Cruise Report

Atalante Cruise Leg – 2

MARSUED IV

(replacement of MSM06/3)

07.01.08 Recife - 31.01.08 Dakar

Contents

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2.2 Research Program

The research cruise had, in the time available, two major aims: returning to observe and sample at the 4°48´S hydrothermal site (Turtle Pits etc.) and observing and sampling the lower crust on the 5°S Inside Corner High. The following gives some details on these goals:

4°48´S (Turtle Pits, Red Lion, Wideawake Field)

Vents at Turtle Pits (location, Fig. 2.2.1) show turbulent fluid emanations with temperatures of about 400°C. This is the highest temperature measured so far in fluids at the MAR. Consequently, the system is close to the critical point of seawater on the two-phase boundary

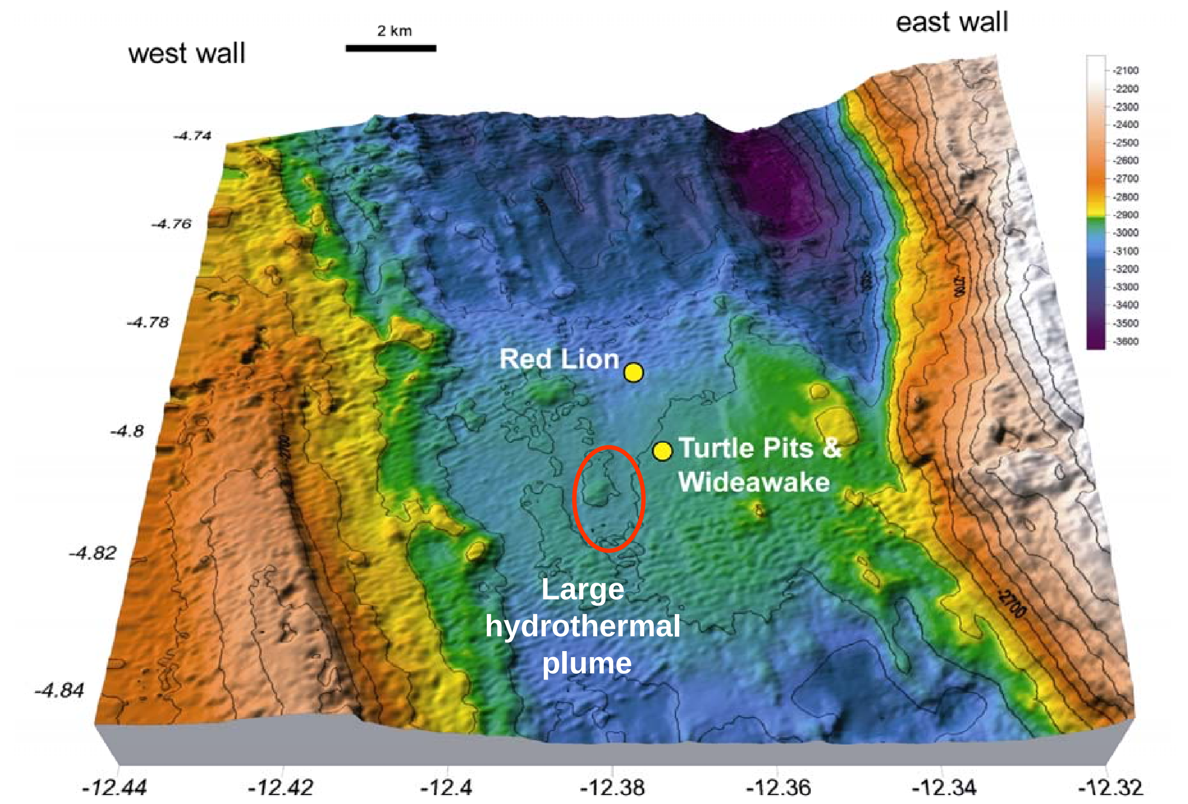


Fig. 2.2.1: The location of the Turtle Pits, Wideawake and Red Lion hydrothermal fields based on data collected during M64/1.

for a boiling system. The Turtle Pits boiling fluids have significantly reduced chloride concentrations (end member value of 254 mmol/l Cl, Fig. 2.2.2) compared to a background bottom seawater value of about 560 mmol/l Cl. This indicates that the fluids are phase-separated and that the samples collected represent the vapour-type phase in the boiling fluids. The diffuse-flow Wideawake mussel field, which is located at a distance of only a few hundred meters from Turtle Pits, is on the same mixing line of seawater and hydrothermal end member chlorinity (Fig. 2.2.2), indicating that Turtle Pits and Wideawake are supplied from the same fluid source at depth. Interestingly, the fluids from the Red Lion field apparently do not show any signs of phase separation (chlorinity end member of 563 mM undistinguishable from seawater, Fig. 2.2.2). Although we have no in-situ temperatures from the Red Lion vents, we can deduce that the Red Lion fluid source at depth has a significantly lower temperature than at Turtle Pits. The high Fe/Mn ratio of 6.8 at Turtle Pits is as high as it is documented for ultramafic systems such as Rainbow and Logatchev fields (Douville et al., 2002) and contrasts with a Fe/Mn ratio of 1 in the Red Lion fluids.

The Turtle Pits fluids have a very high H_2/CH_4 ratio of about 15, even exceeding those found in the serpentinite-hosted Logatchev and Rainbow hydrothermal vents (see data for cruise

M60/3 and from Douville et al., 2002). In contrast, the H_2/CH_4 ratio at Red Lion is only 2.7. Dissolved sulphide concentrations for the three individual hydrothermal vent sites at 5°S are quite variable, ranging from a low abundance of 3 µmol/l (measured data) in the diffuse fluids at the Wideawake Mussel Field to concentrations as high as 830 µmol/l (measured; endmember 1.3 mM) for hot fluids emanating from black smokers at the Turtle Pits site.

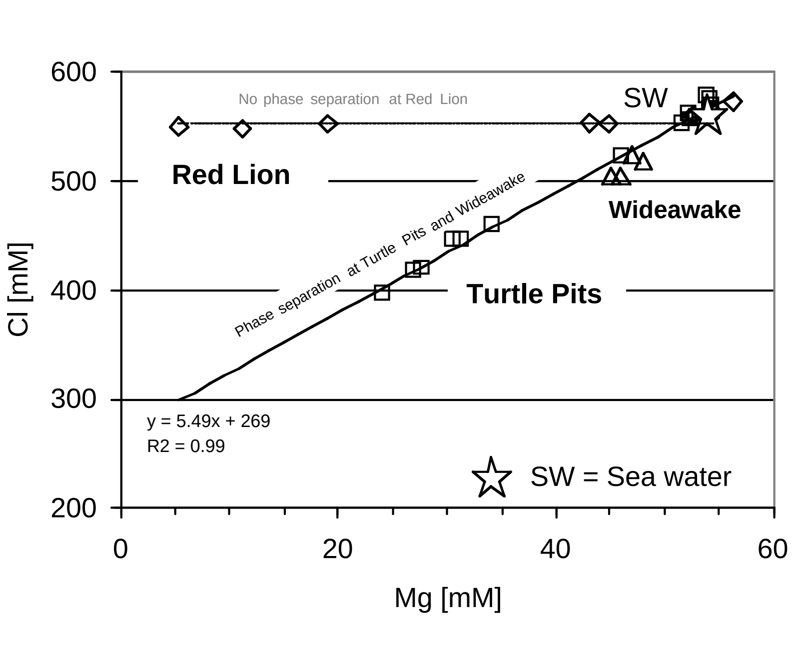


Fig. 2.2.2: Concentrations of Mg and Cl measured in vent waters from the 4°48´S hydrothermal fields.

Preliminary sulphur isotope data for sulphide particles in the hydrothermal fluids as well as for massive sulphides from different chimneys at Turtle Pits display a range between +3.5 to +6.7 ‰ (VCDT). Based on respective data for sulphide precipitates from other sites of hydrothermal activity at mid-ocean ridges, this range in d^{34}S suggests that sulphur in the fluid represents a mixture of mantle sulphur and seawater sulphate sulphur.

During M64/1 the first microbiological studies at the southern hydrothermal vent sites of the MAR were initiated. Genetic analyses and cultivation experiments are in progress, microscopic observations of microorganisms from the Wideawake field revealed heterogeneous morphological assemblages in most cases. Interestingly, enough rock samples collected at the border of Bathymodiolus assemblages showed white structures (0.5-2 mm length) which covered the entire rock and could easily be recognized by eye. Morphological these cells had the typical features of Thiothrix species. In addition, some netlike cracks were observed which were dominated by a large coccoid microorganism (20 µm width) with obvious similarity to species of Achromatium. Both microorganisms contained numerous sulphur globules and represent members of the group of colorless sulphur bacteria. Both microorganisms are important primary producers and are highly abundant at these vent sites. To our knowledge, this is the first observation of these two colorless sulphur bacteria at deep sea hydrothermal vent systems.

Lower crustal and mantle rocks in the spreading axis

Decompression melting of adiabatically upwelling mantle is probably the cause of most magmatism at the mid-ocean ridges (e.g. Klein and Langmuir, 1987). At most ridges, the lower crust and upper mantle are therefore difficult to study as they are coated by and buried beneath 2+ km of dikes and lavas. At slower spreading rates, however, the adaibatic melting process can start to become heterogeneous and rocks from the lower crust and mantle start to become more accessible.

This occurs through two processes. Firstly, the mantle produces generally less melt and this melt production becomes focussed towards the spreading segment centres as a result of 3-D upwelling (Parmentier and Morgan, 1990). The „crust" is then made up of a mixture of basalt and mantle rocks, the latter of which may contain intrusives such as gabbros (e.g. Cannat, 1996; Cannat et al., 1992; Cannat et al., 1995). Secondly, the increasing importance of tectonic processes in accommodating the spreading movement at magma-starved slower spreading ridges can lead to the formation of low-angle normal faults (Cann et al., 1997). These faults generate tectonic windows which can provide the necessary exposures of the lower crust and mantle (Tucholke et al., 1998). They can lead to the formation both of so-called „megamullions“ (areas of striated seafloor close to the ridge axis reflecting the slip surface of the low-angle normal faults) and also of inside corner highs (areas of raised

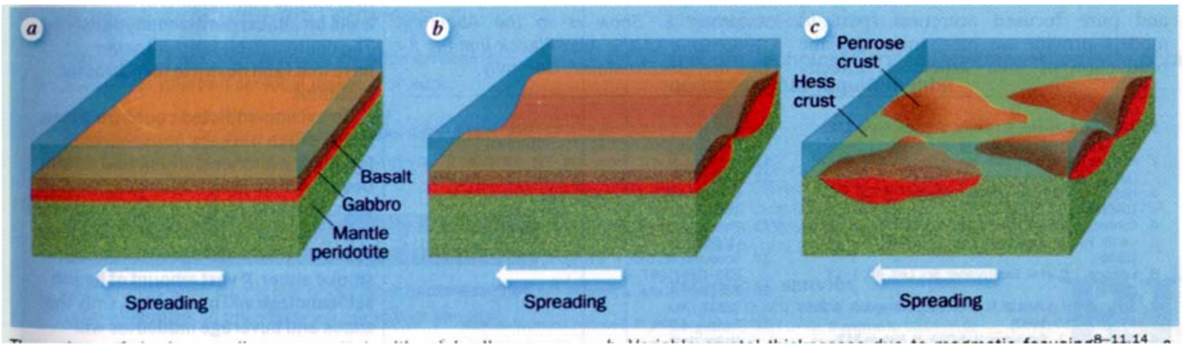


Fig. 2.2.3: Theoretical variations in seafloor structure with decreasing spreading rate (from left to right). From Snow (1995)

bathymetry on the inner side of a spreading axis – transform boundary). These low-angle detachment faults may be rooted above a shallow magma chamber, or even cut all the way into the mantle rocks. Baines et al. (2003) showed that the uplift of "inside corner highs" is partially caused by transpressional forces of large faults around them.

The seafloor generated at slow-spreading ridges (Fig. 2.2.3, c) is therefore in principle vastly different to that generated at fast-spreading ridges (Fig. 2.2.3, a).

This could have enormous implications for hydrothermal processes, as the nature of the rock in which the hydrothermal system is rooted is of paramount importance for the composition of the hydrothermal fluids. This point was made forcibly by the serendipitous discovery of a hydrothermal system situated on, and deriving all its energy from, ultramfic (mantle) rocks at the Lost City site in the Atlantic (Kelley et al., 2001).

The low-angle normal faults also bring samples from great depth up to the seafloor. This allows us almost unique access to rocks from the lower crust and upper mantle influenced by the hydrothermal circulation operating at very high temperatures at the interface between magmatic and hydrothermal processes. The geological record of this process was discovered in many gabbros from the Kane Fracture zone at the MAR, 23°N (Koepke et al., 2005b) and also from the Atlantis II core complex of the slow-spreading Southwest Indian Ridge (Koepke et al., 2005a; Koepke et al., 2004). These authors found evidence to support the hypothesis that seawater-derived water-rich fluids

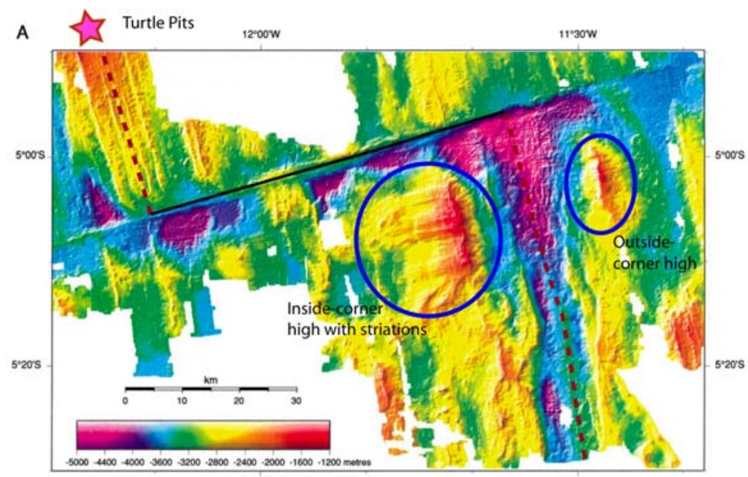


Fig. 2.2.4: Bathymetric map of the region around the 5°S Fracture Zone (from Reston et al., 2002). The present-day spreading axis is marked with a dashed line, the tranform fault with a black line. The location of the Turtle Pits hydrothermal field (see Fig. 2.2.1) is also shown.

propagate along high-temperature shear zones down into the deep oceanic crust causing locally hydrous partial melting on grain boundaries. This results in the formation of a characteristic interstitial mineral paragenesis and a SiO_2-rich melt which may separate and crystallize within cracks forming typical felsic veins or netveining matrices. With the help of a newly developed in-situ Sr isotope technique it was recently verified that the fluids triggering the partial melting are seawater-derived. Thus, the observed fluid/melt transport in the deep oceanic crust within core complexes represents a first and fundamental stage in the transfer of heat from the crust to the surface.

Two areas in which lower crustal and mantle rocks are exposed are known from previous work in the MARSUED-area. Geophysical and rudimentary sampling studies south of a small fracture zone at 5°S (Reston et al., 2002) have shown the presence of both gabbros and serpentinites on a so-called inside-corner high. This high appears to have been split in relatively recent times (0.75 Ma) by rifting, forming a new axis in the middle of the uplifted block and generating a complimentary outside-corner high (see Fig. 2.2.4).

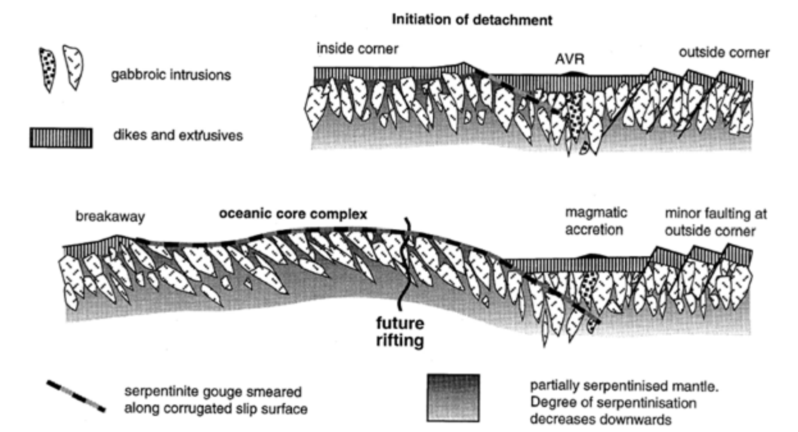


Fig. 2.2.5: Reston et al.´s (2002) model for the interplay of tectonics and magmatism south of the 5°S fracture zone. They envisage no clear distinction between periods of magmatic and tectonic accretion, instead the detachment fault which leads to the formation of an oceanic core complex initiates close to the axial volcanic zone and may at times be split by a ridge jump.

Four dredges collected by Reston during M47/2 showed that the inside-corner massif is predominantly made of gabbroic intrusive rocks, although serpentinised peridotites were found on the corrugated upper surface of the massif, probably associated with smearing along the detachment fault. These authors suggest that detachment faulting and uplift of lower crustal and mantle rocks may be occurring concurrently with magmatic rifting (see Fig. 2.2.5). This situation may be exactly the one which is needed to explain the types of hydrothermal activity seen at the other SPP site at Logatchev and perhaps even at Nibelungenfeld, where fluids with temperatures which require them to have been in close contact with magmas are vented in areas of the seafloor characterised by lower crustal or mantle rocks. One of the major aims of the cruise proposed here will be to study this uplifted massif to determine (a) its geology and the distribution of rock types and (b) to look for the distribution of alteration channels which may have been former root zones for hydrothermal systems.

Reston et al.´s (2002) observation of gabbronorite among the plutonic rocks of the inside corner high is significant, since the dominance of orthopyroxene primocrysts in primitive gabbros indicates crystallization and fractionation at depth, several km deeper than that level where the axial magma chambers under ridges are typically located. For example, high amounts of gabbronorites were recovered farther north, between 14° - 16°N by both M60/3 and the ODP (Ocean Drilling Program, Leg 209) recording cooling and partial crystallization of ascending MORB at great depth (15–25 km). Moreover, crystallization and fractionation of MORB magmas at depth is also in agreement with phase equilibria modelling in combination with experimental work based on the dredged basalts of different segments of the MARSUED area, revealing different equilibrium pressures for individual segments between 1.5 and 8 kbar. These results show also that the differentiation under distinct segments was strongly influenced by water activity.

2.3 Cruise Narrative

The N.O. "Atalante" left Recife harbour on schedule in the morning of 7th January 2008. There followed a 7 day transit to the working area, including a stop to lower the ROV cable to 5500m to remove twists in the wire. The ship arrived in the working area late in the evening of 13th January and the research program started with CTD stations to establish the strength and position of any hydrothermal plume. This was the beginning of activities which repeated each day – a night program consisting of CTD work or rock sampling with the volcanic corer interspersed with a day program of ROV dives. Whenever the ROV needed maintenance the day program consisted of mapping or longer CTD stations. The penultimate day of the working period was marked by an attempt (unfortunately unsuccessful) to recover releasers from the University of Bremen mooring which did not surface followed by the deployment of a profiling mooring from IFM-GEOMAR. The last day saw a long dive on the fracture zone wall at 5°S. Early in the morning of 26th January the ship left the working area on course for Dakar where we docked at 08:00 on 31st January 2008.

2.4 Preliminary Results

2.4.1 Physical Oceanography

(C. Mertens, G. Fraas, P. Günnewig)

2.4.1.1 Instruments and Methods

Conductivity-temperature-depth (CTD) casts were carried out using a Sea-Bird Electronics, Inc. SBE 911plus system (IFM-GEOMAR) that was equipped with double temperature, conductivity, and oxygen sensors as well as with a Wetlab C-Star transmissometer (D. Quadfasel, Univ. Hamburg). The underwater unit was attached to a SBE 32 carousel water sampler with 24 Niskin bottles. Three bottles were left out for a lowered acoustic Doppler current profiler system (LADCP), hence a maximum of 21 bottles was used. The complete system worked properly throughout the entire cruise. Salinity samples, typically three on each cast, were collected for later analysis at home. In total 20 CTD casts were carried out, including three time series (yoyo) stations, and one towed transect across the rift valley (Fig. 2.4.1.1).

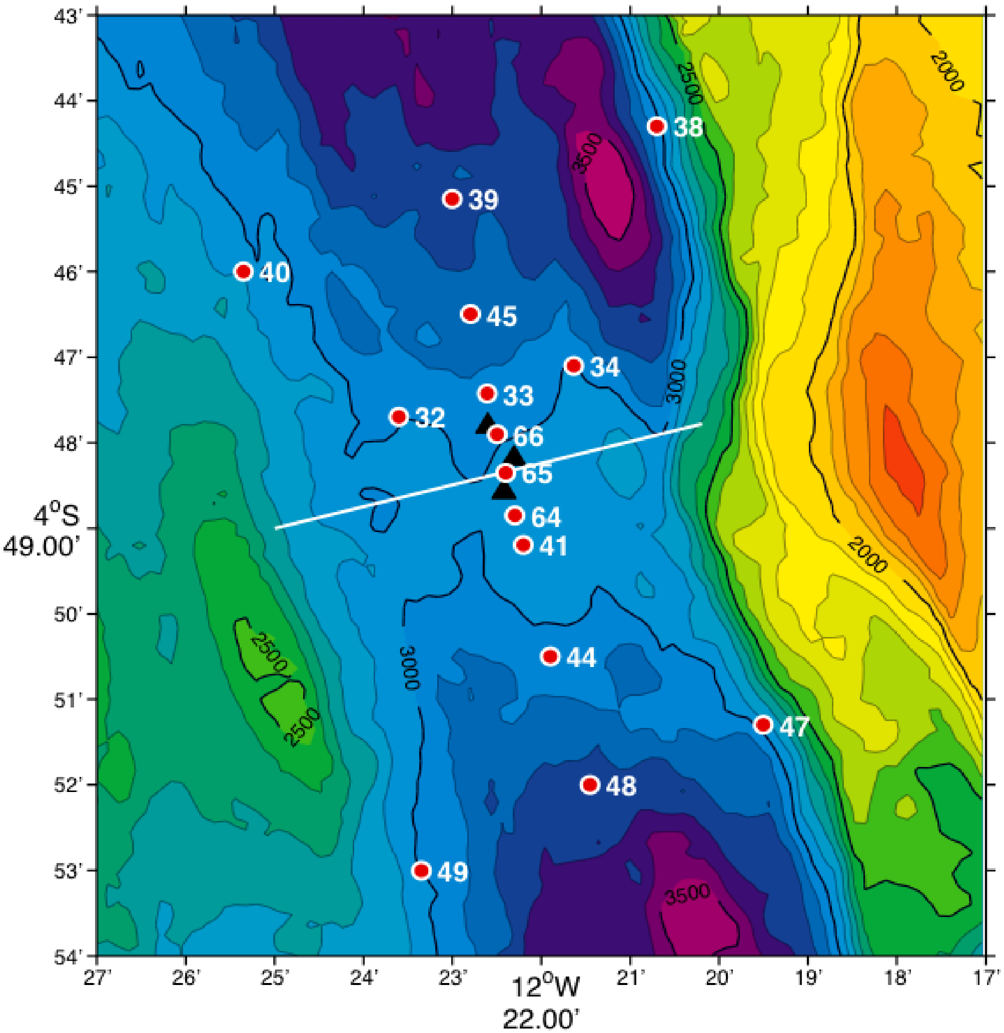


Fig. 2.4.1.1: Map of the working area showing the CTD/LADCP stations (dots). The track of a tow-yo track across the rift valley is shown as a white line. The hydrothermal vent sites Turtle Pits, Comfortless Cove, and Red Lion are depicted as black triangles. Additionally three time series stations were carried out. Two north of Red Lion (at station 33) and one north of Comfortless Cove (near station 66).

The LADCP system consisted of two RD Instruments 300 kHz Workhorse Monitor ADCPs. The instruments worked in a synchronized master-and-slave setup, where the downward looking master (S/N 630, IFM-GEOMAR) triggers the upward looking slave (S/N 7915, Univ. Bremen). The instruments were powered by an external battery supply, that consisted of 35 commercial quality 1.5 V batteries assembled in a pressure resistant Aanderaa housing. On one of the time series stations (62, CTD17) the slave instrument did not collect any data. This was presumably caused by a communication problem between master and slave.

An inverse method incorporating the bottom track velocities was used for the post processing of the raw data. The overall performance of the two instruments was very good: The range of each instrument was typically 150 m in the upper parts of the water column and 60 to 70 m at depth exceeding 1500 m. Thus, the total range of the package reached from 150 to 300 m. With lowering and heaving velocities of 1 m/s of the instrument package, this range amounted to 100 to over 200 estimates of current shear in each depth cell in the deep water, and more in the shallow layers, depending on the amount of backscatter. For the cast with the single instrument, the reduction of range lead to a decrease of shear estimates per bin, but as the water depth did not exceed 3000 m and the abundance of backscatterers was high, the resulting current data were still of good quality.

During yoyo and towyo stations three (serial numbers 33, 36, and 38) miniature autonomous plume recorders (MAPR, E. Baker, NOAA/PMEL) were used to improve the data coverage. MAPRs are self-contained instruments, that record data at pre-set time intervals from temperature (thermistor mounted in a titanium probe, resolution 0.001°C), pressure (0 - 6000 psi gauge sensor, resolution 0.2 psi), and nephelometer (Sea Tech Light Backscatter Sensor, LBSS) sensors. One MAPR (S/N 38) had an additional redox potential (Eh) probe build by K. Nakamura. During operation two of the MAPRs were clamped on the hydrgraphic wire, 100 m and 200 m above the water sampler, and the MAPR with the Eh probe was directly attached to the water sampler. The instruments were working fine throughout the cruise, with only one exception during the cross-valley towyo, were one MAPR (S/N 38) recorded only the first 70% of data. On four CTD stations near the vent sites the MAPR with Eh probe was also attached to the water sampler. In total, MAPRs were used on 9 of the 20 CTD stations.

For measurements of the Helium concentrations and isotopic signature, water samples were taken in the water column from the Niskin bottles (94 samples in total) and directly from the vents with the ROV (3 samples). The samples were sealed free of head space and gas tight in copper tubes (sample volume 40 ml). Special containers for sampling vent fluid (developed & tested in the framework of the SPP 1144) were used for the ROV samples. The sampling containers can keep a pressure of more than 3·107 Pa and avoid phase separation of vent fluids and gases. Helium isotope measurements will be carried out at the University of Bremen with a fully automated UHV mass spectrometric system. The sample preparation includes gas extraction in a controlled high vacuum system. Helium and neon are separated from permanent gases in a cryo system at 25 K. A split of the sample is analyzed for 4He, 20Ne and 22Ne with a quadrupole mass spectrometer. At 14 K He is separated from Ne and released into the sector field mass spectrometer for analysis of 3He and 4He. The facility achieves about ± 0.2% precision for 3He/4He ratios, and ± 0.5% or better for helium and neon concentrations. The primodial components of helium isotopes are ideal tracers for large-scale distribution of vent fluids in the water column. Samples collected during this cruise are supposed to provide the regional distribution of dispersing vent fluids in the water column leading to an estimate of its volume.

On January 14, an attempt was made to recover a mooring with three Aanderaa RCM11 current meters (Univ. Bremen) at 4° 48.21' S, 12° 22.50' W, that was deployed during Meteor cruise M68/1 in May 2006. However, the mooring did not leave the ground, although the release execution command was clearly confirmed during several attempts from both releasers. Acoustic ranging revealed that the releasers were located at a depth of about 3000 m which is the seafloor depth at this location. It was therefore concluded that the mooring must have lost all buoyancy because the nominal depth of the releasers was 45 m above the seafloor. Knowing the approximate position of the releasers from the acoustic ranging measurements, a recovery dive with the ROV was undertaken in the evening of January 24 to find the two releasers and possibly one of the current meters. During the dive an area of about 150 m x 100 m was searched but (probably because of the rough terrain) the instruments could not be found.

A new mooring equipped with a CTD profiler and an acoustic current meter (IFM-GEOMAR) was deployed at nearly the same location as the previous mooring. The instrument was programmed to carry out 11 profiles between 2295 dbar and 2990 dbar every 5 days. The deployment started on January 24, 23:10 with the anchor first. The top buoy went into the water on January 25, 01:18. Afterwards the mooring was carefully lowered towards the seafloor and acoustically released as the anchor was 15 m above the ground at 02:55. The position of the anchor drop was 4° 48.20' S, 12° 22.51' W and the water depth 3004 m.

2.4.1.2 *First results*

Two hydrographic sections with 3 casts each (CTD/LADCP/Water sampling/48 Helium samples) were carried out north (CTD6-CTD8) and south (CTD13-CTD15) of the area. The local topography is closed to the sides below a water depth of 2700 m, hence these two sections form a box where measurements of the current field and the stratification allow to calculate fluxes of volume, heat and helium into and out of the vent field area. A third section, again with 3 casts (CTD2-CTD4, 34 Helium samples) was carried out directly north of the Red Lion vent site. Six additional CTD stations (CTD9, CTD11, CTD12, CTD18-CTD20) were used to close an along-valley section (including 13 on stations 11 and 12). Three time series stations (yoyo) were carried out; two north of Red Lion (CTD5 and CTD17) and one north of Comfortless Cove (CTD16). Finally a 5 nm long tow-yo transect completely covering the deep part of the axial valley below the maximum plume hight. During the tow-

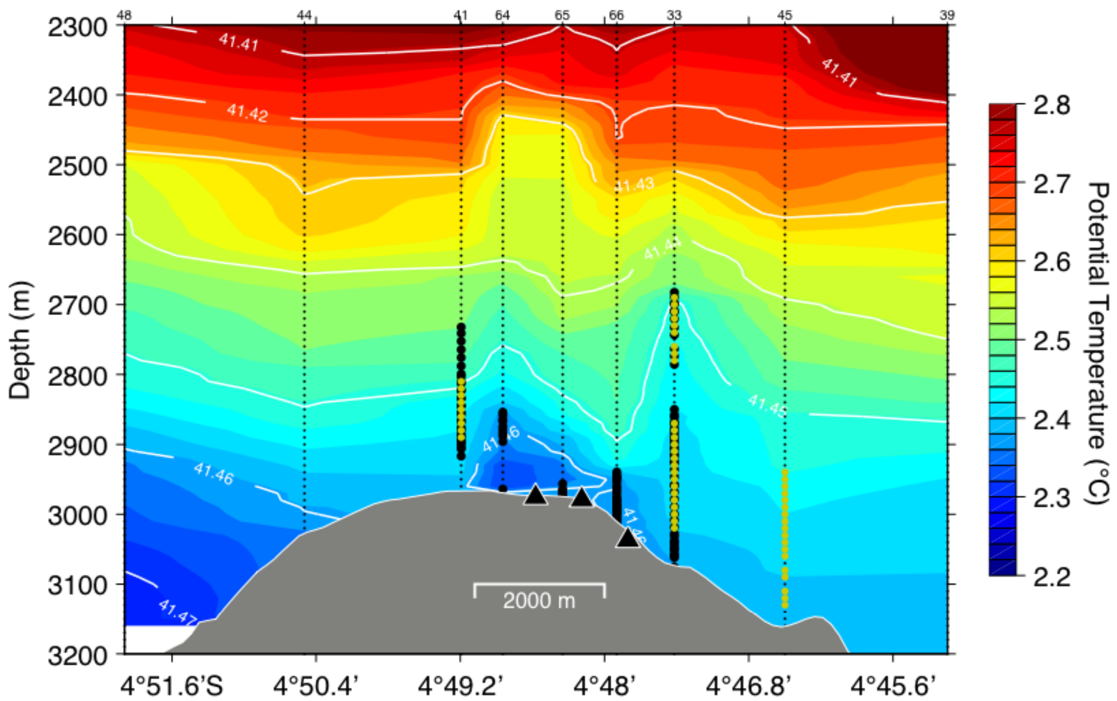


Fig. 2.4.1.2: Potential temperature section along the rift valley put together from nine non-synoptic CTD stations. Contours of potential density are shown in white. Transmission and Eh anomalies are marked with yellow and black dots (no Eh data on station 45). The locations of the vent sites are indicated by black triangles.

yow, POSIDONIA was used to navigate the CTD.

The along-valley temperature and density structure (Fig. 2.4.1.2) clearly indicates a mean northward flow, as the water below sill level is colder and denser on the southern side. Downstream of the sill, the isotherms and isopycnals (and hence the plume anomalies) deepen, showing that water spills over the sill, and the water column stretches, i.e. the vertical spacing between isopycnals increases. Plume signals, either transmission or Eh anomalies, were found at all stations close to the vent sites (33, 41, 45, 64-66) up to a depth of about 2700 m. The distance from the vent sites where plume signals are still found in the water column is larger in northward than in southward direction which indicates prevailing northward currents in the plume layer. Interestingly, Eh signals were found on three stations (64-66) rather close to the vent sites but no indications for the particle plume, neither in the transmissometer data nor in the backscatter measurements of the MAPR. Above the sill the isopycnals show large vertical excursions of up to ±100 m caused by tides and internal waves.

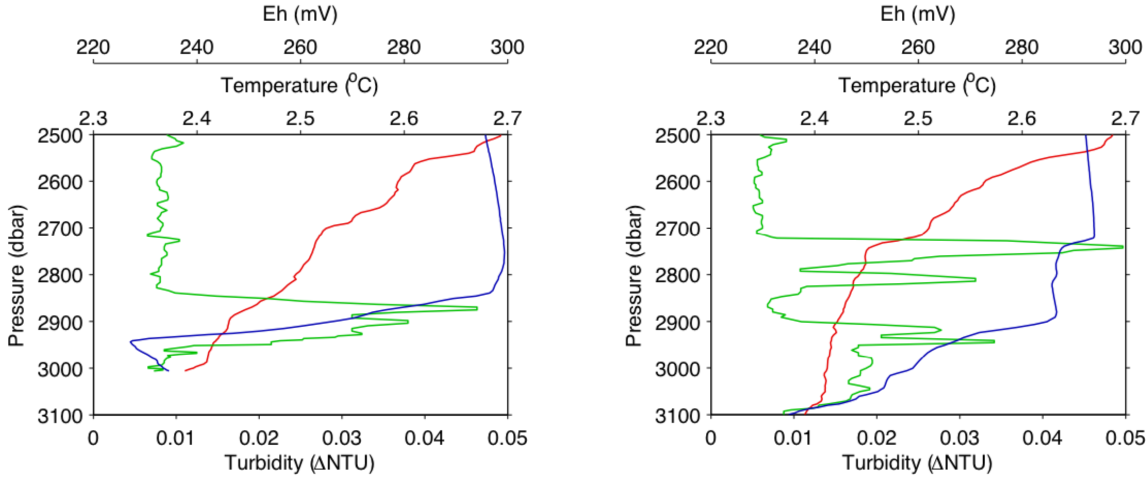


Fig. 2.4.1.3: Vertical MAPR profiles of temperature (red), turbidity (green), and Eh (blue) at two stations south (station 41, left) and north (station 33, right) of the vent sites.

The maximum rise hight of the plume corresponds roughly to the 2.5 °C isotherm, observed at the stations 33 and 41. The MAPR data at these two stations are shown in Fig. 2.4.1.3. At the southern station a single plume between 2800 and 2950 m was observed. At the northern station the vertical structure of turbidity and Eh reveal an upper plume between 2700 and 2850 m, followed by a second plume between 2900 and 3000 m. The decrease in Eh in the upper plume is smaller compared to the second plume and therefore the water in upper plume is farther away from the source and probably originating from the Turtle Pits vent site. Below 3050 m a third decrease in Eh is observed again smaller than in the second plume, suggesting comfortless cove as the source. The central plume with the strongest Eh signal should therefore be attributed to the Red Lion vent site.

Detailed measurements of the plume variability were obtained during two time series stations (yoyo) carried out about 700 m north of the Red Lion vent site. The first yoyo was on January 14/15 with a duration of 9 hours and the second was about 8 days later on January 22/23. The time series of turbidity (Fig. 2.4.1.4) show a large variability of the particle plume. During the first yoyo stations two distinct maxima were observable, although changing in depth and intensity with time. These two maxima could be attributed to Turtle Pits (upper) and Red Lion (lower). The lowest plume that originates from Comfortless Cove starts to appear after 4-5 hours between 3000 and 3050 m. The vertical excursions of the plumes can be explained by internal waves, as the plume clearly follows the isotherms.

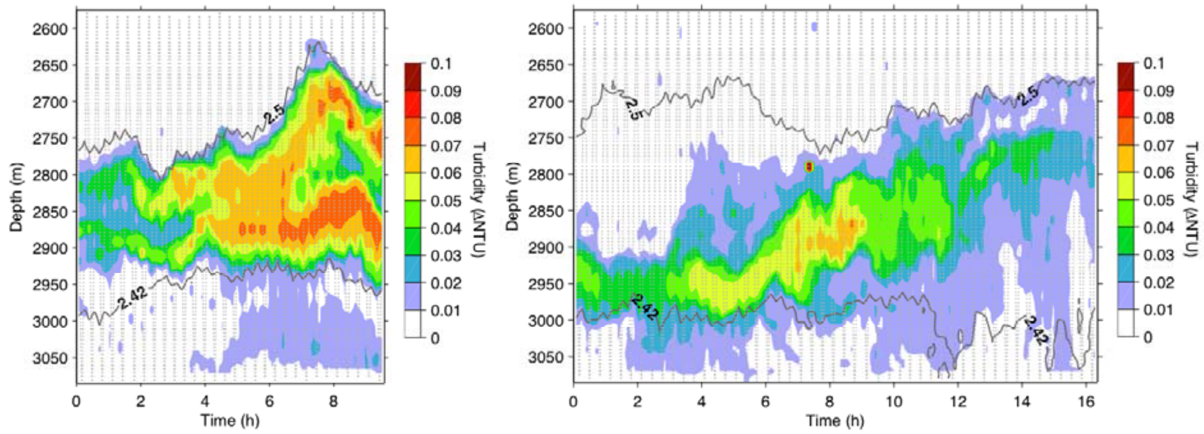


Fig. 2.4.1.4: Time series of turbidity measured during two yoyo stations carried out on January 14/15 (left) and January 22/23 (right), both at the same location about 700 m north of the Red Lion vent field (at station 33 in Fig. 2.4.1.1). Also shown are two temperature contours that depict the upper and lower boundaries of the non-buoyant plume.

During the second yoyo the turbidity measurements suggest a slowly rising single plume, which makes physically no sense in a non-buoyant plume. Instead the variability of the currents has to be taken into account which show a nearly constant northward flow and tidal fluctuations of ±4 cm/s in east-west direction (Fig. 2.4.1.5). Therefore the path of the particles from the source to the observational site is strongly bent, depending on the tidal phase. At the beginning of the time series the current is purely northward and we observe the lower plume from Red Lion not the Turtle Pits plume, because during the hours before the current had an eastward component, driving the Turtle Pits plume away from the observational site. Later on, as the currents get a westward component, the upper Turtle Pits plume appears while the lower Red Lion plume gets weaker.

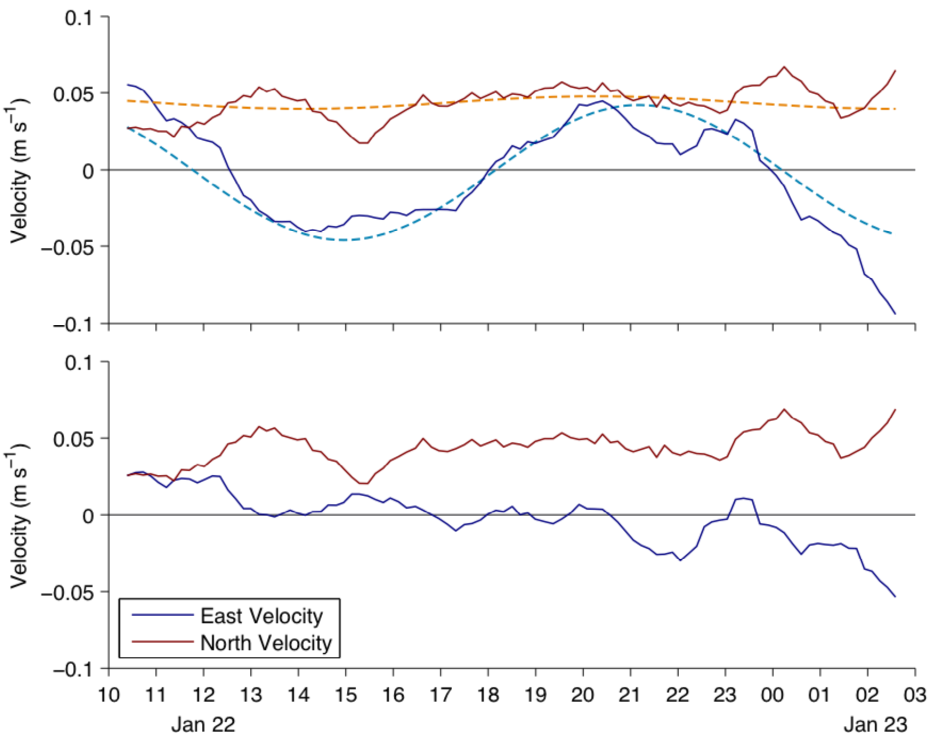


Fig. 2.4.1.5: Time series of the mean velocity in the plume layer between 2750 m and 3000 m measured on January 22/23 about 700 m north of the Red Lion vent field. The east velocity is shown in blue and north velocity in red. Harmonic fits of the semidiurnal M_2 tide are shown as dashed lines. The residual velocities after removal of the tides are shown in the lower panel

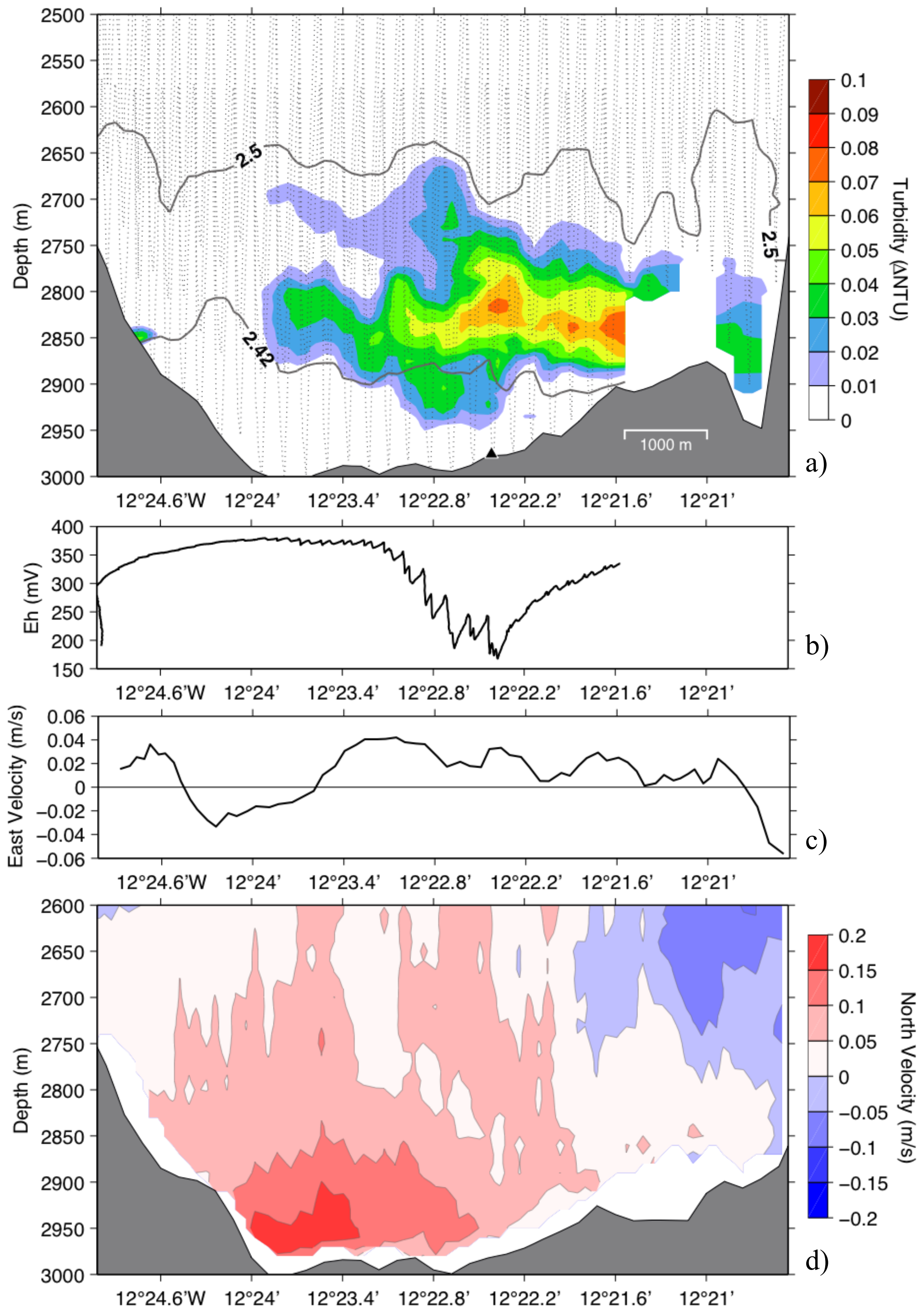


Fig. 2.4.1.6: Observations during a 5 nm long tow-yo crossing the rift valley from west to east. The CTD was navigated using POSIDONIA. (a) Turbidity from three MAPRs, one mounted on the CTD frame and two attached to the wire 100 m and 200 m above the CTD. (b) Eh from the MAPR parallel to the CTD. (c) Mean eastward current velocity below 2750 m from ADCP measurements. (d) Contours of northward velocity from ADCP measurements

The tidal phase of the currents is also of large importance to explain the structure of the particle plume that was observed during the cross-valley tow-yo. The plume appears to be extremely wide and covers about three fourth of the section (Fig. 2.4.1.6). Again we have a northward flow of about 5 cm/s and a fluctuating east-west component that is eastward at the beginning of the towyo, then westward for about two hours, and then mostly eastward for the remaining part of the towyo. Thus we can assume that the plume is first pushed westward toward the ship for a few hours which explains the far west reaching plume. Afterwards the plume moves eastward and more or less follows the ship and instrument package.

The current measurements during the towyo show that the area was dominated by along-valley northward currents. The average current velocity is typically of about 5 cm/s, with maxima of more than 15 cm/s. The strongest currents were observed close to the bottom where the overflow across the sill takes place. The volume transport associated with the flow observed during the towyo amounts to 0.12 Sv (1 Sv = 10^6 m^3/s). For a more general determination of the background flow field that takes long term variability into account and for the precise determination of tidal amplitudes and phases, a moored profiler that measures CTD and velocity data in the lower 700 m was deployed at the sill of the valley, in the center of the vent fields at 12° 22.51' S, 4° 48.20' S.

2.4.2 Microbiology from low-temperature, diffuse and hot hydrothermal fluids

(Mirjam Perner, Nadine Markus)

The main objective of the microbiology group during this cruise was to collect low-temperature, diffuse and hot hydrothermal fluids from hydrothermal fields on the southern Mid-Atlantic Ridge to investigate:

1. the intra-field and inter-field microbial variability
2. the functioning of the microbial community, specifically focusing on microbial H_2- and H_2S-oxidation and CO_2 fixation.

Intra-field and inter-field microbial variability

To investigate the intra-field and inter-field microbial variability the following fluids were collected (see table 2.4.2.2):

3 hot hydrothermal fluids (Sisters Peak, Mephisto, Two Boats)

5 low-temperature diffuse fluids (Wideawake and Clueless, mussel patches)

To identify and quantify the local microorganisms in the fluids of different sites material was collected to construct clone libraries using the 16S rRNA gene and perform fluorescence *in situ* hybridization in the home laboratory.

Functioning of the microbial community

The functioning of the vent microbial community is studied by two approaches. The first includes cultivation of selected groups of bacteria and archaea. The second involves analysis of functional genes and parallel-performed ^{14}C-incubation experiments with the decrease of potential electron-donors and acceptors being monitored.

Cultivation experiments

To characterize at least parts of the microbial community cultivations have been started on board (and will be continued in the home laboratory) specifically selecting for H_2-oxidizing and CO_2 fixing microorganisms (e.g. *Epsilonproteobacteria*, *Aquificales*, and

Methanococcales). For this purpose, selective media for autotrophic microorganisms was supplemented with various electron donors (H_2, H_2S, S°, S_2O_3) as well as suitable electron acceptors (O_2, NO_3, S°, S_2O_3) in the presence of CO_2.

Additionally, media for aerobic and anaerobic heterotrophic microorganisms was used. Cultivations were conducted along a temperature gradient of 25-75°C.

For the cultivation experiments, material was gathered from:

1 hot hydrothermal fluid (Sisters Peak, Comfortless Cove)
3 low-temperature diffuse fluids (Wideawake and Clueless mussel patches)

^{14}C-incorporation experiments

The second approach investigates the functioning of the vent microbial community by using functional genes encoding for key enzymes of H_2-oxidation, oxidation of reduced sulfur compounds and CO_2 fixation. However, the presence of functional genes encoding key enzymes of specific metabolisms is no proof of the actual functioning of this metabolism. Therefore, additionally, ^{14}C-incorporation experiments (at 25°C) were performed with hydrothermal fluids, which were supplemented with H_2 (under oxic and anoxic conditions) or H_2S as electron donor. The decrease of the supplied electron donors (H_2 or H_2S) and electron acceptors (O_2) was monitored during the 30 hours of incubation.

For this experiment hydrothermal fluids were collected from 3 diffuse fluids (Wideawake, Clueless) and 1 hot fluid from Mephisto (Red Lion)

Four parallels with each 15 ml of the hydrothermal fluids were supplemented with

- H_2-gas under anoxic conditions
- H_2-gas under oxic conditions
- H_2S
- nothing (reference)

and injected with $^{14}CO_3^{2-}$. Three parallel controls using liquids that were microorganism-free (filtered through a 0.1 µm filter) and liquids with non-active microorganisms (sample was fixed with formaldehyde) were incubated to determine the non-biological loss of H_2, O_2 and H_2S in the incubation bottles. These values were taken into consideration when evaluating the decrease of H_2, O_2 and H_2S in the incubation experiment.

H_2, O_2 and H_2S contents were monitored at time points 0 and after 30 hours of incubation (Fig. 2.4.2.1). The amount of labeled inorganic carbon, which has been incorporated into the cells, has been measured for one of the parallels on board (Fig. 2.4.2.1) and will be determined for the other three parallels in the home laboratory.

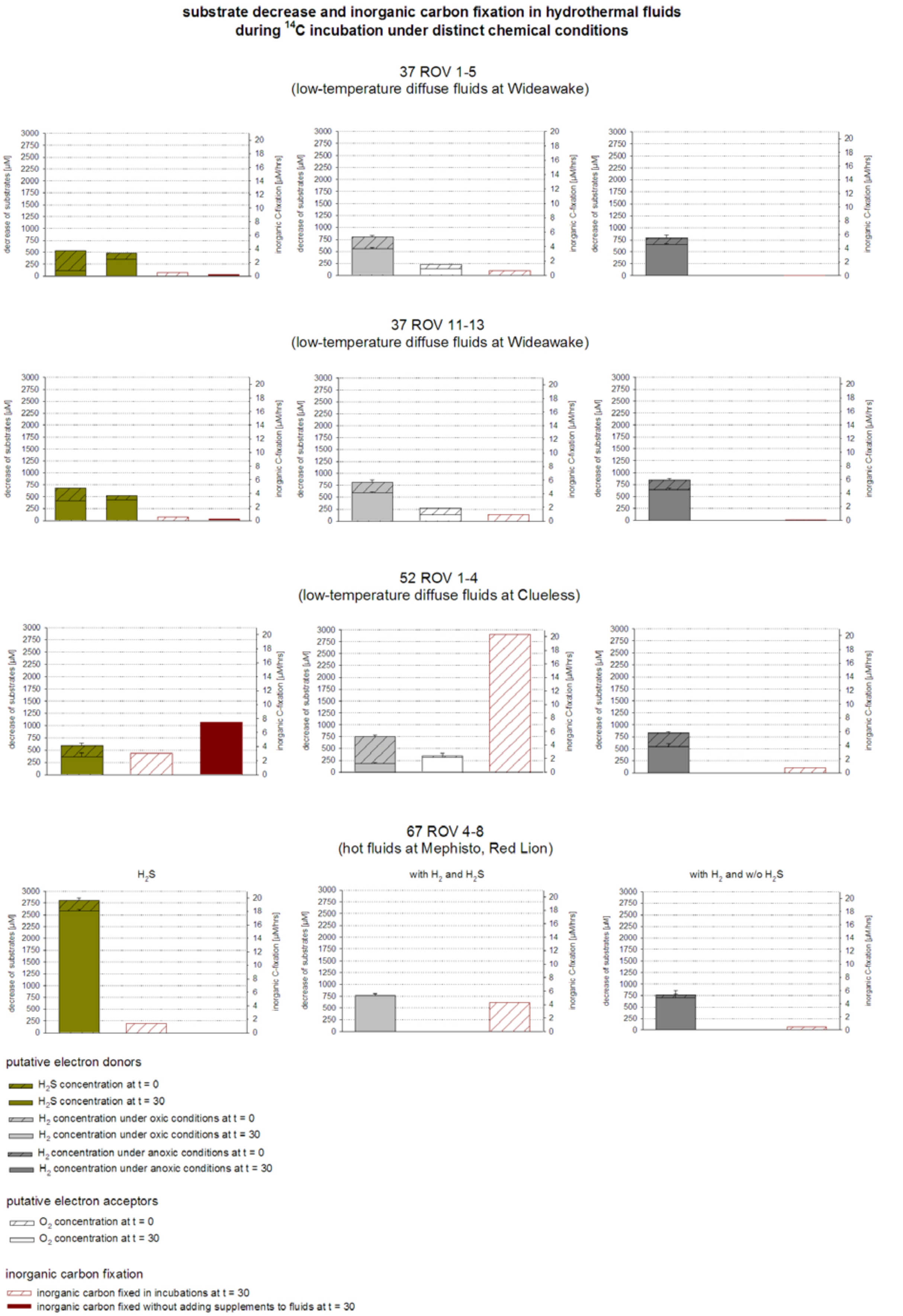


Fig. 2.4.2.1: The decrease of substrates (H_2, H_2S and O_2) under distinct conditions is shown for a 30 hour time-period in the incubation experiments at 25°C. H_2 data by Marko Warmuth and Richard Seifert (University Hamburg); H_2S data by Harald Strauss (University Münster). Fluids at Mephisto were anoxic therefore no O_2 decrease could be determined.

Table 2.4.2.1: Sample list of CTDs

station	depth [m]	niskin bottle number	DNA (-70°C)	FISH (fixed in formaldehyde)
ATA02-31CTD = ATA02-CTD01	3000	1-6	filter 2-2 (900 mL)	filter 3000 (100mL)
	2700	13	filter 2-3 (900 mL)	filter 2700 (100mL)
	2600	14	filter 2-1 (900 mL)	filter 2600 (100 mL)
	2200	17	filter 2-7 (450 mL)	filter 2200 (45 mL)
	1800	19	filter 2-5 (450 mL)	filter 1800 (45 mL)
	100	20	filter 2-4 (900 mL)	filter 100 (100mL)

Table 2.4.2.2: Sample list of hydrothermal fluids taken with the KIPS during the ROV dives

station	**site**	**KIPS bottle number**	**DNA (-70°C)**	**FISH (fixed in formaldehyde)**	**culture name**	**target organism**	**t (°C)**	**CO_2 rates**
Rocks Turtle Pits 35 ROV								
ATA02-35 ROV 16	Turtle Pits		rock	rock				
ATA02-35 ROV 16A	Turtle Pits		rock	rock				
Diffuse fluids Wideawake (4 bottles taken) 37 ROV 1-5 11:50-12:18 UTC					38	Desulfurobacterium group,	25	1H2.0-1
ATA02-37 ROV 1-5	Wideawake	C8/B6/B5	filter 2-8 (200 mL)	filter (200 mL)	39	Desulfurococcales &	55	1H2.0-2
			filter 2-9 (400 mL)		40	Epsilonproteobacteria	75	1H2.0-3
			filter 2-10 (200 mL)		41	Thermales + Aeropyrum	55	1H2.0-4
					42	Thermales + Aeropyrum	75	1H2.A-1
					43	Methanococcales	37	1H2.A-2
					44	Methanococcales	55	1H2.A-3
					45	Methanococcales	75	1H2.A-4
					46	Thermococcales	75	1H2S-1
					47	Aquificales + Epsilonproteobacteria	25	1H2S-2
					48	Aquificales + Epsilonproteobacteria	37	1H2S-3
					49	Aquificales + Epsilonproteobacteria	55	1H2S-4
					50	Aquificales + Epsilonproteobacteria	75	1Ref1
					51	Archaeoglobales	55	1Ref2
					52	Archaeoglobales	75	1Ref3
								1Ref4

station	site	KIPS bottle number	DNA (-70°C)	FISH (fixed in formaldehyde)	name	culture target organism	t (°C)	CO_2 rates
Diffuse fluids Wideawake (5 bottles taken) 37 ROV 10-13 15:58-16:18 UTC					55	Desulfurobacterium group,	25	2H2.0-1
ATA02-37 ROV 11-13	Wideawake	A2/A3	filter 2- 11 (500 mL)	filter (200 mL)	56	Desulfurococcales &	55	2H2.0-2
					57	Epsilonproteobacteria	75	2H2.0-3
					53	Thermales + Aeropyrum	55	2H2.0-4
					54	Thermales + Aeropyrum	75	2H2.A-1
					58	Methanococcales	37	2H2.A-2
					59	Methanococcales	55	2H2.A-3
					60	Methanococcales	75	2H2.A-4
					61	Thermococcales	75	2H2S-1
					62	Aquificales + Epsilonproteobacteria	25	2H2S-2
					63	Aquificales + Epsilonproteobacteria	37	2H2S-3
					64	Aquificales + Epsilonproteobacteria	55	2H2S-4
					65	Aquificales + Epsilonproteobacteria	75	2Ref1
					66	Archaeoglobales	55	2Ref2
					67	Archaeoglobales	75	2Ref3
								2Ref4
Hot fluids ATA02-42 ROV 12 (Sisters Peak, Comfortless Cove) 16:54-16:58 UTC					68	Desulfurobacterium group	75	
ATA02-42 ROV 12			filter 2-12 (100 mL)	filter (10 mL)	69	Methanococcales	75	
			filter 2-13 (100 mL)	filter (40 mL)	70	Thermococcales	75	
			filter 2-14 (100 mL)		71	Aquificales + Epsilonproteobacteria	75	
					72	Archaeoglobales	75	

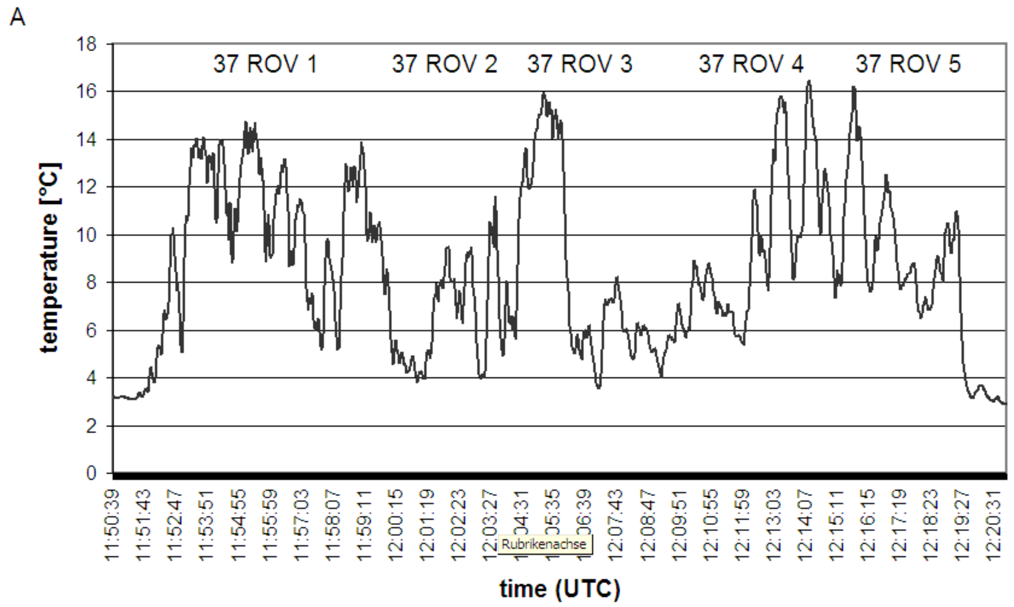
station	site	KIPS bottle number	DNA (-70°C)	FISH (fixed in formaldehyde)	name	culture	t (°C)	CO_2 rates
Rocks ATA02- 46 ROV (Wideawake slurp gun)			rock					
Diffuse fluids Clueless (4 bottles taken) 52 ROV 1-4 13:59-14:17 UTC					73	Desulfurobacterium group, Desulfurococcales & Epsilonproteobacteria	37	3H2.0-1
ATA02-52 ROV 1,2, 4	Clueless	C9/C8/B6	filter 2-21 (100 mL)		74		55	3H2.0-2
			filter 2-22 (100 mL)		75		75	3H2.0-3
			filter 2-23 (100 mL)		76	Methanococcales	37	3H2.0-4
			filter 2-24 (100 mL)		77	Methanococcales	55	3H2.A-1
					78	Methanococcales	75	3H2.A-2
					79	Thermococcales	37	3H2.A-3
					80	Thermococcales	55	3H2.A-4
					81	Thermococcales	75	3H2S-1
					82	Aquificales + Epsilonproteobacteria	37	3H2S-2
					83	Aquificales + Epsilonproteobacteria	55	3H2S-3
					84	Aquificales + Epsilonproteobacteria	75	3H2S-4
					85	Archaeoglobales	37	3Ref1
					86	Archaeoglobales	55	3Ref2
					87	Archaeoglobales	75	3Ref3
ATA02-52 ROV 5,6,7	Clueless	B4/B5/A3	filter 2-20 (400 mL)					3Ref4
ATA02-52 ROV 8,9	Clueless	A2/A1	filter 2-15 (150 mL)					
			filter 2-16 (55 mL)					
			filter 2-17 (55 mL)					
			filter 2-18 (55 mL)					
			filter 2-19 (55 mL)					
Hot fluids 57 ROV 2 (Turtle Pits) (4 bottles) 15:35-15:39 UTC								
ATA02-57 ROV 2	Turtle Pits		filter 2-25 (3 x 66 mL)	filter (1 mL)				
			filter 2-26 (3 x 66 mL)					
				filter (45 mL)				

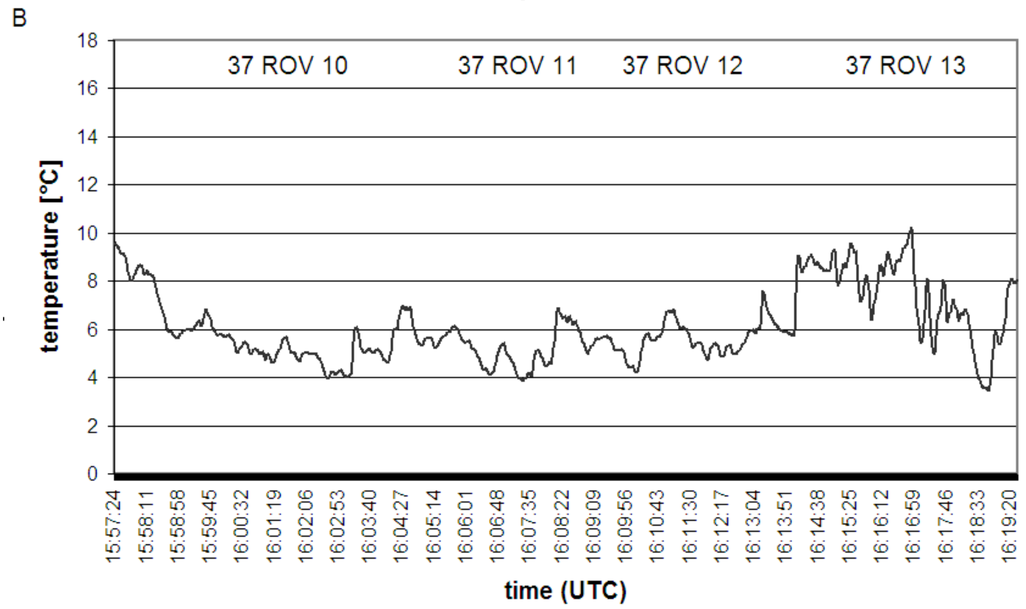
station	site	KIPS bottle number	DNA (-70°C)	FISH (fixed in formaldehyde)	culture name	culture t (°C)	CO_2 rates
Hot fluids Mephisto (Red Lion) (5 bottles taken) 67 ROV 4-8 14:48-15:03 UTC							
ATA02-67 ROV 4-8	Mephisto	C9/C8/B6	filter 2-27 (50 ml)	filter (1 mL)			4H2.0-1
			filter 2-28 (50 ml)	filter (45 mL)			4H2.0-2
							4H2.0-3
							4H2.0-4
							4H2.A-1
							4H2.A-2
							4H2.A-3
							4H2.A-4
							4H2S-1
							4H2S-2
							4H2S-3
							4H2S-4
							4Ref1
							4Ref2
							4Ref3
							4Ref4

2.4.3 Temperature measurements of low-temperature, diffuse hydrothermal fluids

(Mirjam Perner, Dieter Garbe-Schönberg)

During the sampling of the low-temperature hydrothermal fluids with the KIPS at Wideawake and Clueless the temperature was monitored (Fig. 2.4.3.1 A-C).





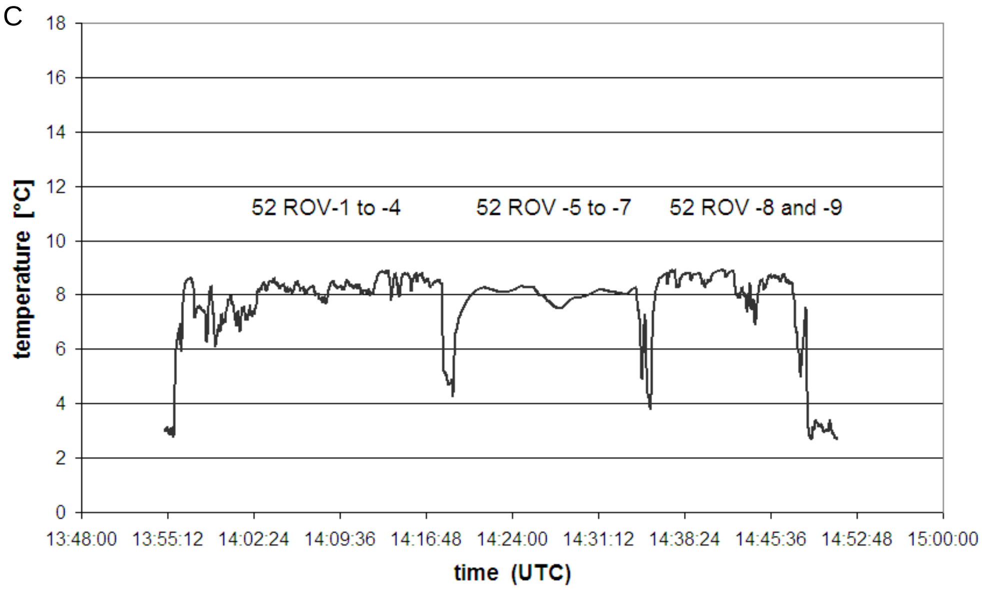


Fig. 2.4.3.1: Temperature measured during sampling of low-temperature diffuse fluids at Wideawake (A, B) and at Clueless (C).

Following the fluid sampling the 8-chanel temperature logger was inserted into the spot of sampling and measured temperatures along a vertical gradient for 20-30 minutes (Figs. 2.4.3.3, 2.4.3.5, 2.4.3.7).

Fig. 2.4.3.2: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Wideawake (37 ROV6).

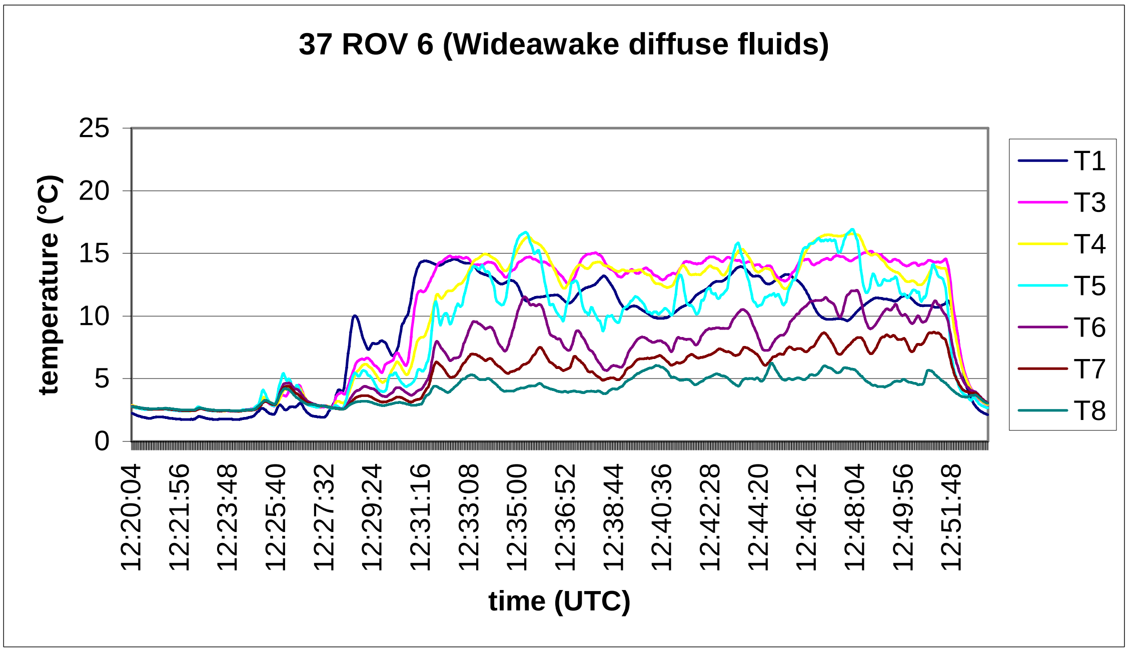


Fig. 2.4.3.3: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Wideawake (37 ROV6). T1 = 28 cm depth, T3 = 24 cm, T4 = 20 cm, T5 = 16 cm, T6 = 12 cm and T7 = 8 cm.

Fig. 2.4.3.4: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Wideawake (37 ROV13).

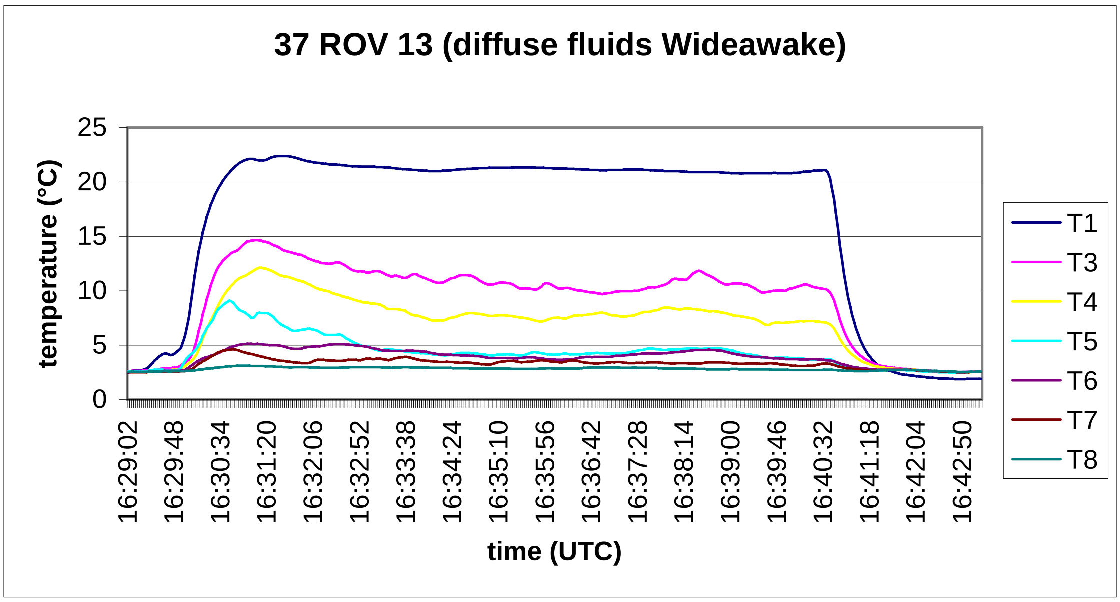


Fig. 2.4.3.5: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Wideawake (37 ROV13). T1 = 28 cm depth, T3 = 24 cm, T4 = 20 cm, T5 = 16 cm, T6 = 12 cm and T7 = 8 cm.

Fig. 2.4.3.6: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Clueless (52 ROV10).

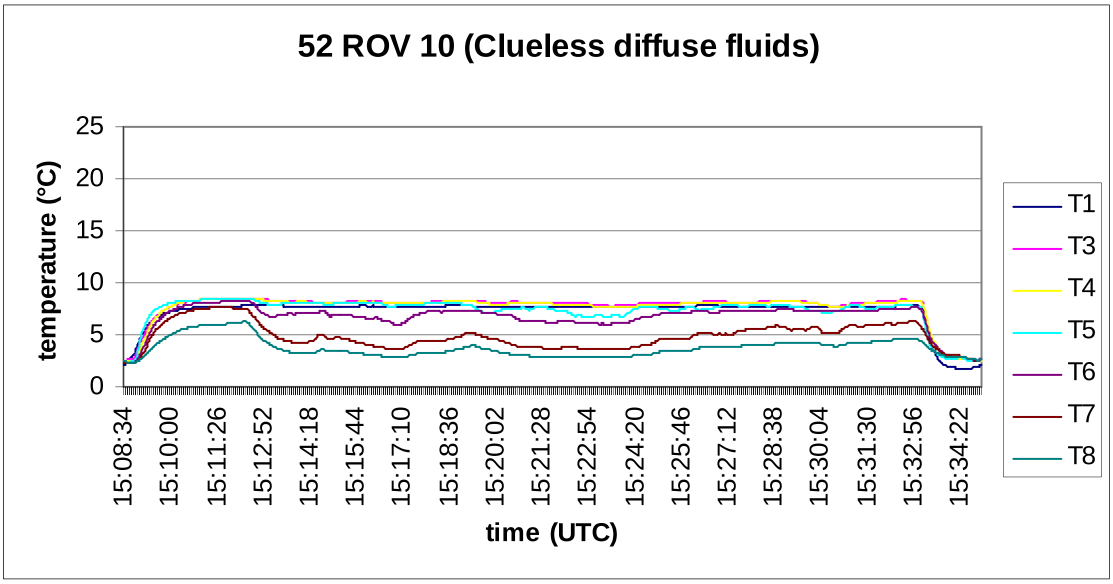


Fig. 2.4.3.7: Measurment of temperature with the 8-channel temperature logger at the low-temperature diffuse outlet at Clueless (52 ROV10). T1 = 28 cm depth, T3 = 24 cm, T4 = 20 cm, T5 = 16 cm, T6 = 12 cm and T7 = 8 cm.

2.4.4 Fluid chemistry

(Dieter Garbe-Schönberg, Katja Schmidt, Harald Strauss, Verena Klevenz, and Phillip Hach)

2.4.4.1 Fluid sampling

Kiel Pumping System (KIPS)

One pre-requisite for an accurate estimate of the composition of hydrothermal fluids venting at high-temperature Black Smokers or from diffuse mussel-field sites is sampling of the hydrothermal fluids without entrainment of ambient seawater which would cause immediate precipitation of sulphides and barite and, hence, loss of these compounds from solution. One measure of the purity of the sampled hydrothermal fluid is temperature. Consequently, real-time *in-situ* measurement of the temperature helps to guide the tip of the sampling nozzle to the hottest region within the vent orifice where the purity of the venting fluid is highest and least diluted with seawater. Another pre-requisite is that all materials coming into contact with the sampled fluid are inert and have lowest adsorption coefficients preventing systematic errors introduced by either contamination or losses due to adsorption. Precipitation during cooling of the sampled fluid, however, cannot completely be avoided.

A remotely controlled flow-through system – the Kiel Pumping System (KIPS-3) - mounted on the ROV's starboard tool sled was used for this purpose (Garbe-Schönberg et al., 2006). The parts of the system getting into contact with the sample are entirely made of inert materials and are stable up to temperatures of 260 °C (short-term 305 °C): perfluoralkoxy (PFA), polyetherethyleneketone (PEEK), polytetrafluorethylene (PTFE, Teflon®), and a short tube of high-purity titanium (99.9 % Ti). Fluid enters via this titanium tube (40 cm length, 6 mm I.D., bent to 90°) - the nozzle - mounted to a T-handle which is guided by the

ROV's ORION manipulator arm (Fig 2.4.4.1). Parallel to the titanium nozzle is a high-temperature sensor (see below) delivering real-time temperature data for the tip of the nozzle. Coiled PFA tubing (3/8" O.D., 3 m length) connects the nozzle to a remotely controlled multi-port valve (PEEK/ PTFE) delivering the fluid to the respective sampling flask. The valve is driven by a stepper motor (electric actuator, Schilling Robotics, U.S.A.) and controlled from a separate laptop via RS232 tunneling through the ROV control system (Kiel 6000 ROV: Node 6, port #14). The software package used was FluidCtrl V. 3.0.0 by Jens Renken @ Marum Soft, Bremen.

The multiport valve has 9 ports connected to 9 single PFA flasks with 675 ml volume each (Nalgene, USA). Each bottle is equipped with a check valve at the outlet. The flasks are mounted in three racks A-C, with every rack containing three horizontally positioned bottles (A1-A3, B4-B6, C7-C9), allowing an easy transfer of the racks to the laboratory where sub-sampling was done. Flasks were pre-filled with ambient bottom seawater (North Atlantic Deep Water, NADW) obtained from previous CTD hydrocasts. A 24 V deep sea mechanical gear-pump is mounted downstream to the sample flasks, thus avoiding contamination of the samples. The pumping rate was approx. 1 L/min at 24 VDC. The standard pumping time per sample was set to 4 min. making sure that the flask volume was exchanged at least 5 times. The outlet of the KIPS system is located on the porch at the front-side of the ROV, where video control allows the observation of warm shimmering fluids leaving the system. In addition, a flow mobile was attached to the outlet tube at diffuse vent sites.

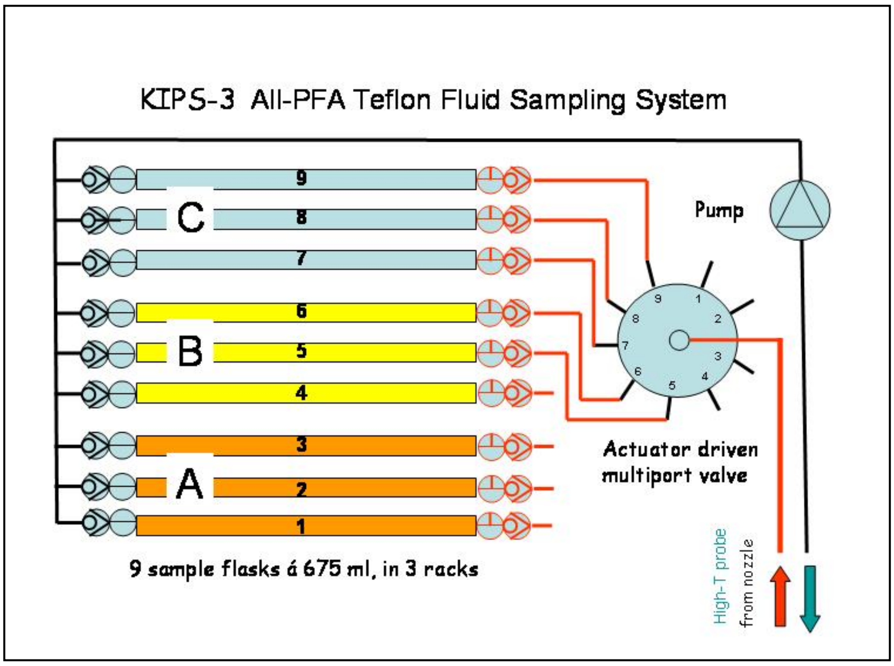


Fig. 2.4.4.1: Schematic configuration of the inert KIPS fluid sampling system (only tubing connections to flasks # 5 - # 9 are shown for clarity). Fluid entering the nozzle is distributed by a motorized multiport-valve to 9 PFA sample flasks á 675 ml, each with check valves and stopcocks. The pump is positioned downstream. Racks A, B, C with 3 flasks each can be quickly removed and sub-sampled in the lab.

A high-precision thermistor temperature sensor (manufactured by H.-H. Gennerich, Bremen) inside a stainless steel pressure housing was attached parallel to the nozzle. The 90% time constant of the sensor in water was better than 10 s. The sensor is connected to a RBR logger TR-1050R (Serial# 12644, RBR Brancker, Canada) for real time data conversion to calibrated temperatures and data storage. A Y-splice cable connection accomplished real time data transfer through the ROV's RS232 data line and the display on a ROV control van monitor. Two individual sensors were used during this cruise: temperature probe #5 during stations ATA 35 ROV through ATA 42 ROV, and T probe #4 for all subsequent dives. Calibration coefficients used during the cruise are tabulated in Table 2.4.4.1. Prior to the cruise a 23-points high-precision calibration covering 0-450 °C was performed at an ISO-certified calibration lab (TESTO, Germany) for each of the sensors.

Table 2.4.4.1: Calibration coefficients for resistance data-to-temperature conversion of T probes #5 and #4 at RBR logger TR-1050.

T probe #5 (NTC No 193729)		T probe #4 (NTC No 193731)	
A0	0.003516129399127	A0	0.00347114037326
A1	-0.000256163403706	A1	-0.000255203453916
A2	0.000002731961606	A2	0.000002719519579
A3	-0.000000081982648	A3	-0.000000080192994

Major water samplers

In addition to the KIPS, we used two titanium syringes ("Major" after von Damm et al., 1985; manufactured by IFREMER/ BREST-MECA) to collect hot hydrothermal fluids at Turtle Pits, Comfortless Cove and Red Lion. The total sample volume for one major is 750 ml (Fig 2.4.4.2). The samplers were constructed primarily of titanium with seals made of teflon and viton. The syringes are not gas-tight: a simple lab test showed that bubbling from the samplers started at 1.5 bars overpressure. They are constructed to be self-flushing and are sent to the seafloor in chocked mode. To take a fluid sample, the snorkel is placed into the vent orifice. First, only the snorkel gets flushed by the fluid; a control for a good position in the undiluted part of the fluid outflow is allowed by observing the small flushing outlet opening. Undiluted hydrothermal fluid without seawater mixing is indicated by a clear solution leaving the outlet. Triggering the sampler is accomplished by pushing the releaser with a hydraulic cylinder mounted on the ROV manipulator arm. This releaser 1) closes the flushing valve, 2) opens the valve to the sample chamber, and 3) releases the pin holding the piston rod so that the large spring can pull the piston back soaking hydrothermal fluid into the sample chamber. To recover the sample on board tubing is connected to the small outlet valve of the sample chamber. For gas sampling, vacuum extraction was applied (see section on Dissolved Gas Chemistry). Thin black coatings in the sample chamber were observed in most cases, caused by precipitation of sulfides.

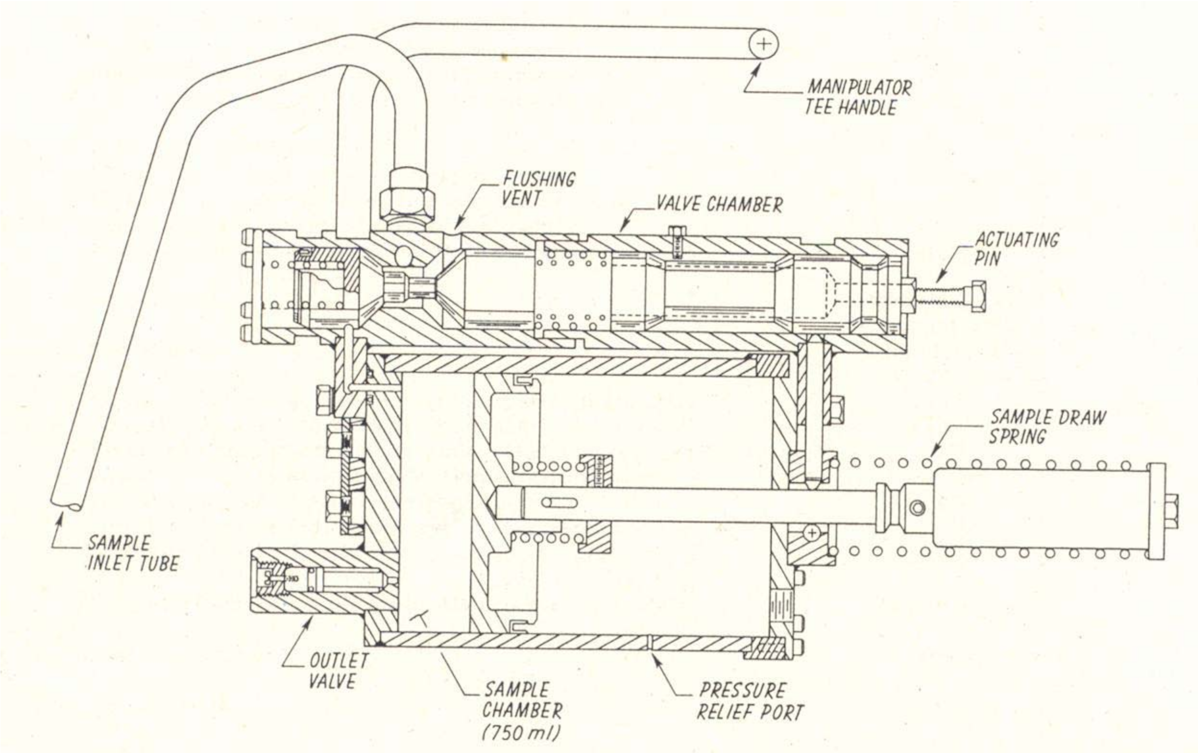


Fig. 2.4.4.2: Schematic drawing of "Major" titanium syringe sampler after von Damm, 1985 (Geochimica et Cosmochimica Acta 49, 2197–2220).

In total, 22 hot fluid samples were collected utilizing KIPS and Majors: seven from Turtle Pits (Two Boats), nine from Comfortless Cove (Sisters Peak) and six from Red Lion (Mephisto). Diffuse fluids were collected at two different locations at Wideawake (9 samples) and Comfortless Cove (Golden Valley – 9 samples).

Buoyant hydrothermal plumes were sampled by means of the CTD/Rosette, equipped with 24 bottles à 10 l volume and operated as tow-yos (see section oceanography for details). In total, 16 water column profiles were sampled and immediately acidified in order to determine Fe and Mn in these samples.

Sub-sampling and sample preparation for on-board analyses and subsequent measurements in the home laboratories

Immediately after recovery of the ROV on deck KIPS sample racks and Ti majors were transferred to the laboratory for subsampling following a standardized protocol (see appendix). In addition to the onboard analyses, further fluid sample aliquotes were taken for measuring fluid chemical composition and selected isotopes.

In order to fullfill the requirement for trace metal analyses to work on indentical sample aliquots, the rest of each sample was first transferred to one PFA bottle, homogenized by shaking and further distributed to the respective bottles. Furthermore, hot hydrothermal fluids emanating from black smokers contain precipitates formed during cooling and mixing with seawater. On board, aliquots were not filtered but acidified with 1-5 ml subboiled HNO_3 per 100 ml fluid and stored in PFA bottles. A second set of aliquots were pressure filtrated (99.9990 nitrogen) through 0.2 µm Nuclepore PC membrane filters in a Sartorius filtration unit, acidified with 0.2 ml subboiled concentrated nitric acid per 100 ml and also stored in

100 ml PFA bottles until analyses. Procedural blanks were processed in regular intervals. All work was done in a class 100 clean bench (Slee, Germany) using all-plastic labware (HDPE, PC, FEP, PFA). Rinse water was ultrapure (>18.2 MOhm) dispensed from a Millipore Milli-Q system.

After return to the home labs in Kiel and Bremen samples will be analysed for major and minor elemental composition (Na, K, Ca, Mg, Sr, Ba, B, Fe, Mn, Cu, Zn) by means of ICP-optical emission spectrometry (Ciros SOP; Spectro) and trace elements (e.g., I, Br, B, Li, Al, Ti, Cs, Ba, Sr, Y-REE, Fe, Mn, Cr, V, Cu, Co, Ni, Pb, U, Mo, As, Sb, W) by ICP-mass spectrometry using both collision-cell quadrupole (U-Kiel: 7500 cs, Agilent, JU-Bremen: Elan DRC-e, Perkin Elmer) and high resolution sector-field instrumentation (U-Kiel: PlasmaTrace 2, Micromass). At JUB in Bremen, complementary analyses on the speciation of metals will be carried out using voltammetry (computrace VA 757, Metrohm). For anion analyses (e.g., Cl^-, Br^-, I^-, SO_4^{2-}), aliquots of hot hydrothermal fluids with precipitate were pressure-filtrated through 0.2 µm PC membrane filters (Nuclepore). For amino acids and other organic compounds, respective measurements will be carried out in collaboration with Dr. Ostertag-Henning at Bundesanstalt für Geowissenschaften und Rohstoffe (BGR, Hannover, Germany). Onboard, non-filtered sub-samples for organic analyses were immediately frozen (-20°C) as 50 ml aliquots in glas bottles. Filters from filtration of the KIPS fluid samples of the ROV were kept in plastic containers. Samples for the detection of dissolved inorganic silica were diluted 1:50 from the concentrated fluid (filtered and acidified) with DI water.

Further subsamples were collected for stable isotope analyses. Filtered aliquotes of hot hydrothermal fluids (2x2 ml) were stored with no headspace in crimp-sealed glass vials for hydrogen (δ^2H) and oxygen isotope measurements ($\delta^{18}O$). Hydrogen sulfide disolved in the hydrothermal fluids was precipitated as zinc sulfide with a 3% zinc-acetate solution, filtered and dried for measuring the four stable sulfur isotopes (^{32}S, ^{33}S, ^{34}S, ^{36}S). For determining the carbon isotopic composition of inorganic carbon ($\delta^{13}C$) dissolved in hot and diffuse hydrothermal fluids, 20 ml aliquotes were poisened with two drops of $HgCl_2$ and stored in the dark. Stable isotope measurements will be carried out at the Geologisch-Paläontologisches Institut, Universität Münster, Germany. For Ca, Sr, and Cl isotope measurements, 50 ml of non-filtered hydrothermal fluid were stored in HDPE bottles.

2.4.4.2 Analytical procedures on-board

In general, on-board measurements were performed immediately after sample recovery on deck. Sampling followed a standardized protocol in order to avoid oxidation of highly redox-sensitive dissolved constituents in the hydrothermal fluids.

pH and Eh

Non-filtered aliquots of each sample were subjected to immediate pH and Eh measurements (Ag/AgCl reference electrode).

Dissolved oxygen

Dissolved oxygen was determined for diffuse hydrothermal fluids following the classical Winkler method as outlined in Grasshoff (1999). The method was slightly modified in order to utilize 10 ml volumetric flasks. The detection limit is approx. 0.5 ml/l O_2, precision is in the range of ± 0.1 ml/l O_2. The samples were analysed by Mirjam Perner and Nadine Markus (see section on Microbiological Diversity).

Iron speciation

Determination of iron speciation was performed spectrophotometrically. The method is based on determining the orange-red ferroin complex, which is formed by Fe(II) ions in the fluid sample complexed with 1% (w/v) 1,10-phenantroline in a pH range of 3-5. In addition to the quantification of Fe(II), the total Fe content is measured by reducing all Fe with a 1% (w/v) ascorbic acid solution. Fe(III) concentration is calculated as the difference between total Fe and Fe(II). Analyses were carried out with a Biochrom Libra S12 spectrophotometer at a wavelength of 511 nm.

Dissolved sulfide

For onboard analysis of dissolved sulfide concentrations, initially two different methods were applied: voltammetry and spectrophotometry.

All voltammetric measurements were performed on a 757 VA Computrace with a standard PC (Metrohm, Herisau, Switzerland). The three-electrode configuration consisted of the static mercury drop electrode (SMDE) as the working electrode, an Ag/AgCl reference electrode (3M KCl), and a platinum wire as the auxiliary electrode. Sulfide concentrations were determined by using a NaOH 0.1M oxygen-free solution (Application Bulletin No. 199/3, Metrohm, Herisau, Switzerland).

Spectrophotometry of dissolved sulfide is based on the light absorption of methylene blue at a wave length of 660 nm. Dissolved sulfide is stabilized in a colloidal form as zinc sulfide using zinc acetate gelatine solution (100 µl for 1 ml of hydrothermal fluid). The sulfide reacts with N,N_dimethyl-1,4-phenylene-diamine-dihydrochloride to colourless leucomethylene and – through oxidation by Fe(III) supplied by an $FeCl_3$-solution – further to methylene blue. Photometric measurements were performed using a Biochrom Libra S12 spectrophotometer. Concentrations of the freshly prepared stock solution utilized for calibration were determined by titration with a 0,02N sodium-thiosulfate solution.

Further measurements of sulfur speciation (i.e., intermediate sulfur species like sulfite or thiosulfate) will be performed at the home laboratory, following the monobromobimane method (Fahey and Newton, 1987). On board, 50µl volume of the hydrothermal fluid was added to 110µl of previously prepared derivatization mixture, composed as follows: 50µl of HEPES buffer, 50µl acetonitrile and 10µl monobromobimane (48mmol/L). Derivatization was performed in the dark and was stopped after 30 min by adding 100µl of methanesulfonic acid (Rethmeier et al., 1997). Several advantages derive from this approach: the opportunity to quantify additional metastable sulfur phases, to separate these for isotopic measurements (method currently being developed in cooperation with Dr. Ostertag-Henning, BGR Hannover), and to perform respective measurements on substantially smaller sample volumes.

Chloride

Phase separation in hydrothermal fluids is reflected in chlorinities substantially different from seawater. Accordingly, chloride concentrations were quantified by titration with 0.1M $AgNO_3$ using fluoresceine-sodium as indicator (after FAJANS). For reference, seawater was measured at 560 mM.

2.4.4.3 First results

In situ-temperatures and chemistry of Black Smoker hydrothermal fluids

A dedicated high-precision thermistor-based temperature sensor integrated within the KIPS fluid sampling system and mounted parallel to the sampling nozzle was used for our temperature measurements of hydrothermal fluids. It has to be kept in mind that fluids emerging e.g., at the top of a 12 m tall chimney may have already cooled or mixed with seawater inside the chimney structure. Moreover, vigorous venting involves turbulent mixing of hydrothermal fluids with seawater leading to a highly chaotic temperature distribution within the orifice. It becomes evident that temperature measurements under these conditions and with a ROV difficult to hold in position within a few millimetre for some tens of seconds are only a rough estimate of the real temperature of the hydrothermal fluid. However, quite constant temperature readings could be obtained for some high-temperature vents including the Two Boats vent at Turtle Pits where we measured a stable temperature of 451 ± 1.6 °C and a maximum temperature of 529 °C. These are the highest temperatures ever obtained for a black smoker fluid on the seafloor. This suggests that the phase-separated hydrothermal system at Turtle Pits and Comfortless Cove (T_{max} = 429 °C (529 °C) might react above the critical curve of the NaCl-H_2O system. In contrast, non-phase-separated fluids emerging at the Mephisto vent in the Red Lion hydrothermal system - in only 1 km distance to Two Boats - have temperatures of 366 °C (Table 2.4.4.2). The following Figs. 2.4.4.3 through 2.4.4.9 illustrate the temperature conditions during our fluid sampling of the high-temperature black smoker chimneys.

Table 2.4.4.2: Measured temperatures of venting hydrothermal fluids

Area	*Site*	*2006 T_{max} (°C)*	*2008 Station*	*2008 T_{max} (°C)*	*2008 T_{avg} (°C)*	*Fluid sample No.*
Hot venting						
Turtle Pits	Two Boats-Top	409	35 ROV	429	416 ± 2.3	No sample
	Two Boats-Bottom		35 ROV	529	451 ± 1.6	35 ROV-7
	Two Boats-Bottom		46 ROV	412	./.	46 ROV-7
	Two Boats-Bottom		57 ROV	371	./.	57 ROV-2/ -5
Comfortless Cove	Sisters Peak	400	42 ROV	379	367 ± 4.9	42 ROV-2 /-7
Red Lion	Mephisto	346	67 ROV	366	364 ± 0.6	67 ROV-3/ -8
Diffuse venting						
Wideawake	Wideawake mussel field	19	37 ROV	16	8	37 ROV-1/ -5 37 ROV-10/ -13
Comfortless Cove	Golden Valley/ Clueless Site	4	52 ROV	9	9	52 ROV-1 /-9

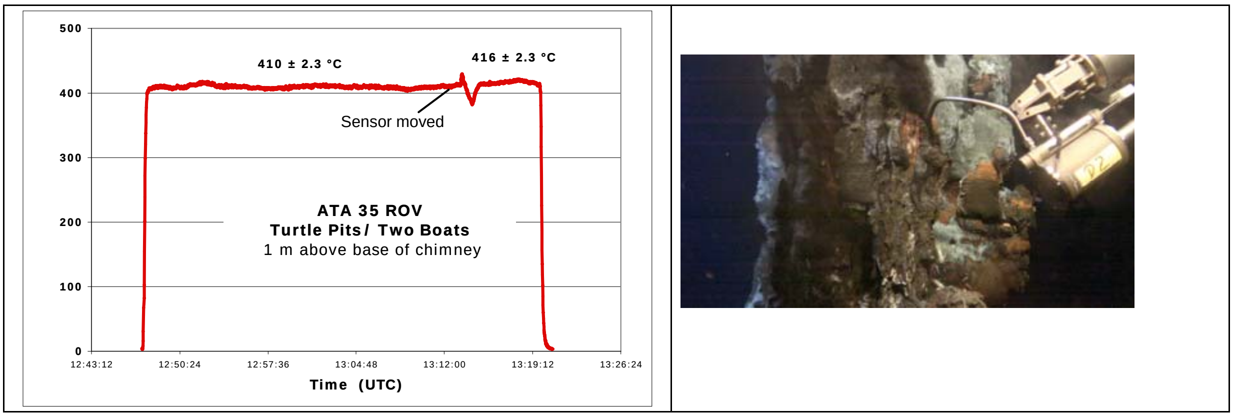


*Fig. 2.4.4.3: Station ATA 35 ROV, Turtle Pits. Temperature readings and fluid sampling was at a small outlet approx. 1m above the base of Two Boats. Average over 20 minutes: **410 ± 2.3 °C.** After the sensor had been repositioned temperature readings were **416 ± 2.3 °C** over 5 minutes. The maximum temperature recorded was **T_{max} = 429 °C**. KIPS fluid sampling failed. Ti Major D2 filled, 35 ROV-7.*

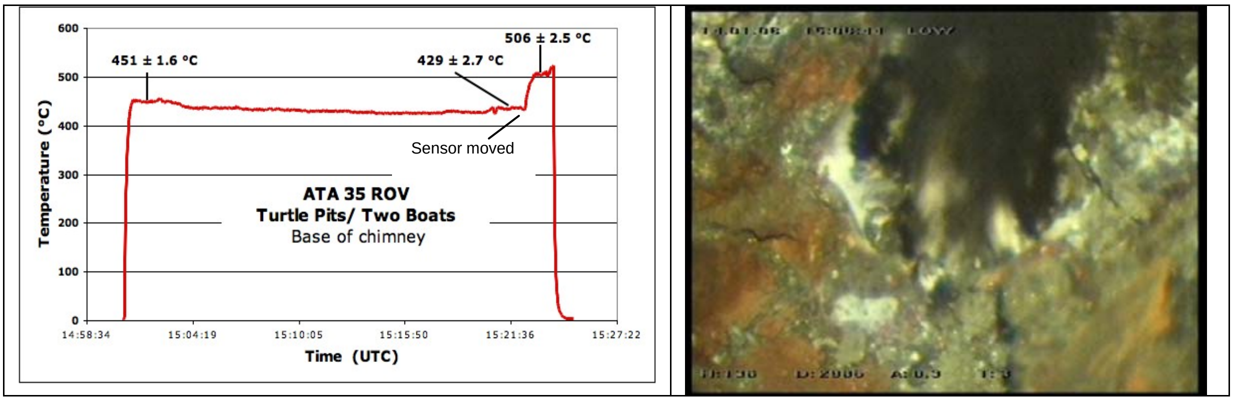


*Fig. 2.4.4.4: Station ATA 35 ROV, Turtle Pits. Temperature readings were from a newly opened orifice at the base of the Two Boats black smoker. Initially, temperature was at **451 ± 1.6 °C** but faded to 428 °C. Repositioning of the nozzle resulted in temperatures of **429 ± 2.7 °C** . After fluid sampling was finished an attempt was made to relocate the hottest spot by careful scanning the orifice opening. Temperature readings increased to **506 ± 2.5 °C**, and topped at **529 °C**. After opening the orifice vigorous venting with schlieren of clear hydrothermal fluid leaving the orifice could be observed. Fluid sampling failed ☹.*

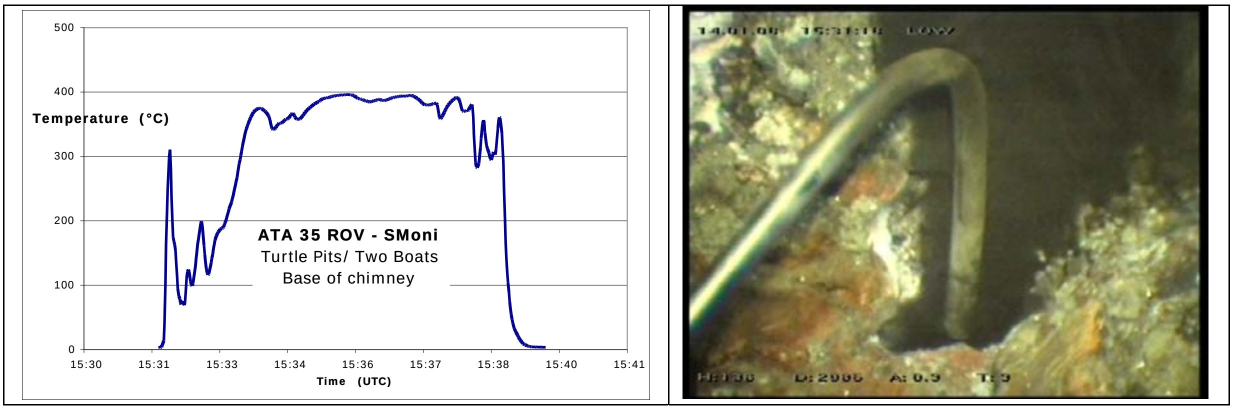


*Fig. 2.4.4.5: Station ATA 35 ROV, Turtle Pits. Temperature readings were taken in the same orifice at the base of the Two Boats black smoker, but with the SMoni offline sensor+logger combination. SMoni uses different thermistor technology than that used in the KIPS sensors. Maximum temperature obtained was **396 °C**. However, the offline design of the probe makes a systematic search for the tiny spot with the hottest temperature in the orifice impossible. (Note: The SMoni logger was unfortunately flooded during the next use at station ATA 42 ROV.)*

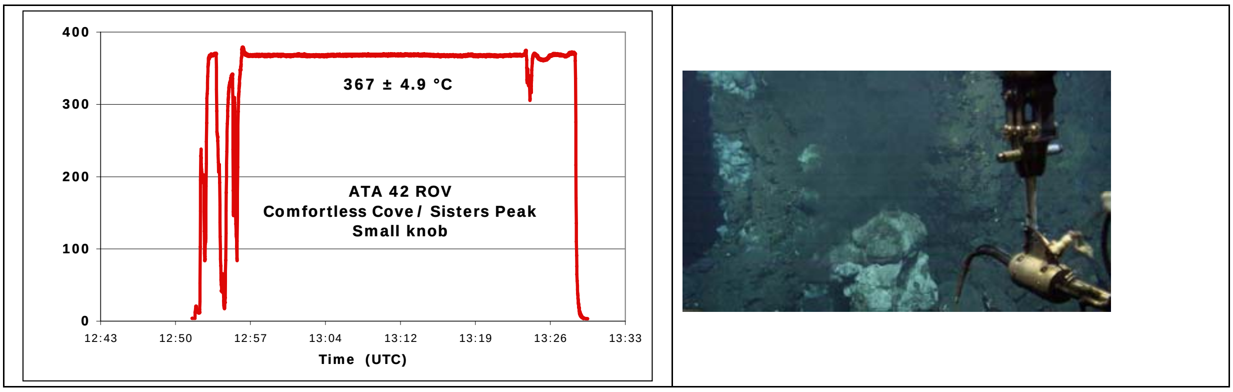


*Fig. 2.4.4.6: Station ATA 42 ROV, Comfortless Cove. Temperature readings and fluid sampling were at a small knob in the top region of the Sisters Peak chimney. Average over 20 minutes: **367 ± 4.9 °C, T_{max} = 379 °C**, KIPS fluid samples 42 ROV-2 to -5 taken and Ti-Major D1 42-ROV-7 filled. KIPS fluid samples 42 ROV-11 to -14 were taken without temperature reading because the cable had been cut during handling.*

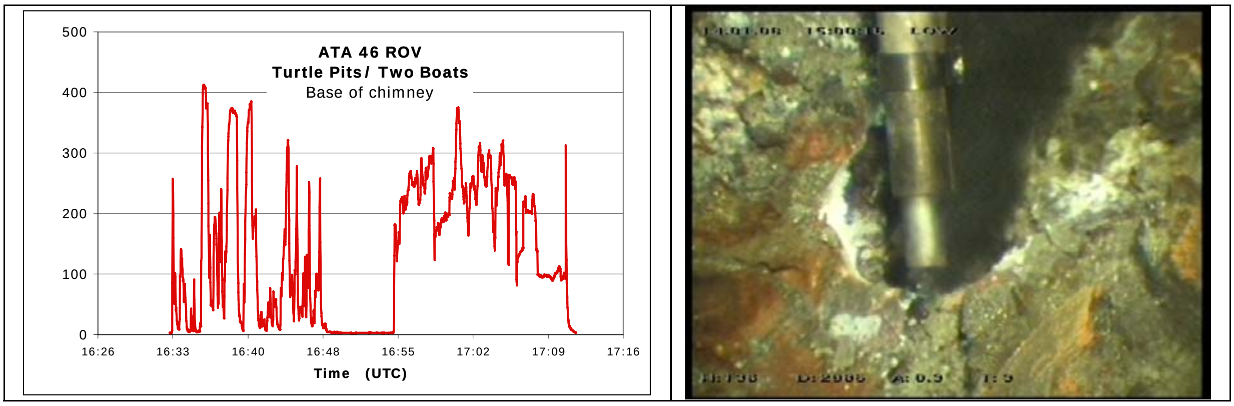


Fig. 2.4.4.7: Station ATA 46 ROV, Turtle Pits. KIPS fluid samples 46 ROV-7 and -8 were taken from the same orifice at the base of the black smoker as three days before (35 ROV). Meanwhile, a 20 cm tall chimney was re-grown over this period. After collapse of the new small chimney the venting from the orifice was found to be significantly less vigorous than during the previous visit. The feeding outlets must have plumbed by fresh precipitates. There was no accurate temperature control during fluid sampling because the T sensor had been displaced from the tip of the sampling nozzle. A maximum temperature of ***412 °C*** *was recorded.*

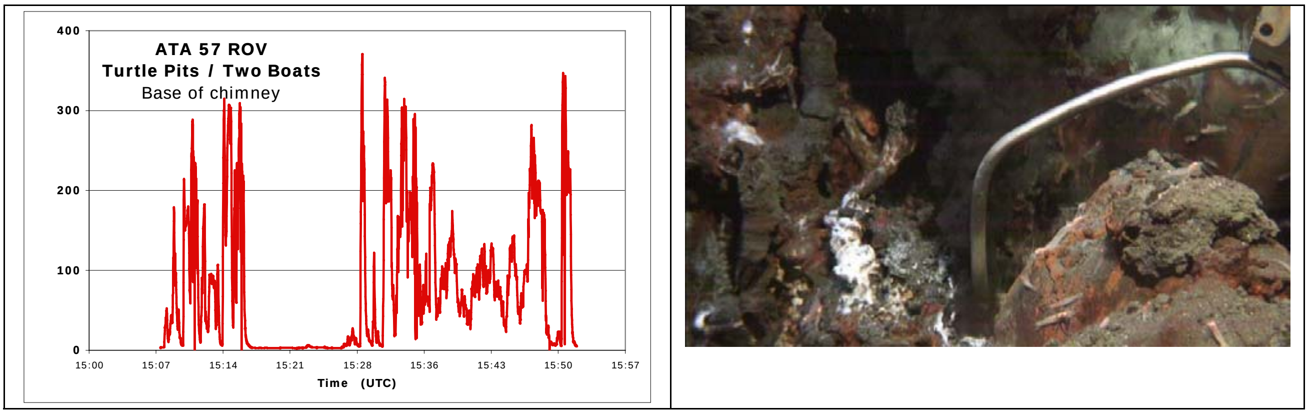


Fig. 2.4.4.8: Station ATA 57 ROV, Turtle Pits. KIPS fluid samples 57 ROV-2 to -5 collected again at base of chimney Two Boats. The orifice was now even more plumbed, and fluid flow was significantly reduced. Every attempt to reopen the orifice failed. The maximum temperature reading was 371 °C.

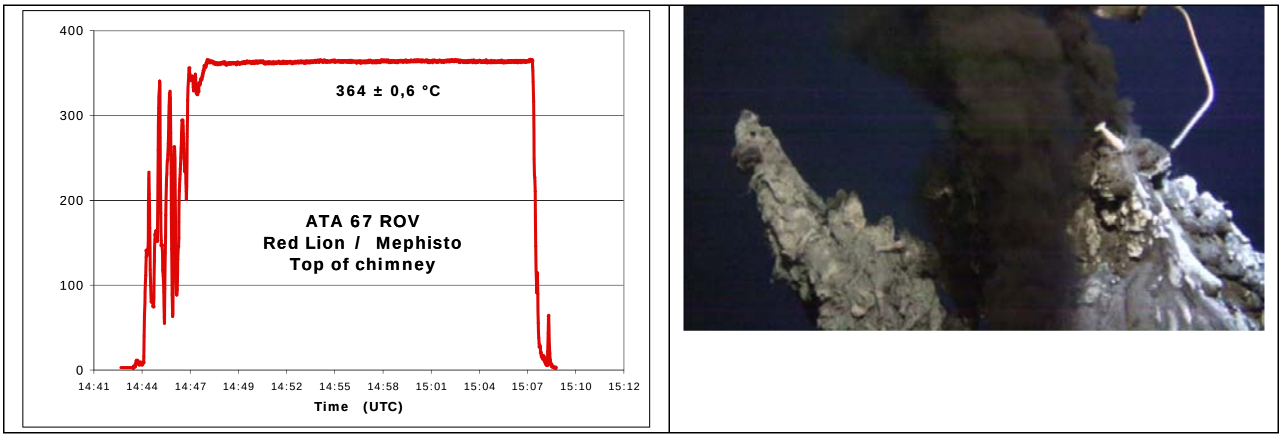


Fig. 2.4.4.9: Station ATA 67 ROV, Red Lion. A newly opened orifice in the summit region of the Mephisto chimney was sampled with Ti Major D2, 67 ROV-3, and KIPS fluid samples 67 ROV-4 to -8. Clear fluid was leaving the outlet of KIPS. Temperatures were 364 ± 0.6 °C with a maximum of 366 °C.

Chemical composition

On-board measurements comprised pH, Eh, concentrations of oxygen, sulfide, chloride and Fe speciation. For selected samples, the concentrations of dissolved H_2, CH_4, CO_2 and CO were also quantified (see chapter on Gas Chemistry). Analyses were performed in order to ascertain the quality of sampled hydrothermal fluids (i.e., the degree of admixed seawater) and to provide an initial characterization of fluid composition and characteristics, particularly with respect to phase separation. Results are presented in Figures 2.4.4.10 to 2.4.4.13 and Tables A1 and A2 (Appendix).

Turtle Pits (Two Boats)

Sampling the Two Boats chimney with the Kiel ROV 6000 turned out to be extremely difficult. Orifices with vigorous venting at the top of the smoker were inaccessible for the ROV. In addition, fluid sampling failed during the first attempt in 35 ROV. However, hydrothermal fluids were collected 1 m above, and at the base of the Two Boats chimney. However, the temperature probe was displaced from the sampling nozzle such that sampling was not guided by the temperature maximum in the orifice and more diluted fluids were sampled. Consequently, the pH range is wide between 2.8 and 6.6 in these samples. The sample with the lowest pH (57 ROV-4) displays the highest Fe concentration of 3.9 mM, and maximum sulfide concentrations of 4.8 mM were measured. Chlorinity in these Turtle Pits fluid samples is significantly reduced compared to seawater, ranging between 300 mM and 550 mM. This can only be caused by phase separation of the fluid in the subseafloor, at P/T conditions above the critical point of seawater (<3000 m, >405 °C) and the emanation of the low-salinity vapor phase.

This year's results are in good agreement with the chemical signature of fluids sampled at the same chimney in 2005 and 2006 (endmember chloride concentration: 270 mM; endmember Fe concentration: 4 mM, endmember H_2S concentration: 4.2 mM). It may be suggested from these results that the Two Boats chimney is constantly emanating a vapor phase since 2005, and, probably, the general chemical composition will be found to be as constant. Quantification of the relative percentage of hydrothermal fluid in the collected samples will be performed in the home laboratory, allowing the calculation of endmember compositions.

Comfortless Cove (Sisters Peak)

Fluids at the chimney structure Sisters Peak have been collected at 3 different orifices: one at the base of the chimney (42 ROV-2 to 42 ROV-7) and two others at the top (42 ROV-11 to 42 ROV-14). Due to difficulties in accessing the small orifices at the top, those samples contain a high amount of admixed seawater, expressed in pH values >5.6. The pH values for samples from the bottom orifice range between 3.4 and 6.8, corresponding to total Fe concentrations between 3.7 mM and 0.07 mM. The best quality sample contains 9.7 mM H_2S and 310 mM Cl; phase separation with the emanation of a low-Cl vapor phase is evident. As Two Boats, the Sisters Peak chimney has been sampled before, in 2006. Recent results for the concentrations of Fe, H_2S, and Cl are in reasonable agreement with data obtained in 2006 (endmember Fe concentration: 3.8 mM; endmember H_2S concentration: 8 mM; endmember Cl concentration: 220 mM). Again, this confirms stability in fluid composition as already observed in Turtle Pits. The chlorinity seems to be somewhat higher when compared to 2006, which could result from slight changes in P/T conditions of phase separation. However, measured data are not yet endmember-corrected.

Red Lion (Mephisto)

In the Red Lion field, six fluid samples were collected from a collapsed beehive on top of the Mephisto structure. Temperature measurements during KIPS sampling (15 minutes) recorded stable 363 °C. Fluid pH ranges between 2.8 and 5.1. A chloride concentration of 540 mM (median of 5 samples) indicates that phase separation is not a process currently taking place. Total Fe concentrations vary between 0.25 and 0.93 mM. H_2S concentrations display a maximum value of 7.6 mM. Again, concentrations of Fe, Cl, and H_2S measured during this cruise are comparable to samples from 2005 and 2006, attesting to an overall stability in fluid composition.

Compositional differences between hot hydrothermal fluids emanating at Red Lion and those emanating at Turtle Pits and Comfortless Cove are a clear function of temperature and phase separation.

Wideawake

At Wideawake, diffuse fluids emanate in an area of intense mussel inhabitation. Fluids were collected at two different locations (37 ROV-1 to 37 ROV-5; 37 ROV-10 to 37 ROV-13). Measured temperatures (KIPS) were 4 and 16 °C. The pH ranges between 7.05 and 7.5. Fe concentrations are as high as 25 µM. Concentrations of H_2S range between 1.2 and 76 µM. There is no clear correlation between H_2S and Fe concentrations. The measured chlorinity is seawater-like, with a median value of 550 mM.

Comfortless Cove (Golden Valley)

Diffuse fluids sampled at a mussel field (locality "Clueless") in the Golden Valley area seep at constant temperatures between 8 and 9°C. The pH ranges between 6.8 and 7.6. Fluids contain up to 43 µM Fe and up to 56 µM H_2S. Similar to diffuse fluids from the Wideawake mussel field, the H_2S concentrations do not correlate with respective Fe concentrations, but with pH.

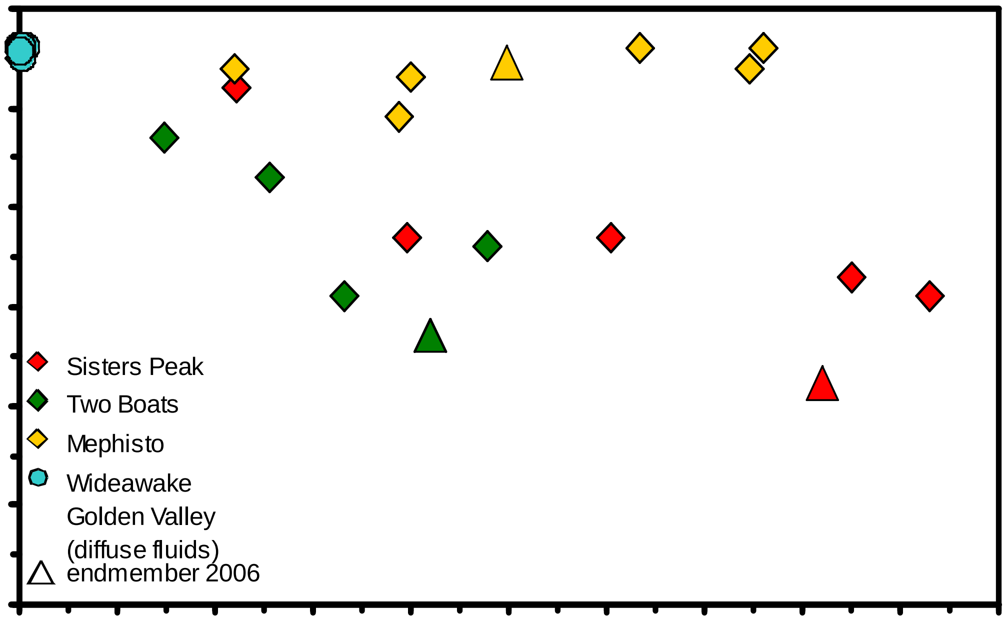


Fig. 2.4.4.10: Crossplot of H_2S and Cl concentrations for hot and diffuse hydrothermal fluids.

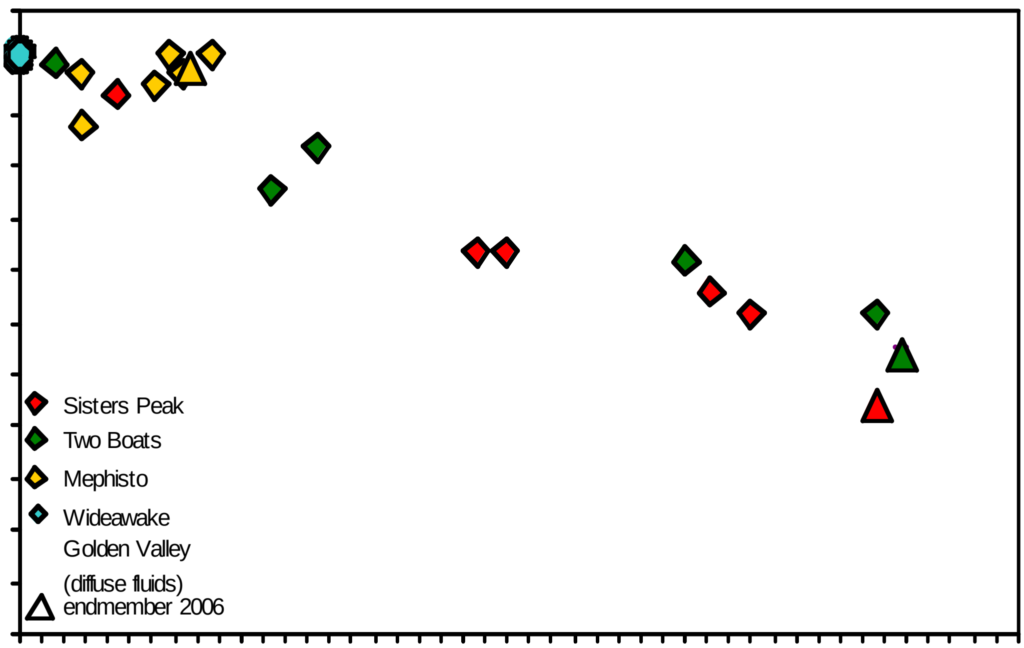


Fig. 2.4.4.11: Crossplot of Fe(II) and Cl concentrations for hot and diffuse hydrothermal fluids.

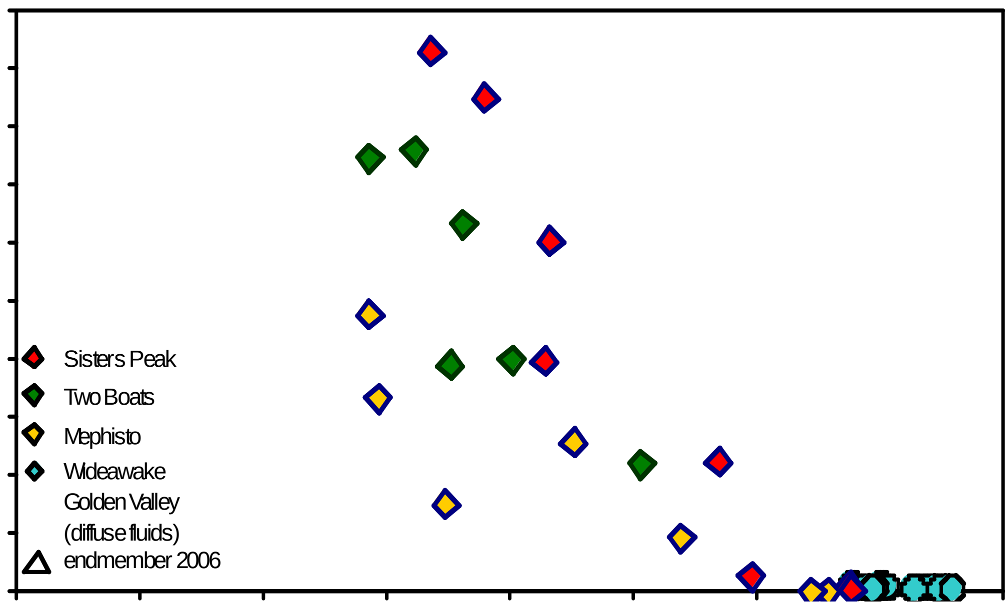


Fig. 2.4.4.12: Crossplot of pH and H_2S concentrations for hot and diffuse hydrothermal fluids.

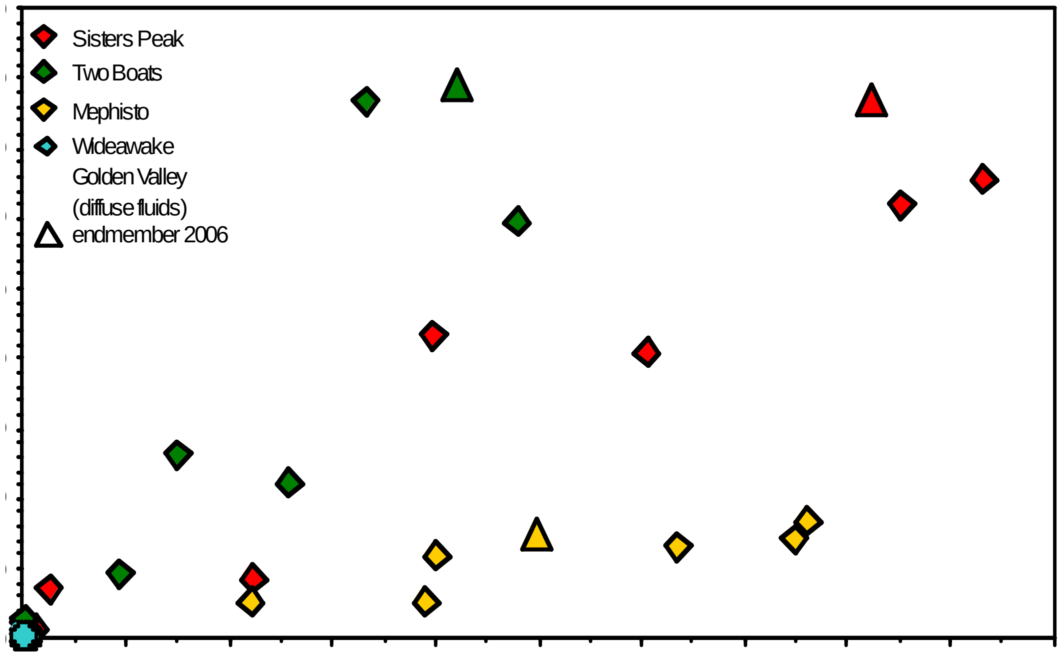


Fig. 2.4.4.13: Crossplot of H_2S and Fe(II) concentrations for hot and diffuse hydrothermal fluids.

2.4.4.4 The chemical composition of hydrothermal fluids – Perspectives

The chemical and isotopic composition of hydrothermal fluids is largely governed by the interaction of rocks and heated seawater percolating through the oceanic crust. Additional effects derive from phase separation of the hydrothermal fluid into a low-chlorinity, gas-rich vapour phase and a high-chlorinity brine phase. This process is accompanied by a strong partitioning of certain elements into either one phase. The latter aspect, i.e. phase separation, is most relevant for the two hydrothermal vent fields at Turtle Pits (Two Boats) and Comfortless Cove (Sisters Peak), as evident from respective chlorinity data measured on-board. In contrast, the Red Lion hydrothermal system shows no indication of phase separation serving as a reference site hosted in the same geological setting. This provides the unique opportunity to study partitioning effects induced by phase separation.

Resulting from these general characteristics, subsequent measurements in the home laboratories will aim to discriminate compositional effects derived from water-rock interaction from those caused by phase separation. The analytical approach comprises a wide array of analytical techniques for measuring the concentrations of major, minor and trace elements and the isotopic compositions for selected elements (Ca, Sr, Cl, Hf, S, C, H, O) in the hydrothermal fluid. **The ultimate goal is a quantitative characterization of fluid composition that will represent the base for balancing the mass flux from mantle to ocean.**

2.4.5 Gas Chemistry

(Ralf Lendt, Marco Warmuth, Frederic von Guilleaume, and Richard Seifert)

CH_4, H_2, CO, and CO_2 were measured on board by gas chromatography. Focus was given to hot fluids to obtain information on the sub-surface hydrothermal processes and on diffuse vents emphasizing on the energy and food supply of vent organisms. In addition, the stable carbon and hydrogen isotope ratio of methane from the fluid samples will be measured in the isotope laboratory at the IfBM.

The water samples for these analyses were collected from 11 CTD stations and 6 ROV dives. For ROV dives, samples were obtained by three different advices namely the KIPS, titanium in situ gas samplers (MAJORS) and an isobaric sampler.

In addition, hydrogen was monitored within incubation experiments conducted by M. Perner on the metabolism of microorganisms present in hydrothermal fluids (Section 2.4.2).

Methods

In order to analyze dissolved CH_4, H_2, CO and CO_2, the fluid samples were degassed using a vacuum degassing technique modified from the method described by Rehder et al. (1999). In brief, water sample is drawn directly into a pre-evacuated flask which is then filled to only about half of the total flask volume. During this sampling, most of the dissolved gas exsolves into the remaining headspace. The amount of water taken was measured with a flow meter (Engolit Flow Control 100S/Typ DMK). The extracted gas phase is subsequently recompressed to atmospheric pressure and transferred to a gas burette. The mole fraction of the analysts are determined by gas chromatography on aliquots of this gas.

For the determination of dissolved CH_4 a CARLO ERBA (GC 4000) gas chromatograph equipped with a flame ionization detector was used in connection with an integration software. Helium was used as carrier gas, and separation was performed using a 4m Al_2O_3 column run isothermally at 130 °C.

CO, CO_2, and CH_4 concentrations of extracted gas were determined using a gas chromatograph (CARLO ERBA, 8000 top). 0.1 to 1 ml of gas was injected on and separated by a 10m long packed column, passed a thermal conductivity detector to a methanizer transforming all oxidized carbon species into CH_4 which then is quantified by a flame ionization detector. Data are recorded for both detectors by a PC based commercial integration software. Carrier gas was helium, oven temperature was 3 min isotherm 60°C, 40°/min to 120° kept for 10 min.

A TRACE Ultra gas chromatograph (Thermo Electron) equipped with HaySep Q, and Molecular Sieve 5 A columns was used to determine the H_2 and CH_4 concentrations of the extracted gas. The run was performed isothermally at 40 °C, helium was used as carrier gas. The eluted gas was detected via a PDD (pulsed discharge detector, VICI).

After transferring the remainder of the gas into a 20 ml glass vial, the septum is sealed with silicone on the outside and with degassed saturated salt solution on the inside. ROV samples are listed in Table 2.4.5.1; CTD samples are listed in Table 2.4.5.2.

Table 2.4.5.1: ROV samples studied for gas content of fluids

Station	KIPS	Ti-MAJOR	IB
ATA 35 ROV	1	2	
ATA 37 ROV	2		
ATA 42 ROV	1		1
ATA 46 ROV			1
ATA 52 ROV	3		
ATA 67 ROV		1	

Table 2.4.5.2: Samples obtained by CTD-Rosette studied for gas content

Station	samples	H_2	CH_4	CO
ATA 31 CTD	6	6	6	
ATA 32 CTD	6	6	6	5
ATA 33 CTD	5	4	5	5
ATA 38 CTD	8	8	8	
ATA 39 CTD	8	8	8	
ATA 40 CTD	7		7	
ATA 44 CTD	6		6	6
ATA 45 CTD	8		8	8
ATA 47 CTD	7		7	
ATA 48 CTD	9	5	9	
ATA 49 CTD	4		4	
ATA 64 CTD	6		6	6

Preliminary results

CTD/Rosette samples were mainly obtained from the Turtle Pits area. Highest concentrations H_2 were found at 2740m depth with 4.4 nM, while CH_4 where up to 1.72 nM. CO was found in concentrations of about 20 nM showing no positive correlation with CH_4 or H_2. An overview on the content of CH_4 and H_2 in water samples studied is given in Fig. 2.4.5.1

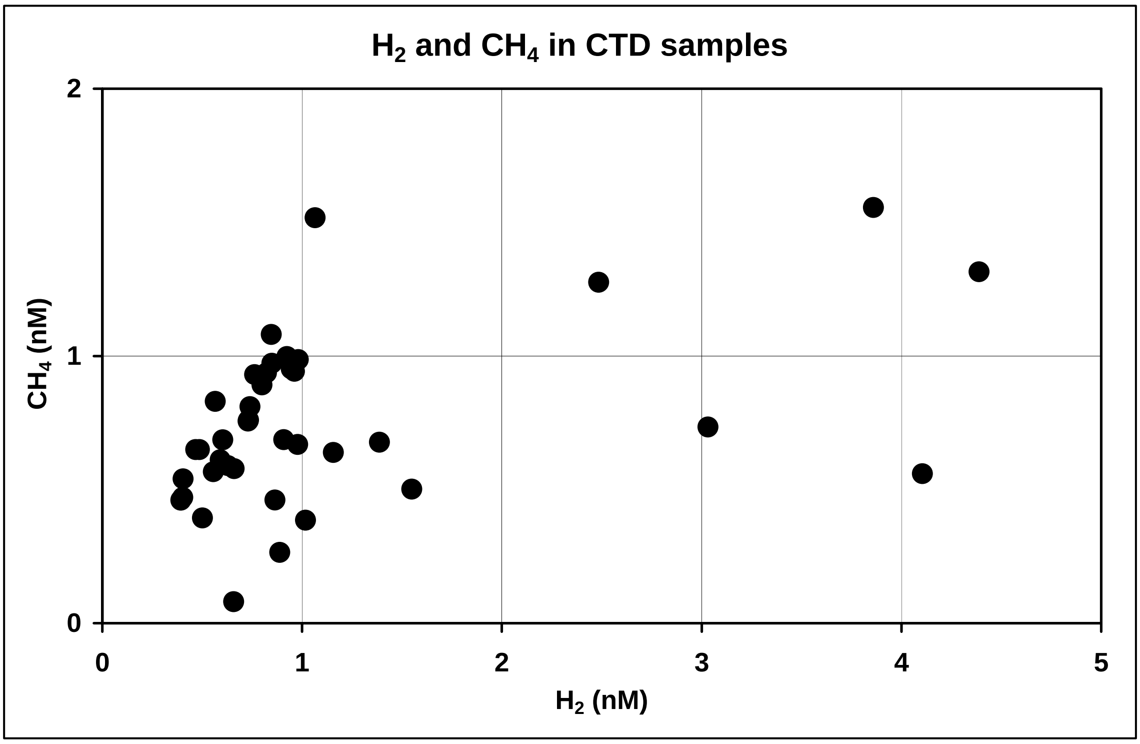


Fig. 2.4.5.1: Concentrations of CH_4 and H_2 in water samples obtained by CTD/Rosette.

A main objective of the cruise was to take samples of black smoker fluids by avoiding degassing of the sample prior to on board analysis. For this purpose, a newly built isobaric sampler (IB) was used for the first time. Figure 2.4.5.2 shows the IB brought into position by the Rick Master of the ROV Kiel 6000 during dive ATA 42 ROV at the black smoker Sisters Peak located in the area Comfortless cove (see Table 2.4.5.3). Comparison between the data obtained from the fluid taken by IB and those obtained from a sample taken by KIPS at the same location illustrates sampling of hot hydrothermal fluids by KIPS to be not suitable for studies of gas chemistry. Though from its design, the KIPS allows much better gaining samples of pure fluid when compared to the IB. Samples of high quality could also be retrieved using titanium samplers (MAJOR). Especially for the smoker Two Boats of the Turtle Pits hydrothermal field (figure 2.4.5.3), samples obtained this way showed the expected high gas concentrations (Table 2.4.5.3) exceeding those determined on KIPS samples during earlier cruises by far. The concentration of H_2 was close to 0.5 mM, exceptionally high for a fluid of

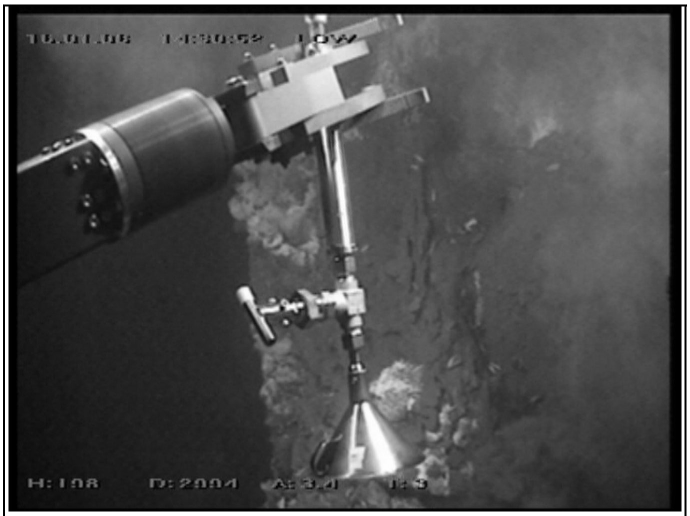


Fig. 2.4.5.2: Sampling of Sisters Peak with the IB-sampler

a system hosted by basaltic rocks, with a H_2/CH_4 ratio of 25.5. In view on the high temperatures of well above 400°C measured for the fluids during dive ATA 42 ROV, and the visual observations, we assume to have investigated an hypercritical fluid. New data on the gas content were also obtained for the fluid of the smoker Mephisto with 270 µM of H_2, 14 µM of CH4, and 8 µM of CO.

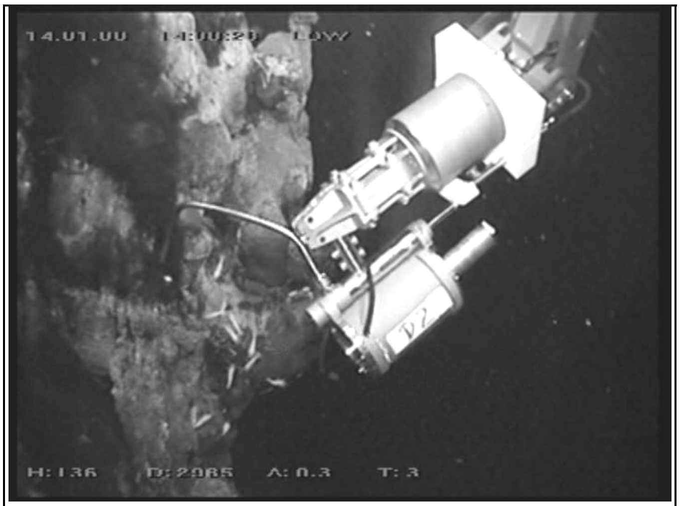


Fig. 2.4.5.3: Sampling of Two Boats with the Ti-Major sampler

Table 2.4.5.3: Gas content of selected hot black smoker fluids

Area / sample	H_2 (µM)	CH_4 (µM)	CO_2 (µM)	CO (µM)
Turtle Pits, Two Boats				
ATA 35 ROV, Major D2	406	16	12956	4
Comfortless Cove, Sisters Peak				
ATA 42 ROV, IB	204	6.8	6745	1.5
ATA 42 ROV, KIPS C9	8.5	0.3	221	0.05
Red Lion, Mephisto				
ATA 67 ROV, Major DS	270	14	n.d.	8

Investigations of fluids from diffuse vents were accomplished for samples of the Wideawake field at Turtle Pits and the Golden Valley at Comfortless Cove (Table 2.4.5.4). These data are of high relevance for the biological studies of vent faunas.

Table 2.4.5.4: Gas content of selected diffuse fluids

Area / sample	H_2 (nM)	CH_4 (nM)	CO_2 (µM)	CO (nM)
Turtle Pits, Wideawake				
ATA 37 ROV, KIPS C7	197	15	65	113
ATA 37 ROV, KIPS A1	194	22		105
Comfortless Cove, Golden Valley				
ATA 42 ROV, KIPS A1	355	36	138	992

2.4.6 Hydrothermal Symbioses

(Jillian Struck and Nicole Dubilier)

1) Genomic analyses: Our main goal for this cruise was to collect and prepare *Bathymodiolus* mussels for genomic analyses of their symbionts. Knowledge of the genomes of chemosynthetic symbionts provides us with an invaluable catalogue of their potential metabolic pathways and can show us how the symbionts gain energy from hydrothermal fluids and pass these on to their hosts. These genomic analyses can then provide the basis for examining which pathways are actually used by the symbionts under different environmental conditions through transcriptomic and proteomic analyses.

As yet, no one has been able to cultivate the symbionts of animals from hydrothermal vents and cold seeps, making direct sequencing of their genomes from cultured cells impossible. Metagenomics, the sequencing of genomes of organisms from the environment, provides an ideal tool for gaining metabolic and genomic information about uncultivable bacteria. In 2007, we were successful in obtaining a grant from the French sequencing facility Genoscope to sequence the metagenome of the bacteria in *Bathymodiolus* gill tissues. These include the methane- and sulfur-oxidizing symbionts as well as a novel bacterial parasite that lives in the nuclei of bathymodiolin mussels. Since the host genome is so much larger than the bacterial genomes (estimated sizes of 200-300 megabases (MB) for the host and 3 - 5 MB each for the bacteria), we can not simply provide Genoscope with *Bathymodiolus* gill tissues. Our sequencing allotment of 300 MB would be "wasted" on sequencing of the host instead of the bacterial genes. It is therefore essential to physically separate the bacteria from the gill tissues, and such separations or enrichments of the bacterial fraction are best done on fresh material.

To separate the *Bathymodiolus* bacteria from host gill tissues we used density gradient centrifugation. In this method, a density gradient is created by carefully layering decreasing concentrations of a sugar compound called Histodenz (here 70 – 5%) on each other. Centrifugation of particles with different sizes and weights causes them to migrate to different density gradient layers. When a mixture of host tissue and bacteria is centrifuged in such a gradient, layers enriched in bacterial cells can thus be separated from host tissues.

To prepare tissues for density gradient centrifugation, we dissected the gills out of 6 freshly collected mussels from Wideawake and Clueless (see Sampling List). Care was taken to use only a single mussel individual for each gradient, to ensure that bacterial strain variability between host individuals does not complicate the genomic analyses. One of the two gills of each mussel was fixed for morphological and molecular analyses of the bacteria in the home laboratory (transmission electron microscopy, fluorescence in situ hybridization, PCR analyses of phylogenetic and functional genes) while the other gill was prepared for genomic analyses by homogenization on ice in 1X phosphate buffered saline (PBS). For some gradients, the homogenate was filtered through 12 and 5 µm filters before centrifugation, in others unfiltered homogenate was placed directly on the gradients. Gradients were centrifuged in the cold room (ca. 10°C) for 1.5 – 2 h at 5000 RPM. In all gradients a similar layering pattern was observed: 1) at the top of the gradient (5 – 10% Histodenz) lay a thin white fraction, followed by a light brown fraction with 2 sublayers, the top one light brown (~20% Histodenz), the bottom one milky brown (~30% Histodenz). The next fraction (~40% Histodenz) was thick and dark brown, followed by a light brown fraction with a crystalline appearance (~50% Histodenz). The bottom layers (~60 - 70% Histodenz) were all clear.

Fractions were removed from the gradient in 500 µl steps and a subsample from each fraction was fixed for fluorescence in situ analyses (FISH) with probes specific to the bacteria in *Bathymodiolus puteoserpentis* from Logatchev. Analysis of the gradients with specific probes on board was difficult because the probes for the sulfur- and methane-oxidizing symbionts did not show a signal, presumably because these probes had too many mismatches to the symbionts from the Wideawake mussels. Using a probe for the intranuclear parasite, we only saw these bacteria in a single fraction (thick, dark-brown layer) from a single individual (46ROV1-1) in very low abundance. This layer was characterized by high abundances of bacteria presumed to be the sulfur- and methane-oxidizing symbionts based on DAPI-staining and their hybridization signal using the general bacterial probe EUB338. Contaminating host tissue concentrations were very low in this fraction. DAPI and EUB338 analyses of the top white layer of the gradients indicated that these were highly enriched in sulfur-oxidizing symbionts. Further analyses of these gradients in the home laboratory with probes specific to the Wideawake symbionts will allow us to decide which gradients we will use for our metagenomic analyses.

2) In situ fixation chamber DieFast: One of our main goals within the SPP 1144 is to understand the interactions between hydrothermalism and biology. To date, all animals from hydrothermal vents and other deep-sea environments are brought up to the surface and dissected and fixed on board. Most of the sites we are studying within the SPP 1144 are at 3000 m water depth. It thus can take up to 3 hours after the animals have left their environment before we can prepare them, often even longer if animal collection is not the last station for the ROV work of that day. This is a problem for analyzing the metabolic pathways the animals use in their environment. Changes in the transcription of genes to messenger RNA (mRNA) can occur within minutes, changes at the protein level within hours. We therefore designed an in situ fixation chamber, called DieFast, for fixing mussels or other biological samples directly on the seafloor within minutes of their collection (Fig. 2.4.6.1). DieFast consists of a fixation chamber with a rubber sealed lid (volume: 3 liters) that is connected through tubing to 3 syringes (each 100 ml). The chamber weighs 17 kg in air and easily fits on the ROV porch. Before deployment, the chamber and the tubing are filled with seawater. The syringes are filled with 40% formalin with stoppers placed in the syringes to prevent the formalin from running through the tubing into the fixation chambers. During deployment, the organisms are placed in the chamber, and the lid is closed and the stoppers released mechanically by the ROV arm. The 300 ml of 40% formalin are diluted to 4% in the fixation chamber, which is an ideal concentration for fixing biological samples for morphological analyses of their mRNA (mRNA FISH) and proteins (immunohistochemistry).

Our first (and only) deployment of DieFast at the Wideawake site (ATA 37 ROV 9) was highly successful. Mussels were collected singly or in clumps of 3-5 individuals and placed in the chamber using the ROV Orion arm. Closing of the chamber lid and release of the stoppers using the appropriate monkey fists was easily and quickly performed by the ROV pilots with the Orion arm. The entire time for deployment including the collection of mussels was less than 30 minutes. After recovery of the ROV, we examined the mussels: they were almost all intact and had clearly all been fixed by the formalin. Analyses of these specimens in the home laboratory and comparison with mussels fixed on board will reveal the importance of fixing animals in-situ.

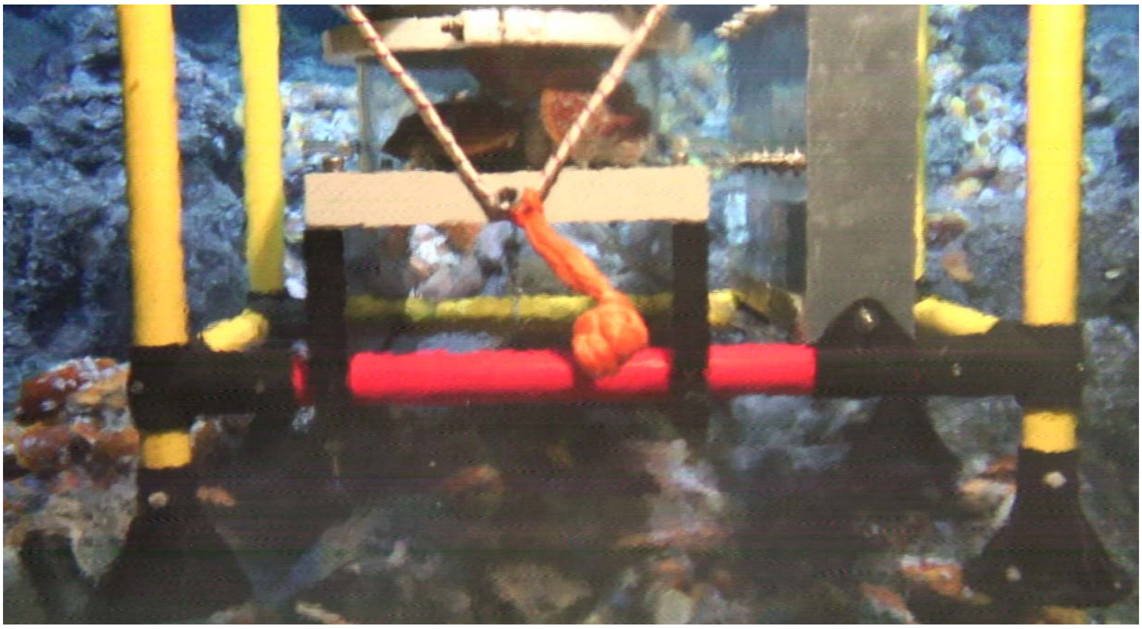


Fig. 2.4.6.1: DieFast during deployment at Wideawake. The mussels have already been placed in the fixation chamber and its lid has been closed using the elastic strap and the orange monkey fist attached to it. The syringes with formalin are on the right of the chamber behind the metal casing.

3) Collection of animals for biogeography

Our final goal for this cruise was to collect as many animals as possible for biogeography analyses (Table 2.4.6.1). One of the goals within the SPP 1144 is to better understand how ridge morphology and ocean currents influence the dispersal of vent organisms along the ridge. To do this, we compare the phylogenetic relationships of animals from different vent sites using genes as indicators of their relatedness. For example, if animals from Logatchev on the northern Mid-Atlantic Ridge were more closely related to animals from other northern MAR vents than to those from the southern MAR vents, this would suggest that geological barriers at the equator including the large offset of the ridge-axis prevented gene flow between southern and northern MAR vents. In addition to collecting mussels, we also collected at least two species of shrimp (*Rimicaris exoculata* and *Mirocaris fortuna*), and possibly a third species (*Opaepele* sp.), first found and described during the 2007 Meteor M68/1 cruise to the southern MAR. We were extremely fortunate to find a clam individual (*Calyptogena* sp.) at Clueless (ATA 52 ROV 11). This is only the second specimen that we have found at 5°S. These clams are extremely rare on the MAR and are only known from Logatchev and 5°S. We have only found dead clam shells at Logatchev but were recently given 5 alcohol-fixed *Calyptogena* sp. individuals from Logatchev by Dr. Andrey Gebruk (Shirshov Institute of Oceanology, Moscow). Phylogenetic analyses of the Logatchev and the 5°S individuals will show how these clams are related to other clams from vents and seeps around the world and may reveal their geographic origin for colonizing the MAR.

Table 1: Animals collected during L'Atalante cruise MSM06/3 to 5°S

Station number	Site	Sample	Sample treatments	Gradient centrifugation
ATA 35 ROV 18	Turtle Pits	Slurp	*R. exoculata* samples for FISH and DNA *Mirocaris fortuna* samples for FISH and DNA possibly 3 *Opaepele* sp. individuals for FISH and DNA	
ATA 37 ROV 7	Wideawake	Mussel net	*Bathymodiolus* sp. samples for FISH, DNA, RNA, electron microscopy whole *B.* sp. frozen for DNA	2 Individuals
ATA 37 ROV 8	Wideawake	Slurp	*R. exoculata* samples for FISH and DNA	
ATA 37 ROV 9	Wideawake	Die Fast	Whole *B* sp. fixed in situ for FISH	
ATA 46 ROV 1	Wideawake	Mussel net	*B* sp. samples for FISH, DNA, and electron microscopy	1 Individual
ATA 46 ROV 4	Wideawake	Slurp	Whole frozen *B.* sp.	
ATA 46 ROV 5	Wideawake	Slurp	Small *B.* sp. frozen whole for DNA	
ATA 52 ROV 11	Clueless (near Golden Valley)	Mussel net	*B.* sp. for FISH, DNA, RNA, electron microscopy *Calyptogena* sp. for FISH, DNA, RNA, electron microscopy Whole *B.* sp. frozen for DNA	2 Individuals
ATA 57 ROV 7	Wideawake	Mussel net	*B.* sp for FISH, DNA, RNA, electron microscopy *B.* sp. for cultivation experiments Whole *B.* sp. frozen for DNA	1 Individual
ATA 67 ROV 1	Red Lion - Mephisto	Slurp	Crab - *Segonzacia*, for DNA	
ATA 67 ROV 2	Red Lion - Mephisto	Slurp	*R. exoculata* samples for FISH and DNA	

2.4.7 Paleaoceanography

(Almuth Harbers)

Goals

During Leg 2 paleoceanographical investigations were focused on collecting planktonic foraminifera and pteropods. Refering to the project **Future Ocean** - "Changing habitats of calcareous plankton in the Green House World" planktonic foraminifera and their response to climate change is going to be studied. For the next hundred years a surface ocean warming of 3°-5°C is expected (Mitchell, 2005). An estimated pH drop of 0.7 units in surface waters is the effect of absorption of 50% of fossil fuel CO_2 emissions (Caldeira and Wickett, 2003).

One goal is to show the impact of acidification and surface ocean warming on planktonic foraminifera with reference to former investigations.

Investigations will include faunal inventory, assemblage composition, size distribution and shell weights, and chemical and isotopic composition regarding to $\delta^{13}C$, $\delta^{18}O$, Mg/Ca and Sr/Ca.

Methods

Samples were taken two times a day. With a, in the ship´s sytem integrated pump, $3m^3$ seawater were filtered over a 63µm sieve. The water was pumped from below the vessel, in a depth of 4-5m. The samples were washed with fresh water and put into a vial with nearly 120ml ethanol. 32 samples were taken between 09.01.2008 and 29.01.2008. The first two samples RD 1 and RD 2 have only a volume of $1m^3$. Because of low inventory volume was then increased to $3m^3$.

Other 18 samples were taken on several days with an Apstein net (100µm). Samples were taken in depth sections of 0-10m, 10-20m, 20-30m, 30-40m and 40-50m. The net with an aperture of 17cm was deployed and lifted five times in each section, so nearly $1m^3$ got filtered in each section. The samples were washed with fresh water and stored with nearly 120ml ethanol in vials. Only three depth sections were done at sampling station TP 2 because the assisting Crew had to work on other stations.

Taking water samples for isotopic analyses took place once a day between 14.01.2008 and 29.01.2008. Seawater was collected with the water pump right before or right after the other samplings (pump and/or Apstein) took place. They got stored in a 100ml vial. Because of missing Mercury Chloride ($HgCl_2$) solution in the first days of cruise, only few samples were intoxicated to stop bacterial activity.

Any analyses will be done onshore at the IFM-GEOMAR, Kiel.

Sampling stations

Pump

Sample	Date	UTM/start	UTM/end	local time	Latitude/start	Longitude/start	Latitude/end	Longitude/end
RD 1	09.01.2008	11:36	12:30	-3	07°03.443S	27°45.880W	07°02.250S	27°37.700 W
RD 2	09.01.2008	16:00	17:13	-3	07°02.144S	27°28.445W	07°02.440S	27°27.723W
RD 3	10.01.2008	9:46	12:02	-2	06°42.355S	25°07.930W	06°39.245S	24°46.878W
RD 4	10.01.2008	15:50	18:06	-2	06°34.055S	24°11.740W	06°31.088S	23°51.278W
RD 5	11.01.2008	9:50	12:22	-2	06°09.079S	21°22.808W	06°05.390S	20°57.900W
RD 6	11.01.2008	15:54	18:39	-2	06°00.368S	20°23.920W	05°56.585S	19°57.322W
RD 7	12.01.2008	9:45	11:40	-1	05°34.876S	17°30.957W	05°32.145S	17°12.581W
RD 8	12.01.2008	14:33	17:28	-1	05°27.412S	16°45.324W	05°22.640S	16°22.940W
RD 9	13.01.2008	9:01	11:39	-1	05°05.019S	14°17.077W	05°01.616S	13°52.626W
RD 10	13.01.2008	14:48	17:32	-1	04°57.474S	13°22.850W	04°53.745S	12°57.190W
RD 11	14.01.2008	9:18	11:40	-1	04°48.379S	12°22.632W	04°48.583S	12°22.427W
RD 12	14.01.2008	14:50	17:27	-1	04°48.594S	12°22.412W	04°48.590S	12°22.416W
RD 13	17.01.2008	10:55	13:45	-1	04°48.857S	12°22.332W	05°00.285S	11°59.704W
RD 14	17.01.2008	15:49	18:43	-1	05°09.764S	11°45.261W	05°06.959S	11°42.113W
RD 15	18.01.2008	9:24	12:28	-1	04°48.442S	12°22.314W	04°48.610S	12°22.346W
RD 16	18.01.2008	15:50	18:51	-1	04°48.588S	12°22.359W	04°48.586S	12°22.364W
RD 17	20.01.2008	10:11	12:57	-1	04°48.121S	12°22.282W	04°48.198S	12°22.268W
RD 18	20.01.2008	15:53	18:13	-1	04°48.193S	12°22.275W	04°48.200S	12°22.267W
RD 19	22.01.2008	11:36	13:44	-1	04°47.395S	12°22.604W	04°47.389S	12°22.599W
RD 20	22.01.2008	17:05	19:45	-1	04°47.391S	12°22.600W	04°47.398S	12°22.600W
RD 21	24.01.2008	9:11	11:36	-1	04°48.626S	12°22.721W	04°48.852S	12°22.297W
RD 22	24.01.2008	16:50	19:46	-1	04°48.044S	12°22.425W	04°48.114S	12°22.347W
RD 23	25.01.2008	9:36	12:02	-1	04°56.021S	11°39.493W	04°56.506S	11°36.996W
RD 24	25.01.2008	14:57	17:37	-1	04°56.501S	11°37.002W	04°56.339S	11°37.002W
RD 25	26.01.2008	10:32	12:32	-1	03°14.099S	12°13.800W	02°53.613S	12°21.219W
RD 26	26.01.2008	15:50	18:43	-1	02°20.826S	12°33.066W	01°52.050S	12°43.476W
RD 27	27.01.2008	9:07	11:10	-1	00°34.227N	13°36.325W	00°55.074N	13°43.866W
RD 28	27.01.2008	15:26	17:17	-1	01°39.038N	13°59.752W	01°58.295N	14°06.715W
RD 29	28.01.2008	10:03	12:12	0	04°53.398N	15°10.118W	05°14.830N	15°17.890W
RD 30	28.01.2008	15:36	17:32	0	05°48.503N	15°30.120W	05°59.988N	15°34.293W
RD 31	29.01.2008	9:25	11:33	0	08°24.125N	16°26.805W	08°44.798N	16°34.351W
RD 32	29.01.2008	15:27	17:30	0	09°20.454N	16°47.439W	09°21.026N	16°48.481W

Apstein

Sample	Date	UTM/start	UTM/end	local time	Latitude	Longitude	Depth
TP 1	15.01.2008	10:31	11:37	-1	04°48.632S	12°22.354W	0-50m
TP 2	19.01.2008	15:04	15:48	-1	05°05.697S	11°39.961W	0-30m
TP 3	21.01.2008	11:00	12:20	-1	04°48.572S	12°22.450W	0-50m
TP 4	24.01.2008	15:04	16:29	-1	04°48.832S	12°22.611W	0-50m

Water samples

Sample	Date	UTM	local time	Latitude	Longitude
RDO1	14.01.2008	17:28	-1	04°48.590S	12°22.416W
RDO2	15.01.2008	16:42	-1	04°48.637S	12°22.349W
RDO3	16.01.2008	18:22	-1	04°48.117S	12°22.270W
RDO4	18.01.2008	15:50	-1	04°48.588S	12°22.359W
RDO5	19.01.2008	11:16	-1	05°05.467S	11°39.238W
RDO6	20.01.2008	13:00	-1	04°48.175S	12°22.271W
RDO7	21.01.2008	18:32	-1	04°48.617S	12°22.411W
RDO8	22.01.2008	17:05	-1	04°47.391S	12°22.600W
RDO9	23.01.2008	13:39	-1	05°05.952S	11°40.582W
RDO10 + $HgCl_2$	24.01.2008	16:49	-1	04°48.044S	12°22.425W
RDO11 + $HgCl_2$	25.01.2008	09:35	-1	04°56.021S	11°39.493W
RDO12 + $HgCl_2$	26.01.2008	10:31	-1	03°14.099S	12°13.800W
RDO13 + $HgCl_2$	27.01.2008	09:01	-1	00°33.126N	13°35.930W
RDO14 + $HgCl_2$	28.01.2008	9:55	0	04°52.091N	15°09.647W
RDO15 + $HgCl_2$	29.01.2008	9:23	0	08°23.714N	16°26.805W

2.4.8 Global distribution and atmospheric transport of volatile and semi-volatile polyfluorinated compounds

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Persistent and toxic perfluorinated organic acids have been detected in high concentrations in polar biota. As these perfluorinated acids are not volatile and only partly water soluble, the mode of transport of these compounds to remote regions is not yet satisfactorily explained. Two transport modes are being thought of: directly via the water phase and indirectly by the degradation of precursors via the atmosphere. To further elucidate this problem air samples were collected at the cruise L'Atalante Recife-Dakar and analysed for organic poly- and perfluoarinated compounds. These measurements will improve understanding of the long-range transport of this emerging class of organic contaminants to remote regions and lead to a better predictability.

2.4.9 Volcanic rocks

(B. Melchert, H. Paulick)

The volcanological investigations during ROV deployments focussed on mapping individual lava flow units and taking samples from flow units with stratigraphically defined age relationships. Furthermore, we used the „Vulkanitstossrohr (VSR)“ („wax corer“) in oder to obtain geochemical samples from the areas immediately to the north and south of the regional topographic high on which the hydrothermally active region at 4°48'S is located. Sample descriptions are provided in the Appendix.

Regional-scale sampling of basalt lava

The existing basalt sample set, obtained during previous visits to the area in 2005 (M64-1) and 2006 (M68-1), is restricted to an aera of approximately 2 km x 2 km representing lava units from the immediate vecinities of the hydrothermally active sites. These are located on a topographically elevated portion of the ridge axis valley rising to around 2990 m below sea level [mbsl] whereas water depths increase to 3300 m at ~8 to 10 km to the north and the south (Fig. 2.4.9.1). The geochemical and isotopic compositions of this densely sampled area has been investigated as part of research projects at Kiel and Bonn and the data show that the magmas from this area are fairly homogenous in composition (unpublished data from Karsten Haase, Thomas Kokfeld and Holger Paulick). In order to determine whether the apparently increased volcanic activity in this area, generates a locallized ridge with an elevation in the order of 300 m, samples from the surrounding axial valley are required.

We obtained 6 VSR samples from the north and south of the Turtle Pits area returning sufficient volcanic glass for geochemical analyses (Fig. 2.4.9.1). These data will be used to determine whether there are compositional gradients in the lavas which may provide contraints of the sublithospheric controlling parameters on volcanism in the area.

Turtle Pits and Wideawake hydrothermal sites and the 2002 (?) lava flow

The volcanology of the Turtle Pits and Wideawake hydrothermal sites has been investigated during previous cruises and documented in Haase et al. (2007). In addition, deployment of the AUV ABE during the Cruise M68-1 (2006) provided detailed sea floor images of the geological situation at the Wideawake mussle bed site. Here, a young, lobate lava flow with a black, glassy luster has partly covered pre- exsisting mussle beds located on top of an older lava flow with a jumbled flow top morphology. Based on the intense hydrothermal activity at Turtle Pits and the occurrence of this young lavaflow in the immediate vicinity (ca. 200 m to the east, Fig. 2.4.9.2) it has been inferred by Haase et al. (2007) that this eruption may conincide with the record of a major seismic crisis in the area from 25 to 26 June 2002. Hence, this lava flow may represent one of the few occasion in submarine volcanological studies where the age of formation for a particular lava unit is actually known. Therefore, one half of a ROV dive (station ATA-46ROV) was devoted to the task of determining the dimensions and structures of the lava flow and to define its eastern and southern borders. This information shall be used in order to guide future deployments of an AUV (potentially during the next scheduled visit of the area in 2009) for locating the eruptive vent and areal extend of this flow unit.

Dive ATA-46ROV was successful in locating the eastern, strongly serrated contact of the 2002 (?) flow and to the south. Samples from older lava units have been obtained at two locations (ATA-46ROV-2 und -3). In the south, the older sheet lava flow is characterized by the construction of up to 3 m high lava tunnels which are locally collapsed providing evidence that most of these structures are hollow (Fig. 2.4.9.3; collapse structure).

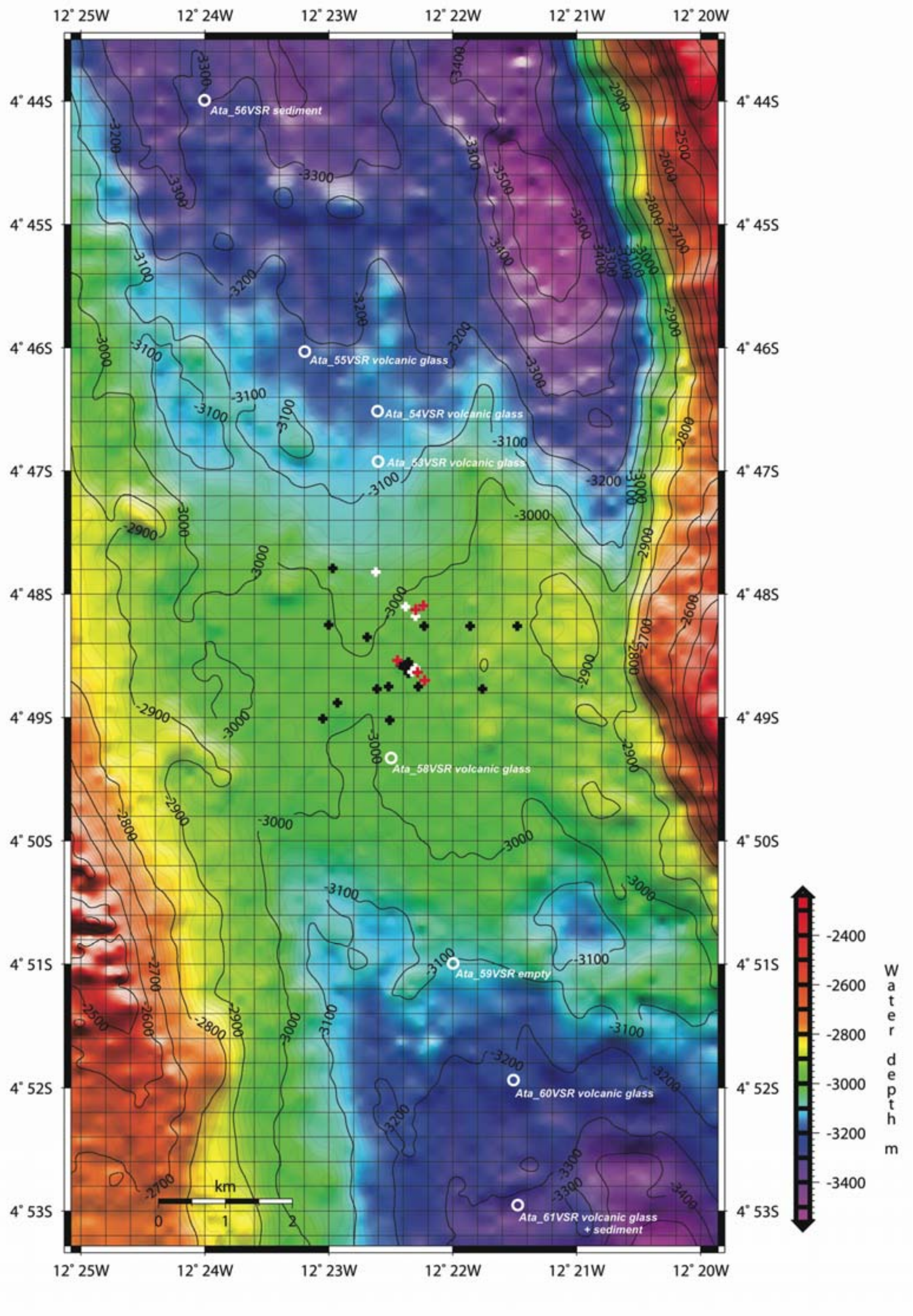


Fig. 2.4.9.1: Lava samples from the Turtle Pits area – samples collected during this cruise shown in white circles with sample numbers marked. Red crosses mark locations of basalt samples collected during ROV dives.

The lava flowing through these systems was apparently well insulated from cooling and discharged at the flow front when magma supply ceased. Such eruption processes are a common phenomenon at subaerial lava fields with high eruption rates of low viscosity-high temperature basalt lavas such as Hawaii. Clearly, recognition of such processes is important if erupted volumes are to be determined.

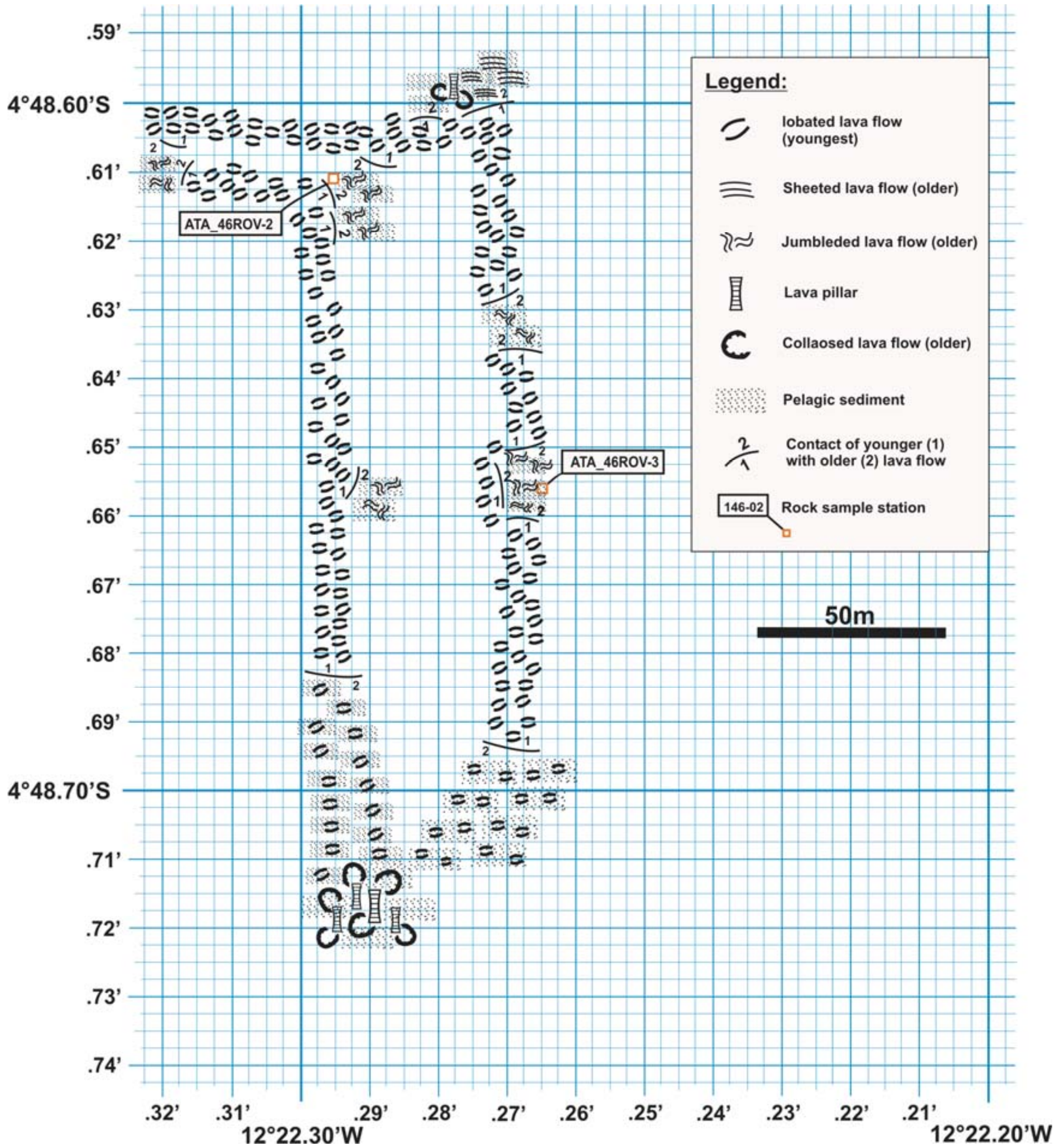


Fig. 2.4.9.2: Geological mapping of the Wideawake lava field.

As an additional complication, we recognized that the young, 2002 (?) flow is locally channelled into the pre-exsisting lava drainage system prodived by the sheet flow lava tubes. Hence, some portion of that eruption may have been emplaced below the seafloor, escaping seafloor mapping efforts.

Fig. 2.4.9.3: Young lava flow (left) in old collapsed "hall"

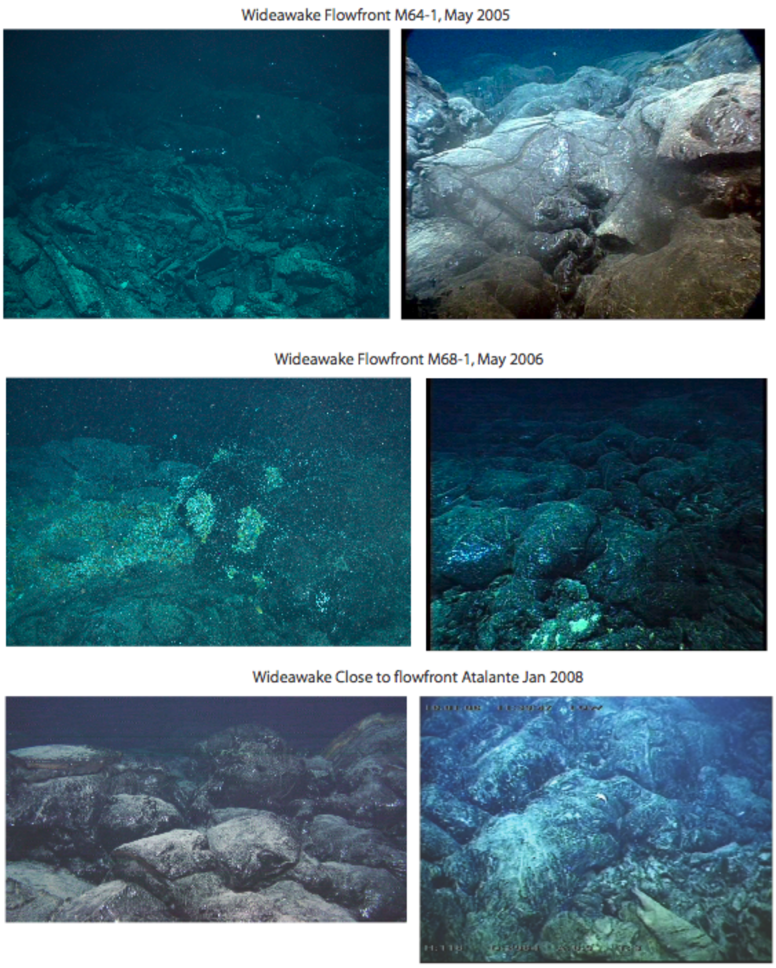


Fig. 2.4.9.4: The ageing of the Wideawake flow

Furthermore, we recognized some signs of „aging“ of the 2002 (?) lava flow. Comparing the seafloor images obtained in 2005, 2006 and during this cruise, we observed that the „glassy luster“ of the flow surface (described by Haase et al., 2007) is apparently waning (Fig. 2.4.9.4). This could be inferred to be due to progressive incipient alteration of the upper surface of the quenched basalt glass covering the lava lobes. Also, we encountered a site of low T (up to 10 °C) fluid discharge on the 2002 (?) lava flow itself. Fluid discharge (shimmering water) is concentrated in lava lobe intersticies and the site is colonized by abundant small mussles colonizing cracks of the lava surface. These observational similarities to the Lilliput hydrothermal site (located at ~9°30'S), discovered during cruise M64-1, are astonishing. For both sites, recent initiation of hydrothermal discharge and colonization by mussles may be inferred. Potentially, the 2002 (?) lava flow may have covered a pre-exsisitng hydrothermal discharge site and hydrothermal fluid ascent through this flow has now been established.

Comfortless Cove hydrothermal area

The ROV dives to this hydrothermally active area, located approximately 2 km to the NNE of Turtle Pits were mainly focussed on obtaining fluid and biological samples. However, it has been possible to add observational data and basalt samples to the material collected during cruise M68-1. The basalt pillow mound located to the north of the Sisters Peak black smoker chimney was sampled (ATA-42ROV-16). This pillow flow overlies the older sheet flow that the Sisters Peak smoker is situated on (sample of this sheet flow was obtained during the previous cruise: M68-1_20ROV-3B). In addition, a following dive (station 52ROV) provided spectacular insight into an eruptive fissure located on top of the pillow mound (to the east of sampling site ATA-42ROV-16). The walls of this fissure show remarkable lava flow features in cross section such as sheet flow tops and elongated tubes. In this zone, shells of dead mussles were abundant. At the southern margin of the fissure, patches of living mussels were located and sampled. From this area a basalt sample was also obtained (ATA-52ROV-12).

2.4.10 Rocks from the deeper crust

(Günter Suhr, Jürgen Koepcke)

Three ROV dives were devoted to map and sample the deeper oceanic crust around 5°S. Two dives investigated the "Inside Corner High" at 5°06'S and 11°40'W, one dive was spent at the transform wall opposing the nodal deep at 4°56'S and 11°37W (Fig. 2.4.10.1). Each dive required about 1000 m of ROV climbing.

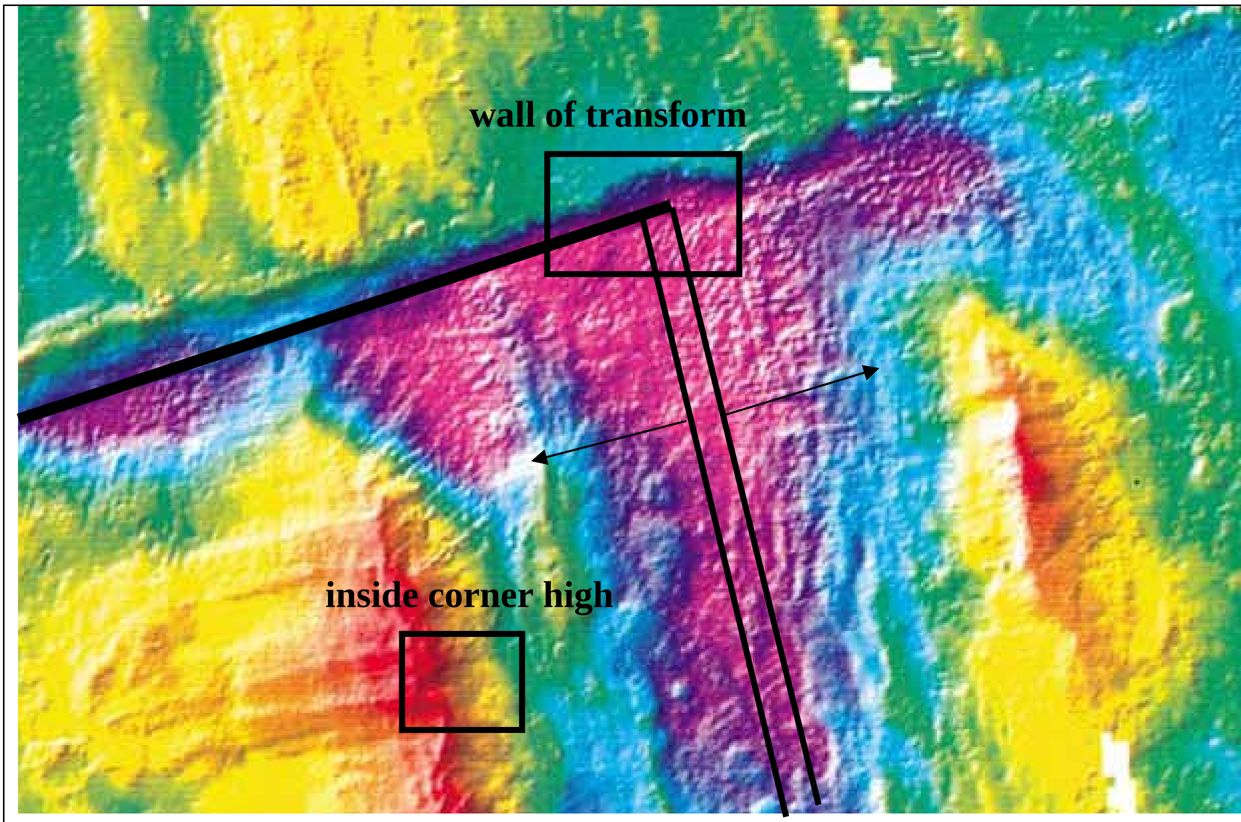


Fig. 2.4.10.1: Shaded relief map of seafloor topography in the 5°S region (Reston et al., 2002). The two areas of interest are marked by rectangles, the (new) ridge axis by a double line, and the transform fault by a thick black line. Massif to east of the ridge axis is the eastern part of the inside corner high, rifted away by the new ridge axis.

Inside corner highs are elevated plateaus with a curved surface at the intersection of a transform fault and an ocean ridge. Experience has shown that they preferentially expose unfaulted lower crustal rocks (Dick et al., 2000; Ildefonse et al., 2007), thus the common term "core complex". Our current understanding of how these rocks are exhumed is by long-term focusing of strain into a single normal fault associated with internal rotation of the block of up to 90° degrees (Lavier et al., 1999, Fig. 2.4.10.2).

The strain focusing is favored by the occurrence of volumentrically minor, rheologically weak, serpentinized mantle rocks between an otherwise gabbroic crust (Reston et al., 2002; Escartin et al., 2003; Ildefonse et al., 2007). As a result, the inside corner highs tend to have a thin cover of altered and sheared mantle rocks around a gabbroic core. Normally, the rocks inside the core would only be accessible by drilling. However, in case of the occurrence at 5°S, a westward-directed ridge-jump of the eastern ridge axis of the ridge-transform system has rifted apart the core complex, giving access to its internal setup.

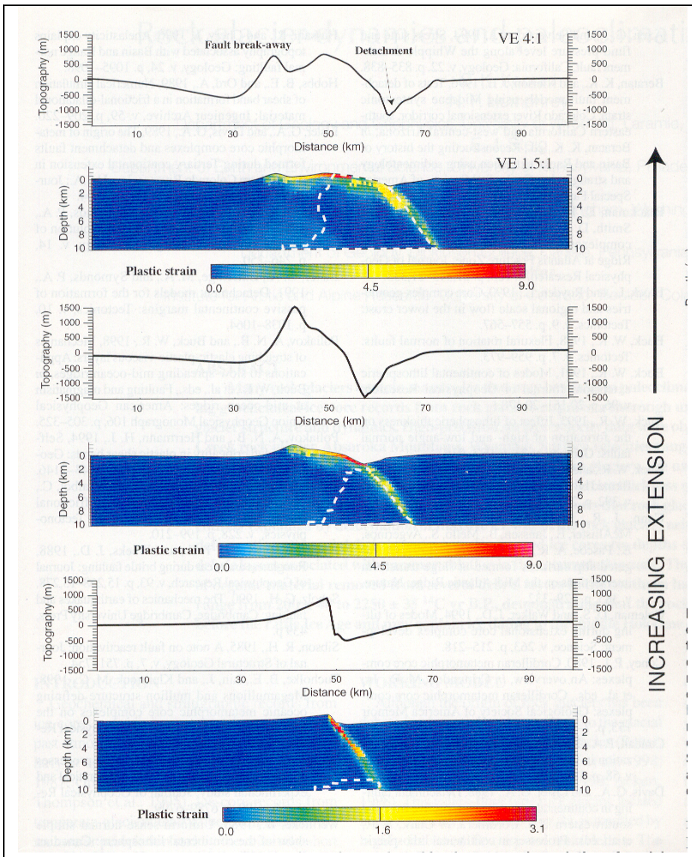


Fig. 2.4.10.2: Numerical model simulating the formation of inside corner highs. Note how an original horizontal marker rotates in an anti-clockwise fashion during exhumation (Lavier et al., 1999).

We decided to explore the western rift flank of the disected core complex with the ROV, since the eastern flank would perhaps expose a cross-section parallel to igneous units (Fig. 2.4.10.3). The targets for the dives were thus: (1) is the lithology along the rift flank as expected, i.e. deep rift volcanics, followed by gabbros, capped by sheared peridotite? And (2), can we see expressions of the rift tectonics?

The plan to investigate the northern wall of the transform was a consequence of the requirement to undertake a deep dive to test the ability of the ROV in the 5-6000 mbsf range. This was feasible in the basin forming at the intersection of the ridge axis with the transform fault ("nodal basin", the origin of which is actually poorly understood). The transform wall to the north of it was expected to expose rocks formed at the inside corner of the intersection of the northwestern ridge axis with the transform. This lithosphere has drifted with a half-spreading rate of 1.6 cm/year to the east and the rocks located at the northern extension of the south-eastern ridge axis should be ca. 5 Ma old. Since magmatism is thought to decrease (Cannat 1996) near the terminations of first-order segments as defined by transform faults (MacDonald et al., 1988), the questions for this day of the dive were (1) would the transform wall expose mantle rocks reflecting a low magmatic budget or volcanics reflecting abundant magmatism and (2) what is the expression of the transform tectonics?

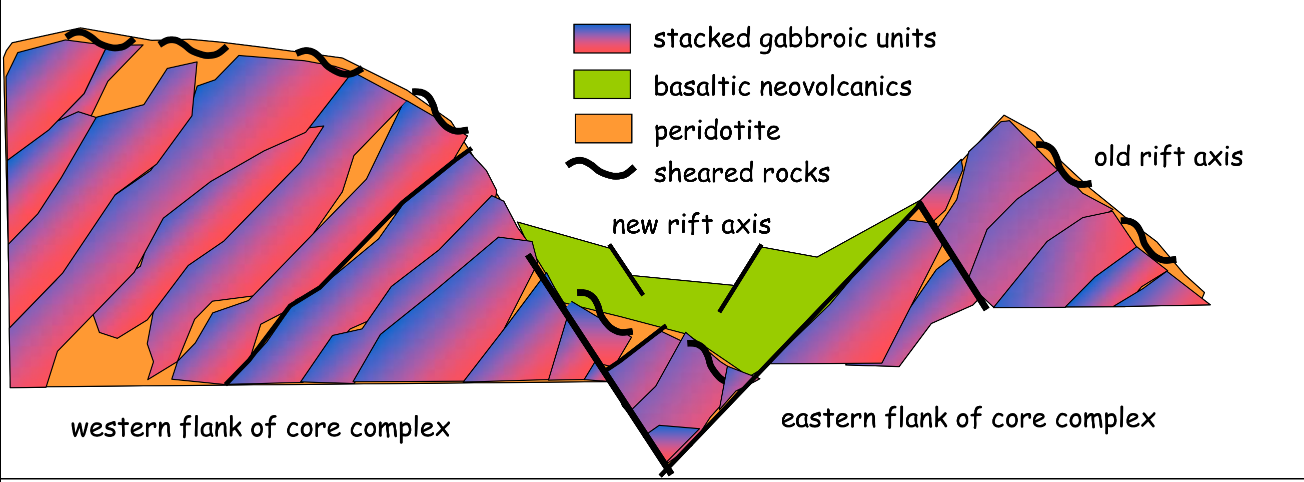


Fig. 2.4.10.3: Pre-dive model of the core-complex at 5°S. Note how the rift of the new ridge is thought to disect the core complex which would presumably be enveloped by a thin veneer of sheared mantle rocks.

Practical experience gained during the dives

The first two days of diving went without technical problems though conditions must be considered challenging. Lateral traversing meant that the ship had to follow the ROV with an equivalent speed, the covered vertical distance implied an on-going operation of the winch to haul in cable. Cliffs, corners, and huge boulders presented a danger for the cable to get caught. The group agreed that alternative sampling of this slope by dredging methods would be extremely hazardous since the dredge-container could easily be caught and ripped off. On the deep-dive test, the Orion arm behaved erratic.

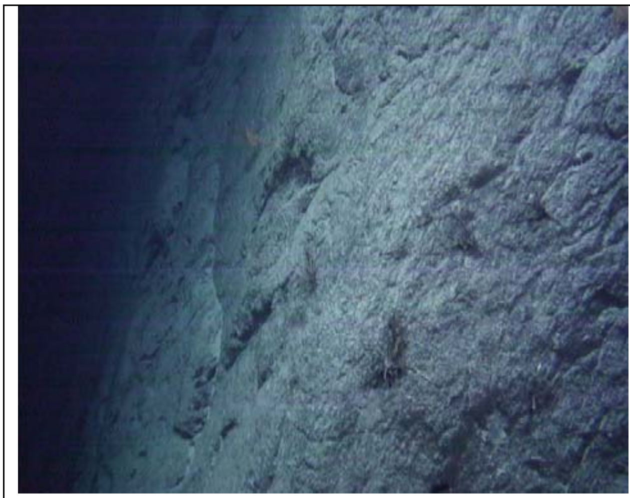


Fig. 2.4.10.4: Cliff face in gabbro with true dip of ~75° on Inside-Corner High traverse. Visible height estimated 2, in, distance 10 m. Parking the ROV and take a sample? No easy task!

On the first day we took seven, on the second day fifteen, on the third day fourteen samples, usually using the Orion-arm, but exceptionally also the Rigmaster arm. Dislodging in-situ samples turned out to be nearly impossible, so we mostly collected samples which were already loose. In most cases, we could convince ourselves that they were locally derived. Parking the ROV at the often near-vertical cliff-faces was extremely challenging and in several cases our pilots had to grab samples "on the fly". Samples were stored away in any of the four drawer compartment or – in the case of big samples – on the "porch" at the front of the ROV. Untangling some fifteen similar-looking samples required a strict book keeping during sampling and more smaller instead of few larger compartment might have been preferable for our purposes.

Fig. 2.4.10.5: The ROV drawer, configured for – and filled with – rocks. Bookkeeping required! Additional tools from left: IB sampler, shovel, bionet.

It turned out nearly impossible to discriminate different lithologies by direct observations during our dives, since nearly all rocks were covered by Mn-crusts. We thus had to use morphological features and later calibrate our mapping with the samples taken. Here, the monitoring of the dive by video and HD cameras turned out to be very useful. Measuring the orientation of the structural elements like cliffs, joints, faults, laminations, corrugations on surfaces and suspected dyke contacts was feasible thanks to the known heading of the ROV. The on-bord sonar was of great help in finding and measuring the orientation of interesting elements. It showed reliably boulders in sediments and cliffs with their orientation at distances far beyond the area illuminated by the search lights. The available topographic seafloor maps were not accurate enough for planing the route during our dives though we always used them as a rough guide. Some features of the maps turned out to be relevant, others were only artifacts. In the end, we agreed that the visual information and geographic coordinates (for us, mainly depth) associated with our samples will be of invaluable help in interpreting the data.

Geological Results of the Inside Corner High Dives

The two-day traverse covered the depths from 3400 to 1500 mbsf. The base of western rift flank was heavily sediment (Fig. 2.4.10.6). We could only collect one boulder sample which turned out to be a peridotite breccia, ultimately perhaps derived from the very top of the plateau.

As we headed westward, the slope steepened and cliffs appeared which strike between 300 and 340° and typically dip 70° to the E to NE. The major wall of the rift is a shear cliff of some 200m vertical distance, starting at 2500 mbsf (Fig. 2.4.10.4).

We could identify downdip slickensides, consistent with rift-related faulting (Fig. 2.4.10.7).

The orientation of the major cliff face, interpretated as the master rift fault, was repeatedly measured and is not quite understood since it is at an angle of some 10°-50° to the current ridge axis (trending 350°). In more detail, the rift-flank consists of ridges and valleys, the latter ones probably originating in transverse faults. The valleys tended to be full of tallus in a matrix of foraminiferous ooze so that we preferred to ascend along the ridges. A single, doubtful observation of igneous banding on a E-W trending cliff face showed the banding dipping 30° to the west, i.e. towards the core complex.

Fig. 2.4.10.8: View in plane polarized light of an entire thin section (3 cm long) showing olivine gabbronorite. Sample D2-S12 from the 5°S core complex.

Samples taken along the rift flank are mainly gabbros with a subordinate group of microgabbros and dolerite in the upper part (63ROV-9 to 63ROV-11 at 1767 m, 1674 m, and 1636 m). The gabbros range from melanocratic to leucogabbroic. Noritic gabbros are strongly suspected by inspection of hand-specimens. Olivine was not positively identified but is present in one of the samples taking from the *Meteor* cruise M47/2 during dredging

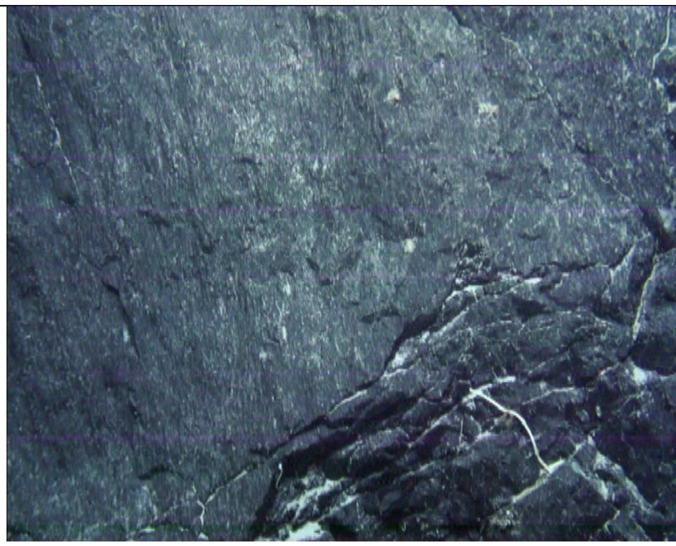


Fig. 2.4.10.6 (top): View of seafloor at the base of the rift flank: large boulders (~ 1 m) in carbonaceous ooze.

Fig. 2.4.10.7 (right):. Slickensides on fault plane indicating down-thrown frontal block.

(Fig. 2.4.10.8). The gabbros are usually medium-grained, one sample is coarse-grained. Felsic netveining is relatively widespread, a vague argument for a closed system evolution (see rock sample photos in Appendix). Oxide gabbros, on the other hand, also representing advanced stages of differentation only reached in nearly closed systems, were not recovered. Magmatic strain was not observed, suggesting that the gabbro body cooled in the lithosphere. Plastic strain, probably mylonitic, was observed in two samples (50ROV-3 and 63ROV-14). Both appear peridotitic.

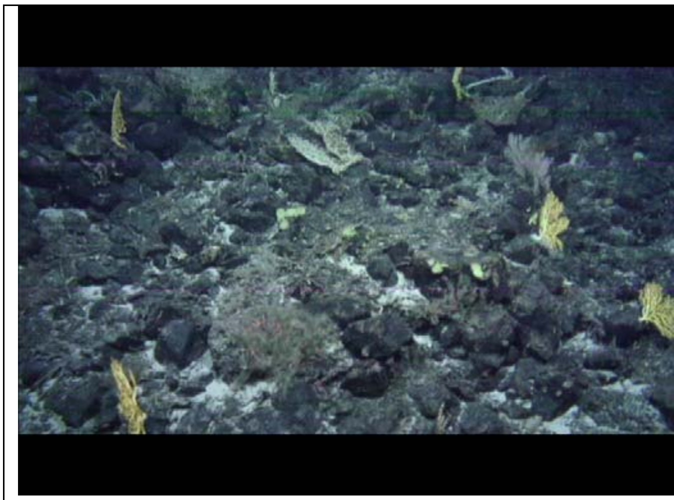


Fig. 2.4.10.9: Top of the Inside Corner High. Sampling confirmed that this is a coral-grown peridotite breccia horizon (ATA-63ROV-13 and -15).

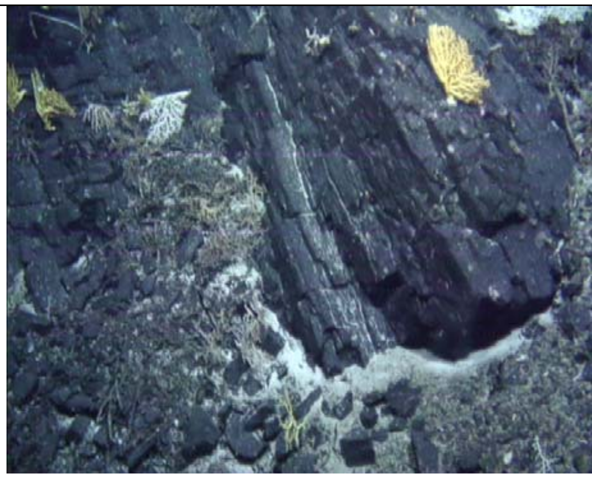


Fig. 2.4.10.10: Highly sheared block of (ultramylonitic?) peridotite (?) 50 m beneath the plateau (ATA 63ROV-14)

Our impression is that the samples show a certain degree of greenschist-grade alteration. This is somewhat surprising, since the usually internally unfaulted nature of core complexes would make the penetration of water difficult.

The transition from the rift flank to the top of the plateau was abrupt. We traversed this edge twice to confirm the observation. Two samples taken at the top very near the edge turned out to be peridotite breccias (Fig. 2.4.10.9) whereas this breccia is absent all along the rift flank. A highly interesting, in-situ sample was recovered just beneath the plateau (ATA-63ROV-14): the dense, laminated rock appears to be ultramylonitic, probably peridotitic and may represent an early, higher temperature stage of the detachment fault (Fig. 2.4.10.10). Its orientation is moderately dipping to the NE. In total, all deformed samples (breccias and mylonites) are probably peridotitic. This strongly supports the current model of peridotite-related strain softening of the master normal fault. A cross-section and map of the traversed terrane is shown in Figs. 2.4.10.11 and 2.4.10.12, respectively.

About 32 hours video material taken with three cameras were cut to a condensed version of 20 minutes showing the main geological and morphological features.

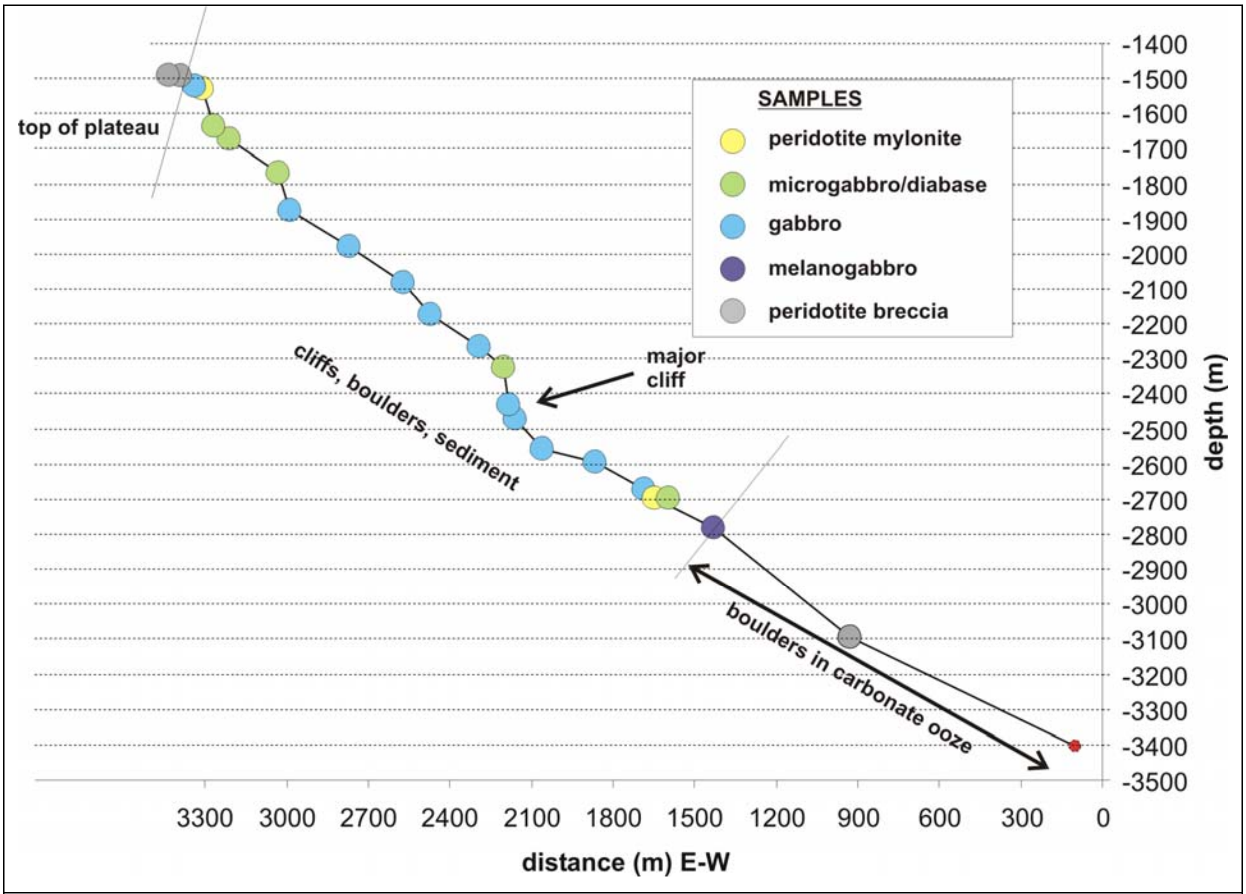


Fig. 2.4.10.11: Inside Corner High traverse projected onto an E-W profile. Sample locations are shown.

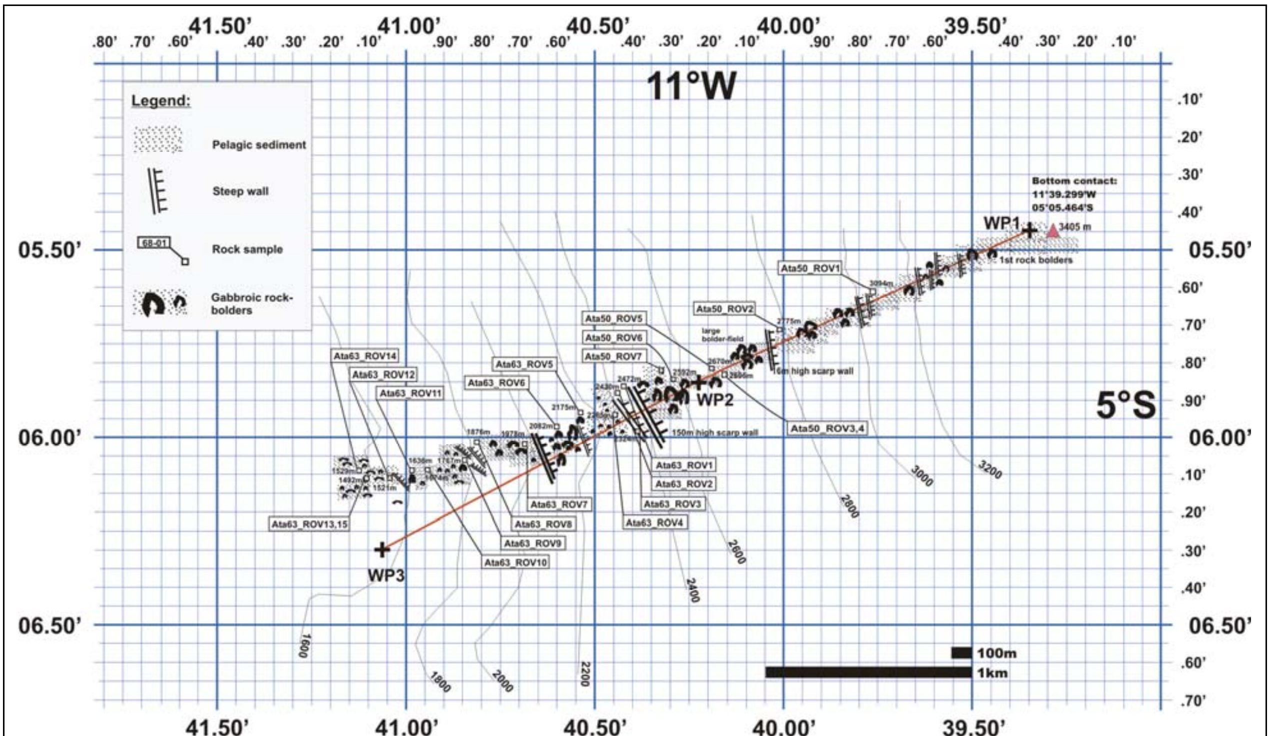


Fig. 2.4.10.12: Outcrop map of the two day traverse up the inside corner high.

Geological Results of the Transform Fault Dive

The topographic overview Fig. 2.4.10.1 shows that the new south-eastern ridge axis has also affected the opposing transform wall, since the latter shows a marked topographic depression where the continuation of the ridge axis intersects the transform wall. During our dive, however, there was a clear predominance of E-W trending cliff faces in the transform wall which we logically attribute to strike slip faulting associated with transform tectonics.

An impression of both the inside corner high and transform traverses are the striking similarity of continental and submarine landscapes. Near vertical cliff faces, talus slopes, *Felsenmeere* (Fig. 2.4.10.13) and slopes with rugged ridges and sediment-filled valleys were all recurring views familiar from land. Particularly the transform transect showed abundant evidence for mass-wasting. Perhaps the major difference to continental landscapes are the valley floors filled smoothly with sedimented, hosting groups of sticking out, large boulders as well as slopes which appeared generally to be somewhat steeper than on land (because of the reducted gravitational force available for collapse?).

Fig. 2.4.10.13: Felsenmeer, presumably collecting rocks from the dyke complex.

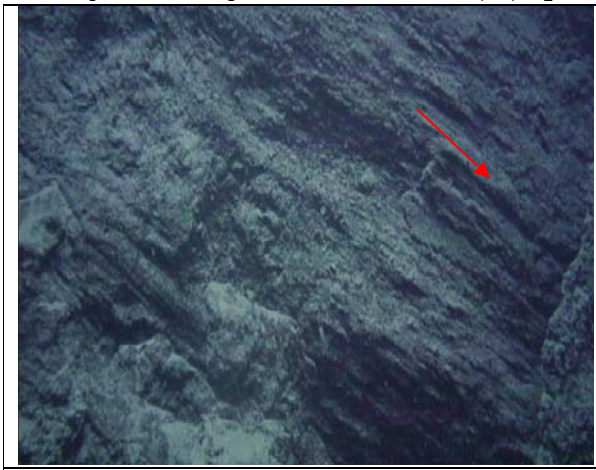
During the dive itself, we were convinced that in the lower part, serpentinite and gabbro is exposed. However, ground truthing via sampling showed that the entire traverse was within diabase and microgabbro which we crossed in east-west trending ridges with intervening shallower, more sedimented parts perhaps related to faulting. We thus covered about 1000 vertical meters of upper oceanic crust with the likely addition of another 300 m above the point where we had to abandon the traverse due to time constraints. Thus, the upper crust in this region is likely to be fully developed with some 1.5 km of volcanics and subvolcancis. A so-called "transform effect" with a reduced or even absent crust seems very unlikely. Our contrasting traverses up the inside corner high and the transform wall emphasized the uniqueness of core complexes in giving easy access to lower crustal rocks.

In several locations, there is strong evidence for an exposure of sheeted dykes (Fig. 2.4.10.14). Consistently, the locally sampled rocks are diabases, representing rapid cooling but no contact to seawater. We may even have collected one chilled margin sample (70ROV-7). Joints developed in the sheeted dyke complex during cooling give a characteristic, facetted outcrop picture but a dominating joints system represents the dyke contacts. Based on our observations, it seems likely that the entire cliff between 4380 and 4050 m is mainly made out of sheeted dykes. The dykes appear to have a predominant jointing dipping 70° to the west, interpreted as dyke-dyke contacts. This would translate to an inward rotation of an assumed original vertically oriented dyke swarm at the western ridge. There was no evidence for felsic veining as would be typical for the sheeted dyke – gabbro transition. Nor did we see pillow lavas which would represent the near sea-floor environment.

Fig. 2.4.10.14. View of sheeted dykes with dominant joint-system dipping 75° to the left (west). Looking north at 4300 mbsf.

The degree of hydrothermal alteration can only be safely determined petrographically but hand-specimen inspection suggests that it is pervasively present. An excellent opportunity will offer itself by comparing our section to IODP Hole 1256D which recently covered 1.5 km of upper oceanic, fast-spreading crust by drilling (Koepke et al., submitted) as well as to the famous ODP Hole 504B.

The trend of the dykes appears to be – as it should – normal to the transform and the cliff faces. What would then form the E-W trending, steeply south dipping cliffs? In some cases we found good evidence for exposed shear planes with, in one case striations on such a face with a 25° eastern pitch (several attempts to sample this rock failed) (Fig. 2.4.10.15). Assuming a dextral shear as derived from the overall transform movement, this would mean a thrust component on the transverse movement, i.e. the southern block appears to have moved obliquely up and west with respect to the northern block (moving obliquely down and east). Higher up in the profile, at 4000 mbsf, a fault plane dipping 40° to the south was observed. Note that in this upper part, the topography is also shallower. We speculate that most of the near-vertical cliff are the expression of a late, brittle transverse fault.



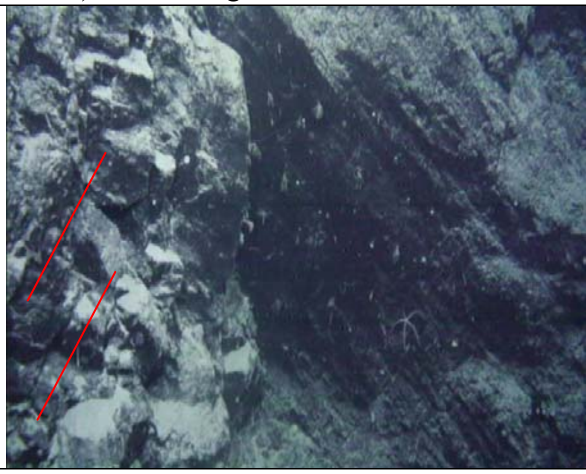


Fig. 2.4.10.15: At the left, a steeply south (towards viewer) dipping fault surface with striations (arrow) is shown (4350 mbsf.). Photo at right shows same feature in the geological context: the fault plane occurs as a wall behind a dyke complex which strikes at high angle to it and with contacts dipping steeply to the left (west, red lines)

The highest section covered with the ROV has a markedly different appearance. The dominant jointing system is absent, the rocks show a small-scale, intensely fractured surface, and a dominant structural grain may represent flow planes (Fig. 2.4.10.16). A working model calls here for massive flows.

Fig. 2.4.10.16: Near the upper end of the profile, intensely jointed rocks with a locally visible structural grain (here from top right to bottom left) became dominant. Our working model calls for an origin as massive flows.

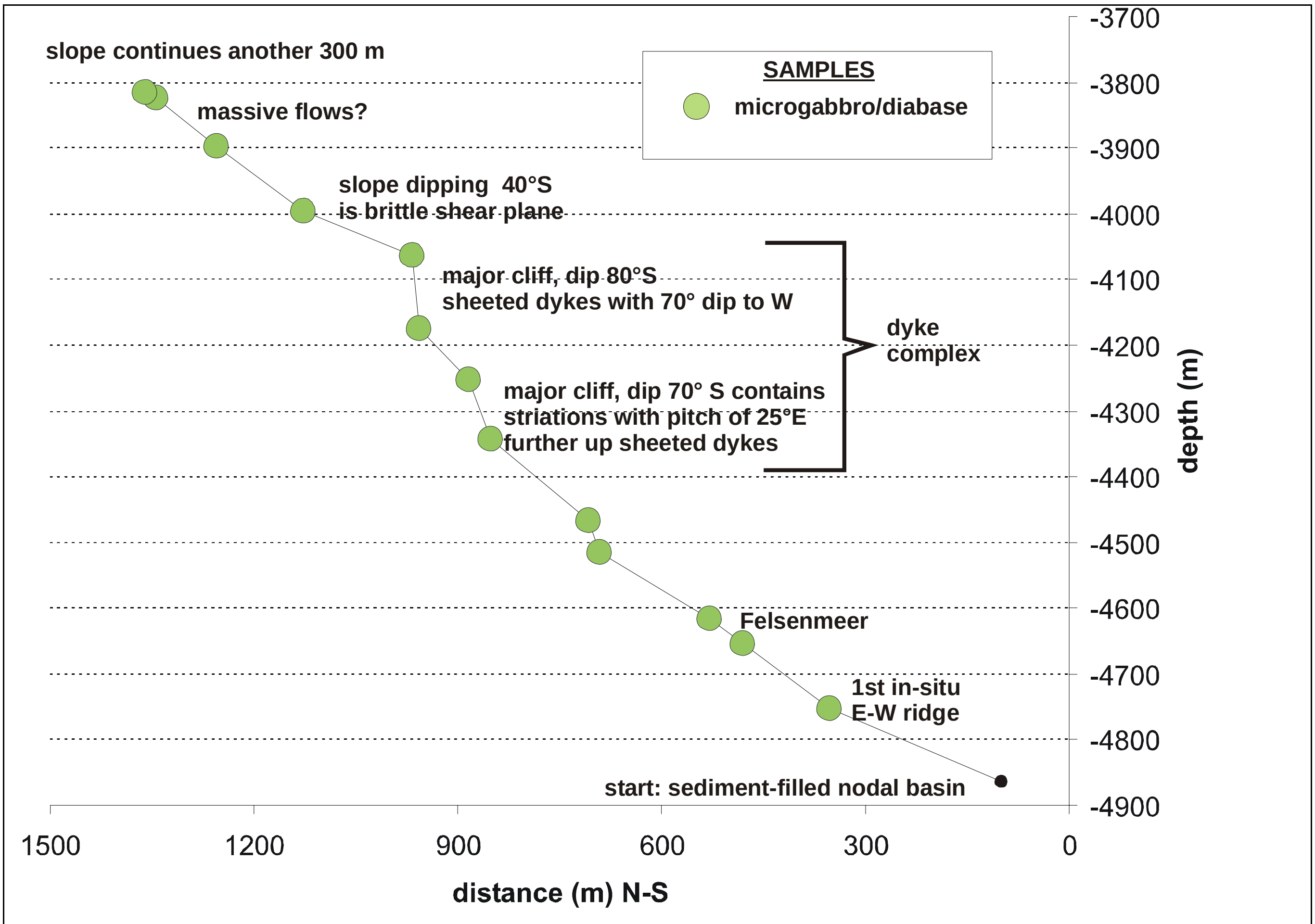


Fig. 2.4.10.17: Transform wall traverse projected onto a N-S plane. Sample locations in green.

2.4.11 ROV deployments during MAR SOUTH IV

(K. Lackschewitz, D. Comany, A. Foster, C. Hinz, E. Labahn, A. Meier, M. Pieper, J. Schneider)

Leg 2 of RV ATALANTE is the second scientific cruise of the Kiel ROV 6000 within the priority program 1144 „From mantle to ocean". A detailed technical description and operation of the entire system is given in the „chapter 1.4.10" of the Leg 1 cruise report „HYDROMAR V".

Table 2.4.11.1: Summary of ROV dives during MAR SOUTH IV

ATA-Leg 2 Station #	IFM-GEOMAR Dive #	Date	Site	Depth (m)	Time Launch	Time (UTC) Start (Bottom)	Time (UTC) End (Bottom)	Time (UTC) on Deck	Bottom Time	Total Dive Time
35ROV	13	14.01.08	Turtle Pits	2988	09:39	11:13	17:40	18:55	**06:27**	**09:16**
37ROV	14	15.01.08	Wideawake/	3000	09:39	11:12	16:50	18:15	**05:38**	**08:36**
42ROV	15	16.01.08	Comfortless Cove	3000	09:20	10:48	18:08	19:24	**07:20**	**10:04**
46ROV	16	18.01.08	Turtle Pits/ Wideawake	3000	09:25	11:10	17:58	19:15	**06:48**	**09:50**
50ROV	17	19.01.08	Inside Corner High 5°S	3095	09:40	11:29	17:32	18:43	**06:03**	**09:03**
52ROV	18	20.01.08	Comfortless Cove	2990	10:00	11:43	17:20	18:39	**05:37**	**8:39**
57ROV	19	21.01.08	Turtle Pits	2990	09:36	11:03	19:29	20:50	**08:26**	**11:14**
63ROV	20	23.01.08	Inside Corner High 5°S	2000	08:50	10:34	17:32	18:29	**06:58**	**9:39**
67ROV	21	24.01.08	Red Lion	2960	09:20	11:42	15:19	16:26	**03:37**	**7:06**
68ROV	22	24.01.08	400m NW of Comfortless Cove	3000	17:17	18:33	21:36	22:45	**03:03**	**5:28**
70ROV	23	25.01.08	Ascension Fracture Zone	4890	10:45	13:04	22:32	00:06	**09:28**	**13:21**

The technical innovations of the ROV provided a flexible and highly adaptable platform for scientific sampling and observation tasks and therefore played a major role for the scientific success aboard RV ATALANTE. Since the previous leg we have additionally installed a rotary sampler with a slurp gun.

In total 11 dives were carried out on 13 working days on the southern Mid Atlantic Ridge at 5°S. A summary about the statistics of the ROV dives are presented in Tab. 2.4.11.1. Launch and recovery has been done at sea states < 2m and winds < 4 bft.

Total dive times of 102 h including almost 70 h bottom time could be achieved at depths of 3000m. During our last dive ROV Kiel 6000 was deployed for the first time to a depth of 4890 m which is also the deepest dive for a ROV manufactured by Schilling Robotics.

The following scientific tools and devices were used on "KIEL ROV 6000m" during the above mentioned dives for obtaining biological, petrological and fluid-geochemical samples:

- KIPS fluid sampling system (incl. high-temperature sensor)
- Ti-Majors fluid sampler
- Isobaric gas sampler
- He tube
- 8-channel low-temperature lance
- SMONI (1-channel high temperature logger)
- Nets for biological sampling
- Slurp gun with rotary sampler

Three colour video cameras (1 HDTV and 2 Standard PAL cameras) have produced a large amount of video data. Videos from the standard cameras were permanently and synchronously recorded as mpeg2 files to a video server. HDTV videos were recorded only at scientific request. They are stored in HD format on a MacintoshPro and as mpeg2 files on the same video server as the standard videos. Approximately one hour of HDTV video was stored per dive. The video data stored on the video server is available to all scientists in SD converted format via the vessel's intranet using a web browser. The so-called Proxsys™ software on the server enables video previews (as mpeg4), cut and download of selected video sequences (as mpeg2).

Unfortunately, the digital still camera did not work after we had changed the defect controller board with a new board provided by the manufacturer.

After some problems during Leg 1, the Posodonia USBL navigation worked well. However, due to a malfunction of the Posidonia system it could not be used for dive 18 (station ATA-52ROV). In addition, at the beginning of our station work two homer beacons were set on the seafloor at Turtle Pits and Wideawake as reference positioning stations. Both were collected at the end of our dive operation in these areas.

2.5 Acknowledgements

The scientists of Atalante Leg 2 would like to thank Capt. Glehen and his crew for superb support at sea. The flexibility of the Senatskommission für Ozeanographie, the Deutsche Forschungsgemeinschaft and the Leitstelle Meteor/Merian in making these cruises possible in the short time available is gratefully acknowledged.

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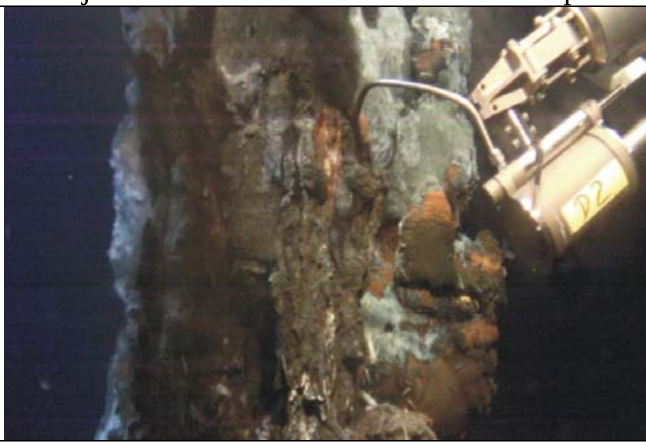
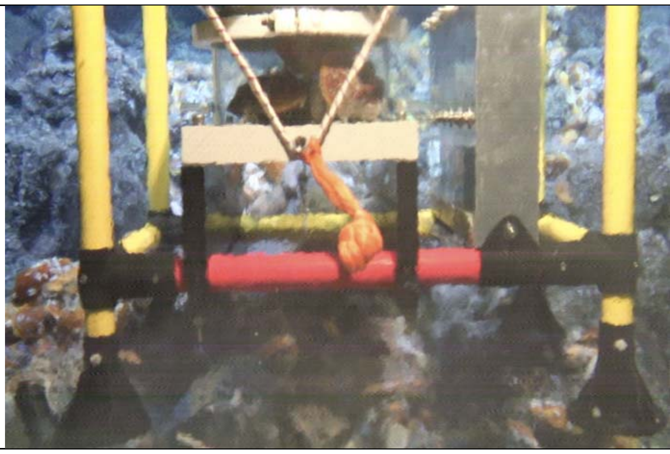
Appendix

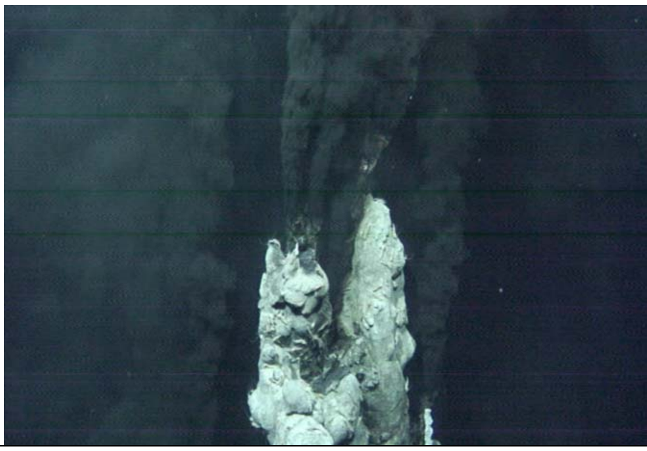
Appendix 1

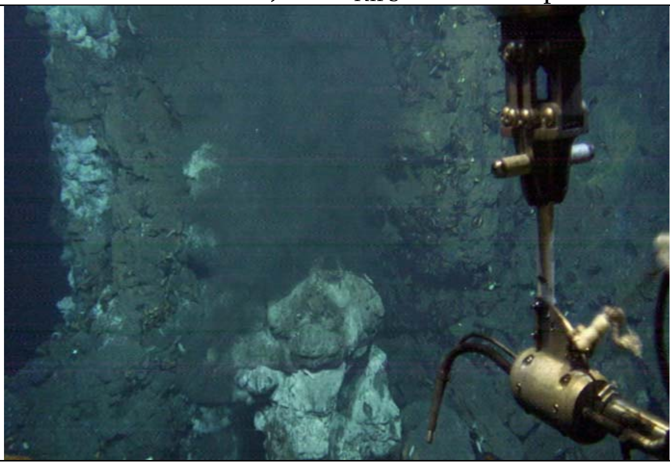
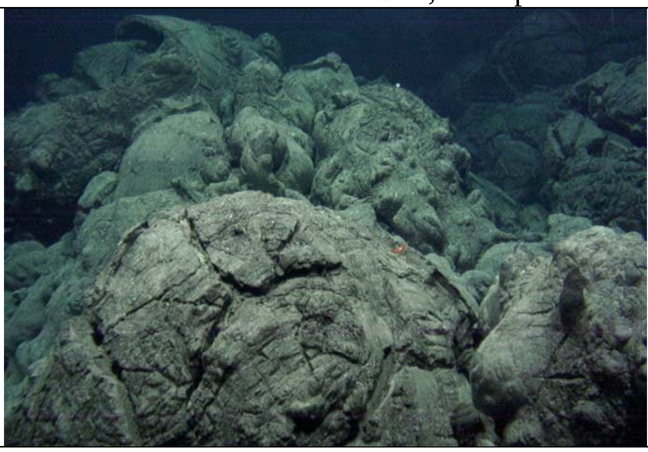
Extended list of operations

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
12.01.08		
ATA-31CTD 17:17:57 – 19:11:30	LADCP, no MAPR, 21 bottles	05°22.396'S, 16°22.917'W @ 4164 m cable out
13.01.08		
ATA-32CTD 21:57:00 – 23:49:35	LADCP, no MAPR, 16 bottles	04°47.701'S, 12°23.604'W @ 3017 m cable out
14.01.08		
ATA-33CTD 01:05:33 – 02:58:26	LADCP, 1x MAPR, 21 bottles, 2 not closed, 1 not tight	04°47.422'S, 12°22.603'W @ 3088 m cable out
ATA-34CTD 04:20:22 – 06:15:35	LADCP, no MAPR, 16 bottles	04°47.103'S, 12°21.635'W @ 3013 m cable out
ATA-35ROV *deployment* 09:39 *at bottom* 11:13	*tools: SMoni, ROV-Beacon, 2x He tubes, 2x Titan Majors*	*ship at* 04° 48.5696S, 2°22.4497W
12:13 :22 *deployment homer beacon*		04°48.583'S, 12°22.414W homer beacon
12:17:50	Site Two Boats	

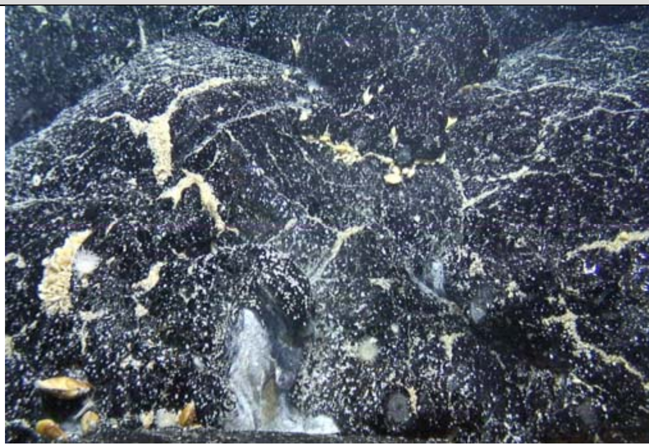
Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
	KIPS fluids from hot vent, but bottled turn out to be not filled, thus no pH, chlorinity	
12:49:25	Bottle C9 =35ROV1; T_{KIPS}=406°C pH= Cl=	
12:54:24	Bottle C8 =35ROV2; T_{KIPS}=417°C pH= Cl=	
12:58:59	Bottle C7 =35ROV3; T_{KIPS}=412°C pH= Cl=	
13:04:20	Bottle B6 =35ROV4; T_{KIPS}= pH= Cl=	
13:09:12	Bottle B5 =35ROV5; T_{KIPS}= pH= Cl=	
13:14:14	Bottle B4 =35ROV6; T_{KIPS}=420°C pH= Cl=	
13:47:54	Ti-major bottle D1 = 35ROV7 pH= 6.44 Cl=550	
		Fluid sampling with Ti-majors
14:34:39	Ti-major bottle D2 = 35ROV8 pH=2.92 Cl=360	
14:43:32	SMoni measurement =35ROV9; Tmax=393°C	
15:06:35	Bottle A3 =35ROV10; T_{KIPS}=451°C pH= Cl=	
15:12:13	Bottle A2 =35ROV11; T_{KIPS}=427°C pH= Cl=	
15:17:03	Bottle A1 =35ROV12; T_{KIPS}=427°C pH= Cl=	
15:31:26	SMoni measurement =35ROV13; Tmax=396°C	
15:43:01	He-sample =35ROV14 (AA label)	
16:04:24	He-sample =35ROV15 (BB label)	
16:46:27	Sulfide sample 35ROV16	
16:46:27	Slurp gun sample (bottle 1) = 35ROV17	
17:34:00	Slurp gun sample (bottle 2) = 35ROV18	
17:40:09 leaving *bottom* 18:55 *ROV on deck*		
ATA-36CTD 20:00:22 – 07:32:30	LADCP, 1xMAPR, keine Proben, JoJo bis 2600m	04°47.394'S, 12°22.600'W @ 3088 m cable out
15.01.08		
ATA-37ROV 09:39	*tools: ROV-Beacon, 8-channel, T-logger," die fast", 5 bionets*	*ship at* 04° 48.6186S, 12°22.339W

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
deployment 11:12:23 *at bottom*		
11:31:00 *deployment homer beacon*		04° 48.626'S, 12° 22.342'W
11:33:25	*Site Wideawake*	
		KIPS temperature measurement in mussel bed
	KIPS fluids ROV2-5 and ROV10-13 = Diffuse fluids	
11:54:47	Bottle C9 =37ROV1; T_{KIPS}= 7-11° pH=7.5 Cl=560	
11:59:21	Bottle C8 =37ROV2; T_{KIPS}= 4-11° pH=7.05 Cl=550	
12:04:44	Bottle C7 =37ROV3; T_{KIPS}=8-11° pH=7.29 Cl=550	
12:10:45	Bottle B6 =37ROV4; T_{KIPS}= pH=7.03 Cl=560	
12:14:53	Bottle B5 =37ROV5; T_{KIPS}= 12-16° pH= Cl=560	
12:31:05	8-channel T-probe, = 37ROV6, T from 16.7 to 4.4°	
13:49:46	Mussels with net #3; sample 37ROV7	
14:11:07	Slurp gun, bottle 1, sample 37ROV8	
14:48:00	Die-fast instrument is filled 37ROV9	
		"Die-fast" instrument
15:58:16	Bottle B4 =37ROV10; T_{KIPS}=8-9°C pH=7.5 Cl=550	
16:05:02	Bottle A3 =37ROV11; T_{KIPS}=5-7°C pH=7.42 Cl=560	
16:08:57	Bottle A2 =37ROV12; T_{KIPS}=6°C pH=7.39 Cl=550	

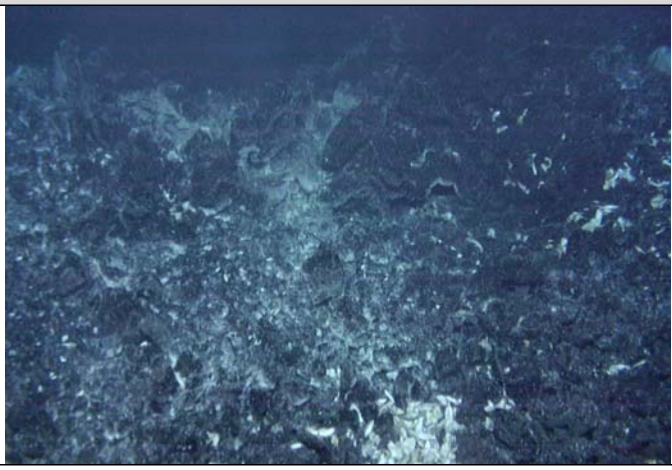
Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
16:14:33	Bottle A1 =37ROV13; T_{KIPS}=9°C pH=7.7	Cl=550
16:29:50	8-channel T-probe, = 37ROV14, 18°C at tip of lance	
16:50:10 *off bottom* 18:15 *ROV on deck*		
ATA-38CTD 19:51:28 – 21:44:58	LADCP, no MAPR, 16 bottles, 1 bottle open	04°44.298'S, 12°20.698'W @ 3082 m cable out
ATA-39CTD 23:51:30 – 01:51:10	LADCP, no MAPR, 20 bottles, 1 bottle not closed	04°45.147'S,12°23.002'W @ 3250 m cable out
16.01.08		
ATA-40CTD 03:07:20 – 04:55:10	LADCP, no MAPR, 16 bottles	04°45.999'S, 12°25.350'W @ 2929 m cable out
ATA-41CTD 06:06:05 – 07:55:20	LADCP, 1x MAPR, 14 bottles	04°49.197'S, 12°22.199'W @ 2980 m cable out
ATA-42ROV 9:20 *deployment* 10:48:04 *at bottom*	*Tools: SMoni, 2 bionets, 1x He tube, 2x Titan Majors, IB-sampler*	*Ship at* 4°48,188´S, 12°22,301´W
	Site: Comfortless Cove	
11:04:43	*Found* Sister Peak 	*ROV at* 4°48.222´S, 12°22.270´W Sister Peak
12:43:26	Sample from chimney = 42 ROV-1	
	KIPS fluids ROV2-5 from base of vent	

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
13:00:04	Bottle C9 =42ROV2; T_{KIPS}=367° pH=6.75 Cl=n.d	
13:05:26	Bottle C8 =42ROV3; T_{KIPS}=367° pH=4.33 Cl=380	
13:10:34	Bottle C7 =42ROV4; T_{KIPS}=368° pH=3.8 Cl=340	
13:16:30	Bottle B6 =42ROV5; T_{KIPS}=368° pH=4.28 Cl=360	
		KIPS sampler
14:26:42	IB sample = 42ROV6	
15:22:51	Ti-major bottle D1 = 42ROV7 pH=3.36 Cl=320	
15:40:32	SMoni measurement =42ROV8; shipboard examination failed	
15:53:28	SMoni measurement =42ROV9; shipboard examination failed	
	KIPS fluids ROV11-ROV14 from top of vent	
16:13:42	No bottle filled? =42ROV10; T_{KIPS}=220°	
16:49:06	Bottle B5 =42ROV11; T_{KIPS}=?° pH=5.69 Cl=520	
16:54:41	Bottle B4 =42ROV12; T_{KIPS}=?° pH=6.76 Cl=n.d.	
17:10:01	Bottle A3 =42ROV13; T_{KIPS}=?° pH= Cl=	
17:13:56	Bottle A2 =42ROV14; T_{KIPS}=?° pH=5.95 Cl=n.d.	
17:30:59	SMoni measurement =42ROV15; shipboard examination failed	
		pillow lava at Golden Valley
18:03:41	Lava rock sample = 42ROV16	*ROV at* 4°48.159 S, 12°22.298 W
18:08:28 *leaving bottom 19:24 ROV*		

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
on deck		
17.01.08		
entire day	ROV idle. Short circuit requires shortening of cable	
ATA- 43CTD 20:38:50 – 08:10:40	LADCP, 3xMAPR, TOW-YO, no bottles, (starts on 16th, ends on 17th)	04°48.992S,12°25.002 @ 2804 m cable out, START 04°47.784'S,12°20.190'W bei 2700 m Tiefe, END
18.01.08		
ATA- 44CTD 01:01:45 – 03:09:05	LADCP, no MAPR, 16 bottles,	04°50.500'S,12°11.898'W @ 3055 m cable out
ATA- 45CTD 04:22:25 – 06:23:40	LADCP, no MAPR, 18 bottles,	04°46.503'S,12°22.798'W @ 3185 m cable out
ATA- 46ROV *9:25 deployment* *11:10:15 on bottom*	*Tools: SMoni, IB-sampler, 1x He tubes, 2x Titan Majors, 2 bionets* *Sites*: Wideawake and Turtle Pits	*ship at* 04°48,620'S, 12°22,353'W
11:33:57	Bionet sample = 46ROV1 at Wideawake	
11:38:14 to 13:20:18	Mapping Wideawake lave fields	
11:57:45	Basalt sample = 46ROV2	
		Fossil submarine lava gauge in Wideawake field
13:10:25	Basalt sample = 46ROV3	04°48.656'S, 12°22.265'W; @ 2983 m water depth
13:45:43	Slurp gun sampling of mussels; bottle 1= 46ROV4	04°48.632'S, 12°22.331'W
13:58:36	Slurp gun sampling of mussels; bottle 2= 46ROV5	

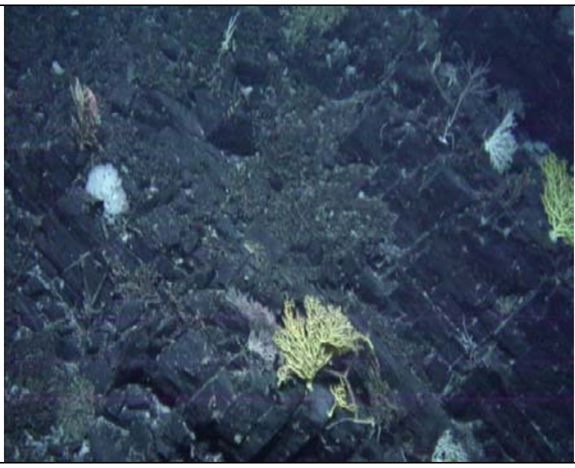
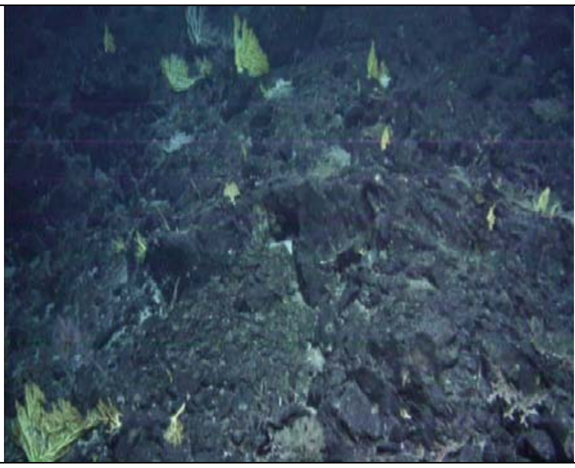
Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
		First colonialization (?) of lava by mussels
	Site: Two Boats	
16:15:30	IB sample = 46ROV6	4°48.577S, 12°22.412 W
16:57:54	Bottle C9 =46ROV7; T_{KIPS}= 180° pH=3.47 Cl=470 KIPS temp. sensor is displaced by 2 cm from nozzle	
17:01:52	Bottle C8=46ROV8,........T_{KIPS}= 180° pH=n/a Cl=n/a no temp. because of sensor problem	
17:58:06 *leaving bottom* 19:15 *on deck*		
ATA-47CTD 20:24:00 – 22:11:23	LADCP, no MAPR, 16 bottles, 1 bottle not closed	04°51.297'S,12°19.504'W @ 2944 m cable out
ATA-48CTD 23:09:30 – 01:03:10	LADCP, no MAPR, 20 bottles, 1 "Schöpfer" not closed	04°52.000'S, 12°21.453'W @ 3271 m cable out
19.01.08		
ATA-49CTD 02:04:03 – 03:53:20	LADCP, no MAPR, 16 bottles	04°53.003'S, 12°23.350'W @ 3035 m cable out
ATAROV50 *09:40:42 deployment 11:29:15 on bottom*	*Tools: 1x Titan Majors, 2 bionets, IB-sampler, Shovel; port drawer configured for rocks* *Site:* Inside Corner High 1	*Ship coordinates* 5°05.3771´S, 11°39.393´W
13:26:05	Rock sample = 50ROV1, Mn-encrusted peridotite breccia	05°05.622'S, 11°39.764'W, depth 3094m
15:24:48	Rock sample = 50ROV2, melano-gabbro	05°05.746'S, 11°40.045'W

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
		depth 2775 m
16:21:56	Rock sample = 50ROV3, small serpentinte mylonite	05°05.830'S, 11°40.170'W, depth 2696 m
16:24:21	Rock sample = 50ROV4, small piece of microgabbro or dolerite	05°05.830'S, 11°40.170'W, depth 2696 m
16:34:58	Rock small = 50ROV5, large piece of leucogabbro with corner of felsic intrusvie	05°5.815'S, 11°40.191'W, 2670m
16:55:45	Rock sample = 50ROV6, gabbro with two merging high T shear zones	05,840'S, 11°40,289'W, depth 2592 m
17:22:19	Rock sample = 50ROV7, qtz-diorite intrusive into gabbro pegmatite and regular gabbro	05°05.827'S, 11°40.311'W, depth 2555m
17:32:25 *leaving bottom* 18:43 *on deck*		Leaving traverse for today at 05°05.833'S, 11°40.372'W, depth 2484 m
ATA-51CTD 23:39:28 – 08:07:40	LADCP, 3x MAPR, 3 bottles, YoYo, hit ground from 05:22:33 to 05:26:09	04°47.998'S, 12°22.353'W @ 3005 m cable out
20.01.08		
ATA-ROV52 10:00 *deployment:* 11:*43 on bottom*	*8-channel T-logger; 4 bionets, He tube*	04°48.102' S, 12°22.286' W, depth 2992 m
	Site Golden Valley, further planned operations were cancelled due to failure of Posidonia position system 	Amazing volcanic morphology in Golden Valley

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
		mussel cemetary in Golden Valley area
13:59:38	Bottle C9 =52ROV1; T_{KIPS}=8.9°C° pH= 7.61 Cl=n.d.	
		view of mussel field in Golden Valley area
14:04:08	Bottle C8 =52ROV2; T_{KIPS}=8.6C° pH=7.08 Cl= n.d.	
14:09:13	Bottle C7 =52ROV3; T_{KIPS}=8.5C° pH=6.92 Cl= n.d.	
14:13:10	Bottle B6 =52ROV4; T_{KIPS}=8.9C° pH=6.97 Cl= n.d.	
14:20:04	Bottle B5 =52ROV5; T_{KIPS}=8.0C° pH=6.79 Cl= n.d.	
14:24:45	Bottle B4 =52ROV6; T_{KIPS}=8.3C° pH= 6.84 Cl= n.d.	
14:28:43	Bottle A3 =52ROV7; T_{KIPS}=7.8C° pH= 6.88 Cl= n.d.	
14:36:52	Bottle A2 =52ROV8; T_{KIPS}=8.8C° pH=6.96 Cl= n.d.	
14:41:51	Bottle A1 =52ROV9; T_{KIPS}=8.8C° pH= 7.29 Cl= n.d.	
15:09:10	8-channel T-probe, = 52ROV10, Tmax = 6°C°	
15:51:39	mussels in net B = 52ROV11	
16:12:15	collecting rock fragments with shovel = 52ROV12	
16:35:26	placing bionet as marker = 52ROV13	
17:20:08 leaving bottom		

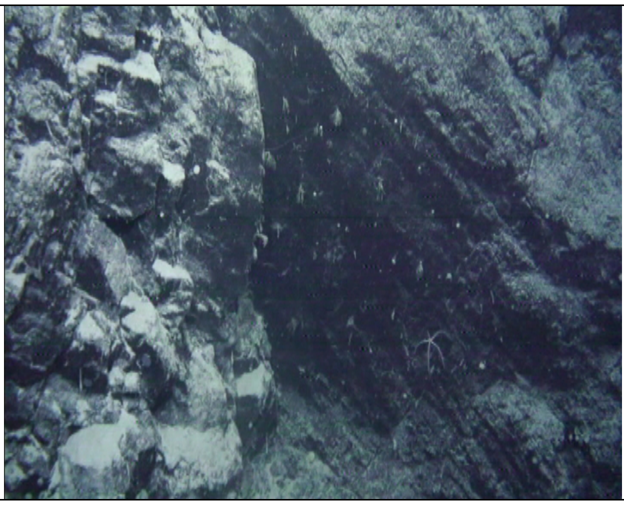
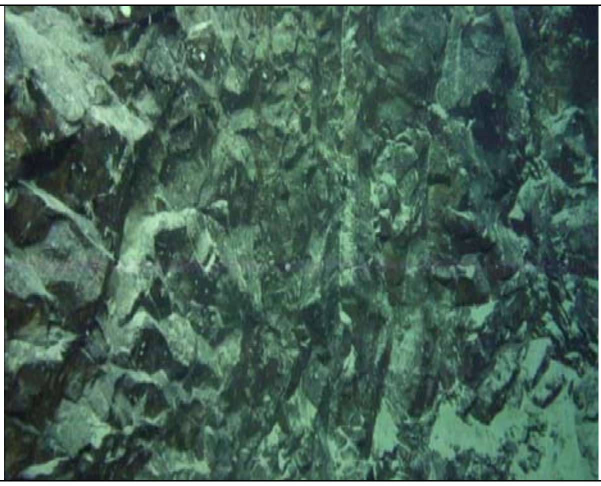
Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
18:39 *ROV on deck*		
ATA53VSR c. 20:30	volcanic glass = 53VSR1	Ship at 04°46.914'S, 12°22.596', depth at contact 3139 m
21.01.08		
ATA54VSR c. 23:30	volcanic glass = 54VSR	ship at 04°46.48'S, 12°22.52'W, depth at contact 3161 m
ATA55VSR c. 03:00	volcanic glass = 55VSR	ship at 04.46.093'S, 12°23.209'W, depth at contact 3207 m
ATA56VSR c. 06:00	sediment = 56VSR	ship at 04°43.962'S, 12°24.061'W, depth at contact 3321 m
ATA-ROV57	*Tools: IB sampler, 2 bionets; 1x He tubes, 2x Titan Majors*	Ship at 4°48.558´S, 12°22.463´W; depth 2989
09:36:00 *deployment* 11:03:43 *on bottom*		
	Site: Turtle Pits	
13:34:09	Rock sample from chimney = ATA-57ROV-1	
15:35:56	Bottle C9 =57ROV2; T_{KIPS}= >220°C pH=6.57 Cl=n.d.	
15:39:44	Bottle C8 =57ROV3; T_{KIPS}= >220°C pH=5.38 Cl=n.d.	
15:43:06	Bottle C7 =57ROV4; T_{KIPS}= >220°C pH= 2.85 Cl=360	
15:46:46	Bottle B6 =57ROV5; T_{KIPS}= >220°C pH=4.51 Cl=430	
16:47:22	IB tube = sample 57ROV6	
18:32:11	Collecting beacon 11	
19:01:09	Collecting beacon 10	
19:09:17	Bionet with mussels = 57ROV6	
19:29:31 *leaving bottom* 20:50 *on deck*		
ATA58VSR c. 22:30	volcanic glass = sample 58VSR	*ship at* 04°49.36'S, 12°22.53'W, depth at contact 3019 m
22.01.08		

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
ATA59VSR c. 1:30	volcanic glass = sample 59VSR, bulk of sample lost before on board	*ship at* 04°50.965'S. 12°22.024'W; depth at contact 3097 m
ATA60VSR c. 4:30	volcanic glass = sample 60VSR	*ship at* 04°51.959'S, 12°21.533'W, depth at contact 3233 m
ATA61VSR c. 7:30	sediment plus bit volcanic glass = 61VSR	*ship at* 04°52.985'S, 12°21.533'W, water depth at contact 3310 m
	Service on ROV, no flying today	
ATA-62CTD 09:16:59 – 03:31:55	LADCP, 3x MAPR, no bottles	*ship at* 04°47.394'S, 12°22.600'W @ 3086 m cable out
23.01.08		
ATA-63ROV	*Tools: 1x Titan Majors, 2 bionets, IB-sampler, Shovel, port drawer configured for rocks*	*ship at* 5°05.848'S, 11°40.429'W
	Site: Inside Corner High 2	
09:00:00 *deployment;* 10:44:04 *on bottom*		05°05.798'S, 11°40.368'W 2489m depth
11:12:57	Rock sample = 63ROV1, coarse-grained gabbro	05°05.854S', 11°40.356'W at depth 2472m
11:29:56	Rock sample = 63ROV2, medium-grained gabbro	05°05.863'S, 11°40.369'W at depth 2430m
12:01:49	Rock sample = 63ROV3, microgabbro	05°05.919'S, 11°40.382'W at depth 2324m
12:20:56	Rock sample = 63ROV4, medium-grained gabbro	05 05.927S, 11°40.433'W at 2265m
		steeply dipping fault plane developed in a gabbro cliff
12:51:22	Rock sample = 63ROV5, medium-grained gabbro	05°05.931'S, 11°40.527'W at depth 2175m

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
13:25:59	Rock sample = 63ROV6, medium-grained gabbro	05°05.968'S, 11°40.583'W. at depth 2082m
14:01:40	Rock sample = 63ROV7, coarse-grained gabbro	05°06.022'S, 11°40.698'W at depth 1978m
14:25:11	Rock sample = 63ROV8, medium-grained gabbro	05°06.013'S, 11°40.817'W at depth 1876m
15:01:56	Rock sample = 63ROV, microgabbro	05°06.059'S, 11°40.843'W at depth 1767m
15:25:58	Rock sample = 63ROV10, perhaps basaltic with felsic magmatic veins	05°06.081' S, 12°40.949'W at depth 1673.8 m
15:40:14	Rock sample = 63ROV11, microgabbro	05°06.089'S, 11°40.982'W at depth 1636m
16:34:02	Rock sample = 63ROV12, medium-grained gabbro with net veins	05°06.104'S, 11°41.061'W at depth 1521m
16:52:28	Rock sample = 63ROV13, peridotite breccia	05°06.118'S, 11°41.102'W at depth 1491m
17:18:11	Rock sample = 63ROV14, ultramylonitic rock?	05°06.093'S, 11°41.125W at depth 1529 m
		probable ultramylonitic peridotite 50 m below edge of inside corner high plateau
17:26:25	Rock sample = 63ROV15, peridotite breccia	5°06.116'S, 11°41.101'W at depth 1492 m
		coral grown ultramafic breccia on plateau of inside corner massif

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
17:32:39 *leaving bottom* 18:29 *.on deck*		
ATA-64CTD 23:50:14 – 01:38:30	LADCP, 1x MAPR, 20 bottles	04°48.848'S, 12°22.298'W @ 2983 m cable out
24.01.08		
ATA-65CTD 02:32:12 – 04:22:40	LADCP, 1x MAPR, 20 bottles	04°22.40'S, 12°22.395'W @ 2992 m cable out
ATA-66CTD 05:07:45 – 07:06:00	LADCP, 1x MAPR, 20 bottles	04°47.902'S, 12°22.492'W @ 3023 m cable out
ATA-67ROV	*Tools*: IB-sampler, 1x He tubes, 2x Titan Majors, 2 bionets, rock-bio box	*Ship at* 4°48.661S, 12°22.60'W, depth 2995 m
	Site: Red Lion	
09:20:*00 in water*	Fly one mile to correct location	
11:42:31 on bottom		04°47.821'S, 12°22.641'W at depth of 3048 m
13:15:27	Slurp gun collects shrimps = 67ROV1	
13:21:28	Slurp gun collects shrimps = 67ROV2	
14:29:54	Ti-major bottle D2 = 67ROV3 pH=3.51 Cl=490	
14:48:17	Bottle C9 =67ROV4 T_{KIPS}= 350°C pH=4.01 Cl=530	
14:51:51	Bottle C8 =67ROV5 T_{KIPS}= 363°C pH=2.85 Cl=540	
14:54:39	Bottle C7 =67ROV6 T_{KIPS}= no T°C pH=3.62 Cl=560	
14:58:58	Bottle B6 =67ROV7 T_{KIPS}= no T°C pH=5.06 Cl=540	
15:05:43	Bottle B5 =67ROV8 T_{KIPS}= no T°C pH=3.22 Cl=560	
15:17:12	He-sample = 67ROV9	
15:19:35 *leaving bottom* 16:*26 on deck*	Leaving ground early because of oil leak from slurp gun	
ATA-		*Ship at* 4°48.152'S,

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
ROV68		12°22.381'W, depth 2995 m
17:17:15 *in water* 18:33:16 *on bottom*	*Site*: Comfortless Cove area	4°48.090'S, 12°22.384'W, depth 3002 m
	Searching in a 120 x 120 m square for oceanographic tool (mooring) suspected in this area, but no success	
21:36:55 leaving bottom 22:45..on deck		
ATA-ROV69	Mooring loaded with MMP,700m length	
23:10 deployment 02.55 *released*		04°48.197'S,12°22.510'W, depth 3004 m
25.01.08		
ATA-ROV70	*Tools: 1x Titan Majors, 1 bionet, IB-sampler, Shovel, port drawer configured for rocks*	*Ship at* 4°56.420´S, 11°37.044'W, depth 4765m
	Site: North wall of transform, 5°S at nodal basin	
10:45:00 *in water,* 13:04:39 *at bottom*		11°36.987W, 04°56.473'S depth 4864 m
	Testing ROV functions at large dephts	
16:53:37	Subvolcanic basalt = 70ROV-1	04°56.336´S, 11°37.057´W 4753 m
17:53:56	Microgabbro to diabase = 70ROV-2	04°56.258'S, 11°37.055'W depth 4654 m
18:11:10	Solidified foraminiferous ooze = 70ROV-3	04°56.231'S, 11°37.073'W depth 4617 m
18:15:26	Doleritic basalt = 70ROV-4	04°56.231'S, 11°37.073'W depth 4617 m
18:42:12	Microgabbro to diabase = 70ROV-5	04°56.145´S, 11° 37.088´W depth 4515 m
18:58:35	Doleritic basalt = 70ROV-6	04°56.124´S, 11°37.111´W depth 4468 m

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
19:44:17	Basaltic with flow texture = 70ROV-7	04 56.046´S, 11°37.131 depth 4343 m
		striations related to movement on a steep fault. They appear to truncate a sheeted dyke complex visible in foreground
20:12:40	Diabase = 70ROV-8	04 56.028'S, 11°37.114 depth 4252 m
		well developed sheeted dykes in cliff face of the transform wall
20:38:45	Diabase = 70ROV-9	04° 55.990'S, 11°37.124'W, depth 4175m
21:13:58	Diabase = 70ROV-10	04°55.983'S, 11°37.113'W, depth 4063m
21:37:21	Basaltic breccia = 70ROV-11	04°55.895'S, 11°37.148'W, depth 3996m
22:00:15	Diabase = 70ROV-12	04°55.816'S, 11°37.166'W, depth 3897m,
22:17:13	Diabase = 70ROV-13	04° 55,765'S, 11°37.201'W, depth 3825m

Extended list of operations		
station (date/time UTC)	instruments used /samples /comments	location
22:29:45	Diabase = 70ROV-14	04°55.757'S, 11°37.212' W, depth 3815m
22:32:08 *leaving bottom* 00:06. *on deck*		

Appendix 2: Fluid Chemistry results and subsamples

Table A1: Summary of hydrothermal fluid subsamples taken during Atalante Leg 2

							Jacobs University Bremen, AG Koschinsky						Westfaelische Universitaet M nster, AG Strauss				Christian-Albrechts-Universitaet Kiel, AG Garbe-Sch nberg				
Location	Station Nr.	Sample ID	Bottle	Sample Type	Date	onboard	anions	cations NF	cations F	Si-det.	AAs	trace metals REE, HFSE	DIC	H-Iso, O-Iso	S-Iso	MBB	Mg-det	Trace metals	Cations NF	Cl-Iso	PGE
Two Boats, top	35 ROV	7	D1	hot fluid	14.01.2008	x	x	x	x					x	x						
Two boats, bottom	35 ROV	8	D2	hot fluid		x	x	x	x	x			x	x	x	x	x	x	x		x
Wideawake 1	37 ROV	1	C9	diffuse fluid	15.01.2008	x	x	x				x					x	x	x		
	37 ROV	2	C8	diffuse fluid		x							x		x						
	37 ROV	3	C7	diffuse fluid		x					x										
	37 ROV	4	B6	diffuse fluid		x										x					
Wideawake 2	37 ROV	5	B5	diffuse fluid		x															
	37 ROV	10	B4	diffuse fluid		x	x	x				x					x	x	x		
	37 ROV	11	A3	diffuse fluid		x									x						
	37 ROV	12	A2	diffuse fluid		x							x			x					
	37 ROV	13	A1	diffuse fluid		x					x										
Sisters Peak, bottom	42 ROV	2	C9	hot fluid	16.01.2008	x	x	x	x					x	x	x	x	x	x		
	42 ROV	3	C8	hot fluid		x	x	x	x	x	x		x	x		x	x	x	x		
	42 ROV	4	C7	hot fluid		x	x	x	x					x		x	x	x	x		x
	42 ROV	5	B6	hot fluid		x	x	x	x	x		x	x	x		x	x	x	x		
	42 ROV	6	gas	hot fluid		x															
	42 ROV	7	D1	hot fluid		x	x	x	x	x		x	x	x		x	x	x	x	x	
Sisters Peak, top (1)	42 ROV	11	B5	hot fluid		x	x	x	x		x			x		x	x	x	x		
	42 ROV	12	B4	hot fluid		x	x	x	x					x		x	x	x	x		
Sisters Peak, top (2)	42 ROV	14	A1	hot fluid		x	x	x	x				x	x	x	x	x	x	x		
Two Boats, bottom	46 ROV	7	C9	hot fluid	18.01.2008	x	x	x	x	x			x	x	x	x	x	x	x	x	
Golden Valley	52 ROV	1	C9	diffuse fluid	20.01.2008	x	x				x					x	x	x	x		
	52 ROV	2	C8	diffuse fluid		x							x			x	x				
	52 ROV	3	C7	diffuse fluid		x										x	x				
	52 ROV	4	B6	diffuse fluid		x							x			x	x				
	52 ROV	5	B5	diffuse fluid		x										x	x				
	52 ROV	6	B4	diffuse fluid		x										x	x	x	x		
	52 ROV	7	A3	diffuse fluid		x					x					x	x	x	x		
	52 ROV	8	A2	diffuse fluid		x	x									x	x	x	x		
	52 ROV	9	A1	diffuse fluid		x										x	x	x	x		
Two Boats, bottom	57 ROV	2	C9	hot fluid	21.01.2008	x		x	x	x	x			x		x	x	x	x		
	57 ROV	3	C8	hot fluid		x	x	x	x	x	x		x	x	x	x	x	x	x		
	57 ROV	4	C7	hot fluid		x		x	x	x	x		x	x	x	x	x	x	x		
	57 ROV	5	B6	hot fluid		x	x	x	x	x	x			x	x	x	x	x	x		x
Mephisto	67 ROV	3	D2	hot fluid	24.01.2008	x	x	x	x	x				x	x	x	x	x	x	x	
	67 ROV	4	C9	hot fluid		x	x	x	x	x	x			x		x	x	x	x		
	67 ROV	5	C8	hot fluid		x		x	x	x			x	x	x	x	x	x	x		x
	67 ROV	6	C7	hot fluid		x		x	x	x	x			x	x	x	x	x	x		
	67 ROV	7	B6	hot fluid		x		x	x	x	x			x		x	x	x	x		
	67 ROV	8	B5	hot fluid		x	x	x	x	x	x	x		x	x	x	x	x	x		

Abbreviations: onboard: determination of pH, Eh, H2S, Fe speciation; F: filtered; NF: non-filtered; Si-det: silica determination; AAs: Amino Acids; REE: Rare Earth Elements including Y; HFSE: High Field Strength Elements; DIC: Dissolved Inorganic Carbon; H-Iso: Hydrogen Isotopes; O-Iso: Oxygen Isotopes; S-Iso: Sulfur isotopes; MBB: Monobromobimane fixation for S speciation; Mg-det: magnesium determination; Cl-Iso: stable Cl, Ca, Mg, Sr Isotopes (AG A. Eisenhauer, Kiel); PGE: Platinum group Elements

Table A2: Results from on-board chemical analyses and measured data

Location	Station Nr.	Sample ID	Bottle	Sample Type	Date	T (C)	pH	Eh	H2S (µM)	H2S (µM)	Fe (II) mg/l	Fe (II) µM	Fe (tot) (mg/l)	Fe (tot) (mM)	Cl (mM)	O2 (µM)
Two Boats, top	35 ROV	7	D1	hot fluid	14.01.2008		6,44	5	n.d.	1,57	8,53	152,3	9,74	173,9	550	
Two boats, bottom	35 ROV	8	D2	hot fluid		429-451*	2,92	-245	3370	3323	216	3857	221	3946	310	
Wideawake 1	37 ROV	1	C9	diffuse fluid	15.01.2008	7-11	7,5	-50		1,16	0,1	1,8	0,85	15,2	560	225
	37 ROV	2	C8	diffuse fluid		4-11	7,05	-206		47,24	0,45	8,0	0,5	8,9	550	
	37 ROV	3	C7	diffuse fluid		8-11	7,29	-180		14,65	0,78	13,9	1,23	22,0	560	
	37 ROV	4	B6	diffuse fluid		n.a.	7,03	-217		76,16	0,38	6,8	0,41	7,3	560	
	37 ROV	5	B5	diffuse fluid		12-16				27,96	0,45	8,0	0,74	13,2	560	
Wideawake 2	37 ROV	10	B4	diffuse fluid		8-9	7,5	-213,6		39,1	0,13	2,3	0,19	3,4	550	
	37 ROV	11	A3	diffuse fluid		5-7	7,42	-212,7		33,12	0,17	3,0	0,24	4,3	560	270
	37 ROV	12	A2	diffuse fluid		6	7,39	-217,9		48,59	0,13	2,3	0,13	2,3	550	
	37 ROV	13	A1	diffuse fluid		9	7,5	-176,3		12,23	0,44	7,9	1,39	24,8	555	
Sisters Peak, bottom	42 ROV	2	C9	hot fluid	16.01.2008	367	6,75		390	100	4,42	79,0	4,36	77,9		
	42 ROV	3	C8	hot fluid		367	4,33		6650	6038	115,03	2054,1	119,26	2129,7	370	
	42 ROV	4	C7	hot fluid		367	3,8		9960	8494	174,06	3108	176	3141	330	
	42 ROV	5	B6	hot fluid		367	4,28		4300	3960	122,48	2187,2	111,35	1988,4	370	
	42 ROV	6	gas	hot fluid												
	42 ROV	7	D1	hot fluid			3,36		7800	9296	184,18	3289	205	3667	310	
Sisters Peak, top (1)	42 ROV	11	B5	hot fluid		n.d.**	5,69		530	2219	24,30	433,9	26,57	474,5	520	
	42 ROV	12	B4	hot fluid		n.d.**	6,76		< 30	38	4,19	74,9	3,92	69,9		
Sisters Peak, top (2)	42 ROV	14	A1	hot fluid		n.d.**	5,95		110	251	20,78	371,0	23,08	412,1		
Two Boats, bottom	46 ROV	7	C9	hot fluid	18.01.2008	max. 412	3,47	-222,7		1486	74,46	1330	83,67	1494	470	
Golden Valley	52 ROV	1	C9	diffuse fluid	20.01.2008	8,9	7,61	2,6		1	0	0,0	0,08	1,4		450
	52 ROV	2	C8	diffuse fluid		8,6	7,08	-136		21	0,11	2,0	0,18	3,2		
	52 ROV	3	C7	diffuse fluid		8,5	6,92	-170		43	0,2	3,6	0,23	4,1		
	52 ROV	4	B6	diffuse fluid		8,9	6,97	-128		20	0,55	9,8	1,25	22,3		
	52 ROV	5	B5	diffuse fluid		8	6,79	-196		56			0			
	52 ROV	6	B4	diffuse fluid		8,3	6,84	-186		40			0,02	0,4		244
	52 ROV	7	A3	diffuse fluid		7,8	6,88	-195		22	0	0,0	0			
	52 ROV	8	A2	diffuse fluid		8,9	6,96	-26,3		7	1,04	18,6	2,39	42,7		290
	52 ROV	9	A1	diffuse fluid		8,8	7,29	68,4		1	0,79	14,1	1,65	29,5		
Two Boats, bottom	57 ROV	2	C9	hot fluid	21.01.2008	max: 371	6,57	10		4	7,58	135,4	10,03	179,1		
	57 ROV	3	C8	hot fluid			5,38	-290		925	27,01	482,3	30,54	545,4		
	57 ROV	4	C7	hot fluid			2,85	-189		4782	167,5	2991	216	3857	360	
	57 ROV	5	B6	hot fluid			4,51	-274		2561	63,28	1130,0	73,22	1307,5	430	
Mephisto	67 ROV	3	D2	hot fluid	24.01.2008		3,51	-224,4		3885	15,68	280,0	21,54	384,6	490	
	67 ROV	4	C9	hot fluid		363	4,01	-207,4		3990	33,94	606,1	33,61	600,2	530	0
	67 ROV	5	C8	hot fluid		363	2,85	-180,2		7465	40,8	729	44,3	791	540	
	67 ROV	6	C7	hot fluid		363	3,62	-215,2		6336	37,39	667,7	46,74	834,6	560	
	67 ROV	7	B6	hot fluid		363	5,06	-241,2		2203	15,34	273,9	13,74	245,4	540	
	67 ROV	8	B5	hot fluid		363	3,22	-190,8		7593	47,88	855	52,19	932	560	

* max. T range measured in the same orifice
** T sensor failed

Table A2: Results from on-board chemical analyses and measured data (cont.)

Location	Station Nr.	Sample ID	Bottle	Sample Type	Date	T (C)	pH	Eh	H2S (µM)	H2S (µM)	Fe (II) mg/l	Fe (II) µM	Fe (tot) (mg/l)	Fe (tot) (mM)	Cl (mM)	O2 (µM)
Two Boats, top	35 ROV	7	D1	hot fluid	14.01.2008		6,44	5	n.d.	1,57	8,53	152,3	9,74	173,9	550	
Two boats, bottom	35 ROV	8	D2	hot fluid		429-451*	2,92	-245	3370	3323	216	3857	221	3946	310	
Wideawake 1	37 ROV	1	C9	diffuse fluid	15.01.2008	7-11	7,5	-50		1,16	0,1	1,8	0,85	15,2	560	225
	37 ROV	2	C8	diffuse fluid		4-11	7,05	-206		47,24	0,45	8,0	0,5	8,9	550	
	37 ROV	3	C7	diffuse fluid		8-11	7,29	-180		14,65	0,78	13,9	1,23	22,0	560	
	37 ROV	4	B6	diffuse fluid		n.a.	7,03	-217		76,16	0,38	6,8	0,41	7,3	560	
	37 ROV	5	B5	diffuse fluid		12-16				27,96	0,45	8,0	0,74	13,2	560	
Wideawake 2	37 ROV	10	B4	diffuse fluid		8-9	7,5	-213,6		39,1	0,13	2,3	0,19	3,4	550	
	37 ROV	11	A3	diffuse fluid		5-7	7,42	-212,7		33,12	0,17	3,0	0,24	4,3	560	270
	37 ROV	12	A2	diffuse fluid		6	7,39	-217,9		48,59	0,13	2,3	0,13	2,3	550	
	37 ROV	13	A1	diffuse fluid		9	7,5	-176,3		12,23	0,44	7,9	1,39	24,8	555	
Sisters Peak, bottom	42 ROV	2	C9	hot fluid	16.01.2008	367	6,75		390	100	4,42	79,0	4,36	77,9		
	42 ROV	3	C8	hot fluid		367	4,33		6650	6038	115,03	2054,1	119,26	2129,7	370	
	42 ROV	4	C7	hot fluid		367	3,8		9960	8494	174,06	3108	176	3141	330	
	42 ROV	5	B6	hot fluid		367	4,28		4300	3960	122,48	2187,2	111,35	1988,4	370	
	42 ROV	6	gas	hot fluid												
	42 ROV	7	D1	hot fluid			3,36		7800	9296	184,18	3289	205	3667	310	
Sisters Peak, top (1)	42 ROV	11	B5	hot fluid		n.d.**	5,69		530	2219	24,30	433,9	26,57	474,5	520	
	42 ROV	12	B4	hot fluid		n.d.**	6,76		< 30	38	4,19	74,9	3,92	69,9		
Sisters Peak, top (2)	42 ROV	14	A1	hot fluid		n.d.**	5,95		110	251	20,78	371,0	23,08	412,1		
Two Boats, bottom	46 ROV	7	C9	hot fluid	18.01.2008	max. 412	3,47	-222,7		1486	74,46	1330	83,67	1494	470	
Golden Valley	52 ROV	1	C9	diffuse fluid	20.01.2008	8,9	7,61	2,6		1	0	0,0	0,08	1,4		450
	52 ROV	2	C8	diffuse fluid		8,6	7,08	-136		21	0,11	2,0	0,18	3,2		
	52 ROV	3	C7	diffuse fluid		8,5	6,92	-170		43	0,2	3,6	0,23	4,1		
	52 ROV	4	B6	diffuse fluid		8,9	6,97	-128		20	0,55	9,8	1,25	22,3		
	52 ROV	5	B5	diffuse fluid		8	6,79	-196		56			0			
	52 ROV	6	B4	diffuse fluid		8,3	6,84	-186		40			0,02	0,4		244
	52 ROV	7	A3	diffuse fluid		7,8	6,88	-195		22	0	0,0	0			
	52 ROV	8	A2	diffuse fluid		8,9	6,96	-26,3		7	1,04	18,6	2,39	42,7		290
	52 ROV	9	A1	diffuse fluid		8,8	7,29	68,4		1	0,79	14,1	1,65	29,5		
Two Boats, bottom	57 ROV	2	C9	hot fluid	21.01.2008	max: 371	6,57	10		4	7,58	135,4	10,03	179,1		
	57 ROV	3	C8	hot fluid			5,38	-290		925	27,01	482,3	30,54	545,4		
	57 ROV	4	C7	hot fluid			2,85	-189		4782	167,5	2991	216	3857	360	
	57 ROV	5	B6	hot fluid			4,51	-274		2561	63,28	1130,0	73,22	1307,5	430	
Mephisto	67 ROV	3	D2	hot fluid	24.01.2008		3,51	-224,4		3885	15,68	280,0	21,54	384,6	490	
	67 ROV	4	C9	hot fluid		363	4,01	-207,4		3990	33,94	606,1	33,61	600,2	530	0
	67 ROV	5	C8	hot fluid		363	2,85	-180,2		7465	40,8	729	44,3	791	540	
	67 ROV	6	C7	hot fluid		363	3,62	-215,2		6336	37,39	667,7	46,74	834,6	560	
	67 ROV	7	B6	hot fluid		363	5,06	-241,2		2203	15,34	273,9	13,74	245,4	540	
	67 ROV	8	B5	hot fluid		363	3,22	-190,8		7593	47,88	855	52,19	932	560	

* max. T range measured in the same orifice
** T sensor failed

Appendix 3

ROV dive protocols

ArcGIS Mapping with numbers below:

1 - pelagic sediment (totally covering seafloor)
2 - rocks (outcropping or blocks)
3 - hydrothermal sediment
4 - hydrothermal crust
5 - active sulfide chimney
6 - inactive sulfide chimney
7 - diffuse venting
8 - bacterial mat
9 - mussle field
10 - single mussles
11 - scarp
12 - fluid sampling
13 - mussle sampling
14 - geophysical instrument
15 - T logger
16 - T mooring

Cruise Number	Atalante Leg 2
Station Number	35ROV
Dive Number	#13
Location	Turtle Pits
Coordinates	4°48.566´S 12° 22.4497´W
Water Depth	2988m
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
9:00:00	Begin Station	
9:39:00	ROV in Water	
10:18:51	Stop at 1013m, pressure drop in Compensator Node 1	
10:19:36	Time check - this computer is 6 seconds behind UTC	
11:11:35	Bottom sighting	
11:13:11	9 m off bottom, not much to see	
11:15:01	Directly in fornt of us is Pinnochio apparently, not visible in science lounge	
11:15:55	Sheet flow, flat topped, striated surface	
11:17:08	Mussels on top of flow, not sure if living or dead	
11:18:08	Mussel beds in Turtle Pits	
11:21:12	Ship 4 48.5696S 12 22.4497, ROV 4 48.562 12 22.415	
11:23:38	Still adjusting winch	
11:24:31	Slowly drifting northward, away from pits	
11:26:46	White balance check on cameras	
11:27:11	Marker 3 in front of us.	
11:27:42	HD an, go south (young man	
11:30:03	HDTV shows no mussels but white mats	
11:30:27	Shimmering water with hydroth. Deposits	
11:31:18	Marker 2, at foot of Two Boats, net fish	HDTV ATA-35ROV_1
11:31:41	Marker partially buried in sulphide talus.	
11:36:02	Flying around smoker looking for a good point to sample	
11:37:36	Strange root-like structure at base of smoker, isolated shrimps swimming around	
11:40:28	Still filming HDTV, Southern tower visible in distance.	
11:41:05	Preparing to deploy beacon	
11:41:18	HDtTV off	
11:47:18	Looking for a place to putr beacon	
11:50:59	On bottom, placing beacon	
11:51:10	HDTV On Seafloor near beacon	HDTV ATA-35ROV_2
11:52:07	HDTV Off	
12:09:08	Trying to place beacon	
12:13:22	Beacon placed at 12 22.418W 4 48.579S fix from Poseidonia now	

12:14:11	HDTV On, fly round of Homer beacon	HDTV ATA-35ROV_3
12:15:15	HDTV Off	
12:17:50	Moving back to Two Boats to take temperature and samples	
12:19:16	Chimney at Two Boats is 6 m high.	
12:24:51	Looking for a sampling position	
12:26:27	Nupsie ab!	
12:26:51	Another try	
12:28:50	Sampling of chimney material not easy, very friable	
12:33:33	carb in sight	
12:33:50	preparing for T measurement => KIPS deployment	
12:35:30	HDTV On Foot of Two Boats smoker (not too exciting, some shrimp)	
12:36:10	KIPS handle in ORION	HDTV ATA-35ROV_4
12:36:28	HDTV Off	
12:38:08	nozzle placed in smoking exit of chimney.	
12:39:57	trying to find a suitable site	
12:44:04	180°C measured max T	
12:44:28	227°C measured max T	
12:45:47	exit widened with nozzle	
12:48:02	nozzle deep in exit 410 Tmax measured	
12:49:25	starting to fill KIPS bottle C9	ATA-35ROV1
12:50:30	HD camera on, KIPS nozzle in Two Boats smoker	
12:51:24	T constant at 407 - 408°C	HDTV ATA-35ROV_5
12:52:42	HD camera off	
12:53:12	pump shifted off	

12:53:51	pumps on bottle C8	ATA-35ROV2
12:54:24	T max measured is 417°C	
12:58:18	pumps off	
12:58:46	T constant at 407 - 408°C	
12:58:59	pumps on bottle C7	ATA-35ROV3
13:03:11	pumps off	
13:03:53	measured T: 400 to 410° currently 412°C	
13:04:20	pumps on bottle B6	ATA-35-ROV4
13:07:43	pumps off	
13:09:12	pumps on bottle B5	ATA-35ROV5
13:10:19	ROV: 4 48.578S 12 22.412W	
13:13:32	pumps off	
13:14:14	pumps on bottle B4	ATA-35ROV6
13:18:53	420°C measured max	
13:19:14	pumps off, KIPS finished, change to Ti-Majors	
13:21:20	HDTV On Two Boats smoker again	
13:21:49	KIPS back in garage; perfect drive	HDTV ATA-35ROV_6
13:22:09	HDTV Off	
13:23:23	handling Ti-Majors, positioning bottle D1	
13:23:30	HDTV On Preparing Ti-Majors deployment in Two Boats	HDTV ATA-35ROV_7
14.01.2008 13:24	HDTV Off	
13:28:12	positioning Ti-Majors nozzle in the same hole as before	
13:30:51	waiting for "clear" water at the fitting of the nozzle tube	
13:36:16	first try to close the valve of D1; probably problems with closing the valve ; probalby fluid was already sampled;current attempt interrupted, new try	
13:38:03	fine adjustment of nozzle	
13:43:11	still positioning the nozzle	
13:47:54	Filling of bottle D1 is finished; not clear whether bottle worked properly	ATA-35ROV7
13:56:23	positioning Ti-Majors bottle D2	
13:58:23	positioning the nozzle auf bottle D2 in the hole	
14:01:28	waiting for "clear" water at the fitting of the nozzle tube; new try	

14:06:32	still positioning the nozzle	
14:07:40	HDTV On Ti-Majors D2 in Two Boats chimney	HDTV ATA-35ROV_8
14:08:23	HDTV Off	
14:09:04	waiting for clear water at the fitting of the nozzle tube	
14:11:20	drop off of bottle D2 from ORION	
14:13:01	successful fishing of the bottle D2	
14:15:02	ORION positions bottle D2	
14:18:12	next try	
14:20:37	looking for locations in the chimney; breaking away some parts of the chimney	
14:26:09	positioning the nozzle auf bottle D2 in the hole	
14:29:37	next try in the same hole	
14:31:23	waiting for clear water at the fitting of the nozzle tube	
14:31:30	HDTV On Ti-Majors in Two Boats again	
14:32:51	not clear whether bubbles inside the fluid or not	
14:33:36	ready to fire: closing of valve D2	HDTV ATA-35ROV_9
14:34:39	sussessful closing of valve of D2	ATA-35ROV8
14.01.2008 14:35	HD off	
14:40:25	positioning of bottle D2 in box	
14:41:15	taking up of S-Moni: attempt to measure temerature in the same hole where Ti-Majors bottle D2 was filled	
14:43:32	starting of T measurement with S-Moni in the same hole	ATA-35ROV9
14:50:30	finishing of T measurement with S-Moni	
14:53:15	KIPS sampling st the same point; bottle A3	
14:57:42	seems that bubbles are present inside the fluid	
15:00:31	posititionig of the KIPS nozzle, breaking some parts away	
15:00:52	HDTV On, 2nd KIPS sampling at Two Boats, Rimicaris sitting in black smoke	
15:01:11	Kipps-Temperatures: 370, 410, 420, 452 °C; 452°C stable	
15:02:16	pumps on	HDTV ATA-35ROV_10
15:03:16	measured T: 451°C	
15:06:35	pumps off	ATA-35ROV10
15:06:40	HDTV Off	
15:07:18	KIPS bottle A2, pump on	
15:07:38	HD was running a while, now off	
15:12:13	pump off	ATA-35ROV11
15:12:48	KIPS bottle A1, pump on	
15:14:41	Temperature decreases, now 427°C	
15:17:03	KIPS pump off, Temp nozzle stays inside for checking temperature evolution	ATA-35ROV12
15:19:58	427-428 °C measured; further positioning for reproducing initial high Temperature (450°C)	
15:20:55	measured 438°C	
15:22:36	476°C	
15:23:05	506°C max T measured!!	
15:24:29	another S-Moni deployment in order to confirm these extemely high T	

15:31:26	S-Moni nozzle deeply inserted into the smoking exit of the chimney	ATA-35ROV13
15:31:40	HDTV On Smoni zoomed in at Two Boats	
15:32:40	HD has been on for a while	HDTV ATA-35ROV_11
14.01.2008 15:34	HD off	
15:36:26	End of S-Moni deployment after 5 minutes	
15:43:01	Deployment of Cu-tube for He-sampling (AA label)	ATA-35-ROV14
15:44:40	HDTV On, He sampling handling	
15:50:08	Cu-tube successfully placed in rigmaster	HDTV ATA-35ROV_12
14.01.2008 15:50	HD off	
15:53:01	funnel of Cu-tube being placed on top of exiting black smoke,	
15:54:02	unexpected chimney collapse	
15:55:53	looking for suitable place to locate the funnel	
15:58:51	HD camera on, He sampling	
15:59:25	black smoke exiting from Cu-tube	
16:00:14	closing Cu tube: top closed	HDTV ATA-335ROV_13
16:01:17	bottom valve closed	
14.01.2008 16:01	HD off	
16:04:24	deployment of second Cu-tube (Label BB)	ATA-35ROV15
14.01.2008 16:05	HD on, Smoke at Two Boats (uninteresting)	HDTV ATA-35ROV_14
14.01.2008 16:07	HD off	
16:09:02	Cu-tube in Rigmaster	
16:10:45	smoke exiting Cu-tube	
16:12:34	upper valve closed	
16:14:12	lower valve closed	
16:24:58	placement of both Cu-tubes into sample box	
16:26:56	next target: taking sulfide rock sample	
16:39:41	some fragments of a sample put into the white plastic box (no sample #)	
16:43:09	attempt to use the net for sulfide sampling	
16:46:27	fishing of very fragile samples with the net	ATA-35ROV16
16:47:53	attempt to use the slurp gun for fishing shrimps	
16:54:00	HDTV On Slup gunning shrimps	
16:54:37	taking up slurp gun with ORION	
16:56:03	positioning the slurp gun for shrimp fishing	
16:59:31	slurp on: rock particles and shrimps visible flushing into the bottle 1	ATA-35ROV17
17:05:03	Another try to catch a big shrimp	HDTV ATA-35ROV_15
17:07:28	Changing to bottle 2, slurp gun on	
17:10:46	visible in bottle2: fragments of rocks, dust, shrimps	
14.01.2008 17:11	HD off	
17:14:50	still slurping; seems not very efficient to catch shrimps	
17:17:18	at least one shrimp visible, swimming in the tube above bottle 2	
17:28:21	slurping rock fragments and shrimps, visible in the tube above bottle 2	
17:33:51	loss of slurp gun from ORION	
17:34:00	finishing of slurp gun fishing for bottle 2	ATA-35ROV18
17:35:21	fishing of the "Schlauchschelle" and dropping into the container box	
17:39:19	Southern Tower in sight	
17:40:09	Leaving the bootom	

Cruise Number	Atalante Leg 2
Station Number	37ROV
Dive Number	#14
Location	Wideawake
Coordinates	4°48.549´S 12° 22.5051´W
Water Depth	2992m
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
9:30:00	Begin Station	
9:39:00	ROV in Water	
11:12:23	Bottom sighting, unsedimented lava, not fresh flow. 12°22,339W 4° 48,618´S.	
11:14:00	HDTV On, Flight over Wideawake field, camera too high and Die Fast in picture	
11:14:54	Going S, mussel beds	HDTV ATA-ROV37_1
11:16:23	Mussel bed,	
11:17:24	Taking close-ups of mussel beds, looking for clams	
11:17:12	HDTV Off	
11:18:03	12 22,338W 4 48,624S ROV Position	
15.01.2008 11:19	HDTV On, mussel bed	
11:21:41	Polyps	
11:26:09	Swimming worms in front of porch	HDTV ATA-ROV37_2
	Fish and mussels	
11:26:21	HDTV Off	
11:29:33	Preparing to place beacon	
11:31:00	Beacon at 12 22,342W 4 48,626S	
11:33:25	Looking at mussels to see if alive or dead	
11:37:26	decide to check around for larger mussel field	
15.01.2008 11:39	HDTV On, mussel bed	
11:43:32	ROV set down, looking for sampling position	HDTV ATA-ROV37_3
15.01.2008 11:44	HDTV Off	
11:49:11	die-fast machine removed from ROV and employed on seafloor	
11:53:00	HDTV On, KIPS sampling of mussel bed	
11:53:22	KIPS measurement14 degree W 12 22.339 S 04 48. 618 to S 04 48.622	HDTV ATA-ROV37_4
11:54:29	HDTV Off	

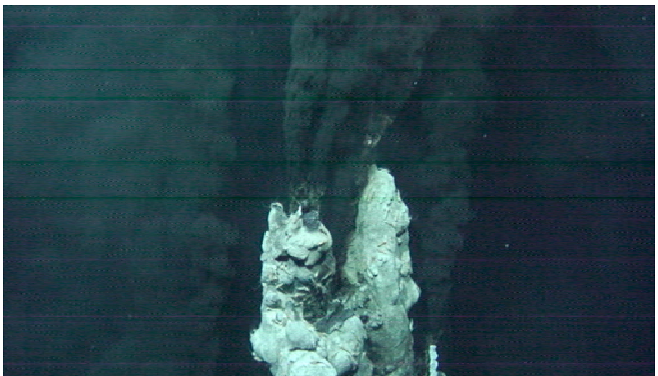
11:54:47	pump is on	ATA 37ROV-1, Flasche C-9
11:57:18	KIPS zwischen 7 und 11 Grad	
11:58:57	pump off	
11:59:21	KIPS pump on, T varies between 4 and 7 degrees	ATA 37ROV-2, Flasche C-8
12:03:19	pump off	
12:04:44	KIPS pump on	ATA 37ROV-3, Flasche C-7
12:05:57	T zwischen 8 und 11 Grad	
12:07:13	for one minute T between 4 and 6 degrees	
12:07:17	pump off	
12:10:45	KIPS pump on, 9 degrees	ATA 37ROV-4, Flasche B-6
12:12:00	HDTV On, KIPS in mussel bed again	HDTV ATA-ROV37_5
12:13:00	HDTV Off	
12:14:15	pump off	
12:14:53	KIPS pump on	ATA 37ROV-5, Flasche B-5
12:16:17	T = 12 to 16 degrees	
12:18:54	pump off	
12:20:00	HDTV On, Close-up of mussels	
12:20:30	HDTV Off	HDTV ATA-37ROV_6
12:23:12	try release 8-channel T lance	
12:29:14	still finding best place to measure with 8 channel lance	
12:31:05	T in channel ranges from 16.7 to 4.4	ATA 37ROV-6
12:32:00	HDTV On, 8-channel T lance in mussel bed	
12:32:43	HDTV Off	HDTV ATA-37ROV_7
12:34:05	lance buried in mussel field for about 1/3, rest is out of water	
12:34:10	announce that measurement will take up to 20 mins	
12:50:53	taking lance from bottom; stop of T measurement,B9 35 min, T max 15°C, at the bottom tip	
12:52:56	next attempt: mussle fishing, use slurp gun	
12:53:37	lance back in garage	
12:56:25	first mussle gripped with ORION	
13:11:44	plan: taking mussles with net, the fishing shrimp for placing into die-fast	
13:13:01	taking of net #3	
13:16:02	trying to fish mussels in net#3	
13:29:31	still trying to fish mussles	
13:40:26	still trying to fish mussles	

13:44:02	successful fishing of a bunch of mussles	
13:46:15	successful fishing of another bunch of mussles into the same net	
13:49:46	drop of net#3 filled with mussles into box	ATA 37ROV-7
13:51:49	new positioning of die-fast	
15.01.2008 13:52	HD on, for taking movies of the diffuse fluid field	
15.01.2008 13:53	HD off	HDTV ATA-ROV37_8
13:54:57	taking the slurp gun	
13:57:26	attempt to slurp shrimps where the diffuse fluid comes out	
14:00:12	first shrimp visible in the tube above the bottle....and finally escaped	
14:01:18	slurping more shrimps	
14:03:12	a slurped mussle is stucked in the slurp nozzle	
14:08:03	attempt to use the slurp gun for picking mussles bunches	
14:11:07	finishing of first shrimp sampling into bottle 1; eventually one shrimp inside	ATA 37ROV-8
14:13:58	new positioning of die-fast on the mussle field with shimmering water	
15.01.2008 14:17	HD on, for taking movies of the die-fast in the mussle bed	
15.01.2008 14:18	HD off	HDTV ATA-ROV37_9
15.01.2008 14:20	HD on	
14:21:20	Opening of die-fast	HDTV ATA-37ROV_10
15.01.2008 14:21	HD off	
14:24:49	new positioning of die-fast on the mussle field with shimmering water, since it was located at that plache where the former mussle sampling with net was performed	
14:28:40	starting to take mussles for die-fast	
14:33:09	try to use the slurp gun for carrying mussles into the die-fast	
14:40:26	finishing of use of slurp gun for mussle fishing	
	notice: all the time gaz bubble visible in the camera observing slurp gun tube	
14:41:57	using ORION for taking bunches mussles	
14:42:54	dropping of first mussles from the same field of before into die-fast	
14:44:43	continuing of dropping mussles into die-fast	
14:48:00	"the pot is full"; closing the lid	ATA 37ROV-9
14:51:30	new positioning of die-fast	
15.01.2008 14:53	HDTV on MUSSELS IN DIE FAST	
15.01.2008 14:53	HD off	HDTV ATA37ROV_11
14:56:35	check if lid of the chamber is closed properly	

15:03:20	DIE-FAST initiated: mussels executed!	
15:25:24	leave this point heading for another mussel field	
15:26:00	HDTV on, flight across Wideawake	
15:30:33	heading: 249°, dense thicket of polyps	HDTV ATA-ROV37-12
15:32:18	sedimented lava flow, likely north of Wideawake	
15:32:30	HDTV Off	
15:34:00	HDTV On, flight back to Wideawake and landing on mussel bed	
15:34:25	heading 140°, search for the mussel bed	
15:38:50	large area covered densely with mussels, 4°48,639 S; 12°22,356 W	HDTV ATA-ROV37_13
15:47:01	new reading: 4°48,639 S; 12°22,343 W	
15:52:05	7,5°C temperature in mussel bed	
15:55:50	HDTV Off	
15:57:00	HDTV On, KIPS in 2nd mussel field	
15:58:16	8-9°C temperature in mussel bed, pump on, filling bottle B4	ATA 37ROV-10
16:00:04	HDTV Off	HDTV ATA-ROV37_14
16:01:02	HD camera off	
16:02:21	pump off	
16:05:02	pump on, 5-7°C, filling bottle A3	ATA 37ROV-11
16:08:19	pump off	
16:08:57	pump on, 6°C, filling bottle A2	ATA 37ROV-12
16:12:46	pump off	
16:14:33	pump on, 9°C, filling bottle A1	ATA 37ROV-13
16:19:26	pump off	
16:25:00	HDTV On, just a mussel bed	
16:25:11	HDTV Off	HDTV ATA-ROV37_15
16:29:00	HDTV On 8-channel T sensor in 2nd mussel field	
16:29:50	measuring with 8-channel T lance, 18° at the tip of lance (C1)	ATA 37ROV-14
16:34:01	hdtv 6ff	HDTV ATA-ROV37_16
16:39:49	end of T lance measurement. T max was 22°C	
16:49:45	lance back in holder	
16:50:10	leaving ground due to low oil pressure	
16:53:07	end of dive	

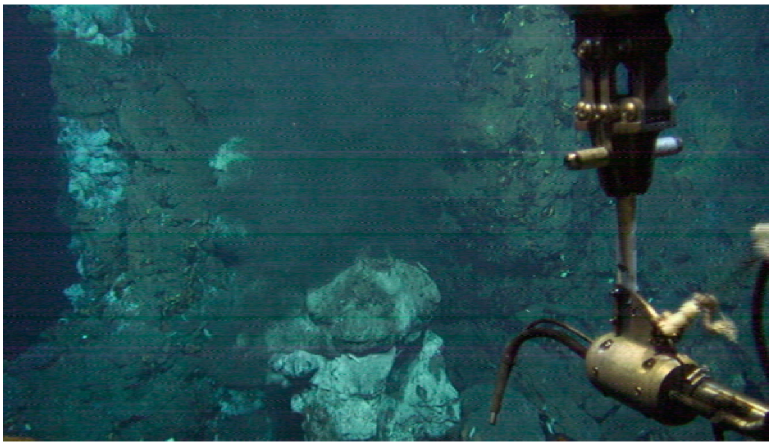
Cruise Number Atalante Leg 2
Station Number 42ROV
Dive Number #15
Location Comfortless Cove
Coordinates 4°48,188´S 12°22,301´W
Water Depth 2996m
Vessel Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
8:00:00	Begin Station	
8:20:00	ROV in Water	
10:48:04	Bottom sighting	
10:51:31	Sheet flow	
10:52:09	Pillows with swediment in gaps	
10:53:08	Lobate flows, flattened pillows	
10:57:25	Hydrothermal deposits	
10:58:00	HDTV On, flight to sister´s peak	
10:58:30	Collapse structures in lava flow, white hydroth. Deposits (mats?)	
11:01:07	Turning to fiund smoker	HDTV ATA-42ROV_1
11:02:45	Lots of old smoker rubble, no active balck smoke to see	
11:03:37	HDTV Off	
11:03:53	Oops, there it is	
11:04:43	Sister´s Peak 4°48,222´S 12°22,270´W	
11:09:39	2nd inactive peak visible	
11:12:32	Waitging for compüuter reboot	
11:15:03	Still sorting computer out, 16m above ground.	
11:17:00	HDTV On, Sister´s peak approach and lower third, wobbly	
11:18:44	Going to make a vertical profile of the smoker, computer problems sorted out apparently	
11:21:23	Hyrothermal rubble	
11:22:14	4 48, 227´S 12 22,272W	HDTV ATA-42ROV_2
11:22:52	Mussels visible inn HDTV and shrimp	
11:24:18	Some shimmering water seen on flanks of structure	
11:25:11	HDTV close-up of shrimps and shimmering water	
11:25:57	HDTV Off	
11:26:39	Adjusting white balance of cameras	
11:31:55	HDTV on, top of Sister´s Peak	
11:33:09	White colour not shrimps, looking with HDTV	
11:34:01	White colour not filamentous, looks like precipitates	
11:43:31	Top of smoker, fantastic view	HDTV ATA-42ROV_3
11:45:03	Sonar computer crashed again	
11:45:56	Chimney 10,3m high	
11:46:56	HDTV off	
11:53:27	HDTV on, top of Sister´s Peak again then descent	
11:55:09	Going to try T measurement at top of active smoker	
12:01:08	Going down and around the chimney	HDTV ATA-42ROV_4
12:03:00	cloud of shrimps chasen from chimney	
12:05:06	about 7m hight, patches of dense shrimps	
12:06:26	HDTV off	



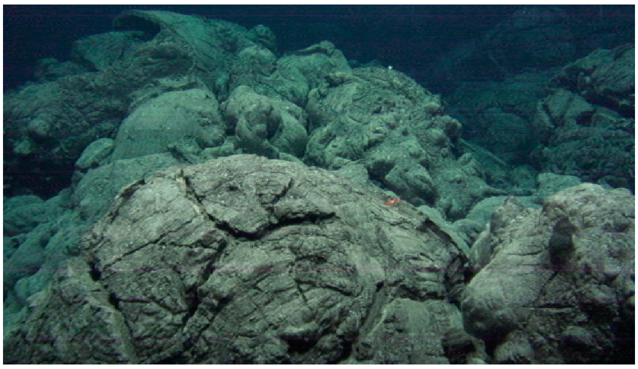
12:07:27	shimmring water, 7m	
12:07:55	HDTV on, slow pan of Sister´s peak summit	
12:10:18	Chimney is from the south side 16m 50cm high	
12:12:57	Looking at dead spire	
12:14:58	Marker 5 looking 345°	HDTV ATA-42ROV_5
12:19:02	looking 227°, in front of small chimney releasing black smoke	
12:20:05	duffuse ouflows and dense shrimps, Bathymodiolus	
12:22:05	HDTV off	
12:43:26	opening at the top of little knob, two chimney pieces on porch	42 ROV-1
12:45:13	computer crashed again	
12:48:15	HDTV on, KIPS foot Sister´s Peak	HDTV ATA-42ROV_6

12:49:19	HDTV off	
12:53:07	220°C, KIPS T Sensor close to orifice	
12:53:50	360°C	
12:57:58	stable 367°C, short-term 370°C	
12:58:31	start to sample with KIPS, water depth is 2996,1 m, ROV parking on talus	
13:00:04	pump on, bottle C9, T stable at 367°C	42 ROV-2
13:04:54	pump off	
13:05:26	pump on, bottle C8, T stable at 367°C	42 ROV-3
13:08:54	pump off	
13:10:34	pump on, bottle C7, T stable at 368°C	42 ROV-4
13:14:52	pump off	
13:16:30	pump on, bottle B6, T stable at 368°C	42 ROV-5
13:20:45	pump off	
	parking the KIPS took longer than anticipated	
13:42:25	HDTV on, parking KIPS	HDTV ATA-42ROV_7
13:43:24	HDTV off	



13:49:24	KIPS handle on porch, cannot move to park position anymore	
14:15:23	prepare to utilize the isobaric sampler	
14:24:49	start taking a sample with the isobaric sampler by opening the valve a full turn	
14:26:42	sample taken	42 ROV-6
14:27:12	closing valve again	
14:55:56	taking Ti-Majors D1 from the box	
15:02:18	trying to positon D1 nozzlet; bad conditions for viewing due to heavy smoke	
15:09:17	positioning of D1 nozzle into exit	
15:11:06	new try	
15:15:51	positoning of D1 nozzlet in exit	
15:17:55	new try	
15:19:07	positoning of D1 nozzlet in exit	
15:22:51	trying to close the valve of D1; problems with closing the valvve; sample was taken, but eventually only filled partly	42 ROV-7
15:25:32	stop with the attempt of sampling with Ti-majors; next step: S-Moni measurement	
15:31:43	dropping of Ti-Majors D1 bottle into the box	
15:32:43	Taking S-Moni from the box	
15:40:32	starting measuring with S-Moni	42 ROV-8
15:46:33	stop T measurement	
15:47:11	looking for another position for S-Moni	
15:53:28	starting measuring with S-Moni at another location as before	42 ROV-9
15:54:40	stop T measurement	
15:56:27	attempt to measure Temp in the same exit with KIPS	
16:06:58	positioning of KIPS in the same exit where second S-Moni measuring was performed	
16:13:42	measured T: max 220°C	42 ROV-10
16:14:44	measured T: max 365°C	
16:16:33	HD on; moving to the top of Sister´s Peak	HDTV ATA-42ROV_8
16:22:58	HD off	
16:30:46	HD on, smoke!	HDTV ATA-42ROV_9
16:31:26	HD off	
16:32:20	HD on, smoker fingers at top SP	HDTV ATA-42ROV_10
16:33:03	HD off	
16.01.2008 16:34	HD on, smoke	HDTV ATA-42ROV_11
16:34:50	HDTV Off	
16:40:22	Deployment of KIPS: nozzle apparently inserted in fluid exit but low T reading ("Badewanne")	
16:45:03	still trying to locate position for Sampling hot fluids	
16:47:38	T sensor of KIPS is faulty: constant readin of 27°C even in background water: plan sample fluids by KIPS	
16:49:06	pumps on filling bottle B5	42 ROV-11
16:51:26	Plan: fill KIPS, fill one Ti-major then proceed towards Golden Valley in order to obtain a basalt sample. Expected time of leaving ground: 17:00	
16:53:50	pump is off	
16:54:41	pumps on filling bottle B4	42 ROV-12
16:58:18	pump off; KIPS sampling finished.	
17:10:01	pumps on filling bottle A3	42 ROV-13

17:13:47	pumps off	
17:13:56	pumps on filling bottle A2	42 ROV-14
17:17:35	pumps off, end of KIPS sampling	
17:30:59	S-Moni deployment in order to obtain Temperature	42 ROV-15
17:33:20	S-Moni measurement finished	
17:42:56	move 20 m North	
17:46:50	HDTV on, pillow hill N of SP	
17:47:38	pillow flow, looking for sampling site	HDTV ATA-42ROV_12
17:51:22	HDTV off	



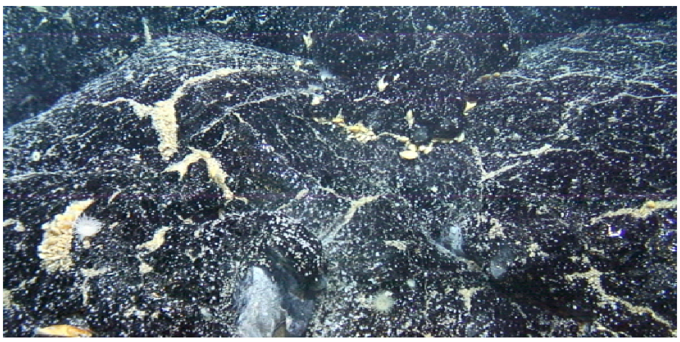
17:58:25	start sampling a piece of lave crust from pillow; 4°48,159 S, 12°22,298 W	
17:59:15	HDTV on, sampling pillow	HDTV ATA-42ROV_13
18:02:38	HDTV off	
18:03:41	small piece of lava collected and placed into sampling drawer at front	42 ROV-16
18:08:24	collecting a second piece, placed in box 3	
18:08:28	ROV off bottom	

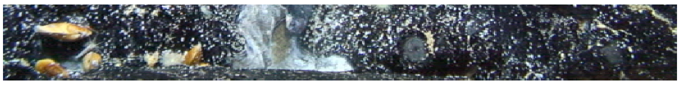
Cruise Number Atalante Leg 2
Station Number 46ROV
Dive Number #16
Location Wideawake & Bturtle Pits
Coordinates 4°48.610´S/12°22.342´W
Water Depth 2987m
Vessel Atalante

Metadata	**Observation**	**Actions**
Timecode default	allowed	allowed
8:15:00	Begin Station	
8:25:00	ROV in Water	
9:43:47	533m	
10:06:05	1300m	
10:27:57	1600m	
10:44:53	2160m	
11:04:28	2800m	
11:08:51	seafloor in sight; ROV 2958m 22 m over ground, some high structure visible	
11:10:15	4°48,620'S 12°22,353'W	
11:11:34	Target find homer beacon, sonar on	
11:12:23	jumbled flow some mussle patches	
11:15:35	homer beacon found	
11:16:50	next action: take mussle sample from this site	
11:18:55	suitable site for mussle sampling located	
11:19:49	HDTV On, mussel patch in Wideawake	HDTV ATA-46ROV_1
11:20:48	HD off	
11:21:16	HDTV On, snails in mussel patch at Wideawake	
11:21:22	sonar off	HDTV ATA-46ROV_2
11:22:06	HD off	
11:24:51	Orion takes bio net (no lable) in claw	
11:25:54	HD on, unsuccessful mussel sampling at Wideawake	
11:29:27	Need to change bionet position in claw	HDTV ATA-46ROV_3
11:29:49	HD off	
11:31:08	orion manoever successful	
11:31:01	HDTV on, SUCCESSFUL MUSSEL sampling	HDTV ATA-46ROV_4
11:33:42	HDTV off	
11:33:57	bionet sampling completed	ATA-46ROV-1
11:37:52	shimmering water and mussle beds	
11:38:14	heading 110, search for lava flow front to the east	
11:38:58	jumbled flow	
11:39:50	reached flow front of 2002? Flow, lobate	
11:40:09	HD on, flying east 110 heading over fresh flow	HDTV ATA-46ROV_5
11:43:04	HD off	
11:43:19	4°48,612'S 12°22,316'W, lobate flow	
11:44:47	HD on, flying over contact and then into old sedimented flow	
11:45:50	strong sediment cover here, older flow	
11:46:42	turn heading to 270 to investigate contact	HDTV ATA-46ROV_6
11:47:47	HD off	
11:47:34	collapse structure	
11:48:19	HD on of contact young flow to older flow looking south; older flow east and young flow to the west.	HDTV ATA-46ROV_7
11:49:56	HD off	
11:50:23	4°48,612S 12°22.295'W location of contact and sampling	
11:50:50	HDTV On, young flow to sampling of old flow	
11:51:29	HD on without thrusters	
11:51:52	ROV being pulled to the back, thrusters on	HDTV ATA-46ROV_8
11:53:19	found nice spot to take basalt sample. Overhang of older lava flow. The younger flow is located in the collapse structure of the older flow. Apparently utilizing the pre-exsisting lava tube drainage system.	
11:53:30	HDTV Off	
11:54:25	HD on, sampling old flow with Rigmaster	
11:57:45	sample in Rigmaster claw, 4°48,612S 12°22.295'W, 2985m	ATA-46ROV-2
11:58:04	HD off	HDTV ATA-46ROV_9
11:59:39	working with orion in order to place sample into sample box	
12:09:07	relocating for restarting mapping procedures	
12:19:08	proceeding towards south	
12:20:16	back in fresh glassy lobate flow	
12:20:40	HDTV On, flight over new flow	
12:20:44	crossing from older to younger flow	
12:21:05	just passed across the mapped (ABE) island of older lava	
12:21:59	flyiing over fresh lobate 2002 flow	
12:23:29	contact to lightly sedimented lava flow 4°48.660 12°22.293'W	
12:24:47	back in fresh glassy lobate flow	HDTV ATA46ROV_10
12:25:52	very nice fresh luster on young lobate flow	
12:28:30	ROV flying to the south for a while. Ship needs to follow up.	
12:29:44	moved 140m south from sample 46ROV-2. Depth: 2984m	
12:30:38	still flying over fresh lobate lava flow	
12:32:46	Continue flying to the south. Stll young lava flow.	
12:33:12	HD off	
12:34:13	HDTV On, southern boundary of flow with skylights in old flow	
12:34:18	Contact 183 m from last sampling, turning W to check surrounding	
12:35:47	the older sheet flow is highly sedimented, collapse structure in sight	
12:36:46	sonar off	
12:37:21	checking out collapse structure, very nice pillar 4°48,717'S 12°22.290'W	

12:39:05	great view of pillar structures! Text book example!	HDTV ATA-46ROV_11
12:40:22	Is the tube flow filled with rubble or younger jumbeld flow? Difficult to make out.	

12:41:15	Flying to the east heading 90	
12:41:57	HD still on	
12:42:18	Flying quickly to the east (0.4 kn)	
12:43:17	back into older sedmineted lava flow at 64 m distance from the collapse structure examined	
12:43:54	HD off	
12:47:53	moving north now, heading 10	
12:49:10	back in fresh glassy lobate flow	
12:49:53	flying across contact, young lobate lava flow overlying older, more sedimented jumbled flow	
12:50:51	Flow front apparently shifitng estwards.New hHeading 10 to 20	
12:51:57	small embayment of older lava flow ("Wideawake flow")	
12:52:20	HD on, old flow	
12:53:06	fresh young lobate lava from with glasy luster	
12:53:31	nice plastic deformation texture	HDTV ATA-46ROV_12
12:54:25	crossing from older to younger flow; locallized embayment. This serated nature of the contact indicates that we are really close at thr eastern flow marign	
12:54:49	HD off	
12:56:10	Another contact; superbly explosed! Older flow is jumbled with pronounced hummocky structure. Younger flow is flowing around this structure. Displace nice ropy, floded flow top structure, locally.	
12:57:03	HDTV On, young flow and eastern contact to Wideawake flow	
12:59:40	Returning to contact location in a wider turn to the south	HDTV ATA-46ROV_13
13:01:30	HDTV Off	
13:04:20	back at superb contact site, trying to obtain a sample of the older jumbled flow. It maywell be the wideawake flow (ie., the stuff the the mussles are growing on). However, this is may as well be an independant flow.	
13:06:44	4°48,656'S 12°22,265'W; 2983 m	
13:08:35	sampling operations started with Orion	
13:10:25	Basalt piece placed in Box 1 of sample sledge. Older jumbled flow sampled	ATA-46ROV-3
13:11:40	Heading north, measuring distance fron this sampling site	
13:13:07	back in fresh glassy lobate flow	
13:13:28	very nice flow top structures	
13:13:44	Another contact: local empayment of old jumpled flow.	
13:14:35	back in fresh glassy lobate flow	
13:15:49	Another contact, local embaymnet of older jumbeld flow.	
13:16:12	back in fresh glassy lobate flow	
13:16:24	lobes on flow top are aligned in N-S direction.	
13:19:18	Impressing lava tube structures. 83 m from last sampling site. 4°48.606'S 12°22.275'W	
13:20:18	Heading N on to of the older sheet flow, heavy sediment covering, local collapse structures.	
13:21:16	Aiming for Turtle Pits beacon.	
13:27:13	contact fresh lava	
18.01.2008 13:28	HD on, west over new flow until a diffuse field found east of Wideawake boundary (i.e. on young flow)	HDTV ATA-46ROV_14
13:32:54	HDTV Off	
13:33:09	cluster of yourg mussles at the top of fresh lavas, at S4 48.632S W12 22.331; dusty water, not shimmering	
13:37:07	aim to inestagate mussle cluster; looking for small species	
13:39:27	attempt to use slurp gun for small mussles	
13:43:44	taking slurp gun	
18.01.2008 13:45	HD on, slurping larger mussels	
13:45:43	starting to slurp small mussles into bottle 1	ATA-46ROV-4
13:50:34	slurp gun back to garage	HDTV ATA-46ROV_15
13:50:42	HDTV Off	
13:51:45	attempt to look in detail for the mussle field nearby	
18.01.2008 13:51	HD on, zoom in on small mussel site	
13:56:06	attempt to zoom in with HD to check whether the whitish structures visible are really mussles	
13:57:28	taking slurp gun	HDTV ATA-46ROV_16
13:58:36	Slurping young, small mussles into bottle 2	ATA-46ROV-5





14:04:03	HDTV Off	
14:05:58	dropping of slurped mussles into front slit near IB sampler of the box; same smple# as a above. INCLUDES basalt glass chips (some appear to have also dropped into box 1)	
14:08:06	finishing slurp gun sampling;aim to fly to Turtle pits	
14:10:48	next step: finding Wideawake beacon	
14:16:06	attempt to get posidonia data failed	
14:17:10	got signal from beacon	
14:19:18	got signal from Turtle Pits beacon: 180m away, heading 305	
14:23:08	Posidonia is running again	
14:25:53	fresh young lobate flow above older lava ; 4° 48.606S 12° 22,369W	
14:26:42	heavy sediment cover	
14:27:12	jumbled flow	
14:27:33	minor sediment cover	
14:28:30	old smoker in sight	
14:30:18	Turtle pits beacon in sight	
14:35:05	Southern Tower? in sight	
14:37:36	Two boats in sight	
14:47:01	moving ship	
14:57:40	attempt to find smoker	
14:59:22	smoker in sight, two boats?	
15:01:11	marker in sight;	
15:11:02	waiting for the final ship position	
15:16:11	still waiting for the ship	
15:17:00	finding marker 2, the position where fluid samples from first day were taken	
15:23:02	found lot to park ROV, 4°48.577S and 12°22.412 W	
15:28:07	artificial hole of T measurement from first day still smoking away	
15:32:53	preparing to release the tube = IB sampler	
15:42:04	problems to release the tube	
15:46:47	handing over the tube to the rig master	
15:54:33	little chimney has grown already on the new outlet, broken off to place the tube, will attempt to pick up later	
15:56:48	tube apparently place properly	
16:01:32	after new grip on tube with rig master, tube now placed onto vent	
16:07:46	problems to open valve, also funnel no more over vent.	
16:13:00	HDTV On IB-Sampler	HDTV ATA-46ROV_17
16:13:24	HDTV Off	
16:13:28	tube turned so that opening the valve will be easier	
18.01.2008 16:14	HD on, IB sampler at Two Boats	
16:15:30	opening valve! Of IB samples.	ATA-46ROV-6
18.01.2008 16:15	HD off	HDTV ATA-46ROV_18
16:16:30	closing valve	
16:20:00	rigmaster has released the IB sampler	
16:25:45	placing IB sampler into drawer	
16:27:53	KIPS fiever measurement is being prepared	
16:33:19	KIPS is out of garage	
16:33:20	HDTV On, KIPS at Two Boats	HDTV ATA-46ROV_19
16:34:00	HDTV Off	
16:36:52	T = 412°C	
16:37:12	T = 370°C	
16:41:18	T = 380°C	
16:48:55	announcement that T-sensor of nozzle ripped off	
16:51:19	KIPS inlet and T nozzle have been twisted during search for hot fluid exit	
16:57:54	Filling bottle C9, 180°C measured but sensor about 2 cm displaced from nozzle	ATA-46ROV-7
17:00:45	pumps off	
17:01:52	pumps on, bottle C8	ATA-46ROV-8
17:04:32	stopped filling of bottle C8. Not enough fluid discharging from KIPS exhaust.	
17:06:11	interuption of KIPS sampling, potentially nozzle is blocked	
17:14:16	nothing much happening	
17:17:41	leaving current sampling site	
17:19:20	HDTV On, black smoke, nothing else	
17:19:40	looking at top of two boats smoker	HDTV ATA-46ROV_20
17:20:11	>HDTV Off	
17:22:03	or is it southern tower?	
17:24:25	looking for a suitable orifice	
17:26:16	KIPS deployment	
17:32:09	looking for a suitable orifice	
17:36:39	T measurement by KIPS sensor at intensely discharging orifice. Abandoned.	
18.01.2008 17:39	HD on, bent KIPS	HDTV ATA-46ROV_21
18.01.2008 17:40	HD off	
17:47:59	reapproaching orifice, T measurement?	
17:51:58	KIPS away from orifices	
17:52:18	new attempt	
17:55:20	KIPS T sensor in orifice (max T measured is 300°C... But this is not the discharge T, T sensor not properly inserted in orifice).	
17:58:06	end of dive. Leaving bottom.	
NOTE ADDED	chimney fragment from Southern Tower in the back of ROV - sample number assigned after dive	ATA-46ROV-9

Cruise Number Atalante Leg 2
Station Number 50ROV
Dive Number #17
Location Inside Corner High #1
Coordinates 5°05,3771´S 11° 39,393´W
Water Depth 3403m
Vessel Atalante

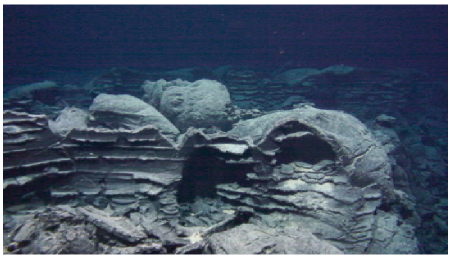
Metadata Timecode default	**Observation** allowed	**Actions** allowed
9:30:00	Begin Station	
9:40:42	ROV in Water	
11:08:16	2700 m	
11:25:53	20m above bottom 5°05.451 S; 11°39.300 W	
11:29:15	bottom sight	
11:30:49	heavily sedimented	
11:32:56	start traverse with heading 252°	
11:40:00	HDTV on, prawn on sedimented seafloor	
11:41:08	HDTV off	HDTV ATA-50ROV_3
11:42:00	HDTV On, strange slug	
11:47:47	HDTV Off	HDTV ATA-50ROV_5
11:47:35	HDTV on, 5°05.522S; 11°39.428W, still only sediment	This video is not present
11:53:24	HDTV off	
11:59:07	sonar shows solid structures in the distance	
11:59:25	large boulders, ? Talus; 5°05.524S; 11°39.468W, near WP 1, 3390 m	
12:04:48	trying to get a better picture of the rocks, also waiting for the ship	
12:06:45	waiting for ship	
12:15:28	continue traverse with direction 252°, sedimented area	
12:17:52	more boulders, 5°05,545S; 11°39.508W, 3356 m	
12:18:54	slope steepens now	
12:21:19	reaching foot of the slope at 3320m, start measuring the distance	
12:23:59	3300m water depth	
12:25:06	more large blocks and plenty of sediment	
12:28:46	large boulders	
12:31:40	more blocks, 3230m depth, 5°05.620S; 11°39.624W	
12:38:29	Large boulder, 3207 depth	
12:41:45	sediment	
12:42:03	boulder, looking for suitable spot in order to take a rock sample	
12:42:46	steep hill side, highly sedimented some blocks sticking out of trhe ground	
12:48:24	suitable rock in sight. 5°05.610'S 11°39,658'W, 3143m	
12:52:36	sompling of this particular fragment abondoned	
12:53:50	proceeding towards 270	
12:55:21	new sampling target locallized	
12:57:40	proceeding a little further to the west	
12:59:05	more large blocks and plenty of sediment	
13:02:14	shift change of ROV pilots	
13:07:29	more large blocks and plenty of sediment	
13:08:16	3110m 5°5,618S 11°39.753W	
19.01.2008 13:10	HD on, boulders in sediemtn	
19.01.2008 13:11	HD off	HDTV ATA-50ROV_7
13:12:24	sampling initiated	
13:19:06	sampling abandoned	
13:19:45	continue heading 270. bolders and sediment.	
13:22:59	another go at sampling	
19.01.2008 13:24	HD on, sampling	
13:25:32	HD off	HDTV ATA-50ROV_8
13:26:05	Sampling was successful! Sample: looks like breccia with thick layer of solidified foram ooze. 5°05.622S 11°39.764'W. 3094m	ATA-50ROV-1
13:29:58	proceeding to the W. Still large boulders and sediment.	
13:34:10	more large blocks and plenty of sediment	
13:35:56	sediment	
13:36:03	blocks	
13:36:22	big blocks	
13:37:05	steep rocky cliff, in-situ rocks?	
19.01.2008 13:38	HD on, flight over boulder field	
13:38:41	terrace full of sediment	HDTV ATA-50ROV_9
13:39:09	5°05.647'S 11°39.831W 3013M	
19.01.2008 13:39	HD off	

13:40:23	proceeding towards 242, boulders and sediment.	
13:41:09	sediment	
13:41:43	3000 m, sediment	
13:41:58	sediment and boulders	
13:44:31	sediment and boulders. Heading 246, try to find another sample	
13:48:07	sediment and boulders. 2960m	
13:52:12	try to take sample	
19.01.2008 13:57	Hd on, sampling attempt	HDTV ATA-50ROV_10
19.01.2008 13:58	HD off	
14:01:40	sampling abandoned	
14:01:53	still slope with abundant blocks and sediment	
14:06:52	HD on, capture a panoramic view of the slope	HDTV ATA-50ROV_11 (Timemarks wrong on video?)
14:07:52	HD off	
14:30:44	2875m depth	
14:36:35	trying to collect a sample	
14:44:00	sediment and boulders	
14:49:40	still trying to sample. 2842m.	
14:50:34	sampling abandoned	
14:52:51	sediment and boulders	
19.01.2008 14:53	HD on, boulders on slope	
19.01.2008 14:54	HD off	HDTV ATA-50ROV_12
15:01:36	trying to take sample	
15:02:17	2810 m 5°05.728'S 11°40.016'W	
15:07:15	sampling abandoned	
15:08:26	very steep slope, big blocks	
15:09:51	investigating blocks	
15:11:05	proceeding heading 272	
15:11:41	sediment on slope	
15:11:53	heading 290	
15:13:45	5°05.746'S 11°40.045'S 2775 m, ROCK FACE striking N-S	
15:14:44	investigating outcrop: black rock with 10s of cm wide vein running parallel (NO. The white stuff is sediment.) and vertically across the outcrop	
15:13:30	HDTV On, big rock face and then nothing	
19.01.2008 15:16	HD has been on; now switched off	HDTV ATA-50ROV_13
15:16:53	wall is not really high, flying over	
15:17:05	HDTV on, massive rocks	
15:17:31	trying to grab a particular sample (knobly clast on a cliff poarch) with the rigmaster!	
15:24:48	sampling SUCCESSFUL. Round knobbly sample placed on poarch. Size ca. Rigmaster claw.	ATA-50ROV-2
15:27:58	HD is on and has been on for a while	
15:30:23	moving up the flank of the cliff, starting at 2783.6 m	
15:30:57	passed fantastic deed sea corals (hydrozoan) living at the cliff edge	
15:31:39	2768.8m Still moving up.	
15:32:00	2767.5m Total of 16 m for the cliff.	HDTV ATA-50ROV_14
15:33:17	Reached peak of a MEGA-BLOCK. Hence sample take was not in-situ.	
15:34:13	Flying around cliff peak.	
15:35:39	Examining cliff surface: striation are recognizable. HD still on.	
15:37:00	Moving closer.	
15:38:14	Rock type: Gabbro	
19.01.2008 15:38	HD off	
15:38:54	Examination finished. Progressing dive.	
15:39:40	Cliff top colonized by Hydrozoan	
15:40:32	Flying across sedimneted cliff surface	
15:44:33	very steep slope, heavily sedimented, abundant ripple	
15:45:29	Sedimented terrace, 2772m	
15:45:56	Still heading towards the west. 251	
15:48:07	waiting for ship	
15:49:39	Moving to the west, 250, sediment and boulders	
15:54:33	sediment and boulders	
15:55:47	Large boulder (size range: several m to 10s of meters) field, massive blocks, clast-supported.	
15:56:59	5°5.796'S 11°40.140'W; 2730m	
15:59:03	still large boulder field	
16:02:35	trying to take sample	
16:10:00	Huge slabby blocks, interlocking	
16:11:32	Steep cliff face of large block	
16:12:27	reached sedimented top of cliff	
16:13:02	Observation: In the lower portion of the dive investigated earlier the blocks were rounded (reminicent of "Wollsack Verwitterung"). In contrast, in this area up here the blocks are slabbx with sharp angular outlines.	
16:16:06	2700m	
19.01.2008 16:17	HD on, landing in sedimented talus	
16:17:35	Preparing for taking a sample from a local scree slope	HDTV ATA-50ROV_16
19.01.2008 16:17	HD off	

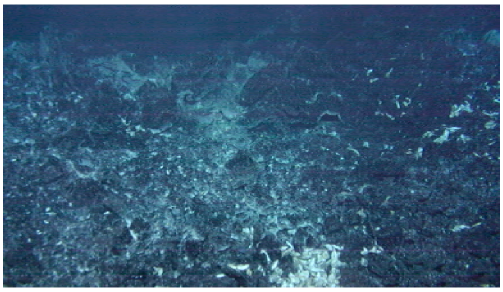
16:21:56	sample placed in box 1 (smaller than sample ATA-ROV-1) This sample is black an shiny and may be a glassy blast crust or a Mn-crust	ATA-50ROV-3
16:23:28	5°05.830'S 11°40.170'W 2696 m. About 100m away from WP2	
16:24:21	Second sample from this location placed in box 2.	ATA-50ROV-4
16:28:29	sediment and boulders. Proceeding to W 268	
16:29:54	giant scree field.	
16:30:05	HD on.	No film
16:31:54	HD off	
16:32:39	Preparing for taking a sample from a local scree slope	
16:32:56	Rigmaster	
16:33:59	sample in rigmaster!	
16:34:58	sample with white crust, angular clast, lying on Orion side of poarch	ATA-50ROV-5
16:35:53	5°5.815'S 11°40.191'W 2670m	
16:36:48	Progressing to the west. Heading 256	
16:37:55	sediment and boulders	
16:39:32	traveling up the slope	
16:41:03	Blocks have grey surfaces, some banding perhaps visible.	
19.01.2008 16:41	HD On, boulder	HDTV ATA-50ROV_17
16:43:11	Was that banding or sediment? Not sure.	
16:43:18	HDTV Off	
16:45:00	Lots of boulders which are flat, angular. Dickbankig is the expression	
16:47:34	Still large, flat blocks,	
16:48:53	These boulders are loose - can see collision marks between them	
19.01.2008 16:51	HD On, looking for sampling site, small talus	HDTV ATA-50ROV_19
16:52:40	Attempting sampling	
19.01.2008 16:53	HD Off	
16:55:45	Got sample, black surface top and bottom, brown fracture surface on side, placed in rear big compartment 5°S05,824 ???? Depth??	ATA-50ROV-6
17:01:16	11 39,525 5 06,510??? Posidonia problem??	
17:02:26	5 05,840 11 40,289 is perhaps good fix	
17:05:43	Boulder field	
17:06:03	All joint surfaces look to dip OUT of teh slope - i.e. Towards the east, perhaps also slightly to the S	
17:07:35	Blocks becoming more plate-like	
17:08:47	Looking at a place which looks like slickensides	
19.01.2008 17:09	HD on, big gabbro boulder	HDTV ATA-50ROV_20
17:10:31	Günter is sure it is slickensides	
17:10:53	HD Off	
17:16:00	HD Off already	
17:18:16	Facing block, steady. Going to sample	
17:22:19	Getting a sample. 5 05.827S 11 40.311W 2555m	ATA-50ROV-7
19.01.2008 17:28	HD On, in situ gabbro wall	HDTV ATA-50ROV-21
17:29:08	Wall strikes 340°	
17:30:10	Looking to find strike and dip of structures	
19.01.2008 17:31	HD Off	
17:32:25	5 05.833S 11° 40,372 2484m end of dive, coming up	
during coming up:	the last wall shows a height of ~ 150 m, monitored by sonar; strike: 330°	

Cruise Number	Atalante Leg 2
Station Number	52ROV
Dive Number	#18
Location	Golden Valley & Red Lion
Coordinates	4° 48.102´S 12° 22.286´W
Water Depth	2992m
Vessel	Atalante

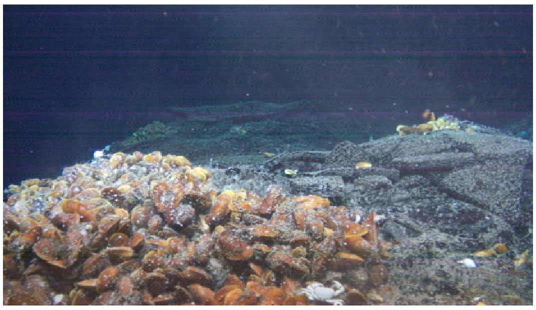
Metadata Timecode default	**Observation** allowed	**Actions** allowed
9:00:00	Begin Station	
10:00:00	ROV in Water, problem with Posidonia signal in van, changing cables out whilst diving to 1000m	
11:27:20	2473m	
11:35:28	New plan for the dive: Locate golden valley without Posidonia positioning signal. Return ROV on deck immediately after sampling in order to fix this problem on deck.	
11:38:14	2820m	
11:42:34	seafloor in bottom sonar	
11:43:58	seafloor in view: 2990 m	
11:44:28	sedimented sheet flow with intense laminar striations	
11:45:10	search for Sisters peak chimney structure using the sonar	
11:45:55	great view of sedimented sheet flow plain	
11:47:23	turning vehicle at 60 degrees intervals in order to locate smoker in the sonar	
11:52:30	positioning ROV several m above the ground in order to pick up Sisters peak in the sonar	
11:59:57	sonar shows structure that may represent Sisters Peak in the SW. Hence Golden Valley should be towards the north. Plan: Dive to the north	
12:02:26	returning to seafloor	
12:03:01	round circular patches and larger domains filled with sediment on top of sheet flow	
12:04:08	turning vehicle around: Large sheet flow plain	
12:04:36	HDTV On, flght over pillows	HDTV ATA-52ROV _1
12:04:37	moving northwards	
12:04:56	hummocky structures	
12:05:27	contact of sheet flow to overlying pillow flow.	
12:05:55	climbing up pillow flow front	
20.01.2008 12:06	HD off	
12:07:58	very nice pillow flow morphologies, minor sediment in interstities	
20.01.2008 12:08	HD on, volcanic flight and first mussel patches	
12:10:33	mussels! Dead ones...	
12:11:37	trying to follow the "mussle gradient"	HDTV ATA-52ROV_2
12:12:02	living mussles and shimmering water!	
12:12:53	HD Off	
12:14:10	still trying to locate the valley. Low mussle density	
12:15:01	there is the fracture/valley!	
12:15:17	HDTV, flying south in volcanic fissure	
12:15:53	HD on flying southwardthis is the fissure of a major lava flow eruption, passing site of sheet flow emmissions	
12:18:02	great volcanic morphology	



12:18:52	multiple sheetflow tops and lava tube structures	HDTV ATA-52ROV_3
12:20:07	HD still on, "Grand canyon-like" views	
12:24:56	some dead mussle on fissure floor	
12:25:26	HD Off	
12:26:05	plenty of crabs! Sitting on pillows	
20.01.2008 12:26	HD on, lots of mussel patches in valley, most look dead, shimmering water everywhere (looks like activity is waning, far rewer mussels living now than shells lying around.	
12:27:32	abundant polyps around the mussle beds. Very similar situation to Wideawake.	
12:29:05	abundant dead mussles	
12:29:52	following large patches of dead mussles	
12:30:29	abundant dead mussles	
12:31:24	shimmering water around. BUT no live mussels near shimmering water. Too hot?	



12:32:06	still abundant mussles. This is no longer a valley structure. Difficult for orientation. Following towards the south.	
12:33:54	abundant dead mussles	HDTV ATA-52ROV_4
12:34:18	abundant shimmering water emmitting from interstices of lava lobes.	
12:35:03	We crossed the souther margin of the pillow flow. Jumbles lavaflow morphologies are abundant. ROV touched the ground=> lava sample of sheet flow sitting on poarch.	
12:35:41	Abundant hot water emmitting from the seafloor. Becoming more intense: Foggy. However, no macrofauna.	
12:36:37	Sheet flow top, lightly sedimented.	
12:38:01	NO more shimmering water. Some (minor) dead mussles.	
12:38:43	Bach in more active region progressing towards the east. Fissure reappears.	
12:39:39	Again abundant dead mussle patches and shimmering water.	
20.01.2008 12:40	HD off	
12:40:29	Lifting ROV up into the water column in order to locate Sisters Peak using the sonar.	
12:50:03	returning to seafloor	
12:50:23	Landed on abundant mussle beds alive and dead mussles + shimmering water	
12:51:13	abundant lliving mussles!	
12:51:56	passing over steep cliff	
12:53:01	floor of fissure colonized by some mussles	
13:00:12	pilot change, biologists resign to idea to sample whatever they get because orientation remains difficult without Possidonia	
13:08:31	plan to take Ti-majors once find fluid vent	
20.01.2008 13:17	HD on, mussel patch	
20.01.2008 13:20	HD off	HDTV ATA-52ROV_5
20.01.2008 13:21	HD on, more mussels	
13:24:29	HD off	HDTV ATA-52ROV_6
20.01.2008 13:29	HD on, polyp close up	
20.01.2008 13:30	HD off	HDTV ATA-52ROV_7
20.01.2008 13:30	HD on, shrimp feeding	
13:31:05	HD off	HDTV ATA-52ROV_8
13:32:53	diffuse fluid vent over entire area, trie to measure now T at margin of the mussel field with 8 channel lance, but difficult to find proper landing place	
13:48:27	searching for a proper sampling spot according to KIPS temperature readings. Current readings are in the 2-5 degree C range	
13:55:06	T 3-3.5°C and one time 5°	
13:56:40	T = 6.9°C!	
13:57:26	T = 8.6°C	
13:59:38	KIPS pump on, bottle C9, T = 8.9°C	52 ROV-1
14:00:01	HDTV On, view over mussel field whilst sampling	
14:00:23	HDTV Off	HDTV ATA-52ROV_9



14:03:35	pump off	
14:04:08	KIPS pump on, bottle C8, T = 8.6°C	52 ROV-2
14:08:40	pump off	
14:09:13	KIPS pump on, bottle C7, T = 8.5°C	52 ROV-3
14:12:38	pump off	
14:13:10	KIPS pump on, bottle B6, T = 8.9°C	52 ROV-4
14:15:45	HDTV On, view over mussel field whilst sampling	
14:17:27	pump off	HDTV ATA-52ROV_10
20.01.2008 14:17	HD off	
14:20:04	KIPS pump on, bottle B5, T = 8.0°C	52 ROV-5
14:24:07	pump off	
14:24:45	KIPS pump on, bottle B4, T = 8.3°C	52 ROV-6
14:28:02	pump off	
14:28:43	KIPS pump on, bottle A3, T = 7.8°C	52 ROV-7
14:33:28	pump off, T = 8.0°C	

14:34:42	remove nozzle from site and return it again for a second set of fluid samples	
14:36:52	KIPS pump on, bottle A2, T = 8.8°C	52 ROV-8
14:41:08	pump off	
	Site is called "Clueless Site"	
14:41:51	KIPS pump on, bottle A1, T = 8.8°C	52 ROV-9
14:46:27	pump off, T remained constant between 8.5 and 8.8°C	
14:47:09	next task will be the 20 minute 8-Channel temperature measurement	
14:55:07	start deployment of the 8-Channel T-Logger	
15:09:10	8-Channel T-logger in position, start measuring for 20 minutes, T-max 6°C	52 ROV-10
15:35:48	stop of T-measurement	
15:36:32	next step: fishing mussles for Nicole	
15:37:50	8-Channel T-logger back in garage	
15:42:41	taking net # B	
15:51:39	fishing mussles into net # B	52 ROV-11
15:53:22	drop of of net # B into box 1	
15:55:25	opening of of lid from plastic box	
15:58:54	taking rock sample covered with bio; sample broke; only small fragments placed into plastic box with lid; no sample number	
15:58:58	taking another rock sample covered with bio, attempt failed	
16:04:09	tainkg the shovel for taking a rocks sample	
16:11:54	HDTV On, tin-panning for rocks	
16:12:15	taking rock fragments with shovel; surface covered with bio; placing into plastic box	52 ROV-12
16:13:19	HDTV Off	HDTV ATA-52ROV_11
16:28:21	taking a second rock sample with shovel, surface covered with bio; placing into plastic box; same sample numer	
16:35:26	attempt to place a bio net as marker;	52 ROV-13
16:47:52	taking the Ti Majors which was lost from porch during operation for rock sampling	
16:52:29	HDTV On, lookng for somewhere to drop net	
16:57:35	HDTV Off	HDTV ATA-52ROV_12
17:00:56	HDTV On, bionet on seafloor	
17:01:14	placing the bio net as marker; marker gets a sample number	52 ROV-13
20.01.2008 17:02	HD off	HDTV ATA-52ROV_13
17:03:44	sampling location was on the eastern flank of a fissure; a sheet flow is visible not covered with mussles	
17:03:51	attempt to fly some 100 meters in the direction of "Sisters Peak"; 350° heading; some 100 meters with the aim to find to sisters peak	
17:07:23	lobate flow associated with sheet flow	
20.01.2008 17:07	HD on, for the whole flight N across lava lookng for Sister´s Peak	
17:10:28	80 m from start of traverse	
17:11:24	very massive flow of lobates/pillows without bio	
17:13:51	water seems to get smoky	HDTV ATA-52ROV_14
17:14:15	looking around if smokers are visible	
17:17:07	big sediment carpet	
17:17:33	HDTV Off	
17:17:20	HDTV On, more flight over seafloor and looking for S.P.	
17:19:24	HDTV Off	HDTV ATA-52ROV_15
17:20:08	end of dive	

Cruise Number Atalante Leg 2
Station Number 57ROV
Dive Number #19
Location Turtle Pits#3
Coordinates 4°48,558´S 12°22.463´W
Water Depth 2989m
Vessel Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
9:00:00	Begin Station	
9:36:00	ROV in Water	
11:03:43	Bottom sighting	
11:14:35	ABE dive weight	
11:19:27	Turtle Pits	
11:24:14	A smoker is visible, not clear which one it is.	
11:30:34	AT southern tower, making HD film as some bubbles coming out	
11:34:33	Looks like venting vapour on side of southern Tower	
11:37:00	HD did not want to work	
11:37:31	Moving to Two Boats	
11:40:38	Slowly moving to Two Boats	
11:42:17	Marker 2 found	
11:43:11	HD On, flying around Two Boats	HDTV ATA-57ROV_1
11:48:18	HD Off	
11:55:27	HD On, landing base of Two Boats	
11:56:07	HD Off	HDTV ATA-57ROV_2
11:59:29	HD On, base of Two Boats	
12:00:19	HD Off	HDTV ATA-57ROV_3
12:03:40	HD On, shrimps and fluid at base of Two Boats	
12:04:57	want to meassure temp.	HDTV ATA-57ROV_4
12:05:15	HD off	
12:05:36	HD On, small smoker with shrimps	
12:05:56	HD Off	HDTV ATA-57ROV_5 (note times wrong on video)
12:06:48	HD On, more small shrimp on smoker	
12:07:19	HD Off	HDTV ATA-57ROV_6 (note times wrong on video)
12:11:44	HD On, shrimps and the end of something, smoke in bkgnd	
12:13:00	HD Off	HDTV ATA-57ROV_7 (note times wrong on video)
12:14:01	Temperature: 334, 370, not hot enough, the vent also does not look very active	
12:16:27	Deciding where to go	
12:28:45	HD on, fly round top of smoker	
12:29:10	HD Off	HDTV ATA-57ROV_8 (note times wrong on video)
12:32:23	ROV touched smoker	
12:49:33	HD On, lots of prop. Wash on top of smoker	
12:52:06	HD Off	HDTV ATA-57ROV_9 (note times wrong on video)
12:54:03	Want to approach smoker with Rig Master extended	
12:59:26	Trying at base of Tower	
13:01:35	Landed on SE base of Southern Tower, looks hopeful but is difficult to get to.	
13:13:12	taking KIPS for T-measurement; measurement failed	
13:19:06	still looking for a good place	
13:20:48	HD on, flight arond base of Southern Tower	
21.01.2008 13:23	HD off	HDTV ATA-57ROV_10 (note times wrong on video)
13:23:00	HD On, top of smoker	
13:23:31	HD Off	HDTV ATA-57ROV_11 (times wrong)
13:34:09	Taking a large sample from chimney with Riggmaster, placing on porch	ATA-57ROV-1
13:39:00	HD On, smoke at top of smoker	
13:39:51	HD off	HDTV ATA-57ROV_12 (times wrong)
13:55:37	HD on, approach to base of smoker	
13:57:18	HD off	HDTV ATA-57ROV_13 (times wrong)
14:10:42	taking KIPS for T-measurement	
14:17:42	stop of the attempt to measure Temp,.	
21.01.2008 14:25	HD on, Two Boats from a distance	
14:26:50	HD off	HDTV ATA-57ROV_14 (times wrong)
14:26:00	HD On, another flight to Two Boats?	
14:27:10	HD Off	HDTV ATA-57ROV_15 (times wrong)
14:32:20	proceeding to two boats, attempt to measure temp	
14:35:00	HD On, rigmaster on smoker outlet	
14:35:36	HD Off	HDTV ATA-57ROV_16 (times wrong)
14:36:02	now trying to make a vent with rig master	
14:41:59	still working with rig master on two boats	
14:48:04	several attempts to get a temp reading from a vent	
14:52:39	Tmax currently at 200°C	
14:55:43	relocating ROV to new posititon at two boats vent	
15:03:32	still cruising	
15:07:56	irrespective of the temperature reading to come, sampling will go ahead now	
15:16:40	T max now 340°C though opening small, vent openings apparently are very dynamic, they close and open in a day or two	
15:18:17	try to make 340°C vent bigger	
15:23:21	another KIPS deployment still at Two Boats	
15:32:03	T measurements in the range of 270 to 370°C	
15:35:56	pumps on filling bottle C9	ATA-57ROV-2
15:36:56	measured T is about 220°C however, nozzle is placed more directly above discharging fluid so that fliud sample temperatures are probably higher	
15:39:24	pumps off	
15:39:44	pumps on filling bottle C8	ATA-57ROV-3
15:42:31	pumps off	
15:43:06	pumps on filling bottle C7	ATA-57ROV-4
15:46:17	pumps off	
15:46:46	pumps on filling bottle B6	ATA-57ROV-5
15:50:02	pumps off	
15:52:03	next deployment: IB sampler	
15:58:53	still working on putting KIPS in garage...	
16:03:35	KIPS in garage. ROV 20 m off the ground	

16:07:13	landing on sheet flow, lightly sedimented	
16:08:09	great striations!	
16:10:29	still sheet flow	
16:11:05	no more communication to ROV container. Walkie-Talkie stopped working for some non apparent reason. Difficult to relocate Turtle Pits. No beacon reading. Trying to locate using Posidonia.	
16:14:50	Dead mussles	
16:16:51	beacon found	
16:20:02	sheet flow agin	
16:24:49	back at Turtle Pits, Two Boats	
16:35:59	next deployment: IB sampler	
16:47:22	IB sampler opened	ATA-57 ROV-6
16:48:00	HD On, IB Sampler sampling	
16:48:33	HD Off	HDTV ATA-57ROV_17 (times wrong)
16:49:49	HD was on for IB sampling	
16:50:59	HD on, trying to close He tube with Orion	
16:51:51	HD off	HDTV ATA-57ROV_18 (times wrong)
17:01:08	IB sampler closed	
17:14:13	Major D2 is next	
17:34:32	could not be released	
17:42:06	try again	
17:54:17	Major D2 released by error, no sample	
18:06:20	stowing IB sampler	
18:32:11	Beacon 11 found and collected	
18:36:28	next target: Wideawake beacon	
18:38:41	crossing from jumbled flow to sedimented lobate flow (mapped as "old flow" in ABE volcanological interpretation by C.Devey)	
18:46:46	beacon found even without signal	
18:52:47	Attempt to take mussles with bionet	
19:01:09	chnage of plan: First beacon 10 placed on poarch	
19:01:32	now start of biosampling	
19:04:29	bionet "J" fallen out of Orion into sample box	
19:07:00	"it is one of these f...ing stupid days..."	
19:09:17	bionet in Orion!	ATA-57ROV-7
19:12:31	mussles in bionet!	
19:13:20	HD On, mussel net with Orion	
19:13:58	more mussles	
19:14:12	bionet in big sample box	HDTV ATA-57ROV_19 (times wrong)
19:18:39	HD Off	
19:22:52	manipulating beacon in order to ensure its fixed position	
19:26:44	beacon fixed. Rigmaster bings in second beacon.	
19:29:31	leaving ground	

Cruise Number	Atalante Leg 2
Station Number	63 ROV
Dive Number	#20
Location	Inside Corner High #2
Coordinates	5°05.848´S 11°40.429´W
Water Depth	2400m
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
8:50:00	Begin Station	
9:00:00	ROV in Water	
9:52:14	ROV Descent stop at 1130m	
10:10:07	ROV decends. 1562m	
10:22:48	2000m	
10:34:16	Wand in sonar zu sehen in 40m entfernung	
10:34:40	Bottom sighting, sediment and small stones 20m W of steep wall	
10:38:54	boulder field	
10:41:15	No sign of steep wall! Sonar picture probably just this boulder field	
10:42:13	Looking for steep wall.	
10:43:33	Probably 150m north of steep wall from dive#1 acording to map	
10:44:04	5°05.798 11°40.368 are ROV coords, 2489m depth, going south	
10:46:18	Something on sonar in 30m distance	
10:47:26	HDTV On, talus blocks with sed cover	
10:48:19	Looking at rocks, trying for an interpretation	HDTV ATA-63ROV_1
10:49:25	Interpretation difficult due to sediment	
10:51:39	HDTV Off	
10:51:53	Climbing wall slowly	
10:52:19	Verticval crack - fault or joint	
10:52:31	HDTV On, joint may be cliff face, dips 70°to E 2476m	
10:53:39	Strong jointing 70°E, interner Strukturen dip 30° to W	
10:54:31	A Ruschel-Zone	HDTV ATA-63ROV_2
10:55:01	Going to try sampling	
10:55:38	HDTV Off	
10:56:10	Deploying Rigmaster	
10:58:00	HDTV On, massive rock wall	
10:59:21	Attempting sampling, looks very broken, lozenge-shaped pieces	HDTV ATA-63ROV_3
10:59:43	HDTV Off	
11:01:59	Still trying	
11:02:27	Not sure whether tectonics or rock-type responsible for the look of this rock	
11:06:05	Going to try to put porch on	
11:07:51	Docked!	
11:11:24	Rocks keep falling down between porch and wall!	
11:12:57	A good day for Dan, a bad day for a rock (and one giant leap for mankind)	
	5° 05.854 11°40.356 2472m rock on porch, sample in-situ	ATA-63ROV-1
11:15:45	Kluftung 70° in den Hang, nach W	
11:16:00	HD On	
11:16:29	Thinly bedded/jointed	HDTV ATA-63ROV_4
11:16:46	HD Off	
11:16:51	HD On	
11:17:03	Thinly-banked units, jointed dipping steeply W	HDTV ATA-63ROV_5
11:18:21	The thick banks have disappeared, looks much more broken. It is tectonic effect	
11:19:26	HD Off	
11:20:01	Looking West onto the short end of the eastward-dipping blocks	
11:20:29	The cliff is tectonic surface, not just a landslide surface	
11:20:47	HD On	
11:21:22	Joint surfaces well seen dipping 70° into cliffs	HDTV ATA-63ROV_6
11:21:56	HD Off	
11:23:14	HD On	
11:23:40	On E-W striking wall, see two joint systems, one dipping steeply to W, one slightly shallower to E	
11:24:40	Attempting another sampling	HDTV ATA-63ROV_7
11:24:53	HD Off	
11:26:42	Sampling attempt, droped in the slips	
11:29:56	Trying again, huge piece	
	5° 5.863 11°40.369 2430m	ATA-63ROV-2
11:32:59	Wall strikes 300° in sonar	
11:35:30	The structure which we have been calling joints dippingW looks irreguklar and like banking - magmatic contracts/Layering??	
11:36:54	Small step, in 10m it continues	
11:37:43	Going over step	
11:38:49	Stripes on rock probably sediment	
11:41:01	Wall strike 315°	
11:41:14	HD On	
11:42:35	Want to go W to try and find another wall orientation, we appear to be climbing a joint surface	HDTV ATA-63ROV_8
11:42:56	HD Off	
11:43:33	Corner of wall, can look from both sides	
11:44:03	HD On	
11:44:22	Lots of structures dipping to east	
11:45:11	Already ascended 130m wall	HDTV ATA-63ROV_9
11:45:54	Joint system dipping 70° to E is clearly visible	
11:46:14	HD Off	
11:46:55	HD On	
11:47:03	Lots of tectonic L, to right a big joint	HDTV ATA-63ROV_10
11:47:31	HD Off	
11:47:36	Heavily tectonised possible fault surface	
11:48:59	Wall strikes 300° in sonar	
11:50:09	Vertical movement surfaces visible, harnisch is the word which is being bandied about	
11:52:02	Still on wall	
11:52:38	Moving to SE to try and get another viewing angle	
11:53:54	Heavily colonised surface	
11:54:18	Traversing slope to se what is going on	
11:55:16	HDTV On	
11:56:27	HDTV Off	HDTV ATA-63ROV_11
11:55:45	IN small talus pile, looking for a piece to take	
11:56:33	Sampling attempt, putting in drawer, box 2	
12:01:49	5°05.919 11°40.382 2324m	ATA-63ROV-3
12:04:57	Sonar shows no hard echos, looks more like talus slope	
12:06:24	Found a solid face, ascending	
12:08:25	ON broken surface, hoping to see some structure when the surface is continuously breaking	
12:10:51	Many more small blocks here, may be different rock although in container does not look like it	
12:14:05	HD On	
12:14:53	HD Off	HDTV ATA-63ROV_12
12:14:59	Steep slope infront of ROV, possibly parallel to dip direction	

12:15:38	ROV oriented 300° to find that wall	
12:16:21	Possibly end of wall, sample attempt	
12:17:14	HD On, approach for sampling	
12:18:06	HD Off	HDTV ATA-63ROV_13
12:19:40	Grabbed, will it fit in drawer?	
12:20:56	5 05.927 11 40.433 2265m, box 3	ATA-63ROV-4
12:22:31	Vehicle still positively buoyant	
12:23:59	Talus slope	
12:24:33	Top of slope or talus pile. Sonar is also less clear. The big wall is visible on sonar behind through	
12:28:21	Basic topo map no good in this terrain	
12:29:49	Still on talus slope	
12:31:40	HD On	
12:31:41	Xenolith in gabbro??	HDTV ATA-63ROV_14
12:32:58	May be a surface covering, not a xeno though	
12:33:38	HD Off	
12:35:24	Joints steep, dipping to NW	
12:39:05	Rocks more rounded, more sediment and animals - slope older?	
12:39:41	Sonar picture is diffuse, no wall visible, probably talus + seds.	
12:40:27	Moving N looking for wall	
12:43:26	On a wall again, now looking 214°	
12:44:29	Looking for a place to take a sample	
12:45:16	Massive rock wall	
12:45:30	HD On	
12:46:19	Pentagon scalöe bar	HDTV ATA-63ROV_15
12:46:34	HD Off	
12:47:22	ON bottom, starting sampling	
12:48:19	Difficult to grab anything	
12:49:05	5°05.934´S 11°40.527´W 2175m, let´s see if we get a sample	
12:51:22	5°05.931 11°40.527 2175m have a sample now, in box 2 closer to ROV	ATA-63ROV-5
12:57:08	Still on blocky talus, moderately sedimented	
12:58:09	Solid wall, still gabbro, less jointing (perhaps reason for old talus, or we are looking at main joint surface)	
12:59:31	Now more broken	
13:01:15	Main fault surface, dipping east	
13:02:50	passing through another "Ruschelzone" 2130 m	
13:03:31	Changing course in order to gain another view on the western cliff face	
13:05:26	looking on western face of cliff, blocky scree	
13:08:14	ROV pilot shift change	
13:09:43	progressing up the hill. 2113m	
13:10:00	passing plastic bag? NO. Its a "Fächerkoralle". On scree slope.	
13:11:30	Facing 320. Blocky scree slope.	
13:12:37	Blocky outcrop. 2106m	
13:15:01	scree slope. Sediment. 2092m	
13:16:29	climbing scree slope, platy blocks.	
13:17:57	ROV still facing W: 246	
13:19:19	Looks like a good spot to take another sample. Also, sonar indicates that speep slope may terminate a little further up.	
13:25:59	Sample in orion. Placed in box 1 next to shovel. 5°5.968'S 11°40.583'W. 2082m	ATA-63ROV-6
13:29:12	NOTE for the ROV Weight Watchers: After this sample the ROV has no more Buoyancy.	
13:30:21	After an area dominated by rounded blocks we are back in area with blocks/slabby scree. ROV still travelling westward.	
13:31:26	passing over in-situ outcrop.	
13:32:19	HD on. In order to document the structures in this upper region.	
13:33:56	ROV parallel to main thrust plain which is striking 300. 2065m	HDTV ATA-63ROV_16
13:35:17	HD off.	
13:36:18	Steep nose ahead. Travelling up this outcrop. Little sediment cover. Abundant Gorgonaria.	
13:41:39	HD on.	
13:42:32	HD off	HDTV ATA-63ROV_17
13:43:15	steep cliff ahead. Climbing steeply facing massive rock outcrop. Strike 330. Rock type: gabbro. 2015m	
13:46:23	Still climbing vertically. 1996m	
13:46:48	Reaching blocky scree slope. Abundant sediment.	
13:47:48	Reached top of 20m high cliff. Terrace covered with blocky scree. Looks like in-situ material. Good opportunity to look for a sampling spot.	
13:51:33	HD on and off.	HDTV ATA-63ROV_18
13:53:52	passing over in-situ outcrop and in-situ blocky breccia.	
13:55:19	Found a good spot for sampling	
13:57:42	Sample in Orion claw. Dropped.	
13:58:39	sample in Orion claw. Too big => dropped.	
14:01:40	Suitable rock found. 5°6.022'S 11°40.698'W 1978m Placed in big sample box. Middle position.	ATA-63ROV-7
14:05:40	Travelling S in order to return to the old track followed before towards waypoint 3.	
14:11:15	Strongly sedimented boulder slope. Reached track. Heading upwards.	
14:12:10	1945m 5°5.987S 11°40.775'W	
14:14:57	Climbing steep cliff face. Joints running ~N-S.	
14:15:54	Strongly sedimented blocky boulder slope.	
14:16:36	Back in seep rocky outcrop face. Heading 217	
14:19:41	Found suitable sampling location.	
14:22:23	Orion deployed	
14:22:51	HD on	
14:24:52	HD off	HDTV ATA-63ROV_19
14:25:11	Sample with Hydrozoa shaft. 5°6.013'S 11°40.817'W 1876m Sample in box 3.	ATA-63ROV-8
14:30:44	Traveling across blocky boulder field. Sedimented. Heading 218	
14:33:41	Blocky outcrops. Huge slabby blocks, lightly sedimented.	
14:35:51	1810m. Heading 236	
14:38:35	Morphology: Steeply terraced terrain.	
14:40:08	just a joint... ROV facing 180. 1782m	
14:41:49	In this area the slope is striking N-S with little opportunity to investigate the inner structures (i.e., looking at E-W oriented outcrop faces)	
14:42:58	Looking for suitable sampling spot. However this is rather steep rocky terrain.	
14:45:15	HD on	
14:45:33	HD off	HDTV ATA-63ROV_20
14:46:10	HD on	
14:47:12	HD off	HDTV ATA-63ROV_21
14:49:48	Orion deployed but this site is not quite suitable.	
14:54:30	HD on targeting new sampling site.	
14:55:30	HD off	HDTV ATA-63ROV_22
14:56:44	Sampling successful at new site. 5°6.059'S 11°40.843W 1767m	
14:58:01	shift change of ROV pilots	
14:58:59	Leaving sampling site in order to put rock sample in a save place on the ROV.	
15:01:56	Sample placed in big sample box. On the Orion side of sample ROV-7 (below IB sampler)	ATA-63ROV-9
15:04:04	300° striking cliff surface ahead. Orientation unchanged. Seems peculiar since ridge axsis is striking at 330°	
15:04:06	HD on, fish	
15:04:19	HD off	HDTV ATA-63ROV_23
15:04:42	strongly sedimented terrace. We are travelling westward.	
15:05:45	boulder field with sediment	
15:07:42	slope is dipping with 30°, sediment covered	
15:08:29	approaching a steep wall, the cliff face is striking North-South	

15:10:21	climbing up	
15:11:48	surface is covered with sediment and rock debris	
15:14:29	big blocky debris on sediment covered surface	
15:17:12	searching for a place to park and collect a rock sample	
15:18:12	HD on	
15:18:30	rocks look more tectonized than previous exposures	HDTV ATA-63ROV_24
15:19:32	HD off	
15:25:58	sampling: 5°6.081 S, 12°40.949 W, 1673.8 m, sample placed in drawer in box 2, on top of everything in the back of this box	ATA 63 ROV-10
15:32:22	continue up the steep slope	
15:34:46	HD on	
15:34:53	surface of rocks look darker in comparison to further down, may be even the fresh material is darker, rocks slap more flat	HDTV ATA-63ROV_25
15:35:55	HD off	
15:40:14	black rock sample with white dots (two pieces) in box3 at 5°06.089S 11°40.982W, 1636m	ATA 63 ROV-11
15:48:26	HD on	
15:49:31	HD off	HDTV ATA-63ROV_26
15:50:47	Dip of the rocks appears to have changed. Was 70° below.	
15:51:09	The little valley in front has steep flanks. This may be one of the corrugated streaks? Valley is 16 wide and 18 m at its deepest point. The valley is horseshoe shaped. Strike: 260. However, the corrated streaks visible in bathymetric maps are in 100 meters dimensions (each pixel is about 200m). Maybe this is a smaller scale version not detectable in bathymetric maps?	
15:57:16	HD on. There are differences in structure. 1603m	
15:58:45	HD off.	HDTV ATA-63ROV_27
16:00:09	Steep rocky outcrop. No sediment. Facing 270. Streaky vertical structures.	
16:01:22	HD on. The rock face is striking N-S. There are prominent slicken side structures! Dip is to steeply to the east.	
16:04:16	1573m Sediment filled crack looks like whitish vein...	HDTV ATA-63ROV_28
16:05:04	HD off.	
16:05:19	HD on. Vertical view on shear zones. Dipping South to southwest.	
16:06:52	HD off.	HDTV ATA-63ROV_29
16:07:20	Still climbing wall strike is 10°; 60° dipping to the east. Which has a total height in the order of 30 to 40m	
16:09:57	keep on climbing. 1541m. Cliff face heavily jointed.	
16:12:24	Plan: Taking another sample...	
16:13:48	HD on.	
16:14:25	HD off	HDTV ATA-63ROV_30
16:15:00	HD On	
16:15:05	Trying to take sample here.	
16:15:33	HD Off	HDTV ATA-63ROV_31
16:20:54	too difficult. Moving to a different spot.	
16:24:34	The rocks look massive with some jointing. Looks like blocky to columnar jointing.	
16:25:00	HD On	
16:25:39	HD Off	HDTV ATA-63ROV_32
16:26:35	Moving to yet another site.	
16:31:05	Still having problems with sampling.	
16:32:43	Sample in Orion claw.	
16:34:02	5°6.104'S 11°41.061'W. 1521m. Placed on top of box1.	ATA-63ROV-12
16:38:19	This location here is about 100 m to the north of the planned waypoint 3. The terrain is still very steep. Plan: Continue straight to the west to reach top of inside corner high structure.	
16:39:12	HD on	
16:39:58	HD off	
16:40:50	Climbing to 1510m Facing 270. Moving along surface.	
16:42:18	Changing position facing 210. Steep rocky black surfaces.	
16:43:25	HD on	
16:43:33	Abundant corals.Looking at SW striking flank.	HDTV ATA-63ROV_33
16:44:15	Blocky rocky scree.	
16:45:39	HD off	
16:46:10	1493m	
16:46:28	It is getting more shallow and the rock character has changed. The black rocky scree is sedimented and abundant deep sea corals.	
16:50:04	SHARK! HD movie.	
16:50:42	HD Off	HDTV ATA-63ROV_34
16:50:20	Reached plateau at 1489 m	
16:50:39	Taking sample.	
16:52:28	5°6.118'S 11°41.102'W 1491m Sample with intense Mn crusting.	
16:53:11	HD on, nice sampling shot!	
16:54:08	HD off	HDTV ATA-63ROV_35
16:54:48	Fist sized, knobbly sample placed in big sampling compartment. Apparently the other samples have moved around...	ATA-63ROV-13
17:06:12	flat sedimented area, top of escarpment reached	
17:06:50	move north now	
17:08:09	try to reach the cliff face again, searching for a less sedimented area	
17:09:14	steep slope down in front, turn west to search for cliff	
17:09:58	wall appears in sonar to the west	
17:10:26	reached the wall, moving up	
17:11:26	HD On	
17:11:45	investigated a vertical structure, more massive to the left, more structured to the right	HDTV ATA-63ROV_36
17:12:27	HD Off. looks like a sediment debris flow (HD on for short time)	
17:13:17	HD on	
17:13:32	narrowly spaced exhumation (tectonized) streeks	
17:14:29	strongly tectonized area, trying to collect sample	HDTV ATA-63ROV_37
17:15:30	HD off	
17:18:11	sampling: 5°6.093 S, 11°41.125 W, 1529 m, small triangular sample placed in drawer in box 1, next to shovel	ATA 63ROV-14
17:21:42	sample is pervasively sheared material	
17:21:58	HD on	
17:22:27	slope is dipping at shallow angle	HDTV ATA-63ROV_38
17:24:35	HD off	
17:24:48	almost reached the top at 1497 m, looking for final sample	
17:25:56	reached the top, searching for a parking lot in order to sample	
17:26:25	sampling at 5°6.116 S, 11°41.101 W, 1492 m	ATA 63 ROV-15
17:30:33	sample placed at the left corner of the porch	
17:32:39	ROV is leaving the bottom, (almost) on time!	

Cruise Number	Atalante Leg 2
Station Number	67ROV
Dive Number	#21
Location	Red Lion
Coordinates	4°48.661S 12°22.606
Water Depth	2995
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
	Begin Station	
9:20:00	ROV in Water	
9:30:00	Coordinates wrong in plan, need to move ship 1 mile N	
9:51:41	Fahrtleiter not very happy with himself	
11:40:37	2966m depth approaching target	
11:42:31	bottom contact for ROV	
11:47:08	4°47.821/12°22.641 at depth of 3048 m	
11:47:43	hackly to pillow flow transition here	
11:48:22	Posidonia tells us that ROV direct west of smoker	
11:50:10	Proceeding towards east. Aim: locating Red Lion	
11:54:30	FOUND smoker! Shrimp Farm. NO shrimp. Apparently no hydrothermal activity.	
11:55:06	HD on, Shrimp farm	
11:55:47	4°47.822'S 12°22.602'W 3040m	
11:59:55	Proceeding towards Tannenbaum smoker	
12:00:17	Pillows are intensely covered by hydrothermal sediment	HDTV ATA-67ROV_1
12:01:41	Tannnenbaum localted, Mephisto visible in the distance. Tannenbaum still actively discharging black fluids from its top. Vigorous.. No shrimp. No apparent biological colonization. Ca. 5m high including foot hill of sulfide talus.	
12:02:53	HDTV Off	
12:02:54	HDTV On Tannenbaum	
12:04:44	HDTV Off	HDTV ATA-67ROV_2
12:05:43	Mephisto located.Hydrothermal discharge at top, three small orifices. Discharge appears reduced compared to last years observations. Also the colonization by shrip is substantially reduced. Only some white, shrimp patches on the to region.	
12:05:50	HD On	
12:07:42	HD Off	HDTV ATA-67ROV_3
12:07:54	HD ON	
12:09:21	HD Off	HDTV ATA-67ROV_4
12:10:05	preparing for video mapping	
12:12:25	start video mapping	
12:14:00	HD On	
12:14:10	HD Off	HDTV ATA-67ROV_6
12:15:21	HDTV crashed, start all over again	
12:17:06	start video mapping again	
12:26:39	HDTV circle at foot of structure completed, starting a similar round towards the top of the structure	
12:33:42	video mapping finished	
12:33:56	moving west to smoker structure that was visible in the back	
12:37:19	distance between Mephisto and Tannenbaum measured to be 8 m	
12:37:50	HD On	
12:38:20	HD on at Sugar Head	
12:39:40	shrimps almost gone from Sugar Head, moreover from the entire Red Lion field	HDTV ATA-67ROV_7
12:39:59	HD Off	
12:42:29	back at Mephisto, searching for landing spot	
12:44:50	HD On	
12:48:51	landing on top of structure	HDTV ATA-67ROV_8
12:48:59	HD Off	
12:50:51	start sampling for shrimp with slurp gun	
12:55:44	HD On	
12:55:59	HD Off	
12:57:52	left the ground...	
12:59:23	Back at Mephisto	
13:07:10	Still trying to slup shrimp while flying	
13:11:41	Difficulty is to find a suitable spot for landing and fixing the ROV. Slurping while flying is apparently not an option.	
13:13:59	ROV apparently fixed in the same position than previously, just before slup sampling initiated	
13:15:27	Slurping going on, apparently 1 or 2 shrimp caught + one carb! Sitting in Slup container 1. Caroussel turned to position 2.	ATA-67ROV-1
13:19:37	One shrimp is caught in the sample shamber.	
13:20:40	Trying to obtain samples while flying but there is apparently a lot of turbulence making flying difficult.	
13:21:28	Trying to suck shrim one by one... But there does not seem to be enough strength in the slurping. However, at least 2 shrimp have been caught. Sample in slurp container 2. Slurp gun container shifted to position 3.	ATA-67ROV-2
13:24:08	Slurp gun broken. T handle ripped off.	
13:28:54	ROV pilot shift change.	
13:32:14	next operation: Get fluid sample with Ti major.	
13:33:17	HD on. Nice picture	

13:34:10	HD off	HDTV ATA-67ROV_10
13:37:10	oil bubbles visible in slurp gun image	
13:39:06	slowly approaching top smokers	
13:39:15	HD On	
13:39:45	HD off nice picture of shimmering beehive	HDTV ATA-67ROV_11
13:41:32	New orifice open due to sudden beehive collapse.	
13:45:13	Plan: Fill Ti major bottles	
13:47:18	Ti major number D2 in Orion.	
13:49:42	HD on	
13:50:22	Placing Ti major nozzle in new orifice is difficult	HDTV ATA-67ROV_12
13:54:30	Ti major nozzle upright in orifice	
13:56:44	HD off	
14:01:05	Ti major release is difficult...	
14:05:56	Technical note: ROV is loosing oil. Projected time left for diving: 3h 20 min. Priorities: Filling KIPS and locating oceanographic tools.	
14:07:54	Still working on releasing Ti major	
14:14:43	this Ti major bottle does not seem to be able to be released...	
14:15:30	Rigmaster comes to the rescue	
14:26:46	Ti major now held by Rigmaster, will be released with the Orion arm	
14:29:54	Ti major released, D2 sampled	ATA 67ROV-3
14:34:11	compensator pressure is at 50%	
14:36:20	placing Ti major in back part of the sample box	
14:39:36	HD on	
14:40:12	HD off	HDTV ATA-67ROV_13
14:44:42	sampling smaller chimney near to the big hole, believed to be more vigorously emanating	
14:46:31	measured T max is 340°C, 365°C	
14:48:17	pump on, filling bottle C9, clear fluid at exhaust	ATA 67 ROV-4
14:49:27	HD on	
14:51:46	pump off, then pump on	HDTV ATA-67ROV_14
14:51:51	filling bottle C8, T stable at 363°C	ATA 67 ROV-5
14:52:23	HD off	
14:54:29	pump off	
14:54:39	pump on, filling bottle C7	ATA 67 ROV-6
14:58:45	pump off	
14:58:58	pump on, filling bottle B6	ATA 67 ROV-7
15:03:14	pump off and on again, filling bottle B5, clear fluid coming out of exhaust	ATA 67 ROV-8
15:05:43	pump re-started for bottle B5	
15:07:37	pump off, KIPS sampling finished	
15:15:55	filling He tube at large orifice where beehive structure "collapsed" before	
15:17:12	He tube filled	ATA 67 ROV-9
15:19:13	compensator pressure is at 30% ! Coming up	
15:19:35	ROV off bottom	

Cruise Number	Atalante Leg 2
Station Number	68ROV
Dive Number	#22
Location	NW of Comfortless Cove area
Coordinates	4°48.152'S 12°22.381'W
Water Depth	2995
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
	Begin Station	
17:17:15 U17r.U17r	ROV in water. Starting dive to recover oceanographic tool.	
17:20:57 U17r.U17r	No Posidonia???	
17:26:00 U17r.U17r	Posidonia Si, oui, JA.	
17:26:21 U17r.U17r	350m	
18:32:27 U18r.U18r	bottom recognized with ROV sonar	
18:33:16 U18r.U18r	bottom visible, depth 3002 m, position 4°48.090'S and 12°22.384'W	
18:36:38 U18r.U18r	ROV over pillow lavas with plenty of sediment filling in between, searching for mooring	
18:39:44 U18r.U18r	ROV flies 270	
18:40:12 U18r.U18r	jumbled flow with no sediment, i.e. Is younger	
18:42:58 U18r.U18r	course now 295	
18:43:32 U18r.U18r	now at predicted mooring location	
18:44:09 U18r.U18r	heading bit north, heavily jumbled flow, hummocky terrane	
18:46:17 U18r.U18r	4°48.098'S and 12°22.451'W	
18:47:53 U18r.U18r	now checking terrane in south, heavily jumbled, hummocky terrane, bit sediment	
18:50:03 U18r.U18r	proceeding south	
18:50:35 U18r.U18r	4°48.136 and 12°22.432 entering pillow terrane, pillows are above jumbled flow!	
18:52:19 U18r.U18r	heading east, jumbled terrane with sediment	
18:52:55 U18r.U18r	now pillows with seds with initial transitions to tubular flow	
18:56:35 U18r.U18r	heading north	
18:57:40 U18r.U18r	heading west 12°22.405W and 4 48.110'S	
18:58:35 U18r.U18r	jumbled flow no sed	
19:02:23 U19r.U19r	12°22.458'W and 4°48.119'S marks contact of jumbled flow against pillow, pillow appears younger, however, pillowed flows has more sediment....	
19:06:38 U19r.U19r	12°22.470'W 4°48.132'S jumbled flow	
19:10:46 U19r.U19r	continue to head east	
19:13:22 U19r.U19r	12°22.427 and 4°48.098'S, contact jumbled (so far) into pillow	
19:15:41 U19r.U19r	pillows with abundant collapse structures	
19:18:09 U19r.U19r	12°22.405 and 4°48.104'S, turning south	
19:19:53 U19r.U19r	heading west 4°48.109 and 12°22.403 pillows with sediment	
19:22:11 U19r.U19r	all jumbled now with no sediment	
	perhaps lobate at tip transitional to pillow, only lobate can collapse to form jumbled, thus jumbled against pillows, both have same age	
19:26:38 U19r.U19r	continue west in jumbled flows	
19:30:31 U19r.U19r	12°22.472'W and 4°48.1109 S, heading south	
19:30:54 U19r.U19r	now into pillows then into jumbled	
19:32:59 U19r.U19r	12°22.467'W and 48.116°S heading E	
19:33:49 U19r.U19r	still jumbled	
19:36:29 U19r.U19r	heading north 12.22.433'W and 4°48.097'S	
19:38:12 U19r.U19r	heading east 12.22.432 and 4.48.096'S	
19:39:04 U19r.U19r	contact to Pillow flow marked by lobate structures	
19:39:51 U19r.U19r	big pillows	
19:40:59 U19r.U19r	looking around. Pillows everywhere	
19:42:11 U19r.U19r	22.412W 48.087S Pillows	
19:43:35 U19r.U19r	Turned back W. Crossing over into jumbled flow.	
19:48:13 U19r.U19r	jumbled flow heading W	
19:53:57 U19r.U19r	No Posidonia readings. Turning back east.	
19:54:44 U19r.U19r	still jumbled flow	
19:56:51 U19r.U19r	Crossing into lobate flow overlying jumbled flow to the east. However, as usual this lobate to pillowed flow appears to be more strongly covered by sediment than the jumbled flow. Still it is lying on top of it...	
19:59:19 U19r.U19r	moving upwards, 3004m This is a pillow mound.	
20:03:23 U20r.U20r	Turning around. Pillows everywhere. 3004m	
20:04:54 U20r.U20r	22.417'W 48.068'S Pillows	
20:10:15 U20r.U20r	Heading West	
20:10:36 U20r.U20r	Back in jumbled flow	
20:10:47 U20r.U20r	Rather: contact zone between lobate flow structures and jumbled flow.	
20:11:30 U20r.U20r	Heading further south over jumbled flow.	
20:12:28 U20r.U20r	22.439'W 48.094'S jumbeld flow. 3006 m	
20:14:20 U20r.U20r	Heading west acoss jumbled flow	
20:15:42 U20r.U20r	jumbeld flow. 3008m. Still heading West.	
20:18:06 U20r.U20r	heading north	
20:19:14 U20r.U20r	jumbled flow. 3010m	
20:21:30 U20r.U20r	turning around. Jumbled flow everywhere.	
20:23:25 U20r.U20r	Jumbled flow. Steeply hummocky terrain.	
20:24:09 U20r.U20r	Heading south.	
20:26:02 U20r.U20r	Heading east. Jumbled flow.	
20:26:27 U20r.U20r	Contact to lobate flow in the east appears. Clearly this is overlying the jumbled flow!	
20:27:28 U20r.U20r	Turning around. To the south: Jumbled flow.	
20:28:21 U20r.U20r	22.451'W 48.072'S: Contact zone.	
20:29:22 U20r.U20r	Lobate to pillowed flow.	
20:30:01 U20r.U20r	Pillows. 3008m	
20:31:08 U20r.U20r	22.421'W 48.067'S Pillow flow. Apparently the pillow flows are enclosing the jumbled flow to the north.	

20:36:19	U20r.U20r	Heading south.
20:36:47	U20r.U20r	22.417'W 48.084'S Pillows. 3005m,
20:38:46	U20r.U20r	Turning around. To the west there is the transition to lobate flow.
20:39:53	U20r.U20r	Heading south across pillows.
20:41:19	U20r.U20r	22.400'W 48.120'S Pillows. 3002m
20:44:56	U20r.U20r	pillows
20:45:26	U20r.U20r	Heading W crossing into jumbeld flow
20:45:43	U20r.U20r	jumbeld flow. 3005m.
20:48:44	U20r.U20r	22.436'W 48.123'S jumbled flow. 3005 m
20:49:36	U20r.U20r	heading west
20:51:20	U20r.U20r	Crossing over contact: Lobate flow overlying jumbled flow. Lobate is about 1m thick at most.
20:54:06	U20r.U20r	22.480'W 48.127'S
20:55:31	U20r.U20r	Heading south.
20:58:38	U20r.U20r	heading north 22.472 and 4° 48.138S
20:59:14	U20r.U20r	continue in jumbled flow
21:02:09	U21r.U21r	12°22.447W 04°48.124S heading east
21:02:58	U21r.U21r	continue in jumbled flow, turning to 110°
21:07:00	U21r.U21r	in pillows 22.408 and 48.116
21:09:15	U21r.U21r	22.393 and 48.113 turning W
21:10:33	U21r.U21r	heading west in pillows
21:14:34	U21r.U21r	22.430 and 48.115 in jumbled flow continue west
21:19:57	U21r.U21r	22.450 and 48.116 break of search in jumbled flow
21:31:00	U21r.U21r	abandoned attempt to get a nice piece of jumbled flow
21:34:07	U21r.U21r	abandoned attempt to get a nice piece of jumbled flow
21:34:22	U21r.U21r	ready for take off
21:36:55	U21r.U21r	we have a lift off

Cruise Number	Atalante Leg 2
Station Number	70ROV
Dive Number	#23
Location	5°S Fracture Zone
Coordinates	4°56.420´S / 11°37.044
Water Depth	4765m
Vessel	Atalante

Metadata Timecode default	**Observation** allowed	**Actions** allowed
	Begin Station	
10:45:00	ROV in Water	
13:04:39	at bottom, depth 4864 m!!, coordinates 11°36.987W 4°56.473S	
13:08:19	test have started, working with Orion arm	
13:16:38	one horizontal thruster seems dead as of 4300 m, possible water ingression	
13:17:12	video looks at our payload: painted styrofoam cups. The question is: will they be more compressed at this depth than before (at 3000 m)	
13:25:12	test start	
13:59:21	tests ongoing	
14:08:20	sediment on porch, drawer does not open, will try to wipe off with knife	
14:09:22	feedback problem with Orion, extra 180 bars starts causing more problems than hoped, thus problems getting knife out with Orion	
14:17:24	porch cleared with knife, but drawer still does not open	
14:19:52	drawer opens! Orion has still a feedback problem, operation thus difficult	
14:20:59	knife put back, this time into drawer	
14:33:08	ongoing tests of unknown nature	
14:42:33	a rock in the sediment	
15:06:22	attempt to deploy a marker; can be difficult, since the orion has problems	
15:11:43	Orion has still problems; delay in operation; moves very slowly and not accurate	
15:13:06	stop the attempt to work with Orion	
15:16:28	stop to work with Orion	
15:44:40	technical tests completed	
15:44:48	HD on	
15:47:02	Heading N	HDTV ATA-70ROV_1
15:48:34	HD off	
15:50:01	Sonar: big boulders ahead at about 30 m distance	
15:50:38	passing over sediment with occational rocks	
15:51:53	rocky blocks and boulders partly covered by sediment. 4840m	
15:54:04	Proceeding to the N	
15:55:11	sediment	
15:55:38	Sonar: blocks in about 20 m distance	
15:56:22	reached foot of rocks boulder rising about 10 m from 4820m.	
15:58:59	Sonar: Boulder ahead.	
16:00:02	Heading N. Over sediment.	
16:00:50	4800. Sediment.	
16:02:20	ROV speed: ca. 1 km/h.	
16:03:12	4780m Sediment. Heading N.	
16:08:47	Located plastic water bottle on the seafloor sediment. 4772m	
16:10:24	Heading N. Reaching sedimented boulder.	
16:11:13	Climbing up steep E-W striking cliff face. Looks like in-situ outcrop. Plan: Take sample with Rigmaster (since Orion is out of action...)	
16:11:41	HD On	
16:13:55	HD has been on for a while in order to document the outcrop. 4760m. 4°56.347'S 11°37.055'W	HDTV ATA-70ROV_2
16:18:49	We may spend some time here since getting a sample from this deep outcrop would be important for comparison with the previous samples from shalower depths.	
16:21:44	Morphology of the outcrop surface looks distinctive from the previous dives. Knobbly texture suggests a serpentinitc lithology. However, maybe this is gabbro with a different type of weathering/alteration.	
16:24:37	Orion deployment. At least a try. However, movements are hardly controlable...	
16:31:01	Orion is catastrophic, parked and de-activated	
16:33:35	Rigmaster not good at this place,	
16:35:34	Rock looks massive but heavily jointed, probably Serpentinite	
16:36:04	HD On	
16:37:21	HD Off	HDTV ATA-70ROV_3
16:41:12	Attempting landing	
16:51:55	Atempting sampling 4°56.336´S 11°37.057´W 4753m	
16:53:37	Sample taken, hopefully it will go on porch. Crumbled and just fell on porch, front right position on the porch, in front of Orion	ATA-70ROV-1
17:02:28	crumbly piece of rock, totally different from inside corner high, could be serpentinite	
17:13:22	HD on, rocks look more and more like serpentinite	
17:14:21	HD off	HDTV ATA-70ROV_4
17:16:01	climbing up heading N, rocky boulders and sediments. 4710m	
17:17:21	approaching steep cliff	
17:17:54	HD On	
17:18:01	60° dipping, N-S striking fractures.	HDTV ATA-70ROV_5
17:19:01	HD off, has been on for a while.	
17:20:02	4690m	
17:21:01	HD on. Investigating vertical structure. May be just a feature due to particular sediment cover	
17:22:27	HD off. The strucure is due to sediment dripping down a rock face.	HDTV ATA-70ROV_6
17:26:49	Climbing up passing blocky boulders and sediment covered slopes. Rock still look similar to the lithology sampled below.	
17:27:46	HD on.	

17:27:59	Blocks present may be different types of lithologies. Investigating some whitish looking blocks.	HDTV ATA-70ROV_7
17:29:09	HD off. White block may be solidified sediment toumbled down from above.	
17:29:39	The knobbly rock type appears to be mixed with more blocky to platy rock types.	
17:30:58	Retrying Orion with one function disabled (6 of 7 working functions).	
17:32:08	HD on	
17:32:28	some blocks are banded	HDTV ATA-70ROV_8
17:32:50	HD off.	
17:37:22	Looking for parking spot in order to take a sample	
17:41:40	Trying to work with Orion arm.	
17:44:22	Difficult. Looking for other spot.	
17:46:14	Reached steep nose-like rock cliff. Climbing up over sedimented boulder field. 4652 m. NO biology.	
17:48:46	Found a new place for sampling operations.	
17:51:20	"What a guy" Sample in Orion claw. Very elegantly done.	
17:53:56	4°56.258'S 11°37.055'W 4654m	ATA-70ROV-2
17:56:26	Placing dislodged Timajor bottle in big sampling box.So it is savely stowed now.	
18:00:29	Based on morphology of the rocks there appear to be more blocky lithologies and more knobbly rocks.	
18:01:32	HD on. Strange breccia-like rock with white matrix. Rounded clasts (got rounded when rolling down this slope). Internal layering visible.	
18:02:36	HD off	HDTV ATA-70ROV_9
18:03:14	climbing up. 4630m	
18:04:10	Scree slope of rocky blocks. Little sediment cover. "Felsenmeer"	
18:06:23	Probably formed as an avalanche deposit. This is a tectonically active zone!	
18:06:58	Parking in order to take samples.	
18:07:43	HD on. Pictures of "Felsenmeer"	
18:08:14	HD off	HDTV ATA-70ROV_10
18:11:10	whitish rock sample (strongly rounded) breaks apart under Orion claw. Foraminiferous Ooze? Placed in Box 1. 4°56.231'S 11°37.073'W 4617m	ATA-70ROV-3
18:15:26	Placed big platy block of Gabbro in the big sample box. Outside margin.	ATA-70ROV-4
18:18:27	sediment and some boulders. 4605m Left "Felsenmeer"	
18:20:25	Passing white rounded blocks and black platy blocks.	
18:20:52	35° slope, strike 270 (E-W). Turning to get images of the slope that we have been traveling up.	
18:22:34	Apparently we have moved up into differnt lithologies now. The earler rock types below (serpentinite) are no more present up here. Rather this looks like avalanche and scree deposits fed by gabbroic lithologies further up slope.	
18:23:56	"Hangschutt" deposits.	
18:24:15	Passing possible in-situ cliff of gabbro?	
18:26:37	Scree slope with sediment locally with apparently young, unsedimented blocky avalanche patches.	
18:27:52	Climbing N. 4557m, sedimented scree slope.	
18:28:41	occational white block, rounded together with dark platy blocks	
18:32:29	Step in the topo., looks like massive gabbro makes a small cliff	
18:32:53	HD On	
18:33:50	HD Off	HDTV ATA-70ROV_11
18:42:12	4°56.145´S 11° 37.088´W 4515m	ATA-70ROV_5
18:51:09	In situ, we will take a sample	
18:51:35	HD On	
18:52:59	HD Off	HDTV ATA-70ROV_12
18:55:24	Landed, full of sed. Clouds	
18:58:35	4°56.124´S 11°37.111´W 4468m. Sample taken and put on top of 1a	ATA-70ROV_6
19:02:06	Large wall in front of us.	
19:04:09	Going sidewaysw to look at slope	
19:10:27	Think we are still in gabbros	
19:12:57	Big gabbro block	
19:14:20	HD On	
19:14:32	Heavily tectonised	HDTV ATA-70ROV_13
19:15:11	Banded, bands dipping ca. 45° to E, start of cliff 4350m	
19:16:14	HD Off	
19:16:21	Going back down for sample, cliff is >20m high and vertical	
19:19:42	HD On	
19:20:52	Lava tube cut so that cooling joints visible, although Günter thinks it is a shear zone	HDTV ATA-70ROV_14
19:21:09	HD Off	
19:23:41	HD On	
19:24:10	HD Off	HDTV ATA-70ROV_15
19:27:17	Going to land, no sampling possible in hover	
19:28:08	HD On	
19:29:36	HD Off	HDTV ATA-70ROV_16
19:32:29	No chance to take sample, going up	
19:34:37	HD On	
19:35:21	HD OffWe see small intrusions with hyaloclastites around	HDTV ATA-70ROV_17
19:37:02	HD On	
19:38:50	OK; Günter may be correct, several zones with lineations dipping 45° to E.	HDTV ATA-70ROV_18
19:39:30	HD Off	
19:42:08	Going in again	
19:44:17	Sample grabbed 4 56.046´S11°37.131 4343m in Box 2	ATA-70ROV_7
19:45:06	Hdon	
19:45:15	HD Off	HDTV ATA-70ROV_19
19:46:52	Cliff strikes E-W, difficult to determine orientation of other structures	
19:47:27	Schichten 50° nach SE einfallen, lineation is 20 ° on this	
19:50:42	Still climbing up the cliff, 4310m Lithology unchanged.	
19:52:32	Steep vertical cliff face. Some biology, occational sediment dusting.	
19:54:00	Reaching strongly sedimented portion of slope. 4295m Still rising steepl but with thich sediment cover.	
19:54:53	4292m	
19:56:00	Climbing steep cliff. 4289m	

19:59:27	HD On	
20:00:18	Going to structure dipping to ESE	HDTV ATA-70ROV_20
20:01:48	HD Off	
20:02:46	Wall is vertical, the marks on wall dip to E and S, perhaps two ages of structures	
20:03:20	HD On	
20:04:20	HD Off	HDTV ATA-70ROV_21
20:06:46	Going in for sample	
20:09:31	HD On	
20:09:46	HD Off	HDTV ATA-70ROV_22
20:12:40	Sample grabbed 4 56.028 11 37.114 4252m taken on the fly, put in box 3	ATA-70ROV_8
20:13:00	HD On	
20:14:49	HD Off	HDTV ATA-70ROV_23
20:16:47	Break in slope, 4242 m depth	
20:20:42	Strike E-W, dip to S with 45°, clearly visible on sedimented slope	
20:22:03	Taking a sample, easy to get. But didn´t work	
20:26:24	Joints dipping to W with 80°	
20:29:24	4 56.006´S 11°37.118 4218m sampling atempt	
20:31:20	HD On	
20:32:12	HD Off	HDTV ATA-70ROV_24
20:32:18	Seespinne (8 legs)	
20:34:11	Steep slope down to S	
20:37:11	Looks massive, lots of joints, not apparently fully deformed	
20:38:45	4 55.990 11 37.124 4175m, sample in box 2	ATA-70ROV_9
20:38:58	HD On	
20:39:14	HD Off	HDTV ATA-7ßROV_25
20:40:58	HD On	
20:41:56	HD Off	HDTV ATA-70ROV_26
20:42:04	HD On	
20:42:14	Hyaloclastites in background E-W strike, 80° S dip	HDTV ATA-70ROV_27
20:42:51	HD Off	
20:43:35	HD On	
20:48:17	HD Off	HDTV ATA-70ROV_28
20:48:38	Steep wall again	
20:49:20	HD On	
20:49:54	HD Off	HDTV ATA-70ROV_29
20:51:27	Last sampling attempt	
20:51:35	HD On	
20:52:41	HD Off Even Jürgen and Günter think that this is volcanic!!	HDTV ATA-70ROV_30
20:53:29	Completely steep wall, different rock type	
20:54:08	HD ON	
20:55:06	HD Off	HDTV ATA-70ROV_31
20:56:57	HD On	
20:58:44	HD Off	HDTV ATA-70ROV_32
20:59:26	sonar shows a flat surface some 300 m above	
21:00:02	wall: strike 25°, dip SW 30° ???	
21:06:10	HD on for landscape pictures	
21:06:45	HD off	HDTV ATA-70ROV_33
21:07:43	planning to collect a sample	
21:13:58	collect a sample at: 4°55.983 S, 11°37.113 W, 4063m, placed in large box in the back	ATA 70ROV-10
21:21:31	HD on - fish	
21:22:09	HD off	HDTV ATA-70ROV_34
21:23:59	more sedimented somwhat flat area	
21:27:07	crossing a large flat surface, sediment covered, some blocks, looked more like gabbro	
21:30:05	depth is 4000m in contrast to existing map that shows 3900m	
21:30:51	again some rocks	
21:33:58	Strike E-W, dip to S with 25 to 30°	
21:37:21	collect a sample at: 4°55.895 S, 11°37.148 W, 3996m, angular+platy, placed in box 2	ATA 70ROV-11
21:43:34	steepness of the slope is increasing again which fits the topographic map	
21:45:26	HD on, rocks look more volcanic again	
21:46:42	HD off	HDTV ATA-70ROV_35
21:54:34	slope shows lots of sediment and debris flows/talus, no real outcrop for sampling	
21:58:58	HD on, looking for spot to sample	
22:00:15	collecting sample at: 4°55.816 S, 11°37.166 W, 3897m, placed in the back box, fist size	ATA 70ROV-12
22:03:04	HD off	HDTV ATA-70ROV_36
22:07:54	changing NNW, topographic map shows a high	
22:09:56	HD on	
22:10:34	HD off	HDTV ATA-70ROV_37
22:11:55	HD on	
22:12:23	HD off	HDTV ATA-70ROV_38
22:13:58	HD on	
22:16:55	HD off	HDTV ATA-70ROV_39
22:17:13	collecting a small sample of presumed serpentinite breccia, placed in the back box	ATA 70ROV-13
22:26:17	HD on	
22:26:58	HD off	HDTV ATA-70ROV_40
22:27:28	problems with thruster	
22:28:53	4° 55,765 S, 11° 37.201 W, 3825m (noted a few moments later)	
22:29:45	collecting another sample at 4°55.757 S, 11°37.212 W, 3815m, box 2, front part	ATA 70ROV-14
22:32:08	ROV leaving the bottom	
22:33:42	HD on	
22:34:16	HD off	HDTV ATA-70ROV_41