
Mon-57	A6-01	Hampel	Andrea Hampel, Ralf Hetzel	Numerical modelling of wind gap formation in fault-bounded mountain ranges
Mon-58	A6-01	Lange	Thomas Lange, Georg Büchel, Thomas Jahr	A valley over the course of time: Detailed geomagnetic mapping of two lava flows as base for a morphological reconstruction of the Alf valley, Quaternary Westeifel Volcanic Field (Germany).
Mon-59	A6-01	Sobczyk	Artur Sobczyk, Edward Sobel	Apatite fission-track dating reveals post-Variscan history of the Orlica-Śnieżnik Dome, Eastern Sudetes Mts. (Bohemian Massif, SW Poland)
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Mon-64	A6-02	Spiegel	Wolfgang Reiter, Simon Elfert, Christoph Glotzbach, Cornelia Spiegel	Plio-Pleistocene evolution of the north Alpine drainage system: constraints from detrital thermochronology of foreland deposits
Mon-65	A6-02	Stalder	Nadja Franziska Stalder, Maria Giuditta Fellin, Wilfried Winkler	Provenance Analysis of the Laga Formation (Messinian, Central Apennines)
Mon-66	A6-05	Kenzler	M. Kenzler, S. Tsukamoto, S. Meng, M. Frechen, H. Hueneke	The Weichselian deposits of the Jasmund peninsula (German Baltic Sea coast) – Chronostratigraphical reassessment based on luminescence dating
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Mon-69	A6-05	Struck	Martin Struck, John D. Jansen, Alexandru T. Codilean, Toshiyuki Fujioka, David Fink, Steven Kotevski	Quantifying sediment transport time and burial duration in central Australian low-gradient landscapes using 10Be and 26Al
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Mon-90	B2-02	Qi	Dongmei Qi, Harald Behrens, Roman Botcharnikov, Insa Derrey, Francois Holtz	A synthetic fluid inclusion study of copper solubility in $NaCl\text{-}H_2O$ fluids at 800°C and 200 MPa
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Mon-93	B2-02	Romer	Rolf L. Romer, Uwe Kroner	Contrasting tectonic setting of magmatic Acadian-Variscan-Appalachian tin and tungsten mineralization
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Mon-95	B2-02	Stratakis	Georgios Alevizos, Athanasios Apostolikas, Antonios Stratakis	Mineralogical and ore-petrographic investigation of the nickeliferous lateritic deposit of Hudenisht in Pogradec area (Albania)
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Mon-104	B4-03	Kniewald	Goran Kniewald	The geological and tectonic structure of the Krka river estuary - integrated coastal zone management issues of the Adriatic Sea
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Mon-107	B5-01	Kempka	Markus Adams, Elena Tillner, Thomas Kempka, Martin Feinendegen, Martin Ziegler	An innovative hydro-mechanical coupling approach for fault reac-tivation
Mon-108	B5-01	Kühn	Fabien Magri, Sebastian Möller, Nimrod In-bar, Christian Siebert, Peter Möller, Eliyahu Rosenthal, and Michael Kühn	Convective regimes in the Tiberias Basin, Israel/Jordan, and their consequences on relic brine migration
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Mon-122	B6-01	Werner	Daniel Werner, André Gardei, Sebastian Simon, Birgit Meng	Microscopic and microchemical investigation of building materials affected by alkali-silica reaction
Mon-123	C5	Krauß	Felix Krauß, Helge Simon, Peter Hedin, Rüdiger Giese, Stefan Buske, Christopher Juhlin, Henning Lorenz	Borehole seismic in the ICDP borehole COSC-1
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Mon-125	C5	Harms	Ulrich Harms and Henning Lorenz	Caledonian thrust sheet emplacement along basal mylonites in the COSC-1 borehole in Central Sweden

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Tue-4	A1-03	Loges	Anselm Loges, Dina Schultze, Jana Rehm, Gerhard Franz	Paleosedimentological reconstruction of amphibolite facies metasediments: a holistic approach
Tue-5	A1-04	Götze	Lutz C. Götze, Ralf Milke, Susan Schorr, Rainer Abart, Richard Wirth	In-situ monitoring of mineral reactions using synchrotron X-ray diffraction
Tue-6	A1-04	Matysiak	Agnes Matysiak, Claudia Trepmann	The deformation record of olivine in mylonitic peridotites from the Finero Complex, Ivrea Zone - separate deformation cycles during exhumation
Tue-7	A1-04	Schultze	Dina Schultze, Gerhard Franz, Richard Wirth, Dirk Berger, Hans-Peter Schertl	The dissolution-precipitation reactions and the role of aqueous fluids in the transformation of corundum to kyanite - three natural examples on a metamorphic cycle
Tue-8	A1-06	Bran-des	Christian Brandes, Karsten Piepjohn, Dieter Franke, Christoph Gaedicke	Paleostress field analysis of collisional tectonics along the margin of the Alaska-Chukotka microplate
Tue-9	A1-06	Geersen	Jacob Geersen, Karen Leever, Kathrin Lieser, Lisa McNeill	Fault reactivation and landward vergent thrusting in the accretion-ary prism of Northern Sumatra revealed by analogue experiments
Tue-10	A1-06	Glerum	A. C. Glerum, C. Thieulot, C. C. Pranger, D. J. J. van Hinsbergen, M. Fraters, W. Spakman	Three-dimensional instantaneous dynamics modeling of present-day Aegean subduction
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Tue-12	A1-06	Kurza-wski	Robert M. Kurzawski, Michael Stipp, Ralf Doose, Detlef Schulte-Kortnack	Triaxial testing of marine sediments from offshore Costa Rica (Costa Rica Seismogenesis Project – IODP Expeditions 334 and 344)
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Tue-20	A2-04	Neu-kampf	Julia Neukampf, Armin Freundt, Timm John	Study of the evolution of the intra-plate magma plumbing system beneath Fogo
Tue-21	A2-04	Kemner	F. Kemner, C. Beier, K. Haase	The geochemical evolution of oceanic intraplate volcanoes
Tue-22	A2-04	Wilke	Sören Wilke, Torsten Bolte, Renat Almeev, Eric H. Christiansen, Francois Holtz,	Experimental calibration of a new geobarometer for rhyolitic melts based on cotectic melt compositions
Tue-23	A2-04	Zirner	Aurelia L.K. Zirner, Chris Ballhaus, Roman Botcharnikov, Raúl O.C. Fonseca, Carsten Münker	Anorthositic dykes in Cyprus – precipitates of magmatic fluids?
Tue-24	A2-04	Ghani	Irum, M. Arif, M. Sajid, H. Ghani	Petrographical Study of Rocks from Indus Suture Zone and Jijal Complex, NW Pakistan
Tue-25	A3-03	Tosi	Nicola Tosi, Ondrej Cadek, Marie Behoun-kova, Michela Kanova, Ana-Catalina Plesa, Matthias Grott, Doris Breuer, Sebastiano Padovan, Mark Wieczorek	Mercury's Low-Degree Geoid and Topography from Insolation-Driven Elastic Deformation
Tue-26	A3-03	Cizkova	Hana Cizkova, Arie van den Berg, Volker Steinbach, Michel Jacobs	Heat transport characteristics of large terrestrial exoplanets
Tue-27	A3-03	Tosi	Ana-Catalina Plesa, Sebastian Prinz, Nicola Tosi, Christian Hüttig, Doris Breuer	Thermal evolution and heat-pipe melt transport: implications for one-plate planets
Tue-28	A3-03	Stein-berger	Bernhard Steinberger, Stephanie Werner, Tobias Rolf	Mantle dynamics models of the the gravity spectrum of Mercury
Tue-29	A3-03	Wong	Teresa Wong, Viatcheslav S. Solomatov	Variations in timing of plate tectonics initiation on Earth-like planets due to chaotic nature of mantle convection
Tue-30	A4-01/02	Jain	Charitra Jain, Antoine Rozel, Paul Tackley	Is there any correlation between continents and elevated tempera-tures in the subcontinental mantle?
Tue-31	A4-01/02	Kosty-anev	Simeon Kostyanev, Georgi Trapov, Velislav Stoyanov	Numerical modelling of heat flows in Black Sea
Tue-32	A4-01/02	Mar-quardt	H. Marquardt, G.J. Golabek, L. Miyagi, T.V. Gerya	The response of subducting slabs to a strength increase in the shallow lower mantle constrained by numerical modelling
Tue-33	A4-01/02	Nikolaou	Athanasia Nikolaou, Nicola Tosi, Ana-Catalina Plesa	Modelling magma ocean evolution and volatile outgassing using a 1-D atmosphere-interior coupled model for the early earth
Tue-34	A4-01/02	Osei Tutu	Anthony Osei Tutu, Bernhard Steinberger, Stephen Sobolev, Irina Rogozhina	Linking global mantle dynamics with lithosphere considering the effect of visco-elasto-plastic rheology in the upper 300 km
Tue-35	A4-01/02	Ruedas	Thomas Ruedas	Effects of impacts on the thermochemical evolution of Mars
Tue-36	A4-01/02	Wagner	Frank Walter Wagner, Ana-Catalina Plesa	Modeling the convective heat transfer in solid planets
Tue-37	A4-03	Cordier	J. Amodeo, B.S.A. Schuberth, H.-P. Bunge, Ph. Carrez, P. Cordier	On the role of thermal heterogeneities on the rheology of MgO under conditions of the Earth's lower mantle
Tue-38	A4-03	Cordier	Francesca Boioli, Philippe Carrez, Patrick Cordier	Modeling the rheology of olivine using 2.5D dislocation dynamics simulations
Tue-39	A4-03	Herting-Agthe	Susanne F. Herting-Agthe	Calcite – star-shaped oriented intergrowths with other minerals
Tue-40	A4-03	Mar-quardt	Alexander Kurnosov, Hauke Marquardt, Tiziane Boffa Ballaran, Daniel J. Frost	The effect of iron and aluminium incorporation on the single-crystal elasticity of bridgmanite at high pressure
Tue-41	A4-03	Mar-quardt	H. Marquardt, L. Miyagi, Sergio Speziale, Hanns-Peter Liermann	Deformation of (Mg,Fe)O ferropericlase at high-pressures and high-temperatures and slab stagnation in the shallow lower mantle
Tue-42	A4-03	Miyajima	Nobuyoshi Miyajima, Yang Li, Florian Heidelbach	Electron channeling contrast imaging of dislocations in geological materials using a scanning electron microscope
Tue-43	A4-05	Bläsing	Saskia Bläsing, Marc Grund, Christoph Heubeck	Petrography and Structural Geology of the westernmost Dycedale Syncline (Barberton Greenstone Belt, South Africa) – Implications for Archean tectonics and depositional environments
Tue-44	A4-05	Heubeck	Paul Fugmann, Christoph Heubeck, Eleu-therios Profitis	Sedimentology of the "Tsunami"- chert-slab conglomerate of the Archean Fig Tree Group (3.24 Ga), Barberton Greenstone Belt, South Africa
Tue-45	A4-05	Heubeck	Christoph Heubeck	Reassessing evidence of Moon-Earth dynamics: No evidence of shorter lunar months from tidal bundles of the Moodies Group (Barberton Greenstone Belt, 3.22 Ga)
Tue-46	A4-05	Ho-mann	Martin Homann, Christoph Heubeck, Ales-sandro Airo	Morphological adaptations of 3.22 Ga-old phototrophic microbial mats to Archean coastal habitats (Moodies Group, Barberton Greenstone Belt, South Africa)
Tue-47	A4-05	Müller	Matthias Müller, Alessandro Airo	Modeling Microbialite Growth
Tue-48	A4-05	Nabhan	Sami Nabhan, Christoph Heubeck, Michael Wiedenbeck, Harald Strauß	Biogenic overgrowth on detrital pyrite in Archean paleosols in the ~3.2 Ga old Moodies Group, BGB, South Africa.

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Tue-49	A4-05	Ra-bethge	Carolin Rabethge, Christoph Heubeck	Depositional environment of ferruginous sediment in the Moodies Group, Barberton Greenstone Belt, South Africa
Tue-50	A4-05	Rentinck	Marc-Nicolas Rentinck, Alessandro Airo	Bioflumology: Cyanobacterial biomat morphologies under flow conditions
Tue-51	A4-05	Sager	Christof Sager, Julia Hulin, Alessandro Airo	Bioflumology: Cyanobacterial biomat morphologies under tidal conditions
Tue-52	A4-05	Schley	Nicolas Schley, Martin Homann, Alessandro Airo	Mico-CT analysis of Archean microbial mats
Tue-53	A6-03	Voigt	Sietske J. Batenburg, Silke Voigt, Oliver Friedrich, Anne Osborne, Tina Klein, Christoph Neu, Martin Frank	Atlantic Ocean Circulation during the Latest Cretaceous and Early Paleogene: Progressive Deep Water Exchange
Tue-54	A6-07	Geh-rmann	Anna Gehrmann, Martin Meschede, Heiko Hüneke, Henrik Rother, Karsten Obst	The Jasmund Glaciotectonic Complex (NE Rügen Island): Geomorphological Mapping and Landform Analyses based on LiDAR Data
Tue-55	A6-07	Mey	Jürgen Mey, Dirk Scherler, Andrew Wickert, David L. Egholm, Magdala Tesauro, Manred R. Strecker	Estimating the contribution of GIA to the present-day uplift of the European Alps considering post-glacial sediment redistribution and variations in lithospheric strength
Tue-56	A6-07	Tanner	David C. Tanner, Jan Igel, Thomas Günther, Christian Brandes, Charlotte M. Krawczyk	Glacial structures revealed in County Kerry, Ireland, by detailed 3D geophysical investigation
Tue-57	B1-01	Arfai	Jashar Arfai, Rüdiger Lutz, Lutz Reinhardt, Christoph Gaedicke	3D petroleum system modelling and hydrocarbon generation potential: the Entenschnabel area, northwestern German North Sea
Tue-58	B1-01	Emmel	Benjamin Emmel Krzysztof Jan Zieba	Thermochronology based revised Cenozoic uplift and erosion estimates for the western Barents Sea
Tue-59	B1-01	Ondrak	Robert Ondrak, Ursuala Hammes	Modeling the burial and maturation history of the Haynesville Shale in the East Texas Salt Basin and the Sabine Uplift area
Tue-60	B1-01	Tanner	David C. Tanner, Jennifer Ziesch, Thies Beilecke, Charlotte M. Krawczyk	Kinematic analysis of syn-sedimentary normal faults in the Otway Basin, Australia
Tue-61	B1-01	Theis-sen-Krah	S. Theissen-Krah, D. W. Schmid, J.-I. Faleide, S. Planke, L. H. Ruepke, E. H. Hartz	Extension and thermal evolution at the Mid-Norwegian Margin – Insights from basin modelling between Greenland and the Møre Margin
Tue-62	B1-01	War-sitzka	Michael Warsitzka, Jonas Kley, Nina Kukowski	Understanding salt structure evolution in the Central Glueckstadt Graben (Northern Germany) by means of restoration of minibasins
Tue-63	B1-01	Zieba	Krzysztof Jan Zieba, Arnt Grøver	Glacial erosion, deposition and ice loading: Impact on structural development of the western Barents Sea sedimentary basins
Tue-64	B1-02	Purser	G. Purser, K. Bateman, A.D. Kilpatrick, L. Selby	An experimental investigation of the fluid-rock reaction of Bowland Shale with a shale gas injection fluid.
Tue-65	B1-03	Baniasad	Alireza Baniasad, Ahmadreza Rabbani, Victoria Sachse, Ralf Littke	Organic Geochemistry and Basin Modeling Study in the Northwestern Part of the Persian Gulf
Tue-66	B1-03	Weniger	Martin Blumenberg, Jolanta Kus, Lutz Reinhardt, Christoph Gaedicke, Karsten Piepjohn, Georg Scheeder, Stefan Schlömer, Philipp Weniger, Christian Ostertag-Henning	The oil generation potential of coals from Svalbard and the Northern Barents Sea
Tue-67	B1-03	Ghassal	Bandar Ghassal, Victoria Sachse and Ralf Littke	Source Rock Assessment of Upper Albian to Turonian Sedimentary Rocks from the Tarfaya Basin, SW Morocco
Tue-68	B1-03	Ghaz-wani	Assad Ghazwani, Ralf Littke, Reinhard Fink, Christoph Hartkopf-Fröder, Nicolaj Mahlstaedt, Victoria Sachse	Organic Geochemistry, Petrology and Palynofacies of Middle Devonian Lacustrine Flagstone in the Orcadian Basin, Scotland: Depositional Environment, Thermal History and Petroleum Generation Potential
Tue-69	B1-03	Stock	Alexander T. Stock, Ralf Littke	Analysis of oils from the Lower Saxony Basin and the Gifhorn Trough – Oil quality and biodegradation as related to reservoir depth and source rock maturity
Tue-70	B1-03	Stück	Heidrun Stueck, David Houseknecht, Dieter Franke, Donald Gautier, Andreas Bahr, Stefan Ladage	Shale gas assessments – Comparison of performance-based vs. gas in place approach
Tue-71	B1-03	Stück	Heidrun Stueck, Carsten Helm, Rüdiger Lutz, Steffen Biermann, Christian Ostertag-Henning, Andreas Bahr, Dieter Franke, Stefan Ladage	Shale Gas and Shale Oil in Germany: In-Place assessment and technically recoverable resources
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Tue-73	B1-04	Gorka	Torsten Gorka, Stephan Peters	Nutzung von Kohle durch untertägige Vergasung (UCG) am Beispiel von zwei aktuellen Pilotversuchen in Polen

Tue-74	B1-04	Baban	Ezzadin Najmadin Baban	Study of the gravity data of south of Talafar - Mosul area – NE Iraq
Tue-75	B1-04	Faturrahman Rusli	Fadli Faturrahman R, Andri Dian Nugraha, Rachmat Sule	Three-Dimensional (3-D) Attenuation Tomography in "FF" Geothermal Field.
Tue-76	B1-04	Franke	K. Berglar, M. Blumenberg, D. Franke, M. Krüger, R. Lutz & PANORAMA team	Hydrocarbon Potential of the European Arctic - Chances and challenges
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Tue-78	B1-04	Lutz	R. Lutz, L. Reinhardt, A. Lückge	Triassic source rocks in the Barents Sea – Input for hydrocarbon assessment of the European Arctic
Tue-79	B1-04	Seifert	Thomas Seifert	Comparison between the Marienberg-Pobershau, Seiffen-Hora Sv. Kateřiny and Ehrenfriedersdorf-Geyer Sn-polymetallic districts and their potential for tin resources
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Tue-81	B5-02	Körting	O. Körting, H. Babayan, G. Melikadze, B. Müller, T. Neumann, H.-G. Stosch, P. Tozalakyan	Natural analogue investigation for CCS in the Southern Caucasus
Tue-82	B5-02	Kuhlmann	Gesa Kuhlmann, Lisa Kaatz, Klaus Reinhold	Early Jurassic lithology and facies distribution in the eastern part of the North German Basin revisited from litho-facies maps and borehole descriptions
Tue-83	B5-02	May	Franz May	How can environmental monitoring date be used in the Risk Management of CO2 storage sites?
Tue-84	B5-02	Mueller	Christian Mueller, Gabriela von Goerne, and Project Group	TUNB: A 3D Model of the North German Basin – Project Overview
Tue-85	B5-02	Obst	Karsten Obst, Sabine Matting, André Deutschmann, Juliane Brandes	TUNB-Projekt (TP3): Recherche geologischer und geophysikalischer Daten und digitale Aufbereitung für ein 3D-Landesmodell Mecklenburg-Vorpommern
Tue-86	B5-02	Offermann	Katrin Lademann, Thomas Liebsch-Dörschner, Petra Offermann	Geological 3D modeling of the deep underground in Schleswig-Holstein and Hamburg (north german basin). – A part of the joint project TUNB (Tieferer Untergrund Norddeutsches Becken)
Tue-87	B5-02	Pastrik	Nicole Pastrik, Katharina Bairlein	Petrophysical and geoeletrical investigations on analogue outcrops of the South German Malm
Tue-88	B5-02	Peltz	Markus Peltz, Georg Grathoff, Laurence N. Warr, Karsten Obst	The influence of CO_2-charged brine on mineralogy and pore space of caprocks: An XRD and FIB-SEM study on Toarcian claystones
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Tue-93	B5-02	Tatarinov	Victor Tatariniv, Vladislav Morozov, Tatiana Tatarinova	Prediction geodynamic safety in the disposal of high-level radioactive waste in geological formations
Tue-94	B5-02	Wolf	Marco Wolf, Stephan Steuer, Frithjof Bense, Fabian Jähne-Klingberg	Seismo-stratigraphic subdivision of the Triassic in the Central German North Sea
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Tue-99	B6-03	He	Jianhan He, Klaus Bandel, Marc Theodor, Ulrich Bismayer	Shells of bivalves and gastropods – perfect bio-composites
Tue-100	B6-03	Keuper	Melanie Keuper, Klaus G. Nickel, Christoph Berthold, Kathrin Termin, Katharina Klang, Anita Roth-Nebelsick	Manufacturing of Ordered Porous Materials: Freeze Casting and Ionotropic Gelation

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Tue-104	B6-03	Sajid	Muhammad Sajid, John Coggan, Mohammad Arif, Jens Andersen, Gavyn Rollinson	Textural characteristics as an efficient indicator towards rock strength: Insights from studies on Granites from north Pakistan
Tue-105	B6-03	Zietlow	P. Zietlow, T. Beirau, B. Mihailova, T. Malcherek, J. Schlüter, C. Paulmann, R. Škoda, L.A. Groat, U. Bismayer	Thermal annealing behaviour of radiation damaged pyrochlore
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Tue-109	C1/C2	Berthold	Nadja Wichtner, Christoph Berthold, Klaus G. Nickel	Coupling μ-XRD2 & DTA: Advantages using large 2D-detectors for the real-time monitoring of temperature dependent processes
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Tue-115	C4	Leuschner	Annette Leuschner, Frank Mattern, Stephan van Gasselt	Alluvial Fans of the Oman Mountains: Morphometry and Hydrodynamic Characteristics
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Tue-118	C4	Prinz	Linda Prinz, Andreas Schäfer, Torsten Utescher, Tom McCann, Sven Asmus, Peter Lokay	Coastal high-energy Neurath Sand in Cenozoic-age Lower Rhine Basin (W Germany)
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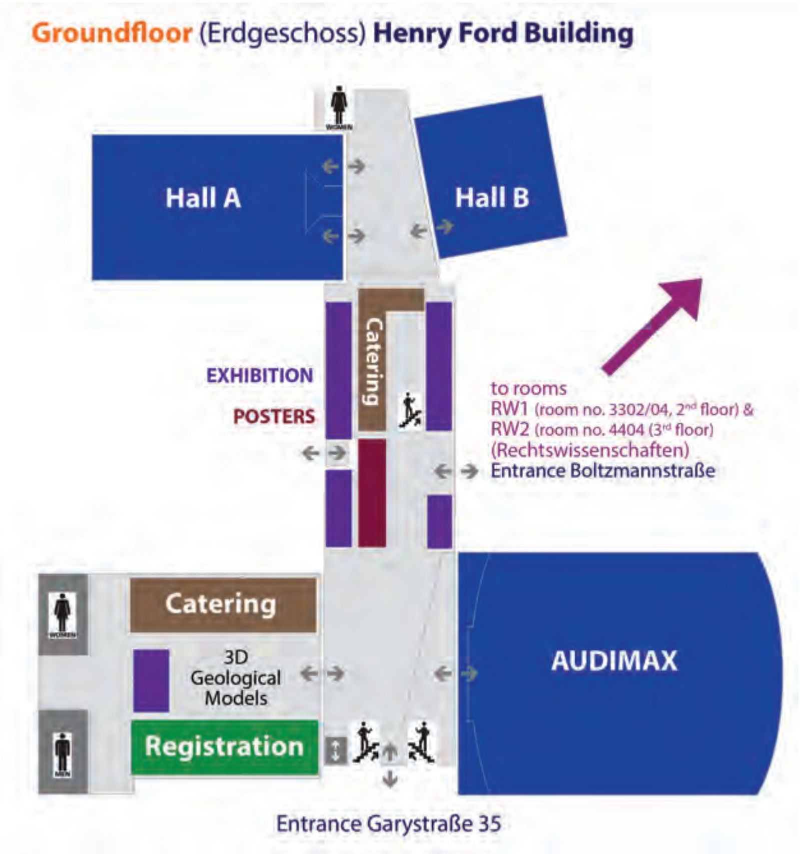
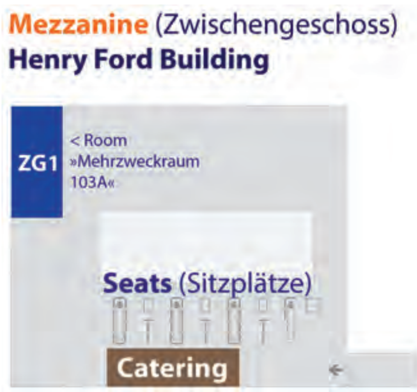
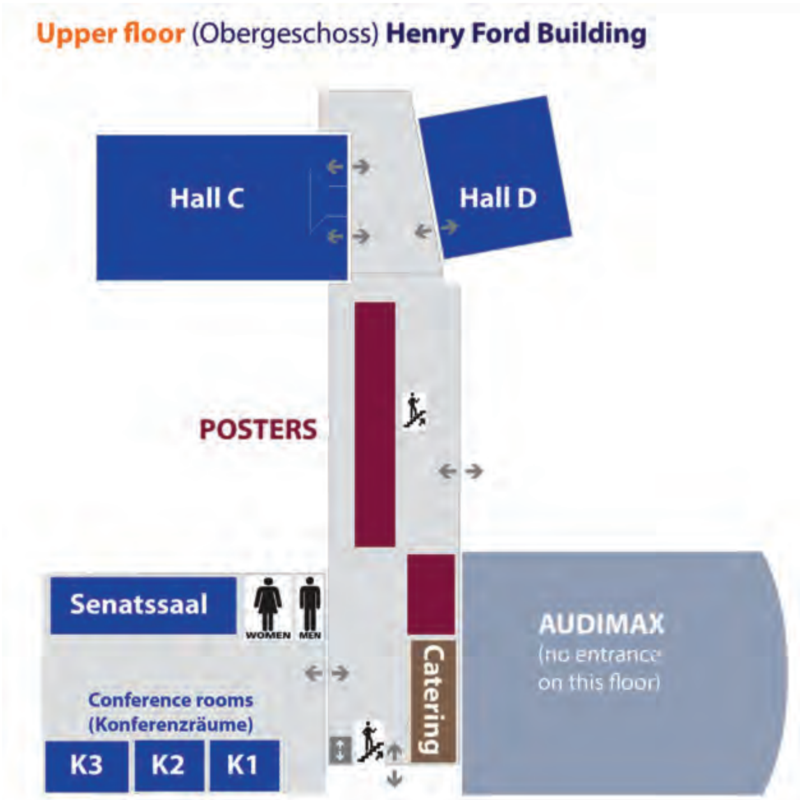
Tue-120	C4	Rütters	Sophia Rütters, Tom McCann	Pre-Messinian Salinity Crisis sedimentary successions of the southern Vera Basin, SE Spain
Tue-121	C4	Rütters	Sophia Rütters, Tom McCann	An overview of Neogene-age deposition within the Vera Basin, SE Spain
Tue-122	C4	Zuo	Fanfan Zuo, Ulrich Heimhofer, Stefan Huck, Jochen Erbacher	Carbon-isotope chemostratigraphy and sedimentary characteristics of Kimmeridgian shallow-water deposits in the Lower Saxony Basin of northern German

Conference Venue/Floor Plan







Announcement for the next DMG and DGGV meeting

The 2nd **European Mineralogical Conference** will be held at the Palacongressi of Rimini, Italy, **11-15 September 2016**

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SFMC	Société Française de Minéralogie et de Cristallographie
SIMP	Società Italiana di Mineralogia e Petrologia
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There will be a series of invited plenary lectures, including the acceptance speech of the recipient of the IMA medal award. Chairmen: Giuseppe Cruciani and Bernardo Cesare on behalf of SIMP. Email: info@emc2016.socminpet.it

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