



Expeditionsprogramm Nr. 77

FS POLARSTERN

ANT-XXIII/8

ANT-XXIII/9

ANT-XXIII/10

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Z 432

77
2006

ALFRED-WEGENER-INSTITUT FÜR POLAR-
UND MEERESFORSCHUNG
DER HERMANN VON HELMHOLTZ-GEMEINSCHAFT
DEUTSCHER FORSCHUNGSZENTREN E.V. (HGF)

BREMERHAVEN, OKTOBER 2006

EXPEDITIONSPROGRAMME No. 77

RV POLARSTERN

ANT-XXIII/8

**23 November 2006 - 30 January 2007
Cape Town - Punta Arenas**

ANT-XXIII/9

**2 February 2007 - 11 April 2007
Punta Arenas - Cape Town**

ANT-XXIII/10

**12 April 2007 - 4 May 2007
Cape Town - Bremerhaven**

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ANT-XXIII/8

23 November 2006 – 30 January 2007
Cape Town – Punta Arenas

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1. ÜBERBLICK UND FAHRTVERLAUF

J. Gutt (AWI)

Der achte Fahrtabschnitt der Expedition ANT-XXIII mit FS *Polarstern* dient der Durchführung von zwei wissenschaftlichen Vorhaben. Es handelt sich dabei um maßgebliche Beiträge zu internationalen Forschungsprogrammen:

- (1) Fischereibiologische Untersuchungen westlich der Antarktischen Halbinsel um *Elephant Island*, die *South Shetland Islands* und vor *Joinville Island* zur Analyse der Biologie, Altersstruktur und Größe antarktischer Fischbestände; Beitrag zu:

Convention on the Conservation of Antarctic Marine Living Resources
(*Konvention zum Schutz der lebenden Meeresschätze der Antarktis*)

- (2) Ökosystemforschung im ehemaligen Larsen-A/B-Schelfeisgebiet östlich der Antarktischen Halbinsel zur Klärung des Wandels der Lebensvielfalt als Folge des klimabedingten Wegbrechens des Schelfeises und zur Aufklärung marin-ökologischer Funktionsprinzipien; Beitrag zu:

Evolution and Biodiversity in the Antarctic & Census of Antarctic Marine Life
(*Evolution und Lebensvielfalt in der Antarktis & Bestandsaufnahme der antarktischen Meeresorganismen*)

Nach dem Auslaufen in Kapstadt muss zunächst die Atka-Bucht im östlichen Wedellmeer angelaufen werden, um die Neumayer-Station ungefähr am 4./5.12. zu versorgen. Auch bei günstigen Meereis- und Wetterbedingungen wird die Antarktische Halbinsel, wo beide wissenschaftliche Vorhaben stattfinden werden, nicht vor dem 14.12. erreicht werden (Abb. 1).

Zunächst sollen die Untersuchungen zu den lebenden Ressourcen westlich der Antarktischen Halbinsel realisiert werden. Da die fischereibiologischen Grundschleppnetz-Fänge tagsüber stattfinden, können nachts zusätzliche Organismengruppen mit wenig personalaufwändigem Gerät beprobt werden. Anschließend steht für die ökologischen Arbeiten östlich der Antarktischen Halbinsel im ehemaligen Larsen-A/B-Schelfeisgebiet ein ebenso langer Zeitabschnitt zur Verfügung; dies schließt bei günstigen Bedingungen auch einige Grundschleppnetzfänge für vergleichenden fischereibiologische Analysen ein. Sollte das Larsen -A/B-Gebiet wegen der Meereisbedeckung nicht erreichbar sein, wird ein ähnliches Programm um *Joinville Island* durchgeführt (Abb. 2).

Die wissenschaftlichen Arbeiten werden spätestens am 26.01.2007 eingestellt werden, um mit dem Einlaufen am 30.1. in Punta Arenas den Fahrtabschnitt zu beenden.

Konvention zum Schutz der lebenden Meeresschätze der Antarktis (CCAMLR)

Deutschland untersucht antarktische Fischbestände seit seiner ersten Antarktis – Expedition 1975/76. Seit der 2. Hälfte der 70er Jahre wurden die Ergebnisse in die SCAR "Working Group on Fish Biology" (später Ecology) eingespeist. Sie bildeten 1980 eine wesentliche Grundlage für die ersten, noch sehr groben Bestandsanalysen antarktischer Fischbestände, die seit Ende der 60er Jahre im Nordteil des Südpolarmeeres, seit der 2. Hälfte der 70er Jahre auch bis in die Nähe des antarktischen Kontinents befischt wurden. Selbst diese groben Analysen zeigten, dass Fischbestände, wie die des Marmorbarsches (*Notothenia rossii*), bereits überfischt waren.

1982 trat das "Übereinkommen zum Schutz der lebenden Meeresschätze der Antarktis (CCAMLR)" in Kraft, deren Gründungsmitglied Deutschland war. Eine der Bedingungen für die Mitgliedschaft in CCAMLR ist die regelmäßige Lieferung von Forschungsbeiträgen aus dem Konventionsgebiet. Diese Forschung leistet das Institut für Seefischerei der Bundesforschungsanstalt für Fischerei (BFA Fisch). Seit Gründung der CCAMLR "Working Group on Fish Stock Assessment" 1985 konzentrierten sich die Arbeiten des Instituts auf Analysen der Bestandsstärken und des Befischungszustandes kommerziell genutzter antarktischer Fischbestände, wie Bändereisfisch (*Champscephalus gunnari*), Scotia See Eisfisch (*Chaenocephalus aceratus*) oder Gelbe Notothenia (*Gobionotothen gibberifrons*). Da RV *Polarstern* der BFA Fisch nur alle 4 – 5 Jahre zur Verfügung steht, arbeitete sie mit Nationen, wie Großbritannien und den USA, zusammen, um die Lücken in der Zeiterfolge nicht zu groß werden zu lassen.

Die kommerzielle Fischerei südlich von 60°S war insbesondere zwischen 1977/78 und 1980/81 mit Fängen zwischen 50 000 und 140 000 Tonnen (in erster Linie Bändereisfisch) ertragreich. Danach brachen die Fänge ein, weil die Bestände überfischt waren. Die Daten und Analysen Deutschlands trugen wesentlich dazu bei, dass CCAMLR die Fischerei auf antarktische Fische im westlichen Teil des Atlantischen Sektors südlich von 60°S (Untergebiet 48.1 und 48.2) nach der Saison 1989/90 einstellte, um den Fischbeständen die Möglichkeit der Erholung zu geben. Deutschland führte seit 1996 mit der RV *Polarstern* und in Zusammenarbeit mit den amerikanischen Kooperationspartnern vom Southwest Fisheries Science Centre in La Jolla (Kalifornien) regelmäßige Surveys um die *South Orkney Islands* und *Elephant Island* und die *South Shetland Islands* durch. Die Ergebnisse dieser Surveys werden dann auf der folgenden Jahrestagung vorgelegt, um zu dokumentieren, ob und in welchem Umfang sich die Bestände von den Einwirkungen der Fischerei erholt haben. Die letzten Surveys wurden 2002 mit der RV *Polarstern* und 2003 in Zusammenarbeit mit den amerikanischen Kooperationspartnern mit dem gecharterten russischen Forschungsschiff *Yuzhmorgeologiya* durchgeführt. 2006 wurde zum ersten Male der Schelf der westlichen Spitze der Antarktischen Halbinsel untersucht, auf dem das FS *Polarstern* im Februar 2002 für einen Tag gefischt hatte, um Vergleichsmaterial zu sammeln. Die Surveys zeigten, dass sich die Bestände von Beifangarten, wie Gelber *Notothenia* oder Scotia See Eisfisch von den Einwirkungen der Fischerei gut erholt haben, während die Bestände an Bändereisfisch kaum größer sind als bei Einstellen der kommerziellen Fischerei 1990.

Einen der beiden Forschungsschwerpunkte während ANT-XXIII/8 bildet ein weiterer Grundschleppnetzsurvey um *Elephant Island*, die *South Shetland Islands* und *Joinville Island*, der die intensiven Untersuchungen der USA und Deutschlands in dem Untergebiet 48.1 fortsetzt. Der Survey wird Einblick in die Zusammensetzung und Veränderungen der Fischfaunen um die drei Inselgruppen aufgrund anthropogener und natürlicher Veränderungen geben, biologische Daten aus dem Übergang Frühjahr – Sommer sammeln, die bisher kaum vorliegen, Proben für Bestandstrennungen und Schadstoffuntersuchungen erheben, und es ermöglichen, die Bestandsstärken der häufigsten Fischbestände abzuschätzen. Eine Box (7 x 10 sm) westlich von *Elephant Island*, wird, wie im Februar 2002, dazu dienen, die mesoskalige Verbreitung und Abundanz häufiger antarktischer Fischarten, wie Gelber *Notothenia* und Bändereisfisch, zu dokumentieren.

Evolution und Lebensvielfalt in der Antarktis (EBA), Bestandsaufnahme der antarktischen Meeresorganismen (CAML)

Schelfeisgebiete bedecken in der Antarktis ungefähr 1/3 des Kontinentalsockels. Wegen der schwierigen Bedingungen, einen solchen für die Antarktis typischen marinen Lebensraum zu untersuchen, gibt es erst ganz wenige sporadische Ergebnisse. Diese zeigen, dass dort

deutlich andere Verhältnisse als in "normalen" Schelfgebieten der hohen Antarktis, z.B. im östlichen Weddellmeer oder im Rossmeer herrschen. Durch eine großräumige regionale atmosphärische Erwärmung sind in den vergangenen 15 Jahren an der Ostküste der Antarktischen Halbinsel die beiden Schelfeisgebiete Larsen A und B mit einer Gesamtfläche von insgesamt ca. 80 x 80 km komplett weggebrochen. Dieses Gebiet stellt daher eine einmalige Gelegenheit dar, einen "weißen Fleck" in der antarktischen Biodiversitäts- und Ökosystemforschung zu bearbeiten und Grundlage für Prognosen im Falle weitergehender Umweltveränderungen zu erstellen. Die Ergebnisse werden auch dazu beitragen, bisher noch gar nicht richtig verstandene ökologische Funktionsweisen durch vergleichende Forschungsansätze mit dem Leben auf dem "normalen" Schelf aufzuklären. Im Vordergrund stehen dabei zwei klimasensible typisch polare Faktoren, die das Leben am Meeresboden prinzipiell erheblich strukturieren und limitieren: die vom Schelfeis bzw. Eisbergen ausgehenden mechanischen Störungen mit danach eintretender Wiederbesiedlung und die Rolle der durch Schelf- und Meereis sowie Strömung kontrollierte Nahrungsverfügbarkeit für das Benthos. Die Vorhaben gliedern sich in folgende Aspekte:

1. Bisher unbekannte Lebensgemeinschaften unter dem ehemaligen Schelfeis, die es wahrscheinlich wegen ihrer langsamen Entwicklung noch in einem weitgehend ursprünglichen Zustand gibt, sollen beprobt und analysiert werden. Dies schließt Untersuchungen an ökologisch relevanten physikalischen Schlüssel-Parametern (Geochemie, Sedimentologie, Hydrodynamik, Bathymetrie) zur Aufklärung spezifischer Anpassungen, insbesondere auch zur Strömung und damit zur Nahrungszufuhr ein.
2. Es soll festgestellt werden, ob durch das Wegbrechen des Schelfeises und weitergehender Folgen in der physikalischen Umgebung bereits eine nachhaltige Verschiebung der Lebensvielfalt eingesetzt hat. Es ist ebenfalls zu untersuchen, ob während des Wegbrechens kurzfristige mechanische Störungen durch hohe Frequenz von Eisbergstrandungen erfolgten.
3. In zuvor von aufliegendem Schelfeis gekennzeichneten und damit über Jahrhunderte nicht für die Besiedlung zur Verfügung gestandenen Gebieten sollen erste Besiedlungsstadien in einem völlig neuen und einzigartigen Lebensraum untersucht werden. Solche Areale im Bereich der "Grounding-Line" sollen mit Hilfe der bildgebenden Methoden und der Bathymetrie aufgespürt werden.
4. Modellierungsansätze sollen Prognosen ermöglichen, die klimabedingte Verschiebungen in der Biodiversität von einem durch Eis geprägten Ökosystem hin zu Lebensgemeinschaften des offenen Wassers simulieren.

Mit diesen Fragestellungen wird ANT-XXIII/8 einen wesentlichen Beitrag zu dem Projekt "Census of Antarctic Marine Life" als Teil des biologischen SCAR-Programmes "Evolution and biodiversity in the Antarctic" liefern mit dem Ziel:

"...will investigate the distribution and abundance of Antarctica's marine biodiversity, how it is affected by climate change, and how change will alter the nature of the ecosystem services currently provided by the Southern Ocean for the benefit of humankind."

Untersuchungen in dem Larsen-A/B-Gebiet durch eine U.S. amerikanische Arbeitsgruppe haben erste Erkenntnisse über Voraussetzungen für das dortige Leben am Meeresboden unter ganz besonderen Bedingungen erbracht. Die Bodentopographie zeigt in wenigen

ausgewählten Arealen eine heterogene Struktur. Es gibt nahe der ehemaligen "Grounding-Line" für das Weddellmeer ungewöhnlich flache Gebiete. In diesem Punkt ähnelt das Untersuchungsgebiet eher der Westküste der Antarktischen Halbinsel. Gräben im Schelf deuten auf ein komplexes Strömungsregime hin, das Unterschiede in der Nahrungszufuhr erwarten lässt. Untersuchungen im Sediment vermitteln Hinweise darauf, dass es im Larsen-A-Gebiet schon immer einen erheblichen Eintrag von organischem Material gegeben hat. Unter Larsen-B-müssen in den vergangenen ca. 5000 Jahren hingegen sehr nahrungsarme Verhältnisse geherrscht haben. Dieser regionale Unterschied kann auch auf die südlich diesem Gebiet vorgelagerte große Fläche mit permanentem Meereis zurückzuführen sein. Erstmals für die Antarktis ist auch eine möglicherweise vom Sonnenlicht und damit von pflanzlichem Leben unabhängige Bakteriengemeinschaft gefunden worden.

Um dem oben beschriebenen Fragenkomplex gerecht zu werden, wird eine synoptische Erfassung der verschiedenen Ökosystemkomponenten von Mikroben bis zu Walen angestrebt. Bei günstigen Meereiskonditionen sollen mehrere Transekte die Heterogenität im Flachen erfassen, die Tiefenabhängigkeit der Artenassoziationen beschreiben und einen Gradienten von einem Gebiet, das bisher weit unter dem Schelfeis lag, hin zum offenen Wasser beschreiben. Vergleichende Untersuchungen zwischen dem Larsen-A- und dem Larsen-B-Gebiet sollen klären, inwieweit die oben beschriebenen Unterschiede in der langfristigen Sedimentation auch die Makrofauna, ihre trophischen Interaktionen und Anpassungen beeinflusst haben. Im Rahmen der Evolutionsforschung ist zu prüfen, ob die Habitafraktionierung auch genetisch zur Heterogenität und Lebensvielfalt in der Antarktis beigetragen hat. Der Bedeutung des Schelfeises und auch der Meereisbedeckung für entsprechende lang- und kurzfristige Entwicklungen im Benthos soll durch Vergleiche mit dem selektiv zu beprobenden Gebiet westlich und an der Spitze der Halbinsel aufgeklärt werden. Die gründlichen ökologischen und faunistischen Ergebnisse der Vergangenheit aus dem östlichen Weddellmeer erlauben durch einen entsprechenden Vergleich eine viel versprechende Identifikation weiterer ökologischer Schlüsselprozesse. Die einzelnen zu untersuchenden Ökosystemkomponenten sind:

- a) das von Mikroorganismen, über die Meio- bis zur Makrofauna reichende Leben im Sediment, einschließlich biogeochemischer Parameter; spezifisches Augenmerk verdient hier ein möglicher Schlammvulkan mit einer ganz eigenen, auf Bakterien aufbauenden biologisch-trophischen Struktur.
- b) die Beschreibung ökologisch relevanter Umweltfaktoren in Meeresbodennähe, z.B. Mikrotopographie sowie Strömungsintensität und -richtung,
- c) die Makrofauna auf dem Sediment sowie die demersalen Fische in ihrer Struktur, Entwicklung, physiologischen Anpassung und biologischen Wechselwirkungen,
- d) die Kopplung zwischen Prozessen in der Wassersäule und am Meeresboden sowie
- e) die Abhängigkeit der Warmblüter, insbesondere der Wale, von den großräumig unterschiedlichen Lebensbedingungen im Gebiet westlich und östlich der Antarktischen Halbinsel.

Für die meisten der entsprechenden Untersuchungen werden auf ausgewählten Stationen alle Standard-Geräte nacheinander eingesetzt, um das Zusammenspiel der verschiedenen Ökosystemkomponenten besonders gut zu erfassen und damit zu einem guten

synökologischen Verständnis beizutragen. Hierzu gehören verschiedene Greifer zur Beprobung der Sedimente mit der darin lebenden Fauna und Mikroorganismen, geschleppte Geräte und Reusen für Untersuchungen an der Makrofauna, Verankerungen zur Erfassung des Partikelflusses und der Strömung, CTD-Sonde mit Wasserschöpferrosette und nicht-invasive bildgebende Methoden (Unterwasserfotografie und –video) mit Hilfe eines für kleine Sedimentprobennahme ausgerüsteten ferngesteuerten Unterwasserfahrzeugs (ROV), das vorrangig der hochauflösenden Beschreibung epibenthischer Strukturen und Biodiversität dient. Im Untersuchungsgebiet bereits liegende Verankerungen des U.S.-amerikanischen Teams sollen eingeholt und wieder ausgebracht werden. Ein genaues Probennahmedesign kann erst beim Erreichen des Untersuchungsgebietes auf der Grundlage der dann vorherrschenden Meereisbedeckung beschlossen werden. Entsprechende theoretische Konzepte zur Optimierung der Probennahme werden bereits vorher entwickelt und müssen dann nur noch in die Praxis umgesetzt werden. Um die Bedeutung der ehemaligen Eisbedeckung für die Fauna gründlich erfassen zu können und den Unterschied zu anderen antarktischen Ökosystemen herausarbeiten zu können, sind vergleichende Untersuchungen im Bereich der South Shetland Inseln nötig. Diese werden parallel zu den fischereibiologischen Aktivitäten im Rahmen von CCAMLR durchgeführt.

Für den Fall, dass durch starke Meereisbedeckung das Larsen -A/B-Gebiet nicht erreicht wird, stehen Alternativen bereit. Eine Entscheidung wird erst an Bord auf der Grundlage der dann an der Antarktischen Halbinsel vorliegenden Eisverhältnisse getroffen. Wenn ein größeres exponiertes Schelfgebiet um *Joinville Island* an der Spitze der Antarktischen Halbinsel gute Arbeitsbedingungen zulässt, kann hier an Stelle des Einflusses des Schelfeises der Einfluss des permanenten Meereises in Kombination mit dem großräumigen Weddellwirbel auf ökologische Prozesse und biologische Strukturen am Meeresboden durchgeführt werden. Vergleichende Untersuchungen sollen in dem Gebiet um die *South Shetlands* und dem südöstlich angrenzenden Schelf des Festlandes, durchgeführt werden, weil die dortigen benthischen Systeme im Gegensatz zum Larsen-A/B-Gebiet und dem Schelf östlich und südlich von *Joinville Island* ozeanographisch überwiegend durch die Hydrodynamik des pazifischen Sektors beeinflusst werden.

Diese Vorhaben stellen in ihrer Auswertungsphase einen wesentlichen Beitrag zu dem nach Ende der Expedition beginnenden Internationalen Polarjahr (IPY), insbesondere auch deshalb, weil sie in dessen beide Kernprojekte "Census of Antarctic Marine Life" und "Evolution and Biodiversity in the Antarctic" eingebettet sind.

Aus dem IPY-Programm:

"The three fastest warming regions on the planet in the last two decades have been Alaska, Siberia and parts of the Antarctic Peninsula. Thus the Polar Regions are highly sensitive to climate change and this raises real concern for the future of polar ecosystems and Arctic society."

ITINERARY AND SUMMARY

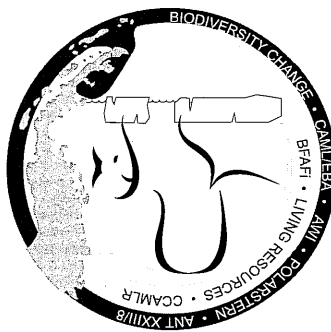
Leg 8 of expedition ANT-XXIII of the RV *Polarstern* serves the purpose of two scientific investigations. It will contribute substantially to international research projects.

1. Biological investigations on fish stocks west of the Antarctic Peninsula, around Elephant Island, South Shetland Islands and off Joinville Island to analyse age distribution, and to assess stock size. Contributes to:

Convention on the Conservation of Antarctic Marine Living Resources (**CCAMLR**)

2. Ecosystem research in the former Larsen A/B ice shelf area east of the Antarctic Peninsula to investigate changes in biodiversity as a consequence of the climate-induced collapse of the ice shelf and to examine principles of ecological functioning in the marine environment. Contributes to:

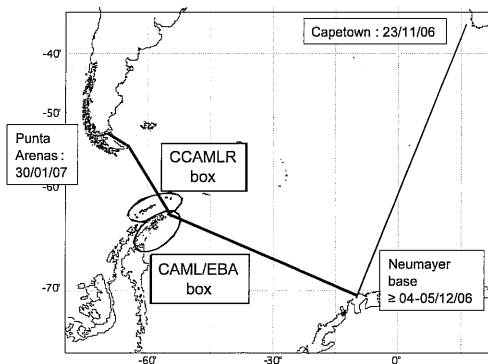
Evolution and Biodiversity in the Antarctic & Census of Antarctic Marine Life (**EBA & CAML**)



After leaving Cape Town RV *Polarstern* is heading towards Atka Bay in the eastern Weddell Sea to supply the Neumayer Station probably on 4 - 5 December. Even under most fortunate sea ice and weather conditions the Antarctic Peninsula, the area of investigation, is not scheduled before 14 December (Fig. 1).

Abb. 1.1: Fahrtverlauf von FS *Polarstern*

Fig. 1.1: Cruise track of RV *Polarstern*



At first investigations on the living resources west of the Antarctic Peninsula (CCAML) shall be accomplished. As scientific bottom trawl survey is completed during the day less human-resource demanding devices can be employed during night time to further examine other groups of organisms. Subsequent ecological work in the former Larsen A/B ice shelf area (EBA/CAML) is scheduled for the same length of time. Should favourable conditions allow for some bottom-trawls in this area this opportunity will be fully exploited. In case sea ice cover around the former Larsen A/B ice shelf area is impenetrable an alternative area around Joinville Island will be used instead (Fig. 2).

All scientific work will be finished by 26 January 2007 at the latest to arrive in Punta Arenas on 30 January. This will be the end of leg 8 of expedition ANT-XXIII.

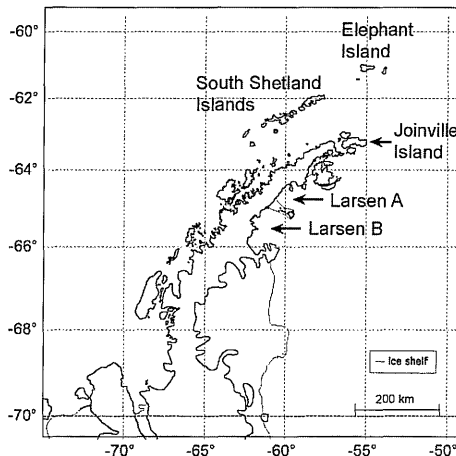


Abb. 1.2: Untersuchungsgebiete
Fig. 1.2: areas of investigation

Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)

German studies on Antarctic fish began with the first German Antarctic Expedition in 1975/76. In the late 1970's, results of these investigations were provided to the SCAR 'Working Group on Antarctic Fish Biology' (later Ecology) which were the first to assess exploited Antarctic fish stocks in 1980. Antarctic fish stocks have been exploited in the northern part of the Southern Ocean from the late 1960's onwards and in its southern part from 1977/78 onwards. Although crude, these assessments suggested that most stocks of species, such as marbled notothenia (*Notothenia rossii*), were already overexploited.

The 'Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)' came into force in 1982. Germany was one of the first signatory states. One of the prerequisites of membership to the convention is a regular contribution in terms of research. Since the creation of the CCAMLR 'Working Group on Fish Stock Assessment' in 1985 Antarctic fish research in Germany is focussing on fish stock assessment and the state of stocks, such as mackerel icefish (*Champsocephalus gunnari*), Scotia Sea icefish (*Chaenocephalus aceratus*) and green Notothenia (*Gobionotothen gibberifrons*). The

German research vessel RV *Polarstern* is available to the Federal Research Centre for Fisheries (BFA Fisch) only once every 4 – 5 years. The centre was therefore cooperating with international partners, such as British Antarctic Survey in Cambridge/UK and Southwest Fisheries Science Centre in La Jolla/USA to conduct surveys more often to reduce the size of time gaps in the series of surveys.

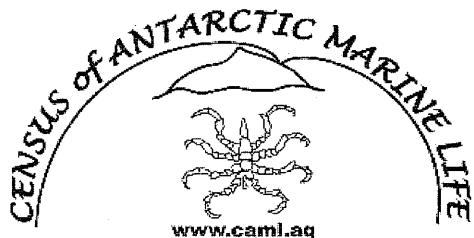
Commercial fisheries south of 60°S were lucrative from 1977/78 to 1980/81. Catches taken were in the order of 50,000 to 140,000 tones and consisted primarily of mackerel icefish. Catches tended to be low thereafter when stocks were overexploited. Partly due to the analysis of data from German surveys CCAMLR was able to bring commercial harvesting in the western part of the Atlantic Ocean sector (Subareas 48.1. & 48.2.) to an end after the 1989/90 season and provided stocks with an opportunity to recover.

Germany has conducted surveys south of 60°S since 1998 in cooperation with the Southwest Fisheries Science Centre in La Jolla (USA). The research vessels used were either the RV *Polarstern* or the chartered Russian research vessel *Yuzhmorgeologiya*. Results from these surveys are being provided to the CCAMLR 'Working Group on Fish Stock Assessment' within 6 – 7 months after completion of the survey in order to document if and to what extent stocks have recovered from (over) exploitation and to supplement biological information collected previously. Results from surveys until 2003 (the last year a survey was conducted) demonstrated that by – catch species, such as green notothenia or Scotia Sea icefish have recovered from exploitation while the target species of the fishery, mackerel icefish, show little signs of a recovery.

One of the two main topics of the research programme conducted during ANT-XXIII/8 is a bottom trawl survey around Elephant Island, the South Shetland Islands and off Joinville Island at the tip of the Antarctic Peninsula. The survey will provide insight in the composition of the demersal fish fauna around the three island groups, enable us to collect additional biological information relatively early in the season and to assess stock size of the most abundant fish species, and provide samples to be used for stock discrimination and pollutant levels.

Evolution and Biodiversity in the Antarctic & Census of Antarctic Marine Life (EBA/CAML)

Ice shelf covers roughly one third of the continental shelf of Antarctica. Due to difficulties for scientists to conduct research in such marine environments, even though these conditions are typical for Antarctic marine life, only sparse data exist. These data reveal that conditions around the Antarctic Peninsula differ distinctly from those found in "normal" ice shelf areas in the high Antarctic, e.g. eastern Weddell Sea or Ross Sea. Regional atmospheric



warming over the past 15 years has led to the total collapse of two ice shelves, Larsen A and B with a total area of 80 x 80 km, east of the Antarctic Peninsula. This area offers a unique opportunity to investigate a "white spot" of Antarctic biodiversity and ecosystem research, thereby providing a basis for prognoses for further environmental changes. The results obtained from this cruise will also contribute to a better understanding of the ecological functioning using comparative scientific approaches. For example could functions observed on the "normal" continental shelf explain ecological functions elsewhere which are still insufficiently understood to this date. Two climate-sensitive, typical polar factors are of particular importance in structuring and limiting benthic life substantially: ice shelf or iceberg induced mechanical disturbance with subsequent recolonization and the role of food availability for benthic organisms controlled by currents as well as ice shelves and sea ice. The investigations can be split into the following aspects:

1. To date unknown communities under former ice shelf areas, which due to slow biological development are still in more or less pristine conditions will be sampled and analysed. This includes the investigation of ecological relevant key parameters such as geochemistry, sedimentology, hydrodynamics, and bathymetry to determine specific adaptations, especially in respect to current regime and its consequential food regime.
2. To determine whether a shift in diversity has already started due to the collapse of the ice shelf. Furthermore, examining the effects of mechanical disturbances by the Larsen A/B ice shelves during their collapse mediated by high frequency of iceberg groundings.
3. To investigate first colonization stages in a completely new and unique environment which has not been available for centuries as a substrate to marine organisms prior to the ice shelf collapse. Such areas close to the grounding line will be investigated using underwater photography and underwater videography as well as sonar devices.
4. Modelling will enable prognoses on how climate-induced shifts in biodiversity will change in ecosystems structured largely by ice as well as communities dependent on primary production in the open sea.

Under these consideration ANT-XXIII/8 will provide a major contribution to the project "Census of Antarctic Marine Life" as a part of the biological SCAR programme "Evolution and Biodiversity in the Antarctic" with the following aim:

"...will investigate the distribution and abundance of Antarctica's marine biodiversity, how it is affected by climate change, and how change will alter the nature of the ecosystem services currently provided by the Southern Ocean for the benefit of humankind."

Investigations by US scientists in the former Larsen A/B area have shown the first results on prerequisites for life on this newly available seafloor. Seafloor topography is heterogeneous in a few chosen areas. Close to the grounding line areas of for the Weddell Sea unusually shallow have been found. Considering this feature there is a rather close resemblance to the west coast of the Antarctic Peninsula. Trenches on the continental shelf hint at a very complex current regime which leads to speculations of different food supply regimes. Examinations of the sediment showed that there has been always a substantial input of organic material below the Larsen A ice shelf. In contrast, below the Larsen B ice shelf very poor food conditions prevailed for the past 5,000 years. These regional differences can also be attributed to the large permanently sea ice covered area due south. For the first time an

assumed sunlight and photosynthesis independent bacterial community has been discovered in the area of investigation.

To accommodate the complexity of the questions raised above a synoptic acquisition of the several ecosystem components from microbes to whales will be approached. Depending on favourable sea ice conditions we will measure the heterogeneity in the shallows on several transects. It consists of the depth-dependence of species associations as well as of gradients from an area formerly covered by the ice shelf to the open sea. It is hoped that comparing of the former Larsen A and B ice shelf areas will help explain how differences in long-term sedimentation impacted macrofauna, their trophic interactions and adaptations. From an evolutionary point of view it is to test whether habitat fragmentation has led to genetic heterogeneity and therefore increased biodiversity in Antarctica. The role of ice shelves as well as sea ice cover in long-term and short-term development in benthic communities will be investigated by comparing selected sample sites west of the Antarctic Peninsula as well as the tip of the Antarctic Peninsula. High-quality results from the past of the eastern Weddell Sea allow for a comparison of ecological and faunistic data that promise identification of key ecological processes. Specific ecosystem components to investigate are:

- a) Life in the sediment ranging from microorganisms, over meiofauna to macrofauna, including biogeochemical parameters; particular attention should be paid to a possible mud volcano with its own bacteria-based biological trophic structure.
- b) Report of ecologically relevant environmental factors of the seafloor and its proximity, e.g. micro-topography, current intensity and direction,
- c) benthic macro-epifauna structure as well as associated demersal fish, development, physiological adaptation, and biological interactions,
- d) benthopelagic coupling,
- e) dependence of warm blooded animals, especially whales, on large-scale differences in environmental conditions between areas east and west of the Antarctic Peninsula.

For most investigations all standard measuring or sampling devices will be deployed successively at each predefined station in order to best acquire interactions between specific ecosystem components which will serve a better synecological understanding. Sampling devices are comprised of different grab-samplers to sample sediments including its inhabitants (infauna and microorganisms), towed devices (trawls) to investigate macrofauna, anchored/moored traps and sensors to measure particle flux and currents respectively, CTD with rosette water sampler, and non-invasive underwater photography and videography using a remotely operated vehicle (ROV) with a small sediment sampling facility, which will be primarily used to record high-resolution epibenthic structures and biodiversity. US American moorings/buoys deployed in the investigation area will be recovered and redeployed. A decision on a precise sampling design will only be possible after arrival in the investigation area and adjustments accounting for sea ice cover. Corresponding theoretical concepts for sampling optimization have been developed prior to the cruise and it will be a matter of putting theory into practise. In order to measure the impact of former ice cover on fauna adequately and to distinguish them from other Antarctic ecosystems comparative investigations around the South Shetland Islands will be necessary. These investigations will run parallel to fisheries research activities within the framework of CCAMLR.

If in the unfortunate event of impenetrable sea ice cover access to the former Larsen A/B ice shelf area is denied there will be alternative areas of investigation. A final decision will be made on board the RV *Polarstern* based on ice conditions around the Antarctic Peninsula. Provided an exposed (ice-free) continental shelf area of sufficient size around Joinville an investigation of the impact of permanent sea ice in combination with the large-scale Weddell gyre on ecological processes and biological structures on the seafloor could be conducted. Comparative investigations around the South Shetland Islands and the adjacent continental shelf area due southeast are desirable as these benthic systems in contrast to the former Larsen A/B ice shelf areas and the areas due east and south off Joinville Island are in oceanographic terms largely affected by the hydrodynamics of the Pacific.

These projects comprise a substantial contribution to the International Polar Year 2007-2008 particularly with regards to the expedition's implementation into the two core projects "Census of Antarctic Marine Life" and "Evolution and Biodiversity in the Antarctic". From the IPY-Programme:

"The three fastest warming regions on the planet in the last two decades have been Alaska, Siberia and parts of the Antarctic Peninsula, Thus the Polar Regions are highly sensitive to climate change and this raises real concern for the future of polar ecosystems and Arctic society."

2. OUTREACH PROGRAMME

G. Chapelle (IPF)

Objectives

As a main contributor to CAML, the RV *Polarstern* expedition to the Larsen A/B ice shelf areas will be a major event to open and illustrate the International Polar Year 2007-2008. Antarctica wilderness is almost completely marine based and has a clear attractiveness within the international public opinion, both in the Northern and Southern hemispheres. Furthermore, as the first expedition focuses on the biological impacts of the Larsen ice shelves' collapse, it offers a remarkable opportunity to demonstrate the link between climate change and its impact on Antarctic biodiversity.

Meanwhile, the CCAMLR component of the cruise will show the importance of mid to long term monitoring to determine the appropriate conservation measures. It is to take advantage of this set of circumstances that the AWI and CAML have asked the Cousteau Society and the IPF to develop an outreach programme to establish a powerful link between the scientists onboard and the general public. Besides reflecting the work of an international team at sea – more than 13 countries from 3 continents are represented – the programme has a wider aim of helping raising the level of perceptions and attitudes around the value and the use of this world's last unspoiled wilderness for the heritage of the future generations.

Work at sea

To ensure a high media exposure, G. Chapelle will be the outreach liaison officer onboard. Pictures and written material such as weekly reports and interviews will be sent to the two scientific journalists on land, so that up to date information remains available for the partnered international newspapers, magazines and information web sites. He will also be available for opportunistic phone calls from journalists during the expedition.

ROV sequences and video footages will be filmed and edited onboard for subsequent use by international TV channels. Together with pictures, a 30 minutes report on the expedition will be included in a travelling bipolar exhibition during IPY, starting its tour in the prestigious City Hall of Paris. A dedicated part will be named "Marine Life in Antarctica", reflecting the CAML vision and work and the contribution of the RV *Polarstern* mission.

3. LIVING RESOURCES (CCAMLR) AND RELATED TOPICS

3.1 INVESTIGATING THE DEMERSAL FISH FAUNA

K.-H. Kock (BFAFi), L. Pshenichnov (LSOB), D. Pietschok (BFAFi), S. Schöling (BFA), M. Holst (BFAFi, UOL)

Objectives

Previous German surveys to the area:

- Elephant Island in 1976, 1978, 1981, 1983, 1985 – 87, 1996 and 1998, 2001, 2002 and 2003,
- The South Shetland Islands in 1978, 1998, 2001, 2002 and 2003, and
- Joinville Island/tip of the Antarctic Peninsula in 2002 and 2006

The main objectives covered by the bottom trawl survey are:

- Distribution and abundance of fish species around Elephant Island,
- Population (stock) structure of the most abundant fish species,
- Food and feeding of demersal fish species, in particular icefish species,
- Reproductive characteristics of selected fish species, such as spiny icefish (*Chaenodraco wilsoni*).

All objectives form part of a long-term study of the Federal Research Centre for Fisheries.

Work at sea

85–90 net tows will be conducted around Elephant Island, the South Shetland Islands, off Joinville Island and in a box west of Elephant Island in the course of the cruise (Fig. 1 and 2). The trawl used will be the 140' bottom trawl deployed during previous RV *Polarstern* surveys since 1983. The trawl is of commercial size and has a wing spread of 17– 19 m and a net height of 3.0–3.5 m.

The depth range fished will be 50–500 m. Trawl stations are selected according to a 'stratified random sampling scheme'. The distribution of stations over the shelf is provided in figure 1. A box (7 x 10 nm) west of Elephant Island covering the depth range of 100–300 m and already established in February 2002 will be re-worked again and enable us to study the mesoscale distribution of abundant fish species, such as mackerel icefish and yellow notothenia (Fig. 2). Towing time will be 30 minutes on the bottom. The catch will be processed either completely if the catch does not exceed 300 kg. From larger catches, representative subsamples will be taken of each species. Fish will be processed according to the standard methods recommended for CCAMLR members.

3.2 NATURAL AND ANTHROPOGENIC CHANGES IN ANTARCTIC ECOSYSTEMS

M. Umani (UNISI)

Objectives

The general objectives are to identify and study key organisms and specific processes sensitive to subtle environmental changes in Antarctica, to detect the effects of human impacts, and to evaluate the occurrence of stress in Antarctic organisms. Specific objectives are to evaluate organic matter/energy flows and xenobiotic contaminant residue in tissues along the marine trophic webs. Moreover, the toxic potential of dioxin-like substances will be evaluated. The presence of emerging persistent organic pollutants will also be investigated.

Work at sea

(1) fishing using a WP2 plankton net, 200µm mesh size to collect mesozooplankton; (2) use of the box-corer to collect filter-feeders, benthic bivalves and other invertebrates (Molluscs, such as *Adamussium* sp., *Yoldia* sp., *Neobuccinum* sp. and *Limatula* sp.); (3) catching of small zooplanktivorous fishes and larger predatory fishes using a pelagic trawl (hopefully including *Trematomus* sp., *Electrona* sp., *Gymnoscopelus nicholsi*); (4) if possible, collection of sediment at each/most sampling point(s). (5) All samples have to be stored at -20° C. Mesozooplankton should be maintained in 4-6 % buffered formalin for taxonomic analysis. Some sample of *Trematomus* sp. should be kept at -80° C, in order to preserve DNA structure.

3.3 EVOLUTION OF ANTARCTIC NOTHOTHENIOID FISH

K. Janko (IAPG)

Objectives

The Institute of Animal Physiology and Genetics (Libechov, Czech Republic) has been involved in the research on evolutionary history of Antarctic fish for about three years. The research is motivated by the discovery of the radiation within the suborder Notothenioidei during Eocene-Oligocene drop of sea-water temperatures. In the recent past, two additional bursts of speciation events within the suborder gave rise to the groups Trematominae and Channichthyidae. Both are ideal models for studies of speciation due to their geographical isolation, ecological diversification, and fast radiation, which makes them to fit into the definition of species-flock. We are interested in macro- as well as microevolutionary events during the evolution of both groups. Reconstruction of their multilocus phylogeny is aimed to better understand the relations among the species, which have so far been reconstructed only by mitochondrial markers, but also to date the cladogenetic events with higher precision. Population genetics and phylogeographic analysis of selected species representing both benthic as well as pelagic forms shall help us to understand the roles of historical climatic changes and contemporary barriers to the gene-flow in shaping their genetic structures. Such knowledge is important in assessing the role of isolation mechanisms in the microevolution and may ultimately offer an answer on the speciation mechanisms within both groups. In particular, we hope to distinguish among the sympatric vs. allopatric speciation modes.

Work at sea

We shall profit from the specimens caught during the bottom trawl survey around Elephant Island, the South Shetland Islands and off Joinville Island. Identified samples shall be preserved in ethanol and transported to the Laboratory of Fish Genetics, where we shall

isolate the genomic DNA, amplify and sequence suitable nuclear and mitochondrial loci, which have been already identified during previous analyses. Since we managed so far to gather the samples from the vicinity of the Ross and Davis Seas, such an extension of our collection shall fill in an important gap in the geographical coverage of this study.

3.4 POPULATION GENETICS OF ANTARCTIC NOTOTHENIOID FISH

E. Bortolotto (UPA)

Objective

The proposed activity continues the work done during ANT-XIX/3 that allowed to obtain population samples for population genetic analyses of several species. During ANT-XIX/3, sample collection for genetics was integrated in the fishing activity performed to monitor stock recovery in the Elephant Island-South Shetland area, and coordinated with collection of otoliths for age assessment. A unique individual identifier was assigned to a sub-sample of the fish collected, thus allowing for the first time to record ancillary information such as sex, length, maturity stage, and age for each fish used in the following genetic analyses. Samples allowed the isolation of microsatellite markers for *Chionodraco rastrispinosus* whose applicability to other species has been tested. Preliminary results for *C. rastrispinosus* evidenced significant genetic differentiation between age classes, underlying the importance to continue this strategy of sample collection. Our preliminary results represent the first evidence for genetic heterogeneity between cohorts in an Antarctic fish species, and could have important management implications.

Work at sea

We propose to mark a consistent amount of individuals, in coordination with Andrea De Felice for otolith sampling through appropriate tagging protocols. Based on sample size, preliminary analyses, and age data availability, target species will be mainly *C. rastrispinosus* and *Chaenocephalus aceratus*. In addition, sample size will be increased for *Notothenia coriiceps*, *Notothenia rossii*, and *Gobionotothen gibberifrons* allowing preliminary population analyses. Furthermore, we expect to collect population samples of the following species: *Lepidonotothen larseni*, *Lepidonotothen squamiformis*, *Pleuragramma antarcticum*, *Pseudochaenichthys georgianus* and *Trematomus eulepidotus* that will be useful for future studies. Finally we anticipate that population samples of *Euphausia superba* will be occasionally collected as by-catch, and will be very useful for ongoing studies at Padova University.

A small slice of muscular tissue including epidermis and scales will be cut from every specimen. The tissue will be stored in RNA later (RNAlater™ Ambion) and stored at -20° C.

3.5 AGE AND GROWTH OF NOTOTHENIOID FISH

A. De Felice (ISMAR-CNR)

Objective

We plan to study age and growth of local fish species. A study focused on age and growth of fish inhabiting the Elephant-South Shetland Islands is of particular interest, as in the same area, both low and high-Antarctic fish species are present. In addition, the shelf around Elephant Island, and in general the South Shetland Islands represented in the recent past important fishing grounds. It is therefore intriguing to study longevity and growth rate of species of different origin, in order to compare different life strategies, and of species previously exploited by the fishery to detect the state of stock recovery. The present proposal is intended as a continuation of a previous study on age and growth of fish carried out in the

same area during the RV Polarstern' cruise ANT-XIX/3. Consequently, the main aim is to acquire data on a multi-annual basis, in order to follow the fish population dynamics and to estimate growth performance in different years.

Work at sea

As regard the field work that will be carried out on board, a set of otoliths will be collected on the whole size range of fish sampled. The otoliths will be stored in vials and put aside. The study of age and growth will be carried out later in Italy, following the preparation methods adopted in other previous works. In order to validate ageing data from adult fish, studies on length composition and daily ring patterns of juveniles will be carried out.

3.6 STUDIES ON EGGS AND OVARIES OF ANTARCTIC FISHES

R. Riehl (HHUD)

Objectives

Electron microscopical studies on the oogenesis of Antarctic fishes were carried out up to now only on light microscopical level and on a few species. A detailed electron microscopical investigation of these events is still lacking. For that reason I will exploit (use) the cruise ANT-XXIII/8 to collect mature eggs and ovary tissue to work out the following aims:

1. The investigation of oogenesis from oogonia to ova by Transmission Electron Microscopy (TEM) on selected species from the families Nototheniidae and Channichthyidae.
2. The formation of the egg envelope (zona radiata) until its full differentiation using TEM, too. Structure and thickness of the zona gives also information on the mode of spawning and therefore some hints on still unknown spawning areas (sites).
3. The analysis of the zona radiata (egg envelope) by cytochemical methods to detect especially the zona radiata externa on attaching substances. The presence or absence of those gives information, whether the spawned eggs are benthic or pelagic.
4. The possible search for some new species and better material (more mature) used for our SEM catalogue on the eggs of Antarctic species.

4. CENSUS OF ANTARCTIC MARINE LIFE & EVOLUTION AND BIODIVERSITY IN THE ANTARCTIC (CAML/EBA) AND RELATED TOPICS

4.1 BENTHIC CLIMATE-INDUCED BIODIVERSITY-SHIFT

J. Gutt (AWI), J. Seiler (UWB, AWI), W. Dimmler (FIELAX), H. Bohlmann (ISITEC), S. Langner (UOL), G. Kohlberg (UBR,AWI)

Objectives

Benthic communities of the deeper Antarctic continental shelf were long considered to be fully adapted to stable environmental conditions. Constant low temperatures, salinity, near-bottom current velocity, and remoteness from physical and biological processes in the upper water column were thought to justify such interpretation. An additional factor is the obvious seasonal food supply including sinking algal blooms after melt of sea ice. Consequently attempts to link large-scale patchiness of benthic communities with differences in food availability have been made. Few studies, typically using visual methods, under ice shelf areas revealed that near-bottom currents are able to widely distribute food particles. This is proof that there is no direct correlation between primary production in the upper water column and benthic utilisation. Scientists have been puzzled about whether type of sediment can explain why at one spot there is a dominance of sessile filter feeders and on another spot there are grazers or burrowing species. This correlation could not be confirmed either. Generally specific adaptations to the poorly sorted sediment allow a large number of species to widely disperse. Only on distinct substrates, e.g. pure muds in sheltered bays or rocks in the shallow dominant growth of certain species is favoured. But if these two factors combined cannot explain benthic patchiness one question remains: What can?

In recent years scientists attributed unexpected dynamics in Antarctic benthic communities to iceberg groundings and scouring. On one hand iceberg scouring destroys fauna on a small scale but on the other hand subsequent recolonization results in habitat fragmentation with concomitant increase in biodiversity. An investigation of food availability and its impact on benthic assemblages will test the following hypothesis: unpredictable food supply after the annual algal bloom made especially adult filter feeders less susceptible to the highly variable food supply. On the contrary newly settled juveniles may have far more specific demands on their environment. If these needs are not sufficiently met it will lead inevitably to the demise of the organism. After surviving this critical stage demands are lessened and adults can quite comfortably lead a hungry existence. In such low-density assemblages the absence of other organisms with similar feeding strategies is rather striking. Particularly rich communities develop where there are favourable conditions for the juvenile stage. Predators and scavengers as well as some bacteria are even less coupled to algal blooms.

Furthermore, in conjunction with objectives mentioned above an investigation of the impact of the collapse of Larsen A and Larsen B ice shelf and its subsequent change in biodiversity on the seafloor is planned.

Work at sea

The remotely operated vehicle (ROV) Cherokee and an underwater camera will be deployed in combination with traditional sampling devices. Video footage provides spatially continuous data dedicated to analyse mesoscale patterns, which are created by disturbance events and

subsequent recolonization. In theory locating the grounding line should be possible using the ROV. Landwards of this line the substrate would have been available for colonization only after the event of collapse. Going in the opposite direction of this line a change in diversity is most likely. Transects using underwater videography will be roughly 1 km in length and ideally approach a straight line. There are circa 20 casts (deployments) planned. Exact positioning during operation will be accomplished by the underwater acoustic positioning system POSIDONIA. The deployment of the ROV has been possible due to collaboration between University of Bremen (RCOM) and the Alfred-Wegener-Institute. It will also be used to investigate a possible cold seep with bacterial mats on the sediment surface. The underwater camera is able to take high-resolution photographs which enable later species identification. This technique is particularly suited for research on biodiversity. It is aimed to take about 70 pictures per station in order to have a large enough sample size to compare with older photographs (<http://www.pangaea.de>) from the eastern Weddell Sea.

4.2 BENTHIC-PELAGIC COUPLING IN POORLY KNOWN ENVIRONMENTS

E. Isla, I. Fiolrillo, L.A. Saez, E. Sañe (ICM-CSIC), P. López-Gonzales (US)

Objectives

The environmental differences at the sea surface and close to the seabed inspire questions about how pelagic and benthic ecosystems work and connect between each other, especially where seasonality is intense in the upper layers of the water column and more constant in the benthic realm. Previous studies on the high-latitude Weddell Sea continental shelf have shown that the particles exported from the sea ice and the water column settle onto the seabed and constitute a reservoir of nutritive sediment or "food bank" (also described as "green mats"), which fuels the benthic fauna even during the dark winter. Lipids have been identified as an important link in this trophic chain; however, their trajectory throughout this path has not been fully tracked and it may provide important information on the velocity and intensity of the pelagic-benthic coupling.

The interdisciplinary ICM/US group has the aim of assembling several compartments of the pelagic and benthic systems by combining information from climate, sea ice, settling particulate matter (e.g., plankton detritus, lithogenic debris), chemical and physical characteristics of the water (e.g., dissolved nutrients, S‰ (salinity), temperature, current velocity and direction, turbidity), and sediment columns (e.g., grain size, organic contents) and benthic fauna studies. The idea is to produce a comprehensive benthic-pelagic coupling interpretation of a poorly known ecosystem such as the recently opened area beneath the former Larsen A and B ice shelves. Special interest will be given to the biochemistry of particles collected from sea ice, the water and sediment columns as tracers of pelagic-benthic coupling paths complemented with ^{14}C analyses.

Work at sea

Sea ice and iceberg ice will be collected whenever possible. Total and organic carbon, nitrogen, biogenic silica, nutrients and biochemical variables (protein, lipid, carbohydrates, chlorophyll, EHAA, THAA) will be measured to quantify available organic matter. Fatty acids and stable isotopes (^{14}C , ^{13}C and ^{15}N) in them will be used to estimate energy transfer from one link to the other in the trophic chain. Nutrients and some biochemical variables will be analyzed on board with a spectrophotometer. Ice analyses are intended to identify the importance of sea ice as a provider of microalgae and bacteria to the surrounding sea water.

Further, to estimate the proportion of microorganisms arriving at the seabed and its relation to the carbon, nitrogen and silicon cycles. Stable isotopes analyses will be particularly useful as molecular markers especially in selected fatty acids.

Plankton samples will be collected with plankton nets to identify potential food sources for zooplankton. Water samples will be taken from Niskin bottles. CTD profiles will include fluorescence and turbidity (CTDFT). The set of variables measured in the ice samples will be analyzed in water column samples as well, plus the quantification of suspended particles. These measurements will enable to determine relationships between the water column, the environment and the benthos.

A conical SMT 234 (K.U.M. Meerestechnik, Kiel) sediment trap will be moored 20 m above the seabed coupled to a current meter Aanderaa RCM9. These instruments will be operating for approx. 20 days. Total mass fluxes and its principal constituents (lithogenics, organic and inorganic carbon, nitrogen, biogenic silica, ^{210}Pb and ^{14}C) will be measured to estimate the transport intensity of organics. Radionuclide analyses will allow identifying the importance of ice, sediment and plankton contributions to the total mass flux. Current velocity and direction will enable to relate transport of particles to resuspension and tides. This information will be related to the availability of particles for benthic fauna.

Agassiz Trawl and box corer will be used to collect samples from representative benthic groups (e.g., cnidarians, molluscs, sponges, ascidians). Biochemical variables will be measured in addition to stable isotopes and fatty acids. With this approach we will estimate the healthy state of the organisms through the availability of food, its sources and intensity. Taxonomic and feeding experiments will also be performed. For biodiversity studies, cnidarians and pycnogonids, individuals will be fixed in formaldehyde (morphological work) or 96 % ethanol (molecular analysis). In the case of pycnogonids, appendages (fourth leg left as a rule) of the different species and genera will be preserved for molecular studies. For dispersal capacities and genetic variability within and among different populations of known hexactinellid sponges, specimens will be collected from AGT and bottom trawl. A sub sample of tissue will be fixed with 96 % ethanol, photographed and sub sampled for taxonomic purposes. A minimum of 10 individuals will be collected at each station.

Feeding experiments

After an acclimation period, fragments of colonies will be placed in experimental aquaria, with a known concentration of natural zooplankton. After an incubation period, replicates of gorgonian fragments will be collected and fixed at different times to evaluate digestion activity. Gorgonian fragments before and after the ingestion period, as well as plankton samples, will be also taken to evaluate the zooplankton capture. Zooplankton and gorgonian samples will be fixed for further studies at the ICM-CSIC facilities.

Surface sediment and sediment cores will be sampled with a giant box corer, a multibox corer and a MUC, respectively. Sediment cores will be subsampled on board in slices 0.5 cm to 2 cm thick to measure in each of them carbon, nitrogen, biogenic silica, ^{14}C and biochemical variables. In addition, ^{14}C and ^{210}Pb activities will be measured to calculate sedimentation rates and burial budgets for several variables. Grain size will also be measured to analyze the sedimentary dynamics and the availability of sediment for benthos as a potential food source. Further, particle diffusion and microbial abundances will be estimated in surface sediment samples and the short water column (up to 5 cm) above.

4.3 ECHINOIDS IN THE LARSEN ICE SHELF AREA

T. Saucède (UBD)

Objectives

About 80 species of echinoids occur in the Antarctic; this corresponds to 10 % of the extant species of echinoids and indicates that the Antarctic is a "hot spot" for echinoid biodiversity. Antarctic echinoids belong to nine families and seven orders, and display highly diverse morphologies. Today, ca. 65 % of the Antarctic echinoid species belong to two families, the Cidaridae and the Schizasteridae, that underwent an *in situ* radiation, which has led to a high percentage of endemic species, 81 % and 67 % respectively. These species have diversified when Antarctica became isolated and underwent drastic environmental changes. Antarctic echinoids display particular features compared to echinoids from other regions: (1) most of the Antarctic echinoids are either carnivores or deposit-feeders while algivores and omnivores species are rather scarce; (2) many Antarctic echinoids are direct developers.

The objectives are to investigate at different structural and functional levels the echinoid fauna on the Larsen continental shelf in order to stress the effects of particular environmental conditions. More specifically, the three following aspects will be examined. (1) Echinoid biodiversity. This first point implies to determine and interpret the spatial distribution (depth, geography) of echinoids in the "Larsen area". (2) Cidaroids ectosymbioses. The study of the diversity of ectosymbionts associated with cidaroid echinoids have indicated that the spines are sources of microhabitats and of ecological niches; this approach has stressed out the potential effect of symbioses on the biodiversity in a given environment, i.e., through the settlement of opportunistic or specific symbionts (mainly on soft bottoms where possibilities of fixation for sessile animals are rare). (3) Food and feeding mechanisms of echinoids. In the Antarctic, carnivores (Cidaridae) and deposit-feeders (Schizasteridae) are largely predominant. In contrast, algivores (mostly Arbaciidae) are almost lacking and restricted to the Peninsula or to the sub-Antarctic islands while omnivores (mostly Echinidae) are moderately present. This is quite different from observations in most other marine ecosystems where most regular echinoids are algivores and omnivores. The objective is to characterize the influence of food resources on their distribution in order to determine their potential response to current and future environmental changes in relation to their trophic categories.

Work at sea

Echinoids have to be sampled with the Agassiz trawl. Secondly, experience showed that small, juvenile specimens happen to be gathered by the lowest net of the suprabenthic sledge. Most of sampled specimens will be fixed in denatured ethanol. The analysis of cidaroids ectosymbioses implies the separate fixation of specimens (host and their respective epizoans) with ethanol 70. Ideally, the analysis of echinoids' diets necessitates the dissection of several specimens of one of the eurybathyal species present in each station in order to take samples of muscles, gonads, and gut pellets with their content. Then, samples are placed in a cryotube, to be frozen at -80° C. The remaining body mass and test are fixed with pure ethanol for further investigations.

4.4 LIMITS TO LIFE: ADAPTATIONS OF THE AMPHIPOD TAXOCOENOSIS

C. De Broyer, H. Robert (IRScNB)

Objectives

The first exploration of the benthic life under an Antarctic ice shelf was performed by the Ross Ice Shelf Drilling Project at a point 475 km from the shelf edge and allowed recording a few species of crustaceans and fish. In contrast to the other animals, the scavenging amphipods were surprisingly abundant, indicating their particular adaptation to the local trophic conditions. To contribute to a better understanding of the very poorly known under-ice benthic ecosystems the general aim of the project is to compare and explain the biodiversity patterns and the ecological adaptations of the amphipod crustacean taxocoenosis in "extreme" (Larsen A/B area) and "normal" Antarctic conditions (eastern Weddell Sea, western Peninsula). Specific topics to investigate will comprise:

1. Biodiversity: Comparative composition of the amphipod communities (Which species can afford these extreme conditions?), presence of pioneer species, detection of new and cryptic species by morphological and molecular approach.
2. Ecomorphological and trophic adaptations: The ecofunctional characterization of the Larsen amphipod communities will focus on: (a) trophic habits of selected species, the determination of the feeding guilds and the trophic structure (e.g. how important is necrophagy?), (b) identification of the various ecomorphological types and life styles, and (c) amphipod habitat diversity and complexity. Investigations of the amphipod trophic role will rely on digestive tract analyses, feeding behaviour observation of living animals, feeding experiments, functional morphology of feeding appendages, as well as trophic marker approaches using stable isotopes (C and N).
3. Size spectrum: Comprehensive datasets on world and Southern Ocean amphipod size spectra allowed analyses of size trends and causal factors, in particular of the polar gigantism. Comparative analysis of the Larsen amphipod communities will contribute to reveal the influence of the particular Larsen conditions and attempt to confirm the role of the oxygen factor in determining large size.
4. Geographic distribution patterns: The eastern side of the Peninsula has been rarely sampled and information on the species distribution is scarce. Intensive sampling in the eastern Weddell Sea has shown that a number of Scotia Sea and western Peninsula species reached the eastern Weddell Sea. The project should contribute to clarify the faunal relationships between the eastern and the western Weddell Sea and to understand the possible role of the Weddell Gyre in influencing the local biogeography.

Work at sea

Sampling will be performed by different collecting methods: trawls, "Rauschert" dredge, corers, autonomous trap system. Sorting, preparation of samples, identification, as well as DNA extractions will be done on board. Observations and experiments on living animals will be conducted in aquaria in a cool container. In addition to contributing to the SCAR EBA programme and the CAML, the project will be a part of the BIANZO II project of the Belgian Antarctic Programme and of the "Ant'Phipoda" project (<http://www.naturalsciences/amphi>).

4.5 BENTHIC COLONIZATION AND RECRUITMENT IN CRUSTACEANS

C. McClelland (CMN)

Objectives

The first objective is to study how carbon cycles through the benthic community in the beginning of the colonization process. Also of particular interest are respiration processes at methane seeps and variously aged ice scours, which we will compare with what we have found from methane seeps and ice scours in the Arctic. Our second objective is to compare reproductive strategies of benthic amphipods inhabiting the western Weddell Sea with those already studied on the McMurdo coast. The hypothesis is that reproduction is less synchronized in Weddell amphipods than McMurdo amphipods because of the much less seasonal nature of primary production in the former than the latter.

Work at Sea

To measure respiration, our work at sea consists of subsampling sediment collected with a 0.5 m² boxcorer. Approx. five 15 cm push cores will be taken from each station. Subsamples for CHN (carbon, hydrogen and nitrogen), grain size and chlorophyll analysis will also be collected to complement the information derived from the incubations. CHN samples will be taken for elemental analysis to determine the total organic carbon of the system within the incubations. To account for the contributions of primary production, sediment subsamples will be collected, frozen, filtered with bottom water from the rosette, washed with acetone and analysed with a portable fluorometer. Respiration cores will be topped up with bottom water, either from the box or collected with the rosette and will be incubated at ~0-4° C until 15-25 % of the dissolved oxygen is depleted; at which time the incubations will be sieved through 400 μ m mesh to remove the animals present in the sample. The animals will be relaxed with menthol crystals, fixed with 4 % formalin.

To study the peracarid recruitment process, animals will be collected using either the boxcore or the bottom trawl. Live female specimens will be observed, any eggs will be removed and the development stage assessed. Voucher specimens will be preserved in either formalin or ethanol for further identification purposes upon return to the museum.

4.6 THE IMPACT OF SHELF ICE COVER ON SPONGE COMMUNITIES

D. Janussen (FIS)

Objectives

Sponges are one of most important benthic animals, particularly in the Antarctic ocean. About 400 poriferan genera and species collected from the Southern Ocean have been described, and still many new species are found during Antarctic expeditions, especially in the deep-sea. The Antarctic sponge fauna is unique. Most famous are the giant sized and probably very old rossellidae hexactinellids that populate the Antarctic shelf, but also the deep-sea fauna shows gigantism and very high diversities especially of the class Hexactinellida. The bathymetric distribution of sponges on the deep Antarctic shelf and slope is different from other oceans, because many shallow shelf taxa occur at larger depths, and on the other hand part of the deep-sea fauna ascends high up onto the shelf. Planned is the investigation of gradients in diversity and richness of sponge fauna, including genetic distances, at the eastern shelf of the Antarctic Peninsula, with the largest extent of almost permanent pack ice cover, in comparison with "normal" Antarctic shelf conditions. My working hypothesis is that areas under permanent ice covering will reveal higher proportions of deep-sea sponges than the surroundings, because these taxa are generally better

adapted to live under difficult conditions, such as food limitation. The body size of deep-sea sponges is generally smaller than that of shallow water species; dwarfism can be expected among the Demospongiae and Calcarea. Still it is unknown, how the abundance and diversity of "normal" shelf taxa respond to ice cover; are they poor or normal? How is their growth? Is the bottom type a controlling factor for diversity? Which kind of associations with other organisms exist?

Work at sea

(1) Collection and immediate photo documentation of all sponges, fixation of samples for different purposes, e. g. histology, electron microscopy and molecular biology. (2) Skeletal preparations for identification. (3) Preliminary taxonomic identification and first evaluation of UW videos. (4) Start the investigation of skeletal architecture, spicules and soft body characteristics, such as distribution of collagen, endosymbionts, special cells and possible reproductive products.

Work at home institution: (A) Continue morphological and taxonomic investigations started on the ship. (B) Detailed taxonomic determinations, evaluation and description of all sponge species, including description of new taxa. (C) Detailed evaluation of UW videos and photo material. (D) Comparisons with the sponges fauna of other shelf areas and the deep-sea. (E) Molecular biology of especially the Hexactinellida. investigation of genetic distances between and within taxa on the shelf and in comparison with the deep-sea.

4.7 TROPHIC STRUCTURE AND ENERGY FLOW

O. Heilmayer, K. Beyer (AWI)

Objectives

In high latitude marine systems, food availability is strongly seasonal and spatially patchy, whereas the temperature dependence of biochemical processes causes a general slowdown of metabolism. The short phytoplankton bloom is not an obvious limiting factor for macrobenthic species richness. Studying trophic limitations and ecosystem resilience in the recently disturbed Larsen ice shelf area provides excellent conditions to test theories on how communities can exist under such conditions. The crucial point is to compare the Larsen shelf food web, most likely fueled by lateral food advection with recent findings for the Weddell Sea food web.

Work at sea

(1) Trophic links between different species of the benthos community: Biochemical biomarkers such as stable isotope and lipid compositions will provide temporally integrated signatures of trophic relationships. Stable isotope ratios ($^{14}\text{N}/^{15}\text{N}$, $^{12}\text{C}/^{13}\text{C}$) in organic matter change with the passing of N and C through the food web. Hence, stable isotope ratios can be used to determine the relative trophic position of taxa/groups within the community. (2) Metabolic activity: Respiration rates will be measured for dominant ectotherms to get information about the energy flow within the trophic system. (3) Length-mass relationships are important information to calculate productivity and energy flow rates. We will sample dominant invertebrates and freeze them for later analysis.

4.8 ECOLOGY OF COLD SEEP INVERTEBRATES AND PHYSIOLOGICAL ADAPTATIONS

O. Heilmayer, K. Beyer (AWI)

Objectives

Cold seeps have regions of low oxygen and high hydrogen sulfide, as well as other potentially harmful substances. Specially adapted animals not only tolerate these conditions, they often thrive under them. In most cases this tolerance is due to a combination of physiological and behavioural adaptations. The discovery of a vast ecosystem beneath the collapsed Larsen Ice Shelf is the first cold-seep described in the Antarctic. Here assemblages of bivalves have been reported, which are most probably of the family Vesicomidae, of which ≥ 50 species have been described so far from cold seep and hot vent communities. All these clams rely on sulphide-oxidizing endosymbionts, which may be able to attain a maximum age of several decades or even beyond 100 years. Thus, physical and chemical properties of their shells may reflect environmental conditions during life time, which can be accessed via proxies such as shell growth increments, stable isotope ratios and trace element concentrations.

Work at sea

Sampling will be performed by different collecting methods: trawls, corers and grabs. Observations and experiments on living specimens will be performed in a cool container. Experiments aim to determine the mechanisms that allow cold seep invertebrates to maintain aerobic respiration and normal metabolic rate even at very low oxygen tensions (oxyregulation of respiration). Furthermore shells will be prepared for further measurements of bivalve growth (shell increments, stable isotopes) and variability in methane outflow (trace elements) at the AWI.

4.9 COMPARATIVE BENTHIC POPULATION STUDIES

A. Montiel San Martín (UMA)

Objectives

The Antarctic polychaetes and asteroids represent important components of the Antarctic benthos and contribute considerably to the overall biodiversity. The species are widely distributed in the Weddell Sea, the Antarctic Peninsula and up to the Magellan area. They seem to be successfully adapted to extreme environmental conditions, such as austral cooling and the last maximum glaciations in South America. Recently, morphology and taxonomy studies revealed the presence of species-complexes, i.e., groups of species with slight morphological differences, which may suggest to occur in crypt and/or sibling species. The combination of molecular-genetics and traditional morphological approaches has been widely applied to several Antarctic taxa, but studies on polychaetes and asteroids are lacking. This research proposal is a continuation of previous studies carried out on board of RV *Polarstern* during EASIZ III and one LAMPOS cruise. The proposal is divided into two closely related sub-projects. (1) Genetic approach to the zoogeography of polychaetes and asteroids; (2) Biodiversity and traditional zoogeography of polychaetes and asteroids.

Work at sea

Polychaetes and asteroids will be collected from multibox-corer samples and Agassiz-trawl catches at different water depths and with replicates from each site according to the sampling strategy described above. On board all sediment samples will be sieved, the animals will be preliminarily determined and preserved for further identification and more detailed analyses in the lab.

4.10 HABITAT USE OF MARINE MAMMALS IN ANTARCTIC WATERS

M. Scheidat, L. Lehnert (FTZ)

Objective

Using aerial surveys to investigate how marine mammal distribution and density relates to heterogeneity of the marginal ice zone in Antarctic waters. The results will be used to model marine mammal habitat use in the Antarctic marginal ice zone under varying ice conditions. Additionally, if sufficient sightings of Antarctic Minke Whales (*Balaenoptera acutorostrata*) are made, the results can then be used to improve current abundance estimates for this species in Antarctic waters.

Work at sea

Aerial surveys will be used to cover predesigned zig-zag tracks, with the starting point being determined during the survey when detailed information on ice conditions and the course of the RV *Polarstern* is available. Surveys will be conducted using two observers at a height of 600 feet and a speed of 50-60kn. All marine mammals will be recorded during survey. Surveys will be interrupted when Killer Whales (*Orcinus orca*) or Southern Right Whales (*Eubalaena australis*) are sighted, in order to take photos (from the helicopter) for photogrammetry to determine subspecies (Killer Whales) and for photo-identification (Right Whales). Data on ice coverage and other environmental data, e.g. sea state and cloud cover, will be recorded continuously during the flight. Sightings parameters include: species, group size, vertical angle position, swimming direction, on ice/off ice, behaviour, group composition (e.g. calves), mixed groups (different species), sighted at surface/below surface, sex (where possible). Additionally, whenever weather conditions permit, but aerial surveys are not possible, visual observations will be conducted from the bridge of RV *Polarstern*.

4.11 DIVERSITY AND PHYLOGENETIC BIOGEOGRAPHY OF CEPHALOPODS

E. Jorgensen (UWS), S. Klimpel (HHU)

Objectives

Recent research on Antarctic octopods have revealed diversity much higher than previously expected. Based on results of previous RV *Polarstern* cruises (ANT-XIV/2; ANT-XIX/3) we have shown that cirrate octopods are much more abundant in the vicinity of the South Shetland Islands than was suspected. Altogether 20 octopod species occurred, eleven of them only recently being described on the basis of the extensive RV *Polarstern* collections. Most species belonged to the genus *Pareledone*, emphasising the extensive radiation of this endemic genus in the Southern Ocean. Both number of species and specimens increased with sampling depth. In contrast to octopods diversity and biogeography of Antarctic squid is poorly known. The scientific objectives will comprise (i) the continuation of our biogeographic, taxonomic and phylogenetic work on Antarctic cephalopods, (ii) investigations on reproductive strategies of octopods, (iii) studies on age and growth of selected species, (iv) investigations on trophic ecology and parasite loads of Southern Ocean cephalopods.

Work at sea

Our group will sample all cephalopods from the catches taken with the various sampling gears. Examination of freshly caught specimens will be particularly useful for documentation of subtle taxonomic characters such as colour patterns and skin texture. We will record size and morphometric measurements prior to distortion in preservatives, sample and fix tissues for studies of DNA, stable isotopes and histology, and remove statoliths for later age and

growth analyses, and cephalopod beaks for creating a reference collection of Southern Ocean species. A further aspect will be the investigation of stomach contents.

4.12 ANTARCTIC FISH AND CEPHALOPOD PARASITE FAUNA

S. Klimpel, M. W. Busch (HHU)

Objectives

Parasites have an important impact and are an integral part of ecosystems. There is increasing evidence that parasites represent a major factor of global biodiversity. In fisheries biology, parasites can serve as natural markers for fish stock identification. Moreover, they can help to analyse the intermediate diet composition of their hosts. Flatworms are particularly useful for such studies, because life-cycle stages are passed through the food web until they reach their definitive host. Finally, parasites provide information on habitats and trophic status of the studied hosts within the Antarctic ecosystem.

Besides the study of a variety of different fish and cephalopod species from the Antarctic ecosystem, also other potential hosts of parasites, such as Polychaeta and also penguins, will be investigated. The results will reveal further information on the life cycle biology of Antarctic parasites. To study regional differences, fish from the Antarctic Peninsula will be compared with those from the Weddell-Sea in terms of the occurrence of parasitic nematodes, especially belonging to the Anisakidae, such as *Contracaecum osculatum*, *C. radiatum* and *P. decipiens*. Other parasite groups will be collected and fixed for subsequent investigation in Düsseldorf.

Work at sea

Stomach content analyses of fish and cephalopods will provide the background data on the possible transmission pathways of the detected parasites. A total of 35 specimens of each target species will be studied. In addition, fish, squid, polychaetes and penguins (naturally died chicks from the colonies) will be collected and deep frozen for further examination at the Düsseldorf University. The isolated parasites on board will be preserved in 70 % and 100 % ethanol for subsequent parasitological and molecular genetic studies.

4.13 EXPLORATION OF MEIOFAUNA FROM DIFFERENT MICROHABITATS

M. Raes (UGent)

Objectives

Meiofauna has been studied in Antarctic marine environments, mainly in the Atlantic part of the Southern Ocean. Nematodes dominate such communities and show a high diversity. Their trophic position and functional role is still not well known, but they are assumed to play a crucial role in benthic systems. The communities under the former Larsen A/B ice shelves are expected to be impoverished due to a lack of *in situ* primary production. The discovery of a cold seep in this area suggests the existence of a local chemosynthetic food web. Our aims are to study the meiobenthic communities, and more specifically nematodes, along a transect from the former ice edge towards the land to study colonisation patterns. Another point of interest is a global comparative investigation on meiobenthos in microhabitats associated with cold seeps. Stable isotope analysis will allow to study whether the meiobenthos is part of a chemosynthetic food web.

Work at sea

Samples will be collected with a multicorer (MUC). When sediment characteristics do not allow the use of a MUC, subsamples will be taken from the box corer (GKG). Replicate sampling will allow to assess microscale heterogeneity. The use of a video-guided sampling device could allow sampling of the different microhabitats associated with the seep. Sediment cores will be sliced on board, samples for community analysis will be preserved by 4 % formaldehyde. The meiofauna will be extracted from the sediment, counted and nematodes will be prepared for microscopical analysis. Additional samples will be frozen at -20° C for stable isotope analysis to unravel the trophic position of the nematodes.

4.14 LIMITS OF BENTHIC MEIOFAUNAL COMMUNITIES IN THE ANTARCTIC

A. Rose (FIS-DZMB)

Objectives

Meiofauna is not only a size fraction of animals with lengths between 0.04 and 1.00 mm, but also an ecologically distinct unit. Due to its functional distinctness it plays an important role in marine benthic food webs. Almost nothing is known about meiofaunal communities living beneath the Antarctic shelf ice. Is a suggested lower productivity limiting diversity in those environments? The possible existence of meiofaunal diversity gradients, especially among harpacticoid crustaceans are to be discussed according to its resilience after disturbance and diversity models (e.g. productivity-diversity relationship). Comparisons of oligotrophic shallow-water with deep-sea areas are of special interest. Since a mud volcano was recently discovered in the Larsen B area, there is also the chance to study a spot of high productivity within an oligotrophic environment and to compare meiofaunal assemblages of both. Finally, new species are to be expected which will enhance our understanding of Antarctic biodiversity.

Work at sea

Transects of 3-5 stations should be sampled quantitatively with a multicorer (MUC), preferably with ≥ 5 or more replicates. An alternative to transect sampling would be grid sampling. A transect from the margins to the centre of the mud volcano should be sampled quantitatively using a camera system. Additional qualitative meiofauna samplings may be taken by sieving rinse water, sponges, and sediment from other gear. These samplings will be preserved with 70-80 % ethanol and partly investigated at major taxa level on board. All organisms will be sorted and counted on major taxa level at the DZMB (Wilhelmshaven, Germany).

4.15 LIFE HISTORY OF ANTARCTIC OCTOPUSES (CEPHALOPODA)

I. Barratt (QUB)

Objective

The octopod fauna around the Antarctic Peninsula is rich. Despite their high abundance and importance in the Antarctic ecosystem virtually nothing is known about their life histories. Deep-sea and Antarctic octopuses are characterised by low fecundity and large egg sizes, which is in contrast to the high fecundity, and small egg sizes typical of shallow water temperate species. While a "spawn once and die" strategy is typical of shallow water and temperate octopuses it is not known whether Antarctic octopuses would share the same reproductive strategy. The initial aim is to investigate reproductive strategies (ovary maturation) in a range of octopuses through egg-length frequencies and multivariate analysis.

Work at sea

Dissections will be performed on dead specimens collected from the trawls. The ovaries will be removed and weighed; oviducal glands, oviducts and egg lengths will be measured. Since the Antarctic octopus fauna is likely to consist of a number of closely related species in the genera *Pareledone*, *Adelieledone* and *Megaleledone*, this will allow us to assess whether reproductive strategies are taxonomically constrained within this clade. Information collected on their reproduction will also be combined with maturity data from collections obtained in different months to provide a temporal aspect. A second aim is to attempt to age the octopuses using their stylets (one of the few hard parts of an octopus), which may contain growth rings. By analysing stylets and by combining the data obtained with the information on reproduction, it should be possible to deduce much about the life histories of Antarctic octopuses that could not be deduced from their reproductive strategies alone. In addition tissue samples will be collected for DNA analysis to assist with another project that is investigating the evolution of Antarctic and Deep-sea octopuses.

4.16 GENETIC VARIABILITY OF ANTARCTIC BENTHIC INVERTEBRATES

M. Meissner (ZFMK AWI)

Objectives

Molecular studies have shown that the number of species in the Antarctic benthos may be higher than previously estimated. Consequently, genetic variability is less homogeneously structured than previously assumed. These results are corroborated by the small-scale allopatric distribution patterns of newly found cryptic species as well as the distribution of variation of fast evolving molecular markers. It is unclear, however, at which rate genetic variation evolves and propagates on the Antarctic shelf and adjacent deep sea. Larsen A/B provides a unique opportunity to separate the influence of time and space on the distribution of genetic variation. We will concentrate on species with moderate to high abundances, preferably in the area of Larsen A/B as well as outside.

Our working hypotheses are that (1) the early colonizers represent a subset of the faunal inventory of adjacent areas and that (2) the genetic variation realized within the colonizers is also a subset of the variation outside.

The analysis will allow conclusions to be drawn regarding colonization pathways and origin of invaders. We expect our data to be of relevance also for ecological modelling and monitoring future response to climate change. Samples of relevance for another project concerning the evolution towards parasitism within the Peracarida will also be collected.

Work at sea

The work at sea will include taking samples of suitable invertebrates and preserve them for subsequent molecular studies. Suitable samples are expected mostly in trawled gear, such as bottom and Agassiz trawls. Megabenthos will be sorted by hand, macrozoobenthos will be sorted on board under a stereomicroscope. Of particular interest are peracarid crustaceans (isopods, amphipods) but also echinoderms and molluscs. Preservation of samples will take place in pre-chilled ethanol. Extraction of DNA and subsequent molecular work will be carried out at the AWI.

4.17 BIOGEOCHEMISTRY OF SEEPS IN THE LARSEN A/B AREA

H. Niemann (MPI-BRE), D. Fischer (AWI)

Objectives

Ocean margin research of the last decade has provided evidence for a variety of fascinating ecosystems associated with fluid, gas and mud escape structures. These cold seeps are colonized by enormous biomasses of bacterial mats and chemosynthetic fauna. These communities and their metabolic products such as bicarbonate and hydrogen sulphide provide the base of the food web at many cold seeps settings. The activity of these communities is regulated by the availability of electron donors and acceptors, which in return is regulated by fluid and/or gas flux as well as bio irrigation activities. Furthermore, the activity of these communities is of particular importance in reducing the efflux of hydrocarbons to the hydros- and potentially to the atmosphere where they contribute to the green house effect.

In the last few years, vast areas of the Larsen A/B ice shelf broke off. Videographic surveys of the sea floor in this area gave indications for hydrocarbon seepage and associated chemosynthetic megafauna. Nothing is so far known about the bio-geochemistry and associated organisms of Antarctic seeps. Furthermore, Antarctic waters are isolated from the world oceans, which makes the Larsen A/B seep particularly interesting for biogeochemistry, microbiology and biogeography.

The aim of the planned studies is (1) to characterize and to quantify the bio-geochemical reactions and transport processes in cold seep related sediments and across the sediment-water interface. This will be accomplished by flux calculations of pore water constituents and radiotracer incubations. (2) The reconstruction of the variation of methane fluxes and (3) the migration of the sulphate-methane transition zone over time will be assessed by investigations of authigenic minerals formed in these sediments – particularly barite, carbonates and iron sulphides – which have a high potential to trace past fluctuations of redox fronts. (4) The biodiversity of seep microbes and megafauna will be investigated by lipid biomarker, DNA and fluorescence in situ hybridisation (FISH) tools.

Work at sea

The first objective is to locate seep areas with the remotely operated vehicle (ROV) and by echosounder surveys. Targeted sediment structures and fauna will be recovered with the ROV, a video-guided multiple- and a gravity corer. Sediment and fauna samples will be transferred into a cold room and maintained at in situ temperature. Within a few hours after recovery, sediment cores will be sectioned and further processed for pore water extraction and radio tracer incubations as well as for lipid biomarker, DNA and FISH fixations. Pore water extractions will be carried out with rhizones and samples for solid phase and mineralogical analyses will be frozen at -20° C. Sediments for methane oxidation, methanogenesis and sulphate reduction rates will be incubated in acrylic core liners or glass tubes with $^{14}\text{CH}_4$, $\text{H}^{14}\text{CO}_3^-$ and $^{35}\text{SO}_4^{2-}$, respectively. Sediments for lipid biomarker and DNA analysis will be frozen at -20° C or -80° C. Samples for FISH will be fixed in formalin-seawater and Ethanol-PBS solution. Subsamples for analysis of foraminifera will be stored under argon atmosphere at -20° C. Methane concentrations will be determined from syringe samples fixed in vials containing 20 ml of saturated NaCl NaN_3 -solution. Subsamples of megafauna organisms will be sampled for chemosynthetic symbionts (lipid biomarker, FISH, DNA and RNA) after dissection.

Also pore water analyses of Eh, pH, ammonium, phosphate, alkalinity and iron (Fe^{2+}) are planned. Sulphide, sulphate, chloride, CH_4 , DIC and $\delta^{13}\text{C}$ of DIC and methane as well as solid phases will be analysed at the AWI. AOM, methanogenesis and sulphate reduction rate samples as well as lipid biomarker, DNA, RNA and FISH samples will be further processed at the MPI.

4.18 BATHYMETRY

E. Pugacheva (IG-RAS), J.-H. Lott (AWI)

Objectives

Precise depth measurements are necessary to provide seafloor morphology and structure as basic information for marine sciences. The area around the Antarctic Peninsula is up to now only sparsely surveyed by a few hydrographic survey vessels, whalers and other ships. The older data suffer from low quality and from bad navigation in high latitudes and bad weather conditions. Thus the accuracy of the existing bathymetric data sets (GEBCO Sheets 5.16, 97.1 and 97.2, for example), is not sufficient for detailed scientific investigations.

Work at sea

The multibeam data collected on the transits from Cape Town to the Antarctic Peninsula and back to Punta Arenas as well as data collected in the working areas around the Antarctic Peninsula will supplement the existing bathymetric data base. On basis of the collected data, existing charts like the GEBCO and IBCSO (International Bathymetric Chart of the Southern Ocean) will be updated. The major scientific bathymetric work will be performed in the area of the former Larsen A/B ice shelf. In front of the Crane Glacier the existence of a mud volcano at the sea bottom is presumed. Before further detailed investigations and seafloor sampling by other scientific groups, the volcano has to be surveyed in detail on the base of a dense mesh of Hydrosweep profiles with highly overlapping swathes. Water sound velocity profiles must be measured in the survey area. An alternative working area around Joinville Island, South Shetland Islands and Elephant Island is planned. North of the South Shetland Islands several multibeam surveys have been performed during former RV *Polarstern* expeditions which could be extended.

4.19 ADAPTIVE COMPETENCE OF TELEOSTEI

C. Bock, K. Deigweier, T. Hirse, Z. Zittier (AWI)

Objectives

Based on the results obtained from previous RV *Polarstern* cruises (ANT-XXI/2, ANT-XXII/3) we aim to extend our research on the adaptability of cold eurythermal versus more stenothermal Antarctic fish species (Zoarcidae and Nototheniidae). Recently, it could be shown that the circulatory performance is one of the bottlenecks in temperature limitation of Antarctic fish. Oxygen delivery provided by the circulatory system does not match the temperature dependent increase of oxygen demand of an organism. It is still under debate which part of the circulatory system is responsible for the mismatch during warming. One of the main objectives is therefore to reveal the most temperature sensitive part of the circulatory system starting from the heart, arterial and venous branch and the capillary system as well as blood parameters of cold eurythermal and highly stenothermal Antarctic fish. Especially, tissue capillarisation and lipid content may facilitate oxygen delivery in organs under low temperatures. Lipids also are an important substrate for oxidative energy production and support neutral buoyancy for a pelagic mode of life. They are stored in the form of triglycerides in either adipose tissue or in lipid droplets in the cytoplasm of muscle

cells. We therefore want to collect blood and muscle samples of different fish species to analyse the specific content of glycogen and lipids as metabolic substrates. In a second project we want to investigate the effects of increased carbon dioxide concentrations (hypercapnia) on energy budget and acid base regulation of Antarctic fish species as a model system for the prediction of the effects of anthropogenic CO₂ storage in the deep sea.

Work at sea

Fish caught from trawls and baited traps will be collected and kept at habitat temperatures in the aquarium container. Heart rate and blood perfusion levels of different organs will be measured *in vivo* by use of laser Doppler flowmetry (LDF). The effects of temperature on heart rate, blood flow velocity, local hematocrit changes and tissue perfusion will be investigated after adequate periods of recovery. Additionally, blood and tissue samples will be collected for further analysis of hematocrit and blood lactate, glucose, glycogen and lipid levels, muscle fibre thickness and capillarisation. The ratio of muscle type specific intra- and extramyocellular lipids will be determined.

For experiments addressing the effects of hypercapnia on acid base regulation and tissue energy budget we will perform respiration measurements on isolated and perfused fish gills. Gills will be dissected, connected to perfusion cannulae, and placed into respiration chambers filled with pre-equilibrated seawater with a partial pressure of 10.000 ppm CO₂. Oxygen consumption rates will be measured by using oxygen microoptodes and flow-through sensors. The application of specific inhibitors for protein-biosynthesis, RNA/DNA-Synthesis and pH- and ion regulation will show the response of the main energy consuming processes to hypercapnic acidosis. Moreover, we will analyse the acid base compensatory mechanisms in the gill by inhibiting single ion transporters, e.g. Na⁺/K⁺- and H⁺-ATPase, Na⁺/H⁺-exchanger and HCO₃⁻-transporters. To analyse the degree of pH compensation, we will freeze gill samples after the trial and measure pHi in tissue homogenates later at the AWI.

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6. FAHRTTEILNEHMER / PARTICIPANTS

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Heckmann	Markus	HeliTransair	Helicopter techn.
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Riehl	Rüdiger	HHUD	Biologist
Robert	Henri	IRSNB	Biologist
Rose	Armin	DZMB	Biologist

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
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Seiler	Jan	UWB (AWI)	Student, biology
Umani	Marzia	UNISI	Biologist
Zittier	Zora	AWI	Biologist

7. SCHIFFSBESATZUNG / SHIP'S CREW

Name of Ship : RV POLARSTERN
 Nationality : GERMAN
 Cape Town - Punta Arenas

No.	Name	Rank
01.	Pahl, Uwe	Master
02.	Grundmann, Uwe	1.Offc.
03.	Ziemann, Olaf	Ch.Eng.
04.	Bratz, Herbert	2.Offc.
05.	Peine, Lutz	2.Offc.
06.	Hering,Igor	2.Offc.
07.	Weiße, Volker	Doctor
08.	Koch, Georg	R.Offc.
09.	Kotnik, Herbert	2.Eng.
10.	Schnürch, Helmut	2.Eng.
11.	Westphal, Henning	3.Eng.
12.	Holtz, Hartmut	Elec.Tech.
13.	Rehe, Lars	Electron.
14.	Schulz, Harry	Electron.
15.	Fröb, Martin	Electron.
16.	Feiertag, Thomas	Electron.
17.	Clasen, Burkhard	Boatsw.
18.	Neisner,Winfried	Carpenter
19.	Kreis, Reinhard	A.B.
20.	Schultz, Ottomar	A.B.
21.	Burzan, G.-Ekkehard	A.B.
22.	Schröder, Norbert	A.B.
23.	Moser, Siegfried	A.B.
24.	Pousada Martinez, S.	A.B.
25.	Hartwig-L., Andreas	A.B.
26.	Guse, Hartmut	A.B.
27.	Vehlow, Ringo	A.B.
28.	Beth, Detlef	Storekeep.
29.	Hoppe, Kurt	Mot-man
30.	Fritz, Günter	Mot-man
31.	Krösche, Eckard	Mot-man
32.	Dinse, Horst	Mot-man
33.	Watzel, Bernhard	Mot-man
34.	Fischer, Matthias	Cook
35.	Tupy,Mario	Cooksmate
36.	Völske, Thomas	Cooksmate
37.	Dinse, Petra	1.Stwdess
38.	Tillmann, Barbara	Stwdss/KS
39.	Streit, Christina	2.Steward
40.	Schmidt,Maria	2.Stwdess
41.	Deuß, Stefanie	2.Stwdess
42.	NN	2.Steward
43.	Sun,Yong Sheng	2.Steward
44.	Yu, Chung Leung	Laundrym.

ANT-XXIII/9

**2 February 2007 – 11 April 2007
Punta Arenas – Cape Town**

**Chief Scientist:
Hans-Wolfgang Hubberten**

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1. ÜBERBLICK UND FAHRTVERLAUF

Hans-W. Hubberten (AWI-P)

Die Expedition ANT-XXIII/9 des FS *Polarstern* beginnt am 2. Februar 2007 in Punta Arenas und wird über das Weddellmeer in das Hauptarbeitsgebiet der Expedition - in die Region der Prydz-Bucht (Ostantarktis) und auf Schnitten nach Norden zum Kerguelen-Plateau führen (Abb. 1). Wissenschaftliche Schwerpunkte der Expedition sind geophysikalische und meeresgeologische Untersuchungen zur Erkundung der geodynamischen und tektonischen Entwicklung des Kontinentalrandes dieses Gebietes sowie zur Rekonstruktion der glazial-marinen Umweltgeschichte dieser Region im Spätquartär. In Ergänzung dazu werden Feldarbeiten zur Klima- und Umweltrekonstruktion in eisfreien Gebieten in der Umgebung der Prydz-Bucht durchgeführt sowie die Entwicklung des antarktischen Permafrosts und seiner Lebensformen studiert.

Auf der Fahrt zum Hauptarbeitsgebiet wird das FS *Polarstern* im Weddellmeer das italienische Ozeanbodenobservatorium *MABEL* aufnehmen, welches am 5. Dezember 2005 ebenfalls von dem FS *Polarstern* aus abgesetzt wurde. Neben dem wissenschaftlichen Programm an Bord des FS *Polarstern* und in den antarktischen Oasen wird auf diesem Fahrtschnitt auch die Versorgung der *Neumayer*-Station vorgenommen.

Fast auf der gesamten Fahrtsstrecke von Punta Arenas über das Weddellmeer zur Prydz-Bucht und weiter über das Kerguelen-Plateau Richtung Kapstadt werden Proben zur Untersuchung der Konzentration von Nährstoffen und Eisen sowie der Si und N Isotope in Diatomeen genommen. Ziel ist die Schaffung einer ersten Verbreitungskarte dieser Substanzen auf einem Transekt vom atlantischen zum indischen Sektor des Südozeans. Zusätzlich zu den Oberflächenwässern werden an ausgewählten Position Wasserproben mit der CTD-Rosette und Sedimentproben mit Multicorer und Schwerelot genommen.

Der Schwerpunkt der marin-geologischen Arbeiten liegt zwischen Prydz-Bucht und Kerguelen Plateau. Dabei sollen auf dem Schelf der Prydz-Bucht, sowie in den Fjorden und Kanälen vor allem hoch aufgelöste holozäne Abfolgen gewonnen werden. Über die sedimentären Becken des MacRobertson-Schelfs sollen die Ablagerungen am Kontinentalhang sowie Sedimente der Tiefsee-Ebene bis zum südlichen Kerguelen Plateau beprobt werden. Die Untersuchungen an dem Probenmaterial dienen der Rekonstruktion der spätpleistozänen bis holozänen Vereisungs- und Umweltgeschichte dieser Region der Ostantarktis und stehen in engem Zusammenhang mit den Arbeiten an Land. Ergänzende marin-geologische Untersuchungen werden noch am Scotia-Bogen und am Kerguelen-Plateau durchgeführt.

Die Untersuchungen an Land finden vor allem in der am Westrand des Lambert-Gletschers gelegenen Amery-Oase sowie auf den Rauer-Inseln und an den Larsemann-Bergen an der Küste der Prydz-Bucht statt. Vor allem durch die Gewinnung und Untersuchung von Sedimenten aus Süßwasser- und Epi-Schelfseen wird die Klima- und Umweltgeschichte dieser Region rekonstruiert und mit den Informationen aus dem marinen Bereich verknüpft. Neben der Rekonstruktion vergangener Umweltveränderungen werden an den küstennahen Lokalitäten Untersuchungen der mikrobiellen Diversität in Permafrostböden durchgeführt, von denen wichtige Erkenntnisse für die Entwicklung von Lebensformen unter extremen klimatischen Bedingungen erwartet werden.

Die geodynamische und tektonische Entwicklung des Kontinentalrands im Gebiet der Prydz-Bucht wird mit einem umfassenden geophysikalischen Programm untersucht. Zu diesem Zweck wird das FS *Polarstern* gemeinsam mit dem russischen FS *Akademik Alexander Karpinsky* tiefe krustenseismische Untersuchungen in einem Zweischiiff-Unternehmen vornehmen. Dabei werden seismische Linien sowohl parallel als auch quer zu vermuteten Strukturen gelegt und mit einem Mehrkanalseismiksystem unter Nutzung eines 5 km langen digitalen Streamers vermessen. Von dem FS *Polarstern* werden dazu noch bis zu 25 Ozeanboden-Seismographen ausgesetzt, die durch einige seismische Stationen an Land, auf dem Schelfeis und auf Eisströmen ergänzt werden.

Parallel zu den seismischen Arbeiten wird ein engmaschiger magnetischer Survey unter Nutzung eines Hubschraubers der FS *Polarstern* geflogen und durch Messungen mit dem Bordmagnetometer des Schiffes ergänzt.

Die Expedition ANT-XXIII/9 wird am 11. April 2007 in Kapstadt enden.

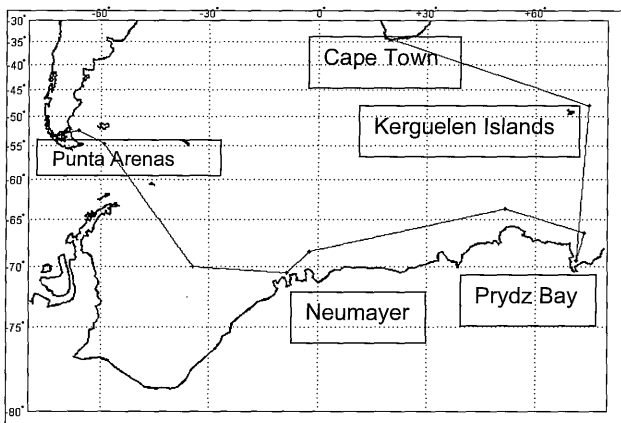


Abb. 1: Übersichtskarte des Untersuchungsgebietes und der geplanten Fahrtroute der FS *Polarstern*-Reise ANT-XXXII/9: Die Reise wird am 2. Februar 2007 in Punta Arenas beginnen und am 11. April 2007 in Kapstadt enden.

Fig. 1: Map of the area of observations and of the planned cruise track of RV *Polarstern* expedition ANT-XXXII/9. The cruise will begin on the 2 of February 2007 in Punta Arenas and will end on the 11 January 2007 in Cape Town.

ITINERARY AND SUMMARY

RV *Polarstern* will leave port in Punta Arenas on 2 February 2007 for the Antarctic expedition ANT-XXIII/9. She will steam first to the Weddell Sea and then head to the major working area of this cruise, the Prydz Bay area (East Antarctica) from where transects will be studied to the northern Kerguelen Plateau (Fig. 1).

The scientific programme of the cruise is mainly devoted to geophysical and marine geological studies to investigate the geodynamic and tectonic development of the continental margin of the region as well as to reconstruct the glaciomarine environmental history of the late Quaternary. In addition, studies of the climatic and environmental reconstruction will be carried out on the ice-free areas surrounding the Prydz Bay, which are complemented by investigations on the development of permafrost and primitive life.

In addition to these major research topics, smaller programmes on oceanographic and petrologic problems will be carried out.

When arriving in the Weddell Sea, an Italian ocean floor observatory called *MABEL*, which was deployed from RV *Polarstern* on 5 December 2005, will be recovered.

In addition to the scientific programme carried out on board of the RV *Polarstern*, this cruise will also provide the annual supplies to the German over-wintering station *Neumayer*.

Surface water samples will be taken to support paleoceanographic reconstructions of nutrient cycling in the Southern Ocean and their impact on atmospheric CO₂ over past climate cycles. By taking samples fairly continuously along the cruise track from Punta Arenas to Cape Town via Prydz Bay and the Kerguelen Plateau, this work will result in the first map of dissolved and particulate Fe, and Si and N isotopes and concentrations over a transect extending through the Atlantic and Indian sectors of the Southern Ocean. In addition, water from CTD casts and sets of surface sediment (multicore) samples will be taken to provide a connection between the water column data and the sediments. Finally, several gravity cores will be taken to provide a picture of isotopic and morphometric shifts over glacial-interglacial cycles.

The major working area for the marine geological studies is located between the Prydz Bay and the Kerguelen Plateau. These studies are devoted to the identification of characteristic depositional units in the study area, as displayed in seismic sections obtained from a Parasound survey, and the recovery of representative marine sediment sections (surface sediments and sediment cores), using multicorer, box corer, piston corer, and gravity corer equipment. Sediments will be sampled from the Prydz Bay shelf area with the special aim to recover high resolved Holocene sequences from fjords, and the Prydz Bay Channel. Sampling of marine sediments will be continued to the sedimentary basins of the Mac Robertsen Shelf, the continental slope and the deep ocean basin to the northern Kerguelen Plateau. The aim of studies of the marine sediments is the reconstruction of the late Pleistocene to Holocene glacial history of this east Antarctic region. The investigations are closely connected to paleoclimate studies on the adjacent land areas. Additional marine geological station work will be undertaken at the southern Scotia Arc and around the Kerguelen Plateau.

The investigations planned on land will take place at the western boarder of the Lambert glacier in the Amery Oasis and at the coastal areas of Prydz Bay at the Rauer Islands and

the Larsemann Hills. Mainly lake sediments from freshwater and epishelf lakes will be sampled by using a light coring device. Through the investigation of the sediments past climatic changes and their consequences on the environmental, glacial and sea level development will be reconstructed and compared with the situation at other east Antarctic coastal regions. In addition to paleoclimatic reconstructions, the diversity and ecology of microbial communities and their function in nutrient turnover under the extreme conditions in Antarctic periglacial regions will be studied in the permafrost soils of the coastal ice free regions.

A comprehensive geophysical programme focuses on the investigation of the geodynamic and tectonic development of the continental margin in the Prydz Bay area. This programme will be undertaken using two vessels operating in the area: The RV *Polarstern* and the Russian RV Akademik Alexander Karpinsky. The seismic programme will be conducted as a two-ship experiment to target in particular the deep crust and crust-mantle boundary. A series of deep crustal seismic refraction profiles will be acquired across the main structural grain of Prydz Bay, the deep-water basin of Cooperation Sea and the southern Kerguelen Plateau using a state-of-the-art seismic reflection system including a 5-6 km long digital streamer from RV Akademik A. Karpinsky. Up to 25 ocean-bottom seismographs will be deployed from RV *Polarstern* along each of 3 to 4 profiles in areas of open water, while a few seismic land-recorders will be placed on land, on the shelf-ice, and on ice-flows by helicopter. Parallel to the seismic studies, densely spaced parallel magnetic survey lines will be flown over parts of Prydz Bay and the oceanic crust in the Cooperation Sea and Davis Sea basins by an RV *Polarstern* helicopter equipped with a towed Caesium magnetometer system. The shipboard fluxgate magnetometer system on RV *Polarstern* will be used to record the magnetic reference field as well as additional ship-track lines.

The RV *Polarstern* expedition ANT-XXIII/9 will end in Cape Town on 11 April 2007.

2. MARINE GEOPHYSICS: GEODYNAMIC AND TECTONIC EVOLUTION OF THE CONTINENTAL MARGIN OF THE PRYDZ BAY AREA

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G. Leitchenkov (VNII), D. Damaske (BGR), Y. Knight (USYD)

Objectives

The separation of Greater India from Antarctica in early Cretaceous time and the break-up of Australia from Antarctica since the Late Cretaceous led to the formation of the modern Indian Ocean and a continuous oceanic passage between the southern Atlantic (Weddell Sea), the Southern Indian Ocean and the western Pacific. The Cretaceous Gondwana break-up was accompanied by enormous volcanic extrusions of so-called Large Igneous Provinces (LIP), such as the Kerguelen Plateau in the Southern Indian Ocean. The geodynamic and depositional record of these events, which probably greatly affected the Earth's climate, is best preserved in the crustal structure and sediment stratigraphy of a large (about 1 million km²) marine region which is juxtaposed to the Amery Ice Shelf and includes the continental

shelf, slope and rise of Prydz Bay and the eastern Cooperation Sea, the eastern Enderby Abyssal Plain, Southern Kerguelen Plateau and the Princess Elizabeth Trough (between Southern Kerguelen Plateau and Princess Elizabeth Land).

Prydz Bay lies at the offshore continuation of the Lambert-Amery Graben that marks one of the most extensive intracontinental rifts. The rift formed in the Late Jurassic and is now occupied by the world's largest outlet glacier draining about 1 million km², or 20% of the EAIS, thus representing a key location for studying both the early history of Gondwana rifting and the Cenozoic glaciation of Antarctica. The Lambert-Amery failed rift is coupled with a deeply submerged pericontinental rift system beneath continental slope and rise of the Cooperation Sea whose highly extended crust marks the transition to Enderby Abyssal Plain sea-floor formed by Early Cretaceous spreading. The Cenozoic sedimentary cover of deep-water basins contains a complete distal record of the earliest glacial events and associated climate changes known in Antarctica. Yet, the history of the origin, evolution and recent to current tectonic activity of the Lambert Rift region is hardly understood. Equally unknown are the consequences of lithospheric dynamics and crustal tectonics for the dynamics of the ice-shield within the drainage basin and graben.

The Lambert Rift is one of the regions in Antarctica in which the behaviour of the ice-shield drainage is closely related to the underlying tectonics. Thermally controlled crustal uplift and subsidence, the variability of the heat flow as well as glacial rebound mechanisms have substantial influence on the ice-stream flow rates. A well constrained model of rift evolution and associated glacial-tectonic processes during its recent history would directly feed into an improved mass-balance budget for the Antarctic ice-sheet.

A broad sea floor high of the southern Kerguelen Plateau marks one of the two most voluminous LIPs in the World Ocean and is attributed to the Kerguelen Plume/Hotspot emplaced at about 120 Ma ago, or c. 15 Ma after the onset of sea-floor spreading between India and Antarctica. It is partly it is underlain by stretched continental crust affected by Late Cretaceous-Early Cenozoic extension. Despite continuous subsidence from early Late Cretaceous to Eocene time, the Kerguelen Plateau remained a shallow marine feature that appreciably influenced the oceanic circulation. For instance, the Antarctic Circum-Polar Current (ACC) is deflected by the topography of the Kerguelen Plateau.

The following questions are addressed by this project:

- Structural parameters, physical properties and interrelations of rifted continental, oceanic and volcanic crust;
- Mechanism of extension of continental crust, geometry of rifting and time (onset and duration) of rifting stage;
- Position and nature of continent-to-ocean boundary, timing and geodynamic regime of sea-floor formation, particularly the position of poles of rotation at early stages of sea floor spreading between India and Antarctica;
- Subsidence history of Prydz Bay - Cooperation Sea Basin and its evolution as deep oceanic gateway;
- Tectonic nature of the southern Kerguelen Plateau (oceanic edifice or continental sliver) and the relationship between sea-floor spreading and LIP formation; the mechanism of Kerguelen Plume emplacement ("active" vs. "passive" model).

Work at sea

This geophysics programme will make use two vessels operating in the area: The RV *Polarstern* expedition ANT-XXIII/9 and the Russian Polar Expedition cruise with the RV *Akademik Alexander Karpinsky*. The seismic programme will be conducted as a two-ship experiment to target in particular the deep crust and crust-mantle boundary.

- a) **Deep crustal seismics in Prydz Bay area, the Cooperation Sea and on the Southern Kerguelen Plateau:** A series of deep crustal seismic refraction profiles will be acquired across the main structural grain of Prydz Bay, the deep-water basin of Cooperation Sea and the southern Kerguelen Plateau. The RV *Akademik Alexander Karpinsky* is equipped with a state-of-the-art seismic reflection system including a 5-6 km long digital streamer. Some profiles will cross, others will parallel the major lineaments which are partly known from maps of older sediments and top of basement taken from earlier seismic surveys. Up to 25 ocean-bottom seismographs are deployed from RV *Polarstern* along each of 3 to 4 profiles in areas of open water, while a few seismic land-recorders are going to be placed on land, on the shelf-ice and on ice-flows by helicopter. Both instrument types will record seismic airgun sources of one or both of the research vessels.
- b) **Magnetic surveying in the Prydz Bay area:** Densely spaced parallel magnetic survey lines will be flown over parts of Prydz Bay and the oceanic crust in the Cooperation Sea and Davis Sea basins by one of the RV *Polarstern* helicopters which is equipped with a towed Caesium magnetometer system. The shipboard fluxgate magnetometer system on RV *Polarstern* will be used to record the magnetic reference field as well as additional ship-track lines.

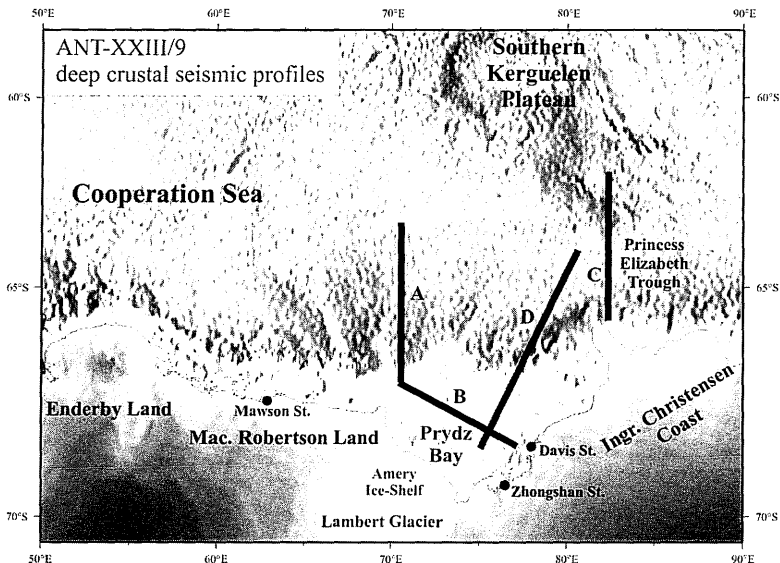


Fig. 2: Deep crustal seismic profiles planned during RV *Polarstern* expedition ANT-XXXII/9

3. LATE QUATERNARY GLACIALMARINE ENVIRONMENT OF THE PRYDZ BAY TO SOUTHERN KERGUELEN PLATEAU REGION AND ITS RELATION TO EAST ANTARCTIC ICE-SHEET AND CLIMATE DYNAMICS

B. Diekmann, A. Eulenburg (AWI-P), H. Grobe, J. Bordenhagen, I. Voigt (AWI), B. Wagner (IOW)

Objectives

The question of ice-sheet stability in Antarctica has attracted palaeoclimatic research during the recent past, because of its potential impact on changes in global sea level and thermohaline ocean circulation. Apart from the dramatic hypotheses of possible total ice-sheet decay in western Antarctica in the face of present global warming, the knowledge of fluctuations of the voluminous East Antarctic Ice Sheet (EAIS) is crucial for the understanding of the late Quaternary global climate system. In the scope of RV *Polarstern* cruise ANT-XXIII/9, marine sediment records on a transect from the Prydz Bay area to the southern Kerguelen Plateau will be investigated, to infer EAIS dynamics (records of ice-rafterd debris, IRD) and its associated effects on Antarctic Bottom Water (AABW) formation. Another aspect will deal with variations in biological productivity and environmental proxies inferred from fossil bioindicators, to infer changes in sea-surface conditions (temperature, sea-ice cover). The study will be conducted in close collaboration with the palaeoceanographic working programme on the Kerguelen Plateau (De La Rocha & Gersonde) and the land-based palaeoenvironmental studies on the Rauer Islands (Bernd Wagner) (Dirk Wagner) and in the Amery Oasis (Melles).

Work at sea

The methodic approach implies the reconstruction of the proximal and distal glacialmarine depositional environment in the study area. The cruise-related studies are devoted to the identification of characteristic depositional units in the study area, as displayed in seismic sections obtained from a Parasound survey, and the recovery of representative marine sediment sections (surface sediments and sediment cores), using multicorer, box corer, piston corer, and gravity corer equipment. Shipboard studies comprise whole-core measurements of geophysical sediment properties (magnetic susceptibility, P-Wave Velocity, Gamma-Ray Density) with a GEOTECH Multi-Sensor Core Logger, sediment-core splitting, description and sampling, and x-ray imaging of sediment slices from the core sections. In connection with the planned seismic lines of the geophysical working group (Gohl), the study will focus on the following areas:

- Prydz Bay shelf, fjords, and Prydz Bay Channel: The shelf and fjord areas comprise condensed Holocene sediment sequences. The depression of the Prydz Bay Channel on the outer shelf was icefree during the late Pleistocene-Holocene and may include sediments older than Holocene. The records are used to reconstruct glacial-marine conditions during the postglacial stage and to identify possible evidence for palaeo ice-shelf water formation.
- Sedimentary basins on the outer Mac Robertson Shelf: These depressions are situated beneath the coastal iceberg track originating in Prydz Bay and include expanded Holocene sediment sequences of laminated diatomaceous muds. IRD records can be used to infer glacial dynamics during the present interglacial at high temporal resolution.

The reconstruction of biological productivity is essential to address the influence of sea-ice formation and changes in sea-surface temperatures.

- Depth transects across the continental slope and rise off Prydz Bay and the Mac Robertson Shelf: Hemipelagic and drift sediments provide good IRD records and give insights into contour current activity through time. Depending on the density of palaeo deep water masses, contourites may occur at different depth levels. The identification of gravitational sediment reworking (deposits that result from slumping, debris flows, or turbidity currents) gives clues for ice-sheet grounding and sediment bulldozing across the shelf edge in the past.
- Transect from the seaward abyssal plain to the southern Kerguelen Plateau: The Kerguelen Plateau is situated at the return loop of iceberg drift from Prydz Bay. IRD records from there are needed to verify the IRD patterns observed in the ice-proximal position, particularly on the higher positions that are not influenced by abyssal currents. In turn, the abyssal records provide evidence on the past flow activity of Antarctic Bottom Water flow. Biogenic sediments on the elevated parts of the Kerguelen Plateau are used for the reconstruction of palaeoceanographic conditions (see De La Rocha and Gersonde).

Expected results

Later onshore sediment-core studies will be focussed on the provenance and dispersal of ice-rafted debris (IRD) and the distribution of contourite/drift deposits in space and time, as indicators of palaeo iceberg drift tracks and AABW activity, respectively. Analyses on the concentration and composition of biogenic matter (carbonate, opal, organic carbon) will provide insights into the modes of biological productivity in the past. In addition to the proxy data inferred from individual samples, high-resolution measurements of downcore compositional variations will be carried out by multispectral colour logging and XRF element scanning of half-core splits at 1-mm resolution, to track environmental changes at centennial to decadal time scales. Cooperation is intended with associated scientists, dealing with stratigraphic items, marine particle fluxes, fossil bioindicators, and land records (see listed below). A synthesis of the new findings seeks to compare and integrate the inferred regional glacial and climate history with the overall pattern of past Antarctic climate and ice-sheet behaviour during the late Pleistocene-Holocene. The study contributes to the AWI POL6 topic "Palaeoclimate since the Pliocene" and is part of the BIPOMAC programme ("Bipolar Climate Machinery"), coordinated by R. Gersonde in the scope of the International Polar Year 2007/2008 (IPY).

Associated Scientists

- Rainer Gersonde, AWI (Siliceous Bioindicators, Mac Robertson Shelf and southern Kerguelen Plateau)
- Gerhard Kuhn, AWI (glacialmarine sedimentology)
- Martin Melles, University Leipzig (land-ocean linkages)
- Gesine Mollenhauer, AWI (Thorium-normalized particle fluxes, radiocarbon dating)
- Andreas Mackensen, AWI (stable-isotope stratigraphy)

4. MEASUREMENT OF SI AND N ISOTOPES, DIATOM MORPHOMETRICS, FE AND NUTRIENTS FROM SURFACE WATERS AND SEDIMENTS ALONG A LONG TRANSECT THROUGH THE SOUTHERN OCEAN

C. De La Rocha (AWI), C. Schlosser (IFM-GEOMAR), E. Anagnostou (RUNJ)
Not on board: R. Gersonde, G. Cortese (AWI), P. Croot (IFM-GEOMAR),
R. Sherrell (RUNJ)

Objectives

The Si and N isotopic composition of sedimentary diatoms are key proxies for reconstructing nutrient cycling in the Southern Ocean and its impact on atmospheric CO₂ over past climate cycles. They are respectively considered to reflect the extent to which the nutrients, silicic acid and nitrate, are removed from the euphotic zone in support of primary production. The extent of CO₂ uptake during primary production relative to the upwelling of CO₂-rich deep waters in the Southern Ocean, in turn, has a strong influence on atmospheric concentrations of CO₂.

To date paleoceanographic reconstructions of silicic acid and nitrate draw down in the Southern Ocean, south of the present day Antarctic polar front (APF), have produced conflicting results. The Si isotopic composition of diatoms has suggested that silicic acid is more completely consumed during interglacials, and is utilized to a significantly lesser extent during glacials, especially the last glacial maximum (LGM) and the maximum of the penultimate glacial cycle. The nitrogen isotopic composition of organic matter trapped within the siliceous framework of diatoms, however, suggests the opposite pattern for nitrate utilization.

One possible solution to this conundrum lies with the availability of the micronutrient, Fe, which should have been in greater supply in the glacial Southern Ocean due to enhanced deposition of Patagonian dust, alleviating phytoplankton growth from the widespread Fe limitation that is observed in the present interglacial. In addition to being crucial for growth, nitrate utilization, and photosynthesis, Fe plays a key role in diatom silicification. Diatoms that are Fe limited are hampered in their ability to take up and utilize nitrate but are at the same time prone to excessive uptake and incorporation of silicon. Thus the two nutrient cycles may be decoupled over time as Fe levels fluctuate. Although the impact of Fe on Si and N uptake has been studied in diatoms both in culture and in various ocean regimes (including the Southern Ocean), the impact of Fe limitation and recovery from Fe limitation on Si and N isotopes in diatoms and seawater has never been investigated.

The objectives of this work are twofold. First, they are to map Fe distributions in the Southern Ocean, relate them to Patagonian dust. Secondly they are to examine the relationship between Fe distributions, nutrient concentrations, algal physiology and morphology, and the Si and N isotopic composition of seawater and diatoms in the Southern Ocean.

Work at sea

By taking samples fairly continuously along the ANT-XXIII/9 cruise track from Pt Arenas to Cape Town via *Neumayer*, Prydz Bay, the Kerguelen and Crozet Plateau (Fig. 3, 4), we will gather information, at high spatial resolution, concerning dissolved Fe concentrations, and Si

and N isotopes and concentrations in the Southern Ocean. Also mapped will be changes in *F. kerguelensis* valve morphometrics that have been previously observed and hypothesized to be associated with shifts in Fe availability. Additionally, concentrations of chlorophyll, particulate organic carbon, and nitrate, silicic acid, and phosphate will be measured.

Surface water sampling for stable isotopes and trace metals will be completed using ship-board pumping systems and a membrane pumping system lowered through the "Brunnenschacht" moon-pool. Surface water will be analysed at sea for soluble, dissolved and particulate iron concentrations using a chemiluminescent flow injection analysis (FIA) system. Chlorophyll will also be measured on board. The remaining analyses (concentrations of other metals in the dissolved and particulate phases, metal:nutrient ratios (e.g. Cd:P or Fe:C), Fe speciation and solubility, intracellular Fe content, Patagonian dust, macronutrient concentrations, Si isotopes, and N isotopes) will be carried out back on land at the AWI, and at Kiel and Rutgers Universities.

To supplement the surface water ground-truthing work tying the metals, isotopes, diatom morphology and physiology, and nutrients together, water for isotopic analysis will be collected from different depths during CTD casts at sites where we will also collect surface sediments (multicores) and sediment cores for reconstruction of Si and N isotopes back through time.

Expected results

The cruise track (Fig. 3, 4) covers temperate to polar regimes, crosses over the Antarctic Divergence, the Antarctic Polar Front, and the Subantarctic Front, regions of low Fe availability as well as those, down wind of islands, where Fe is abundant, and both open and coastal waters, allowing us to document shifts in nutrients, trace elements, physiology, morphology, and isotopes over a broad range of conditions. Such ground-truthing of the relationships between isotopes, trace elements, nutrient concentrations, and diatom morphometrics will help us to improve Si and N isotope-based paleoceanographic reconstructions of nutrient utilization and CO₂ removal.

The data sets, in addition to enhancing our understanding of two proxies fundamental to reconstructions of Southern Ocean paleoceanography, fall under the auspices of the IPY umbrella project, BIPOMAC, and will also contribute to the trace metal and isotope mapping efforts of GEOTRACES.

ANTXXIII (Atlantic sector)

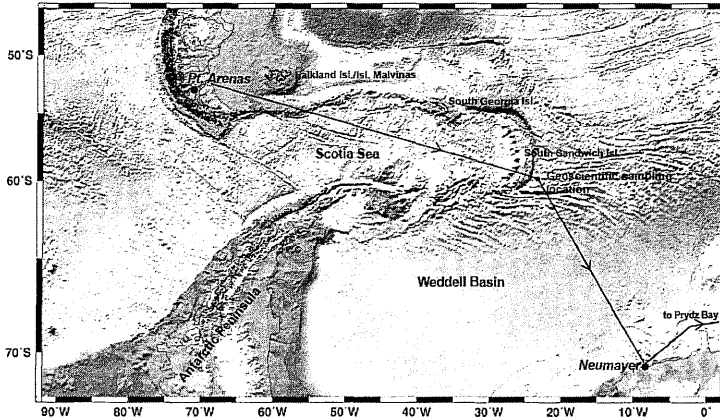


Fig. 3: Location of geoscientific sampling station in the Atlantic sector (East of South Sandwich trench) of the Southern Ocean (topography from Smith and Sandwell 1997)

ANTXXIII-9 (Indian sector)

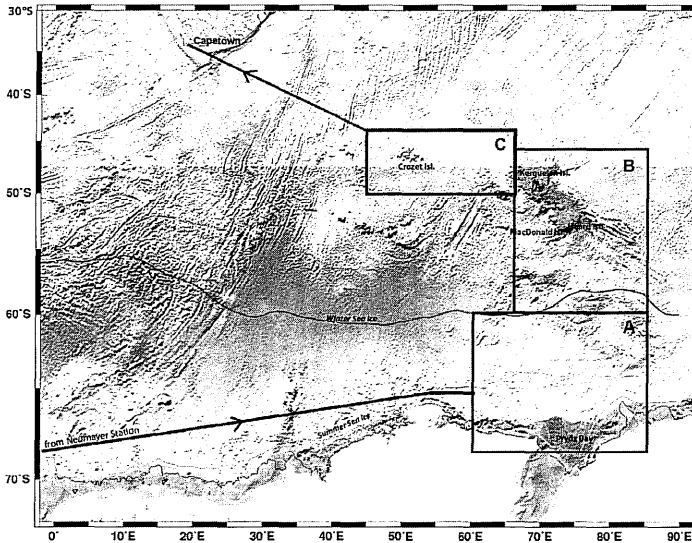


Fig. 4: Location of geoscientific sampling areas in the Indian sector of the Southern Ocean (topography from Smith and Sandwell 1997). Area A, Prydz Bay-Kerguelen Plateau; area B, central and northern Kerguelen Plateau; area C, Kerguelen-Crozet Plateau

5. DOCUMENTATION OF THE HOLOCENE AND PLEISTOCENE VARIABILITY OF THE ANTARCTIC CIRCUMPOLAR CURRENT (ACC)

C. De La Rocha , G. Diekmann, S. Sperlich, N. Lensch (AWI)
Not on board: R. Gersonde (AWI)

Objectives

Paleoceanographic and -climatic results of the past decade highlight the crucial role that physical and biological processes in the Southern Ocean, together with Antarctic ice sheet dynamics, play in defining and shaping global climate. The early response of Southern Ocean sea-surface temperatures (SSTs) and sea ice extent on orbital and suborbital timescales, the close link between Southern Hemisphere temperature and atmospheric CO₂, and the role of Southern Ocean water masses in supplying thermocline nutrients to equatorial and coastal upwelling regions implicates this region as a potential driver of global climate and ecosystem change. As the largest High-Nutrient-Low-Chlorophyll (HNLC) area in the world, the Southern Ocean has the potential to become a major CO₂ sink when the efficiency of the biological pump increases, as has been postulated for the glacial period. Finally, air-sea interactions in the Southern Ocean play a crucial role in closing the global ocean circulation loop and thus Southern Ocean climate has been hypothesized to play a key role in setting the rate of global overturning. To understand the Southern Ocean's role in and response to climate development and to link this information with records from continental ice cores (e.g. EPICA cores), high-resolution records from all sectors of the Southern Ocean are required.

Although station time for this project is limited, expedition ANT-XXIII/9 presents an excellent opportunity to recover additional sedimentary archives to study Holocene and Pleistocene paleoceanographic variability at one site in the Atlantic sector of the Southern Ocean and from a series of sites located on a latitudinal transect across the Indian sector. Successful coring at the Atlantic site will significantly augment our knowledge on the Southern Ocean climate variability during the Holocene at centennial to sub-centennial resolution. The latitudinal transect in the Indian sector will help to establish, together with existing transects in the Pacific and Atlantic sector, a circum-Antarctic view of Pleistocene ACC development.

Work at sea

Recovery of long (up to 25-30 m) piston cores is planned at one site in the Atlantic sector and at a series of sites on a latitudinal transect along the Kerguelen and Crozet Plateau. The site in the Atlantic sector, located east of the South Sandwich Trench (59°50,5'S, 23°23,0'W, water depth 4813 m) (Fig. 3), has been occupied during RV *Polarstern* expedition ANT-X/5 (1992) and a 12.40 m long core has been recovered. This core documents Holocene climate variability at yet unrivalled time-resolution (sedimentation rates around 300 cm/kyr) at an open ocean site in the Southern Ocean. To recover the longest possible core from this important site, time scheduled for this location should allow for more than one coring deployment.

The latitudinal transect in the Indian sector is designed to document Southern Ocean variability (surface water temperature and salinity, sea ice, nutrient regimes) between the Antarctic Zone and the northern boundary of the ACC. Sampling in the Prydz Bay-Southern Kerguelen Plateau area (Fig. 4, Area A) will be in close conjunction with the programme proposed by Diekmann et al.. In Area B (Fig. 4) we plan for piston coring at up to 4 sites and

in Area C (Fig. 4) at two sites. The selection of site locations will be based on shipboard Parasound/Hydrosweep survey and available information on sediment distribution from previous ODP drilling and sediment coring with the "Marion Dufresne" and "Robert Conrad", and will also consider the weather situation during the cruise.

The sediment piston coring will be accompanied by multicorer surface sediment sampling. Additionally, surface sediments will be recovered with the multicorer at selected sites in the Prydz Bay area and in shallower waters downwind of islands on the Kerguelen Plateau (ca. 3 – 5 sites).

Shipboard studies on sediment cores comprise whole-core measurements of geophysical sediment properties (magnetic susceptibility, P-wave velocity, Gamma-ray density) with a GEOTEC Multi-Sensor Core Logger, and to some extent sediment-core splitting, description and sampling, and x-ray imaging of sediment slices from the core sections.

Expected results

We expect to recover a Holocene-last glacial sediment record from the Atlantic sector, which documents paleoceanographic parameters such as surface temperature, sea ice and nutrient regimes at centennial to subcentennial resolution. As such this record will be a unique documentation of Southern Ocean open ocean development to be compared with Holocene high resolution records from coastal deposits (e.g. Mc Robertson Shelf basins, see Diekmann et al.) and continental ice cores.

The latitudinal transect in the Indian sector will provide new data on Pleistocene sea surface physical and biological variability. It will thus help to establish, together with existing transects in the Pacific and Atlantic sector, a circum-Antarctic view of Pleistocene ACC development, which can be compared with climate records obtained from continental ice cores and with records on continental ice stability from near shore sedimentary archives (see project by Diekmann et al.)

The surface sediments will enlarge our reference database on the distribution of siliceous microfossils (diatoms, radiolarians) in the Southern Ocean and will be used for acquisition of opal isotope data, as well as for flux rate measurements of biogenic and non-biogenic compounds via radionuclide measurements. These studies are essential baseline for paleoceanographic reconstructions.

The marine geoscientific studies will be conducted in close cooperation with the programme by B. Diekmann, H. Grobe and D. Wagner in the Prydz Bay area.

This work is an important contribution to the marine programme within MARCOPOLI workpackage POL6 and the international IPY project "Bipolar Climate Machinery" (BIPOMAC).

6. THE INFLUENCE OF SEDIMENT TRANSPORT ON $^{230}\text{Th}_{\text{XS}}$ INVENTORIES AND ^{14}C AGES OF ORGANIC MATTER IN INDIVIDUAL SEDIMENT FRACTION

S. Kretschmer, G. Mollenhauer (AWI)

Objectives

Sediment redistribution by bottom currents can be quantified by use of Thorium-230 inventories. While it is known that transport of sediment particles is selective according to the hydrodynamic properties of the individual sediment fractions (i.e., small grain size material is more susceptible to redistribution), little is known about the distribution of $^{230}\text{Th}_{\text{XS}}$ in the individual size fractions or particle type fractions. Laterally transported material is likely to be pre-aged and contain ^{14}C -depleted organic matter. Therefore, the ^{14}C age of organic matter entrained in the fine grain size fraction is expected to be older than bulk organic matter. Reactivity of individual organic compounds during passage through oxygenated water masses is a further control on their ^{14}C -age, as old and refractory material is selectively preserved.

We plan to compare the distribution of $^{230}\text{Th}_{\text{XS}}$ and $^{14}\text{C}_{\text{org}}$ in the individual grain size fractions from sediments from sites where sediment focusing occurs with results from nearby sites without significant amounts of laterally supplied sediments.

Work at sea

Neighbouring sites from water depth below 1000 m along the downslope seismic lines between Prydz-Bay and the Kerguelen Plateau will be sampled using multicorer and gravity corer. Sites will be selected such that they exhibit different thicknesses of sediment layers. Up to 2 parallel multicorer subcores (or box-corer subcores) per sampling location will be sliced in 1 cm intervals. Samples should be stored frozen aboard ship and during transport. Additional sample material will be retrieved from the deep shelf basins for the study of ^{14}C -ages of individual organic biomarkers.

Expected results

Grain-size fractionated $^{230}\text{Th}_{\text{XS}}$ and ^{14}C studies will contribute to our understanding of sediment transport and its importance in the formation of deep-sea sediment archives, in particular in the highly dynamic Southern Ocean environment. Time-scales of sediment transport can be derived. Furthermore, the controlling mechanisms for the preservation of organic biomarkers, in particular those derived from Antarctic phytoplankton, will be studied. These findings will have important implications for the use of biomarkers as proxies for past environmental conditions and for cycling of organic carbon in the Southern Ocean. In addition, stratigraphic information for related studies will be made available.

7. LATE QUATERNARY ENVIRONMENTAL HISTORY OF AMERY OASIS AND RAUER ISLANDS, PRYDZ BAY REGION, AS DEDUCTED FROM LAKE, EPISHELF LAKE, AND FJORD SEDIMENTS

M. Klug, S. Ortleb (IGUL), G. Müller (AWI-P), B. Wagner, H. Voge (IOW), D. White (GMU), O. Benneke (GEUS), S. Berg (IGUL)
Not on board: M. Melles

Objectives

Paleoclimatological and paleoenvironmental investigations in currently ice-free coastal areas (oases) of Antarctica function as a crucial link between respective investigations on the adjacent Antarctic Ice Sheet and Southern Ocean. From the oases, comprehensive information can exclusively be obtained on the natural variability of the local ice sheet extension, ice sheet altitude, climate, and relative sea-level. A detailed reconstruction of these variabilities throughout the recent geological past, allowing to identify their interdependencies, is a precondition for a thorough understanding of the ice sheet stability or lability against future climate change.

The RV *Polarstern* cruise ANT-XXIII/9 focuses on the Late Quaternary history of the Prydz Bay region, which is regarded as the key area for a better understanding of the East Antarctic Ice Sheet (EAIS) history. Significant volumes of the EAIS, which covers 79 % of the global ice volume, are drained into the Prydz Bay, most of which via the Lambert Glacier / Amery Ice shelf, the world's largest glacial drainage system. In order to investigate the variability of this drainage system in comparison to smaller drainage systems of the Prydz Bay region, and to better understand Holocene climate variabilities, which apparently exist in the coastal regions around Prydz Bay, the terrestrial paleoenvironmental research within the scope of the RV *Polarstern* expedition is carried out in Amery Oasis and Rauer Group. Amery Oasis is located at the western margin of the Lambert Glacier, being inundated by several smaller outlet glaciers from the west. The Rauer Islands, in contrast, form a coastal oasis bordered by the ice sheet to the southeast and the Prydz Bay to the northwest.

The key questions to be answered by the terrestrial paleoenvironmental investigations are

- Paleoglaciology: How did the ice sheet, the outlet glaciers, and the Amery Ice Shelf evolve through time both in extension and altitude, and what are the reasons therefore?
- Sea-level history: Which changes in the relative sea level have occurred in Amery Oasis and Rauer Group, and how did the sea-level changes interact with the glacial history?
- Paleoclimatology: Which changes in temperature and precipitation are documented in Amery Oasis and Rauer Group, and how did these changes interact with the glacial history as well as the sea-ice coverage and oceanic circulation patterns of the adjacent ocean?
- Comparison: Can the regional differences in the climatic and environmental history within the Prydz Bay region and in other East Antarctic coastal regions, as indicated in past work, be confirmed and, if so, what are their reasons?

Work on land

The reconstruction of the Late Quaternary climatic and environmental history of Amery Oasis and Rauer Islands will mainly be based on sediment sequences, which are sampled with light coring devices from lakes and fjords, usually following bathymetrical and hydrological site surveys. The sediments will be investigated with a multi-disciplinary approach involving geochronological, sedimentological, geochemical, and biological methods. The study is carried out in close collaboration with microbiologists, geomorphologists, and geocryologists working in the Rauer Islands (D. Wagner et al.), and with marine geologists working on the continental shelf and slope of Prydz Bay (B. Diekmann et al.). It is part of the BIPOMAC initiative ("Bipolar Climate Machinery"), which has been established within the scope of the International Polar Year (IPY) 2007/2008.

The field work in Amery Oasis will be restricted to a maximum of four weeks, due to the remoteness of the region and the related uncertainties in helicopter transport. The work shall start at a small lake located at c. 60 – 80 m a.s.l. on a bedrock ridge at the southern margin of the oasis. This lake, due to the absence of glacial ice in the catchment and limited fluvial supply, promises to hold a highly biogenic sediment sequence that can well be dated using the radiocarbon method and may very sensitively reflect the climatic history of the oasis in its biogenic composition. Subsequently, the field party shall move the camp to the southwestern shore of the much larger Beaver Lake. This lake is located at the southern end of a horseshoe-shaped valley, which is inundated from the north by a tongue of the Nemesis Glacier. It is a so-called epishelf lake that has a hydraulic connection to the ocean beneath the floating glaciers and Amery Ice Shelf. At Beaver Lake, 3 to 5 transects perpendicular to the shore shall be studied for bathymetry, hydrology, and sediment sections. The major purpose are reconstructions of the glacial history and of sea-level changes below modern.

In the Rauer Group hydrological and bathymetric measurements, water sampling, and sediment coring shall be conducted on the lakes as well as in the fjords, which inundate the oasis from the north. Seven lakes were selected according to different altitudes (2 to 30 m a.s.l.) and hydrological characteristics (e.g., freshwater to hypersaline). Their investigation shall help to reconstruct the sea-level history of the oasis by identification and dating of marine-limnic sediment transitions. Furthermore, reconstructions of paleosalinities of closed saline lakes can supply important information concerning the precipitation history. In the fjords of Rauer Islands, coring sites were selected in bays, which according to their shape likely are separated from the open ocean by submarine sills. Cores from these basins offer the opportunity to study relative sea-level changes below modern, and may contain sapropel sequences, which usually are characterized by a sensitive documentation of regional climate change in their biogenic composition, as well as high sedimentation rates and lack of bioturbation, leading to very good time resolutions.

Expected results

From the results a significantly better understanding of the interactions between the glacial history, the morphology at the ice margin, and changes in relative sea level and climate of the Prydz Bay is expected. The results shall be put in a circum-antarctic context in order to better understand the peculiarities of the Prydz Bay region. Furthermore, they shall be used to validate a new numerical ice sheet model for East Antarctica, which is run by collaborators in Australia and the U.K, and thus foster predictions of the ice sheet behaviour under future climatic and environmental changes.

Associated Scientists

- Bernhard Diekmann (land-ocean linkages)
- Dirk Wagner (permafrost behaviour Rauer Islands)

8. FUNCTIONAL MICROBIAL DIVERSITY IN EXTREME ANTARCTIC HABITATS: ABUNDANCE, PHYLOGENY AND ECOLOGY

D. Wagner, L. Ganzert (AWI-P), C. Miller (AWI), A. Gatteringer (GSF)

Objectives

Within the scope of the project, the diversity and ecology of microbial communities and their function in nutrient turnover under the extreme conditions in Antarctic periglacial regions will be studied. Polar regions are vast and unique natural laboratories, both because of their geographical isolation and the minor anthropogenic influences active there, for studying microbial life under extreme environmental conditions. For this purpose the diversity and abundance of the microflora in dependence of important site characteristics such as hydrological, thermal and weathering processes will be investigated in different habitats in ice-free areas on Larsemann Hills and Rauer Islands (Prydz Bay, Antarctica). The main objectives are the genotypic and phenotypic characterization of the microbial community by cultivation-independent methods such as lipid profiling and rRNA-based analyses and by physiological characterization of isolated microorganisms. Stable isotope probing will be used to identify the main microbial players in nutrient turnover in the different environments. The scientific investigations will concentrate on the following goals:

- Soil chemical and physical characterization of the investigation sites regarding microbial life under extreme environmental conditions,
- Cultivation independent characterization of microbial communities to improve the knowledge of the abundance and biodiversity of the indigenous microflora,
- Understanding of the structure and function relationships of microbial communities in nutrient fluxes in polar habitats.

Field work

During the fieldwork soil samples from ice-free areas of the Prydz Bay region (Larsemann Hills, Rauer Islands) will be taken from each horizon of the different soil and sediment profiles for microbiological analysis. Additionally, physical parameters like soil temperature, soil moisture and permafrost depth as well as the description of the sampled soils and sediments will be done.

The acquired data will give insights into the early stage of life on Earth, the development of extreme habitats and the functioning of microbes within the ecosystem. Furthermore it is planned to obtain pure cultures of microorganisms from soils and sediments of the study sites to characterize and to describe microbes surviving under harsh environmental conditions in Antarctica. The planned study contributes to the research topics of the *International Polar Year* proposal entitled "Antarctic and sub-Antarctic Permafrost, Periglacial and Soil Environments" (ANPAS, No. 627, by Dr. Jan Boelhouwers).

9. DECIPHERING THE EVOLUTION OF ULTRAHIGH TEMPERATURE GRANULITES, PRYDS BAY, ANTARCTICA: REACTION TEXTURES, REACTION HISTORY AND THE RELATIONSHIPS BETWEEN LOWER CRUSTAL AND MANTLE PROCESSES DURING CONTINENT FORMATION AND DESTRUCTION

R. Oberhänsli and P. O'Brien (IGUP)

Objectives

One of the critical areas for understanding Antarctic geology is the Region along the eastern side of Prydz Bay where existing studies reveal metamorphic complexes of different character and age. In the space of about 150 km, from north to south, are found the Vestfold Block, Rauer Group islands, Brattstrand Bluffs and Larsemann Hills. The Rauer Group of islands sits in an unusual situation - just to the North (Vestfold Hills) granulites are Archaean (2520-2485 Ma) whereas just to the south (Brattstrand Bluffs) are widespread units with a dominantly Pan-African (530-510 Ma) age (Fitzsimons and Harley, 1991; Sheraton and Collerson 1983). The rocks of the Rauer Group have yielded ages for three different episodes (Sheraton et al., 1984; Kinny et al., 1993; Hensen and Zhou 1995a) of metamorphic/magmatic activity - Archaean, Grenvillian (1000 Ma) and Pan African (around 500 Ma). Is this just a fragment of reworked Archean basement as to the north? Is this a separate terrane? Is the whole of the Rauer Group a transitional zone with fragments of both? A definitive answer to these questions is needed in order to properly understand the geodynamic evolution during Gondwana formation and destruction.

Our aims are two-fold. Firstly, we wish to use our self-developed, state-of-the-art methods of quantitative mapping of reaction textures combined with domain-linked thermodynamic calculations, to determine more precisely and accurately the pressure-temperature evolution of the granulite facies rocks of the Rauer Group and Larsemann Hills areas. Due to the complexity of multiple reactions, as outlined by previous workers, the rocks show disequilibrium on a large scale but an approach to equilibrium on a local scale can be tested once the actual mass balance has been determined. Combined with this analytical part of the research we will also search out domains where compositional variation exists such that the temperature-time evolution can be determined, or at least bracketed, by diffusion modelling. The second part of the study will be to attempt to determine accurate age information for the different stages of the metamorphic evolution. This will involve microanalytical techniques as well as state-of-the-art micro-extraction techniques many of which have been widely used and developed by our working groups. This information, when combined, will yield a well established pressure-temperature-time path for the Rauer Group and Larsemann Hills areas and thus enable us to clearly determine which of the manifold tectonometamorphic scenarios for the area are appropriate. The ability to distinguish between a supposed Pan-African near isothermal decompression at high temperature and Pan-African re-heating of older (Archaean and/or Grenvillian) medium to high pressure rocks at lower pressures will have extremely important consequences for Gondwana reconstruction and destruction models.

Work on land

The areas to be investigated are the numerous islands of the Rauer Group and the islands and peninsulas comprising the Larsemann Hills (both Prydz Bay). For the islands already visited various geological maps exist (with different emphasis on lithology, structure or metamorphism) but where necessary we will augment these maps with our own observations and interpretations as well as undertaking new mapping of islands and areas not already investigated. In the Rauer Group we will be searching for, and sampling the dominantly felsic orthogneisses, but also mafic dykes, metapelites, calc-silicate gneiss and granitic pegmatites. We will focus on collecting samples with macroscopically-visible (at least with a hand lens) reaction textures such as coronas, symplectites and intergrowths. These will allow us to quantify the different metamorphic stages in terms of formation conditions and hopefully also age. Although two distinctive metamorphic stages have already been identified in the metapelites (e.g. Harley 1987) including an ultrahigh-temperature stage ($>1000^{\circ}\text{C}$) (e.g. Harley, 1998) there is some dispute as to the validity of the methods applied with respect to the particular bulk compositions (e.g. Kelsey et al., 2003). We intend to expand the number of intensively investigated samples and, in the light of new experimental and empirical thermodynamic data and activity models, try to resolve this dispute which has important consequences for the investigation and interpretation of ultrahigh-temperature granulites.

In the Larsemann Hills we will be sampling the dominant migmatitic orthogneisses (e.g. Carson et al., 1997) as well as the various metasedimentary rocks. Again we will be searching for reaction domains – in this case often where partial melting has modified original microstructures and mineral assemblages – with the intention of documenting both the age and conditions for the reaction stages. The critical point to the field studies is to identify and collect rocks that show a definite history. These 'special' samples can then be compared petrologically and geochronologically with our collection of 'standard' rocks from the area.

Expected results

As in all areas of high grade metamorphism with a complex multistage history it is necessary to investigate a large number of samples in order to piece together the whole reaction history. Therefore, despite previous investigations in parts of these areas, we expect, as in other previously-investigated areas where we have studied, that there are still undiscovered pieces of the puzzle to be unearthed. The main advances will come from the state-of-the-art microanalytical techniques we will be using once back in the laboratory. With the use of quantitative compositional mapping of reaction domains (method outlined in de Andrade et al., 2006) we will make the first attempts to quantify the different reaction domains such that powerful thermodynamic methods can be applied with realistic values for changing effective bulk composition (see also Kelsey et al., 2003). One of the expected results is that so-called decompression textures will turn out to require less extreme pressure changes and be more strongly affected by local bulk compositional controls. The quantitative mapping will also allow us to model kinetic effects (such as grain boundary or volume diffusion effects, nucleation site variation or grain size distribution) in order to better understand the extent and controls of reactions. In addition, our in-house microsampling methods combined with microanalysis will be utilised for micro-geochronological investigations of monazite and zircon in the same thin sections for which we undertake geothermobarometric studies in order to get the highest possible controls on pressure-temperature-time histories.

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10. DEPLOYMENT OF ARGO-FLOATS

O. Klatt, K. Muhle (AWI Bremerhaven)

Objectives

The Antarctic ocean contributes through atmosphere-ice-ocean processes to the variability of the climate system. In the Weddell Gyre, Circumpolar Deep Water enters from the north and circulates in intermediate layers within the large cyclonic gyre. By upwelling and entrainment heat and salt of that water mass is transported into the surface layers. This transport counteracts to the heat loss and fresh water gain at the sea surface. The delicate balance controls the stability of the water column.

Our overall objective is to deploy Argo-floats the south-eastern part of the Weddell Gyre and into the Antarctic Coastal Current to the east of the Weddell Gyre. In these areas water mass exchanges between the Weddell Gyre and the Antarctic Circumpolar Current and water mass formation takes place. However, so far not any floats were deployed in these key-regions of the global climate system.

The Argo project intends to continuously monitor temperature and salinity of the upper 2000 m of the global ocean. The project aims for an array of approximately 3000 autonomous, profiling floats on a 3° x 3° grid by 2006. This array will provide basin-wide hydrographic data in near real-time, forming the backbone of operational oceanography and climate research. While the float coverage at low- and mid-latitudes is already moderate to good, float deployments at higher latitudes remained marginal until 2005. This was due to the imminent danger of damage or loss of floats by collision with ice floes. During the last years a significant improvement in the floats' ice-resilience has been carried out. Hence, since mid 2005 ice-compatible floats are available.

Work at sea

We will deploy 20 autonomous, profiling floats in the south-eastern part of the Weddell Gyre and into the Antarctic Coastal Current to the east of the gyre. For calibration purpose of the floats as most as possible profiles with a CTD probe and a rosette water samples we will carried out (conductivity/temperature/depth).

Expected results

During the next 3 years each float will measure a temperature and salinity profile from 2000 m depth to the surface every 10 days, i.e., about 150 profiles per float. In particular, we will get the first winter profile data from these areas. This will offer valuable clues to the

interaction of the Weddell Gyre and the Antarctic Circumpolar Current and the seasonal variability of the upper and intermediate ocean.

11. MABEL: MULTIDISCIPLINARY ANTARCTIC BENTHIC LABORATORY: THE FIRST DEEP-SEA OBSERVATORY IN ANTARCTICA - RECOVERY MISSION

M. Calcara, N. Lo Bue, G. Marinaro, P. Favali (INGV),
H. W. Gerber (TFHB), H. de Vries (TUB)

Introduction

The deep sea plays a key role in global climate changes and is strategic for the Geodynamics studies. The Scientific Community needs to extend the existing land-based network of permanent observatories into ocean basins, especially at abyssal depths, poorly explored. These needs have forced the industry to develop both marine intervention system and the auxiliary systems for sea monitoring. Ocean environment is a sort of buffer system and allows to face different scientific fields as than on land. Moreover, the study of the oceans is growing ever and ever in importance to evaluate Global Change. Efforts have been made worldwide for direct monitoring on the seafloor (Favali and Beranzoli, 2006). Since 1995 European Commission supported and funded the GEOSTAR (GEophysical and Oceanographic SStation for Abyssal Research; Beranzoli et al., 2000; Favali et al., 2002; 2006) project that developed a new concept of seafloor observatory, focusing on modularity, manageability and flexibility for long-term continuous multidisciplinary monitoring. The technological and scientific evolution in the GEOSTAR prototypes led to the deployment of a networked system in Southern Tyrrhenian Sea at the base of the Marsili volcanic seamount (over 3,300 m w.d.) in December 2003 for a more than one year geophysical, oceanographic and geochemical data (Favali et al., 2006). Relative low cost observatories, they are user configurable, quite easily managed by an infrastructure ad hoc developed, MODUS the vehicle for easy and precise deposition and recovery using normal research vessels. From this experience, a first step toward Antarctic observation was made with the Italian PNRA MABEL project (Multidisciplinary Antarctic Benthic Laboratory; Calcara et al., 2001; Favali et al., 2006). Derived from GEOSTAR concepts, this project is adapting and developing a new observatory for its deposition in collaboration with Alfred-Wegener-Institut in an area located northward German Antarctic Base *Neumayer*.

Continuous recording of multidisciplinary parameters will constitute first multidisciplinary data bank of polar deep-sea environment; tectonic features, oceanographic parameters, and chemico-physical parameters will be recorder for a year long. Their data will serve for each discipline; for tectonic studies for first studies on crustal behaviour and properties, for investigating any active tectonic feature, oceanographic and chemical data will depict evolution of water masses, their behaviour in the deepest water state, near to the sea bottom, with physical, chemical and thermodynamic distinct point of view. The overall data could also be useful in pointing out eventual crustal contribution.

MABEL mission

Commercial instruments and custom service packs and home made instruments were tested both in Hamburgische Schiffbau Versuch Anstalt (HSVA) in July-August 2002 (Cenedese et al., 2004) and in dedicated labs in Pordenone (Italy) in 2005. Some parts of the DACS as well some parts of experimental chemical analyser already tested and used in a former Antarctic cruise (Calcara, 2003).

Scientific payload is composed by:

Instrument	Sampling rate
PMD 3-C broadband seismometer	100 Hz (per channel)
Falmouth 3-axial single-point current meter	2 Hz
Sea Bird CTD SBE 16	1 sample/hour
Alphatrack light transmissometer	1 sample/hour
pH and Eh autocalibrating analyser (INGV-Tecnomare prototype)	1 sample/2 days
McLane Water sampler	1 sample/8 days

- Service and communication devices are summarised as follow:
- Data Acquisition and Control System (DACS)
- Central High Precision Rubidium Clock
- Attitude observatory control
- 12 VDC and 24 VDC Battery Vessel
- Acoustic link for command and data transmission.

At 05.32 of 5 December 2005, *MABEL*, the first multidisciplinary deep-sea observatory ever deployed in polar areas, was deployed at a depth of 1874 m (69°24,295' S - 5° 32.220' W). Data acquisition started automatically on the 6th December 2005, 16.00 UTC with the seismometer release, allowing it to be coupled directly with the sea bottom, and with other instruments acquisition. The data recording will last up to 31 December 2006, when the station automatically will end acquisition and all instruments will be undergo to standby. Data are stored in the DACS on dedicated hard disks. Successively, some data were recovered through acoustic modem, after 20 days of *MABEL* mission. Interrogation of the station with acoustic modem demonstrated the overall validity of the system, also in its service parts, e.g. acoustic link and data transmission.

Recovery mission

The recovery mission of *MABEL* observatory must be conducted with the aid of the deployment/recovery vehicle MODUS, winch and sheave. The dimensions of the different parts are described in the following (see Table 1).

Table 1: Size and weight of *MABEL*, MODUS and winch

Item	Dimensions (m) (L x W x H)	Weight (kN) (in air)	Weight (kN) (in water)
MABEL	2.90 x 2.90 x 2.90	14.0	8.5
MODUS	2.88 x 2.35 x 1.70	10.0	7.0
Winch	3.80 x 2.35 x 2.40	181	-
Sheave	1.05 (Ø)	0.2	-

The winch will be placed on the bow, handled as a container ISO 20". The crane present at bow is capable to move weights up to 25 tons, so the handling of our winch should be not a problem. The winch will be placed parallel to the length of the ship; nothing must be present between the winch and the sheave (mounted on the ship's crane) when the cable is in position; right angle must be respected avoiding torsions.

The vehicle will be placed in water, once the ship is positioned on the vertical of *MABEL*. Instrumental and visual detection of *MABEL*, once the vehicle is at depth, will be executed thanks to its payload:

- 4 (or 6) thrusters
- 4 cameras and lights
- sonar
- heading
- tilt, pitch and roll controls.
- altimeter.

First contact is usually with sonar. Once the signal reflected from *MABEL* is acquired and visible to the control station, fine movements of the ship and of the vehicle led to the closest approach of the station, guided also with the images acquired with the cameras. Once the vehicle is placed exactly on the vertical of the pin of the station, the ultimate movement of MODUS is the physical latching with the station. Signal on the control room through telemetry ensure the executed safe latch between MODUS and *MABEL*. At this point, recovery can begin.

When the recovery will be executed, the winch can be handled as a normal container ISO 20" and placed in the normal position (or stowed in the keel), the station will be disassembled and all parts (instruments) can be stored, and data present in the DACS will be generally recovered on board, starting first quality check and analysis of the acquired data.

Conclusion

The deep-sea seafloor observatory (*MABEL*) has been installed in polar areas for the first time. The continuous recording and acquisition of several parameters will allow to focus on tectonic features, structures and eventual local activity, also with the integration of the seismometer data collected both on *MABEL* observatory and *Neumayer* "on-land" seismometers; studies on temporal distribution of metals like Iron and other components, the variability of pH values also seeking possible variations also due to summer and winter stage, on current variations and water masses features in proximity of sea bottom.

Water samples collected will be analysed in on shore labs. The data will be analysed, integrated and compared also with CTD data, in order to depict different chemical characteristics, finding out eventual stratification and clustering, to be eventually related to different water masses origin and history.

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Wagner	Dirk	AWI-P	Biologist
White	Duanne	GMU	Geologist
Ziegler	Jonas	FHK	Television

14. SCHIFFSBESATZUNG / SHIP'S CREW

Name of Ship : RV POLARSTERN

Nationality : GERMAN

Punta Arenas- Cape Town

No.	Name	Rank
1.	Schwarze, Stefan	Master
2.	Spielke, Steffen	1.Offc.
3.	Farysch, Bernd	Ch. Eng.
4.	Fallei, Holger	2. Offc.
5.	Wunderlich, Thomas	2.Offc.
6.	Niehusen, Frank	2.Offc.
7.	NN	Doctor
8.	Hecht, Andreas	R.Offc.
9.	Minzlaff, Hans-Ulrich	2.Eng.
10.	Wanke, Steffen	3.Eng.
11.	Sümnicht, Stefan	3.Eng.
12.	Scholz, Manfred	Elec.Tech.
13.	Nasis, Ilias	Electron.
14.	Verhoeven, Roger	Electron.
15.	Muhle, Helmut	Electron.
16.	Himmel, Frank	Electron
17.	Loidl, Reiner	Boatsw.
18.	Reise, Lutz	Carpenter
19.	NN	A.B.
20.	NN	A.B.
21.	Winkler, Michael	A.B.
22.	NN	A.B.
23.	Hagemann, Manfred	A.B.
24.	Schmidt, Uwe	A.B.
25.	Bäcker, Andreas	A.B.
26.	Wende, Uwe	A.B.
27.	Preußner, Jörg	Storek.
28.	Ipsen, Michael	Mot-man
29.	Voy, Bernd	Mot-man
30.	Elsner, Klaus	Mot-man
31.	Hartmann, Ernst-Uwe	Mot-man
32.	Pinske, Lutz	Mot-man
33.	Müller-Homburg, Ralf-Dieter	Cook
34.	Silinski, Frank	Cooksmate
35.	Martens, Michael	Cooksmate
36.	Jürgens, Monika	1.Stwdess
37.	Wöckener, Martina	Stwdss/KS
38.	Czyborra, Bärbel	2.Stwdess
39.	Silinski, Carmen	2.Stwdess
40.	Gaude, Hans-Jürgen	2.Steward
41.	Möller, Wolfgang	2.Steward
42.	Huang, Wu-Mei	2.Steward
43.	Yu, Kwok Yuen	Laundrym.

ANT-XXIII/10

**12 April 2007 – 4 May 2007
Cape Town – Bremerhaven**

**Chief Scientist:
Andreas Macke**

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1. ÜBERBLICK UND FAHRTVERLAUF

Andreas Macke (IFM-GEOMAR)

Am 12. April 2007 wird das FS *Polarstern* den Atlantiktransfer von Kapstadt nach Bremerhaven antreten. Die Fahrt wird zur kontinuierlichen Untersuchung atmosphärischer Zustandsgrößen wie Aerosolzusammensetzung, Temperatur- und Feuchteprofilen, Bewölkungsstrukturen und Strahlungshaushalt sowie Spurengaskonzentrationen unter unterschiedlichsten klimatischen, meteorologischen und urbanen Bedingungen genutzt. Ein Teil der Messungen dient der Validierung von Satellitenbeobachtungen der Atmosphäre über ozeanischen Regionen. Folgende Projekte werden durchgeführt:

Sauerstoffanomalie atmosphärischer Nitrate (NITRATLANTIK).

Ziel der Arbeiten ist die Erfassung der isotopischen Zusammensetzung von Nitraten im atmosphärischen Aerosol unter unterschiedlichsten Umgebungsbedingungen. Der wissenschaftliche Hintergrund ist die Untersuchung von Oxidationsprozessen in der Atmosphäre.

Spurengaskonzentrationen in der Atmosphäre (MAXDOAS).

Mit Hilfe der bewährten „Differenziellen Optischen Absorptionsspektroskopie“ DOAS werden kontinuierlich die Konzentrationen der Spurengase O_3 , SO_2 , NO_2 , H_2O , BrO und anderen in der Atmosphärensäule gemessen. Ziel der Arbeiten ist u.a. die Validation des SCIAMACHY-Instruments auf dem ENVISAT-Satelliten der ESA.

Atmosphärenzustand und Strahlungsbilanz an der Grenzfläche Atmosphäre/Ozean (MetOp & MORE)

Die Kombination aus Mikrowellenradiometer, Ceilometer, Vollhimmelskamera sowie Pyrano- und Pyrgeometer ermittelt den Zustand der bewölkten Atmosphäre und ihren Einfluss auf die Nettostrahlungsbilanz an der Meeresoberfläche im Rahmen des „Meridional Ocean Radiation Experiment“ MORE. Gemessene Temperatur- und Feuchteprofile dienen auch zur Validation der Produkte des Radiometer IASI an Bord des neuen europäischen Wettersatelliten MetOp.

Am 4. Mai 2006 wird das FS *Polarstern* in Bremerhaven einlaufen.

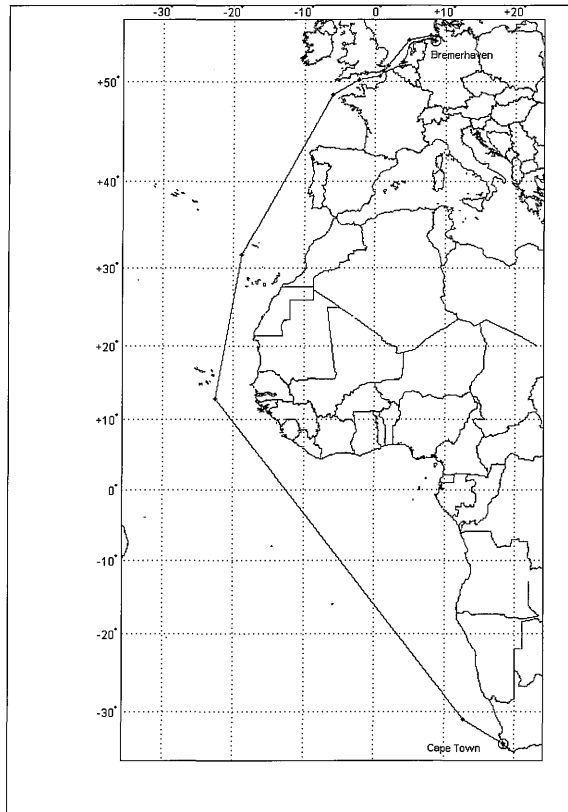


Abb. 1: Geplante Fahrtroute der FS Polarstern-Reise ANT-XXIII/10
Fig. 1: Planned cruise track of RV Polarstern expedition ANT-XXIII/10

ITINERARY AND SUMMARY

On 12 April 2007 RV *Polarstern* will start its transfer from Cape Town to Bremerhaven. The cruise will be used for continuous investigations of atmospheric parameters like composition of aerosol, temperature and humidity profiles, cloud structure and radiation budget as well as trace gas concentrations under a variety of different climatic, meteorological and urban conditions. Parts of the measurements serve as validation for satellite observations of the atmosphere above ocean regions. The following projects will be carried out:

Oxygen anomaly of atmospheric nitrate (NITRATLANTIK).

The work aims at retrieving the isotope composition of nitrates in atmospheric aerosol under different environmental conditions. The scientific background lies in the investigation of oxidation processes in the atmosphere

Trace gas concentrations in the atmosphere (MAXDOAS).

By means of the well established "Differential Optical Absorption Spectroscopy" DOAS concentrations of the trace gases O₃, SO₂, NO₂, H₂O among others will be measured on a continuous basis. One of the goals of these activities is to validate the SCIAMACHY instrument on board the ESA satellite ENVISAT.

Composition of the atmosphere and radiation budget at the atmosphere/ocean intersection (MetOp & MORE)

In the framework of the "Meridional Ocean Radiation Experiment" MORE the state of the atmosphere and its effect on the net radiation budget at the sea surface will be obtained by a combination of a microwave radiometer, ceilometer, full sky imager as well as pyrano- and pyrogeometer. Retrieved temperature- and humidity profiles serve to validate products of the IASI radiometer on board the new European weather satellite MetOp.

On 4 May 2007 RV *Polarstern* will reach the destination Bremerhaven.

2. NITRATLANTIK: INVESTIGATION OF THE OXYGEN ANOMALY OF ATMOSPHERIC NITRATE FROM 50°S TO 50°N IN THE ATLANTIC OCEAN

S. Morin (LGGE)

Not on board : J. Savarino (LGGE)

Objectives

The analysis of the isotopic composition of nitrate in various environments (marine, atmospheric, ice cores ...) is a rapidly- growing field of investigation. Isotope measurements complement concentration data, which alone do not allow for a thorough understanding of the intricate cycling of nitrogen oxides at the surface of the Earth, and in particular in the atmosphere. The discovery that ozone, one of the most prominent oxidant in the atmosphere, could transfer its isotopic anomaly ($\Delta^{17}\text{O}=\delta^{17}\text{O}-0.52\times\delta^{18}\text{O}$) to nitrogen oxides (NO_x, the precursors of nitrate), has brought to light the potential for atmospheric nitrate

isotopes to be a proxy for the oxidative capacity of the atmosphere. So far, coupled measurements of $\delta^{15}\text{N}$, $\delta^{18}\text{O}$ and $\Delta^{17}\text{O}$ in atmospheric nitrate have only been achieved in polar regions (e.g. Dumont D'Urville, Dome C, South Pole (Antarctica) and Alert, Nunavut, Barrow, Alaska and Ny Ålesund, Svalbard) and have shown a strong link between the ozone mixing ratio at the surface and the isotopic composition of nitrate. However, very little is known about the behavior of nitrate isotopes at mid- to low- latitudes, especially in marine conditions. This research programme therefore aims at documenting the isotopic composition of atmospheric nitrate along the route followed by the RV *Polarstern*. During this campaign, many different kinds of air-masses are expected to be probed (polluted marine conditions when leaving Cape Town and reaching Northern Europe, remote marine conditions when far from the coast, air-masses affected by biomass-burning, dust storms, pollution outflow ...). In addition, the route followed by the RV *Polarstern* will parallel a strong gradient in temperature and humidity, hence accompanied by large changes in the oxidative capacity of the atmosphere.

To complement these observations, additional measurements will be carried out on samples taken onboard:

- measurements of the concentration of major ions within the aerosol samples (including Cl^- , NO_3^- , SO_4^{2-} , Br^- , Ca^{2+} , Na^+ , Mg^{2+} , K^+ , NH_4^+)
- characterization of elemental vs. organic carbon in aerosols (EC/ OC, J.L. Jaffrezo - LGGE)
- speciation of organic matter in the aerosols (D. Voisin, M. Legrand, S. Preunkert - LGGE).

Work at sea

Samples taken onboard the RV *Polarstern* will mainly consist of aerosol and gas phase species trapped on paper filters by means of high-volume air sampling : for each sample, about 10 000 m³ of air will be dragged through a filtering medium. Size-segregated aerosols will be sampled using a four-stage cascade impactor, to separate the fine aerosols (end-product of gas-phase atmospheric reactions) from the sea-spray particles (formation of aerosols at the surface of the ocean, hence having a chemical composition very close to that of sea water). Filters will be changed daily under marine conditions, and semi-daily in polluted conditions. Additionally, rain water samples will be taken during each rain episode. Several sea water samples will be collected to estimate the variability of the chemical characteristics described above within the ocean surface itself.

The ozone mixing ratio will be continuously monitored during the cruise, and meteorological data acquired onboard will be used for the interpretation of data.

Expected results

It is expected this campaign to yield the first comprehensive data set of $\delta^{15}\text{N}$, $\delta^{18}\text{O}$ and $\Delta^{17}\text{O}$ in atmospheric nitrate in oceanic conditions and/or at low latitudes. Complimentary data from sea water and rain water will contribute to the representation of several earth surface compartments in terms of nitrogen oxides cycling, with an unprecedented latitudinal resolution. The additional measurements mentioned above will lead to the closure of the mass balance of aerosol samples.

3. TRACE GAS CONCENTRATIONS IN THE ATMOSPHERE (MAXDOAS)

Not on board: T. Wagner (University Heidelberg)

Objectives

An important aspect of environmental sciences is the knowledge on trace gases and their concentration and distribution in the atmosphere. Especially interesting are tropospheric trace gases like NO_2 , H_2O , HCHO , IO , BrO , O_4 and SO_2 as well as stratospheric ones like O_3 , NO_2 , BrO , OCIO , H_2O , HCHO , and IO . According spectroscopic measurements can be performed on different platforms for instance by satellites, such as the instrument SCIAMACHY onboard the European ENVISAT, which was launched into a polar orbit in March 2002. To validate satellite data, however, ground-based control-measurements done at locations beneath the satellite's orbit are necessary. In case of SCIAMACHY, measurements onboard of RV *Polarstern* seem to be best suited for that purpose, because the ship follows a polar course relevant to ENVISAT's orbit when it is going on its way to and from the Antarctica.

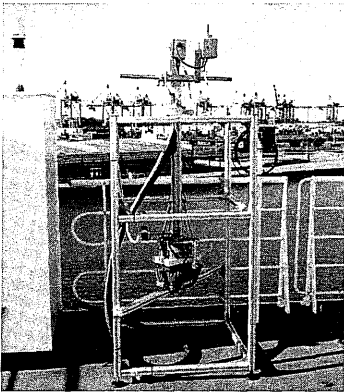


Fig. 2: The on-deck instrumentation of the MAX-DOAS instrument. The telescope unit is mounted on a cardanic system whereby the brush is used for reducing the motion influenced by the ship's movement.

DOAS instrumentation: The method used by the satellite's instrument is the approved Differential Optical Absorption Spectroscopy (DOAS). For this principle, the fact is used that solar light passing through the atmosphere is not only scattered but also absorbed by gas molecules and will thereby yield characteristic absorption lines for each trace gas within the collected spectra. From these lines, identity and amount of atmospheric trace gases can be obtained. For ground-based measurements, it is even possible to derive height profiles of the trace gases: stray light spectra from zenith sky measurements are mainly dominated by stratospheric absorption, whereas measurements from lower telescope elevation angle become more sensitive to tropospheric absorption due to the enhanced light paths in lower atmospheric layers. This is the so-called Multi-Axis-DOAS principle.

The validation instrument onboard RV *Polarstern* also applies the (MAX-)DOAS measurement principle of the satellite's apparatus. Thereby a moveable telescope which is able to point sequentially to different directions in the vertical plane is mounted on a cardanic system to reduce the effect of the ship's movements (see Fig. 5). The incoming light is conducted to a cooled miniature Czerny-Turner spectrograph/CCD-detector unit (OceanOptics USB2000) by glass fibres. The wavelength range of about 290 to 430 nm allows for example the retrieval of NO_2 , BrO , SO_2 and HCHO . Last, the gained spectra are stored in PC hard disk for the later DOAS analysis. The instrument is working mostly automated.

Expected results

E. g. measurements performed during the cruise ANT-XIX of RV *Polarstern* from Bremerhaven to Cape Town using a precursor of the nowadays instrumentation (same instruments, but another configuration of telescope units) show the concentration of BrO and NO₂: The maxima were reached when the ship passed the English Channel with 3.1 ± 1.1 parts per trillion for BrO and 0.36 ± 0.13 parts per billion for NO₂. This was to be expected from the high air pollution in Europe. Furthermore an anti-correlation of BrO and NO₂ could be observed indicating a reservoir substance formed by the two gases (Diploma thesis J. Boßmeyer). On further cruises the ship-based DOAS instrumentation should gather data to investigate such events including other trace gases in combination with the satellite results. Besides the fact that these measurements are mainly done for validation purposes, gathering data in Antarctic seas is important for further atmospheric and climate research

Ship-based DOAS measurements have been carried out before in the years 1990, 1993 and from 2001 through 2005 with good success from the Heidelberg Institute of Environmental Physics.

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4. COMPOSITION OF THE ATMOSPHERE AND RADIATION BUDGET AT THE ATMOSPHERE/OCEAN INTERSECTION (METOP & MORE)

A. Macke, J. Kalisch, L. Klüser (IFM-GEOMAR)
A. Sinitsyn (IORAS)

Objectives

The net radiation budget at the surface is the driving force for most physical processes in the climate system. It is mainly determined by the complex spatial distribution of humidity, temperature and condensates in the atmosphere. The project aims at observing both the radiation budget and the state of the cloudy atmosphere as accurate as possible to provide

realistic atmosphere-radiation relationships for use in climate models and in remote sensing. While similar experiments have been performed from land stations, only few data from measurements over ocean areas exist. The present project is part of the "Meridional Ocean Radiation Experiment" MORE which uses Atlantic transfers of various research vessels for the combined measurements of the atmospheric state.

For the first time a ship based multichannel microwave radiometer will be applied to continuously retrieve temperature and humidity profiles as well as cloud liquid water path over the ocean. Time series of these profiles will show small scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the downwelling shortwave and longwave radiation. The atmospheric profiles will also be used to validate the satellite based profiles from the IASI instrument onboard the new European polar orbiting satellite MetOp. In the long run, based on the experiences of this and later Atlantic transects an autonomous measurement container is planned for operational atmospheric monitoring onboard commercial ships.

Work at sea

Upon shipping to Cape Town the following instruments will be installed onboard RV *Polarstern* for continuous measurements:

- 1) Multichannel microwave radiometer HATRPO. The instruments requires occasional calibrations with liquid nitrogen as well as tipp-calibrations under calm sea and homogeneous atmospheric conditions.
- 2) Ceilometer including tilt measurement device for cloud bottom height measurements.
- 3) IR-Radiometer KT-19 for sea surface and cloud bottom temperature measurements
- 4) Whole sky imager for cloud structure measurements
- 5) Pyranometer and pyrgeometer for fast measurements of downwelling shortwave and longwave radiation.

Two radiosoundings per day have to be performed close to the overpass times of the MetOp satellite. Synoptical observations will be done every hour. Most instruments require non or little maintenance. Only the microwave radiometer performance will be critically observed as this is the first time that such an instrument works under open ocean conditions.

Expected results:

- 1) 2d structure of the clear sky atmosphere and corresponding net radiation budget.
- 2) Horizontal structure of the cloud water path and its effect on the downwelling shortwave and longwave radiation
- 3) Vertical structure of temperature and humidity as well as its variability for validation of IASI products
- 4) All results under mid-latitude, tropical and subtropical climate conditions.

5. BETEILIGTE INSTITUTIONEN/ PARTICIPATING INSTITUTIONS

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IORAS	P. Shirshov Institute of Oceanology Academy of Sciences Krasikova 23 Moscow, 117218 Russian Federation
LGGE	Laboratoire de Glaciologie et Géophysique de l'Environnement (UMR 5183) 54, rue Molière 38402 - Saint Martin d'Hères cedex France
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6. FAHRTTEILNEHMER / PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession
Buldt	Klaus	DWD	Technician
Haerendel	Gerhard	IUB	Scientist
Kalisch	John	IFM-GEOMAR	Meteorologist
Klüser	Lars	IFM-GEOMAR	Student
Knuth	Edmond	DWD	Meteorologist
Macke	Andreas	IFM-GEOMAR	Meteorologist
Morin	Samuel	LGGE	Student
Sinitsyin	Alex	IORAS	Technician

7. SCHIFFSBESATZUNG / SHIP'S CREW

Name of Ship : RV POLARSTERN

Nationality : GERMAN

Cape Town - Bremerhaven

No.	Name	Rank
01.	Schwarze, Stefan	Master
02.	Spielke, Steffen	1.Offc.
03.	Farysch, Bernd	Ch. Eng.
04.	Fallei, Holger	2. Offc.
05.	Wunderlich, Thomas	2.Offc.
06.	NN	Doctor
07.	Hecht, Andreas	R.Offc.
08.	Minzlaff, Hans-Ulrich	2.Eng.
09.	Wanke, Steffen	3.Eng.
10.	Sümnicht, Stefan	3.Eng.
11.	Scholz, Manfred	Elec.Tech.
12.	Nasis, Ilias	Electron.
13.	Verhoeven, Roger	Electron.
14.	Muhle, Helmut	Electron.
15.	Himmel, Frank	Electron
16.	Loidl, Reiner	Boatsw.
17.	Reise, Lutz	Carpenter
18.	NN	A.B.
19.	NN	A.B.
20.	Winkler, Michael	A.B.
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22.	Hagemann, Manfred	A.B.
23.	Schmidt, Uwe	A.B.
24.	Bäcker, Andreas	A.B.
25.	Wende, Uwe	A.B.
26.	Preußner, Jörg	Storek.
27.	Ipsen, Michael	Mot-man
28.	Voy, Bernd	Mot-man
29.	Elsner, Klaus	Mot-man
30.	Hartmann, Ernst-Uwe	Mot-man
31.	Pinske, Lutz	Mot-man
32.	Müller-Homburg, Ralf-Dieter	Cook
33.	Silinski, Frank	Cooksmate
34.	Martens, Michael	Cooksmate
35.	Jürgens, Monika	1.Stwdess
36.	Wöckener, Martina	Stwdss/KS
37.	Czyborra, Bärbel	2.Stwdess
38.	Silinski, Carmen	2.Stwdess
39.	Gaude, Hans-Jürgen	2.Steward
40.	Möller, Wolfgang	2.Steward
41.	Huang, Wu-Mei	2.Steward
42.	Yu, Kwok Yuen	Laundrym.