

# **Cruise Report**

## **Atalante Cruise Leg – 1 HYDROMAR V (replacement of cruise MSM06/2)**

04.12.07 Toulon to 02.01.08 Recife

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## Summary

The overall goal of this leg – conducted under the auspices of the DFG SPP 1144 – is the investigation of causes for temporal and spatial compositional differences of hydrothermal fluids and their effect on the vent communities in the Logatchev hydrothermal field. To achieve this goal, the Logatchev field located at the Mid-Atlantic Ridge at ~15°N and ~45°W has been, and will be, visited annually since 2004 during the HYDROMAR I-IV expeditions in the last years and during this cruise in December 2007. The original scientific program was scheduled for 18 working days. The problems with the research vessel MARIA S. MERIAN resulted in a shortening of the working time for the 4 proposals that were rescheduled onto the French research vessel ATALANTE. We therefore anticipated 12 working days for our program. However, due to a heart attack of a crewmember at Christmas Eve the scientific program had to be stopped early after only 9 working days considerably affecting the scientific program. Taking the unexpected short time of 9 days of station work cruise HYDROMAR V with RV “L'Atalante” and ROV “Kiel 6000” was still successful. We had no downtime of the ROV due to repairs and were able to achieve 8 dives during 8 consecutive days totalling 53 hours of bottom time. Weather conditions (up to seastate 6-7) precluded recovery of the instrument at night for the first couple of days limiting the time available at the seafloor for those first days. Problems with the Posidonia subpositioning systems on board the Atalante or between Atalante and the ROV Kiel 6000 prevented accurate positioning during most dives. However, localization was possible because of our precise knowledge of the hydrothermal field based on the excellent subpositioning during cruise MSM04/3 in January 2007 using the ROV Jason 2.

Due to the overall time limitations of the cruise several geophysical monitoring instruments, previously deployed during MSM04/3 could not be recovered due to time limitations. Also instruments and an additional mooring that should have been installed during this cruise could not be deployed. A major drawback to the scientific program was our inability to deploy the 720 m profiling mooring because of the emergency transit to French-Guayana.

At specific sites around the hydrothermal field we deployed 4 seismometers to monitor local seismicity. These seismometers will be collected on a later cruise of the SPP1144. Additionally, an ocean bottom tiltmeter (OBT) and an ocean bottom accelerometer (OBA) were deployed at Logatchev itself and will allow the correlation of regional and local seismicity to seafloor movements at the black smoker vents. Two high-temperature monitoring recorders are now deployed at two different vent sites and will monitor changes at two different sampling rates (1s for 1 month and 15s for a longer period), it will now be possible to relate changes in hydrothermal activity and vent exit temperature to tectonic processes. The hydrothermal plume as well as low- and high-temperature hydrothermal fluids have been sampled successfully, as have been the vertical temperature gradients in low-temperature diffuse discharge areas. Temperature measurements at individual sites show a pronounced increase in vent fluid

temperatures (353°C to 375°C) when compared to earlier years and even to the last SPP1144 cruise that took place in January 2007. We have to wait for the on-shore geochemical analyses of the vent fluids in order to see if there are major chemical changes of the vent fluids associated with this increase. On-board analyses of the Cl<sup>-</sup> concentration ( $Cl_{min}=540mM$  Cl) reveal no changes to previous measurements indicating that no significant change in the chlorinity has taken place. Another major focus was the sampling of the vent biota, which, due to the limited time on site, recovered less material than originally anticipated. Preliminary data suggest that two different populations are present at the two major working sites Irina 2 and Quest. The gills, foot and gonads of most of the specimens collected vary distinctly between the two sites. Plume surveys were repeatedly performed at the same sites to investigate plume behavior over time and with changing tides. One of the major outcomes of this study was the variability of the plume height above ground. Within 8 hours the plume maximum was recorded at water depths of 2700m and 3000m respectively, a difference of 300 m. This indicates the strong influence of bottom currents and tides on the plume dispersal at Logatchev. During this cruise we deploy an ADCP on a tripod in the immediate vicinity of a black smoker site, measuring local bottom currents and recording plume behavior for 7 days. Preliminary analyses of this unique data set show the strong tidal variations of the bottom currents affecting plume dispersal.

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16.	Martha Schattenhofer	Metagenomics	MPI Bremen
17.	Dr. Mirjam Perner	Microbiology	Uni Hamburg
18.	Thomas Meier	Microbiology	Uni Hamburg
19.	Marc Peters	Chemist/Sulfur cycle	Uni Münster
20.	Anne Westhues	Geology	Uni Münster
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22.	Martin Pieper	ROV-crew	IFM-GEOMAR
23.	Karsten Witkiewicz	ROV-crew	IFM-GEOMAR
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2. Groisard Thibault	Chief Mate
3. Hamon Briac	Mate
4. False Tristan	Mate
5. Pichard Serge	Chief Engineer
6. Rousselot Vincent	SD Engineer
7. Tison Guillaume	Third Engineer
8. Treluyer Loic	Electro. Engineer
9. Rouault Denis	Ass Electro Engineer
10. Tagatamanogi Visessio	Boatswain
11. Raguenes Christian	Able Seaman
12. Le Troadec Regis	Able Seaman
13. Guillerme Alain	Carpenter
14. Rigaux Daniel	Seaman
15. Le Henaff Jean Pierre	Seaman
16. Delarue Jean-Charles	Seaman
17. Le Gall Jerome	Seaman
18. Treguier Michel	Seaman
19. Floc'h Laurent	Chief Greaser
20. Le Reun David	Electrician
21. Paugam Patrick	Greaser
22. Loaec Maxime	Cleaner
23. Seite Jean-Jacques	Chief Cook
24. Allancon Marcel	Chief Cook
25. Appriou Thomas	Second Cook
26. Jacoby Claude	2nd Stewart
27. Ferron Fabrice	Third Cook
28. Saminadin Julien	Steward
29. Morvan Sybille	Steward

## 1.2 Research Program

The Logatchev hydrothermal field is situated on a small plateau within the rift valley of the slow-spreading Mid-Atlantic Ridge (MAR) at 14°45'N (Fig. 1.2.1). This part of the MAR is dominated by ultramafics (mantle rocks) with subordinate basaltic material – largely in the rift valley. Logatchev is one of only a few ultramafic-hosted hydrothermal systems known worldwide.

Extensive bathymetric and video mapping during the HYDROMAR I (2004), II (2005), and IV (2006) cruises revealed three factors that appear to control the location of the Logatchev hydrothermal fields: (1) cross-cutting faults, (2) young basaltic magmatism, and (3) slump structures.

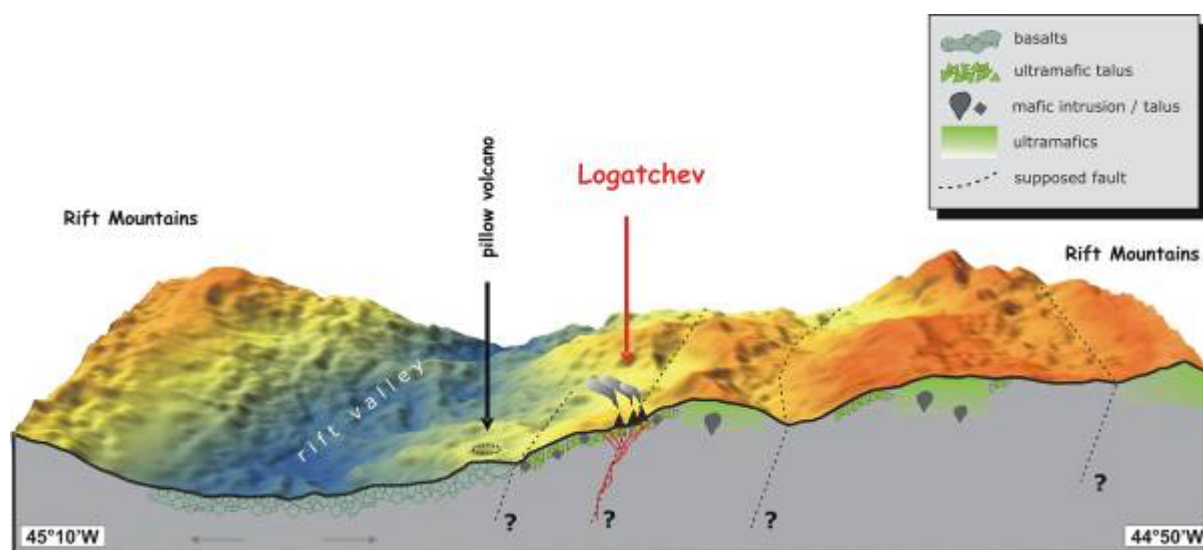


Fig. 1.2.1: W-E profile along 14°45'N without vertical exaggeration with water depths of 4000m in the rift valley and 1600m on the rift mountains. The geology of the ocean floor is interpreted from video mapping and TV-grab and ROV sampling of the seafloor.

Our investigations indicate that hydrothermal circulation takes place through ultramafic and basaltic talus material and is most likely related to the large slumps (Fig. 1.2.1; Augustin et al., 2005; Kuhn et al., 2005). The heat driving hydrothermal convection is probably supplied from magmatic pools associated with intrusive mafic melts localized underneath the adjacent rift valley and/or off-axis volcanic structures and from localized intrusion of melts into the peridotite. The petrology of gabbroic and dolerite fragments embedded in the serpentinized ultramafics suggests late intrusion of magma post dating the emplacement of the serpentinized ultramafics (Fig. 1.2.1; Franz et al., 2005).

On a local scale the Logatchev-1 hydrothermal field is characterized by two different styles of high-temperature hydrothermal activity:

- (i) so called „smoking craters“ (Quest, Anna-Louise, IRINA 1, Candelaber, and Site „B“) and
- (ii) mounds with black smoker chimneys at its top (Irina II and site “A”).



The main characteristics of these sites indicating interaction between magmatic, tectonic, hydrothermal and biological processes are as follows:

- All vents occur along a line striking NW-SE (Fig. 1.2.2). We interpret this alignment as an indication of structural control of the positions of the hydrothermal sites suggesting a connection between hydrothermal activity and seafloor deformation. Therefore geophysical long-term measurements have been set up during cruise HYDROMAR II in May 2005, and HYDROMAR III in January 2007 across this suggested deformation structure.
- The young pillow volcano and the abundance of mafic intrusive rocks in the Logatchev area indicate robust magmatic activity. This is not a magma-starved ridge segment as often stated in the literature. The magmatic activity likely also acts as a possible heat source driving the hydrothermal system.
- Preliminary age dating suggests that hydrothermal activity in the Logatchev-1 field has been occurring for at least 100 000 years.
- Hydrothermal fluids emanate with temperatures up to 350°C in all of these central structures. Isotopic analyses of the hydrothermal fluids ( $\delta^{18}\text{O}_{\text{H}_2\text{O}}$ ,  $\delta^{18}\text{O}_{\text{activity}}$ ), their dissolved ( $\delta^{13}\text{C}_{\text{DIC}}$ ) and particulate ( $\delta^{34}\text{S}_{\text{sulfide}}$ ) components indicate high-T water-rock reactions at depth. In contrast, exothermic serpentinization of mantle rocks can only account for a small fraction of the heat required for the observed vent temperatures.
- The vent fluids have high dissolved methane and hydrogen contents when compared to basaltic systems and these differences may have a major influence on the vent biota and metabolic turnover rates.
- In accordance with high hydrogen contents measured in the fluids diverse bacteria and archaea were identified which are using hydrogen for energy generation. In contrast, no known methane oxidizing species have been detected so far, although methane is a major component in the gas chemistry at Logatchev.
- Hydrothermal fluids also show distinct differences of outflow temperatures (up to 350°C at smoking craters, up to 300°C at the Irina II mound). Spatial and temporal microbial and metabolic variability on species level has been identified for hot as well as diffuse fluids exiting at different sites within the Logatchev hydrothermal vent field. So far no clear correlations between fluid chemistry and the variations of the microbial communities and metabolisms could be identified.
- Differences in the morphology of the vent structures and their geochemical and mineralogical composition are related to the different outflow temperatures as a

consequence of sub-seafloor mixing and cooling processes and subsequent mineral precipitation.

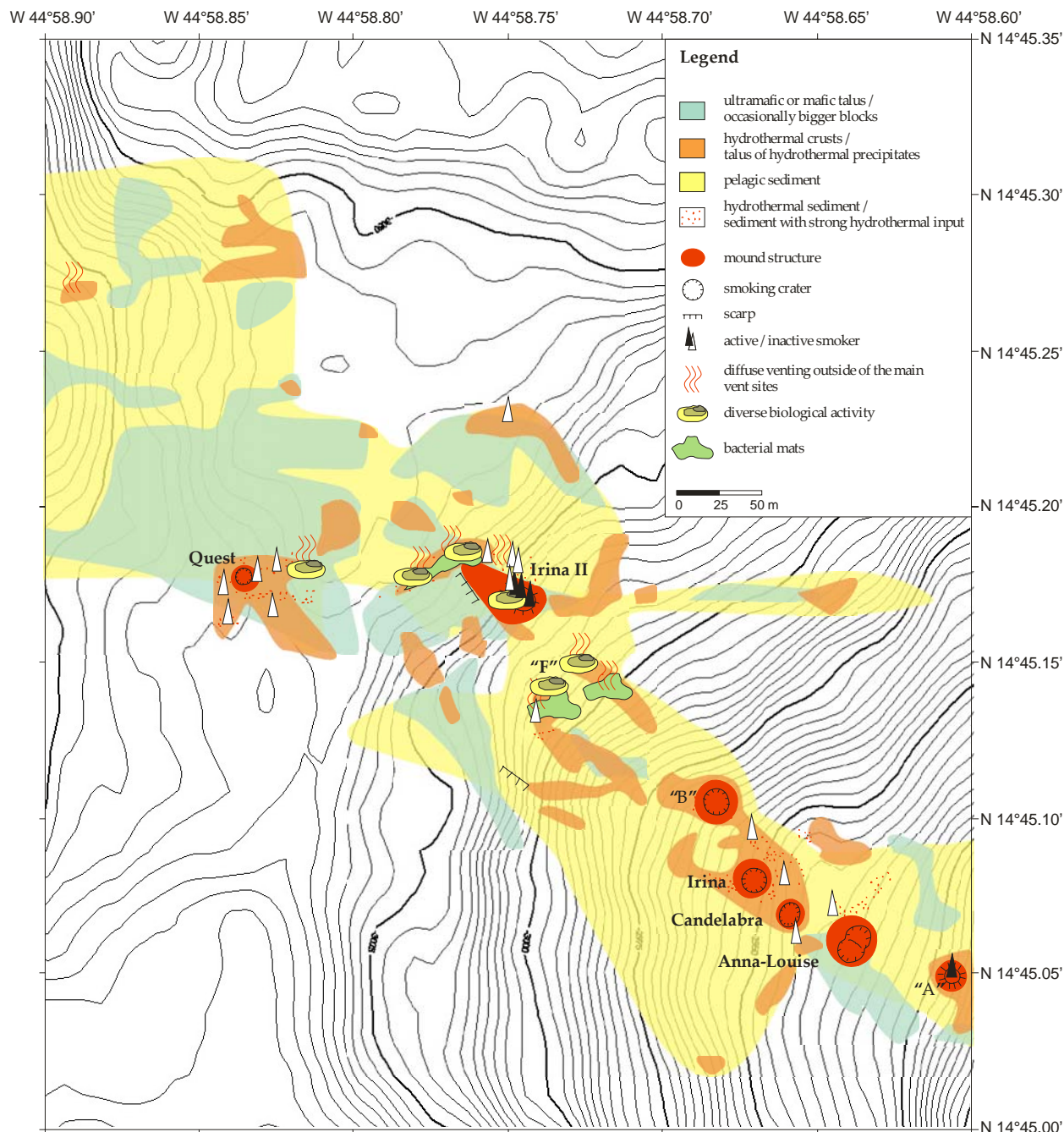


Fig. 1.2.2: Generalized geological map of the Logatchev-1 hydrothermal field based on ROV operations. Bathymetric and geological data from cruises M60/3, M64/2, MSM03/2, and MSM04/3. The high- and low-temperature vent sites are situated in a narrow NW-SE striking zone which might mark a fault zone. However, site "QUEST" is offset to the west probably along a cross-cutting fault which is indicated by cracks with diffuse venting (Kuhn et al submitted).

The unique character of our studies at the Mid-Atlantic Ridge since 2004 (under the auspices of DFG-SPP 1144) stems from the fact, that at least three different hydrothermal field areas – Logatchev at 14°45'N, Turtle Pits, Red Lion, and Wideawake Mussel Field at 5°S, and Lilliput at 9°30'S – have been visited annually. This allows, as

the overall goal of our studies, the evaluation of a multitude of possible causes for the observed compositional differences and temporal variations of the emanating vent fluids and their effect on the vent communities. To approach this general goal, the following scientific questions for investigating the processes at the Logatchev vent sites have been defined for the cruise HYDROMAR V:

### **1. Are changes in hydrothermal activity related to the local tectonic and magmatic activity?**

Local tectonic and magmatic processes and their evolution at 15°N on the MAR may influence the hydrothermal activity and also the vent ecosystem. Fluid pathways in the Logatchev hydrothermal system may be controlled by active faulting. A change of fault geometry due to local earthquakes may either close or open fluid pathways. This may have profound implications for fluid venting and the associated vent community. Such changes will be monitored by short- and long-baseline tilt measurements with the help of high resolution pressure and tilt measuring stations (OBTP), developed in the second phase of LOLEM. They were deployed in 2006 and 2007 across a suspected fault within the Logatchev field which allows us to quantify uplift or subsidence.

In addition an improved seismicity monitoring station (OBA) serves as a proxy for temporal variations in magmatic activity. Enhanced magmatic activity and/or processes in the reaction and upflow zone (like ingress of seawater) can have a profound and rapid effect on phase separation, fluid chemistry and hydrothermal fluxes thereby influencing the vent ecosystems. Therefore, monitoring the local tectonic and magmatic activity and long-term monitoring of environmental parameters such as temperature and pressure are needed to interpret changes in vent fluid chemistry.

The hydrothermal plume represents the output of the hydrothermal fields integrating the individual sources. Changes in the spatial distribution of the plume as well as changes in its physico-chemistry are related to variations of the local hydrography and hydrothermal activity. Three dimensional mapping of the plume thus allows us to establish an inventory of the total hydrothermal flux to the water column which in turn may be related to tectonic and magmatic activity.

### **2. What are the causes of site-specific variations of high-temperature vent fluid chemistry and how do they affect biological communities?**

The venting sites in the Logatchev hydrothermal field (smoking craters versus mounds) are characterized by differences in pH, Eh, temperature, in the abundances of dissolved major and trace metals and gases, and in varying microbial and microbial communities. We hypothesize that these variations are related to the underlying fluid pathways, to differences in water/rock-ratio during hydrothermal alteration, to phase separation, and to variable mixing ratios of seawater and upwelling hydrothermal fluid. Changes in the sub-seafloor are believed to occur with time. As a consequence, the vent communities will also be affected in their composition and life cycles.

We want to document the imprint on fluid composition caused by the local tectonic and magmatic activity (see point 1.) by repeated visits and sampling of individual vent sites. Expected is original information that allow for deciphering sub seafloor processes from fluid characteristics.

### **3. What are the small-scale, vertical physico-chemical variations of diffuse, low-temperature fluids and how do they affect zoology and microbiology?**

The vent biota is fuelled by diffuse outflows of hydrothermal fluids at low to moderate temperatures. While the focus of previous cruises has been on the investigation of horizontal gradients in vent fluids, this cruise will, for the first time, examine small-scale vertical gradients in vent fluids and their influence on the vent organisms. At sites with diffuse venting, organisms closest to the venting source experience higher concentrations of reduced compounds such as methane and sulphide than those further away from the outflow source. Sites where vertical gradients are assumed to play an important role are sediment-bearing areas covered by bacterial mats and mussel beds. At these sites, we plan to examine the vertical gradients in vent fluids using established *ex-situ* analyses of chemical and isotopic composition. These sampling techniques have improved with each HYDROMAR cruise and will ensure that the composition of the vent fluids can be investigated at a scale relevant to the microorganisms and animals that occur at Logatchev.

A combined approach of i) genetic analyses based on 16S rRNA gene and functional gene diversity, ii) metagenome analysis as well as iii) *in-situ* and iv) *ex-situ* cultivation experiments will provide details to fully characterize the site-specific differences in diversity and function of chemosynthetic microbial communities. Furthermore, metabolic capabilities of those organisms that are numerically and functionally important with respect to the coupling of microbiology and geochemistry will be studied. More specific investigations will center on those organisms involved in methane, hydrogen and sulphide turnover. Applying geochemical, microbiological and molecular approaches, we plan to identify and quantify respective processes in free-living and symbiotic microorganisms.

### **4. What are the compositional differences in fluid chemistry and vent biota between the Logatchev hydrothermal field and the hydrothermal vent sites at the southern MAR in relation to different host rocks, water depth, and presence of phase separation?**

In addition to temporal and site-specific variations in fluid and gas chemistry as well as vent community structures observed on different scales at Logatchev, equally distinct differences in these parameters exist between the Logatchev hydrothermal field and the hydrothermal vent sites at the southern MAR at ~5° to ~10°S (MARSÜD). Marked differences in the overall geological and environmental framework characterize these two areas, such as pertinent host rocks (ultramafic at Logatchev versus basaltic at 5°S) and prevailing water depths (3000 m at Logatchev and 5°S versus 1500 m at 9°33'S).

Repeated visits to the Logatchev field over four years and the examination of its variability in different scales will give a profound understanding of this system. As a similar detailed investigation will be performed at the hydrothermal fields on the southern MAR (cruises M64/1, M68/1 and Atalante Leg-1), this will allow a better comparison of the two major target areas of the SPP 1144. A final comparative interpretation of environmental, geological, fluid chemical and biological data will undoubtedly result in a comprehensive understanding of respective processes at these MAR sites and a quantification of the energy, material and life cycles at mid-ocean ridges in more general terms.

### **1.3 Daily Narrative**

#### **Tuesday, Nov 27th**

The majority of the ROV team (Pieper, Meier, Hinz, Witkiewicz, Foster, and Suck) and the chief scientist (Petersen) arrived in Toulon.

#### **Wednesday, Nov 28th**

The ROV team and the chief scientist embarked onto the Atalante (IFREMER at La Seyne Sur Mer) at 08:00 in the morning in order to oversee the arrival of the nine containers with equipment. The trucks all arrived in time and were unloaded until 14:00 in the afternoon. The first containers were unpacked and/or loaded onto the ship. The ROV-team immediately began mobilisation of the ROV. Custom clearance for the containers was given at 16:00. A group of 4 scientists (Buller, Koy, Perner, Westernstroer) arrived in the evening for the mobilisation taking place the following days.

#### **Thursday, Nov 29th**

Begin mobilisation of the science labs. The 4 containers with scientific equipment were unloaded on the pier or on the deck and the boxes distributed to the various labs. In the afternoon Dan Cormany, one of the ROV pilots arrived. One truck with OBS-instruments from Kiel arrived and was assembled by Martin Hansen from KUM.

#### **Friday, Nov 30th**

Continue mobilisation of the science labs and the ROV. Eight containers (5 ROV and 3 science) went on board the vessel, one container was returned to Bremen empty. The last container spot available was filled with the french „isotope container“ which was transferred from the vessel Purqui Pas together with the new lift line for the ROV. In the afternoon, all equipment was transferred onto the vessel.

#### **Saturday, Dec 01st**

Continue mobilisation of the science labs and the ROV. The ROV mobilisation is finalized and the ROV prepared for the harbour test. Five people from Genavir and IFREMER are on board as observers and will also be on board for the sea trials. Harbour test was performed between 16:00 and 19:00 and the system was OK. The coordinator of the ROV-team (Thomas Kuhn) arrived in the early evening.

#### **Sunday, Dec 02nd**

The 4 releaser for the OBS are tested in the morning in a water depth of 2000m and worked fine. Due to an increase in wind speed to 4 bft and increasing wind speeds throughout the day we decided to move the vessel closer to the shore line. The seatrial for the ROV took place in water depths of ~ 700m. During the seatrial the ROV descended to 727m and reached bottom. Handling was trained with all floats and proved to be no problem at the conditions encountered. In the evening the wind picked up again. Observers from IFREMER and Genavir were brought ashore using the ships zodiac.

### **Monday, Dec 03rd**

Seatrials were continued with several deployments and recoveries of the ROV. The wind picked up to 7 bft, but 2 deployments were possible because of the shelter of the coast. Around 11:30 the Atalante set sail and returned to La Seyne Sur Mer. The majority of the scientists arrived in the evening.

### **Tuesday, Dec 04th to Dec 15th**

In Transit to the Logatchev site. Time is used to finalize the lab setup. Several talks provide background information on the work done during previous cruises to the Logatchev field.

### **Sunday, Dec 16th**

In the morning we arrive at our first target position to take a background CTD in water depths of 5300 m. Three attempts to lower the CTD fail because of communication failures (ATA01CTD, -02CTD, -03CTD). The station is abandoned and, since the repair will take several hours, we proceed to the Logatchev site, where 4 ocean bottom seismometers are deployed in a diamond shape (ATA04OBS, -05OBS, -06OBS, -07OBS). The following night is used for a tow-yo (ATA08MAPR) using the gravity corer weight and 5 MAPR units to identify the extent of the hydrothermal plume.

### **Monday, Dec 17th**

The first scientific ROV dive (station ATA09ROV) is deployed despite winds up to 28 knots and seas of 3m. During the dive an ocean bottom pressure sensor and an ADCP are deployed and one OBT recovered. Due to weather conditions recovery is in daylight. Night program consists of three CTD stations (ATA10CTD, -11CTD, -12CTD). One taking a profile at the proposed location of the long (720m) profiling mooring. Station ATA12CTD is used to collect a large volume of water for metagenomic studies.

### **Tuesday, Dec 18th**

The second ROV deployment is again delayed because of the difficult wind and sea state conditions. This dive (ATA13ROV) is intended to sample hot fluids from the smoking craters to the south. Two sites are sampled: site "A" and "Anna Louise". Maximum temperatures at the sites are 317°C for site "A" and 353°C at Anna Louise. Again the recovery is in daylight due to weather conditions. The night is used for a long tow-yo (ATA14CTD) passing just north of the Logatchev hydrothermal field.

### **Wednesday, Dec 19th**

The next day is again used for a ROV-dive (ATA15ROV), this time devoted to sampling of diffuse fluids at Quest. The OBA is deployed west of the Quest crater in an area of intense sediment cover. The second tow-yo station (ATA16CTD), targeted to the south of Logatchev, is performed during the night.

### **Thursday, Dec 20th**

The tow-yo ended at 07:00. The fourth ROV dive (station ATA17ROV) was used to sample hot fluids at site "B" and Irina 1. At site "B" the KIPS system showed temperatures of 363°C at smoker B4. Even higher temperatures were measured at the same smoker by using the 8-channel temperature sensor. The lowermost sensor measured temperatures of 446°C ± 5°C which needs to be confirmed. Site „B was chosen as the site to deploy a temperature sensor (Smoni) for one year in order to monitor temperature changes over time. The second site visited during this dive was site "Irina 1". Here the KIPS systems measured an exit temperature of 375°C at smoker I3, much higher than any previous temperature measurement at the Logatchev hydrothermal field. The 8-channel T-sensor was deployed vertically in the bottom of the pit at Irina 1 and measured temperatures well above 400°C by inserting the probe between cpy-lined small (1 cm) outlets. During the night 3 CTD stations (ATA18CTD, -19CTD, and -20CTD) were deployed around the Logatchev field, one of these to sample ambient seawater for metagenomic studies.

### **Friday, Dec 21st**

The ROV station ATA21ROV is used to sample diffuse fluids and mussels from the area of T-loggers in the musselbed near Irina 2. The temperature loggers are also collected and aided by vertical temperature profiles with the 8-channel T-sensor. Additionally, push cores were taken at "Anyas Garden" for metagenomic studies. Since the work program for this dive was extensive we have a late recovery without any problems. The remainder of the night is used for 2 CTD-stations (ATA22CTD, -23CTD) adding to the profile lines for plume studies.

### **Saturday, Dec 22nd**



The next ROV dive (ATA24ROV) is used to deploy an Ocean Bottom Tiltmeter and to recover another one of these instruments. Sampling of hot fluids at „Irina 2“ and „Quest“ ist the second major task during this dive. Another Smoni is deployed, this time at site „Irina 2“, with a sampling rate of 1 sec in order to monitor the vent temperature for the remainder of the cruise. The Smoni is to be collected on one of the last dives (due to the early end of the station work, see below, this T-logger is still at the seafloor). Again two CTD stations (ATA25CTD, -26CTD) are used to extend the proposed N/S profile across the Logatchev hydrothermal field.

### **Sunday, Dec 23rd**

Station ATA27ROV is devoted to work on diffuse hydrothermal sites in the vicinity of the Quest smoking crater. Extensive temperature measurements using the 8-channel T-sensor accompanied by mussels sampling is undertaken. Fluid sampling with the KIPS system is another part of the work program during this dive. At the end of the dive an Ocean Bottom Pressuremeter is recovered. One CTD station (ATA28CTD) is used for an LADCP-profile, while the last station of the night (ATA29CTD) is again for filtering microbial material for metagenomic studies of the bottom water.

### **Monday, Dec 24th (Joyeux Noel, Merry Christmas, Fröhliche Weihnachten)**

The following day sees another ROV dive (ATA30ROV) aimed at taking hot fluid samples. This time we sample site „B“ and Candelaber where exit temperatures of up to 364°C might again indicate an increase in vent temperatures. During this dive all three temperature probes are used at the same edifice. After the dive, intense testing of the t-logger instruments (KIPS; Smoni, 8-channel sensor) was performed, and it seems, that the 8-channel sensor is not suitable for measuring the gradients within black smokers. See chapter on geophysics (chapter 1.4.5). While taking fluid samples at the seafloor, the seaman Laurent F'loch suffers a heart attack. The captain is on the telephone line with doctors in Toulouse and it is decided that he needs to be brought ashore immediately. The stationwork ends at 16:36 with the recovery of the ROV. The Atalante is starting her transit towards Cayenne in French Guayana, the closest port from Logatchev.

### **Tuesday, Dec 25th to Thursday, Dec 27th**

In Transit to Cayenne. At 06:30 in the morning of Dec. 27th Laurent is picked up by a pilot-boat and transferred to Cayenne. We wish him all the best! The Atalante is beginning its journey towards Recife, which, because of the strong counter currents will take us into Recife on January 2nd, 2008, actually as planned.

### **Friday, Dec 28th to Tuesday, Jan 01st**

Scientists are preparing the cruise report. The labs are cleaned for the next scientific party, also belonging to the SPP 1144. Most working groups only interchange personel,

however, a few instruments have to be uninstalled in preparation for their arrival. A baptizing ceremony is held on December 31st for crew and scientists alike.

### **Wednesday Jan 02nd**

The vessel arrives in Recife around 14:00 LT and the pilot is getting us into port at 15:00. The majority of the scientists and several ROC crew members disembark the next day, whith the new research team arriving on January 5th for the second cruise in the framework of the SPP1144.

## 1.4 Preliminary Results

### 1.4.1 Oceanography

(by Martin Vogt, Claudia Denker, and Uwe Koy)

During this cruise a total of 15 CTD-casts and 2 TOW-YO's were done between December 16th and 24th, 2007. During the first CTD- communication failures happened and we had to change the entire CTD. The first complete profile was made December 17th, 2007. The first TOW-YO took place over the night from 18th to the 19th of December. During this transect the second conductivity sensor broke down. It was changed for the next profile. For this cruise our CTD was packed with two temperature, two conductivity and two oxygen sensors. Additionally, a transmission sensor, to detect the plume, was deployed. Next to this we measured the current velocities with two 300kHz IADCP's. To correct the position of the CTD itself we fasten a releaser, who is able to work with Posidonia, at the CTD frame. With its help we expect more precise measurements of the IADCP's.

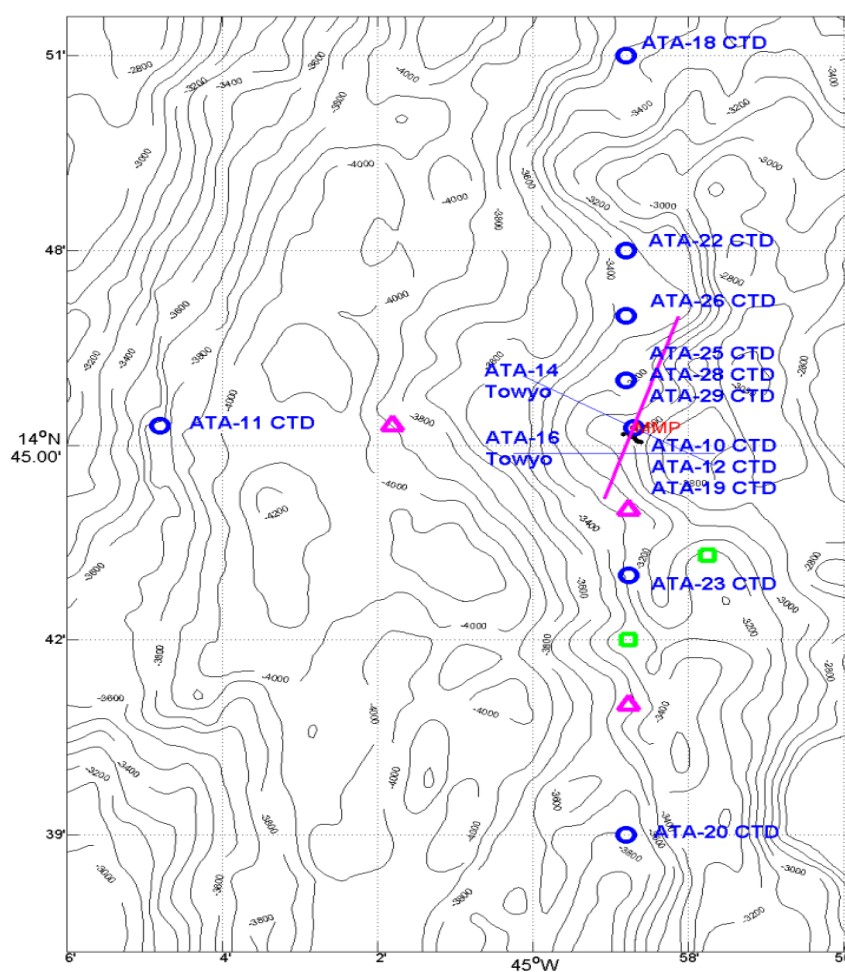


Fig. 1.4.1.1: Map of CTD- and tow-yo stations (blue; green symbols indicate stations performed on earlier cruises; magenta symbols indicate stations that were planned, but could not be done during this cruise).

### CTD-casts

The CTD-casts showed only little lateral variation in salinity and potential temperature. Of main interest were the water samples and the data from the LADCP. The most important observation during this cruise is enormous variability of the location of the plume with time. At two sites we deployed the CTD 3 times in order to document tidal variability. Figure 1.4.1.2 shows the position, potential temperature, salinity and transmission data for the stations ATA-10 CTD and ATA-12 CTD taken at the same position as the planned MMP-Mooring, but with 10 hours in between. The plume is clearly visible in both cases in the transmission sensor. Salinity and potential temperature also show variations in the area of the plume, the water seems to be colder and less saline than that above and below. It is remarkable to see a depth difference of ~300m in the maximum plume extent between the two stations. The LADCP data also showed variations between the two casts. In other stations, where a Plume was measurable, salinity and potential temperature stayed constant throughout the plume, and started to change again after the CTD was below the plume.

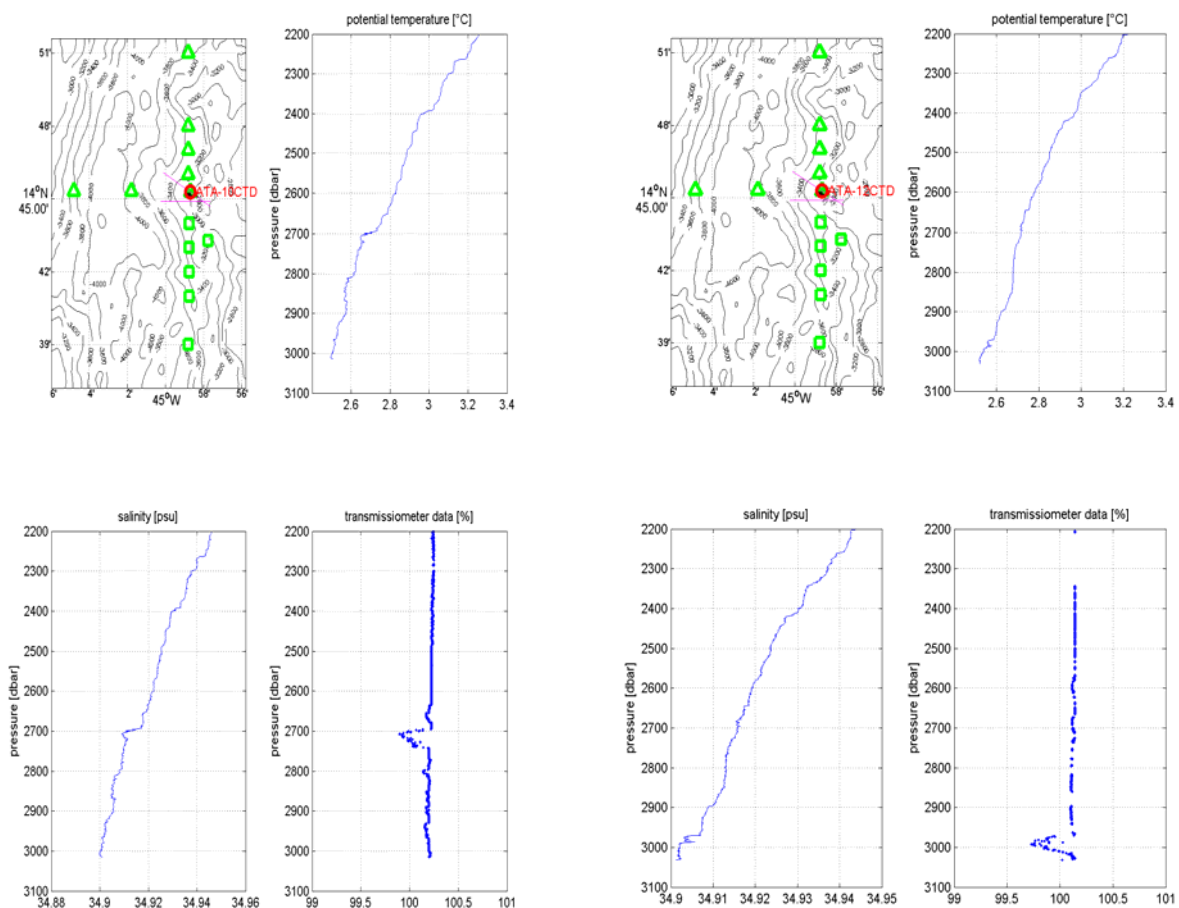


Fig. 1.4.1.2: position and profiles of potential temperature, salinity and transmission of station ATA10CTD (left) and ATA12CTD (right) below 2200m. Note the depth change of the plume maximum.

The LADCP's worked quite good, however, postprocessing of the data is required before interpretation is possible. It seems evident, that the tides are really strong in the area. The shift in the direction of the near-bottom flow of nearly  $180^\circ$  between station ATA-10 CTD and ATA-12 CTD can be used as an example. At last there were some tries to compare the track of the CTD calculated by the LADCP-processing routines with the Posidonia data from the CTD. But the data we got from Posidonia had too much spikes so that this maybe has to be done at home.

### Tow-yo's

The route of the first tow-yo was planned to be at a course of  $300^\circ$ , crossing the place of the planned MMP-Mooring 200m northeast of the smoker Irina II. The start point was on a hill east of Logatchev. The end was placed near the rim of the deeper basin. The path is shown as the northern blue line in Figure 1.4.1.1.

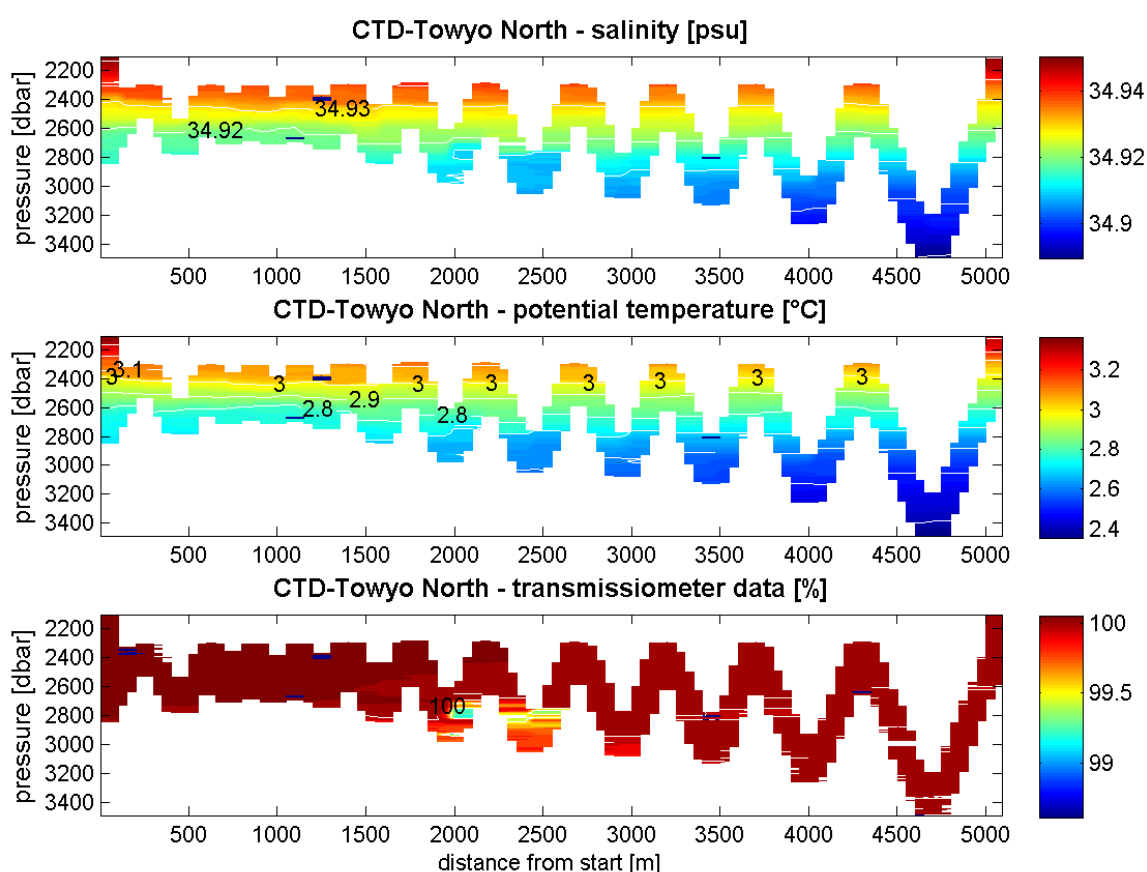


Fig. 1.4.1.3: Sectionplot of the northern tow-yo, shown is distance from the start against pressure above 2200dbar for salinity, potential temperature and transmission.

The data taken by the instruments can be seen in figure 1.4.1.3. The plume was measured at about 2800m depth during the seventh and eighth downcast and maybe in the ninth too. Like on the other stations, the change in temperature and salinity was rather small when the instrument reached the plume. Variations between up- and

downcasts are also visible. They are believed to be due to the fact that the instruments are on the bottom of the rosette. No significant variations in the depth of the isolines of salinity and temperature are visible.

The second tow-yo was along  $14^{\circ} 44.88'$  N, heading from east to west in the south of Logatchev (the southernmost blue line in Fig 1.4.1.1). In the transmissiometer data in figure 1.4.1.4 it can be seen, that the plume was measured again in the middle of the tow-yo. It seems to be stronger and wider but deeper than the northern plume. In the deep area where the plume was measured variations in salinity and potential temperature are apparent, which can again be the result of the CTD sitting in the bottom of the rosette.

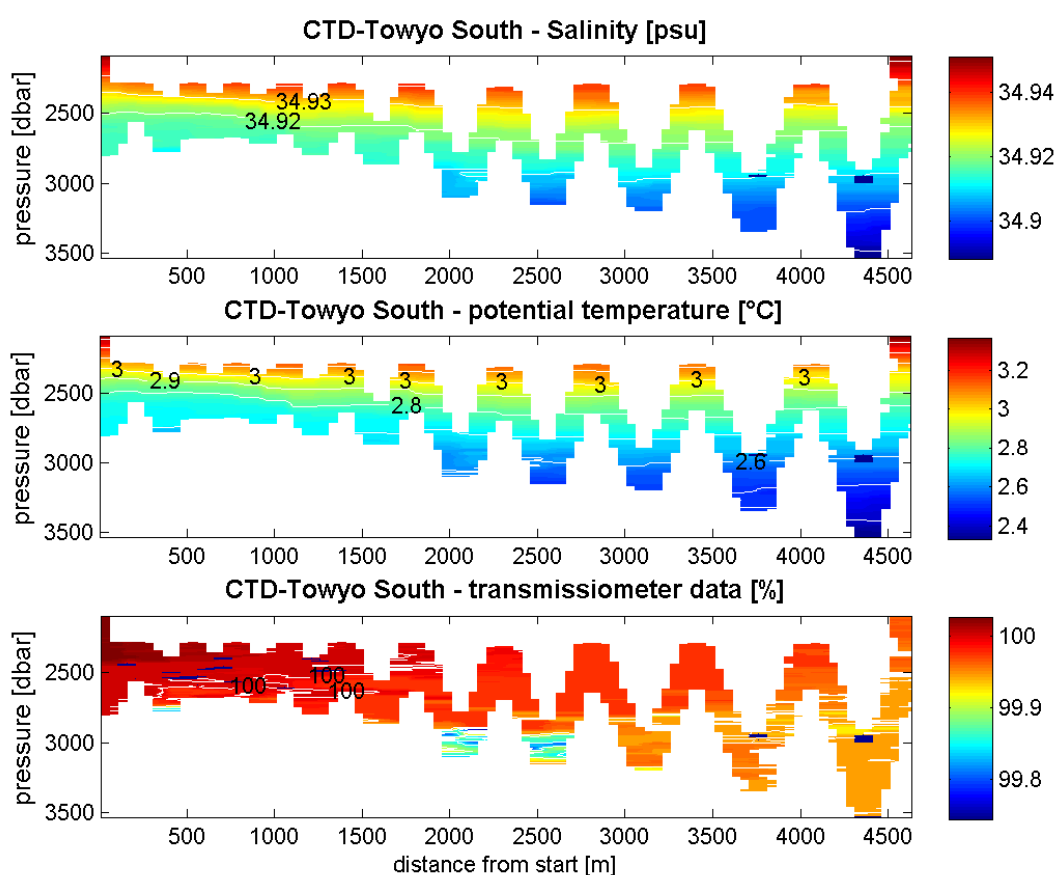


Fig. 1.4.1.4: Sectionplot of the southern tow-yo, shown is distance from the start against pressure above 2200dbar for salinity, potential temperature and transmission.

## Oxygen concentrations

O<sub>2</sub> concentrations [ml/L] were determined for 5 depths of ATA-10 CTD and 2 depths of ATA-11 CTD as well as 4 low-temperature diffuse and 1 hot hydrothermal fluid. Oxygen concentrations were determined by M. Perner and T. Meier. Methods used for determination of dissolved oxygen are described in the fluid chemistry section (chapter 1.4.6).

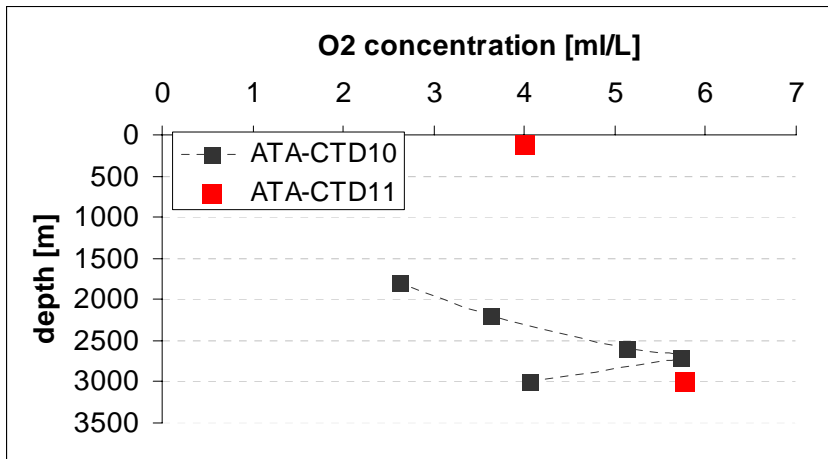


Fig. 1.4.1.5: Concentrations of dissolved oxygen (ml/L) at different depths for CTD10 and CTD11.

This data has not been compared with the data from the CTD's two oxygen sensors in detail. This calibration has to be done back in Kiel.

During the first dive we deployed an ADCP (IFM-GEOMAR, Kiel) on a tripod next to the small black smoker at Irina 2 and measured the current profile and the acoustic backscatter for a duration of 7 days. This record documents the variability of the bottom currents and clearly shows the changes in plume direction at Logatchev (see Fig. 1.4.1.6). This data needs to be further processed in the home institute

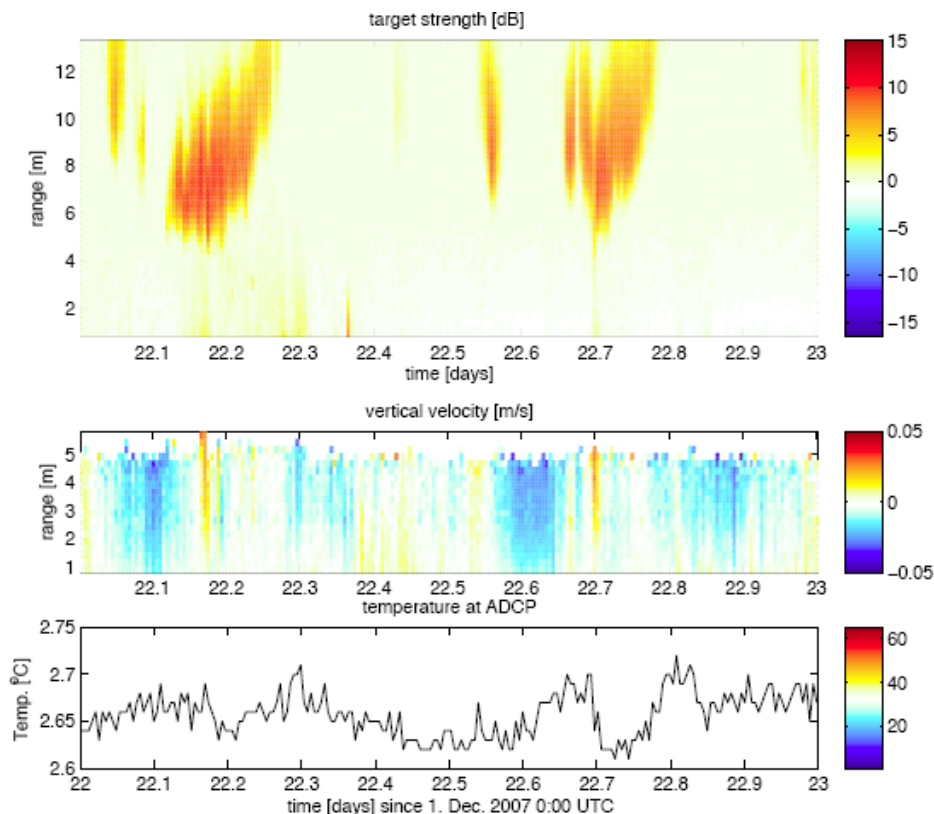


Fig. 1.4.1.6: Selected ADCP data record near the Irina 2 site on December 22<sup>nd</sup> showing evidence for tidal changes affecting plume direction. The upper panel shows the acoustic backscatter, while the lower panels show the vertical velocity and temperature measured by a sensor on the ADCP.

### 1.4.2 Plume mapping with MAPR

(by Herwig Marbler and Nico Augustin)

Hydrothermal plumes above mid-ocean ridges integrate the thermal and chemical output from hydrothermal vent systems, which are very important for the marine geochemical budget (e.g. Lilley et. al., 1995). In order to determine the horizontal expansion and vertical structure as well as the temporal variation of the generated hydrothermal plume above the Logatchev vent field a plume mapping was carried out. Measurements of the hydrothermal signatures in the water column include temperature, turbidity density as well as the redox potential (Eh) in the water column. The extension and structure of the hydrothermal plume is a function of the temperature and the amount of the emanated fluid and particles, the strength and direction of the deep-sea current and the morphology of the seafloor.

#### Methods and measurements

Miniature Autonomous Plume Recorder (MAPR) are self-contained instruments, which record data at pre-set time intervals from temperature (resolution 0.001°C), pressure (0 - 6000 psi gauge sensor), and nephelometer sensors (Sea Tech Light Backscatter Sensor, LBSS; Baker and Milburn, 1997; Baker et al., 2001). One of the five MAPR's includes also an Eh (redox potential) sensor provided by Dr. Nakamura (Tsukuba, Japan; Fig. 1.4.2.1). The instruments were attached to the hydrographic wire around 20 m above the CTD or at the frame of the CTD rosette.



Fig. 1.4.2.1: MAPR mounted on a hydrograph wire (left) with sensors (right): nephelometer LBSS (A), temperature (B), Eh (C), and density (D), instrument from Dr. Edward Baker at NOAA Institution, Seattle USA. Eh-sensor from Dr. Nakamura, Tsukuba, Japan.

All together 13 stations with MAPR deployment in the water column were carried out during the cruise (Table 1): 10 hydrocast stations were conducted as one-point measurements with CTD probe (see chapter 4.1) combined with 1 or 2 MAPR's. Three so-called "tow-yo's" were performed in defined tracks over the vent field (see figure 4.1.2.1): one S-N track with five MAPR's nominally arrayed between 20 and 250 m above a dummy, and two E-W tracks with one MAPR on the CTD frame.



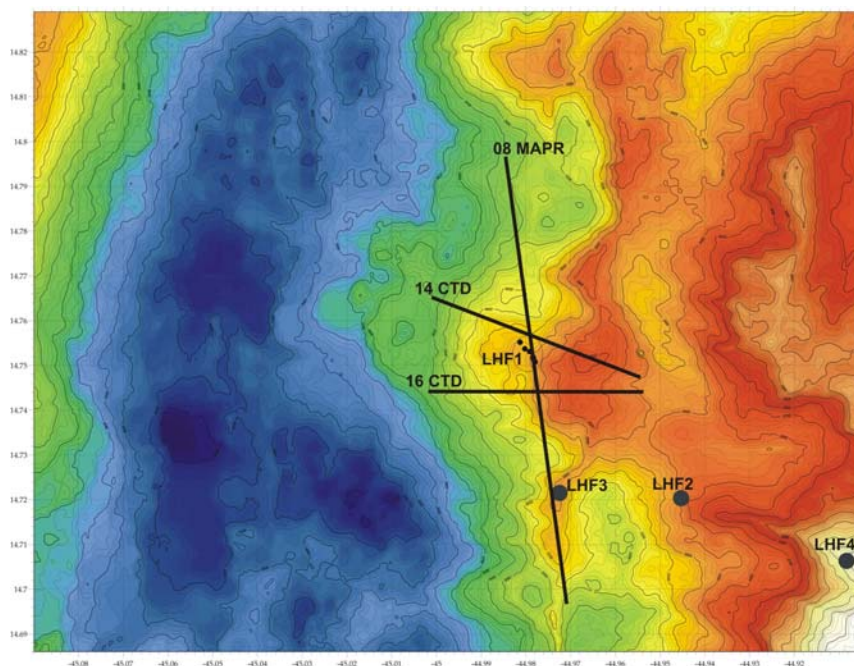


Fig. 1.4.2.2: Bathymetric map of the Logatchev area with the LHF1, LHF2, LHF3 and LHF4 fields and with the tracks of the tow-yo deployments.

At 7 CTD stations water samples were taken from different levels of the water column with a CTD rosette of 22 10L-Niskin bottles for further chemical analyses of dissolved Fe and Mn in the home laboratory of the Jacobs University Bremen. For the production of the profile plots of turbidity and Eh (Figs. 1.4.2.3 and 4) an interpolation of the water column measurements with the Golden Software product Surfer was carried out. Kriging was chosen as the gridding method for high-density measurement points (turbidity and Eh).

**Table 1:** MAPR Stations (mostly attached on the CTD – apart of 08 MAPR), with samples taken with CTD rosette from different water depths (different levels of the hydrothermal plume).

Station	description	Long/Lat (start) / (end)	CTD	MAPR's	Samples
08 MAPR	Tow-yo	14°42.0'N/44°58.07'W / 14°47,72'N/44°59,07'W	-	5	-
10 CTD	station	14°45.26'N/44°58.71'W	1	2	13
14 CTD	Tow-yo	14°44.69'N/44°57.65'W / 14°46.07'N/45°00.12'W	1	1	10
16 CTD	Tow-yo	14°44.88'N/44°57.65'W / 14°44.88N/45°00.25'W	1	1	10
18 CTD	station	14°50.97'N/44°58.80'W	1	1	6
19 CTD	station	14°45.27'N/44°58.74'W	1	1	4
20 CTD	station	14°38.96'N/44°58.81'W	1	1	-
22 CTD	station	14°48.00'N/44°58.80'W	1	1	-
23 CTD	station	14°43.01'N/44°58.76'W	1	1	-
25 CTD	station	14°46.00'N/44°58.81'W	1	1	8
26 CTD	station	14°47.00'N/44°58.81'W	1	1	-
28 CTD	station	14°46.00'N/44°58.80'W	1	1	10
29 CTD	station	14°45.97'N/44°58.80'W	1	1	-

## Results

Above and in the vicinity of the Logatchev Hydrothermal Field turbidity plumes in two depths were observed by MAPR measurements. One intrudes the water column between 2620 m to 2800 m water depth and a second one was found between 2850 m and 2980 m (Fig. 5). The latter is only observed in the close vicinity of LHF. In the LHF the hydrothermal plume is elongated in a NNW-SSE direction (Figs. 1.4.2.3 and 1.4.2.4), following the orientation of the vent sites (Kuhn et al., 2004) and of the ridge axis. The turbidity plume was observed in water depths between 2550 and 3000 m by MAPR measurements. The strongest plume signals (turbidity and Eh) from the lower and intermediate plume layer occur in the close vicinity of LHF. The horizontal and vertical extent of the plumes in the water column could be detected by the observation of turbidity and redox potential (Eh). The along-valley tow-jo track (08 MAPR) crossed the latitudes of LHF3 and LHF1 (Figs. 1.4.2.3 and 1.4.2.4), and shows clearly the turbidity anomaly in the effluent layers and the Eh anomaly in the “core” of the plume above the Logtachev hydrothermal field.

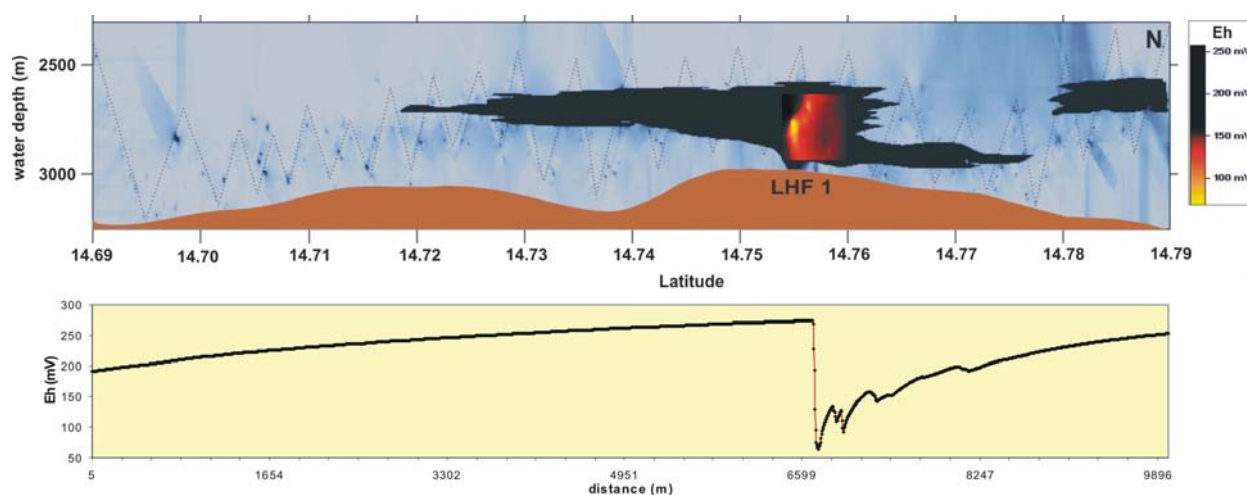


Fig. 1.4.2.3: Anomalies of turbidity and Eh along a south-north orientated tow-yo track (08 MAPR) across the LHF3 and LHF1 and the recorded Eh measurements over the distance of the track.

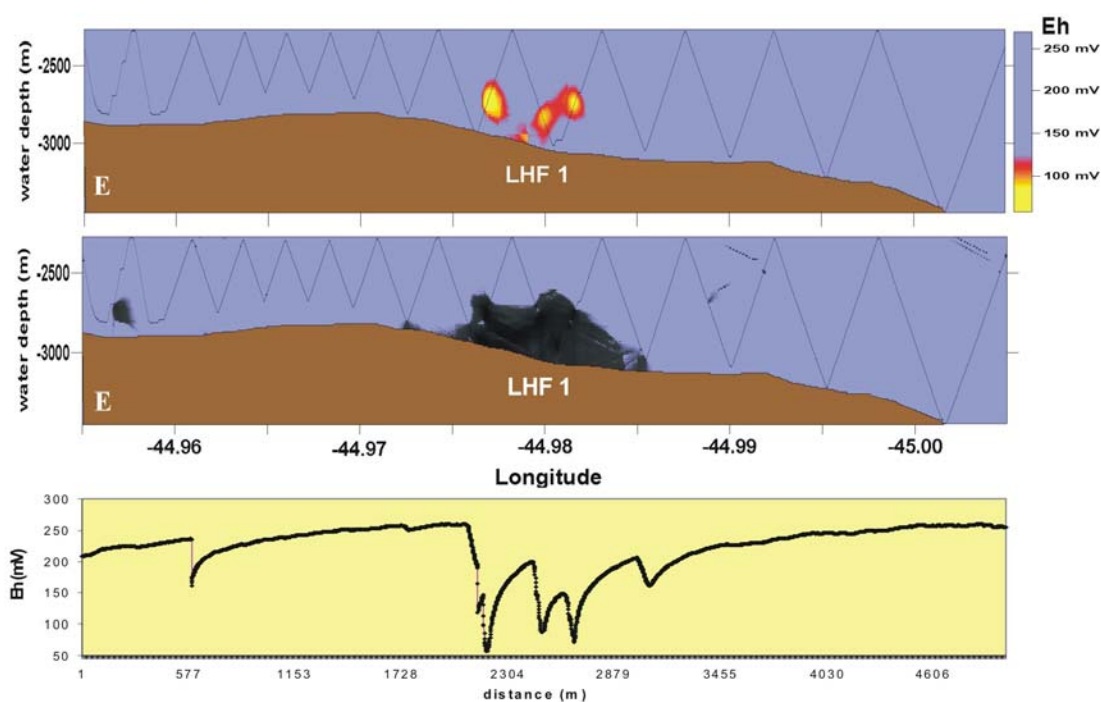


Fig. 1.4.2.4: Anomalies of turbidity and Eh along an east-west orientated tow-yo track with the recorded Eh measurements.

The profile plot of figure 1.4.2.4 shows a clear elongation in S-W direction of the turbidity plume in the area of the LHF. Especially an extension to the south, in the area of LHF3 could be observed. This might be the effect of a north-south directed deep-sea current and/or an influence from LHF3. However, no Eh anomaly, which would be a clear evidence of a further active vent field, could be detected in the area of LHF3. At a distance of about 4 km south from the vent source at LHF 1 almost no turbidity plume could be detected in the water column. The east-west cross-section in figure 5 reveal only a small drift of the hydrothermal plume in the water column with a clear Eh anomaly.

Data from the profile plots (Fig. 1.4.2.5) shows, that the Plume is stratified in up to three layers were the strongest turbidity signal from the intermediate layer appear between 2680 m to 2850 m water depth and from the lower plume layer the highest turbidity were found between 2800 m and 3000 m. The strongest Eh anomaly in the area of the Logatchev vent field is in the intermediate plume level in water depths between 2650 and 2850 m. In this level also the largest time variations were observed. Measurements after three hours at the same coordinates show that the intermediate plume level becomes blurred and pushed in deeper waters cause by deep-sea currents and uncontinuous fluid emanation from the vent field. The turbidity and especially Eh anomaly getting smaller with increasing distance to the source, due to continued mixing and diffusion processes.

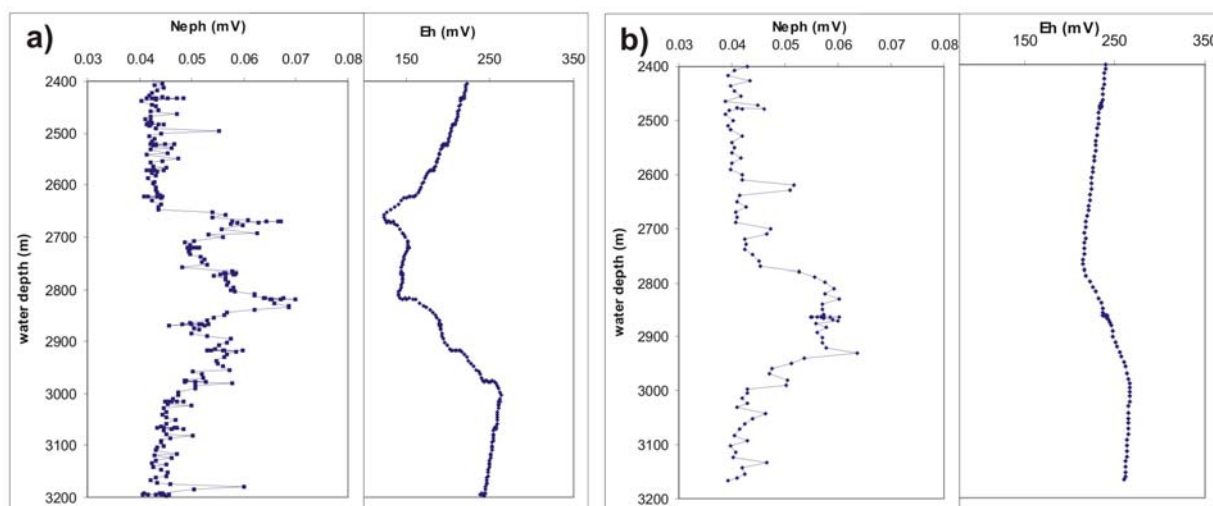


Fig. 1.4.2.5: Profiles of the water column 200 m NE the LHF1 at the same station from CTD 28 (a), and 29 CTD (b) recorded at 03:00 UTC and at 06:00 UTC at the same night.

Caused by the high temperature (up to 375°C) of the hydrothermal fluid (see chapter 1.4.6), the hydrothermal fluid and the blend seawater have an elevated temperature and a reduced density, which rises the plume to an altitude of maximal 400 m above the LHF before attaining a level of neutral buoyancy. The dominant process leading to the increased turbidity within the plume is the rapid Fe(II) oxidation to Fe-oxides and Fe-oxihydroxides and the continuous formation of colloids and particles. The highest concentrations of particulate phases were found in the core of the plume between 2700 and 2800 m water depth. This is related to the high iron concentrations in the hydrothermal fluid at the vent site with up to 246 ppm Fe. With increasing distance from the hydrothermal vent, larger particles will be lost from the plume by gravitational settling and the precipitation of iron-rich sediments on the seafloor. Thus the vanishing of the turbidity plume in the distance of 3-4 km from the vent site could be explained by the increasing dilution with ambient seawater and by sinking of Fe-oxides, Fe-oxihydroxides as well as Mn-oxides together with associated “scavenged” elements (e.g. German, 1990).

### 1.4.3 Gas Chemistry

(by Robin Keir, Peggy Wefers, and Saskia Buller)

During the l'Atalante cruise, methane and hydrogen were measured on board using gas chromatography. These gases are produced by several processes in hydrothermal systems. In the Logatchev field, it appears that serpentinization of ultramafic rocks plays an important role in their production. Primordial  $^3\text{He}$ , which is extracted into circulating hydrothermal fluid from cooling basalt, will be measured in the shore-based isotope laboratory at the University of Bremen. In addition, the stable carbon isotope ratio of methane from the fluid samples will be measured in an isotope laboratory at IFM-GEOMAR. The water samples for these analyses were collected from 9 CTD stations

and 7 ROV dives. The latter collections were mostly done using the KIPS device described in chapter 1.4.6. In addition, our group contributed to incubation experiments on bacteria-innoculated fluids conducted by M. Perner by monitoring the hydrogen concentration of the head space gas.

### **Methods**

In order to analyze dissolved CH<sub>4</sub> and H<sub>2</sub>, the fluid samples were degassed with a modified version of the method described by Lammers and Suess (1994) and Rehder et al. (1999). The separation of the gas and liquid phases is accomplished by drawing the water sample directly into a pre-evacuated flask, which is then only filled to about one to two thirds of the total flask volume. In the case of seawater collected by the CTD-rosette, about 1600 ml was drawn into pre-evacuated 2200 ml glass bottles. During this sampling, most of the dissolved gas (over 90%) 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 CH<sub>4</sub> and H<sub>2</sub> are determined by gas chromatography on two aliquots of this gas. For the determination of dissolved CH<sub>4</sub> a Shimadzu GC14A gas chromatograph equipped with a flame ionization detector was used in connection with a Shimadzu CR6A Integrator. Nitrogen was used as carrier gas, and separation was performed using a 4m Porapack column run isothermally at 50 °C. In addition to the vacuum-extracted gases, methane was also determined on about 30 seawater samples using a headspace method. In this case, about 1 ml helium gas was added to a 20 ml water sample in a closed vial, which was then allowed to equilibrate for a few hours. 100 µl of the headspace gas was then injected into the gas chromatograph.

The H<sub>2</sub>-concentration of the extracted gas was determined using a TRACE Ultra gas chromatograph (Thermo Electron) equipped with HaySep Q, and Molecular Sieve 5 A columns. Helium was used as carrier gas. The run was performed isothermally at 50 °C. The eluted gas was detected via a PDD (pulsed discharge detector). The remainder of the gas is then transferred to an evacuated 20 ml vial, and the septum is sealed on the outside with silicone and on the inside with about 4 ml of degassed saturated salt solution. CTD samples are listed in Table 1.

The sampling of the KIPS from the ROV was conducted in a fashion similar to that of sampling the Niskin bottles on the CTD-Rosette. In this case, either about 350 ml of fluid was drawn into an evacuated 500 ml bottle, or about 100 ml was drawn into a 250 ml bottle in the case of black smoker fluid. The results we obtained with the KIPS sampler are generally lower than those at the same sites using the titanium (MAJOR) samplers on Merian cruise 04/3. One fluid sample was obtained on the l'Atalante cruise with a MAJOR. However; during the sampling the Luerlok tubing did not remain tight. ROV samples are listed in Table 2.

He isotope measurements will be performed at the IUP, section of Oceanography, at the University of Bremen with a fully automated UHV mass spectrometric system (for details see Sültenfuß et al. 2004).

### Preliminary Results

CTD stations taken near the vent field exhibited hydrogen concentrations up to about 2000 nmol/L and methane concentrations up to about 450 nmol/L. In contrast, on the far side of the rift valley, about 10 kilometers to the west of Logatchev, only a trace of the methane plume with a maximum concentration of about 2 nmol/L remains. The hydrogen and methane concentrations are reasonably well correlated at about a 5 to 1 mole ratio (Figure 1.4.3.1). This ratio is the same as that observed on Merian cruise 04/3 to the Logatchev area in February 2007. The highest concentrations were observed during the tow-yo casts and just to the north of the vents at Station 28-CTD. Profiles of methane and hydrogen at this station exhibited three maxima between about 2700 and 3000 meters depth (Figure 1.4.3.2 and 1.4.3.3).

*Table 1.4.3.1: Sample list for CTD-stations*

Station	Long. W / Lat. N.	CH <sub>4</sub>	① <sup>13</sup> CH <sub>4</sub>	H <sub>2</sub>	He
10-CTD	44° 58.7 / 14° 45.3	19	19	19	19
11-CTD	45° 05 / 14° 45	20	20	20	5
12-CTD	44° 58.7 / 14° 58.7	3	3	3	-
14-CTD	Tow-yo	20	20	20	-
16-CTD	Tow-yo	20	20	20	20
18-CTD	44° 58.8 / 14° 51.0	18	18	18	21
20-CTD	44° 58.8 / 14° 45.3	19	19	19	21
22-CTD	44° 58.8 / 14° 48.0	17	17	17	21
25-CTD	44° 58.8 / 14° 46.0	17	17	17	14
28-CTD	44° 58.8 / 14° 46.0	19	19	19	-

*Table 1.4.3.2: Sample list for ROV-stations*

Station	CH <sub>4</sub>	① <sup>13</sup> CH <sub>4</sub>	H <sub>2</sub>	He
13ROV	3	3	3	
15ROV	1	1	1	
17ROV	5	5	5	2
21ROV	3	3	3	
24ROV	5	5	5	1
27ROV	1	1	1	
30ROV	2	2	2	

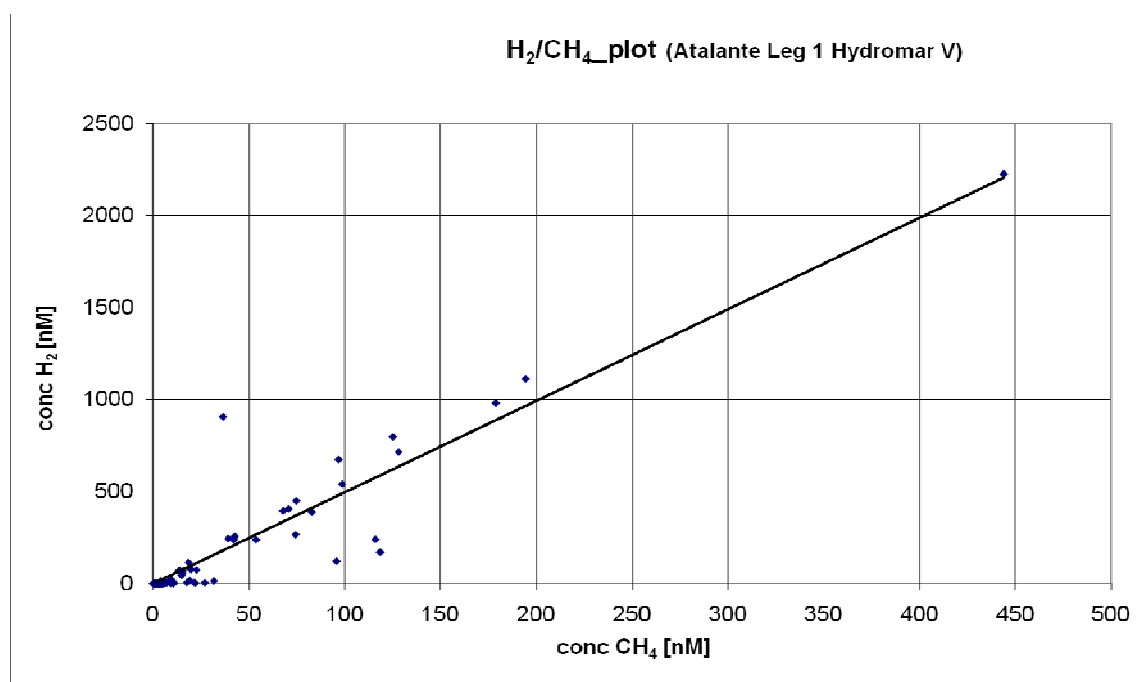


Fig. 1.4.3.1. Hydrogen versus methane concentration in water column samples collected by the CTD-rosette.

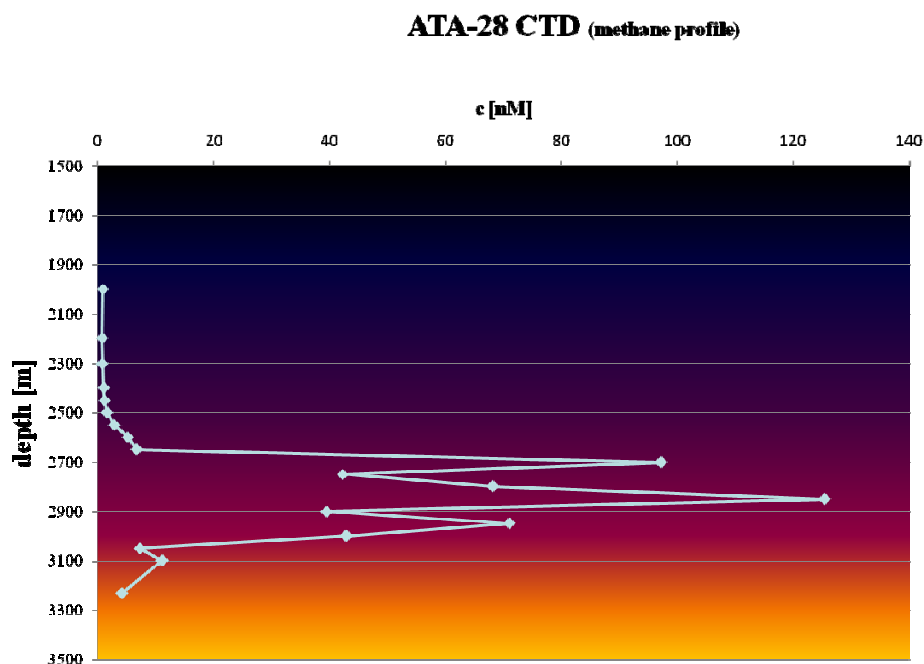


Fig. 1.4.3.2. Dissolved methane versus depth at station ATA28CTD.

Methane and hydrogen values measured on the fluid vent samples from the KIPS were generally lower than those collected at the same sites with the titanium MAJOR sampler on Merian 04/3. We also did not observe a correlation between methane and hydrogen in these samples as we did on the previous Merian cruise (Figure 1.4.3.4). We believe

that this may be because the KIPS sampler, which is designed to sample for trace metals without contamination, is not gas tight, even at atmospheric pressure. Thus some of the dissolved gas may be lost after collection of the fluid sample, during ascension of the ROV. In addition, gas exchange with the air takes place once the KIPS sampler is brought on board.

#### ATA-28 CTD (hydrogene profile)

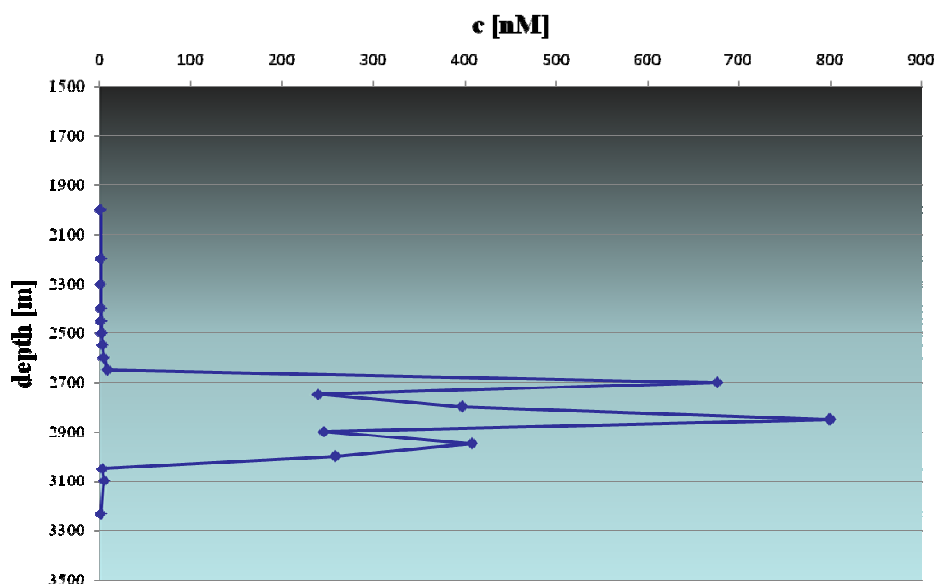


Fig. 1.4.3.3. Dissolved hydrogen versus depth at station ATA28CTD.

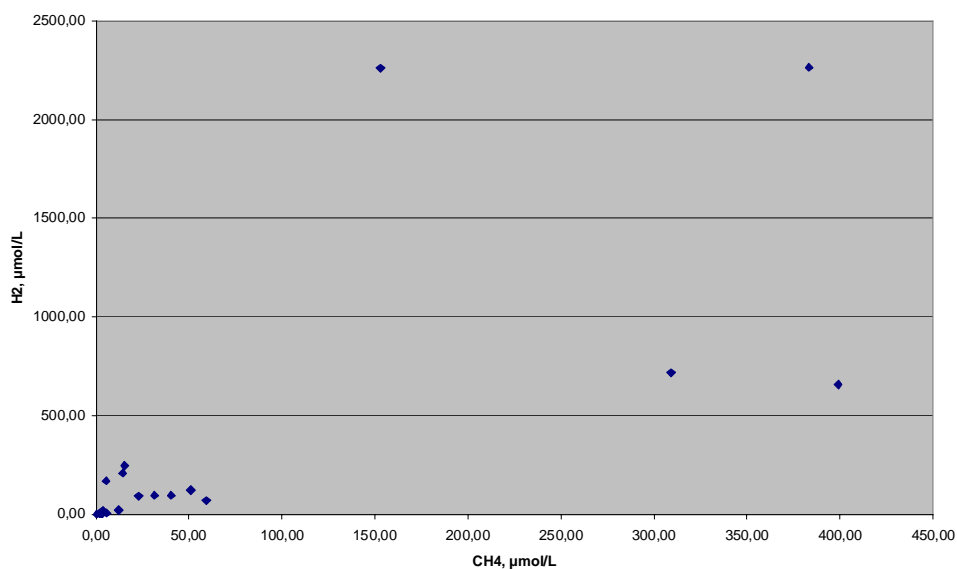


Fig. 1.4.3.4: Hydrogen versus methane concentration in µmol/L of fluid samples taken during the ROV dives.



#### **1.4.4 Logatchev Longterm Environmental Monitoring – LOLEM**

(by Marcus Fabian and Bernd Heesemann)

##### **Overview**

Main part of project LOLEM is monitoring of environmental parameters, which are sea floor tilt, sea floor acceleration, absolute sea floor water pressure, the vertical bottom water temperature profile, Black Smoker outflow temperature and temperatures in mussel fields at the Logatchev Hydrothermal Vent Field (LHF).

The long-term data is essential for assessing local changes in environmental conditions, which might bias the development of biological communities and also the flow patterns in the fluid regime, but are, moreover, important to study local sea floor deformations and mass movements at the sea floor, tectonics, strong sea floor motions and hydrothermally forced flux in the upper subsurface and through vents to the ocean. The data therefore provides boundary values for biology, fluid chemistry, geology and hydrology.

Long-term observation instruments, which were adapted for deployment at the LHF are two Ocean Bottom Tiltmeters (OBT; Fabian & Villinger, 2007, Fabian & Villinger, submitted), an Ocean Bottom Accelerometer (OBA), two Ocean Bottom Pressure meters (OBP), two 25m-Moorings for monitoring of the vertical bottom water temperature profile, high temperature Smoker Monitoring Devices (Smoni), and 20 miniaturized single channel temperature loggers (MTL, Pfender & Villinger, 2002), which are individual sensors embedded in a T-handle housing, and four 8-channel temperature loggers for short-line temperature profile measurements in mussel fields at vent sites "Irina 2" and "Quest". Additionally, a ROV-based 8-channel temperature probe for in-situ measurements with real-time data transfer to the ship was brought in.

##### **Cruise Hydromar V with RV "l'Atalante" and ROV "Kiel 6000"**

Continuation of long-term monitoring was one main objective for project LOLEM. Another important aim for the SPP was the installation of one SMoni and two 25m-Moorings at an active smoker at site "B" to assess, in combination with a 700 m Mooring of IFM-GEOMAR, energy flux through vents. Recovery, upgrade/repair and re-deployment of the installed ocean bottom instruments OBT 1, OBT 2, OBP 2, Mooring 2 and the MTL in mussel fields, which were deployed during cruise MSM04/3 of RV "Maria S. Merian", was necessary. The repaired instruments Mooring 1 and 8-channel temperature loggers, which recorded data during the first deployment after cruise M64/2 of RV "Meteor" (Lackschewitz et al. 2005) should be re-deployed and the new OBA had to find its place at the LHF.

Most of the recovered instruments successfully recorded data as expected. However, various MTL were damaged by hot fluids or had hairline cracks in their housings of unknown origin and lost their data. The old OBT 1 had a leakage in its deep sea cable, so that data is available but mostly corrupted. Figure 1.4.4.1 provides an overview of the available data and of the schedule until the last cruise in 2009.

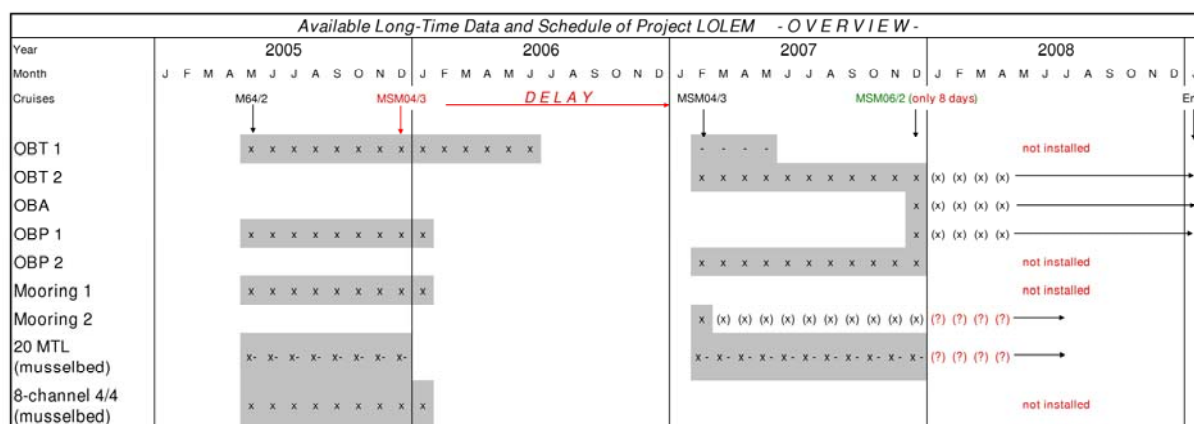


Fig. 1.4.4.1: Overview of long-term data of project LOLEM. Grey blocks mark available data, crosses good data and a minus sign marks corrupted data. Brackets with a cross mark expected data from recently active measurements and brackets with a question mark uncertain data of still running instruments. Due to a delay in the delivery of the RV "MARIA S. MERIAN", a data gap of about one year is in 2006. During MSM04/3 instruments were re-installed or replaced for the first time. As cruise MSM06/2 with RV l'Atalante had only a few working days, a couple of instruments could not be recovered, re-installed or deployed. For older data and station work refer to cruise reports of M64/2 and MSM04/3.

The OBT 2 was re-deployed, and the OBA and the OBP 1 were deployed. OBT 1 and OBP 2 were recovered, had data and were repaired and upgraded, but could not be re-deployed. The Mooring 1, was not deployed. The Mooring 2 could not be recovered and re-deployed. One new SMoni was successfully deployed for long-term monitoring in a black smoker of site "B", whereas another SMoni was deployed for short-term measurements during the cruise at site "Irina 2". 20 new/repared MTL and 8-channel temperature loggers could not be deployed and some old instruments at site "Irina 2" were not collected, so that those instruments continue their recording. The map in Fig. 1.4.4.2 provides an overview of currently installed instruments without the distributed temperature sensing system.

The ROV-based 8-channel temperature probe was successfully used to check temperature profiles in sediments and diffuse fluids, but temperature values from very hot black smoker outflow are uncertain. The fluids possibly have become slightly hotter since the last cruise MSM04/3 (350-375°C instead of 340-350°C) and are now so hot that the temperature probe had to operate at the boundary of its range. Re-calibration of the instrument is necessary to evaluate the high temperature readings of the 8-channel T-sensor.

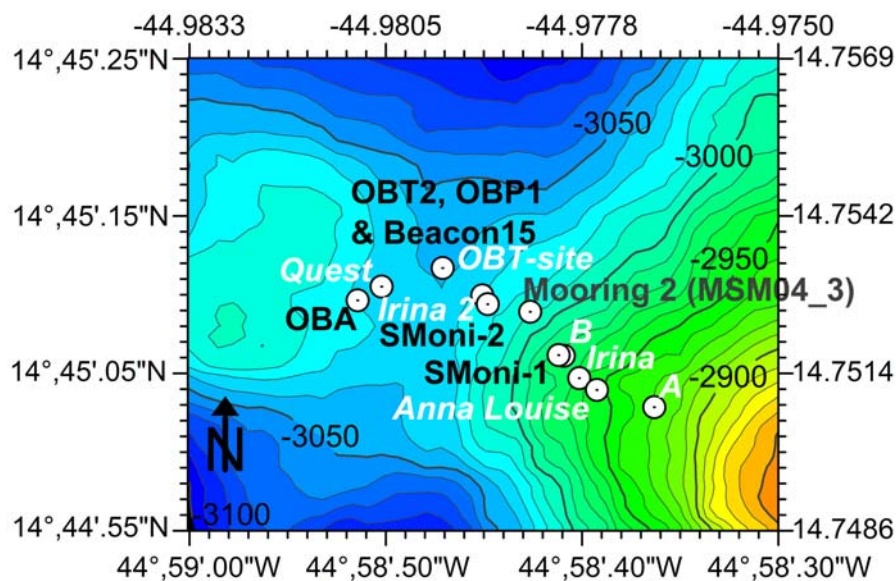


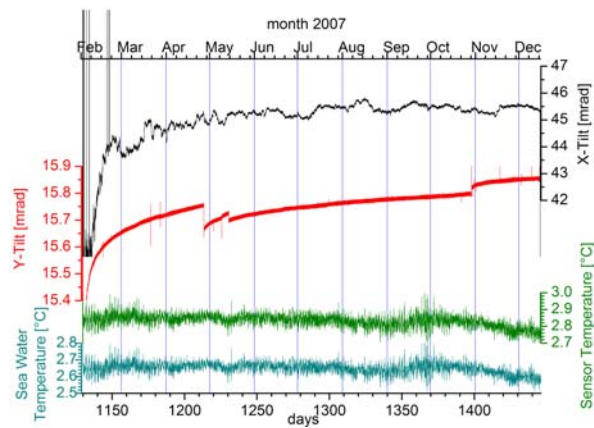
Fig. 1.4.4.2: Map of the LHF with current instrument positions of OBT 2, OBP 1 and a Sonardyne Beacon with identity 15 at the "OBT-site", the OBA near site "Quest", the SMoni-1 in a black smoker at site "B", the SMoni-2 at site "Irina 2" and the Mooring 2, which was deployed during cruise MSM04/3 of RV "MARIA S. MERIAN".

### **OBT instruments**

The OBT 1 and the OBT 2 measure sea floor tilt in two perpendicular horizontal directions with 1  $\mu$ rad resolution in a range of  $\pm 10^\circ$ . Both instruments have a MEMS-accelerometer to record low frequency vertical acceleration from DC/0 Hz to 0.5 Hz. A thermistor measures the sensor temperature and an MTL lashed to the instrument frame records sea water temperatures (Fabian & Villinger, 2007). Sampling of tilt and sensor temperature is 5.7 s, of acceleration is 0.71 s and of sea water temperature is 8 min. The OBT are equipped with a deep sea level (M. Fabian and B. Heesemann, 2006) to facilitate levelling. The first deployment of the OBT 1 was rather successful and provided nearly 400 days of data (Fabian & Villinger, submitted). The new data of the OBT 2, recorded since cruise MSM04/3, is shown in Fig. 1.4.4.3 and is of similar length of 330 days.

After recovery, the OBT 2 could be repaired, upgraded with new electronics, equipped with fresh batteries and re-installed at its old position at the "OBT-site", which has the coordinates  $14^\circ 45.194$  N /  $44^\circ 58.773$  W in 3035 m depth. A marker with two white floats and an anchored buoy with a Sonardyne Beacon (ID 15) mark the site. However, due to the short time between the approval of the recent project-part (beginning of august 2007) and the original schedule of the cruise MSM06/2 (mid of October 2007), as well as the long delivery time of special lithium batteries for the OBT, only alkaline batteries could be bought limiting operation time to a couple of months.

a)



b)

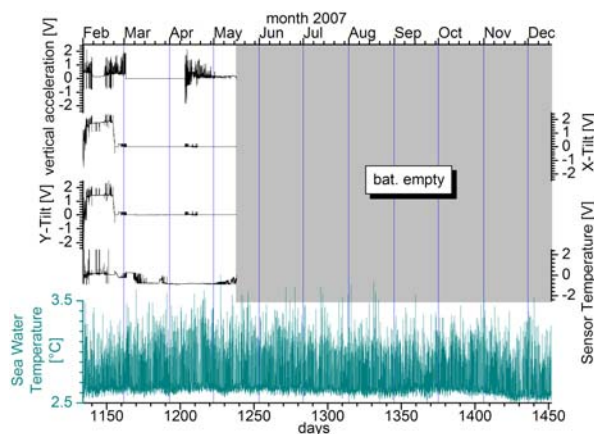
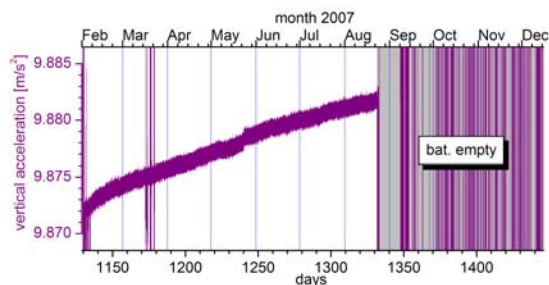


Fig. 1.4.4.3: Long-term data collected by OBT 2 at the "OBT-site". (a) shows tilt in two perpendicular horizontal directions, X-tilt and Y-tilt in mrad, as well as sensor and sea water temperature in °C. Tilt data shows an exponentially decaying long-term trend that is superposed by a small oscillation of about 0.1 mrad and in x-tilt by an additional fluctuation of about 0.5 mrad amplitude. Spike like excursions in the beginning of the record are caused by the installation, whereas the excursions in the third week of February are recently of unknown origin. (b) shows the record of vertical acceleration, which also shows an exponential long-term trend. In the end of August, the batteries of this sensor are empty. Strong excursions during the third week of March might be caused by local seismic activity and correlate in time with some spikes in the record of Y-tilt in (a). Sensor and sea water temperature show nearly the same record. Some stronger fluctuations in the end of September and a trend to lower temperatures thereafter is obvious.

Fig. 1.4.4.4: Long-term data collected by OBT 1. Due to a leakage in the deep sea cable between sensors and data logger since the installation the data is corrupted. Vertical acceleration, tilt and sensor temperature are therefore shown in volts and have erratic curves. However, the sea water temperature record is of high quality and is remarkably different from the same record of the OBT 2.

### OBA-instrument

The Ocean Bottom Accelerometer (OBA) has six micro-electro-mechanical-systems, MEMS-accelerometers of the same type as the OBT (Fabian & Villinger, 2007). The sensors arrange pair wise to record sea floor acceleration in three directions of space. Resolution of acceleration is about  $10^{-5}$  m/s<sup>2</sup> with a range of  $\pm 30$  m/s<sup>2</sup>, so that the

sensitivity is high enough to detect small vibrations above micro seismic noise at the sea floor, and the range is broad enough to record strong events. The sensors operate in a frequency range from DC/0 Hz to 300 Hz. Absolute acceleration is measurable and the sensors can work as tiltmeters. A newly developed low-power digitizer inside the OBA has eight input channels with anti-alias filters and can sample the accelerometers output signals with frequencies of up to 20 Hz and 21 effective bits. The two remaining channels of the digitizer sample an additional tilt sensor of type Applied Geomechanics Inc. 756 with 1  $\mu$ rad resolution and a range of  $\pm 10^\circ$ , so that the OBA can also work like an OBT. Two miniaturized temperature loggers are attached to the instrument frame to record sea water temperature with two different sampling rates of 3 min and 13 min. The size of the OBA is 1.36 m for the long edge, 0.68 m for the perpendicular bisector of the base plate and 0.96 m for the short edges, with a total height of the instrument of 0.78 m. Weight in water is 600 N and in air of 1700 N. Site "Quest" was selected for the OBA installation as it was thought from earlier cruises to have stable ground and is a good place for sea floor deformation measurements in contrast to the OBT-site, where two tiltmeters record data. However, site "Quest" turned out have unfavourable ground with steep slopes and friable hydrothermal crust. As the ROV-time was limited, the OBA was finally installed nearby site Quest and could not be levelled, so that only the accelerometers, but not the tiltmeter are expected to provide data. The position of the OBA is 14°45'9.6" N, 44°58' 51.4" W in about 3032 m depth and is drawn in the map in Fig. 1.4.4.2.

### **OBP-instruments**

Both OBP measure absolute water pressure and have a resolution of about 1 mm in its installation depth of 3035m. In contrast to the OBP 1 the OBP 2 is a completely new instrument that is used for the first time and is equipped with so called Bennest™ technology to sample a Paroscientific pressure sensor at a high rate. Resolution of the OBP 2 should be better than 1 mm. OBP data will be used to assess vertical sea floor displacements with respect to the mean sea level and therefore complement the OBT data. The data also shows a highly resolved tidal signal of the loading of the water column on the sea floor (see Borowski et al., in preparation). The OBP 1 was deployed next to the position of OBP 2 and the OBP 2 was recovered. The OBP 2 recorded since deployment, but the data has to be processed separately for representation. The instrument was checked and repaired, but could not be re-deployed due to the unexpected end of the cruise.

### **25m-Mooring – Bottom Water Vertical Temperature Profiler**

Two 25m-Moorings were supposed to be installed north and south of the highly active site "B" to record variations in the bottom water temperature profile related to nearby black smoker outflow. The aim was to assess flux rates of hot fluids through black smokers. The same type of mooring recorded those temperature variations during its first deployment (see Borowski et al., in preparation), so that the measurements should

be repeated with two instruments and a smoker monitoring device SMoni (see next section) should directly record the temperature variations in a chimney at site "B". Additionally, a larger 700 m long mooring, brought in by IFM-GEOMAR, should record regional plume temperatures and chemistry. This experiment was one main objective of the cruise. However, the old mooring near site "F" could not be recovered and the new mooring could not be deployed. The old mooring is still at 14°45.149 N/44°58.714 W in 3000m depth and has a Sonardyne Beacon with ID 14 at its rope.

### Smoker Monitoring Device SMoni

The SMoni are newly designed instruments to monitor the fluid temperature of smoker outflow directly inside the chimney. The system consists a long and bended sensor housing, the tip of which can be placed directly inside the chimney, and a data logger that is attached through a longer cable to be placed at a cooler place. Fig. 1.4.4.5 shows a photo of one SMoni installed at a black smoker and the associated data record, which displays temperature of about 341°C. One SMoni was installed at site "B" for long-term monitoring until the next cruise using a sampling rate of 15 sec. Another SMoni, set-up for short-term recording (1 sec), was left at the microsmoker at site "Irina 2".

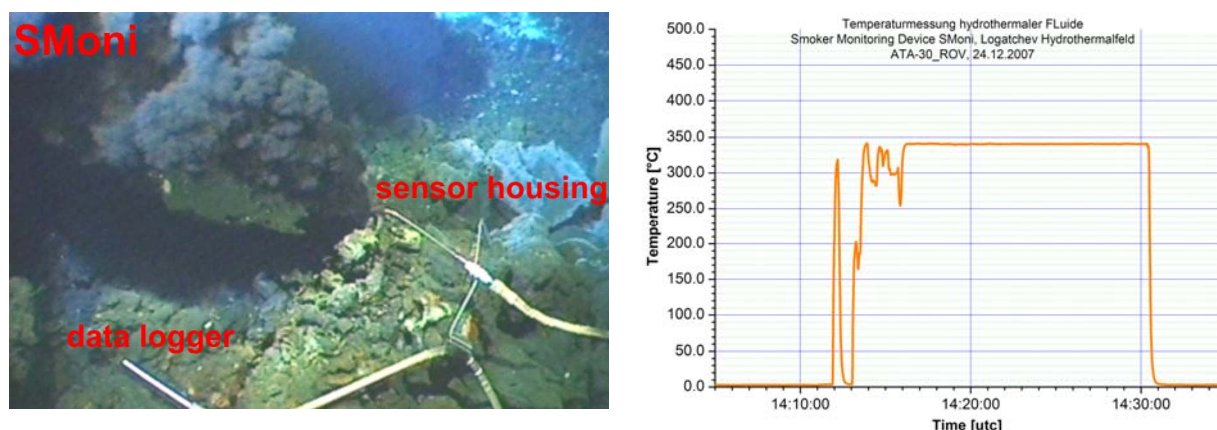
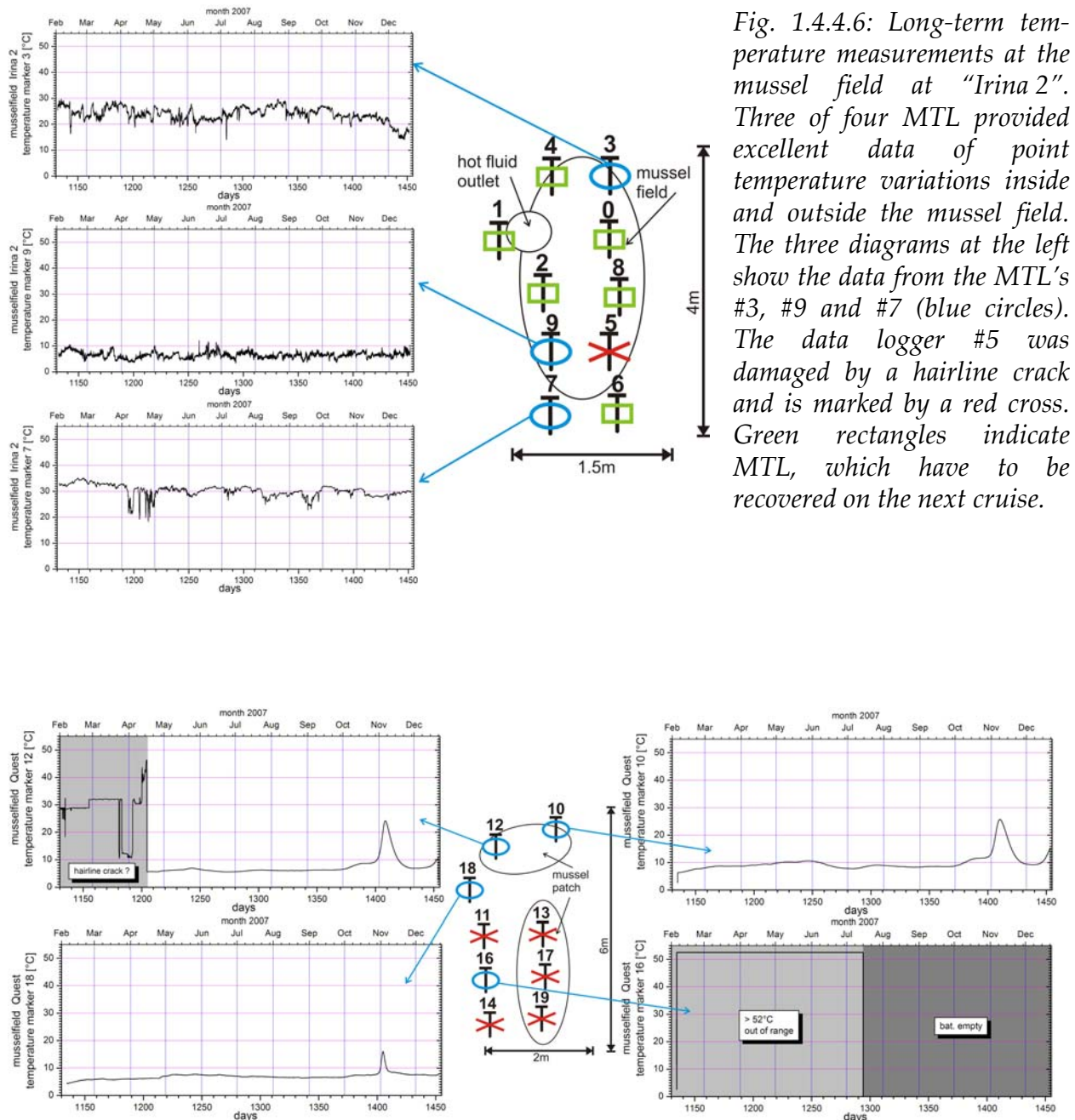


Fig. 1.4.4.5: (a) SMoni with sensor housing with its tip inside the black smoker and the data logger in foreground. (b) Data record from a short term deployment of the Smoni at smoker B1 of site „B“.

### Distributed temperature sensing system, MTL & 8-channel logger

The distributed temperature sensing system measures long-term point temperature variations on the meter to centimetre scale within and across single mussel fields, mussel patches and along cracks and fissures at the sea floor. The system consists of 20 single channel MTL, which reside within T-handle housings with markers (Fig. 1.4.4.6) and four 8-channel temperature probes. During the cruise 13 MTL were recovered, but new instruments could not be installed. Seven of the 13 MTL (4 from „Quest“ and 3 from „Irina 2“) had data, however, hot fluids or hairline cracks in the housing damaged 6 instruments. Six MTL could not be recovered and remain at „Irina 2“ Figures 1.4.4.6

and 1.4.4.7 show the data and provide sketches of the MTLs arrangement at "Irina 2" and "Quest". The data is of high quality and provides detailed information on absolute temperatures and temperature changes in and around the mussel patches.



### ROV-based 8-channel temperature probe

The ROV-based temperature probe was designed to measure in-situ temperatures and temperature profiles in sediments, in black smokers and in the black smoker outflow. The probe has 8 NTC-sensors, which equidistantly arrange along the probes shaft.

During the cruise several measurements at prominent black smoker sites, in sediments and diffuse fluids were done and the data was provided to the SPP-colleagues, who use the temperature values for their analyses. The ROV-based temperature probe displayed some rather high temperatures in some black smokers, which were not observed during cruise MSM04/3 with the same probe. However, these values are uncertain as they are at the border of the measuring range of the probe, so that the probe has to be re-examined for those temperatures. The two diagrams in Fig. 1.4.4.8 show examples of the data collected during the ROV-dives.

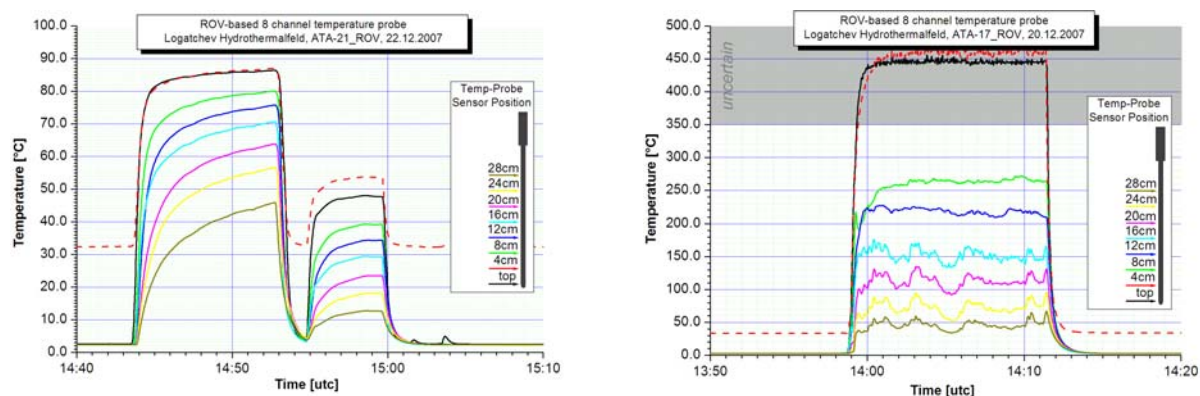


Fig. 1.4.4.8: Data examples of the ROV-based temperature probe. In the diagrams, the black line shows the temperature time series of the sensor in the top of the probe. The other sensors are equidistantly arranged along the probe shaft in 4 cm distance to each other. The sketch in the right part of the figures shows the sensor arrangement. Note that the second sensor from the top of the probe (red line) has lost its calibration. (a) Temperature profiles measured during dive ATA21ROV of ROV Kiel 6000. (b) Rather high temperatures in a black smoker outflow cause the data records to reach the probes range boundary. The data in the grey part of the diagram is uncertain and has to be examined separately.

### **1.4.5 Description of rocks and hydrothermal precipitates**

(by N. Augustin, S. Petersen)

During cruise HYDROMAR V the recovery of geological samples from the seafloor had no priority and geological samples were only recovered as a byproduct (Fig. 1.4.5.1).

Station **ATA15ROV** recovered hydrothermal precipitates from the bottom of a mussel-bed in a water depth of 3045m at T-logger #13 within the musselbed at the **QUEST** site (14°45.174'N / 44°58.833'W). 15ROV-7a is a piece of massive sulfide, primary containing marcasite and pyrite. Diamond-shaped anhydrite crystals and some copper-sulphides are minor components. 15ROV-7b containing well crystallized anhydrite and pyrrhotite as the main minerals (Fig. 1.4.5.2). The presence of anhydrite in these samples indicates



high fluid temperatures at this site, since anhydrite, as a heating product of seawater, only forms at temperatures above 130-150°C in this environment.

Station **ATA17ROV** recovered strongly altered serpentinite breccias in a water depth of 2979m on the southern crater rim of Site „B“ (14°45.100'N / 44°58.684'W). The reddish color of the subsamples 17ROV-1a, b, and c is the result of finely dispersed hematite. 17ROV-1c contains more relics of the former serpentinite than samples 17ROV-1a and b. All samples show veins filled by amorphous silica. Anhydrite and talc are minor components. All samples from station 17ROV show small amounts of hematite grains as well as sulphides growing in the matrix and in veins. In addition, 17ROV-1a reveals traces of hematite grains covered by an orange “fur” made of fine needles of goethite (Fig. 1.4.5.2).

Station **ATA27ROV** recovered 2 pieces (27ROV-20 and -21) of an inactive chimney from the QUEST site (14°45.175'N / 44°58.836'W; depth 3040m) composed of chalcopyrite with Fe±Zn-sulfide rich outer layers and a thin (<1mm) orange Fe-oxide coating (Fig. 1.4.5.2).



Fig. 1.4.5.1: Geological samples recovered during ROV stations: 15 ROV-7a: pyrite and markasite rich massive-sulphide with traces of anhydrite; 15 ROV-7b: massive anhydrite and pyrrhotite; 17 ROV-1a,b,c: strongly altered serpentinites, hematite impregnated; 27 ROV-21: chimney piece, collected at QUEST site, composed of chalcopyrite with Fe±Zn-sulfide rich outer layers.

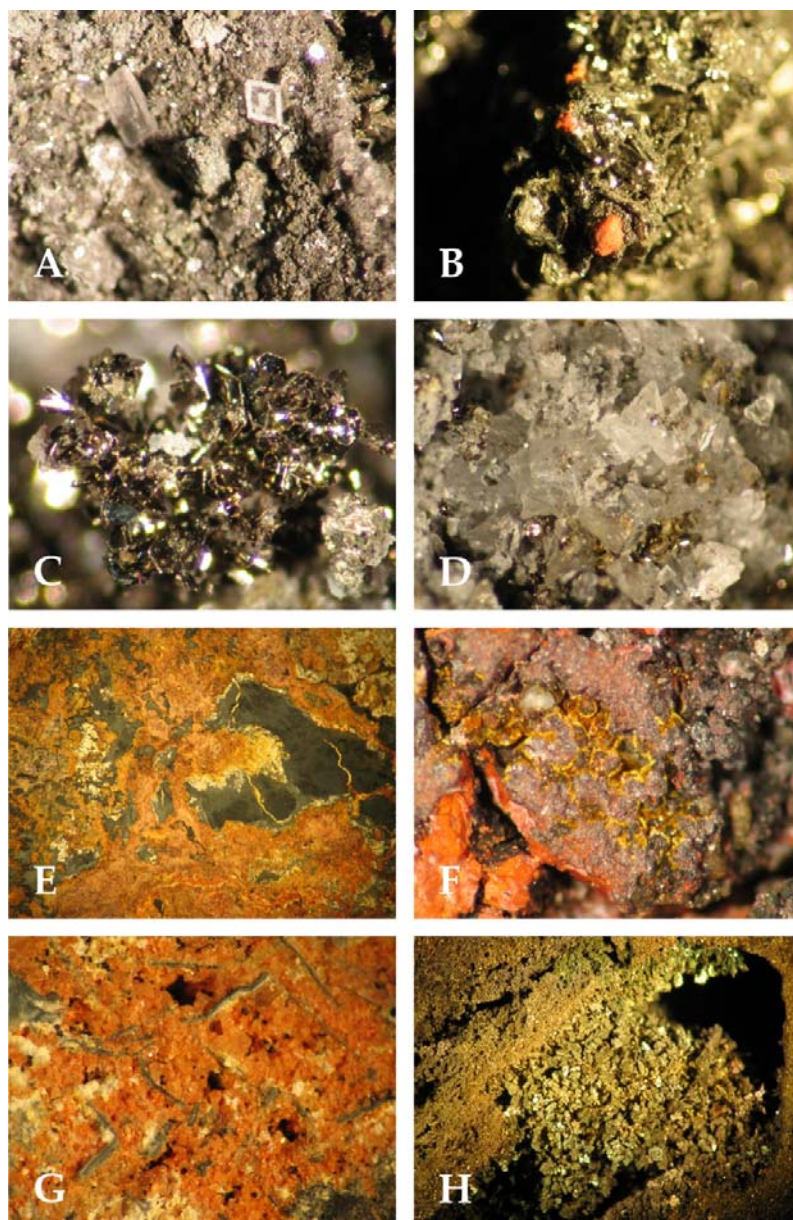


Fig. 1.4.5.2: Binocular pictures of samples recovered during HYDROMAR V:

(A) anhydrite grain in pyritic matrix (15ROV-7a);

(B) marcasite and hematite-stained clay (?) (15ROV-7a);

(C) euhedral pyrrhotite crystals (15ROV-7b);

(D) anhydrite crystals (15ROV-7b);

(E) hematite impregnated altered matrix of a serpentinite with dark grey fragments of the precursor rocks (17ROV-1c);

(F) small spheres of hematite with "fur" of orange goethite in intensely altered serpentinite (17ROV-1a);

(G) hematite impregnated serpentinite, relicts of former silicates are still present as grayish wall-like structures (17ROV-1c);

(H) close up of the inner fluid-channel of an inactive black smoker chimney mainly composed of chalcopyrite (27ROV-21; site "Quest").

## 1.4.6 Fluid chemistry

(by Cristiane Jost, Herwig Marbler, Marc Peters, Ulrike Westernströer, Anne Westhues, and Nico Augustin)

### 1.4.6.1 Sampling and analytical methods

Hydrothermal fluids are characterized by their unique chemical and isotopic composition, which is significantly different from ambient seawater (e.g., von Damm, 2004). Scientific objectives for fluid chemical analyses, both on-board and subsequently in the home laboratories, include the detection of hydrothermal plumes in the water column, and a quantification of the chemical and isotopic composition of hydrothermal fluids discharging from the ocean crust via distinct vent sites - either through black smokers or diffuse venting.

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). Hydrothermal fluids, both from vent orifices and diffuse flow musselfields were collected with the Kiel Pumping System (KIPS) by inserting a titanium sampling nozzle into the orifice of smoker structures. In addition, 2 hot vents were sampled by titanium syringe samplers ("Majors" after von Damm, manufactured by IFREMER, France).

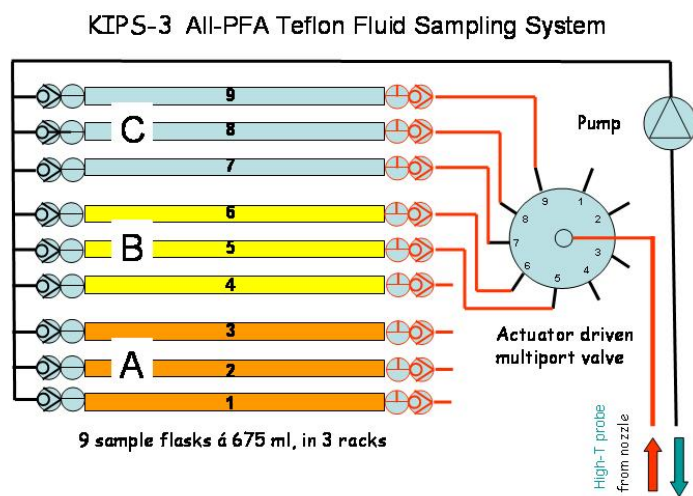
### Sampling with the KIPS fluid sampling system

The 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 important 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 fully 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: polyetheretherketon (PEEK), perfluoralkoxy (PFA) and polytetrafluorethylene (PTFE, Teflon®), and a short tube of high-purity titanium (99.9 % Ti, 40 cm length, 6 mm I.D.). Fluid enters via this titanium tube - the nozzle – mounted to a T-handle which is guided by the ROV's ORION manipulator arm. 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.) with software fully integrated into the ROV control system (Figure 1.4.6.1; ROV Node 6, port # 09, Software FluidCtrl Version. 0.3.0.0, by 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, 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 CTD hydrocasts. A 24 V deep sea

mechanical gear pump is mounted downstream to the sample flasks, thus avoiding contamination of the samples. The pump is integrated into the pressure compensation system of the ROV and electrically controlled with the ROV's port (Node 6, port # 14). The pumping rate was approx. 1250 ml/min. The standard pumping time per sample was set to 3 min making sure that the flask volume was exchanged at least 4 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 fluids leaving the system. In addition, a flow mobile was attached to the outlet tube (Fig. 1.4.6.2).



*Fig. 1.4.6.1: 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. Real-time temperature readings were transferred through a serial port (Node 6, port # 16) to the control van. In addition, the sensor was connected via a Y-splice cable to a data logger (RBR # 12644, Brancker, Canada). The 90% time constant of the sensor in water is better than 10 s. Two individual sensors were used during this cruise: sensor #1 during dive ATA-07\_ROV and sensor #5 for all subsequent dives. Calibration coefficients were obtained through a 25-points high-precision calibration up to 450 °C (Table 1.4.6.1).

*Table 1.4.6.1: Calibration coefficients used for calculation of temperatures for sensor #1 and # 5.*

Calibration coefficients	Range (°C)	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>
Sensor #1 Hi-T01 (NTC # 160176)	0 – 450	3,5306E-03	-2,5298E-04	3,0338E-06	-1,0276E-07
Sensor #5 Hi-T05 (NTC #193729)	0 – 450	3,5161E-03	-2,5616E-04	2,7319E-06	-8,1982E-08

### Sub-sampling and sample preparation

Immediately after recovery of the ROV on deck KIPS sample racks were transferred to the laboratory. Usually, 3-5 flasks were filled at each site. 150 ml original hydrothermal fluid were taken from every flask. For subsequent analyses of dissolved ions the complete volume of one flask was transferred to a FEP bottle, homogenised, and then sub-sampled for the different analytes. Another flask was dedicated for the analysis of dissolved gases and isotopic composition, the sampling technique is described elsewhere in the respective gas chemistry chapter. An overview scheme of sub-samples taken gives Table 1.4.6.2. Titanium syringes were sampled in the same way.

Table 1.4.6.2: Overview of sub-samples taken and analytical parameters determined on-board and, later, to be determined in the home laboratories.

Group	Perner	JUB	IFG Kiel	JUB	JUB	JUB	JUB	Keir	Strauss	Strauss	Perner
Analysis on-board	diss. Oxygen (Winkler)	pH, sulfide, Cl, Fe, Sb, Se						pH, Cl, Mg, (aus Spüllsg) CH4 und H2 Konz.		pH, Cl	Fixierung Kultivierung
Analysis on-shore			major elements filtered / not filtered acidified / not	Anions	Organic complexation	Trace metals, major and minor elements (Si, Fe, Mn, Zn, Cu)	Amino acids	C und H Isotope	S isotopes in dissolved sulfide	O and H isotopes of water DIC-C isotopes, H2S-Konz	
Sub-sample volume mL	12	50	2 * 50 + 250 (für PGEs)	50	100	2 * 100	2 * 40	300 + 75 (zum Spülen)	250	30	400
	Bottle 1							Bottle 2	Bottle 3		

### Sample preparation for on-shore determination of major, minor, and trace elements, anions, and amino acid complexation

Hot hydrothermal fluids emerging from black smokers containing some precipitates formed during cooling were not filtered but acidified with 1-5 ml subb. HNO<sub>3</sub> per 100 ml fluid and stored in PFA bottles until analysis. Warm diffuse fluids emerging in mussel fields were pressure filtrated (99.9990 nitrogen) through 0.2 µm Nuclepore PC membrane filters in Sartorius filtration units and acidified with 0.2 ml subboiled concentrated nitric acid per 100 ml. Acidified samples are stored in 100 ml PFA bottles

until analysis. 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 samples will be analysed for major and minor element 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 (7500 cs, Agilent), and high resolution sector-field instrumentation (PlasmaTrace 2, Micromass). At JUB in Bremen, complementary analyses on major, minor and trace elements will be carried out: A large number of cations (e.g. Zn, Cd, Pb, Cu, Ni, Co, Mn, Mo) will be determined by using voltammetry, as well as major and minor element composition (Na, K, Ca, Mg, Sr, Ba, B, Fe, Mn, Cu, Zn) by means of ICP-Optical Emission Spectrometry (ICP-OES, Spectro), and trace elements (e.g., I, Br, B, Li, Al, Ti, Cs, Sr, Y-REE, Fe, Mn, Cr, Cu, Co, Ni, Pb, U, Mo) by ICP-Mass Spectrometry (ICP-MS, Elan DRC-e, Perkin Elmer) at Jacobs University Bremen (Bremen, Germany). For anions analyses (e.g. Cl-, Br-, I-, SO<sub>4</sub><sup>2-</sup>), aliquots of hot hydrothermal fluids with precipitate were pressure-filtrated through 0.2 µm PC membrane filters (Nuclepore). Warm diffuse fluids were taken as original sample without further treatment and stored in PE-LD bottles until analysis. For amino acids and other organic compounds, the measurements will be carried out in the organic geochemistry lab at Bundesanstalt für Geowissenschaften und Rohstoffe (BGR, Hannover, Germany). Onboard, sub-samples for organic analyses, non-filtered, were immediately frozen (-20°C) as 50 ml aliquots in acid-cleaned PE bottles. Particles from fluid samples will be analyzed by means of later inorganic analysis in addition to organic analyses of the fluids. Filters from filtration of the KIPS fluid samples of the ROV were kept in plastic dishes. Samples for the detection of dissolved inorganic silica were diluted 1:50 from the concentrated fluid with DI water and acidified.

#### 1.4.6.2 Analytical procedures on-board

Winkler titration of dissolved oxygen.

Immediately after sample recovery dissolved oxygen was determined in hydrothermal fluids from diffuse vent sites only. The procedure followed the standard procedure as outlined in Grasshoff (1999) with the exception that 10 ml volumetric flasks were used. The detection limit is approx. 0.5 ml/l O<sub>2</sub>, precision is in the range of ± 0.1 ml/l O<sub>2</sub>. The samples were analysed by Mirjam Perner and Thomas Meier.

#### pH measurements and chloride titration

Especially the anoxic fluids from the hot vents were analyzed and stored immediately after system recovery. Aliquots of non-filtered samples were subjected to immediate pH measurements (Ag/AgCl reference electrode) as well as voltammetric determination of sulfide concentrations. Parallel to that, iron speciation analysis was carried out by using

spectrophotometry. To identify a possible influence of phase separation, the hot fluids were analyzed for chloride by titration with AgNO<sub>3</sub> 0.1M standard solution, after the method of Fajans, by using fluoresceine-sodium as indicator. For further analysis, some samples were acidified with 65% (w/v) HNO<sub>3</sub> in a ratio of 1:1000.

#### Voltammetric analysis of trace metal concentrations and spectrophotometric determination of iron speciation

For onboard trace metal concentration analyses of sulfide, antimony and selenium, the voltammetry was chosen as electroanalytical technique. Immediately after recovery, the fluid samples were prepared for analyses onboard. The unfiltered aliquots were used for determination of the total content of the metals. As no pre-treatment step of the samples was performed, e.g. UV irradiation, only the labile/free fraction of each metal was determined. All measurements were performed by using a 757 VA Computrace with a standard PC (Metrohm, Herisau, Switzerland). The three-electrode configuration consisted of the static mercury drop electrode (SMDE) and of the hanging mercury electrode (HMDE) as the working electrode (respectively for sulfide and antimony/selenium analysis), 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).

The antimony concentration was determined in a 5M HCl solution (adapted from Wagner et al., 1996; Fresenius J. Anal. Chem. 354 (1996) 11, for highly saline fluids by JOST et al. – unpublished results) by using anodic stripping voltammetry (ASV). Selenium was analyzed by using a previous co-electrolysis step with Cu(II) ions and cathodic stripping voltammetry (CSV) in a 0.1M HCl medium (Ferri et al., 1998 P. Anal. Chim. Acta 361 (1998) 113.).

The iron speciation analysis was performed by using spectrophotometry. The determination of the orange-red ferroin complex is the principle of the method. Ferrous ions are complexed by adding an amount of 1% (w/v) 1,10-phenantroline solution to the samples in a pH range of 3-5. The total Fe is measured by reducing all Fe content with a 1% (w/v) ascorbic acid solution. Then, the Fe(III) concentration is determined as the difference between the total Fe and Fe(II) content. A Biochrom Libra S12 spectrophotometer was used for absorbance measurements at a wavelength of 511 nm with 1cm pathlength quartz spectrophotometric cells. Samples with concentrations above 100 mg Fe L<sup>-1</sup> were measured in diluted samples.

#### 1.4.6.3 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 at the top of a 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 time are only a rough estimate of the real temperature of the hydrothermal fluid. The following figures show temperature/time plots and sampling positions during fluid sampling of hot vents. (Compare these plots with sampling intervals compiled in Table A1 in the Appendix). The highest temperatures during this cruise were recorded at site Irina 1 ( $T_{max} \sim 375^{\circ}\text{C}$ ), however, the data was visualized on screen but not logged. Overall temperatures were higher in almost all black smoker chimneys when compared to published analyses and to values obtained during earlier SPP cruises. It is not clear yet, if this indicates an increase in temperatures of the field or if it is related to the sampling, since we were able to access deeper parts of the chimneys when compared to earlier cruises.

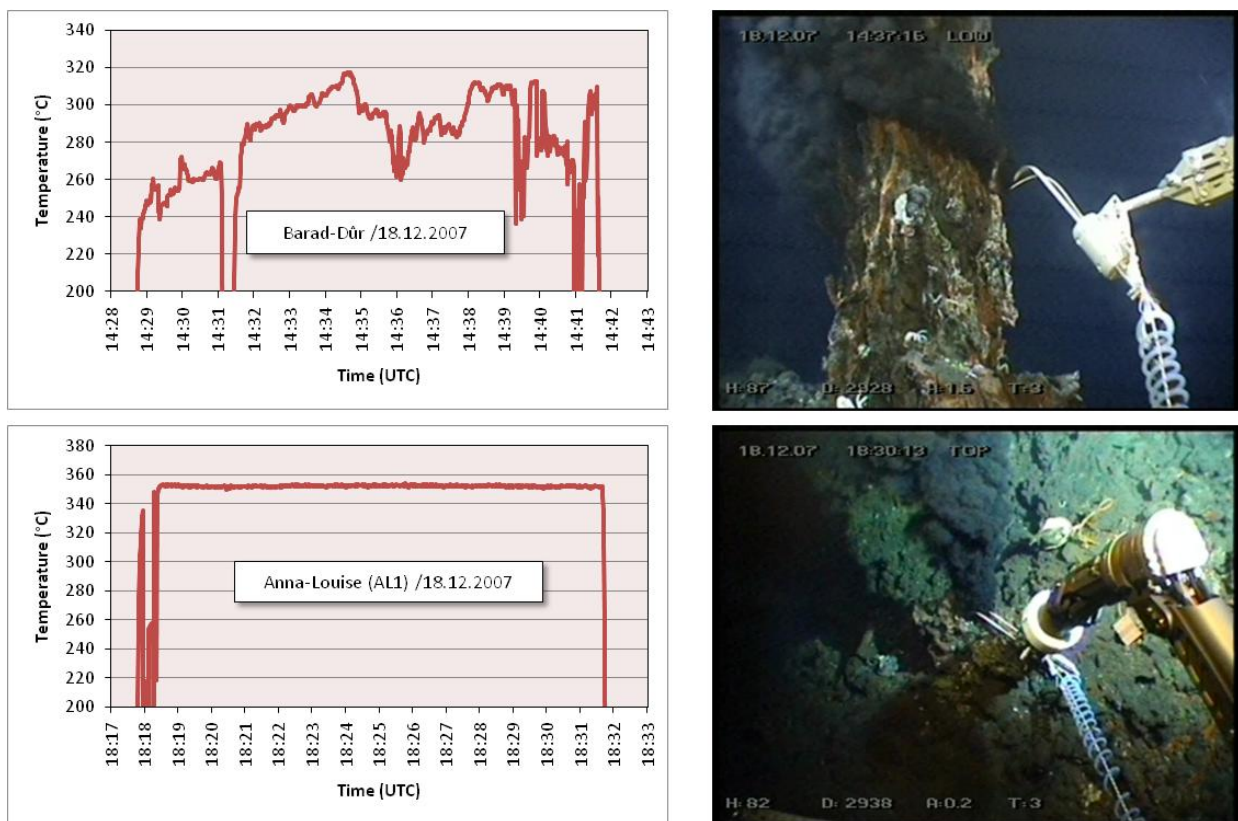


Fig. 1.4.6.2: ATA13ROV hot fluid sampling at Barad-Dûr (site „A“) with  $T_{max} = 317^{\circ}\text{C}$  and Anna-Louise (smoker AL1) with  $T_{plateau} = 352.3 \pm 0.5^{\circ}\text{C}$ .



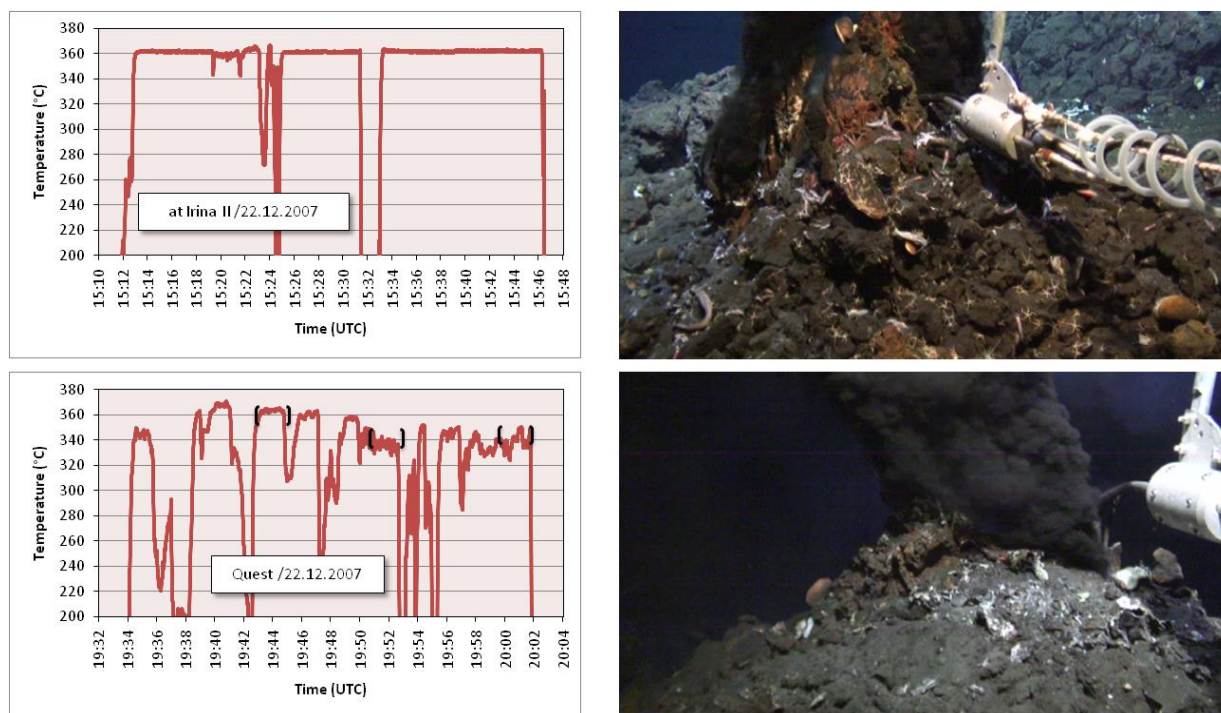


Fig. 1.4.6.3: ATA24ROV hot fluid sampling at Irina II microsmoker with  $T_{\text{plateau}} = 361.7 \pm 0.6$  °C and Quest with its irregular temperature distribution probably caused by venting through talus material. Fluid sampling periods are indicated by brackets.  $T_{\text{max}} = 370.9$ °C.

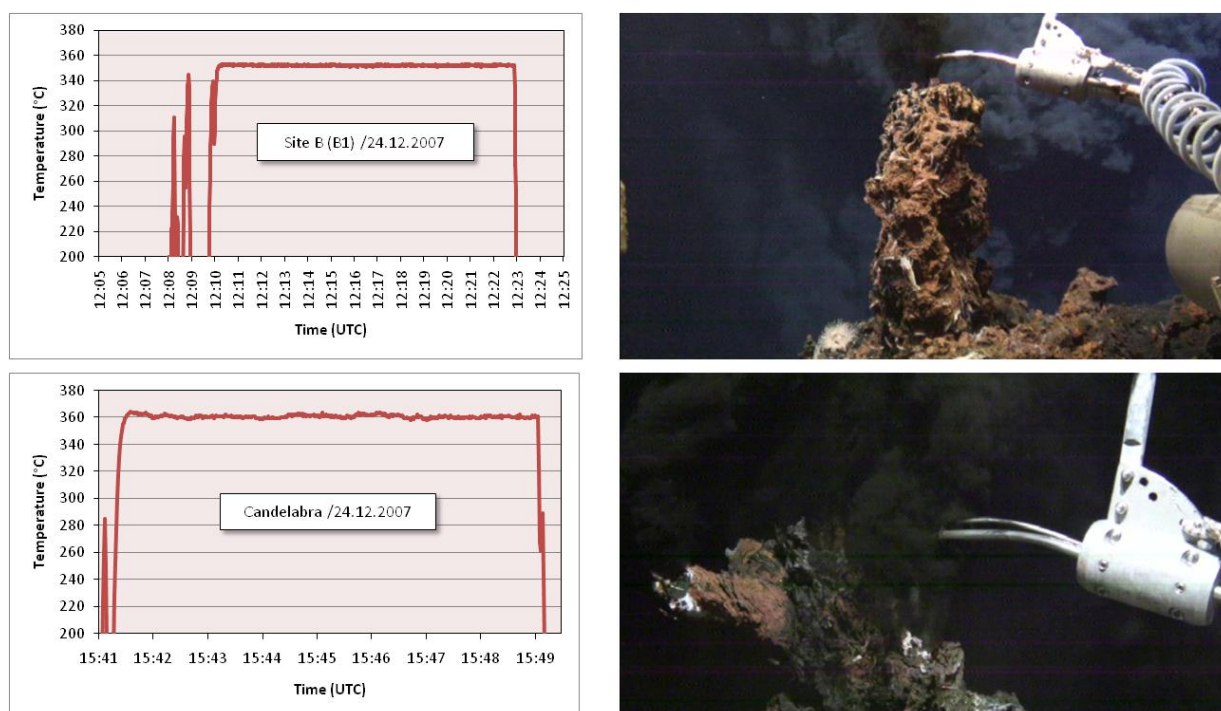


Fig. 1.4.6.4: ATA30ROV hot fluid sampling at Site B (smoker B1) with  $T_{\text{plateau}} = 352.2 \pm 0.4$ °C and Candelabra with  $T_{\text{plateau}} = 360.8 \pm 1.1$ °C.

Measured temperatures of the diffuse hydrothermal fluids are tabulated in Table A1 in the Appendix.

### Chemistry of vent fluid samples

First of all, it must be noted that all hydrothermal fluid samples were diluted by seawater and the results presented here are not yet calculated for endmember compositions. The LHF hydrothermal endmember is characterized by a pH of approx. 3.5 and slightly lower chloride of 540 mM than seawater (550 mM Cl).

The pH of samples taken directly from the vent orifices clearly reflects variable admixture of seawater to the hot reducing hydrothermal endmember fluid. As shown in Fig. 1.4.6.6 where chloride of all samples is plotted against their pH, higher chloride concentrations correlate with higher pH values. Since Fe is highly enriched in hydrothermal fluids a plot of dissolved Fe against pH gives an even stronger correlation (Fig. 1.4.6.7).

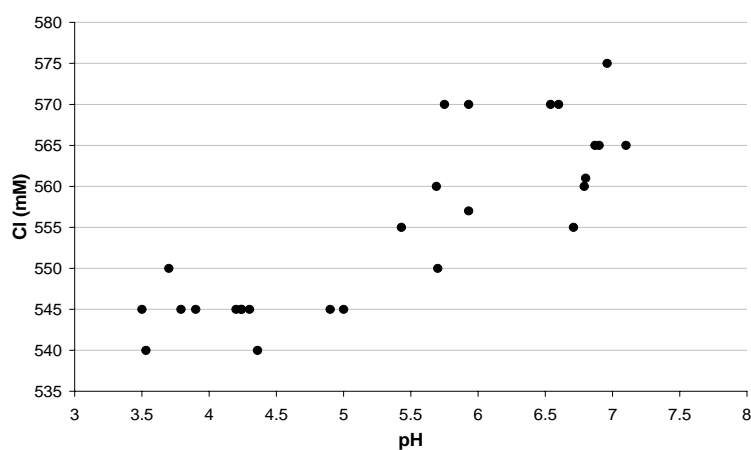


Fig. 1.4.6.5: Chloride concentrations plotted against pH values.

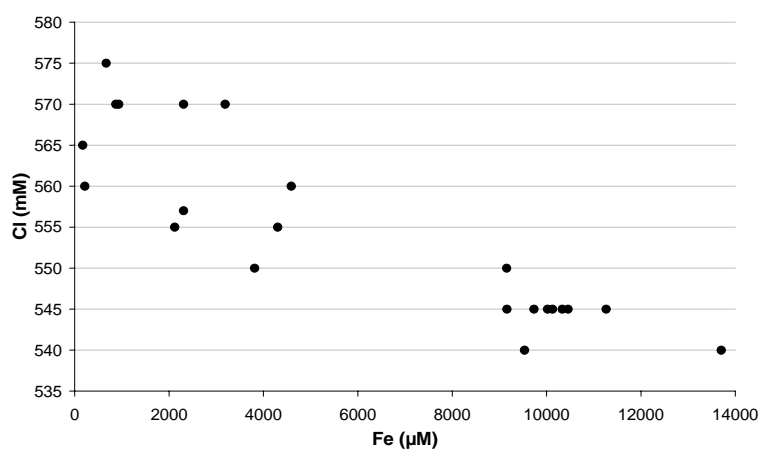


Fig. 1.4.6.6: Variability of chloride concentrations compared to total Fe concentrations.

Hence, pH can be taken as a first estimate for the purity of the sampled hydrothermal fluid. A slight tendency towards decreased salinities is presented in Fig. 1.4.6.8 where chloride was plotted against Fe as hydrothermal element. The higher the chloride concentration, the lower the total Fe amount.

The iron data provided the most interesting results, as speciation analyses were performed. Iron was the dominating heavy metal in all hot fluid samples, with a certain contribution in the form of iron sulfides. The speciation distribution graph (Fig. 1.4.6.7)

demonstrates that Fe(II) dominates over the Fe(III) species: about 80% of the total Fe is present as ferrous species.

According to Fig 1.4.6.8, samples from Site „B“ were the most enriched ones in iron content, followed by Candelabra and Irina II. The pH values of samples from these sites are also the lowest measured compared to all ROV samples collected, as seen in Fig 1.4.6.9 Comparing sulfide, iron and chloride concentrations (Figs. 1.4.6.9-11) the enrichment of Fe and sulfide in a hydrothermal fluid that is slightly depleted in chlorine becomes evident.

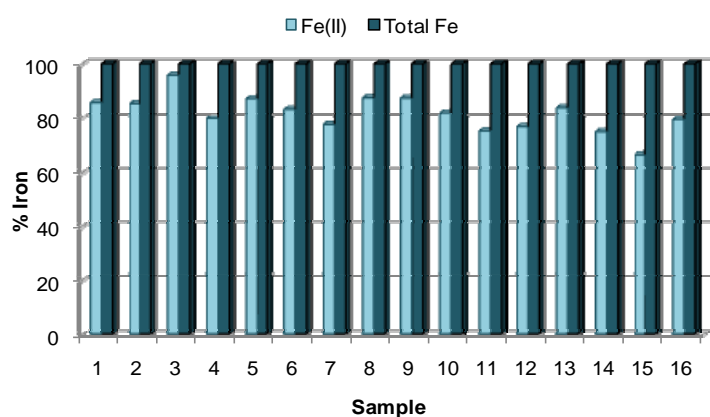


Fig. 1.4.6.7: Iron speciation in different ROV fluid samples.

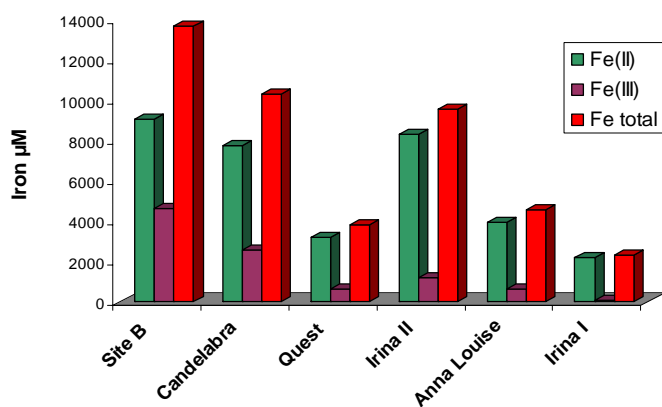


Fig. 1.4.6.8: Iron content in ROV fluid samples: variability according to vent site.

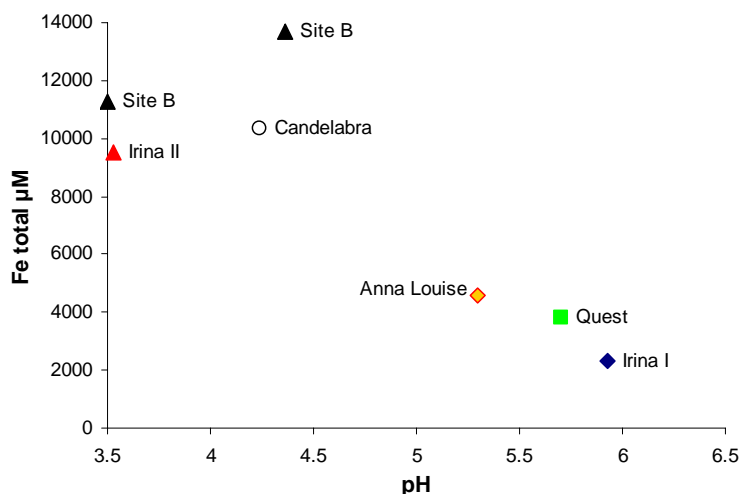


Fig. 1.4.6.9: The highest total Fe content of each site plotted against pH values.

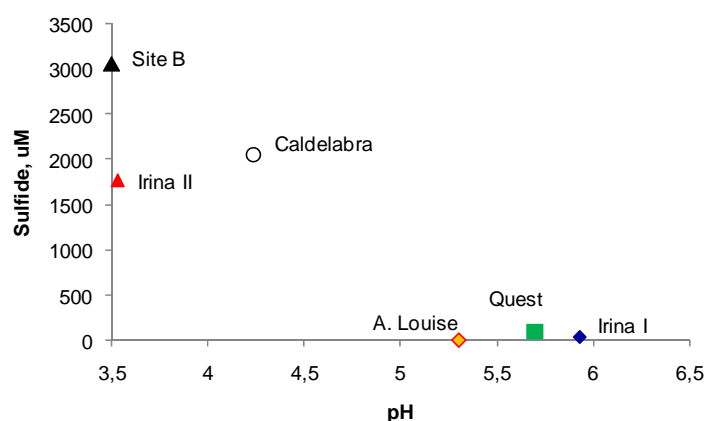


Fig. 1.4.6.10: The highest sulfide content of each site plotted against pH values

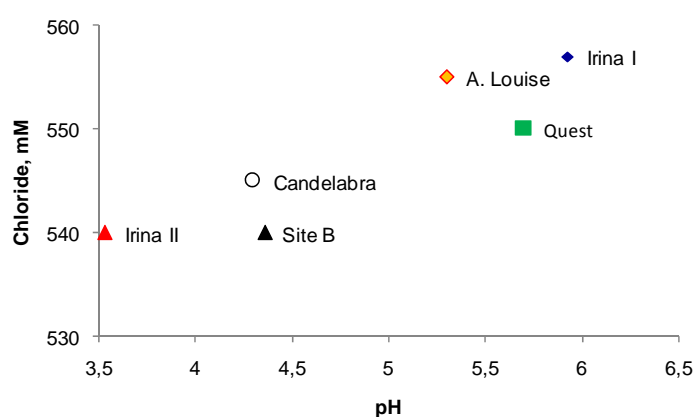


Fig. 1.4.6.11: The lowest chlorinity of each site plotted against pH values.

**Antimony and selenium** concentrations were below the detection limit of the methods (2.5 nM each), as only the labile/free forms of the metals could be analyzed. So, experiments including pre-treatment steps (e.g. UV irradiation) are going to be performed at Universidade Federal de Santa Maria (UFSM, Santa Maria/RS, Brazil).

#### 1.4.6.4 Sulfur Chemistry

Sulfur plays an important role in hydrothermal vent systems at Mid-ocean ridges, because it participates in inorganic and microbially driven processes at these vent sites. The concentration and the sulfur isotopic composition of certain sulfur species in hydrothermal fluids, precipitates, host rocks and vent fauna provides valuable information concerning sulfur cycling at Mid-ocean ridges. In order to constrain the physico-chemical conditions of hydrothermalism, additional isotope systems (C, O, and H) are being considered. All together, a better understanding of element cycling and fluxes is anticipated. This will allow to reconstruct the interaction of hydrosphere, lithosphere and hydrosphere both, on a qualitative and quantitative basis.

### Concentration of dissolved H<sub>2</sub>S

One ml from each fluid samples were taken for dissolved sulfide concentration measurements. 100µl of a zinc acetate gelatine solution was used to fix the sulfide of the fluid. This solution keeps the precipitated zinc sulfide in a colloidal state. The homogeneous distributed sulfide reacts with N,N-dimethyl-1,4-phenylene-diamine-dihydrochloride to colourless leucomethylene. This component is oxidized by Fe<sup>3+</sup> ions of an iron chloride solution to methylene blue. Methylene blue absorbs light with a wavelength of 660nm. One hour after the reagents have been added the solution is measured photometrically. Before the photometric determination a calibration curve is constructed by the measurement of different calibration solutions each with a certain sulfide concentration. For the production of the calibration solutions a fresh stock solution with a sulfide concentration of 5,8mmol/L is used. The exact sulfide concentration of the stock solution is determined by titration with a 0,02N thiosulfate solution.

SAMPLE	SITE	H <sub>2</sub> S concentration. (mg/L)	H <sub>2</sub> S concentration. (µM/L)
ATA 13 ROV-3	Site A	b.d.l.	b.d.l.
ATA 13 ROV-8	Anna Louise	14.3	446
ATA 15 ROV-5	Quest	b.d.l.	b.d.l.
ATA 17 ROV-4	Site B	5.23	164
ATA 17 ROV-8	Irina I	b.d.l.	b.d.l.
ATA 17 ROV-11	Irina I	0.12	3.69
ATA 21 ROV-7	Irina II	b.d.l.	b.d.l.
ATA 21 ROV-13	Irina II	b.d.l.	b.d.l.
ATA 24 ROV-4	Irina II	7.62	238
ATA 24 ROV-7	Irina II	0.20	6.14
ATA 24 ROV-13	Quest	4.27	133
ATA 27 ROV-8	Quest	b.d.l.	b.d.l.
ATA 30 ROV-3	Site B	17.1	535
ATA 30 ROV-4	Site B	14.6	456
ATA 30 ROV-10	Candelaber	15.6	488
ATA 30 ROV-A1	Candelaber	1.35	42.3

b.d.l. = below detection limit (1µmol/L)

### Concentration of other dissolved S species

In addition to the photometrical determination of the sulfide concentration, the monobromobimane method (Fahey & Newton, 1987) was used to stabilize not only the dissolved sulfide, but also other thiols, i.e. intermediate sulfur species like sulfite or thiosulfate. This analytical approach has several advantages: different sulfur-bearing compounds dissolved in the hydrothermal fluids can be quantified, including

metastable phases which are attractive to certain microorganisms; these different sulfur compounds can be separated (and collected) for sulfur isotopic measurements (development of methodology currently in progress); and finally, measurements can be performed on smaller sample volumes. Initial fixation with monobromobimane is done on-board, subsequent measurements are performed in cooperation with Dr. Christian Ostertag-Henning, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

A 50 $\mu$ l volume of the sample was added to 110 $\mu$ l of previously prepared derivatization mixture, composed as follows: 50 $\mu$ l of HEPES buffer, 50 $\mu$ l acetonitrile and 10 $\mu$ l monobromobimane (48mmol/L). Derivatization was performed in the dark and was stopped after 30 min by adding 100 $\mu$ l of methanesulfonic acid (Rethmeier et al., 1997).

#### Isotopic composition of H<sub>2</sub>S

250ml of each sample were added to a zinc acetate solution (3%) to precipitate the dissolved H<sub>2</sub>S. The precipitated sulfide was filtrated and dried. The sulfide sulfur of the samples will be extracted and isotopically analysed ( $\delta^{34}\text{S}$ ) at the Geologisch-Paläontologisches Institut, Westfälische Wilhelms-Universität, Münster.

New insights into the sulfur cycling at the MAR are anticipated from measurements of the rare isotopes of the sulfur system, i.e. <sup>33</sup>S or <sup>36</sup>S for dissolved and precipitated sulfides. It has been shown that multiple sulfur isotope systematics can distinguish and, hence, quantify isotope exchange reactions induced by hydrothermal processes from isotope mixing as well as the contribution of sulfur from biological processes (Ono et al., 2006). Newly developed analytical protocols allow the detection of small differences even in the rare sulfur isotopes. These measurements will be carried out in cooperation with Professor James Farquhar at the University of Maryland, College Park, USA.

#### 1.4.6.5 Isotope ratios of oxygen, hydrogen, and carbon

**Hydrogen and oxygen** in hydrothermal fluids characterize the intensity of water-rock interaction between fluid and host rock. This results in a shift for both, oxygen and hydrogen isotopes, towards more positive values (Shanks, 2001). The magnitude of this shift is determined by the water-rock ratio and the duration of interaction. Low water-rock ratios or prolonged interaction between fluid and host rock (i.e. long residence of fluid in the reaction zone) will result in oxygen and hydrogen values substantially deviating from ambient seawater with 0‰ for both. Four ml of each sample were filled in 2 crimp glasses for determination of the oxygen and hydrogen isotopic composition. Isotopic measurements will be carried out at the University of Münster.

The **carbon** isotopic composition of hydrothermal fluids potentially reflects contributions from various sources, including mantle CO<sub>2</sub>, entrained seawater or oxidized organics and methane (Shanks, 2001). 20 ml of a fluid sample were taken and poisoned with two drops of HgCl<sub>2</sub> to determine the isotopic composition of the dissolved inorganic carbon fraction (DIC) at the University of Münster.

#### **1.4.7 Microbiology from diffuse and hot hydrothermal fluids**

(by Mirjam Perner and Thomas Meier)

The main objective of the microbiology group during this cruise was to collect low-temperature, diffuse and hot hydrothermal fluids from the Logatchev hydrothermal field to investigate:

1. the intra-field microbial variability and to continue the time-series
2. the functioning of the microbial community, specifically focusing on microbial H<sub>2</sub>- and H<sub>2</sub>S-oxidation and CO<sub>2</sub> fixation.

##### **Intra-field microbial variability and time-series**

To investigate the intra-field microbial variability and to continue the time-series the following fluids were collected (see table 2):

- hot hydrothermal fluids (Site A, Anna-Louise, Site B, Irina I, Irina II)
- 1 low-temperature diffuse fluid (Quest, mussel patch)
- low-temperature fluids (Irina II, mussel patch)

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 <sup>14</sup>C- and <sup>13</sup>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<sub>2</sub>-oxidizing and CO<sub>2</sub> fixing microorganisms (e.g. Epsilonproteobacteria, Aquificales, and Methanococcales). For this purpose, selective media for autotrophic microorganisms was supplemented with various electron donors (H<sub>2</sub>, H<sub>2</sub>S, S<sup>0</sup>, S<sub>2</sub>O<sub>3</sub>) as well as suitable electron acceptors (O<sub>2</sub>, NO<sub>3</sub>, S<sup>0</sup>, S<sub>2</sub>O<sub>3</sub>) in the presence of CO<sub>2</sub>. 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:

- hot hydrothermal fluids (Site A, Anna-Louise, Irina II)
- 1 low-temperature diffuse fluid (Quest, mussel patch)
- 1 low-temperature fluid (Irina II, mussel patch)

#### <sup>14</sup>C and <sup>13</sup>C-incorporation experiments

The second approach investigates the functioning of the vent microbial community by using functional genes encoding for key enzymes of H<sub>2</sub>-oxidation, oxidation of reduced sulfur compounds and CO<sub>2</sub> 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, <sup>14</sup>C-incorporation experiments (at 25°C) were performed with hydrothermal fluids, which were supplemented with H<sub>2</sub> (under oxic and anoxic conditions) or H<sub>2</sub>S as electron donor. The decrease of the supplied electron donors (H<sub>2</sub> or H<sub>2</sub>S) and electron acceptors (O<sub>2</sub>) was monitored during the 30 hours of incubation. For this experiment hydrothermal fluids were collected from 1 diffuse fluid at Quest Three parallels of each 15 ml of the hydrothermal fluids were supplemented with

- H<sub>2</sub>-gas under anoxic conditions
- H<sub>2</sub>-gas under oxic conditions
- H<sub>2</sub>S
- nothing (control)

and injected with <sup>14</sup>CO<sub>3</sub>. Three parallel controls with microorganism-free and non-active microorganisms (fixed with formaldehyde) liquids were conducted to determine the non-biological loss of H<sub>2</sub> and O<sub>2</sub> in the incubation bottles. These values were taken into consideration when evaluating the decrease of H<sub>2</sub> and O<sub>2</sub> in the incubation experiment. H<sub>2</sub> and O<sub>2</sub> contents were monitored at t = 0 hrs and t = 30 hrs. The amount of <sup>14</sup>C, which has been incorporated into the cells, will be determined in the home laboratory.



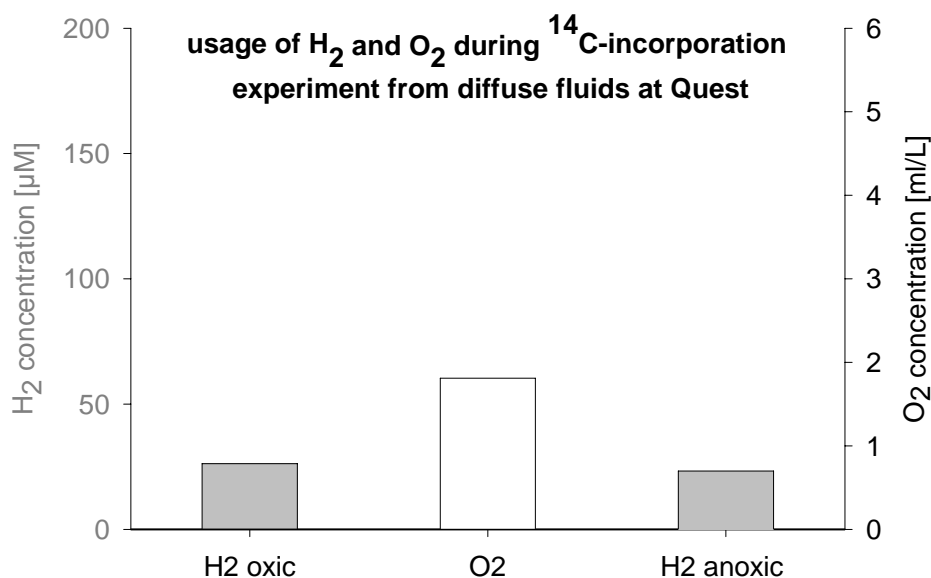


Fig. 1.4.7.1: The decrease of H<sub>2</sub> under anoxic conditions as well as the usage of H<sub>2</sub> under oxic conditions and the corresponding reduction of O<sub>2</sub> is shown for a 30 hours time-period in the incubation experiments at 25°C. H<sub>2</sub> data by P. Wefers

From the data available (Fig. 1.4.7.1) it seems that microorganisms in the oxic H<sub>2</sub>-incubation utilized slightly more H<sub>2</sub> (decrease of 35 μM) (with an O<sub>2</sub> decrease of 1,81 mL/L) than in the anoxic H<sub>2</sub> incubation (decrease of 32 μM). The determination of the amount of <sup>14</sup>C incorporated into the cells, dependent on the electron donor (H<sub>2</sub> and H<sub>2</sub>S) and the oxic vs. anoxic condition, will be conducted in the home laboratory.

A similar experiment was conducted for hot hydrothermal fluids from Site B for which <sup>14</sup>C-incorporation experiments are not available. Nevertheless, <sup>13</sup>C-incorporation data is available allowing a semi-quantitative analysis of whether more <sup>13</sup>C was incorporated into the cells with H<sub>2</sub> or H<sub>2</sub>S as electron donors at 25°C. Three parallels of each 1 ml of the hydrothermal fluids were added to media (selecting for autotrophic organisms) and were supplemented with:

- H<sub>2</sub>-gas under anoxic conditions + NaNO<sub>3</sub> + S<sup>0</sup>
- H<sub>2</sub>-gas under oxic conditions
- H<sub>2</sub>S + NaNO<sub>3</sub>
- nothing (control)

and injected with <sup>13</sup>C. Three parallel controls with microorganism-free liquids were conducted to determine the non-biological loss of H<sub>2</sub>, H<sub>2</sub>S and O<sub>2</sub> in the incubation bottles. These values were taken into consideration when evaluating the decrease of H<sub>2</sub>, H<sub>2</sub>S and O<sub>2</sub> in the incubation experiment. H<sub>2</sub>, H<sub>2</sub>S and O<sub>2</sub> contents were monitored at t = 0 and t = 30. The semi-quantitative analysis of <sup>13</sup>C, which has been incorporated into the cells, will be determined in the home laboratory.

Microorganisms in the H<sub>2</sub>S incubation oxidized 150µM of H<sub>2</sub>S while in the H<sub>2</sub> incubations ~50µM of H<sub>2</sub> was used. Microorganisms in the oxic H<sub>2</sub>-incubation utilized slightly more H<sub>2</sub> than in the anoxic incubation. Approximately 3mL/L of O<sub>2</sub> was used in the oxic H<sub>2</sub>-incubation.

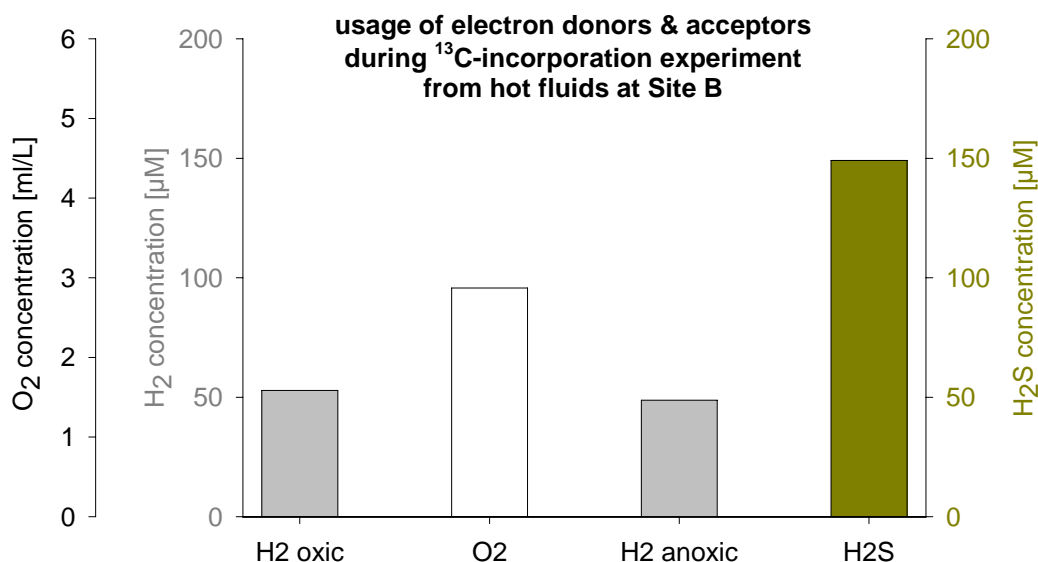


Fig. 1.4.7.2: The decrease of H<sub>2</sub> under anoxic conditions and of H<sub>2</sub>S as well as the usage of H<sub>2</sub> under oxic conditions and the corresponding reduction of O<sub>2</sub> is shown for a 30 hours time-period in the incubation experiments at 25°C. H<sub>2</sub> data by P. Wefers and H<sub>2</sub>S data by M. Peters.

Table 1.4.7.1: Samples list of CTDs

station	depth [m]	niskin bottle number	DNA (-70°C)	FISH (fixed in formaldehyde)
ATA-10CTD	3000	1	filter 4 (500 ml) filter 9 (500ml)	filter 16 (10 ml) filter 17 (90ml)
	2700	7	filter 1 (100ml) filter 2 (150ml) filter 3 (750ml)	filter 24 (10 ml) filter 25 (90 ml)
	2600	9	filter 12 (500 ml) filter 13 (500 ml)	filter 18 (10 ml) filter 19 (90 ml)
	2200	17	filter 10 (500 ml) filter 11 (500 ml)	filter 20 (10 ml) filter 21 (90ml)
	1800	20	filter 5 (500ml)	filter 22 (10 ml)
	1800	20	filter 6 (100ml)*	filter 23 (90ml)
	1800	20	filter 7 (125ml)	
	1800	20	filter 8 (275 ml)	
	ATA-11CTD	3000	7	filter 14 (500 ml) filter 15 (500 ml)
	100	21	-	-

Table 1.4.7.2: Sample list of hydrothermal fluids taken with the KIPS system

Sample number	site	DNA	FISH (fixed in formaldehyde)	#/name	temperature [°C]	Cultures target organisms	<sup>14</sup> C-incorporation
ATA-13 ROV 3	Site A (hot fluids)	filter 28 (200 ml)	filter 30 (10 ml) filter 31 (90 ml)	1	75	Methanococcales + Methanopyrus	
				2	75	Aquificales +	
				3	55	Epsilonproteobacteria	
				4	37	Thermates + Aeropyrum	
				5	75	Methanococcales +	
ATA-13 ROV 8	Anna-Louise (hot fluids)	filter 29 (200 ml)	filter 32 (5 ml) filter 33 (40 ml)	6	75	Methanopyrus	
				7	75	Aquificales +	
				8	55	Epsilonproteobacteria	
				9	37	Thermates + Aeropyrum	
				10	75	Thermates + Aeropyrum	
ATA-15 ROV 2	Quest t-logger 8 (diffuse fluids)						
ATA-15 ROV 4+5	Quest t-logger 8 (diffuse fluids)	filter 34 (200 ml) filter 35 (200 ml)	filter 36 (10 ml) filter 37 (90 ml)	11	75	Thermococcales + Thermotogales	H2.0-1 H2.0-2 H2.0-3
				12	55	Thermococcales + Thermotogales	H2.A-1 H2.A-2 H2.A-3
				13	37	Methanococcales + Methanopyrus	H2S-1
				14	55	Desulfurobacterium +	H2S-2
				15	75	Desulfurococcales +	H2S-3
				16	37	Epsilonproteobacteria	Ref1
				17	55	Thermates + Aeropyrum	Ref2
				18	75	Aquificales +	Ref3
				19	22	Epsilonproteobacteria	Control.1
				20	37	Epsilonproteobacteria	Control.O2
21	55	Archaeoglobales +					
22	75	Thermodesulfobacteria					
23	55	NH <sub>4</sub> <sup>+</sup> -oxidizers					
24	75	NO <sub>2</sub> -oxidizers					
25	25						
AOB3							
NOB3							

Sample number	site	DNA	FISH (fixed in formaldehyde)	#/name	Cultures		target organisms
					temperature °C	temperature	
ATA-17 ROV 5	Site B (hot fluids)	filter 39 (120 ml)	filter 42 (10 ml)	NOB1	25		NO <sub>2</sub> <sup>-</sup> oxidizers
		filter 40 (75 ml)	filter 43 (90 ml)	NOB1.1	25		NO <sub>2</sub> <sup>-</sup> oxidizers
		filter 41 (75 ml)		AOB1	25		NH <sub>4</sub> <sup>+</sup> -oxidizers
ATA-17 ROV 11	Irina I (hot fluids)	filter 38 (280 ml)	filter 44 (10 ml)	AOB1.1	25		NH <sub>4</sub> <sup>+</sup> -oxidizers
			filter 45 (90 ml)	AOB2	25		NH <sub>4</sub> <sup>+</sup> -oxidizers
ATA-21 ROV 5	Irina II t-logger 3 (low-temperature fluids)			NOB2	25		NO <sub>2</sub> <sup>-</sup> oxidizers
ATA-21 ROV 7	Irina II t-logger 7 (low-temperature fluids)	filter 46 (300 ml)	filter 49 (100 ml)	-	-		-
ATA-21 ROV 11							
ATA-21 ROV 13		filter 47 (200 ml)	filter 48 (100 ml)	-	-		Methanococcales + Methanopyrus
ATA-24 ROV 4	Irina II (hot fluids)	filter 50 (250 ml)	filter 51 (45 ml)	26	75		Desulfurobacterium + Desulfurococcales + Epsilonproteobacteria
ATA-27 ROV 8	Quest t-logger 19 (low-temperature fluids)	filter 53 (300 ml)	filter 52 (45 ml)	27	75		Epsilonproteobacteria Aquificales +
				28	75		Epsilonproteobacteria Thermococcales +
				29	75		Thermotogales
				30	55		Methanococcales +
				31	75		Methanopyrus
				32	25		Desulfurobacterium +
				33	55		Desulfurococcales +
				34	75		Epsilonproteobacteria
				35	25		Aquificales +
				36	55		Epsilonproteobacteria
				37	75		
				AOB4	25		NH <sub>4</sub> <sup>+</sup> -oxidizers
				NOB4	25		NO <sub>2</sub> <sup>-</sup> oxidizers

Sample number	site	DNA	FISH (fixed in formaldehyde)	#/name	temperature [°C]	Cultures target organisms	<sup>13</sup> C-incorporation
ATA-30 ROV 1	Site B (hot fluids)	filter 54 (275 ml)	filter 55 (5 ml)	-	-	-	H2.0-1
			filter 56 (45 ml)				H2.0-2
							H2.0-3
							H2.0-4
							H2.A-1
							H2.A-2
							H2.A-3
							H2.A-4
							H2S-1
							H2S-2
							H2S-3
							H2S-4
							Ref1
							Ref2
							Ref3
							Ref4
							Control.1
							Control O2-H2
							Control.O2+H2
							Control H2S 1
							Control H2s 2

### 1.4.8 Hydrothermal Symbioses

(by C. Borowski, and D. Fink)

The main goal for this cruise was to continue the investigations on the transfer of energy from vent fluids to symbiotic invertebrates started during earlier visits of the Logatchev hydrothermal vent field. As no slurp sampler was available in this cruise leg, we concentrated on symbiotic invertebrates that can be sampled with manipulator arm-operated scoop nets, i.e., the dominant mussels *Bathymodiolus puteoserpentis* which are the major faunal biomass producers at the Logatchev vent sites Irina II and Quest. *B. puteoserpentis* is known from the Mid-Atlantic Ridge (MAR) vent fields Snake Pit and Logatchev, and the mussels collected in the recently discovered hydrothermal vent fields Lilliput, Wideawake and Golden Valley on the southern MAR likely also belong to this species. *B. puteoserpentis* harbors two coexisting types of symbionts in its gill tissues: thiotrophic bacteria that use reduced sulfur compounds such as sulfide as an energy source and fix CO<sub>2</sub> as a carbon source, and methanotrophic bacteria that use methane as both an energy and a carbon source. Our investigations during earlier cruises indicated that one or even both symbionts of *B. puteoserpentis* are also able to utilize H<sub>2</sub> as an electron donor for CO<sub>2</sub>-fixation - a result that represents a milestone in symbiosis research because oxidation of H<sub>2</sub> has never been shown for any other symbiont associated with hydrothermal vent invertebrates. The energy-rich electron donors H<sub>2</sub>S, CH<sub>4</sub> and H<sub>2</sub> are available in the diffuse hydrothermal fluids emerging around the smoker structures of Irina II and Quest as a result of subsurface dilution of the hot endmember fluids with seawater. Their concentrations vary over time and space and play a major role in determining the biomass, activity and productivity of the vent community. We have defined these interactions between hydrothermal and biological processes as the geobiological coupling between vent fluids and symbiotic primary producers.

Recent investigations showed that the two symbiotic phylotypes associated with *B. puteoserpentis* are identical to those found in the closely related species *B. azoricus* that lives in the northern MAR hydrothermal vent fields Rainbow, Lucky Strike and Menez Gwen (Duperron et al., 2006). Research on the energy transfer and the activity of the symbionts in *B. puteoserpentis* in Logatchev therefore gains more than only local importance.

Our work during this cruise leg concentrated to a large extent on sampling, dissecting, preparation and preservation of material for analyses that will be performed in the home laboratory. Our onboard work included also incubation experiments for the determination of carbon fixation rates. Subsequent measurements of <sup>14</sup>C-turnover by scintillation counting will follow in the home laboratories. The collection of animal material was strictly coordinated with the sampling of diffuse fluids for concentration analyses of CH<sub>4</sub>, H<sub>2</sub>S, H<sub>2</sub> and with 8-channel T-Lance temperature measurements at the same spots in order to ensure the correlation of biological and environmental data (Tab. 1.4.8.1).

Table 1.4.8.1: Station list for hydrothermal symbiosis research

Vent structure	Mussel samples		8-Channel T-Lance		KIPS data									
	Location	Sample #	Purposes	Location	Sample #	T (°C, online)	Location	Bottle	KIPS T (°C)	CH <sub>4</sub> (µM)	H <sub>2</sub> (µM)	S <sup>2-</sup> (µg/ml)	pH	
Inna II	Below Inna II structure	09 ROV 1	Incubations (H <sub>2</sub> , H <sub>2</sub> S, <sup>14</sup> C and <sup>13</sup> C), Nycodenz gradient (2 x 24 fractions), DNA, FISH, host phylogeny, TEM, shells, entire animals in formalin	Logger 3	21 ROV 4	2.5 - 11.05	21 ROV 5	C9	3.7	1.87	3.25	0.013	7.79	
		21 ROV 9	Nycodenz gradient (2 x 24 fractions), Cell quantification (8 x FISH per Demibranch) DNA/RNA, host phylogeny, TEM, shells, entire animals in formalin	Logger 3	21 ROV 4	2.5 - 11.05	21 ROV 6	C8	3.6	-	-	-	7.82	
		21 ROV 7	Demibranch) DNA/RNA, host phylogeny, TEM, shells, entire animals in formalin	Logger 3	21 ROV 4	2.5 - 11.05	21 ROV 7	C7	3.5	-	-	< d.l.	7.87	
		21 ROV 8	phylogeny, TEM, shells, entire animals in formalin	Logger 3	21 ROV 4	2.5 - 11.05	21 ROV 8	B6	-	-	-	-	7.87	
		21 ROV 14	Only dead shells	Logger 7	21 ROV 10	2.4 - 28.6	21 ROV 11	B5	2.8	3.23	2.16	0.015	7.56	
				Logger 7	21 ROV 10	2.4 - 28.6	21 ROV 12	B4	3	-	-	-	7.77	
				Logger 7	21 ROV 10	2.4 - 28.6	21 ROV 13	A3	2.9	-	-	< d.l.	7.85	
		21 ROV 17	FISH, DNA/RNA, host phylogeny, entire animals in formalin	Logger 9	21 ROV 15	2.4 - 45.2	21 ROV 14	A2	2.7	No sample - nozzle clogged	-	-	-	-
		15 ROV 6	Incubations (H <sub>2</sub> , H <sub>2</sub> S, <sup>14</sup> C and <sup>13</sup> C, RubisCO blocker), Nycodenz gradient (2 x 24 fractions), DNA/RNA, FISH, host phylogeny, TEM, shells, entire animals at -20°	Logger 13	15 ROV 1	11.5 - 192.6	15 ROV 2	C9	10.8	-	-	-	0.0029	7.63
	Quest		15 ROV 7	Incubations (H <sub>2</sub> , H <sub>2</sub> S, <sup>14</sup> C and <sup>13</sup> C, RubisCO blocker), Nycodenz gradient (2 x 24 fractions), DNA/RNA, FISH, host phylogeny, TEM, shells, entire animals at -20°	Logger 13	15 ROV 7	-	15 ROV 3	C8	2.9	12.34	21.22	0.012	7.48
				Logger 13	15 ROV 7	-	15 ROV 4	C7	4.9	-	-	-	-	
				Logger 13	15 ROV 7	-	15 ROV 5	B6	4.8	-	-	< d.l.	7.68	
		27 ROV 9	Nycodenz gradient (24 fractions), Cell quantification (8 x FISH per Demibranch) DNA/RNA, host phylogeny, TEM, shells, entire animals in formalin	Logger 19	27 ROV 4	29.5 - 120.2	21 ROV 6	C9	4.5	5.78	5.68	-	7.64	
				Logger 19	27 ROV 4	29.5 - 120.2	21 ROV 7	C8	< 5	-	-	-	7.54	
				Logger 19	27 ROV 4	29.5 - 120.2	21 ROV 8	C7	< 5	-	-	-	7.57	
		27 ROV 10	Nycodenz gradient (24 fractions), Cell quantification (8 x FISH per Demibranch) DNA/RNA, host phylogeny, TEM, shells, entire animals in formalin	Logger 17	27 ROV 15	6.3 - 115.0	-	-	-	-	-	-	-	
				Logger 17	27 ROV 15	6.3 - 115.0	-	-	-	-	-	-	-	
				Logger 11	27 ROV 11	16.8 - 57.4	-	-	-	-	-	-	-	
				Logger 12	27 ROV 14	4.0 - 10.5	-	-	-	-	-	-	-	
			Logger 10	27 ROV 16	2.3 - 8.7	-	-	-	-	-	-	-		

&lt; d.l. = below detection limit; - = not analyzed

## Goals and methods

### 1. Identification of the *B. puteoserpentis* symbiont that oxidizes H<sub>2</sub> for carbon fixation, and identification of other potential energy sources for carbon fixation

Classic microbiological approaches for empirical assessment of physiological pathways of *B. puteoserpentis* symbionts are not applicable because cultivation of endosymbiotic bacteria outside of the host is not possible to this date and the mussels do not survive in aquaria. An alternative way for receiving information on the potential for physiological pathways of microorganisms can be genome sequencing. As the genome includes the entire physiological potential of an organism, the occurrence of a gene coding for a key enzyme can serve as an indication for a certain physiological pathway. This requires the availability of purified genotypes, which is not the case to this date for symbionts. We approached this problem by separating the different symbiont morphotypes with density gradient centrifugation. We dissected and homogenized the gills of freshly collected mussels, filtered the cell debris/symbiont mixture on micropore filters and centrifuged the homogenates in a Nycodenz density gradient. The consecutive density fractions were removed with pipettes, aliquots were in-situ hybridized with specific oligonucleotide probes (Fluorescence In-Situ Hybridization = FISH) and the separation of the different cell types was pre-controlled on board under a fluorescent microscope. Further control of cell separation and preparation for genome sequencing will follow in the home laboratories.

### 2. Comparison of the rates at which different energy sources are used by the symbionts.

The uptake of H<sub>2</sub> by symbiont containing gill tissue versus non-symbiont containing foot tissue has been demonstrated earlier in incubation experiments by measuring H<sub>2</sub> depletion with time in the medium. In order to determine carbon fixation rates, we incubated during this cruise fresh gill material with NaH<sup>14</sup>CO<sub>2</sub> and added alternatively H<sub>2</sub>S or H<sub>2</sub> as electron donors. Incubations without added electron donors were used as controls. The incubations were stopped after 30, 60, and 120 min, respectively, and the amount of incorporated <sup>14</sup>C carbon will be measured by scintillation counting in the home laboratory. Additional incubations with NaH<sup>13</sup>CO<sub>2</sub> will be analyzed by nanoscale secondary ion mass spectrometry (nanoSIMS). With this high-resolution imaging technique, stable isotopic composition of biological material can be determined down to the sub-micron level. NanoSIMS will visualize metabolically active cells, and will allow to calculate their uptake rates and to determine nutrient fluxes.

### 3. Quantification of symbionts in gill tissues

The activity of a symbiotic population in a host is not only determined by turnover rates of individual symbiont cells, but also by the number of active cells. Earlier in-situ experiments showed that the symbiont abundance in mussel gill tissue can decrease dramatically only a few days after experimental displacement of the animals from



diffuse hydrothermal flux to sites without hydrothermal activity. In order to estimate the potential activity of a symbiont population on the basis of cell abundance, we currently develop at MPI-Bremen methods for reliable determination of quantitative cell distribution in the three dimensional space of the host bacteriocytes and, on a larger scale, in the entire gill. We use 3D analyses with confocal laser scanning microscopy (LSM) and subsequent computer image analyses with specialized software. Our detailed dissection and fixation program of symbiont containing tissue which we performed with respect to later LSM analyses will allow quantification of symbionts throughout the entire gill lengths and separately for inner and outer demibranches. While standard FISH methods targeting ribosomal RNA will be used for the quantification, we will be able to localize activity patterns throughout the gills with special FISH methods targeting the messenger RNA products of functional genes that express key role enzymes in the various pathways of C-fixation such as APR-Reductase for CO<sub>2</sub> fixation by H<sub>2</sub>S-oxidation, Ni/Fe-Hydrogenase for CO<sub>2</sub>-fixation by H<sub>2</sub>-oxidation and the large subunit of the Particulate Monooxygenase for the utilization of methane as an energy and carbon source. We will compare mussels collected at Irina II and Quest for potential differences between these sites.

#### 4. Analyses of population genetics

One key question within the SPP 1144 concerns the biogeographic distribution of invertebrates on the equatorial Mid Atlantic ridge, and we investigate biogeographical patterns on the basis of genetic analyses by comparing eukaryote marker gene sequences such as for the genes COI, ND4, and 18S among populations collected in Logatchev, on the southern MAR, in the Gulf of Mexico and in the Gabon Fan. During this cruise leg we realized that *B. puteoserpentis* specimens collected at Irina II and Quest show morphological differences (Fig. 1.4.8.1): The gills of the Quest animals are generally far more developed and darker colored than those of Irina II specimens; the foot is much larger in Quest animals and the gonads of all Quest animals appeared to be ripe in contrast to those of Irina II. These differences may either represent different nutritional conditions or may point to the presence of two different (sub-)populations separated by only 120 m distance between Quest and Irina II. Nutritional conditions as a factor will be investigated by cell quantification and determination of activity patterns (s. above). The question if genetic differentiation occurs at the two sites will be addressed with genetic analyses of ITS sequences from freshly collected specimens and from material collected during earlier cruises.

#### 5. Growth rates of mussels

Mollusks record variations in the ambient water conditions as changes of shell structure and growth rate and by this act as bioarchives for environmental change. This is known from shallow water species (Mutvei et al. 1996, Richardson 2001, Gaspar et al. 2004) and has recently been shown also for the hydrothermal vent mussel *Bathymodiolus brevior*

from the western Pacific North Fiji Basin (Schöne & Giere 2005). Hydrothermal vent mussels deposit the isotope  $\delta^{18}\text{O}$  in their shells in isotopic equilibrium with ambient sea water (Roux et al. 1985), and the  $\delta^{18}\text{O}$  ratio in seawater is linked to water temperature (Anderson & Arthur 1983).

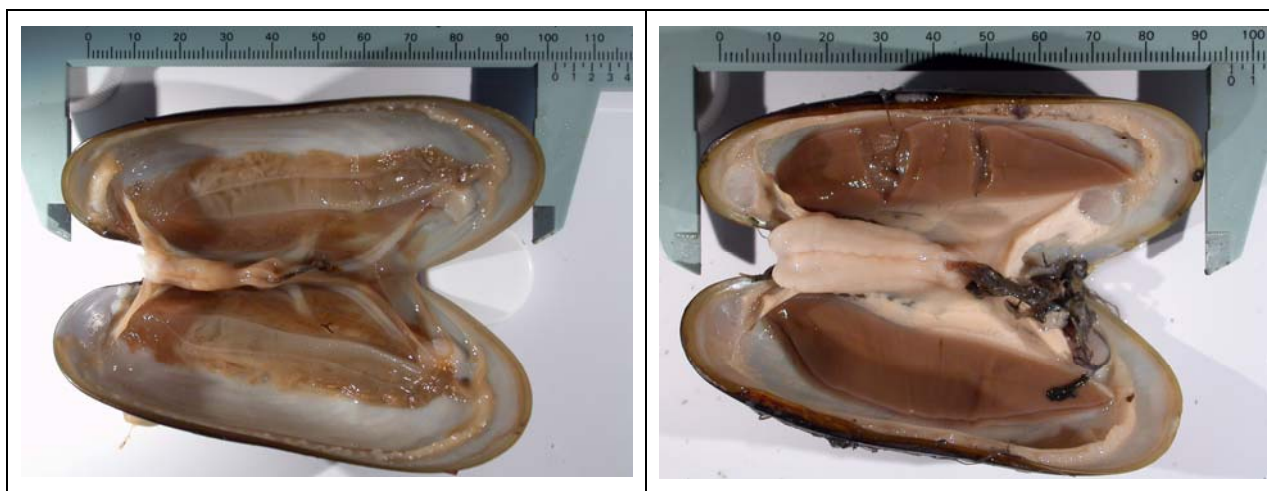


Fig. 1.4.8.1: *B. puteoserpentis* specimens collected at the base of the Irina II structure (left) and from the T-logger field near the Quest smoking crater (right). Note the different appearances of the gills, foot and gonads.

The shells of the mussels collected during this cruise will serve us for analyses of shell growth patterns in Logatchev and will show if differences exist between Quest and Irina II. This information can help the interpretation of above investigations (see 3. and 4.). Comparison with shells collected during earlier expeditions will enable us to align growth patterns among animals sampled at different times. By this we anticipate to extend the range of observation time beyond the life span of individual mussels. The results will be correlated with the geophysical long-term measurements on temperature and microseismicity in Logatchev which give information on hydrothermal activity patterns. These measurements were started in 2005 and have been continued with this cruise. A very important task is also the comparison with growth patterns of mussels from the recently discovered hydrothermal vent fields on the southern MAR, which in contrast to Logatchev are regarded to be highly influenced by young volcanism and frequent hydrothermal events. By analyses of  $\delta^{18}\text{O}$ -ratio micro-profiles along the major growth lines of the shells, we hope to be able to detect major hydrothermal events that happened in the southern MAR sites in the recent past. Complementary information from Logatchev specimens will significantly help the interpretation of such signals.

### **1.4.9 Metagenomics**

(by M. Schattenhofer)

#### **Introduction**

Metagenomics is defined as the genomic analysis of the collective genomes of an assemblage of organisms in a certain habitat (Handelsman et al., 2002). The metagenome analysis has proved to be a useful tool to get deeper insights into the biochemical potential of microorganisms, e.g. of microbial communities at hydrothermal vents. For the construction of metagenomic libraries, usually, large genomic DNA fragments (>35 kbp) are directly extracted from an environmental sample, cloned into high capacity vectors and stably maintained in *E. coli*. The libraries can be randomly sequenced or subsequently be screened for phylogenetic marker genes and functional genes. The genetic context of these genes can be analysed in order to get new and interesting insights into the genetic potential of microbial communities (Riesenfeld et al., 2004).

#### **Objective**

The aim of the participation in cruise HYDROMAR V to the Logatchev hydrothermal field was the sampling of free living microbial communities at few characteristic hydrothermally influenced sites with high biomass for metagenome analyses. Preferred samples were sediments and microbial mats as several grams of a microbial mat or several hundred grams of sediment contain generally sufficient cells for a metagenome study. The samples should be taken in a targeted way, e.g. by the ROV, at well characterised sites.

#### **Methods**

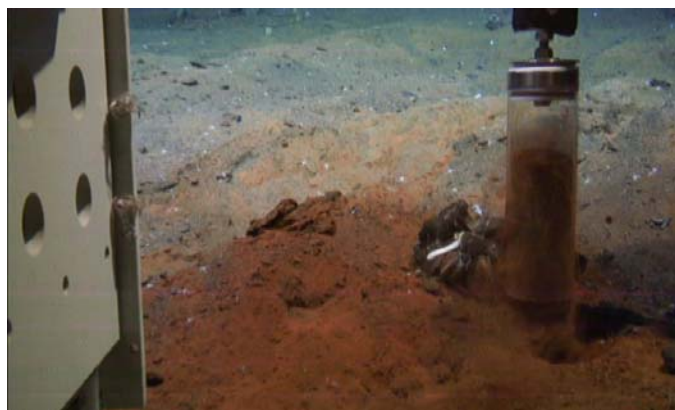
Sediment core was sectioned into 1 cm slices prior to further treatment. Sediment samples were fixed with 50% ethanol in phosphate buffered saline (PBS) and 4% formaldehyde (FA)/PBS, respectively, for cell count determination, and community structure analysis. The major part of the sample was deep frozen for DNA extraction (-80°C) in the home laboratory.

High amount of deep-water and plume samples (180 l) of the CTD-rosette were pumped with a peristaltic pump and filtered on 142 mm celluloseacetate membranes (0.22 µm), which can be used for metagenomic analysis. Additionally, 1 l was concentrated on polycarbonate membrane filters (0.22 µm) for DNA-extraction. Plume samples were fixed with 1% FA for 2 h for CARD-FISH experiments.

#### **Samples and Preliminary Results**

Samples were taken at different characteristic sites by the ROV and the CTD-rosette sampler and included the following material:

- 1) One sediment core was taken in an area close to the marker 20 during Station 27ROV (Site Quest, Fig. 1.4.9.1).
- 2) Hydrothermal plume (3 stations) was collected using the CTD-rosette sampler. About 170 l of hydrothermal plume from ATA12CTD (water depth 3000 m) and about 180 l of plume sampled during ATA19CTD (water depth 2817 m) and ATA29CTD (water depth 2895 m) were filtered for DNA extraction.



*Fig 1.4.9.1: Sampling of sediment cores with a push corer and temperature measurement at the site Quest.*

### **Summary and Outlook**

The analysis of the samples with respect to cell counts, community structure, as well as DNA content will be carried out in the home laboratory in order to determine the best target for a metagenome study. Subsequently few metagenomic libraries will be constructed and analysed.

### **1.4.10 ROV deployments during HYDROMAR V**

(by T. Kuhn, M. Pieper, D. Cormany, A. Foster, C. Hinz, A. Meier, I. Suck, K. Wietkewicz)

#### **Description of ROV KIEL 6000**

ROV KIEL 6000 is an electric, work-class ROV with a depth rating of 6000m. It was built by SCHILLING ROBOTICS LLC within their Quest production line and is equipped with 7 brushless thrusters each with 210 kgf peak thrust, 1x 7-function, spatially-controlled and 1x 5-function, rate-controlled manipulator, a sonar system as well as 1 HDTV video camera, 2 high-resolution color zoom cameras, 4 b/w observation cameras and 1 digital still camera. All color cameras are mounted on pan and tilt units. Scientific tool packages include a laser video measurement system and CTD as well as a tool sled mounted underneath the ROV frame with 2 hydraulically driven trays, a sample basket and up to 130 kg of scientific payload.

The heart of the ROV is a digital telemetry system (DTS) with its basic unit, the communication node, a small, lightweight, 16-port module that can be used alone or daisy-chained for additional functionality. The node features a Gigabit Ethernet backbone, and each port can be individually configured for serial, video, or Ethernet. The DTS™ node routes power and telemetry between the system and all instruments on the WROV and tool skids. Four nodes with 64 ports are supplied with the ROV Kiel 6000 system to operate all standard on board equipment, 24 ports are available for additional scientific instruments. The manipulators are hydraulically driven, 2 valve packs with 12 hydraulic valves each (including 4 proportional valves) provide additional access for scientific instruments to the hydraulic system.

ROV Kiel 6000 is run in life boating mode, i.e., the ROV is directly linked to the surface vessel via a steel-armoured, fiber-optical umbilical. No tether management is used. The ROV control system allows station keeping ( $\pm 0.1$  m) and automatic flight control such as automatic displacement, cruise and trim. Navigation is realized by the USBL-based POSIDONIA™ system supported by the SONARDYNE ROV-Homer™ system. The ROV system works with a 19mm, 6500m fiber-optical umbilical wound up in 20 layers on an electrically-driven winch. Two fibers are used simultaneously during a dive and a third backup fiber is also connected.

The ROV system weights approximately 65 t. It comes with 5 20' containers: 1 control van, 1 power/workshop van, 1 winch container (20' high cube), 1 ROV transport container (20' high cube), and 1 additional transport container.

In August 2007 the ROV was successfully tested during cruise ROVARK with RV SONNE in the Kermadec Volcanic Arc in 1800 m water depth.

### **Technical preparation**

ROV KIEL 6000 is a mobile system and is, therefore, meant to be used on ships-of-opportunity. The system has already proven this flexibility since it was used on the German R/V Sonne and (now) the French N/O I'Atalante. In spite of this general flexibility, a number of technical preparations and adaptations were necessary to allow the use of ROV KIEL 6000 onboard I'Atalante. The following section will shortly describe this work.

The winch of ROV KIEL 6000 is permanently installed in a 20' High Cube ISO container. 6500 m of a 19 mm umbilical is wound in 20 layers onto the winch drum. The whole winch weights 28 t. In order to safely install the winch on the working deck of I'Atalante, eight base plates were welded to the metal deck. Each plate contained a twist lock to fix the winch container on it. Each plate was made to hold 10 t of loading (Fig. 1.4.10.2).

The winch could not be installed 90° to the long axis of the working deck but had to be slightly twisted (approx. 10°) in order to fit with the deck layout, the other ROV containers and the fact that the ROV sheave was not installed in the center of the A-frame but to the side of it (Fig. 1.4.10.2).

To launch and recover the vehicle the deployment frame of ROV KIEL 6000 (red part in Fig. 1.4.10.3) was used. This frame normally consists of 3 modules. However, the upper module was removed and the "structure intermediaire" of R/V l'Atalante was used instead (white part above red deployment frame in Fig. 1.4.10.3). Two adapters were necessary to connect the deployment frame and the "structure intermediaire". They were manufactured by FHF GmbH in Bremen, the company that also built the deployment frame.

Lifting of the ROV was carried out using a flexible lift line provided by the vessel and an overshot tool provided by the ROV team. After launching the vehicle into the water, the overshot tool (latch) was mechanically released. Upon recovery it was necessary to fly the ROV underneath the deployment frame (the A-frame was then completely tilted out). The overshot tool slit down the ROV umbilical until it latches into the ROV lift point. This procedure worked well until a swell of approximately 3.5 m thanks to the excellent co-operation between deck's crew and ROV team.

### **ROV dives**

In total 8 dives were carried out on 8 working days in the Logatchev hydrothermal field. Given the fact that this cruise was the first scientific deployment of ROV KIEL 6000 this result is a great success for the ROV team and the crew of R/V l'Atalante. Further statistics of the ROV dives are summarized in Tab. 1.4.10.1.

ROV stations usually started at 6:30 am LT with the pre-dive, launch starts at 8:00 am. Launch of the vehicle was postponed during the first two dives because of unstable weather and rather high swell. Some discussion was necessary ahead of these first dives as to whether launch the vehicle or not. In the end we decided to dive even if the weather was unsafe and the swell rather high (up to 3.5 m during sea state 5-6). Therefore, 10 persons were necessary to launch the system including the ROV winch and lift line winch drivers. The launch procedure was as follows:

Lifting the ROV underneath the plate of the deployment frame, move the A-frame to its out-tilted position, launch the ROV into the water, switch on high power, release the overshot tool, move ROV some meters away from stern of vessel, attach 3 floats to umbilical, payout 50-60 m of umbilical, attach 9 floats to umbilical, start descend.

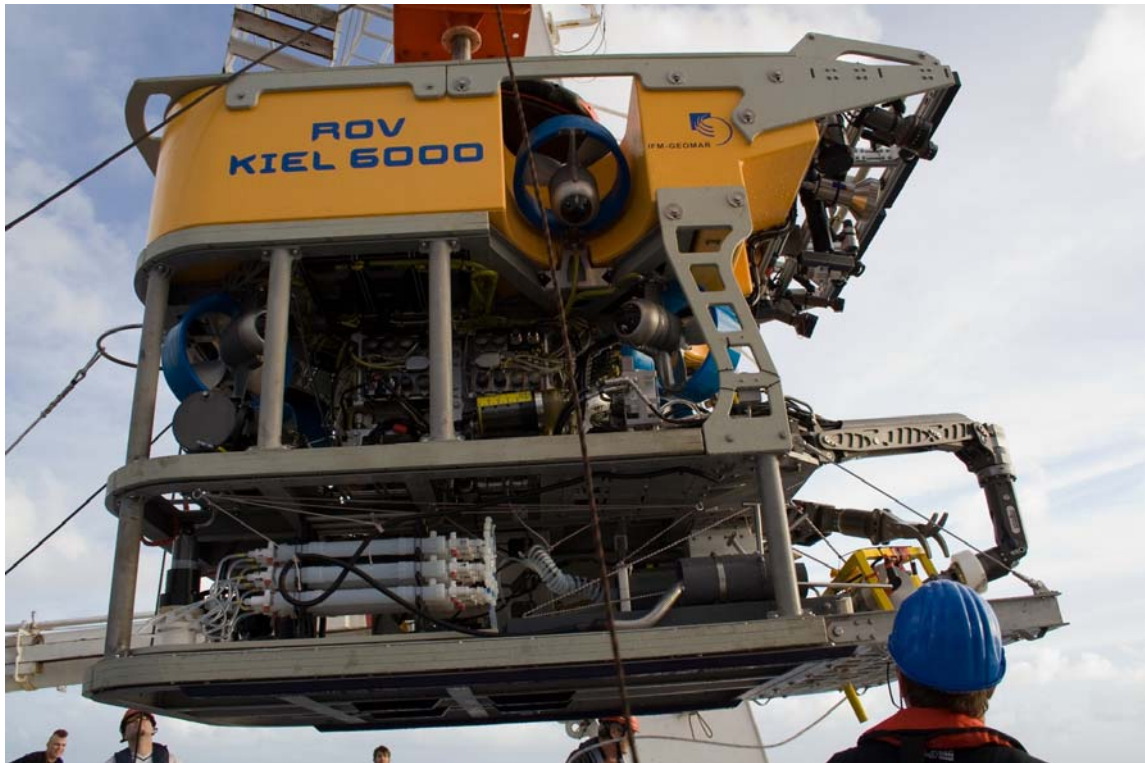
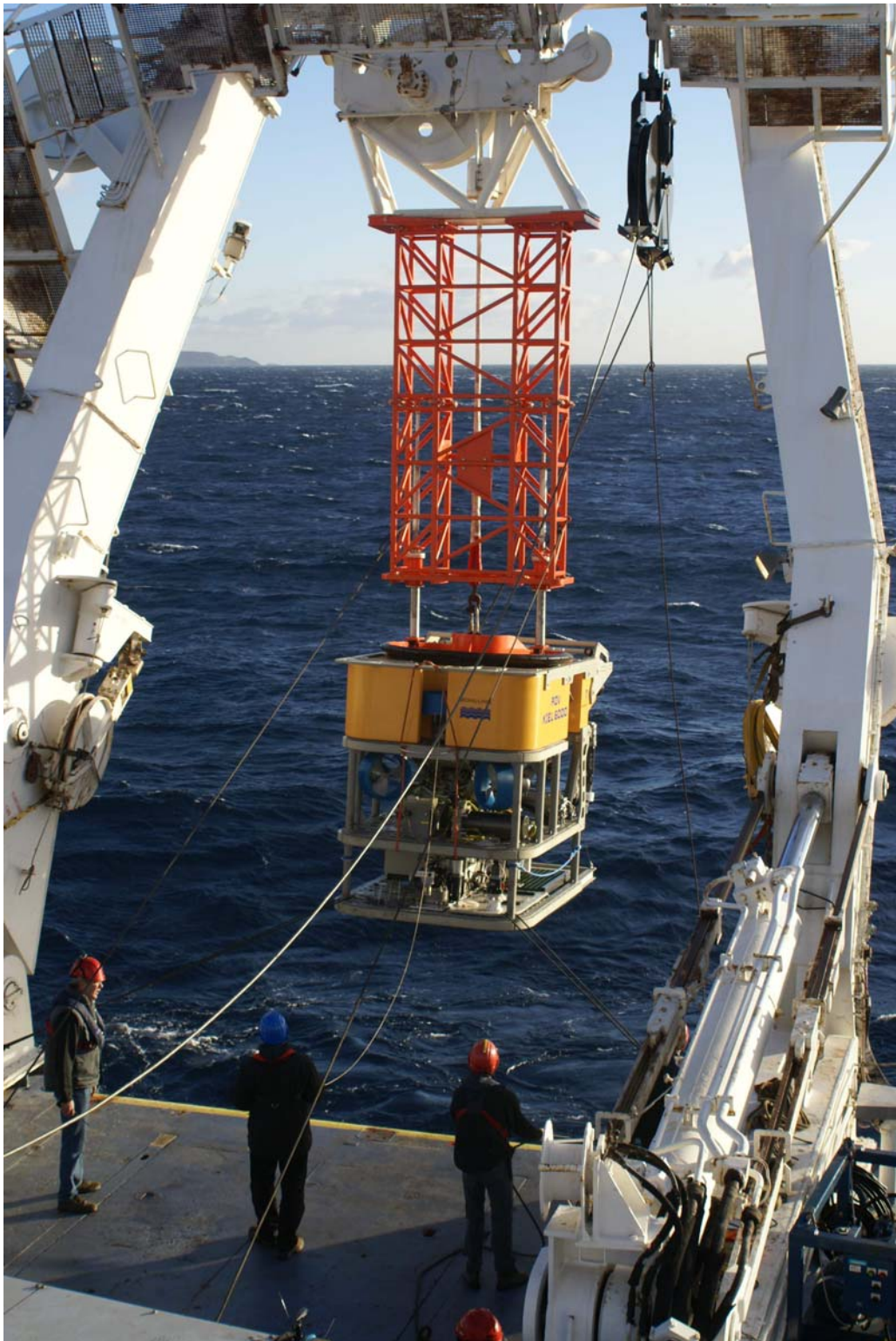


Fig. 1.4.10.1: ROV KIEL 6000 onboard R/V l'Atalante (Foto: N. Augustin).



Fig. 1.4.10.2: Installation of the 28t winch with 6500 m of 19 mm umbilical for ROV KIEL 6000. Eight especially made base plates are used to fix the winch on deck (Foto: A. Massol, Ifremer).



*Fig. 1.4.10.3: Launch of ROV KIEL 6000 from R/V l'Atalante during the seatrials. The red deployment frame (belongs to the ROV system) was fixed to the vessel's "structure intermediaire" (white structure above red frame) with 2 adapters. The ROV was lifted with the white, flexible lift line (Foto: A. Massol, Ifremer).*





Fig. 1.4.10.4: Position of the ROV winch container, the control van, the ROV and its deployment frame at the rear of l'Atalante's working deck. The winch to the left hand side of the ROV winch was used to pay in/out of the lift line to lift the ROV (Foto: A. Massol, Ifremer).

Table 1.4.10.1: Summary of ROV dives during HYDRMAR V

Station #	Date (UTC)	Dive #	Station duration <sup>1</sup> (hrs:min)	ROV bottom time (hrs:min)	% bottom time
ATA09ROV	17.12.2007	6	09:08	03:51	42
ATA13ROV	18.12.2007	7	09:28	03:16	35
ATA15ROV	19.12.2007	8	10:13	06:29	63
ATA17ROV	20.12.2007	9	10:20	07:18	71
ATA21ROV	21.12.2007	10	12:11	08:15	68
ATA24ROV	22.12.2007	11	12:20	09:02	73
ATA27ROV	23.12.2007	12	13:29	09:12	68
ATA30ROV	24.12.2007	13	08:33	05:31	65
Total = 8 Dives			84:42	52:54	62

<sup>1</sup> includes launch from and recovery onto vessel

Recovery of the vehicle was the upper procedure backwards. Since the swell was always rather high it was essential to quickly latch the overshot tool once the floats had been removed. In order to prevent heavy and sudden loads on the umbilical we always tried to latch the tool when the ROV was in 1-2 m water depth. This worked out smoothly and guaranteed a safe return of the vehicle even in rather heavy sea. Descend and ascend velocities were between 0.6 and 1.0 m/s depending on the buoyancy of the vehicle (i.e. what scientific devices were carried).

First dives were scheduled to recover during daylight, i.e. approximately 6:30 pm LT, later dives lasted until up to 21:00 pm LT for recovery of the ROV back to deck. During the dives, the following scientific tools were mounted on the ROV either to transport and place them on the seafloor, recover and carry them back to the vessel, or use them as sampling tools:

- Ocean Bottom Tiltmeter (OBT)
- Ocean Bottom Accelerometer (OBA)
- Ocean Bottom Pressuremeter (OBP)
- KIPS fluid sampling system
- Major fluid samplers
- 1-channel temperature sensor (mounted on the nozzle of KIPS)
- 8-channel temperature lance
- SMONI (1-channel, long-term high-temperature logger)
- Push cores
- Nets for biological sampling
- He sampler

Apart from these mobile scientific tools, there are a number of other permanently installed tools producing scientific data such as:

- CTD
- Sonar system (400 m range @  $\pm 1$  m resolution)
- Laser Camera (for the video-controlled measuring of distances at objects on the seafloor)

Three colour video cameras (1 HDTV and 2 Standard PAL cameras) produce a large amount of video data. Videos from the standard cameras are permanently and synchronously recorded as mpeg2 files to a video server. HDTV videos are recorded only at scientific request. They are stored in DVCPRO-HD format on a MacintoshPro

and as mpeg2 files on the same video server as the standard videos. Approximately one hour of HDTV video can be stored per dive.

The video data stored on the video server is available to all scientists 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) as well as incorporation of metadata using the scientist's browser from their cabin.

Any other data produced during a dive (such as navigation, depth, CTD data) are time-referenced (UTC) and stored in a data base (Davis-ROV™ by Werum GmbH). This data base is also available from the intranet using a standard web browser. D-ROV is very similar in terms of its structure and application as the D-Ship system that is installed on all large German research vessels.

ROV KIEL 6000 performed very well during all dives. There was no general or critical fault of most subsystems or components. Navigating the ROV, positioning it on requested spots at the seafloor, station keep, manipulator work, handling of the umbilical, and co-operation with the vessel all worked out smoothly.

There was still some electronic noise on the colour cameras which is caused by an unclean power supply. The software controlling the Laser camera showed some instabilities and the digital still camera did not work due to the wrong firmware settings in one of the controller boards. The Laser camera software could be stabilized during the cruise. The ROV manufacturer will provide an additional tool to provide clean power supply for the colour cameras as well as a new board for the digi cam. Both parts will be delivered to Recife. Therefore, all three technical problems should not occur during the second leg of this l'Atalante cruise.

However, the Posidonia USBL navigation did not work during most of the dives as soon as the ROV was in reach of the seafloor (i.e., either at or roughly up to 30 m above it). This could be caused by vibrations that change the frequency of the Posidonia transducer at the ROV or acoustic noise that changes signals under water or interferes with them. The following components could cause this problem:

DVL: unlikely since it uses a different frequency and the head is orientated vertically down  
Sonar: unlikely since it uses a different frequency and the head is orientated horizontally forward

Vessel's noise: unlikely since with other tools (like the CTD) Posidonia works fine

The following tests were performed:

- switch off thrusters: no result
- switch off DVL: no result
- cover transducer head with rubber mat to better shield it from vibration and/or acoustic noise: better results
- cleaning all plugs: better results

During the last dive Posidonia worked well. We are not sure if the last two tests/measures really were the cause of the problem. The next cruise will have to prove this.

Furthermore, there was a difference in the depth readings between the ROV depth sensor and the CTD depth. This difference was not constant but changed with depth. Its depth profile is similar but not equal to the sound velocity – depth profile (Fig. 1.4.10.5), but not to the temperature vs. depth or salinity vs. depth profiles. Comparison of depth readings from other cruises (Hydromar I with ROV Quest 5 and Hydromar III with ROV Jason 2) at the same locations revealed that all readings of the depth sensors of ROV KIEL 6000 and Quest 5 are similar whereas those of Jason 2 are different from both the depth sensor and the CTD. The reason for this difference, especially for its change over depth is unclear, since both sensors use strain gauge sensors. Both sensors should be checked under carefully set laboratory conditions to find out which sensor is correct. Afterwards, the other sensor can be re-calibrated.

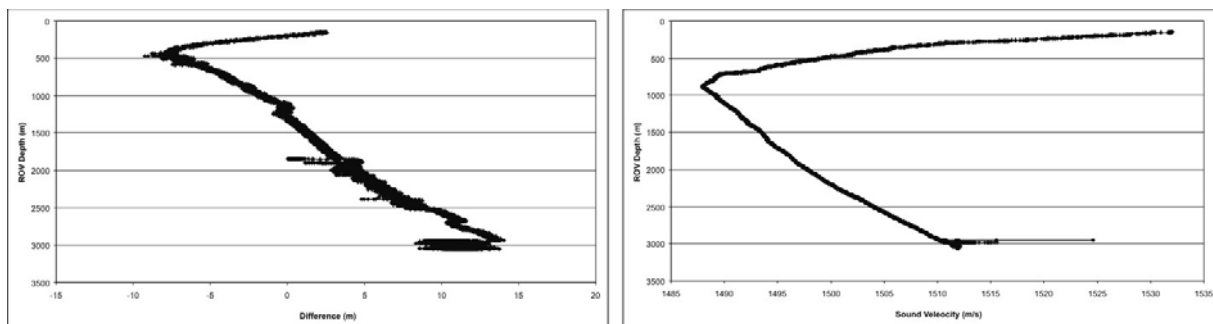


Fig 1.4.10.5: left: ROV depth versus difference between ROV depth sensor and ROV CTD depth; right: ROV depth vs. sound velocity. Note that there is no constant offset between the two depth sensors at the ROV and that there is a general similarity between the two graphs.

## 1.5 Acknowledgements

The scientists of Atalante Leg 1 would like to thank Capt. Philippe and his crew for superb support at sea and the kind atmosphere provided during the entire cruise. We also thank the *Senatskommission für Ozeanographie*, the *Deutsche Forschungsgemeinschaft* and the *Leitstelle Meteor/Merian* for making this cruises possible.

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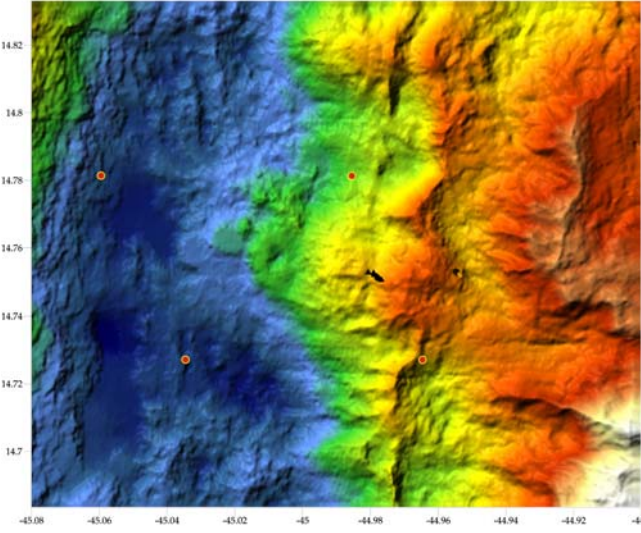
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## 1.7 Appendix

see next pages


### 1.7.1 Extended list of operations


<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
16.12.07		
ATA-01CTD 09:29 – 10:55	LADCP, water sampling, CTD <i>background station @ ~ 5100m; 21 bottles; no MAPR's attached (station aborted due to communication failure @ 1484m)</i>	15°09.40'N / 44°50.50'W
ATA-02CTD 11:31 – 12:28	LADCP, water sampling, CTD <i>(station aborted due to communication failure @ 590m)</i>	15°09.40'N / 44°50.50'W
ATA-03CTD 14:06 – 14:30	LADCP, water sampling, CTD <i>(station aborted due to communication failure @ 122m)</i>	15°09.40'N / 44°50.50'W
transit to first OBS site		
ATA-04OBS 17:12	deployment of OBS #2 No. 0906-043, radio: 159.480 MHz <i>(flag broke off during deployment)</i>	14°46.886'N/44°59.150'W @ 3459 m
ATA-05OBS 18:14	deployment of OBS #4 No. 0906-052, radio: 154.585 MHz	14°46.886'N/45°03.581'W @ 4063 m
ATA-06OBS 19:01	deployment of OBS #3 No. 0906-044, radio: 159.480 MHz	14°43.630'N/45°02.107'W @ 4083 m
ATA-07OBS 19:50	deployment of OBS #1 No. 0906-045, radio: 160.785 MHz	14°43.649'N/44°57.923'W @ 3058 m
		
		OBS sites

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
ATA-08MAPR 00:57 – 09:09	Tow-Yo along axis 5 MAPR @ 20m, 40m, 75m, 125m, 250m above bottom weight + Posidonia + Pinger	14°42.00'N / 44°58.10'W to 14°48.80'N / 44°59.25'W
17.12.07		
ATA-09ROV deployment:10:34 on bottom: 13:48	Tools: OBP-1, ADCP, 3x push cores; 3 small bionets, spare IFM beacon on ROV, 2 marker	ship at 14°45.18'N/44°58.77'W
15:01	<u>deployment:</u> OBP-1 @ OBT-site	14°45.196'N/44°58.783'W**
		
15:10 16:07	<u>move to Irina 2 (~80m)</u> <u>deploy:</u> ADCP tripod next to small black smoker @ „Irina 2“	14°45.165'N/44°58.744'W**
		
16:32	<u>sampling:</u> mussels @ „Irina 2“ at diffuse outlet (for incubation experiments)	14°45.167'N/44°58.749'W**
16:58	<u>move back to OBT site (~80m)</u>	14°45.194'N/44°58.784'W**
17:20	<u>recovery:</u> OBT-2 @ OBT-site	
		
off bottom: 17:40 recovery on deck: 19:42		

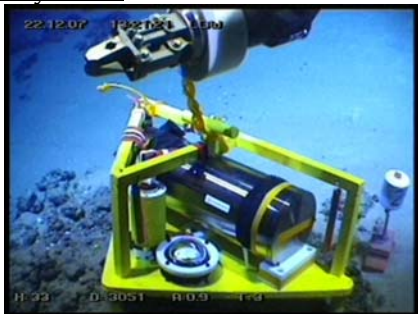



<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
ATA-10CTD 20:39 – 00:18	rosette with CTD, LADCP, 1x MAPR, 21 bottles at site of MMP mooring; bottles 3 and 18 not closed	14°45.272'N/44°58.735'W
18.12.07		
ATA-11CTD 02:06 – 05:16	rosette with CTD, LADCP, 1x MAPR, 21 bottles; bottle 3 not closed	14°44.996'N/45°05.000'W
ATA-12CTD 07:03 – 09:11	rosette with CTD, LADCP, 21 bottles at site of MMP mooring, sampling for metagenomics group; bottle 9 not closed	14°45.271'N/44°58.709'W
ATA-13ROV deployment:10:56 on bottom: 13:24	Tools: Smoni, 1x Ti-major sampler, 2x He-sampler, 3x push core; 2 small bionets, 1 net with lid, 2 marker  move to site "A"	ship at 14°45.070'N/44°58.575'W  14°45.046'N/44°58.607'W**
14:29	KIPS hot fluid sampling at small cpy-lined orifice @ site „A“ (3 bottles) in 2928m water depth bottle A1 = 13ROV-1; T <sub>KIPS</sub> = 240-260°C pH=7.6 Cl=n.d.	
14:35	bottle A2 = 13ROV-2; T <sub>KIPS</sub> = 260-295°C pH=7.8 Cl=n.d.	
14:40	bottle A3 = 13ROV-3; T <sub>KIPS</sub> = 250-306°C pH=n.d. Cl=n.d. T=very variable; T <sub>max</sub> 317°C	
15:06	8-channel T-probe; Tmax 180°C at same vent (sample 13ROV-4). Orifice is too small for the probe.	
15:23	sampling of shrimp with net (13ROV-5); net empty upon recovery	
15:27	move to Anna Louise 1 (~60m)	14°45.057'N/44°58.641'W**
17:40	arrived at Anna Louise sampling: KIPS hot fluid sampling of black smoker AL1 @ „Anna Louise“ in 2938m water depth	
18:18	bottle B4 = 13ROV-6; T <sub>KIPS</sub> = 353°C pH=6.6 Cl=n.d.	
18:22	bottle B5 = 13ROV-7; T <sub>KIPS</sub> = 352°C pH=5.3 Cl=n.d.	
18:25	bottle B6 = 13ROV-8; T <sub>KIPS</sub> = 351°C pH=n.d. Cl=n.d.	
18:28	bottle C7 = 13ROV-9; T <sub>KIPS</sub> = 352°C pH=8.3 Cl=n.d.	
18:30	bottle C8 = 13ROV-10; T <sub>KIPS</sub> = 352°C pH=5.4 Cl=555mM T=352.3±0.5°C; T <sub>max</sub> 353°C	
off bottom: 18:40 recovery on deck: 20:24		
ATA-14CTD 21:37 – 09:00	Tow-Yo with rosette, CTD, LADCP, 1x MAPR, 21 bottles; bottle 3 not closed	14°44.687'N/44°57.656'W to 14°46.070'N/45°00.115'W

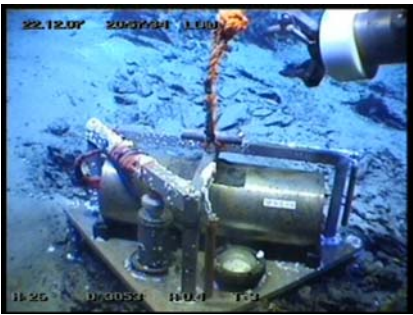
<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
19.12.07		
ATA-15ROV deployment:10:00 on bottom: 12:32	Tools: OBA, Smoni, 3x push cores; 3 small bionets, 2 marker  deployment: OBA west of Quest crater	ship at 14°45.195'N/44°58.815'W  14°45.160'N/44°58.855'W
		
17:37	at Quest musselbed in a water depth of 3045m	14°45.174'N/44°58.833'W**
17:50	8-channel T-probe (15ROV-1; T <sub>max</sub> at lowermost sensor 192°C underneath musselbed at T-logger #13)	
	KIPS diffuse fluid sampling at base of T-logger #13	
17:59	bottle C9 = 15ROV-2; T <sub>KIPS</sub> = 10.8°C	
18:04	bottle C8 = 15ROV-3; T <sub>KIPS</sub> = 2.9°C	
18:08	bottle C7 = 15ROV-4; T <sub>KIPS</sub> = 4.9°C	
18:13	bottle B6 = 15ROV-5; T <sub>KIPS</sub> = 4.8°C	
18:28	sampling T-logger #13 with attached mussels (15ROV-6)	
19:01	sampling mussels at T-logger #13 with net (15ROV-7). Co-sampling of two sulfide pieces (anhydrite-pyrite-pyrrhotite) in the base of the net.	
off bottom: 19:07 recovery on deck: 20:19		
ATA-16CTD 21:02 – 08:30	Tow-Yo with rosette, CTD, LADCP, 1x MAPR, 21 bottles;	14°44.88'N/44°57.65'W to 14°44.88'N/45°01.00'W
20.12.07		
ATA-17ROV deployment:10:01 on bottom: 11:42	Tools: Smoni, 1x Ti-major sampler, 2x He-sampler, 3x push cores; 3 small bionets, 2 marker	ship at 14°45.095'N/44°58.66'W
12:05	move to site "B" rock sampling (hematite-stained and silicified talus) on southern rim of crater (17ROV-1) in a water depth of 2979m	14°45.100'N/44°58.684'W**


<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>				
station (date/time UTC)	instruments used / samples / comments			Location
13:08	sampling of small cpy-lined chimney piece (17ROV-2; piece lost)  <u>sampling:</u> KIPS hot fluid sampling of black smoker chimney B4 @ site „B“ in a water depth of 2978m			
13:36	bottle C9 = 17ROV-3;	T <sub>KIPS</sub> = 363°C	pH=3.8	Cl=545mM
13:40	bottle C8 = 17ROV-4;	T <sub>KIPS</sub> = 357°C	pH=5.8	Cl=570mM
13:44	bottle C7 = 17ROV-5;	T <sub>KIPS</sub> = 358°C	pH=5.9	Cl=570mM
	<i>T-data not logged; T<sub>max</sub> 363°C</i>			
14:02	8-channel logger deployment (17ROV-6) at tip of smoker B4 (T <sub>1</sub> = 446 ± 5°C, T <sub>2</sub> = -, T <sub>3</sub> = 270°C, T <sub>4</sub> = 230°C, T <sub>5</sub> = 180°C, T <sub>6</sub> = 135°C, T <sub>7</sub> = 95°C, T <sub>8</sub> = 70°C; record seems unreliable)			
14:28	He-Sample at smoker B4 (17ROV-7)			
15:03	<u>deployment:</u> Smoni deployment @ smoker B4 of site „B“ for one year (sampling rate = 15 sec).			
				
16:10	move to site "Irina 1" (~45m) <u>sampling:</u> KIPS hot fluid sampling of black smoker I3 @ site „Irina 1“ in a water depth of 2960m			14°45.076'N/44°58.668'W**
16:10	bottle B6 = 17ROV-8;	T <sub>KIPS</sub> = 301-363°C	pH=7.1	Cl=565mM
16:14	bottle B5 = 17ROV-9;	T <sub>KIPS</sub> = ~360°C	pH=6.9	Cl=565mM
16:18	bottle B4 = 17ROV-10;	T <sub>KIPS</sub> = 360-366°C	pH=6.8	Cl=560mM
16:22	bottle A3 = 17ROV-11;	T <sub>KIPS</sub> = 350-369°C	pH=6.9	Cl=565mM
16:25	bottle A2 = 17ROV-12;	T <sub>KIPS</sub> = 334-369°C	pH=6.8	Cl=561mM
16:29	bottle A1 = 17ROV-13;	T <sub>KIPS</sub> = 370-375°C	pH=5.9	Cl=557mM
	<i>(T-data not logged; T<sub>max</sub> 375°C</i>			
17:12	He-Sample at smoker I3 (17ROV-14)			
18:04	8-channel T-probe deployment in the pit of the crater (17ROV-15)			
off bottom:	<i>(T<sub>max</sub> for the individual sensors: T = &gt;400°C)</i>			
19:00	recovery on deck:			

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
20:20		
ATA-18CTD 21:42 – 00:29	CTD, LADCP, 1x MAPR, 21 bottles	14°50.996'N/44°58.802'W (at 3513 m water depth)
ATA-19CTD 02:07 – 04:22	CTD, LADCP, 1x MAPR, 21 bottles <i>sampling for metagenomics group</i>	14°45.273'N/44°58.734'W (at 3059 m water depth)
ATA-20CTD 06:03 – 08:51	CTD, LADCP, 1x MAPR, 21 bottles	14°50.996'N/44°58.802'W (at 3810 m water depth)
21.12.07		
ATA-21ROV deployment:11:01 on bottom: 13:21	<i>Tools: 3x push cores; 4 small bionets, 2 marker, ROV beacon</i>	<i>ship at</i> 14°45.095'N/44°58.66'W
	<i>at Anyas Garden</i>	14°45.171'N/44°58.771'W**
14:44	8-channel T-probe deployment (21ROV-1) (T1=86°C, T2= -, T3=86°C, T4=79°C, T5=69°C, T6=62°C, T7=55°C, T8=44°C)	
14:54	8-channel T-probe deployment (21ROV-2) (T1=48°C, T2= -, T3=39°C, T4=34°C, T5=29°C, T6=23°C, T7=18°C, T8=13°C)	
15:22	push core at Anyas Garden in a water depth of 3053m (21ROV-3; <i>failed</i> )	
	<i>move to Irina 2 (~40m)</i>	14°45.167'N/44°58.749'W**
16:32	8-channel T-probe at T-logger #3 (21ROV-4) (T1=12°C, T2= <i>broken</i> , T3=4°C, T4=3°C, T5=2°C, T6=2°C, T7=2°C, T8=2°C)	
	<u>sampling:</u> KIPS diffuse fluid sampling of musselbeds @ „Irina 2“ (4 bottles near T-logger #3 in a water depth of 3036m	
16:54	bottle C9 = 21ROV-5; T <sub>KIPS</sub> = 3.7°C	pH=7.8
16:59	bottle C8 = 21ROV-6; T <sub>KIPS</sub> = 3.6°C	pH=7.8
17:02	bottle C7 = 21ROV-7; T <sub>KIPS</sub> = 3.5°C	pH=7.9
17:08	bottle B6 = 21ROV-8; T <sub>KIPS</sub> = 3.7°C T <sub>max</sub> 3.7°C	pH=7.9
17:13	collecting T-logger #3, collecting T-logger #5 (which is entangled in the porch and later recovered)	
17:33	collecting mussels at T-logger #3 (21ROV-9)	
18:20	8-channel T-probe (21ROV-10) (T1=29°C, T2= -, T3=8.4°C, T4=4.8°C, T5=3.9°C, T6=3.2°C, T7=2.7°C, T8=2.4°C)	

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
	<u>sampling:</u> KIPS diffuse fluid sampling of musselbeds @ „Irina 2“ (3 bottles) at T-logger # 7 in a water depth of 3038 m	
18:46	bottle B5 = 21ROV-11;      T <sub>KIPS</sub> = 2.9°C	pH=7.6
18:52	bottle B4 = 21ROV-12;      T <sub>KIPS</sub> = 3.1°C	pH=7.8
18:56	bottle A3 = 21ROV-13;      T <sub>KIPS</sub> = 2.9°C T <sub>max</sub> 3.1°C	pH=7.9
19:16	collecting T-logger #7	
19:20	collecting mussels with net at T-logger #7 (21ROV-14)	
19:49	finally collecting T-logger #5	
20:03	8-channel T-probe at T-logger # 9 (21ROV-15) depth 3038m (T1=45°C, T2= -, T3=18°C, T4=8°C, T5=3.8°C, T6=2.7°C, T7=2.6°C, T8=2.4°C)	
	<u>sampling:</u> KIPS diffuse fluid sampling at T-logger #9 (1 bottle)	
20:39	bottle A2 = 21ROV-16; <i>pump fails!, no sample</i>	
21:03	collecting T-logger #9	
21:14	collecting mussels with net at former logger #9 site (21ROV-17)	
<i>off bottom:</i> 21:36		
<i>recovery on deck:</i> 23:09		
22.12.07		
ATA-22CTD 00:02 – 03:06	CTD, LADCP, 1x MAPR, 21 bottles	14°48.00'N/44°58.804'W (at 3352 m cable out)
ATA-23CTD 04:44 – 06:54	CTD, LADCP, 1x MAPR, 21 bottles; bottle 18 not closed	14°43.00'N/44°58.76'W (at 3236 m cable out)
ATA-24ROV deployment:10:52 on bottom: 12:25	Tools: OBT-2; SMoni, 2 small bionets, 2 marker, ROV beacon	ship at 14°45.21'N/44°58.77'W
13:02	<u>deployment:</u> OBT-2 @ OBT-site	14°45.190'N/44°58.777'W**
		

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>				
station (date/time UTC)	instruments used / samples / comments			Location
	<i>move to site "Irina 2" (~80m)</i>			14°45.166'N/44°58.745'W**
14:55	8-channel T-probe at microsmoker (24ROV-1) ( $T_{max} > 500^{\circ}\text{C}$ )			
	<u>sampling:</u> KIPS hot fluid sampling of microsmoker @ „Irina 2“ (6 bottles) water depth 3034m			
15:13	bottle C9 = 24ROV-2;	$T_{KIPS} = 362^{\circ}\text{C}$	pH=3.5	Cl=540mM
15:17	bottle C8 = 24ROV-3;	$T_{KIPS} = 362^{\circ}\text{C}$	pH=3.7	Cl=550mM
15:25	bottle C7 = 24ROV-4;	$T_{KIPS} = 362^{\circ}\text{C}$	pH=5.7	Cl=560mM
	second set of bottles at lower orifice			
15:33	bottle B6 = 24ROV-5;	$T_{KIPS} = 364^{\circ}\text{C}$	pH=6.6	Cl=570mM
15:38	bottle B5 = 24ROV-6;	$T_{KIPS} = 362^{\circ}\text{C}$	pH=7.0	Cl=575mM
15:41	bottle B4 = 24ROV-7;	$T_{KIPS} = 363^{\circ}\text{C}$	pH=6.5	Cl=570mM
	$T=361.7\pm 0.6^{\circ}\text{C}$ ; $T_{max}=367^{\circ}\text{C}$			
16:35	Ti-major bottle D2 (24ROV-8)		pH=5.0	Cl=545mM
17:00	He-sample (24ROV-9) @ microsmoker of „Irina 2“			
17:16	<u>deployment:</u> SMoni deployment @ „Irina 2“ microsmoker (sampling rate 1 sec.) [note: instrument was not recovered during this cruise!]			
				
	<i>move to site "Quest" (~80 m)</i>			14°45.175'N/44°58.836'W**
19:13	8-channel T-probe at smoker (24ROV-10) ( $T_{max} > 400^{\circ}\text{C}$ )			
	KIPS hot fluid sampling of black smoke exiting directly between talus material (no chimney) @ „Quest“ (3 bottles) water depth 3041m			
19:43				
19:52	bottle A3 = 24ROV-11;	$T_{KIPS} = 310-364^{\circ}\text{C}$	pH=5.7	Cl=550mM
20:01	bottle A2 = 24ROV-12;	$T_{KIPS} = 330-340^{\circ}\text{C}$	pH=6.7	Cl=555mM
	bottle A1 = 24ROV-13;	$T_{KIPS} = 330-358^{\circ}\text{C}$	pH=5.9	
	$T=very\ variable$ ; $T_{max}=371^{\circ}\text{C}$			
	<i>find OBT-site (~80m)</i>			14°45.190'N/44°58.777'W**

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
21:02	<u>recover:</u> OBT-1b @ OBT-site	
off bottom: 21:02 recovery on deck: 21:15		
23.12.07		
ATA-25CTD 23:55 – 02:40	CTD, LADCP, 1x MAPR, 21 bottles	14°46.00'N/44°58.80'W (at 3201 m water depth)
ATA-26CTD 03:52 – 06:22	CTD, LADCP, 1x MAPR, 21 bottles	14°47.00'N/44°58.80'W (at 3352 m water depth)
ATA-27ROV deployment:10:28 on bottom: 12:06	Tools: 3x push cores; 4 small bionets, 2 marker, ROV beacon	ship at 14°45.20'N/44°58.81'W
12:19	in musselbed at "Quest"	14°45.171'N/44°58.771'W**
12:51	8-channel T-probe at T-logger #14 (27ROV-1) (T1=125°C,T2=- ,T3=132°C,T4=135°C,T5=134°C,T6=132°C,T7=125°C, T8=110°C)	
12:59	8-channel T-probe at T-logger #16 (27ROV-2) (T1=98°C,T2=- ,T3=79°C,T4=69°C,T5=60°C,T6=49°C,T7=38°C,T8=25°C)	
13:08	8-channel T-probe outside of the musselbed (27ROV-3) (T1=53°C,T2=- ,T3=43°C,T4=39°C,T5=34°C,T6=27°C,T7=20°C,T8=14°C)	
13:27	8-channel T-probe at T-logger #19 (27ROV-4) (T1=120°C,T2=-,T3=119°C,T4=118°C,T5=115°C,T6=106°C,T7=88°C, T8=30°C)	
13:45	8-channel T-probe at T-logger #17 (27ROV-5) (T1=115°C,T2=- ,T3=106°C,T4=47°C,T5=38°C,T6=16°C,T7=11°C,T8=6°C)	
	<u>sampling:</u> KIPS diffuse fluid sampling of musselbeds at T-logger #19 @ „Quest“ (3 bottles)	
13:55	bottle C9 = 27ROV-6;	T <sub>KIPS</sub> = 4.7-7.0°C    pH=7.6
14:01	bottle C8 = 27ROV-7;	T <sub>KIPS</sub> = 6.9-11.8°C    pH=7.5
14:21	bottle C7 = 27ROV-8;	T <sub>KIPS</sub> = 5.1-18.6°C    pH=7.6

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
	$T_{max}$ 18.6°C	
14:55	collecting T-logger #19 with mussels attached (sample 27ROV-9)	
15:00	collecting T-logger #14	
15:12	collecting T-logger #16	
15:23	collecting T-logger #17 with mussels attached (sample 27ROV-10)	
16:45	8-channel T-probe at T-logger #11 (27ROV-11) ( $T1=58^{\circ}\text{C}, T2=-, T3=46^{\circ}\text{C}, T4=40^{\circ}\text{C}, T5=34^{\circ}\text{C}, T6=28^{\circ}\text{C}, T7=23^{\circ}\text{C}, T8=16^{\circ}\text{C}$ )	
16:58	8-channel T-probe (27ROV-12) ( $T_{max} < 6^{\circ}\text{C}$ )	
17:01	8-channel T-probe (27ROV-13) (near ambient)	
17:21	8-channel T-probe at T-logger #12 (27ROV-14) ( $T1=10^{\circ}\text{C}, T2=-, T3=9^{\circ}\text{C}, T4=7^{\circ}\text{C}, T5=6^{\circ}\text{C}, T6=6^{\circ}\text{C}, T7=5^{\circ}\text{C}, T8=4^{\circ}\text{C}$ )	
17:31	8-channel T-probe at T-logger #18 (27ROV-15) ( $T1=8^{\circ}\text{C}, T2=-, T3=6^{\circ}\text{C}, T4=5^{\circ}\text{C}, T5=4^{\circ}\text{C}, T6=4^{\circ}\text{C}, T7=3^{\circ}\text{C}, T8=2^{\circ}\text{C}$ )	
17:54	8-channel T-probe at T-logger #10 (27ROV-16) ( $T1=9^{\circ}\text{C}, T2=-, T3=6^{\circ}\text{C}, T4=4^{\circ}\text{C}, T5=2^{\circ}\text{C}, T6=2^{\circ}\text{C}, T7=2^{\circ}\text{C}, T8=2^{\circ}\text{C}$ )	
19:20	8-channel T-probe in brown sediment next to Quest T-logger field (27ROV-17) in a water depth of 3046m ( $T1=20^{\circ}\text{C}, T2=-, T3=16^{\circ}\text{C}, T4=13^{\circ}\text{C}, T5=10^{\circ}\text{C}, T6=8^{\circ}\text{C}, T7=6^{\circ}\text{C}, T8=5^{\circ}\text{C}$ )	
19:36	push core (sample 27ROV-18) in a water depth of 3046m	
19:56	push core (sample 27ROV-19) in a water depth of 3046m	
20:39	recovered two pieces of an inactive sulfide chimney from southeastern rim of Quest crater in a water depth of 3040m (27ROV-20, 21)	
	move to OBT-site (~80m)	14°45.190'N/44°58.777'W**
21:12	recover: OBP-2 @ OBT-site	
off bottom: 21:19		
recovery on deck: 23:57		
		



<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>				
station (date/time UTC)	instruments used / samples / comments			Location
24.12.2007				
ATA-28CTD 00:30 – 03:19	CTD, LADCP, 1x MAPR, no water samples taken			14°46.003'N/44°58.802'W (at 3211 m water depth)
ATA-29CTD 04:37– 07:01	CTD, LADCP, 1x MAPR, 21 bottles; <i>samples for metagenomics group</i>			14°47.974'N/44°58.791'W (at 3219 m water depth)
ATA-30ROV <i>deployment:10:02 on bottom: 11:45</i>	<i>Tools: 2x Ti-major sampler; 1x SMoni, 2 small bionets, 3 push cores</i>			<i>ship at 14°45.07'N/44°58.70'W</i>
11:54	<i>found site "B"</i>			14°45.100'N/44°58.684'W**
12:00	<u>sampling:</u> KIPS hot fluid sampling of smoker B1 @ „B“ (6 bottles) water depth 3034m			
12:12	bottle C9 = 30ROV-1;	T <sub>KIPS</sub> = 352°C	pH=4.9	Cl=545mM
12:15	bottle C8 = 30ROV-2;	T <sub>KIPS</sub> = 352°C	pH=4.2	Cl=545mM
12:18	bottle C7 = 30ROV-3;	T <sub>KIPS</sub> = 352°C	pH=3.9	Cl=545mM
	<i>T=352.2±0.4°C; T<sub>max</sub>=353°C</i>			
13:23	Ti-major sample at smoker B1 bottle D1 = 30ROV-4;			pH=4.4      Cl=540mM
14:03	Ti-major sample at smoker B1 bottle D2 = 30ROV-5;			pH=3.5      Cl=545mM
14:15	SMoni measurement at smoker B1 (T <sub>max</sub> =341°C) = 30ROV-6			
14:51	8-channel T-probe at smoker B1 = 30ROV-7 (T <sub>max</sub> >450°C; not reliable!)			
15:26	<i>at site "Candelaber" (~80m)</i>			14°45.067'N/44°58.656'W**
	<u>sampling:</u> KIPS hot fluid sampling @ black smoker C1 of site „Candelaber“ (3 bottles) in a water depth of 2948 m; clear fluids and abundant gas bubbles visible			
15:45	bottle B6 = 30ROV-8;	T <sub>KIPS</sub> = 362-364°C	pH=4.2	Cl=545mM
15:49	bottle B5 = 30ROV-9;	T <sub>KIPS</sub> = 360-362°C	pH=4.3	Cl=545mM
15:58	bottle B4 = 30ROV-10;	T <sub>KIPS</sub> = 357-359°C	pH=4.3	Cl=545mM
	<i>T=360.8±1.1°C; T<sub>max</sub>=364°C</i> <i>ROV moved after bottle B5; the ROV had to be repositioned and bottle B4 is from an orifice few cm away!</i>			

<i>extended list of operations (** denotes positions based on Jason 2 dives in January 2007)</i>		
station (date/time UTC)	instruments used / samples / comments	Location
	<i>Emergency call from the bridge! One sailor has suffered a heart attack and needs to get into a hospital as soon as possible. We ask for one hour to recover instruments while the ship is waiting for a response on the emergency signal sent out to ships in the vicinity.</i>	
17:00	<i>found site "Irina 2" (~250m)</i>	14°45.165'N/44°58.744'W
17:10	<i>recovery of ADCP at Irina 2</i>	
<i>off bottom:</i>		
17:16		
<i>recovery on deck:</i>		
18:36		
start transit to Cayenne in French Guayana		
18:45		

## 1.7.2 Fluid chemistry results and subsamples

Table A1: Hydrothermal fluid samples and results from on-board analysis

Station No.	KIPS and major Bottle No.	sample No.	site, vent description	pump start / pump end (UTC)	max. T in-situ (°C)	water depth (m)	pH	diss O2 ml/l	chloride (mM)	total S2- (µM)	Fe (II) (µM)	total Fe (µM)	Fe (III) (µM)	Se (mM)	Sb (mM)
ATA-13-ROV	A1	ATA13ROV-1	Site A, Barad Dur; hot vent	14:29:17 / 14:31:23	240-260	2928	7.60			b.d.l.	14	52.5	38.5		
	A2	ATA13ROV-2		14:35:06 / 14:37:39	260-295	2928	7.80			b.d.l.	n.d.	n.d.	n.d.		
	A3	ATA13ROV-3		14:38:04 / 14:40:36	250-306	2928				b.d.l.	n.d.	n.d.	n.d.		
	B4	ATA13ROV-6	Anna Louise; Smoker AL1; hot vent	18:18:57 / 18:21:40	353	2928	6.63			14.12	704	762	58.03		
	B5	ATA13ROV-7		18:22:14 / 18:24:47	352	2928	5.30			n.d.	3918	4572	654		
	B6	ATA13ROV-8		18:25:21 / 18:27:50	351	2928				457.1	n.d.	n.d.	n.d.		
	C7	ATA13ROV-9		18:28:18 / 18:30:47	352	2928	8.30			n.d.	n.d.	n.d.	n.d.		
	C8	ATA13ROV-10		not pumped	352		5.43		555	2.985	3667	4302	635		
ATA-15-ROV	B6	ATA15ROV-5	Quest; T-Logger 13; diffuse vent	18:12:34 / 18:15:34	4.8	3045	7.7			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	C7	ATA15ROV-4		18:08:39 / 18:11:39	4.9	3045				n.d.	b.d.l.	b.d.l.	b.d.l.		
	C8	ATA15ROV-3		18:04:44 / 18:07:44	2.9	3045	7.48		560	0.385	b.d.l.	b.d.l.	b.d.l.		
	C9	ATA15ROV-2		17:59:45 / 18:03:45	10.8	3045	7.63	6.00	565	0.931	b.d.l.	b.d.l.	b.d.l.		
ATA-17-ROV	A1	ATA17ROV-13	Irina I; Smoker I3; hot vent	16:29:18 / 16:32:18	370-375	2960	5.93		557	41.41	2213	2307	93.74		
	A2	ATA17ROV-12		16:25:40 / 16:28:43	334-369	2960	6.80		561	n.d.	n.d.	n.d.	n.d.		
	A3	ATA17ROV-11		16:22:00 / 16:25:08	350-369	2960	6.90		565	3.852	n.d.	n.d.	n.d.		
	B4	ATA17ROV-10		16:18:32 / 16:21:23	360-366	2960	6.79		560	23.11	98.2	214	115.5		
	B5	ATA17ROV-9		16:14:34 / 16:17:36	360	2960	6.87		565	n.d.	n.d.	n.d.	n.d.		
	B6	ATA17ROV-8		16:10:56 / 16:13:59	301-363	2960	7.10		565	b.d.l.	0.56	169	168.5		
	C7	ATA17ROV-5	Site B; Smoker B4; hot vent	13:44:04 / 13:47:09	358	2978	5.93		570	39.16	1839	2307	468.2		
	C8	ATA17ROV-4	13:40:09 / 13:43:09	357	2978	5.75		570	179.4	2663	3187	524			
	C9	ATA17ROV-3	13:36:16 / 13:39:16	363	2978	3.79		545	230.8	7981	9160	1180	b.d.l.	b.d.l.	
ATA-21-ROV	A3	ATA21ROV-13	Irina II; T-Logger 7; diffuse vent	18:56:00 / 18:59:00	2.9	3038	7.85			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	B4	ATA21ROV-12		18:52:10 / 18:55:18	3.1	3038	7.77			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	B5	ATA21ROV-11		18:48:25 / 18:51:25	2.9	3038	7.56	5.36		0.482		30.7	30.69		
	B6	ATA21ROV-8	Irina II; T-Logger 3;	17:05:47 / 17:08:50	3.7	3036	7.87			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	C7	ATA21ROV-7		17:02:08 / 17:05:09	3.5	3036	7.87			b.d.l.	b.d.l.	b.d.l.	b.d.l.		

Station No.	KIPS and major Bottle No.	sample No.	site, vent description	pump start / pump end (UTC)	max. T in-situ (°C)	water depth (m)	pH	diss O2 ml/l	chloride (mM)	total S2- (µM)	Fe (II) (µM)	total Fe (µM)	Fe (III) (µM)	Se (mM)	Sb (mM)
	C8	ATA21ROV-6	diffuse vent	16:58:27 / 17:01:27	3.6	3036	7.82			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	C9	ATA21ROV-5		16:54:39 / 16:57:39	3.7	3036	7.79	5.50		0.42		17.86	17.86		
ATA-24-ROV	A1	ATA24ROV-13	Quest;	19:58:00 / 20:01:30	330-358	3045	5.85			137.07	n.d.	n.d.	n.d.		
	A2	ATA24ROV-12	Smoker; hot vent	19:49:28 / 19:52:30	330-340	3045	6.71		555	n.d.	385	2118	1734		
	A3	ATA24ROV-11		19:43:18 / 19:46:18	310-364	3045	5.70		550	89.88	3175	3812	637.7	b.d.l.	b.d.l.
	B4	ATA24ROV-7	Irina II,	15:41:46 / 15:44:46	363	3034	6.54		570	1.798	782	934	151.8		
	B5	ATA24ROV-6	Microsmoker; higher orrifice; hot vent	15:38:00 / 15:41:00	362	3034	6.96		575	n.d.	420	667	247.2		
	B6	ATA24ROV-5		15:33:37 / 15:37:18	364	3034	6.60		570	13.58	711	870	159		
	C7	ATA24ROV-4	Irina II,	15:25:39 / 15:28:39	362	3034	5.69		560	75.18	3553	4590	1036		
	C8	ATA24ROV-3	Microsmoker;	15:17:37 / 15:20:47	362	3034	3.70		550	783.6	7997	9153	1156	b.d.l.	b.d.l.
	C9	ATA24ROV-2	lower orrifice; hot vent	15:13:47 / 15:16:51	362	3034	3.53		540	1823	8316	9532	1216	b.d.l.	b.d.l.
	D2	ATA24ROV-8		16:35:25		3034	5		545	n.d.	n.d.	n.d.	n.d.		
ATA-27-ROV	C7	ATA27ROV-8	Quest; T-Logger 19	14:21:30 / 14:24:30	5.1-18.6	3045	7.57	5.07		b.d.l.		36.2	36.15		
	C8	ATA27ROV-7		14:06:58 / 14:09:30	6.9-11.8	3045	7.54			b.d.l.	b.d.l.	b.d.l.	b.d.l.		
	C9	ATA27ROV-6	diffuse vent	13:55:40 / 13:58:52	4.7-7.0	3045	7.64			b.d.l.		40.1	40.08		
ATA-30-ROV	A1	-	Mischprobe ?	not pumped			6.20		575	57.14	1165	1909	744.1		
	A2	-		not pumped			7.00		575	n.d.	210	545	334.8		
	A3	-		not pumped			8.10		575	n.d.		3.72	3.72		
	B4	ATA30ROV-10	Candelabra; hot vent	15:55:36 / 15:58:36	357-359	2948	4.30		545	501.7	8306	10125	1819	b.d.l.	b.d.l.
	B5	ATA30ROV-9		15:46:17 / 15:49:17	360-362	2948	4.24		545	n.d.				b.d.l.	b.d.l.
	B6	ATA30ROV-8		15:42:18 / 15:45:18	362-364	2948	4.24		545	2114	7769	10331	2563	b.d.l.	b.d.l.
	C7	ATA30ROV-3	Site B; smoker B1	12:18:43 / 12:21:46	352	2978	3.90		545	470.6	7686	10021	2335	b.d.l.	b.d.l.
	C8	ATA30ROV-2		12:15:03 / 12:18:03	352	2978	4.20		545	1870	8161	9732	1571	b.d.l.	b.d.l.
	C9	ATA30ROV-1		12:10:39 / 12:14:13	352	2978	4.90	b.d.l.	545	2196	7831	10455	2625	b.d.l.	b.d.l.
	D1	ATA30ROV-4		13:23:35		2978	4.36		540	468.3	9071	13700	4629	b.d.l.	b.d.l.
D2	ATA30ROV-5	14:03:26			2978	3.50		545	3152	8926	11261	2335	b.d.l.	b.d.l.	

empty space = not analysed; n.d. = not detectable (problems with method); b.d.l.= below detection limit; KIPS: A1 - C9; titanium major bottles: D1 and D2

**Table A2: Hydrothermal fluid samples for trace metal analysis at home**  
**Working Group Garbe-Schönberg, CAU-Kiel**

Station No.	KIPS and major Bottle No.	sample No.	site, vent description	60 ml nf/na	100 ml nf/a	100 ml f/a	250 ml f/a for PGE's
ATA13ROV	A1	ATA13ROV-1	Site A, Barad Dur; hot vent	X	X		
	A2	ATA13ROV-2					
	A3	ATA13ROV-3					
	B4	ATA13ROV-6	Anna Louise; Smoker AL1; hot vent	X	X		
	B5	ATA13ROV-7					
	B6	ATA13ROV-8					
	C7	ATA13ROV-9		X	X		
	C8	ATA13ROV-10		X	X		
ATA15ROV	B6	ATA15ROV-5	Quest; T-Logger 13; diffuse vent				
	C7	ATA15ROV-4					
	C8	ATA15ROV-3					
	C9	ATA15ROV-2		X		X	
ATA17ROV	A1	ATA17ROV-13	Irina I; Smoker I3; hot vent	X	X		
	A2	ATA17ROV-12					
	A3	ATA17ROV-11					
	B4	ATA17ROV-10		X	X		
	B5	ATA17ROV-9					
	B6	ATA17ROV-8					X
	C7	ATA17ROV-5	Site B; Smoker B4; hot vent				
	C8	ATA17ROV-4					
	C9	ATA17ROV-3		X	X		X
ATA21ROV	A3	ATA21ROV-13	Irina II; T-Logger 7; diffuse vent				
	B4	ATA21ROV-12					
	B5	ATA21ROV-11		X		X	
	B6	ATA21ROV-8	Irina II; T-Logger 3; diffuse vent				
	C7	ATA21ROV-7					
	C8	ATA21ROV-6					
	C9	ATA21ROV-5		X		X	
ATA24ROV	A1	ATA24ROV-13	Quest; Smoker; hot				
	A2	ATA24ROV-12					

Station No.	KIPS and major Bottle No.	sample No.	site, vent description	60 ml nf/na	100 ml nf/a	100 ml f/a	250 ml f/a for PGE`s	
	A3	ATA24ROV-11	vent	X	X			
	B4	ATA24ROV-7	Irina II, Microsmoker; higher orrifice; hot vent					
	B5	ATA24ROV-6						
	B6	ATA24ROV-5		X	X			
		C7	ATA24ROV-4	Irina II, Microsmoker; lower orrifice; hot vent				
		C8	ATA24ROV-3					
		C9	ATA24ROV-2		X	X		
		D2	ATA24ROV-8					
ATA27ROV	C7	ATA27ROV-8	Quest; T-Logger 19 diffuse vent					
	C8	ATA27ROV-7						
	C9	ATA27ROV-6		X		X		
ATA30ROV	A1	-	Mischprobe ?	X	X			
	A2	-						
	A3	-						
	B4	ATA30ROV-10	Candelabra; hot vent					
	B5	ATA30ROV-9			X			
	B6	ATA30ROV-8		X	X			
	C7	ATA30ROV-3	Site B; smoker B1	X	X			
	C8	ATA30ROV-2						
	C9	ATA30ROV-1						
	D1	ATA30ROV-4						
D2	ATA30ROV-5	X		X				

a = acidified; f = filtrated; na = not acidified; nf = not filtrated

**Table A3: Hydrothermal fluid samples for trace metal, anion and amino acid analysis at home Working Group Andrea Koschinsky, Jacobs University Bremen**

pos	Stat. No.	description	bottle	volume	filtered	acidified	freeze	use, methods	
1	13ROV	Site A; Barad Dur; hot vent	A1	50 ml				anions	
2				50 ml			x	amino acids	
3				60 ml	x			anions	
4				100 ml		x		cations	
5				100 ml	x	x		cations	
6			A2	50 ml (1:50)		x		Si-measurements	
7		Anna Louise; hot vent		B4	50 ml				anions
8					60 ml	x			on board meas.
9					100 ml	x	x		cations
10					100 ml		x		cations
11				C7	80 ml	x	x		cations
12					60 ml			x	amino acids
13					60 ml	x			cations
14				C8	30 ml	x	x		cations
15					70 ml	x			cations
16					50 ml			x	amino acids
17			50 ml (1:50)		x		Si-measurements		
18	15ROV	Quest; diffuse vent	B6	5 ml				on board meas.	
19			C8	50 ml			x	amino acids	
20				50 ml				anions	
21			C9	50 ml				anions	
22				100 ml	x			cations	
23				8 ml				on board meas.	
24				50 ml			x	amino acids	
25	17ROV	Irina 1; hot vent	A1	50 ml				on board meas.	
26				50 ml	x			anions	
27				100 ml		x		cations	
28				100 ml	x	x		cations	
29				50 ml			x	amino acids	
30			A2	50 ml				on board meas.	
31			A3	10 ml				on board meas.	
32			B4	50 ml				on board meas.	
33				40 ml	x			anions	
34				100 ml		x		cations	
35				80 ml	x	x		cations	
36			B5	60 ml			x	amino acids	
37			C7	50 ml				on board meas.	
38		50 ml				amino acids			

pos	Stat. No.	description	bottle	volume	filtered	acidified	freeze	use, methods
39			C8	20 ml				on board meas.
40			C9	50 ml			x	amino acids
41				100 ml	x	x		cations
42				100 ml	x	x		cations
43				50 ml	x			anions
44				15 ml				on board meas.
45			B4	20 ml				on board meas.
46			B5	45 ml				on board meas.
47				50 ml	x			anions
48				100 ml	x	x		cations
49				100 ml		x		cations
50	21ROV	Quest; diffuse vent	B6	40 ml				on board meas.
51			C8	25 ml				on board meas.
52			C9	100 ml	x	x		cations
53				100 ml		x		cations
54				50 ml	x			anions
55				50 ml				on board meas.
56			A2	20 ml				on board meas.
57			A3	100 ml	x	x		cations
58				100 ml		x		cations
59				40 ml				on board meas.
60				40 ml			x	amino acids
61				40 ml	x			anions
62				50 ml				on board meas.
63			B6	50 ml	x			anions
64				50 ml				amino acids
65				40 ml				on board meas.
66				50 ml				on board meas.
67	24ROV	Quest; hot vent		100 ml		x		cations
68				100 ml	x	x		cations
69			B4	40 ml				on board meas.
70			B5	40 ml				on board meas.
71			C7	40 ml				on board meas.
72			C8	20 ml				on board meas.
73			C9	50 ml				on board meas.
74				50 ml	x			anions
75				100 ml	x	x		cations
76				60 ml		x		cations
77				50 ml (1:50)		x		Si-measurements
78	27ROV	Quest; diffuse	C9	100 ml		x		cations



pos	Stat. No.	description	bottle	volume	filtered	acidified	freeze	use, methods	
79		vent		50 ml				anions	
80				50 ml				on board meas.	
81				50 ml			x	amino acids	
82	30ROV	mixed sample of Candelabra and Site B	A1	50 ml	x			anions	
83				100 ml		x		cations	
84				30 ml				on board meas.	
85				50 ml	x	x		cations	
86				A2	30 ml			on board meas.	
87				A3	30 ml			on board meas.	
88				Candelabra	B6	50 ml	x	x	
89					60 ml		x		cations
90					40 ml			x	amino acids
91					50 ml	x			anions
92			B5		50 ml		x		cations
93			B4		5 ml				on board meas.
94			Site B, Smoker B1		C7	50 ml	x	x	
95					40 ml	x			anions
96					5 ml				on board meas.
97					100 ml		x		cations
98				C8	70 ml		x		cations
99					30 ml				anions
100					50 ml (1:50)		x		Si-measurements
101				C9	40 ml	x			anions
102					50 ml				on board meas.
103					100 ml	x	x		cations
104				D1	5 ml				on board meas.
105			D2	100 ml		x		cations	
106			150 ml		x*		HFSE		
107			125 ml	x			anions		
108			125 ml	x	x		cations		

on board meas.: rest of fluid from on board determinations of pH, S<sup>2-</sup>, Fe, Ca, Mg, Se, Sb;

x\* acidified with HCl (for HFSE analysis);

# ROV dive protocol ATA-09ROV

Atalante cruise HYDROMAR V

**Cruise Number** HYDROMAR V  
**Station Number** ATA-09 ROV  
**Dive Number** 6  
**Location** Logatchev hydrothermal field  
**Coordinates**  
**Water Depth**

**Vessel** l'Atalante

**Time** **Observation**

**Actions**

10:34:46	Begin Station	
10:45:29	ROV in Water	
10:45:53	Video on	
11:01:57	ROV starts descending	
11:04:00	ROV stopping at 120m to check Posidonia signal	
11:21:01	still no Posidonia position	
11:38:14	lost communication with the bridge, winch prblem	
11:39:20	ROV proceeds with descend	
11:44:21	ROV at 250m	
11:49:50	Posidonia established on the bridge, currently no feed into the network	
11:50:10	ROV at 430m	
11:51:19	CTD connection is not working	
11:55:14	CTD is running	
12:06:18	ROV is at 900m, halocline in CTD record ships: position 14°45.200'N/44°58.792	
12:16:00	ROV at 1155m	
12:23:00	ROV at 14°45.114'N / 44°58.931'W (250 m SW of target position)	
12:26:07	ship will move 50 meters in 100 direction	
12:38:44	ship is at 14°45.181'N/44°58.772'W	
12:56:38	preparing to pump the KIPS system with bottom water	
12:57:23	KIPS pump on	
12:59:19	ROV at 2105m	
13:01:24	Pump turned off for bottle 1	
13:02:29	KIPS pump on	
13:04:33	Pump turned off for bottle 2	
13:06:10	KIPS pump on	
13:07:29	Pump turned off for bottle 3	
13:08:27	KIPS pump on	
	Pump turned off for bottle 4	
	KIPS pump on	
13:13:37	Pump turned off for bottle 5	
13:14:46	there is a time difference of 6 seconds between displayed shiptime (UTC) and the video-time	
13:15:19	KIPS pump on	
13:17:24	Pump turned off for bottle 6 ROV at 14°45.137 / 44°58.823'W KIPS pump on	
13:20:42	Pump turned off for bottle 7	
13:20:44	KIPS pump on	
13:22:53	Pump turned off for bottle 8	
13:23:50	KIPS pump on	
13:26:34	Pump turned off for bottle 9	
13:27:17	KIPS test succesful, instrument reset	
13:34:59	ROV at 14°45.181'N /44°58.851'W, 2830m	
13:37:49	winch stopped at 3000	
13:40:09	14°45.201 / 44°58.822, due west of our target	
13:40:55	ROV at 3000m winch at 3030m ; add 30m altimeter kicks in	
13:42:01		
13:48:43	OBT in sight, <b>bottom in sight</b>	
13:55:47	landing on the seafloor next to homer beacon, beacon 15 is still working	
14:09:01	at OBT-Site, temporary deployment for ADCP ADCP released at temporary station; too steep, take up again	
14:19:42	slightly moved to the NE	
14:22:23	trying to release the ADCP	
14:25:53	ADCP on the seafloor, 8m S of the homer beacon	
14:28:45	at beacon	

Time	Observation	Actions
14:38:20	at OBP	
14:45:13	grabbed the instrument	
14:48:01	vehicle is tangled in the cable	
14:51:44	ROV at small marker No. 21; should not be here!!	
14:54:52	cable free; winch at 3080m	
14:59:49	back at OBP site	
15:01:35	released instrument directly next to old OBP	
15:26:39	traversing to Irina 2	
15:35:24	one mussel bed on the base of Irina II	
15:37:05	white material on the floor	
15:38:30	bacterial mat ? + iron oxides	
15:46:33	TV-grab position	
15:49:10	14 45,145 44 58,765	
15:51:20	rock outcrop	
15:53:16	marker anya	
15:54:17	white material on the floor	
15:55:23	empty mussel shells	
15:56:01	T-loggers at the base of Irina II	
15:56:25	NW corner of Irina II	
15:57:10	diffuse venting, shrimps	
15:58:11	active black smoker	
15:59:23	shrimps, mussels, snails on chimneys	
16:01:00	active black smoker	
16:07:29	site ADCP released on the sea floor near black smoker Irina II	
16:12:25	single mussels in sediments	
16:13:40	mussel fields on the foot on the inactive sulfide structure	
16:15:43	searching for the place for mussel sampling	
16:17:40	two lines of markers in mussel field	
16:19:33	unknown marker near the in-line markers ?, seems like an older one	
16:21:43	red rocks, iron oxides?	
16:22:42	preparing to get mussels with net H	
16:25:49	moving the place a bit for mussel sampling	
16:30:50	shrimps are getting annoyed of the ROV	
16:31:21	mussel sampling with net H: scoop	
16:31:59	got some more mussels, now about 5 in the net	09 ROV-1
16:35:02	finished mussel sampling with net H, half full	
16:38:15	net H safe back in the container of the ROV	
16:42:57	staying in this position until decision about "staying the night out" is made	
16:51:12	going back to OBT site for recovery	
16:51:58	three little black smoker on the side of one chimney of Irina II, wasn't there before (opened by JASON?)	
16:54:28	HD-Aufnahme	
16:58:33	now moving to the OBT site	
17:03:08	14° 45,172 N 44° 58,739 W	
17:05:11	flying over sediments, ripple marks	
17:06:13	black rocks outcropping	
17:09:51	passing marker 21	
17:12:24	OBT 2 in sight	
17:15:06	getting in position to recover OBT 2	
17:16:16	starting OBT 2 recovery	
17:30:20	OBT 2 secured on the ROV	
17:34:45	employed marker 29 next to the OBT site	
17:39:59	moving up to surface	
17:51:17	ROV ascending (at 2860m)	
19:14:45	ROV at 290m	
19:37:39	ROV out of the water	
19:42:03	ROV on deck	

# ROV dive protocol ATA-13ROV

Atalante cruise HYDROMAR V

Cruise Number	HYDROMAR V	
Station Number	ATA-13 ROV	
Dive Number	7	
Location	Logatchev hydrothermal field	
Coordinates	ships position at the first target is at: 14°45.070'N/44°58.575 slightly NE of site "A"	
Water Depth	from 2900 to 3000m	
Vessel	l'Atalante	
Time	Observation	Actions
	ship is starting in the SW and will move slowly into position; ship is then positioned ahead of the ROV	
10:29:59	time is synchronized to UTC, time difference is 1 second	
10:56:33	Begin Station; ship is at 14°44.914 / 44°58.659 for deployment, depth 2979m	
11:15:05	ROV in Water; ship is at 14°44. / 44°58., depth 2979m	
11:29:35	ROV descending at 90m	
11:31:05	test at 100m; ROV is slightly buoyant	
11:38:30	lights on	
11:39:40	ships position 14°45.064'N 44°58.624'W	
11:51:53	ROV at 300m, heading 249°, no Posidonia	
12:00:54	switched off all thrusters for testing Posidonia at 600m, ROV is slightly buoyant	
12:03:46	switched on all thrusters, continue diving at 575m still without Posidonia data	
12:05:12	ships position 14°45.066'N, 44°58.584'W	
12:15:00	ROV at 1034m, heading 218°	
12:27:12	ROV at 1500m, heading 007°	
12:30:02	ship is at 14°45.055'N / 44°58.571'W	
	ROV 14°45.010'N / 44°58.664'W	
12:44:20	ROV at 14°45.058'N / 44°58.587'W	
	ROV at 14°45.046'N / 44°58.586'W	
12:53:08	winch stopped: ROV at 14°45.041 / 44°58.609	
13:04:24	winch started: ROV at 2430m, no Posidonia	
13:06:11	ship is at 14°45.066'N, 44°58.581'N	
13:12:54	winches is stopped, ROV at 2647m	
13:17:56	ROV 14°45'058'N, 44°58.600'W (Posidonia show: No answer from axponder 1!!!)	
13:23:49	ROV at 2916m	
13:24:15	<b>Bottom contact</b> at 2931m, at site "A"	
13:31:05	marker MB, Barad-Dûr is broken; marker MB is in 152 line with the smoker (NNW)	
13:44:09	trying to position ourselves close to the smoker	
14:00:53	ROV in sample position	
14:08:09	reposition to the western side of the smoker	
14:16:41	start sampling,	
14:27:43	repositioning, Tmax = 299°C	
14:29:10	start pumping; T 240° to 260°C, but nossels are separated; depth is 2928m	13ROV-1
	stopped pumping bottle A1	
14:32:24	Tmax 317°C	
14:35:19	start bottle 2	13ROV-2
14:37:39	stop pumping	
14:40:03	start pumping; T 305 - 250°C, up	13ROV-3
14:40:35	stopped pumping bottle 3.	
14:59:12	preparing to take 8-channel probe	
15:02:24	close to smoker taken T measure	
15:08:59	T-max close to 180°C, the instrument is too big for this orifice	13ROV-4
15:13:40	abundant diffuse outflow from cracks at the base of the mound	
15:14:11	collecting net from drawer	
15:23:14	collected one or two shrimps from site "A"	13ROV-5
15:27:31	several small sulfide samples on the front porch	
15:27:31	starting movement to smoking crater IRINA, heading 330°	
15:39:14	flying uphill, mound of ANNA-LOUISE	
15:41:10	crater rim of ANNA-LOUISE in sight	
15:44:03	Marker "30" in sight	
15:44:57	Ships position is 14°45,080'N, 44°58,588'W, Cable out 3033m	
15:55:17	CANDELABRA smoking crater in sight, elongated smoker	
15:59:53	Ship has finished movement, 14°45.105'N, 44°58.632'W	
16:04:13	big block and sulfide talus on slope	
16:18:11	looking for IRINA, heading 270°	
16:23:06	ROV at 14°45.125'N, 44°58.700'W	
16:25:28	changing course, heading 133°	

# ROV dive protocol ATA-13ROV

Atalante cruise HYDROMAR V

Time	Observation	Actions
16:30:16	mound of B?	
16:41:16	heading 150°, try to fly from B to IRINA	
16:42:06	abundant talus, bigger blocks, redish-brown sediment	
16:43:58	large broken block	
16:45:28	stop flying, trying to get Posidonia position	
16:55:44	still no Posidonia, searching again	
16:57:07	ship at 14°45.102'N, 44°48.630'W	
16:58:35	slope with abundant talus	
17:03:13	Chef de la mission hates Posidonia	
17:20:59	no idea where we are	
17:40:39	found Anna-Louise	
17:40:47	preparing for sampling smoker near Marker 30; depth is 2938m	
17:51:23	repositioned but we are sucking in smoke with the propellers	
18:18:57	pump on, tmax 353°C	13ROV-6
18:21:34	pump off for bottle B4	
18:22:12	pump on for bottle B5	13ROV-7
18:24:40	pump off for bottle B5	
18:25:09	pump on for bottle B6	13ROV-8
18:27:50	pump off for bottle B6	
18:28:27	pump on for bottle C7	13ROV-9
18:30:57	pump off for bottle C7	
18:32:00	fluid pumped through outlet collecting fluid in bottle C8 as well	13ROV-10
18:40:00	<b>off bottom</b>	
18:58:57	test of Posidonia with thrusters not running; at 2850m	
18:59:52	continue ascend	
19:23:16	continue ascend	
19:30:48	continue ascend	
19:40:10	winch stopped	
19:41:00	continue ascend	
19:51:15	ROV at 700m	
19:51:43	lights off	
19:59:42	ROV at 370m	
20:04:19	ROV at 200m	
20:07:30	ROV at 100m	
20:21:28	ROV out of the water	
20:24:00	ROV on deck, end of station	

# ROV dive protocol ATA-15ROV

Atalante cruise HYDROMAR V

**Cruise Number** HYDROMAR V  
**Station Number** ATA-15 ROV  
**Dive Number** 8  
**Location** Logatchev hydrothermal field  
 ships position at the first working target is at: 14°45.20'N / 44°58.81' slightly NE of site "Quest"

**Coordinates**  
**Water Depth** around 3040m  
**Vessel** l'Atalante

Time	ROV Depth	Observation	Actions
09:47:37		objectives: OBA and Smoni deployment, recovery of OBT, sampling of diffuse fluids and associated mussels vessel is positioning against the wind, wind speed 18-22 knots, waves 2-3m	
10:06:12		Begin Station, vessel is at 14°45.135'N / 44°58.871'W	
10:10:17		lift off	
10:12:26		ROV in the water	
10:17:37		deploying floats, ship depth 3031, ship is at 14°45.229'N / 44°58.867'W	
10:21:53		all floats are deployed	
10:23:15		start descend of ROV	
10:25:11		Posidonia fix at 14°45.216'N / 44°58.910'W	
10:27:43	150		
10:28:59	200	time is synchronized to UTC (difference is 1 sec)	
10:36:43	410	ROV is heavily negatively buoyant	
	800	ROV is turning to the east in order to approach the target position, NO Posidonia for the last 25 minutes	
10:49:53			
11:23:24	1750	still no Posidonia signal	
11:33:24	2000		
11:36:15	2032	start pumping KIPS for flushing the bottles, takes place for the next 30 minutes or so	
11:45:15	2300	ROV at 14°45.219'N / 44°58.853'W	
11:53:05	2460	ROV at 14°45.213'N / 44°58.820'W (third fix of the entire dive so far!!)	
12:04:47	2710	KIPS flushing is finished	
12:11:42	2875	winch stopped at 2960m	
12:12:35	2890	ROV stopped to try to get a Posidonia signal	
12:17:35	2908	no signal ROV is sinking due to the heavy load	
12:24:45	2915	signal! ROV is at 14°45.139'N / 44°58.820'W, ~ 40 m to the south of our target	
12:27:30		winch at 3030m going down	
12:28:30	3003	winch all stop 3050m, altimeter kicks	
12:29:43		we turn the thruster off to get position	
12:30:45	3010	ROV at 14°45.158'N / 44°58.870'W	
12:33:29	3015	move 30 m east	
12:34:57		ROV is going down	
12:35:52	3033	<b>bottom contact.</b> Altitude 5 m, winch at 3080m	
12:41:18	3033	ROV to the bottom, thurtsters of to get another position ROV fix at 14°45.147'N / 44°58.854 'W	
12:56:57		rocky outcrops	
13:07:45	3038	black smokers in sight, marker 27 in sight	
13:12:52	3040	preparing to deploy OBA near Quest	
13:14:59	3040	ROV on the ground for deployment on southeastern corner of Quest crater	
13:26:48	3041	untying the ropes of OBA	
13:45:10	3041	instrument at the seafloor needs fine tuning for leveling	
14:01:39	3040	changing pilots	
14:06:26	3040	start of repositioning and calibration of OBA	
14:16:47	3040	bottom to instable and soft for the OBA trying to find new site nearby	
14:25:49	3038	try to positioning the at the T-Logger site near Quest	
14:35:23	3044	no stable place in sight... only hydrothermal precipitates and crusts, to soft and instable	
15:14:26	3032	recovered the instrument and moved to soft ground, trying to put upright	
16:12:57	3032	you want beleave this, we are still adjusting the instrument	
16:55:47	3029	lost orientation, try to find where we are	
16:56:34	3024	seafloor with small ridge with rocky outcrops and sediment cover	
16:58:25	2999	ROV fix 14° 45.175'N 44° 58.831' W, ROV is strongly buoyant, moves far up	
17:01:30	3040	back at seafloor	
17:02:27	3034	back at Quest site	
17:03:10	3035	ROV is on south side of Quest site	
17:06:39	3037	ROV is now on NW site of Quest site	
17:09:28	3039	T-loggers shortly in view, are partly covered by black smoke	
17:15:59	3045	ROV at T-loggers site: mussel bed with shimmering water	
	3045	measurements with 8-ch t lance in mussel bed next to T-logger #13 for 10 min, T lance is working acc. To recordings on screen	
17:36:32			
17:47:40	3045	T lance tip reads 192°C, furthest up reads 12 °C after 11 min	

# ROV dive protocol ATA-15ROV

Atalante cruise HYDROMAR V

Time	ROV Depth	Observation	Actions
	3045	192.6 190.6 164.5 54.7 13.1 10.8 10.3 11.5°C of the diferent channels (lowest logger to highest logger)	Temp measurements as sample # ATA 15ROV-1
17:50:45			
17:51:37	3045	8-ch T lance removed	
17:59:50	3045	fluid sample at T: 10.8 °C	ATA 15ROV-2,
18:03:45	3045	fluid sampling stop T drops to 2.9 °C	
18:04:35	3045	fluid sample at T: 2.8°C	ATA 15ROV-3,
18:07:44	3045	fluid sampling stopped at 3.2 °C	
18:08:29	3045	fluid sampling at T: 4.9°C	ATA-15ROV-4,
18:11:38	3045	fluid sampling stopped at 3.2 °C	
18:12:28	3045	fluid sampling at T: 4.8°C	ATA-15ROV-5,
18:15:41	3045	fluid sampling stopped at 3.2 °C	
18:17:45	3045	KIPS noozle stored back to holder	
	3045	grabing of T logger # 13 and store it in sample box	Mussel samples on T-Logger: ATA-15ROV-6
18:28:30			
18:31:39		problems with rope and float: both were removed before logger is stored	
18:58:39	3045	taking mussel sample with net (scooping), tturns out to be difficult	
	3045	finally mussel sample was taken, net is full (probably hydrothermal precipitates + mussels)	ATA-15ROV-7
19:01:33			
19:05:07	3045	<b>off bottom</b> , start ascent to surface	
19:20:21	2547	cable wound up in front of the ROV	
19:34:10	1999	continue ascend, back-floats and cable still in sight	
19:46:39	1305	continue ascend, back-floats and cable still in sight	
19:59:21	512	continue ascend	
20:13:58	3	ROV on surface	
20:19:45		ROV on Deck, end of station	

# ROV dive protocol ATA-17ROV

Atalante cruise HYDROMAR V

<b>Cruise Number</b>		HYDROMAR V	
<b>Station Number</b>		ATA-17 ROV	
<b>Dive Number</b>		9	
<b>Location</b>		Logatchev hydrothermal field	
		ships position at the first working target is at: 14°45.09'N / 44°58.66' slightly NE of site "Irina"	
<b>Coordinates</b>			
<b>Water Depth</b>		around 2950m	
<b>Vessel</b>		l'Atalante	
<b>Time</b>	<b>ROV Depth</b>	<b>Observation</b>	<b>Actions</b>
09:46:14		objectives: hot fluid sampling with KIPS at Irina 1 and site "B"; Smoni deployment at site "B", sampling of push cores at site "F" vessel is positioning against the wind, wind speed 18-22 knots, waves 2-3m	
10:00:18		Begin Station, vessel is at 14°44.855'N / 44°58.727'W; depth 3018m, heading 84deg	
10:14:46		ROV off the deck	
10:15:59	2	ROV in the water	
10:19:38	4	CTD started	
10:22:28	2	8-channel T-logger is on	
10:23:18		time is checked, 2 seconds behind UTC	
10:24:50		time is now synchronized to UTC; ROV starts descending	
10:27:03	120	time on video overlay is off by 50 seconds - needs to be synchronized	
10:30:33	277	time on video overlay is now synchronized to UTC	
10:32:10		increase winch speed to 0.8 m/s	
10:38:30	620	ROV descending, ship at 14°45.08'N / 44°58.66'W (on target)	
10:46:50	930	ROV fix at 14°44.990'N / 44°58.683'W = south of the target position	
11:01:30		thrusters are off	
11:03:18	1590	thruster turned on again, continue descend	
11:09:13		ROV moving slowly to the north last position of the ROV is 14°44.992'N / 44°58.696'W	
11:14:22	2020	ROV at 14°45.002'N / 44°58.700'W	
11:20:18	2230	ROV at 14°45.031'N / 44°58.701'W	
11:25:12	2410	ROV at 14°45.070 / 44°58.690'W	
11:31:14	2750	ROV at 14°45.059 / 44°58.693'W	
11:35:21		winch slowing down to 0.3	
11:38:27	2940	ROV at 14°45.080 / 44°58.689'W	
11:40:05		ROV at 14°45.099 / 44°58.676'W	
11:42:46	2975	<b>bottom contact,</b>	
11:52:27	2975	Marker 24 and Site "B" in view, SE site, heading 83°	
11:56:04	2978	parking directly in front of marker 24 and black smoker, heading is 47°, SE rim of "B"	
	2978	stiering up to much dust, taking some rocks to make ROV heavier to don't need thrusters	
11:59:30			
12:02:49	2979	trying to grab talus from shimmering water, lots of shrimp in view, heading is 113°	
12:06:21	2979	shovel several crusts to the porch	17ROV-01
12:09:16	2977	flying back to marker 24 for fluid sampling	
12:10:50	2977	black smoke has changed the direction, flying along the crate rim to find new position	
	2975	parking in front of two smokers (B3 and B4), eastern rim of "B", smoke is going from N/NE to S/SW, heading is 301, needing lots of thruster-power to hold position	
12:18:04		repositioning	
12:25:18	2977	repositioning	
12:34:02	2978	trying to repositioning the sampled rocks on the porch to keep free the way for the KIPS	
12:38:31	2978	starting to place KIPS for fluid sampling	
12:52:54	2978	starting to place KIPS for fluid sampling again after short repositioning of ROV	
13:00:06	2978	trying to get closer and higher	
13:08:37	2978	sampled cpy-chimney lining from orifice of B4	17ROV-02
13:17:35		cleaning the front porch	
13:22:44	2978	taking out the KIPS sampler	
13:34:19	2978	KIPS is free	
13:36:14	2978	start pumping bottle C9	17ROV-03
13:39:25	2978	stopped pumping bottle C9	
13:40:13	2978	start pumping bottle C8	17ROV-04
13:43:15	2978	stopped pumping bottle C8	
13:44:03	2978	start pumping bottle C7	17ROV-05
13:47:52	2978	stopped pumping bottle C7	
	2978	8ch T logger deep in orifice of smoker B4 --> first 2 tips show values between 450 and 460°C!!!!; recordings with HD Cam	17ROV-06
14:02:53			
14:11:13	2978	stop 3ch T logging	
14:13:15	2978	preparing He-sampling at Site B, Smoker B4	
14:23:05	2978	start to reach the orifice with the He-sampler	
14:24:51	2978	smoke is emanating from the top of the He-tube	
14:25:35	2978	starting to close the upper ventile of He-tube	
14:27:07	2978	upper ventile is closed	
14:27:46	2978	little repositioning of He-tube to see the lower ventile	
14:28:51	2978	lower ventile is closed	17ROV-07
14:37:55	2978	SF thruster failed / automatically disabled	



Time	ROV Depth	Observation	Actions
14:40:12	2978	try to grab SMONI and deploy it in smoker B4	
14:45:03	2978	SMONI placed to B4 (the logger is still in the sample box)	
14:58:42	2978	SMONI fell off B4 and is repositioned again	
15:03:53	2978	SMONI is repositioned in smoker B4, Site B	
15:08:51	2976	lift off Site B, on the way to IRINA, heading 130° for 40m	
15:12:05	2956	flying over sediments with some black and white material lying on the floor	
15:13:50	2962	iron oxide	
15:14:10	2962	black rock outcrops	
15:15:03	2959	rocks more brighter on the top of a ridge	
15:16:43	2957	structure higher than the rest	
15:17:32	2957	black smoke in sight	
15:17:52	2959	marker Irina, NW corner of Irina	
15:19:19	2959	moving around the crater	
15:21:11	2956	searching a position for fluid sampling	
15:23:15	2958	on the eastern side of the crater no smoke	
15:25:45	2958	cable 3015 m	
15:26:28	2958	looking for the other smoker of Irina, heading N	
15:31:29	2957	line of black smoke release in sight	
15:35:24	2960	screen black because of the smoke, moving backwards	
15:39:07	2959	smokers again in sight, next try	
15:41:12	2960	same shit: screens black	
15:43:38	2961	better view, but unstable position of the ROV, its slipping to the right	
15:45:05	2960	position now stable and not too far away from smoker	
15:47:48	2960	getting ready to take fluid samples from the most right smoker (ROV heading S) smoker named "I 3", NW side of Irina, looking S Smoke out of "schutt", no direct opening	
15:56:27	2960	starting KIPS sampling: getting nossle in position	ATA-17 ROV 8
16:04:12	2960	T: 290, 313, 320, 314 °	
16:04:43	2960	start pumping	
	2960	T: 330, 339,	
	2960	pumpleistung: 3.1	
16:05:46	2960	T: 295, 300, 336, 340,	
16:07:15	2960	T: 274, 290	
16:07:46	2960	pumpe aus	
16:08:40	2960	erste flasche B6 muss nochmal gespült werden,	
16:09:01	2960	pumpe läuft wieder, T 240, 220, 215	
16:09:33	2960	we're losing it, T: 210	
16:10:29	2960	T: 230,	
16:10:51	2960	330, 351, 349 354 361 362	
16:11:32	2960	303 309 308 296 300 307 312 301 313 319 326 °C	
16:12:18	2960	bottle B6	
16:14:02	2960	Pumpe aus	
16:14:18	2960	next bottle B5, Pumpe läuft	ATA-17 ROV 9
	2960	T 360 stabil	
16:17:34	2960	Pumpe aus	
16:18:16	2960	Pumpe wieder an, 3.1 T: 360	ATA-17 ROV 10
	2960	bottle B4	
	2960	T: 365 °C, 366	
16:21:24	2960	pumpe aus	
16:22:00	2960	pumpe an, 2.8 pumpleistung	ATA-17 ROV 11
	2960	bottle A3	
16:22:39	2960	T: 360°C bis 350°C	
16:23:23	2960	T: 320,	
16:23:36	2960	340, 350	
16:24:09	2960	T: 362°C, 366	
	2960	T: 364	
16:25:08	2960	pumpe aus	
16:25:39	2960	Pumpe wieder an, 3.1 T: 360	ATA-17 ROV 12
	2960	bottle A2	
16:26:17	2960	T: 369°C	
16:27:38	2960	T: 340	
16:28:16	2960	T: 360°C bis 350°C	
16:28:42	2960	pumpe aus	
16:29:11	2960	Pumpe wieder an, 3.1 T: 360	ATA-17 ROV 13
16:29:22	2960	T: 375, 374,	
	2960	bottle A 1	
	2960	pumpleistung: 2.5	
16:31:26	2960	T: 367	
16:32:22	2960	Pumpe aus	
16:33:49	2960	end of KIPS sampling, nossel out	
16:39:47		nossel safe back in ROV	

Time	ROV Depth	Observation	Actions
16:41:39	2960	starting He sampling: getting it out of the ROV	
16:58:46	2960	repositioning ROV to get closer to the smoker i3	
17:04:21	2960	positioning the He-tube above the smoker and black smoke is emanating out of the of the tube	
17:15:50	2960	upper ventile is closed	
17:17:49	2960	repositioning a little the position of He-tube to see the lower ventile-handle	
17:20:11	2960	lower ventile is closed	17ROV-14
17:26:47	2960	need some time and brain to put back the He-tube to the sample box	
17:33:55	2959	He-tube is stored in the box	
17:36:04	2960	repositioning in front of the smoker i3 to prepare 8ch T-logger	
17:41:27	2960	positioning the 8ch T-logger	
17:44:27	2969	current changed, we are sinking in black smoke - repositioning of the ROV	
17:48:07	2959	smokers are blocked by black smoke - try to get other smoker to measure T	
17:53:58	2960	try to reach the smoking bottom of IRINA with 8ch T-logger	
18:04:33	2960	T-logging at the bottom of IRINA (T1-4 are above 450°C !!!)	17ROV-15
18:09:53	2960	stopping T-Logging (again with record temperatures!)	
18:12:11	2957	start traveling to Site F, heading is 305°	
18:19:26	2991	travelling over sediment, few white patches on the ground	
18:32:59	2992	flying over sediment, just passed a low lying mound of hydrothermal material, Fe-oxides	
18:36:37	2973	coming up to 20m above ground to get fix ROV at 14°45. 'N / 44°58.	
18:49:53	2999	thrusters are off to get fix. No fixes from Posidonia!	
19:00:32	3000	due to time limitations we are ascending	
19:57:09	580	ROV ascending	
20:15:43	0	ROV out of the water	
20:17:29		ROV on deck	
20:20:50		end of station	

# ROV dive protocol ATA-21ROV

Atalante cruise HYDROMAR V

Cruise Number	HYDROMAR V		
Station Number	ATA-21 ROV		
Dive Number	10		
Location	Logatchev hydrothermal field ships position at the first working target is at: 14°45.185'N / 44°58.750, 40m north of site Irina 2		
Coordinates	2		
Water Depth	around 3030m		
Vessel	l'Atalante		
Time	ROV Depth	Observation	Actions
		objectives: sampling of push cores at Anyas Garden; sampling of diffuse fluids, mussels and T-loggers at Irina 2	
09:35:35		time synchronized to UTC	
11:01:08		Begin Station; ship is at 14°45.085'N / 44°58.781'W; depth is 3010m	
11:08:40		ROV lift off	
11:09:55		ROV in the water	
11:12:09		put first set of three floats on	
11:18:02	3	all floats deployed	
11:18:16	16	ROV starts descend, ground fault on the system, ROV stopped at 16m	
11:20:39		ROV going down to 40m	
11:21:30		going further down, will check the system	
11:22:30	90	ROV descends, ship is at 14°45.165'N / 44°58.754; depth 3033m	
11:27:20		ship is in DP-mode; ship is at 14°45.178'N / 44°58.753'W	
11:36:55	540	ROV descending; ground fault stopped	
	650	Posidonia fix at 14°45.153'N / 44°58.762'W (30 m SE of target position at Anyas Garden)	
11:40:28			
	935	Posidonia fix at 14°45.154'N / 44°58.885'W (since cable out is only 50 m more than ROV depth this cannot be right; this position is almost 200m behind the ship)	
11:49:14			
11:49:53	960	Posidonia fix at 14°45.151'N / 44°58.896'W	
		Posidonia fix at 14°45.162'N / 44°58.901'W	
11:58:38	1210	cable out 1240m, cable is streight, ROV must be below the vessel	
	1640	Posidonia fix at 14°45.343'N / 44°58.552'W (MILES AWAY; GARBAGE) 30m more cable than ROV depth	
12:12:31			
12:18:52	1810	Posidonia fix at 14°45.176'N / 44°58.745'W (thats a good one!)	
12:24:58	1990	start pumping the bottles of the KIPS system (2 minutes per bottle)	
	2330	cable out 2370, ROV fix 14°45.165'N / 44°58.673'W (would be 200 meters to the east of the ship)	
12:37:03			
12:40:15	2345	winch stopped due to spooling problems	
12:45:50		continue descend with 0.4 m/s of the winch	
12:46:54	2405	increase speed of the winch to 0.5 m/s	
12:48:36	2455	cable 2500m out	
12:50:46	2526	Posidonia fix at 14°45.186'N / 44°58.685'W	
13:19:32	3019	18.6 m above bottom (altimeter)	
13:21:15	3038	<b>Bottom view</b>	
13:22:50		160N 763W, need heading 030	
13:24:26		154N 762W	
13:29:58	3040	at Irina II mussel field, T-logger field	
13:30:37		an unknown old marker: square shaped	
13:32:04		writing on marker: MAR 2, position S of T loggers	
13:35:11	3051	inactive smokers	
13:37:15		saw a big anthozoan; try to zoom in with pilot cam, sediment cloud, lost it	
13:41:50	3054	too deep. Heave 5 m and ask for posidonia fix (dvl off)	
13:46:13	3042	780N 146W, at steep slope south of target marker Anya, wait for a second fix	
13:50:41		776N 149W	
13:51:05	3050	move N towrds	
13:51:59		see marker Anya	
13:59:01		mat#1	
13:59:12		marker 23, no trace of former push core sampling	
14:17:17	3055	parked at mat #1. very soft sediment, park mposition: heading 70, porch against slope	
14:31:16	3053	8-channel T: getting in position	
14:39:51	3053	instrument seems to be damaged, no T-signal (cable damaged?) sensor 2 not reliable	
14:40:53	3053	signal is there again, 3° water	
14:43:42	3053	measurement inside white mat: T rising up to over 80 °C	ATA 21 ROV-1
14:46:16	3053	10 minutes measurement	
14:47:44	3053	T max: 85°C; T min: 41°C	
14:52:13	3053	stop measurement, T max 86.3 °C	
14:53:09	3053	another measurement on the right of the white mat	
14:54:36	3053	start measurement, T rising less high	ATA 21 ROV-2
14:56:18	3053	T max 47 °C T min 13°C	
14:59:20	3053	stop measurement, T max 48 °C	
15:04:56		instrument safe back in ROV	
		push core sampling: getting prepared, sample box is not going out far enough, problems to pull out corer #1	
15:05:20			

Time	ROV Depth	Observation	Actions
15:22:52	3053	pushcore Sampling right beside the marker (lots of white stuff also at the bottom of the core -- ATA 21 ROV-3 > Talc (?))	
15:27:21		try to deploy the corer into the holder - shit design of the corer holder	
15:32:05		again problems to pull out corer #2 - still shit design	
15:36:25		take push core #1 from defect holder to the sample box and canceling the sampling - hopefully the sampled core is still "alive" on board	
15:45:35	3054	Marker Anya in sight, trying to get a Posidonia fix (174N, 765W), Posidonia is jumping again	
15:54:26	3054	start flying from ANYA to IRINA II via the SW-NE striking canyon west of IRINA II	
16:01:37	3044	marker "C" in sight, living mussel-patch, position is 20-30m NW of IRINA II	
16:04:57	3039	T-logger field at IRINA II in sight	
16:08:11	3035	surroundind T-logger painned mussel field	
16:14:26	3035	getting parking-position for sampling program at T-logger site at the top of the T-logger field to work down slope	
16:28:00	3035	at T-logger #3, prepare 8-channel lance measurement	
16:32:00	3035	sample #4 8-cannel t-lance, lance once half length intruded (rock below)	21ROV-4
16:38:46	3035	t1 (=tip) = 11.05 °C, 31.7 (T2=kaputsky), 3.8, 2.9, 2.6, 2.5, 2.4, 2.5 (top)	
16:48:36	3035	KIPS T reading above mussel bed 2.85°C	
16:54:39	3035	start KIPS sampling bottle C9, 3.7°C, pump power 4.6 A, sample #5	21ROV-5
16:57:57	3035	"pumpen off" (Andy)	
16:58:31	3035	"pumpen ist an" (Andy) sample #6; bottle C8, T=3.6, Pump 3.8	21ROV-6
17:01:35	3035	"Pumpe ist aus" (Andy)	
17:02:09	3035	"Pump is on" (Andy) KIPS sample #7; bottle C7, T= 3.5, 4.6-5.1	21ROV-7
17:05:10	3035	pump off	
17:05:46	3035	pump on, Kips bottle B6, sample #8, 3.7°C	21ROV-8
17:08:55	3035	pump off	
17:13:53	3035	grab t-logger #3	
17:27:34	3035	HD cam on for mussel scoop	
17:33:14	3036	sample #9 mussel scoop at T-logger #3, some empty shells- some livingnet 13 .	21ROV-9
17:41:40	3036	we try reposition the ROV in line with the t-logger chain	
17:47:03	3037	T-logger #5 entangled in porch	
17:52:40	3038	positioned in front of T-logger #7	
18:10:00	3038	taking 8-channel T-logger	
18:19:11	3038	positioning T-logger	
18:20:25	3038	taking measurement at logger #7	21ROV-10
18:23:44	3038	pushing the probe a little deeper (inserted ~25 cm)	
18:31:11	3038	t1 (=tip) = 28.6°C, 36.9 (T2=kaputsky), 7.7, 4.4, 3.7, 3.0, 2.7, 2.6 (top)	
18:42:51	3038	taking KIPS system out	
18:46:28	3038	KIPS pump on bottle B5 (Tmax 2.9°C)	
18:47:41	3038	pump off! no pumping! Move the nossle up	
18:48:16	3038	pump on again, T = 2.9°C, largely over empty mussels at logger #7, bottle B5	21ROV-11
18:51:27	3038	pump off	
18:52:06	3038	pump on for bottle B4 (T = 3.0°C - 2.8°C)	21ROV-12
18:55:17	3038	pump off for bottle B4	
18:55:59	3038	pump on for bottle A3 (T=2.9°C)	21ROV-13
18:59:09	3038	pump off for bottle A3	
19:06:22	3038	finished KIPS sampling, had to get closer	
19:08:24	3038	collect T-logger #7	
19:16:07	3038	T-logger #7 placed in drawer	
19:20:21	3038	collecting mussels with a bionet	21ROV-14
19:25:52	3038	finished collecting mussels (largely empty shells), net 335	
19:32:28	3038	repositioning in front of logger #9	
19:36:31	3038	dropped maker#5 which we had tangled below the porch, try to collect it	
19:49:00	3038	logger#5 collected	
19:54:41	3038	positioned again in front of T-logger #9	
20:01:26	3038	8-channel T-logger positioned next to T-logger#9	
20:03:54	3038	8-channel logger pushed in	21ROV-15
20:10:39	3038	T1=45.1, (44.4), 17.4, 7.8, 3.8, 2.7, 2.4, 2.4 (top)	
20:11:22	3038	recover 8-channel T-logger	
20:13:20	3038	take out KIPS	
20:21:33	3038	fell out of the hand	
20:32:45	3038	recovered KIPS, trying again	
20:38:04	3038	T 2.7 °C	
20:38:34	3038	start pumping the bottles of the KIPS system (2 minutes per bottle)	21ROV-16
	3038	bottle A2	
	3038	pumpleistung 5.3, verstopft?	
20:40:41	3038	moving the nossel a bit up and down again	
20:41:00	3038	pumpe aus, und wieder an	
20:42:13	3038	pumpe an, 10 Ampere Eingangsstrom	
20:42:38	3038	läuft langsamer als normal	
20:43:18	3038	auch schütteln hilft nicht: keine kontrolle über fließendes Volumen	

Time	ROV Depth	Observation	Actions
20:44:02	3038	Abbruch KIPS (hat keinen Sinn) bottles A2 und A1 without samples	
20:45:06	3038	pumpe aus	
20:51:04	3038	nossel safe back in ROV	
20:51:32	3038	going to collect T-logger #9	
21:03:41	3038	logger# 9 collected	
21:05:02	3038	preparing for mussle scooping	
21:13:30	3038	scooping where logger # 9 has been before	
21:14:00	3038	start mussle sampling	21ROV-17
21:19:22	3038	net full of mussels!!!	
21:24:29	3038	net safe inROV	
21:24:52	3038	end of sampling, preparing to get up	
21:27:50	3038	trying to get the float of the loggers more inside the ROV-drawer	
21:31:56	3038	empty net over the filled one (kind of cap)	
21:36:33	3038	<b>starting to ascend</b>	
22:56:13	150	ascending, preparing for recovery	
23:00:29	50	floats are at surface	
23:04:45	9	all floats recovered	
23:09:25		ROV out of the water	
23:09:57		ROV on the deck	
23:11:49		station end	

# ROV dive protocol ATA-24ROV

Atalante cruise HYDROMAR V

**Cruise Number** HYDROMAR V  
**Station Number** ATA-24 ROV  
**Dive Number** 11  
**Location** Logatchev hydrothermal field  
 ships position at the first working target is at: 14°45.21'N / 44°58.77', 40m NE of OBT site

**Coordinates**  
**Water Depth** around 3030m  
**Vessel** l'Atalante

Time	ROV Depth	Observation	Actions
		objectives: deployment of OBT at OBT site, hot fluid sampling and measuring at Irina 2 and site B, recovery of instrument(s) at OBT site	
10:41:11		in the pre-dive check; ship is at 14°45.10'N / 44°58.83'W, depth 3054m	
10:50:51		prepare to launch	
		ships is at 14°45.145 796	
10:52:45		begin station; ROV off the deck	
10:54:17		ROV in the water, ship at 14°45.177'N / 44°58.778'W	
10:56:24	3	putting floats on	
11:02:03	12	starting to descend	
11:09:34	270	ROV descending	
11:15:04	480	white balance on video cameras	
11:36:08	1420	ROV at 14°45.249'N / 44°58.739'W (too far northeast)	
11:37:54		ROV at 14°45.238'N / 44°58.742'W	
11:40:42	1630	ROV at 14°45.235'N / 44°58.738'W	
11:43:30	1750	ROV at 14°45.233'N / 44°58.744'W	
11:46:01	1860	ship is in DP mode	
11:48:15		ROV at 14°45.217'N / 44°58.760'W	
11:50:20	2015	ROV at 14°45.202'N / 44°58.765'W	
12:00:23	2500	ROV at 14°45.193'N / 44°58.764'W	
12:05:39	2730	ROV at 14°45.192'N / 44°58.774'W	
12:07:50	2855	ROV at 14°45.190'N / 44°58.773'W	
12:08:46	2920	winch at 3000m, ships depth is 3040m	
12:10:46	2975	ROV at 14°45.184'N / 44°58.779'W	
12:12:22	3000	ROV at 14°45.196'N / 44°58.794'W	
12:15:28	2978	ROV at 14°45.203'N / 44°58.785'W	
12:24:00	3036	ROV at 14°45.192'N / 44°58.782'W	
12:25:10	3042	<b>bottom in sight</b>	
12:31:52	3050	at beacon ROV at 14°45.196'N / 44°58.782'W 8channel logger readings at bottom, t1=17.3, 52.8, 16.1, 19.9, 12.5, 14.0, 10.7, 12.7 (top)	
12:44:17	3048	homer beacon 15 is responding, ship is moving to ENE for 20 meters	
12:45:25	3048	restart 8 channel logger to see if it	
12:47:45	3048	read in calibration (t1=2.4, 30.7, 2.2, 2.2, 2.2, 2.2, 2.2, 2.3 (top)	
13:02:38	3051	deploying OBT-2 next to marker #29	
13:07:13	3051	starting to level the instrument	
13:30:19	3051	done, moving vessel 80 meters on a bearing of 110	
13:51:10	3035	arrived at Irina 2, flew around main complex (north side)	
13:52:27	3035	positioning ourselves in the west of the smoker	
13:57:29		ROV started moving because of the cable pull (?)	
14:06:18	3020	approachin bottom again (shift change)	
14:09:01	3034	taking 8-channel T-logger first	
14:55:18	3034	Tmax on the probe was 527°C	24ROV-1
15:04:51	3034	taking KIPS	
15:08:32	3034	positioning the KIPS nossle	
15:13:49	3034	bottle C9, pump on	24ROV-2
15:14:47	3034	T stable: 362 °C	
15:16:20	3034	T still stable	
15:16:52	3034	Pump off	
15:17:31	3034	Pumpe on: bottle C8	24 ROV-3
15:18:02	3034	T: 362°C	
15:19:36	3034	T:359 °C	
15:20:47	3034	pump off	
15:21:56	3034	nossle shaken a bit, T: 364°C	
15:22:44	3034	T: 365°	
15:22:57	3034	Pump on, bottle C7	
	3034	T is sinking down to 290 °C, lost the position	
15:23:47	3034	moving the nossle: T rising again up to 360	
15:24:44	3034	T not stable	
15:25:20	3034	pump off	
15:25:31	3034	T stable: 362 °C	
15:25:39	3034	Pump on again: refilling the bottle C7	24ROV-4
15:28:39	3034	Pump off, bottle filled	
15:29:24	3034	taking HD-pictures	

Time	ROV Depth	Observation	Actions
15:30:44	3034	trying to get the nossle in another outlet a bit further down	
15:32:24	3034	T: 4°C 2 cm away from the smoker	
15:33:04	3034	inside the outlet T rising up to 364°C	
15:33:38	3034	KIPS pump on: bottle B6	24ROV-5
15:34:12	3034	HD-pictures	
15:37:15	3034	pump off	
15:37:38	3034	HD-pictures	
15:37:56	3034	pump on bottle B5	24 ROV-6
15:38:42	3034	HD-camera aus	
15:41:00	3034	pump off	
15:41:15	3034	T stable: 362 °C	
15:41:41	3034	Pump on: bottle B4	24 ROV-7
15:41:59	3034	T: 363 °C	
15:44:49	3034	pump off, KIPS sampling finished at Irina 2	
15:48:46	3034	T (surrounding seawater) :2.7°C	
15:53:21	3034	KIPS nossle safe back in the ROV	
16:00:42	3034	putting SMoni out of the ROV placed SMoni in front of the ROV (in order to have more place for the following operations)	
16:05:42	3034		
16:19:00	3034	prepare to get fluids with the Ti-major bottle D2	
16:24:30	3034	HD-camera started	
16:25:36	3034	Ti-major out of ROV	
16:30:09	3034	HD aus	
16:31:25	3034	nossle of Ti-major getting in position: lower outlet of smoker	
16:35:33	3034	feder löst aus: Ti-major filled	24 ROV-8
16:39:11	3034	Ti-major back	
16:44:56	3034	Ti.-major safe back in ROV	
16:49:27	3034	prepare to get He-sample	
16:57:19	3034	He-pipe placed in the smoke	
17:00:09	3034	He-sample taking	24 ROV-9
17:01:46	3034	He-pipe closed at the upper side	
17:04:12	3034	closed at the lower side	
17:09:46	3034	He-pipe safe back in ROV	
17:10:31	3034	prepare to place SMoni at Irina 2	
17:13:23	3034	HD-camera	
17:18:46	3034	SMoni installed perfectly!	
17:19:38	3034	HD aus	
17:21:01	3034	flying to Quest	
17:22:11	3035	fist catch some nice pictures of the adcp	
17:23:44	3033	start moving to QUEST	
17:24:45	3036	ringstructure on bottom	
17:30:15	3039	straight forward, heading is 290° big unknown inactive chimneys, like a dead IRINA II, Posidonia fix is 44°58.833'W	
17:49:13	3035	14°45.158' N	
17:55:05	3036	arriving at QUEST	
17:57:20	3039	try to find parking position in QUEST crater, QUEST shows more activity than in the years before (more smoke emanating spots and pipes)	
18:04:22	3042	station keep mode, waiting for better visibility, heading is 265°	
18:13:17	3040	trying again to park the ROV at the north-eastern crater rim	
18:23:56	3041	ROV pushed forward to get a closer position to the smoker, heading is 191°	
18:32:07	3041	stop HD, recorded gas bubbles emanating from vent	
18:33:13	3041	preparing 8ch T-logger	
18:38:47	3041	streams of gas bubbles from diverse pipes at this site !!!	
18:42:11	3041	still preparing T-logger	
18:50:22	3041	T-handle of T-logger is grabbed	
18:58:37	3041	sinking in black smoke, bad visibility, waiting	
19:07:10	3041	trying to penetrate tiny smoking hole with T-lance, T at the 1. sensor was 275°C shortly	
19:10:45	3041	343°C at the tip	
19:13:12	3041	367°C Tmax of the tip, getting the lance deeper gently	
19:13:44	3041	measure the smokers temperature, probe was puched in at an angle, Tmax was 400°C	24ROV-10
19:18:46	3041	deploy T-lance back to the holder	
19:22:52	3041	start to preparing KIPS fluid sampling nussel is grabbed and will be positiones to the smoker, look around the ROV shows a lot of	
19:29:42	3041	dust on dieverse components (laser-cam, sonar...)	
19:34:02	3041	positioning KIPS-nussel	
19:34:37	3041	T from nussel is 345°C	
19:38:56	3041	T from nussel is 364°C	
19:40:08	3041	pump is on, 370°C was Tmax and is dropping...	
19:42:21	3041	nossel is out, repositioning	
19:42:52	3041	pump off	
19:43:17	3041	pump on, 362-364°C stable, bottle A3	

## ROV dive protocol ATA-24ROV

Atalante cruise HYDROMAR V

Time	ROV Depth	Observation	Actions
19:45:29	3041	repositioning nussel slightly, 360°C	
19:46:27	3041	T 362°C, pump off at 19:46:18	24ROV-11
19:46:53	3041	pump on, bottle A2	
19:47:37	3041	pump off	
19:49:30	3041	pump on again, bottle A2, temperatures are varying between 330-358°C	
19:52:27	3041	pump off	24ROV-12
19:55:02	3041	try to reach neighbor hole with nussel for fluid sampling	
19:56:53	3041	pump on, T 337-341°C	
19:58:00	3041	time is running, bottle A1	
20:01:32	3041	pump off	24ROV-13
20:03:10	3041	deploying KIPS nussel back to the holder	
20:04:35	3039	lift off for the OBT site	
20:07:30	3041	get signal from beacon 15	
20:16:51	3047	moving towards OBT-site	
20:23:04	3047	moved too far north	
20:48:06	3050	found OBT-1b	
20:52:43	3053	positioned the ROV in front of the OBT	
21:02:37	3049	flying around to position the ROV on smoother ground, deploying OBT on porch	
21:27:36	2445	ascending, <b>OFF BOTTOM ~21:15</b>	
21:48:42	2225	winch stopped because of funky cable layering	
22:21:12	1610	still ascending	
22:48:55	470	still ascending	
23:12:18	0	ROV on Deck, station end	



# ROV dive protocol ATA-27ROV

Atalante cruise HYDROMAR V

**Cruise Number** HYDROMAR V  
**Station Number** ATA\_27ROV  
**Dive Number** 12  
**Location** Logatchev hydrothermal field  
 ships position at the first working target is at: 14°45.21'N / 44°58.81', 40m north of Quest

**Coordinates**  
**Water Depth** 3040m  
**Vessel** l'Atalante

Time	ROV Depth	Observation	Actions
09:13:32		objectives: sample diffuse fluids, associated mussel beds; measure temperatures with 8-channel logger, collect T-loggger, collect bioboxes, move to OBT site and recover OBP	
10:28:27		<b>Station begin</b> , preparing ROV deployment, Ship 14°45.115'N, 44°58.923'W	
10:29:58	0	ROV in water	
10:33:10	2	preparing back-floats	
10:37:38	12	putt on back-floats	
10:38:58	15	begin diving	
10:40:17	49	stop diving to install "Fettabscheider", startind CTD	
10:45:17	49	continue descend	
10:48:07	171	Lights on, T-Logger Software started	
10:50:10	250	white balancing of video cameras	
10:52:09	340	Ships position is 14°45.180'N, 44°58.883'W	
11:02:35	785	"testing" both manipulators	
11:35:19	2020	still descending	
11:42:31	2267	ROV position 14°45.268'N 44°58.810'W (Posidonia)	
		ROV position 14°45.278'N 44°58.811'W	
11:46:34		ROV position 14°45.272'N 44°58.811'W	
11:47:46	2460	ROV at 14°45.271'N 44°58.798'W	
11:49:18	2480	ROV at 14°45.262'N 44°58.795'W	
11:49:53	2520	ROV at 14°45.251'N 44°58.797'W	
11:51:15	2570	ROV at 14°45.241'N 44°58.793'W	
11:52:30	2600	ROV at 14°45.230'N 44°58.790'W	
11:54:07	2640	ROV at 14°45.227'N 44°58.792'W	
11:54:49	2666	ROV at 14°45.219'N 44°58.794'W	
11:56:12	2710	ROV at 14°45.221'N 44°58.797'W	
11:57:28	2770	ROV at 14°45.216'N 44°58.799'W	
11:58:34	2798	ROV at 14°45.213'N 44°58.803'W	
11:59:44	2840	ROV at 14°45.214'N 44°58.808'W	
12:00:32	2880	ROV at 14°45.208'N 44°58.807'W	
12:02:56	2930	ROV at 14°45.194'N 44°58.825'W	
12:03:45	2950	ROV at 14°45.188'N 44°58.827'W	
12:05:05	3000	ROV at 14°45.192'N 44°58.828'W	
12:06:25	3026	ROV at 14°45 18'N 44°58.804W	
12:06:53	3044	<b>Bottom contact</b> Ships position 14°45.202'N 44°58.923'W	
12:08:26	3045	ROV at 14°45.190'N 44°58.829'W	
12:09:23	3040	ROV at 14°45.194'N 44°58.824'W	
12:09:29	3040	Marker 27 in sight	
12:19:43	3040	couple of T-loggers at Quest in sight	
12:21:26	3043	getting nearer to the mussle bed	
12:23:32	3045	finding a parking position for the ROV	
12:26:03	3045	ROV parked, heading SW (243), ship position 14°45.207' N 44° 58.816' W	
12:27:28	3045	shimmering water above mussels	
12:29:52	3045	moving some mussels to the right	
12:33:48	3045	prepare to measure T with 8-channel logger	
12:36:01	3045	T-logger dropped because T-handle has broken	
12:38:45	3045	trying to grab logger without t-handle	
12:42:09	3045	logger grabbed sucessfully	
12:44:00	3045	measure T next to T-logger # 14 (within the mussle bed)	
12:46:38	3045	T: 125 °C	
12:48:09	3045	hard to see numbers of the other loggers because of animals on them	
12:49:26	3045	visible numbers: 16, 11, 10	
12:51:06	3045	8-channel-logger T at logger #14: 125°C ; 130.1°C, 132.4°C, 135.2°C, 133.7°C, 132°C, 124.9°C, 110.3 °C	27ROV-1
12:56:07	3045	putting 8-channel logger in floor next of logger #16 to measure there (a bit away from mussle bed)	
12:59:07	3045	number of another logger: 19	
12:59:29	3045	T at logger #16: 97.9°C, 92.5°C, 78.8°C, 68.5°C, 60.4°C, 48.9°C, 37.5°C, 25.0 °C	27ROV-2
13:01:41	3045	another T-measurement outside the mussle bed	
13:08:22	3045	T outside mussle bed: 52.6°C, 54.6°C, 42.9°C, 39.4°C, 34.4°C, 27.2°C, 20.0°C, 13.8 °C	27ROV-3
13:11:50	3045	T-measurement inside mussle bed, next to logger #19	
13:25:43	3045	T-loggers near marker 20: # 10, 12, 18	
13:27:35	3045	T at logger #19: 120.2°C, 122.1°C, 119.4°C, 118.0°C, 115.0°C, 106.1°C, 88.1°C, 29.5°C	27ROV-4
13:31:04	3045	8-channel logger at logger #17	

Time	ROV Depth	Observation	Actions
13:45:37	3045	end of logging T1=115, (116), 106, 47, 38, 16, 11, 6.3) dtiong fluctuation above the tip	27ROV-5
13:48:37	3045	taking KIPS sample	
13:55:40	3045	pump is on for bottle C9, T betwenn 7.0 and 4.5; strong fluctuation	27ROV-6
13:58:44	3045	pump off	
14:01:31	3045	pump on for bottle C8	27ROV-7
14:09:59	3045	pump off	
14:11:12	3045	pump on bottle C7	
14:12:35	3045	pump off, ROV is moving	
14:21:47	3045	pump on bottle C7	27ROV-8
14:24:35	3045	pump is off	
14:33:00	3045	KIPS nussel is back in holder	
14:36:22	3045	start to recover T-logger	
14:39:36	3045	twister in front of porch	
14:40:34	3043	repositioning the ROV	
14:46:29	3045	start to recover T-logger #19 with mussels	
14:55:35	3045	T-logger #19 is in the sample box (with all mussels)	27ROV-9
14:57:05	3045	start to grab T-logger #14 and a lonesome mussel	
15:02:38	3045	T-logger #14 is in the sample box (with the mussel)	
15:10:19	3045	start to grab T-logger #16	
15:15:34	3045	T-logger #16 is in the box	
15:16:31	3045	start to grab T-logger #17	
15:23:42	3045	deploying the logger #17 back to the box with huge musselpatch on it <b>deploy marker #32</b> at the place were numerous of mussels have been executed (former T-logger #17 place), marker #20 is about 5m to the west	27ROV-10
15:27:46	3045	repositioning the ROV	
15:32:23	3044	ROV at 14°45.128'N 44°58,828'W	
15:37:58	3051	grabbing T-logger #11	
15:41:56	3046	T-logger #11 is in the box	
15:42:52	3046	trying to put 8-channel logger in floor next of logger #11 position to measure there	
15:48:58	3046	repositioning the ROV	
16:03:10	3038	ROV at 14°45.160'N 44°58,855'W	
16:22:06	3051	found OBA that has been set up during the first dive to Quest	
16:25:30	3046	found t-logger site and head to position of logger #11 that was removed before (15:42:52)	
16:35:40	3044		
16:45:04	3049	putting 8-channel logger in floor next to logger #11 position	
16:56:29	3045	T at t-logger #11: 57,4C°; 58,4C°; 44,9C°; 38,8C°; 33,2C°; 28,4C°; 23,4C°; 16,8C° stabbing the musslefield next to logger #11 with 8-channel-temp logger to measure there	27ROV-11
16:58:36	3045		
17:01:03	3045	stopped measurement	27ROV-12
17:01:59	3045	stabbing the musslefield next to logger #11 again, slightly changed position	
17:04:32	3045	max temp at tip 5°C	27ROV-13
17:14:12	3044	repositioning the ROV	
17:21:49	3045	stabbing the 8-channel-t-logger into ground in position of t-logger #12	
17:28:31	3045	T at t-logger #12: 10,5°C; 32,3°C; 8,9°C; 7,3°C; 5,5°C; 5,1°C; 4,6°C; 4°C	27ROV-14
17:31:17	3045	stabbing the 8-channel-t-logger into ground in position of t-logger #18	
17:41:39	3045	T at t-logger #18: 7,4°C; 30,6°C; 5,9°C; 5,1°C; 4,4°C; 3,5°C; 2,9°C; 2,5°C	27ROV-15
17:50:16	3045	repositioning the ROV	
17:54:55	3045	stabbing the 8-channel-t-logger into ground in position of t-logger #10 next to marker #20	
17:59:32	3045	T at T-logger #10: 8,7°C; 30,7°C; 5,3°C; 3,7°C; 2,4°C; 2,3°C; 2,3°C; 2,3°C;	27ROV-16
18:00:33	3045	removed logger	
18:04:40	3045	Grabbing Temp-logger #12	
18:08:11	3045	Deployed logger #12 in the box	
18:23:38	3045	repositioning the ROV	
18:30:40	3045	grabbing T-logger #18	
18:35:37	3045	Deployed logger #18 in the box	
18:39:51	3045	Grabbing T-logger #10	
18:52:06	3045	Deployed logger #10 in the box	
18:55:33	3045	repositioning the ROV	
19:02:15	3045	Looking for brown sediment for Temp & push coring	
19:13:58	3046	Suitable Spot lockated near Quest T-logger field	
19:19:47	3046	Stabbing the 8-channel-t-logger into brown mat (HD-cam on)	
19:20:28	3046	Start measurement	
19:22:38	3046	Stop measurement - Temp in mat: 19,3°C;35,4°C;14,9°C;12,7°C;10,1°C;7,7°C;6,0°C;4,8°C	27ROV-17
19:27:51	3046	removed logger	
19:31:14	3046	Start grabbing push core from box	
19:35:01	3046	HD-Cam on	
19:36:06	3046	Stabbed push core into brown mat (left to position where Temp was taken)	
19:36:34	3046	Removed core from ground	
19:42:18	3046	Push core stored in thre box	27ROV-18

Time	ROV Depth	Observation	Actions
19:44:42	3046	Start grabbing second push core	
19:53:48	3046	taking second puch core	
19:56:08	3046	core is slipping slightly off the corer	
20:00:04	3046	core is back to the holder	27ROV-19
20:04:37	3046	preparing start for QUEST	
20:07:07	3043	lift off	
20:12:08	3040	SE side of QUEST in site, abundand smoke from numerous chimneys	
20:14:55	3041	repositioning because ROV is sitting with porch directly on a smoker (autsch)	
20:23:45	3040	try to grab chimney sample	
20:39:23	3040	one piece of sulphide in porch	27ROV-20
20:44:17	3040	grabed sample of inactive chimney with the rick-master arm	27ROV-21
20:46:12	3041	sample is liying on the porch	
20:46:46	3041	start flying to the OBT site to recover OBP, heading 70°	
20:54:17	3050	near inactive smoker fied discovered during station 24ROV, heading 84°	
20:58:53	3051	no Posidonia fix	
21:06:45	3051	in front of the OBP, prepare to recover	
21:12:11	3051	HD record of OBP recovery	
21:19:08	3051	<b>off bottom</b> , ROV starting ascend	
21:34:22	2684	winch stoped while still having problems	
21:59:44	2670	caught winch electronic cable with box !???! Needs a repair	
22:34:33	2600	winch started after fixing	
23:30:49	215	still ascending, ships position is 14°45.231'N 44°58.759'W, winch is working	
23:57:12		ROV on deck	

# ROV dive protocol ATA-30ROV

Atalante cruise HYDROMAR V

<b>Cruise Number</b>	HYDROMAR V		
<b>Station Number</b>	ATA-30ROV		
<b>Dive Number</b>	13		
<b>Location</b>	Logatchev hydrothermal field		
<b>Coordinates</b>	ships position at the first working target is at: 14°45.070'N/44°58.700'W, 40m west of Irina		
<b>Water Depth</b>	2940m to 2960m		
<b>Vessel</b>	l'Atalante		
<b>Time</b>	<b>ROV Depth</b>	<b>Observation</b>	<b>Sample</b>
		objectives: Frohe Weihnachten / Merry Christmas, Joyeux Noel; hot fluid sampling and temperature measurements at site "B" and "Candelaber"	
09:50:31		pre-dive check finished, prepare to launch	
09:51:46		ship is at 14°44.94'N / 44°59.01'W, depth 3084m	
09:59:15		ship is moving into position	
10:02:54		<b>station begin</b>	
10:03:06		ROV off deck	
10:05:04		ROV in the water, ship at 14°44.937'N / 44°58.826'W, depth 3054	
10:09:35	3	first floats added	
		ship is at 14°44.94'N / 44°58.78'W, depth 3084m	
10:13:05	3	additional 9 floats added	
10:14:39	5	ROV is ready for dive, starts descend	
10:25:14	420	ship is at 14°44.993'N / 44°58.678'W slowly moving to the north	
10:34:50	730	ship is at 14°45.054'N / 44°58.691'W slowly moving to the north	
10:40:20	940	ROV fix at 14°44.902'N / 44°58.744'W	
10:42:02	1010	ROV fix at 14°45.003'N / 44°58.765'W	
10:47:52	1250	ROV fix at 14°45.012'N / 44°58.778'W	
10:50:27	1340	ship is in DP mode	
11:01:50	1730	ROV fix at 14°45.108'N / 44°58.735'W	
11:08:02		ROV fix at 14°45.110'N / 44°58.674'W	
11:18:21	2200	ROV fix at 14°45.119'N / 44°58.673'W	
11:27:25	2500	ROV fix at 14°45.100'N / 44°58.674'W	
11:35:16	2780	ROV fix at 14°45.092'N / 44°58.678'W	
11:38:40		ROV-CTD T= 2.6°C, 8ch T= 2.4°C, Kips T=3.0°C	
11:40:04		altimeter kicks in	
11:44:48	2980	116 689	
11:45:39	2978	<b>on bottom, 45.071 / 58.699</b>	
11:54:26	2978	smoker B1 in sight; heading 52	
11:59:18	2978	depth difference between ROV-CTD and separate pressure sensor is 10 m !!!	
11:59:49	2978	preparing to sample top of the smoker, weak bubbling visible	
12:03:08	2979	ROV position for sampling 14°45.090'N / 44°58.680'W	
12:10:35	2979	pump on for bottle C9, stable at 352°C	30ROV-1
12:14:16	2979	pump off for bottle C9	
12:15:03	2979	pump on for bottle C8, stable at 352°C	30ROV-2
12:18:05	2979	pump off for bottle C8	
12:18:43	2979	pump on for bottle C7, stable at 352°C	30ROV-3
12:21:46	2979	pump off for bottle C7	
	2979	tmax for this sampling was 353°C, note difference to all other measurements during this cruise!! This temperature is the same as in January 2007 with Jason 2.	
12:25:13	2979	prepare for Ti-major sampling, lost instrument, trying to recover	
12:58:18	2979	recovered instrument	
13:01:47	2979	nussel in position	
13:02:01	2979	start triggering, wrist blocked	
13:13:49	2978	smoker is bubbling within the smoke	
13:18:21	2978	try to sample the smoker but it's difficult, nussel is deformed	
		bottle seems to be filled, waiting some time more to get sure, nussel is perfectly and deep	
13:23:35	2978	positioned in the smoker B1, Bottle D-1	30ROV-4
13:31:06	2978	bottle is out and is stored next to the porch	
13:33:43	2978	preparing to sample second Ti-bottle	
13:39:28	2978	move old marker out of the way	
13:44:31	2978	try to remove sampler off the sampling box	
13:57:39	2978	bottle D-2 is grabbed and on the way to the smoker	
14:00:57	2978	bottle is positioned to the smoker	
14:01:49	2978	repositioned a little	
14:03:26	2978	trigger pushed, bottle is filling and nussel is still in the smoker B1	30ROV-5
		bottle D-2 is also stored in front of the porch and SMONI will be prepared for 15min T measurement	
14:09:46	2978	SMONI in the smokers try to reposition because tip is not deep enough	
14:14:34	2978	SMONI is deep in the smoker B1, waiting	30ROV-6
14:15:57	2978	end of SMONI T-logging, pull out nussel	
14:30:09	2978	SMONI is back in the box, recovering Ti-major samplers	
14:33:01	2978	Ti sampler back in box	
14:35:18	2978	preparing 8ch T-logger, smoker B1	
14:36:42	2978		

Time	ROV Depth	Observation	Sample
14:40:16	2978	positioning 8ch T-lance in B1	
14:43:32	2978	starting T-logging T >450°C !!! T3, 4, 5 shows very high values of >600°C (out of range)	
14:46:23	2978	pull out the logger a little, T are more stable and lower (~320°C)	
14:49:23	2978	try it a little deeper, its going hotter again	
		T1 398°C, T3 334°C, T4 440°C, T5 421°C, T6 160°C, T7 130°C, T8 74°C (T's are varying)	
14:51:43	2978		30ROV-7
14:56:05	2978	8ch T-logging stopped, lift off to the CANDELABRA crater	
14:58:12	2980	on the way	
15:04:42	2978	may found MSM 03-2 Rockdrill station	
15:07:00	2965	hydrothermal crusts, talus and sediment all the way	
15:08:46	2960	green bottle and traces in sediment	
15:11:07	2951	TV grab station?	
15:12:04	2957	black smoke coming from the left	
15:14:22	2960	reached smoking crater, identified as IRINA	
15:18:20	2054	heading 120° to CANDELABRA	
15:20:26	2952	hydrothermal crusts, altered rocks and sediment, steep slope	
15:26:27	2948	try to park in front of Candelabra smoker	
15:29:37	2948	having some difficulties to park	
15:37:29	2949	landed in front of C1	
15:41:41	2948	gas bubbling visible	
15:42:19	2948	pump on for bottle B6	
15:45:18	2948	pump off (T 360-362°C)	30ROV-8
15:46:17	2948	pump on for bottle B5	
15:49:15	2948	pump off (T 360-362°C)	30ROV-9
15:49:41	2948	ROV has moved strongly, repositioning, Smoker broken? Bubbles coming out	
15:53:48	2948	ROV seems to be stable now	
15:55:36	2948	pump on for bottle B4	
15:58:36	2948	pump off (T 356°C)	30ROV-10
15:58:55	2948	KIPS sampling is finished	
		EMERGENCY CALL FROM BRIDGE; WE HAVE TO LEAVE THE AREA TO GET SOMEONE TO A HOSPITAL; WE HAVE ONE HOUR TO RECOVER THE ADCP	
16:06:27	2968	Start traveling to IRINA II , Posidonia 44°58.650'W 14°45.065'N	
16:09:08	2988	.660'W .070'N	
16:10:45	2994	.716'W .078'N	
16:11:12	3001	.713'W .084'N	
16:11:50	3003	.723'W .088'N	
16:13:11	3004	.729'W .101'N	
16:14:28	3008	.707'W .096'N	
16:21:33	3030	no posidonia fix	
16:32:46	3049	still searching IRINA II, no posidonia	
16:42:32	3043	something in view, heading 57°, no fix, ship is too noisy	
17:00:08	3033	found ADCP	
17:01:41	3033	parking in front of ADCP	
17:06:17	3036	repositioned and parked again	
17:08:50	3036	start to recover the ADCP	
17:11:46	3036	try to give the ADCP from Orion arm to the Rickmaster	
17:15:21	3036	finished recovery of ADCP	
17:16:16	3036	<b>Off Bottom</b>	
18:21:52	140	near the surface, ascending without problems	
18:32:02	4	at the surface, ship in view	
18:32:57	0	Systems off, high power off	
18:36:17	-	<b>ROV on deck, station end</b>	