First Weekly Report
M76/3b-Guineco Leg 2

17.07.-20.07.08

The second leg of the expedition GUINECO started 11:00 am on Thursday, 17 July with leaving the port of Walvisbay. We left with excellent weather conditions and all equipment, containers, scientists and their luggage, some of who/which arrived just in time. It was an amazing view, seeing the ocean meet the desert, and the departure scenery was quite spectacular, including many glimpses on the abundant marine life such as giant sea turtles, dolphins, seals and whales – as well as a lot of jellyfish.

From Walvisbay to our main target area, the giant pockmarks and diapirs off Congo, Angola and Gabon, we have to steam 1100 nautical miles, so there is ample time for installing the ROV and numerous scientific instruments, as well as with getting familiar with the ship and the work plan. The remotely operating vehicle QUEST4000 of MARUM is the main working tool of this leg, and our goal is to assess the structure and distribution of deep-water habitats and biological communities associated with gas seepage from the seafloor and gas hydrate accumulations. The previous leg has provided us with bathymetry maps of different target areas as well as the positions for giant gas flares marking the escape of free gas from sites as deep as 3100m. We will explore several of these sites with the ROV QUEST and various geological tools, to learn more about the geological, geochemical and biological consequences of such vigorous gas escape.

Unfortunately, on the second day of our departure, in the early hours of the 18 July, we were informed of a tragic loss in the family of one member of the ship's crew and it was decided immediately to disembark him at the nearest harbor, namely Walvisbay. Events like this one remind us how incredibly demanding the job of a seafarer is –the risk to be far away from home and out of reach when one is needed by family and friends is a major personal challenge.

We left Walvisbay again in the morning of the 19 July and are now back on our northward transect along the West African continental margin. Due to excellent weather conditions, the ship makes good progress while we are recording the seafloor bathymetry on the way to our first target, the Diapir Area off Angola. This zone, characterized by an interesting seafloor morphology and signatures of gas escape, will be reached in the morning of the 23 July. We will start with a first exploratory dive in this area, to obtain seafloor images of the source of the gas escape and the surrounding underwater landscape with the ROV QUEST, before we continue to the REGAB area.

All scientific crew members are well and busy installing their laboratories and learning of each others goals and methods. Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de.

http://www.planeterde.de/internationales-jahr-des-planeten/meteor-blog-m76-3b/meteor-expedition-m-76-3b

With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2

Second Weekly Report
M76/3b-Guineco Leg 2

21.07.-27.07.08

Photo 1: Sampling gas bubbles from a mussel bed (DIAPIR site; All Photo sources: MARUM)

We have reached the first target area of a giant gas flare at one of the diapir structures off Angola on the 23 July. After a first reconnaissance of the gas flare by Parasound-enabled acoustic mapping, we started the QUEST4000 dive 207 at around noon. By using a combination of acoustic wayfinding with the forward looking sonar of the ROV and regular checks of characteristic features on the seafloor, we were able to track at least one of the sources of free gas emission at this diapir site. Following the sonar image of gas bubbles, we landed on a giant mussel bed teaming with life. The mussels (mytilids) are symbiotic organisms hosting thiotrophic and methanotrophic bacteria in their gills. They attract many other organisms, which form a fascinatingly rich ecosystem at a depth of 2800 m (Photo 1). As one goal of the first dive, we were testing a variety of the tools and cameras of QUEST and were really happy about the new installation of a vertical camera which allows precise visual mapping of the seafloor – but the most astonishing asset of QUEST remains the HDTV camera which allows to see the single filaments of the mussel gills bathing in the methane-rich fluids, and all the microlife associated to the mussle bed such us dense swarms of tiny copepods. But unfortunately before the end of the dive, a major oil leak was discovered that forced us to interrupt the task list and to recover QUEST.

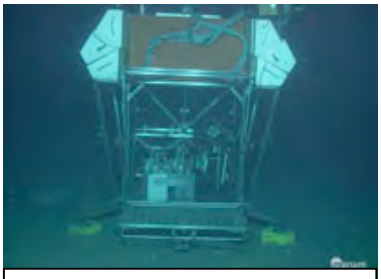


Photo 2: The lift deployed at REGAB carrying benthic chambers and blade cores

After considerable repairs, we attempted further dives at our main working area REGAB, but unfortunately, the problem with oil leakage could not be stopped. Hence, we decided to reorganize the planned dives and to limit ourselves to dives with 3-5 hours bottom time and a lift deployment (Photo 2) every 2 days as long as the oil leakage remains. This will still allow the use of our in situ payloads, and the planned work at main target REGAB, but we will have to sacrifice the program of exploring other areas of the Gabon and Angolan margin. Volker Ratmeyer and his ROV crew are working in shifts around the clock to do their best in providing dives, and continuing with the search for errors and subsequent repairs. Also the METEOR crew supports us very well in these days of very irregular deployment and recovery times and of a high uncertainty with the planning of station work, so we still hope to fulfill a substantial part of the goals of this expedition. The three short dives at REGAB between the 24 and the 27 July have provided us with net and pushcore samples from bacterial mats (Photo 3) and

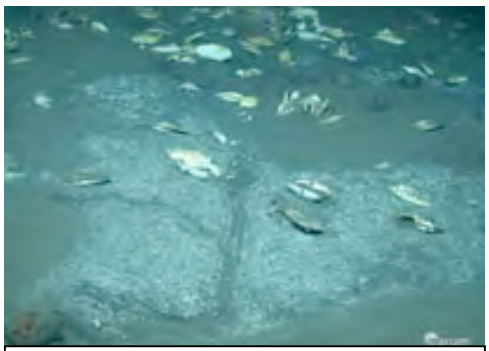


Photo 3: Bacterial mats growing on reduced, highly gassy seafloor

clam fields (Photo 4), as well as with a first in situ microsensor and respiration chamber measurement and we were also able to deploy some colonization experiments (Photo 5). When we cannot dive, we continue with Parasound mapping of the West African deep margin, and we have had a series of interesting sediment samples from 3-6 m gravity cores filled with hydrates or carbonates, and sometimes tubeworms and mussels.

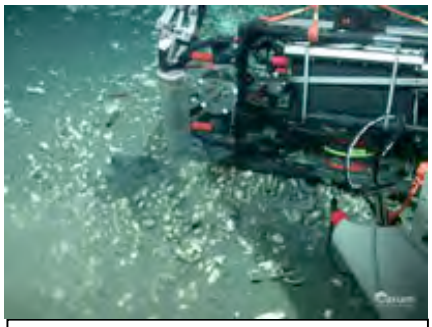


Photo 4: Pushcore sampling in front of the benthic chamber on a

Photo 5: Placing colonization experiments next to tubeworm bushes(TRACS)

All scientific crew members are well and hopeful that the QUEST team can solve the problems with the oil leakage. Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de.

With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2

Third Weekly Report
M76/3b-Guineco Leg 2

28.07.-03.08.08

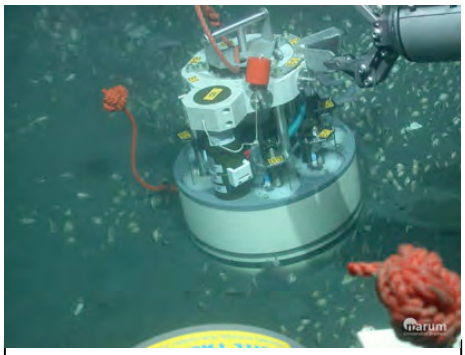


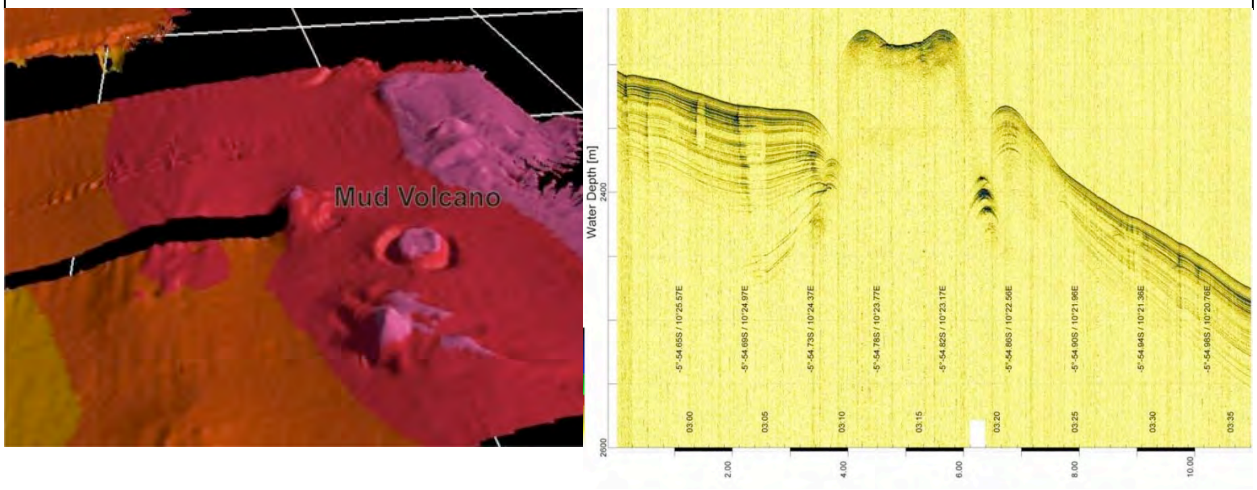
Photo 1: Respiration measurements on field of vesicomyid clams with the benthic chamber CALMAR of IFREMER

The third week of the GUINECO expedition started with two short dives to deploy and recover two types of benthic chambers for the measurements of the respiration of the benthic communities at REGAB (Picture 1). We focused first on a species of bivalves, which dwell the sediments for sulfide to nourish the thiotrophic symbionts hosted in their gills. The vesicomyid clams are often found at cold seeps and in association with hydrate bearing sediments. At REGAB the healthy clams form typical assemblages in the reduced sediments close to the central area of the pockmark. We also came across large fields of dead bivalve shells witnessing previous areas of gas emission, which went extinct. With the chambers we also measure fluxes of dissolved methane from the seafloor as well as those of other compounds like sulfide, CO2, ammonium etc. After having measured the respiration of the clams and their associated community, we sampled the patches with blade and push cores for biogeochemical and biological analyses. Our main goal for the work at REGAB is to identify the main geological, geochemical and biological factors shaping the geobio-system and the habitats of the main megafauna at REGAB – the vesicomyid and mytilid bivalves (Picture 2) as well as the giant tubeworms.

Picture 2: Mytilid bivalves and tubeworms above gassy sediments at REGAB

Despite the continuing problems with oil leakage, we had three short dives on the 28 -30 July targeted to the vesicomyid bivalve site. The problem with the oil leakage improved from dive to dive, because more leakage spots are found and repaired. However, we encountered a major problem with the cable of the ROV. After dive 212, it came up strongly distorted and bent in its top part at the connection to the ROV. Together with the ship a solution was found, namely to cut the top 200 m of cable which showed signs of degradation after 5 years and >210 dives, to steam out the 3500 m of remaining cable in use, and to refit the cable to the ROV. This operation was successful, allowing us to dive on the 31 July to finish the work at the first habitat site. In between the ROV operations we continued work with the gravity corer and multiple corer as well as with Parasound and Multibeam mapping of the wider region around the Congo pockmarks. Cesar Capacharin, the responsible geophysicist on board made a nice discovery of three previously unknown mud volcanoes between the REGAB and the DIAPIR site (Picture 3). We will certainly try to explore if these are active gas emitting structures.

Picture 3: South of REGAB: a mud volcano field. Left: the bathymetry of 2 cone-shaped and one pie-shaped mud volcano. Right: the subsurface structure of the pie-shaped mud volcano, which is about 1.5 km in diameter and extends 100m above the seafloor.



But first we will try to investigate in detail another spectacular habitat at the REGAB site, the associations between the mytilid bivalves with surficial hydrate accumulations as well as gas bubble emission. The sediments in the center of the REGAB pockmark associated with the mussels are oversaturated with gas, and gas bubbles are released upon disturbance, such as landing of the ROV, or sampling. Hence, even at 3200 m and 2.5 °C within the methane clathrate stability zone, free gas remains mobile and hydrate formation seems repressed under some unknown circumstances. However, we observed that hydrate forms where the gas is trapped, e.g. below carbonate crusts or under a dense mussel patch (Picture 4), and we also found hydrate in the gravity cores between 1-5 m depth. Unfortunately, our dives to measure methane fluxes, turnover and respiration rates of the mussel communities were delayed for 2 days by another problem: the replacement of dysfunctional hardware in the main control PCs of the ROV console became necessary on 1-2 August. But today (Sunday evening) we have just completed the first dive to the hydrate and mussel sites, and are happy to have obtained spectacular images from the seafloor.

Picture 4: Bulk gas hydrate accumulating under a carbonate crust. At this site, we also observed streams of free gas bubbles escaping the seafloor

Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de.

With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2

Fourth Weekly Report
M76/3b-Guineco Leg 2

04.08.-10.08.08

The fourth week of the GUINECO leg 2 was dedicated to exploration and measurements on the eastern part of the REGAB pockmark. In 2000, dives of IFREMER's BIOZAIRE expedition found that the eastern part of the pockmark was characterized by a flat and sedimentary seafloor, covered by large mussel beds (Fig. 1) associated with gassy sediments. The first overview of this area 8 years later indicated considerable changes over time. The extension of the mussel beds is strongly reduced and they seem to be replaced by assemblages of vesicomyid clams, potentially indicating a decrease in the gas flux.

Fig 1: Mussel beds on gassy sediments. The assemblages are similar to those on carbonate and include tubeworms, shrimps, snails and copepods

Our plan for the fourth week of this leg was to obtain estimates of community respiration, to sample the different megafauna habitats in the eastern part of REGAB and to analyze sulfide and methane fluxes. However, unfortunately, the ROV team had to cope with more technical problems including oil leakage, arm replacement and the failure of the wonderful HDTV camera system. We used the repair time to explore the mud volcano area with more detailed bathymetric mapping as well as video-guided transects and targeted sampling with the TV-multiple corer.

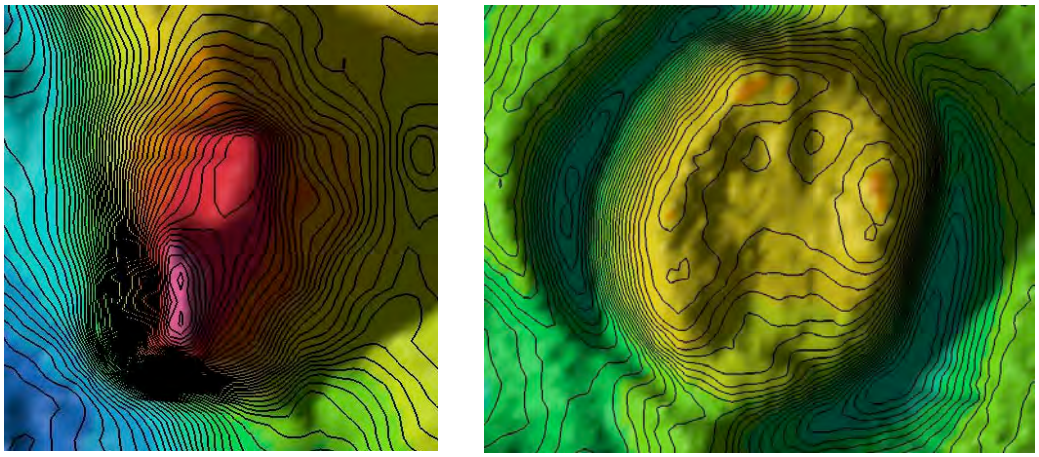


Fig 2: Two mud volcanoes of the Northern Diapir region. Maps by Cesar Caparachin

We investigated the two most prominent mud volcanoes, a cone- and a pie shaped structure (Fig. 2). The cone shaped mud volcano has two peaks in between which we observed extensive carbonate platforms populated by communities of filtering organisms, including what looked like deep-sea corals, and a variety of echinoderms. The pie shaped structure was uniformly covered by pelagic sediments, and did not show any type of structuring, or conspicuous fauna assemblages. For a more precise mapping of potential gas emission sites we lacked the detailed flare mapping by the Parasound system. The parasound was dysfunctional for a week before its

miraculous repair by the ship's electronicians and system operators, just in time for the "Bergfest" (half time party). Hence, the gas flare mapping on the mud volcanoes is a further task for the remaining time of the cruise.

Fig 3. The Eddy correlation system by Frank Wenzhöfer (MPI) to measure integrated oxygen fluxes is placed on the mussel bed.

Fig 4. Carbonate colonization experiments by Florian Brinkmann (MARUM)

Also in time for the Half Time party were two excellent dives at the end of the fourth week. After thorough maintenance, QUEST dives 222 and 223 on Thursday and Friday showed the full excellence of the ROV system – both dives provided over 10 hours of bottom time, and allowed us to finalize the main objectives the fourth week. We carried out a series of benthic flux measurements (Figure 3) on the remaining mussel beds as well as the vesicomyid assemblages in the eastern area of the pockmarks, and we were able to deploy a series of carbonate colonization experiments as well as to collect more megafauna for the investigation of the diversity of chemosynthetic symbioses at REGAB. Also, we found areas of gas bubble escape where they were not expected – away from the center and not associated with carbonate formation or benthic assemblages.

Finally, the week ended with very nice Saturday night Barbicue Party. While completing another transect for Parasound and bathymetry mapping of the West African margin, all scientists and crew got together to officially celebrate the cruise half time (the correct date was 5 August).

It was good to have this moment of recreation before another challenge awaited the ROV team – again the ROV cable came up terribly twisted and bent and needed to be replaced to allow the continuation of dives in the Southwest of the REGAB pockmark.

Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de.

With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2

Fifth Weekly Report
M76/3b-Guineco Leg 2

11.08.-17.08.08

The fifth week of the GUINECO leg 2 was a quite dramatic experience, foremost for our ROV team, but also for all scientists on board hoping for more dives to the deep sea of the West African margin. After steaming out the ROV cable several times until no further twisting (Picture 1) could be observed in the night of the 10-11 August, the dive 224 was planned to explore a new habitat: the southwestern clam fields of REGAB, which probably represents the habitat with the highest density of chemosynthetic vesicomyid clams known today. But at about 1500 m water depth, the ROV suffered a complete black out. As a consequence, the ROV team and ship had to carry out one of the most dreaded maneuvers: a dead-vehicle recovery. This means the ROV cannot be controlled, its thrusters are shut off, and it has to be recovered by its sensitive cable. Luckily and thanks to the excellent support by the deck and bridge crew, the recovery went smooth and without problems. In less than an hour after recovery, the ROV team was able to locate the error: In the last 20 cm of the cable, close to the connection to the ROV, the fiber which transports all data - including those controlling the vehicle - showed a disconnection.

Picture 1: ROV cable "salad" – unfortunately a common view during M76/3b (Source: T Wilkop)

Picture 2: One of the possibilities tried: asking oil exploration platforms for spare parts

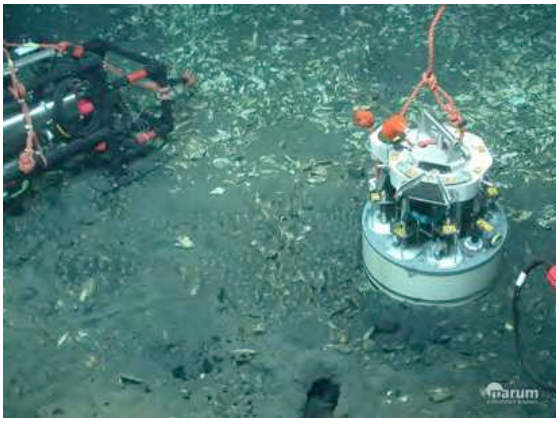
This is what we had feared most: a new termination was impossible, because after all the previous problems, all spare parts were already used up. But after the first shock we started thinking of possibilities to fix the problem and to allow for further dives. After many discussions and phone calls to land during the 12 August, which was spent with Parasound transects and gravity coring, it was decided to initiate the delivery of these spare parts from Bremen to Luanda by courier. We steamed to Luanda on the 13 August, and were lucky enough to be able to pick up the needed parts already in the afternoon of the 14 August. Thanks to the effort of the ROV team, an immediate repair was carried out and a new dive was planned already for the night of the 15 to 16 August.

Picture 3: Steaming to Luanda for a pick up of spare parts

Picture 4: New clam species populating the reduced pockmark sediments (source: K Olu, C Decker)

Luckily, the dive 225 made up for all the extra effort. It was the first dive during the cruise, which lasted for 16 hours bottom time, and allowed for retrieval of samples, in situ measurements and interesting video footage for all scientists on board. The goal of dive 225 was to explore and sample a new site with clam beds (bivalves of family Vesicomyidae) in the Southwestern part of the REGAB pockmark (Picture 4). This site was previously described as the largest clam field of the REGAB pockmark, during its first exploration by the ROV VICTOR in 2001. Most interestingly, two different species of chemosynthetic clams populate the sulfidic sediments. It is also curious, that such an active site is found far away from the center of the pockmark with its hydrates and gas ebullition site, indicating the complexity of the gas and fluid system feeding the pockmark from below.

Already during dive 225 we planned two further dives to use all the remaining time for sampling and diving with the ROV, but as soon as the ROV was on deck, much to our disappointment we faced another major cable failure. The ROV team agreed once more to a full suite of cable cutting, termination and testing, to make sure we have one more dive to recover some experiments and manage at least one detailed videomapping of the active center of the pockmark. Dive 226 will start in a few hours and will be the last dive of this mission, hopefully being as successful as dive 225.



Picture 5 and 6: The dense Vesicomyid clam beds of the southwestern REGAB pockmark. Left: respiration measurements with benthic chambers. Right: Close up of living clams dwelling the sediments for sulfide.

Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de.

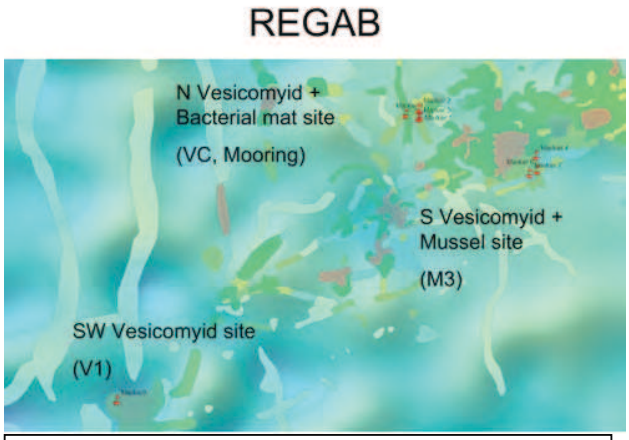
With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2

Sixth Weekly Report
M76/3b-Guineco Leg 2

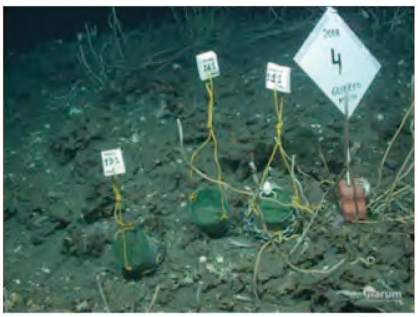
18.08.-24.08.08

The sixth week of the GUINECO leg 2 seemed very short – a final dive, and 5 days of transit time back to Walvisbay, Namibia. However, the scientific program at REGAB ended with the longest dive of mission, dive 226, which was a highly successful 33 hour operation, including shuttle and ROV deployment and recovery.

All scientists got together in the afternoon of the 17 August to plan the final QUEST dive 226. The tasks included deployment of several profiling instruments, recovery of some experimental moorings, biological samples, water chemistry and the time-demanding "videomosaicking" in the areas where we had worked most. This is a special task for the ROV, where it has to fly at a constant altitude and velocity and known track over the seafloor to visually map organisms and habitats. Producing visual maps of benthic habitats is the only way of arriving at quantitative estimates for the areal coverage of visible structures – for example of the different bivalve species, the tubeworms, the carbonates. For this task, QUEST is equipped with a high quality camera looking downwards, to produce video footage and images, which can subsequently be put together like a "Mosaic", using the positioning information. This sounds simple, but is really a complicated endeavor due to the difficulties of underwater positioning.



The main working sites at REGAB indicated by the distribution of markers. The patches demonstrate the different benthic assemblages as recorded in 2001 by IFREMER biologists.



Colonization experiments "TRAC"

DIWOOD colonization experiment

Summarizing dive 226, it was really a success. We were able to recover the colonization experiments of the University of Paris 6, and also to take a look at, and a sample from the wood colonization experiment (project DIWOOD). We could observer that the wood was already accepted as new home to many shrimps, which normally prefer tubeworms and mussels as associates. Also, we carried out a nice set of in situ measurements.

The microprofiler was deployed three times to fill some gaps in measurements, and our Eddy system to measure integrated benthic community respiration was placed close to and away from vesicomyid clams. Also, we stopped in the center to film the beautiful assemblage of organisms in the dense tubeworm forest. A peculiar feature of this habitat is the attachment of mytilid bivalves to the tubes, as well as the dense colonization by hydroid polyps. These are just examples of the fascinating deep sea life, and dive 226 truly gave us a feeling of how things could have been hadn't there be so many technical issues. Again, we were truly grateful to our ROV team who did not give up and realized this final dive of the GUINECO mission.

Microsensor profiler deployed close to a clam patch

The tubeworm landscape – a typical assemblage of organisms in the gassy center of the REGAB pockmark

The dive ended at 5:15 am in the morning of the 19 August with the recovery of the ROV QUEST, and the last action of the scientific program of expedition M76/3b MPI/MARUM was to retrieve the ROV shuttle. Then we set sails for a final, long parasound transect in the direction of Walvisbay. We have five days of transit to Walvisbay – finally everybody gets some time to rest, clean the labs, for packing, and for sorting data and samples.

With the end of the GUINECO leg 2, the METEOR expedition M76 to the West African Margin is also coming to an end. We thank the ship and its excellent crew as well as the coordinator of the M76 expedition Dr. Matthias Zabel, and all other supporters of this expedition. Further details of our daily work and the scientists on board can be found on the expedition BLOG hosted by www.planeterde.de. With regards - Antje Boetius and the Scientific Crew of GUINECO leg 2