R/V Meteor

Cruise 70-2

Heraklion (Crete, Greece) – Heraklion (Crete, Greece)
20. October – 23. November, 2006

Short Cruise Report

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Objectives

This cruise leg combined activities of the ESF EUROCORES EUROMARGIN project MEDIFLUX and the German "Geotechnologien" project MUMM II (funded by BMBF/DFG). The cruise BIONIL has investigated the recently discovered seep systems of the deep Nile fan. These consist of numerous fluid-escape structures outcropping in water depths between 500 and 3000m, which include pockmarks, actively gas emitting mud volcanoes, giant brine pools and ancient seep systems. The rising fluids carry hydrocarbons, mostly methane, to the seabed surface, which build the basis for rich and abundant microbial life and diverse chemosynthetic organisms.

On the basis of geophysical, geochemical and biological data from various seep structures collected during two earlier MEDIFLUX cruises, M 70/2 aimed at gaining better understanding of the distribution and functions of the novel seep ecosystems. The objectives were to understand the controls and mechanisms of chemical element transport and breakdown by seep biota, and to obtain insight in the element cycling and export from the seabed into the water column at different types of fluid seeps in the Mediterranean. To achieve these objectives, we used detailed near-field mapping of selected habitats using the French autonomous underwater vehicle (AUV) ASTERX

(IFREMER) followed by detailed geochemical in-situ measurements and specific sampling of mud, fluids, carbonates and biota along geochemical gradients. Sampling and in-situ measurements were performed with the German ROV QUEST.

Three working areas were selected: The “East Delta” in the eastern Nile fan province, around 32°22’N, 31°42’E with comparably young mud volcanoes with fluid seepage; the “Central Area” around 32°38’N, 29°55’E, with a high density of pockmarks harboring carbonate chimneys and pavements as well as patchy colonies of chemosynthetic organisms, and for one exploratory dive, the “Ménèz Caldera” in the western Nile fan province around 32°12’N, 28°12’E, characterized by several active mud volcanoes and brine pools. M 70/2 was split into two sections of 17 working days each, separated by an intermediate port call in Limassol where part of the scientific crew was exchanged. Both sections M 70a and b visited the same working areas, but focused on different sampling strategies.

R/V Meteor left Heraklion on October 21 at 9 a.m. local time. We steamed to the East Delta of the Deep Nile Fan at 32° 25’ N and 31° 33’ E to start with a CTD profile, parasound and multibeam transects. We arrived on October 22 6 pm at the Amon mud volcano (1100 m water depth), the first target of the BIONIL cruise. After testing of Posidonia and CTD profiling to obtain a sound velocity profile we started a multibeam and parasound transect in the East Delta for 12 hours. In the morning of the 23 October, we deployed for the first time the AUV Asterx of IFREMER with the multibeam of Geosciences Azur mounted. The AUV completed a successful microbathymetry of Amon within 6 hours. Then we started the first reconnaissance dive (ROV QUEST dive 112) in the center of the Amon to the southeastern rim. This dive served to select microhabitats of this active mud volcano for further biological, geochemical and geological investigation. The second AUV dive with the multibeam mounted covered the surrounding of Amon and lasted until the evening of the 24th October. Afterwards we deployed the MPI elevator system to transport the microprofiler and the benthic chamber to the seafloor. The QUEST dive 113 was dedicated to geochemical measurements on the Amon center, in the bacterial mat area as well as in the highly disturbed center. Unfortunately the lift did not release and we had to plan a recovery dive (Dive 114). During the 25 October we carried out a third AUV-multibeam dive, this time covering the Isis mud volcano, leading to the discovery of 3 apparently active centers on the mud volcano. We added a multibeam/parasound transect to cover the wider area of ISIS in the night of the 25-26 October. In the morning of the 26th we collected reference sediments by using the TV-multi corer. The dive (114) dedicated to the recovery of the lift started in the morning of the 26 October. It was interrupted early, because the lift did release and mount to the surface. Soon after, dive 115 was started to do an exploration of the carbonates in combination with S probe measurements and push coring of biogenic mounds and mats. Unfortunately the weather worsened and after the AUV calibration we had to cancel the third AUV dive planned to detect free gas at Amon with the EK60 echosounder. Instead we steamed to the Central Pockmark area and measured a sound velocity profile to carry out two multibeam-parasound transects on the 27 October. Still the weather did not allow for AUV diving, hence the next QUEST dive (116) was carried out on the 28 October with the objective to explore the central area and to sample two different habitats with pushcores and the microprofiler. At the seafloor we found a highly active zone of sediments and carbonates, which we chose as

main target. When the weather conditions improved on the 29 October we carried out the third AUV dive to detect gas on the central pockmarks. No major plume was discovered but 3-4 smaller flares in the wider area. The second ROV dive in the central area (Dive 117) was planned to carry out several types of in situ measurements, but we were once more stroke by bad luck, as the lift landed on outcropping carbonates and was too light to be opened without the risk of sliding. So the dive concentrated on pushcore sampling as well as T- and S-probe measurements as well as microsensor profiling. On the 30 October we carried out the fourth AUV dive with the multibeam tool of Geosciences Azur to obtain a high resolution map of the southern central pockmark area at 1700 m water depth. The following ROV dive (118) on the 30 October was cancelled due to an accident during deployment. The repairs of the thrusters and the complete system check took 2 days. Unfortunately, the weather turned bad again and it was not possible to have further ROV or AUV dives. Instead, on the 31 October we carried out a multibeam/parasound transect of the deep pockmark area and then deployed 2 colonization experiments at the central pockmark site, one on carbonates and one more north in a pockmark area with small bacterial mats. We used the storm of the 1 November for the transit to the Western Delta and arrived at mud volcano Chefren on the 2 November. After a few multibeam transects we used a temporary weather improvement to dive at Chefren. Dive 119 was planned to carry out microsensor profiling in situ at the bottom of the mud volcano close to a brine seep, but unfortunately the area was to steep and muddy to allow a proper landing of the ROV. Instead we used dive 119 to monitor several sites of high activity related to brine seepage. Because of a sudden improvement of the weather we returned then to the central area to attempt a last AUV multibeam dive on the deep (northern) site at 2100 m water depth. The deployment was a little bit risky, so we were very happy to obtain good results from the deepest environment surveyed by Aster^{x}. A final ROV dive (120) at the central area allowed the deployment of several colonizers, an S probe survey and a few bacterial mat pushcores. Due to increasingly bad weather and because of the need to take fuel on the southern side of Crete we had to leave the station early on the 4th November to steam to Heraklion. We could not go faster than 5 knots against wind and waves so we had to give up on getting fuel and returned directly to Heraklion where we arrived in the early morning of the 6th November. 14 members of the scientific crew were exchanged in Heraklion and the AUV was unloaded.

Fig. 1 Ship track and working areas during BIONIL M70/2a and 2b

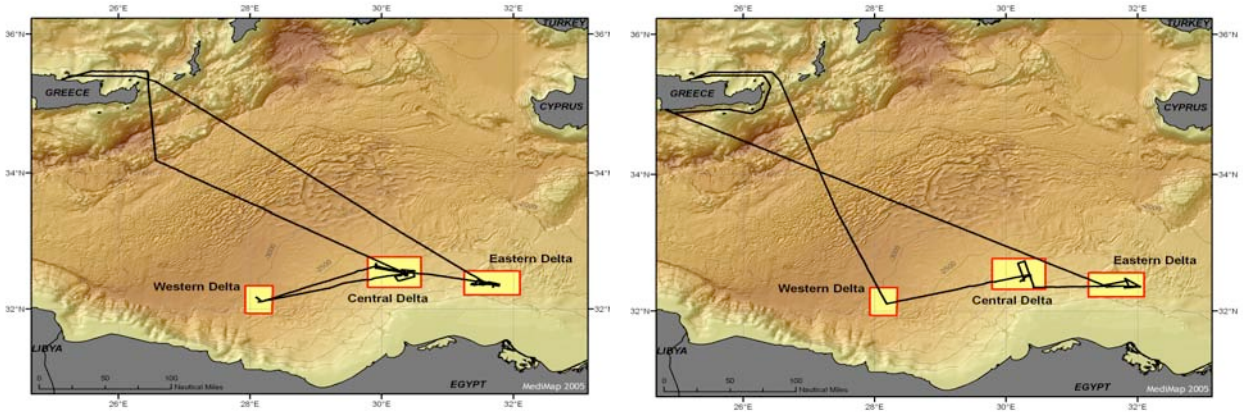

Fig. 2 Main technologies of expedition BIONIL – left: ROV QUEST (MARUM) and right: AUV Aster^{x} (IFREMER)

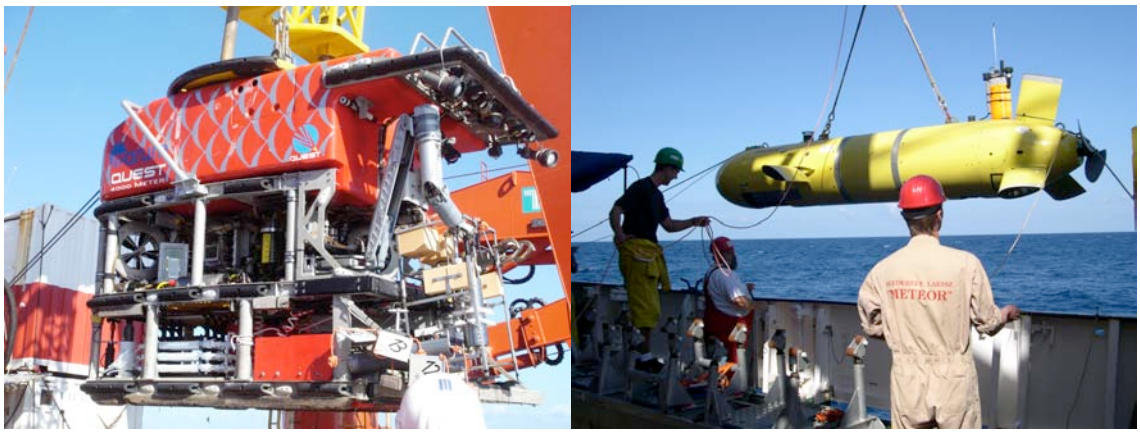

Fig. 3 Comparison of ship-based (EM120 multibeam of METEOR) and AUV-based multibeam data (AUV Asterx (IFREMER) equipped with Simrad multibeam (provided by Geosciences Azur).

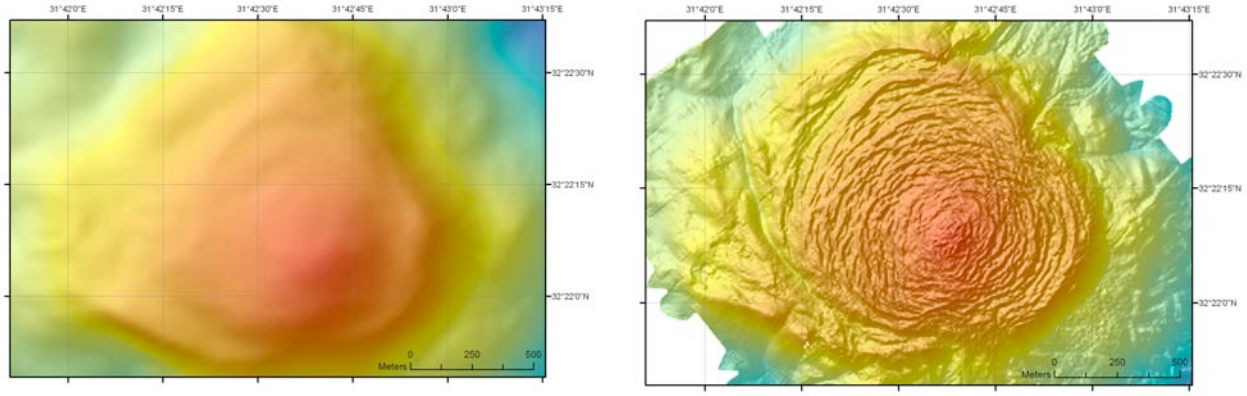

Fig. 4 Scientific crew of BIONIL leg a

Cruise narrative M70/2b

For the second leg of M70/2 we left Heraklion in the morning of the 7th November. First we had to steam south of Crete to Kalli Limenes to get fuel for the remaining legs of M70. In the early morning of the 8th November we steamed from Southern Crete back to the mud volcano Amon of the East Delta. We started station work in the morning of the 9th November with a series of TV guided multiple corers for biological and geochemical sampling. Then the lift was deployed and afterwards the ROV QUEST for dive 121, focused on in situ biogeochemical measurements at the southwestern rim of Amon where we had discovered a band of highly sulfidic sediments adjacent to the carbonate area on an old mud flow of Amon. The ROV had a small technical problem, so a gravity corer equipped with temperature probes was taken from the center of Amon before carrying out dive 121 starting the morning of the 10th November. During dive 121 we used the peeper, the benthic chamber and the profiler to investigate sulfide fluxes on the active rim of the Amon mud volcano. In the evening of the 10th November we continued with gravity coring including in situ temperature measurements, alternating with box coring. Unfortunately the box corer did not release, so no sediments were recovered, independent on the sediment characteristics. We obtained three more gravity cores with temperature measurements along a transect on Amon mud volcano from the active center to the rim. In the morning of the 11 November we deployed the lift once more, this time equipped with biological sampling tools and settlement trays. Afterwards dive 122 started, again in proximity of the sulfur band and the carbonate crusts of the outer rim at the Amon mud volcano. The dive ended in the early morning of the 12th November with the recovery of the ROV QUEST. The lift could not be recovered because the release system was defect. After the ROV recovery we used a sequence of geological sampling tools, namely box corer, multicorer and gravity corer to sample the Amon mud volcano in greater detail. In the evening of the 12th November dive 123 started with the task to release the shuttle and to sample carbonates and do further exploration of the Amon site, as well as measurements with the benthic chamber. The dive ended at noon of the 13th November after the lift was successfully retrieved. Again, we continued with geological sampling, including multi corer sampling, box coring and 2 gravity cores at Amon, before we steamed to the other mud volcano of the Eastern Delta, Isis. Here we took one gravity core equipped with temperature probes before midnight of the 13th November, before we started the exploratory dive on Isis (QUEST dive 124) in the early morning of the 14th November. The dive visited all three main elevations of the Isis mud volcano system. Traces of gas expansion and ebullition were found in the main center, which showed similar patterns as the Amon mud volcano. Outside of the central elevated zones, which showed highly disturbed sediments and patchy bacterial mats, similar areas of biogenic mounds were found. After the dive we sampled the Isis mud volcano along a transect crossing its three centers with 6 gravity cores. Interestingly, the highest temperature gradients were found associated with the centers, and only background temperature was measured between the centers, indicating distinct feeder systems for the three elevations. On the 15th November we carried out a multibeam transect across Isis and then steamed east to obtain gravity cores at positions outside of the mud volcanoes according to the palaeoscience program of Prof. Suzan Kholeif (NIOF Egypt). In the evening of the 15th November we returned to the Amon mud volcano for QUEST dive 125. The focus was on the gassy center of Amon. We used a

combination of tools including the temperature probe, the microprofiler and chamber to investigate the difference between gassy sediments with and without bacterial mat coverage. The dive lasted until the evening of the 16th November. We could then obtain 4 more gravity cores from the Amon mud volcano, to further investigate the relationship between the morphology of the mud volcano, the temperature fluxes and the porewater geochemistry. In between we deployed a wood parcel at the outer rim close to the carbonates, close to the other colonization experiments. In the morning of the 17th November we continued with a multibeam/parasound transect on the transfer to the central province of the Nile deep sea fan. We started with the deployment of the lift system in the afternoon of the 17th, before launching QUEST for dive 126. This dive had the objective to sample biological material associated with carbonate crusts within an actively seeping area. A set of colonization experiments was deployed for revisiting with expedition MEDECO. Furthermore, more benthic chamber measurements were carried out on bacterial mats between the vast carbonate crusts. The dive ended in the afternoon of the 18th November. The night from the 18th to the 19th November was used to complete a gravity core transect (6 cores) across the central province of the Nile deep sea fan. The shuttle was deployed in the morning of the 19th before QUEST dive 127. This dive was dedicated to biogeochemical measurements on an area of highly reduced sediments covered with a thin mat of sulfide oxidizers. The dive ended in the morning of the 20th November. Afterwards we finished the gravity core transect with 1 more corer, filled another gap in the multibeam/parasound mapping and deployed a wood colonization experiment close to the main sampling area of the central province. The QUEST dive 128 started with the deployment of the shuttle in the afternoon and lastet until the morning of the 21st November. During dive 128 we continued to carry out in situ measurements around the large mat and within the carbonates of the central province. Also we relocated the wood deployments. The ROV returned from its last BIONIL dive at 8:00 in the morning of the 22nd November. The last station on the 22nd November included the deployment of another set of sulfide-flux colonizers in the central province. We then steamed to the Western province for a multibeam/parasound survey of the Chefren mud volcano, as well as for an attempt to measure a deep temperature profile in the large brine lake of Chefren. The multibeam transect was finished in the night of the 21st to 22nd November. The last BIONIL station was the brine gravity core equipped with temperature loggers. The station ended around 4:30. We then steamed back to Heraklion where we arrived in the morning of the 23rd November.

Summary

The cruise M70/2a and b allowed for high resolution studies of several novel chemosynthetic communities associated with methane and sulfide seepage on the Nile Deep Sea Fan. On leg M702a and M70/2b we completed 31 and 66 stations, respectively. In total we carried out 6 AUV dives, 18 ROV dives, 9 shuttle deployments, 31 gravity corer, 8 Multiple corer deployments, 2 velocity profiles and 7 deployments of colonization experiments, as well as 56 multibeam/parasound transects with a length of 406 nm.

Fig. 5 In situ instrumentation to measure biogeochemical processes at the seafloor. Upper left: benthic chamber measuring oxygen consumption, Upper middle: in situ temperature probe; Right: Microsensor profiler measuring oxygen, pH, sulfide and T fluxes; Lower left: Benthic colonizer systems RAC and SMAC; Upper middle: Gel peeper for in situ porewater composition analyses

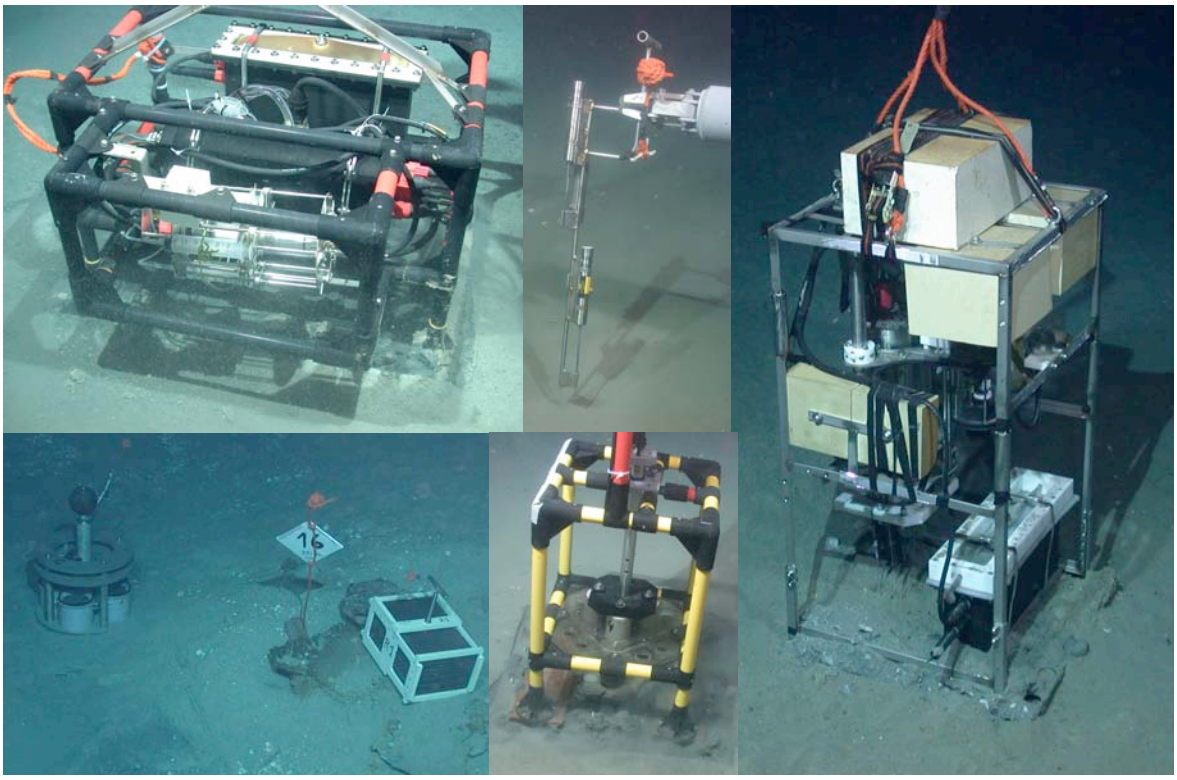

Fig. 6 Scientific crew of BIONIL leg b

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8.	Buhmann, Sitta	ROV	MARUM
9.	Viehweger, Marc	ROV	MPI-Bremen
10.	Seiter, Christian	ROV	MARUM
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15.	Buffet, Georges	AUV mapping	GeoAzur
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18.	Mascle, Jean Robert Pierre	Mapping	GeoAzur
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22.	Wenzhöfer, Frank	in-situ chambers	MPI-Bremen
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6. Mai, Hongh Anh	ROV	MARUM
7. Suck, Inken	ROV	Fielax
8. Buhmann, Sitta	ROV	MARUM
9. Viehweger, Marc	ROV	MPI-Bremen
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