SHORT CRUISE REPORT

METEOR cruise M70/3

Dates: November 26 – December 8, 2006

Port calls: Iraklion – Iraklion

Chief scientist: Prof. Gerhard Bohrmann

Institutions: RCOM: Research Center Ocean Margins, University Bremen, Germany
AWI: Alfred-Wegener-Institute for Polar and Marine Research, Germany
TPAO: Turkish Petroleum Company, Ankara Turkey
DEU: Dokuz Eylul University, Izmir, Turkey

Objectives:

The prime objective of the research in the investigation area "Anaximander Seamounts" south of Turkey was to decipher which key processes occur at the cold seeps. This was planned to be resolved by the interdisciplinary work conducted in the project "Gas and Fluid Seepage" in the frame of the Research Center Ocean Margins (RCOM). In order to achieve this goal the ROV QUEST was used as the main tool in order to map the seafloor and take samples on the spot. ROV served as platform for the deployment and recovery of autonomous tool measuring, e.g., the flow of bubbles at the seafloor.

There were investigations in the Anaximander area before the cruise that documented methane seeps at several mud volcanoes in about 2000 m water depth. Gas hydrates exist in the sediments of the mud volcanoes and there is strong evidence that at some of the structures methane escapes as gas from the seafloor. The main objective during leg M 70/3 was to sample the gas and determine how much methane is escaping from the seafloor as bubbles. Tools that were specially designed for the acoustic and optical detection of bubbles are presently under development at the RCOM. It is planned to deploy these as well as the entire suite of other sampling tools at the seeps south of Turkey. A main goal in this area was to quantify the amount of gas and gas hydrate in the sediments using the dynamic autoclave piston corer (DAPC). DAPC can retrieve sediment cores of up to two meter in a pressure-tight housing at in-situ pressure. Degassing of this core under controlled pressure conditions allowed quantifying the amount of gas and gas hydrate in the sediments.

The following scientific questions were addressed during the cruise:
- Which processes control the different types of cold seeps at the seafloor?
- Which conditions control the escape of fluids (liquid, gas) and mud and how does this shape the appearance of the seeps?
- What is the origin of the different mineral phases that precipitate at seeps and what controls their composition?
- How much methane is escaping as gas bubbles from the seafloor to the water column?
- What is the advective fluid flow and what is the source of the fluids?
- How much gas and gas hydrates exist in the sediments?
- Which organisms live at the seeps?

Cruise narrative:

The R/V METEOR sailed from Iraklion harbour, Crete at 10:00 am on Sunday, November 28 within the Mediterranean to the Anaximander Mountain area. The submarine Anaximander Mountains are located about 75 nautical miles south from Antalya at the Turkish coast. The area is situated at the intersection between the Cyprus Arc in the East and the Hellenic Arc in the West. Both arcs represent elements within the zone of African convergence in the South against Europe /Anatolian Plate in the North.

From the tectonic point of view the Anaximander Mountains represent rather a complicated structure dominated by sinistral strike-slip faults. Within the frame of this compressive tectonic style several mud vulcanoes have been developed, where not only mud but also fluids and gas emanation from the seafloor are found. Those active emissions from the seafloor are a global phenomenon and are interdisciplinarily analysed by the DFG Research Center of Ocean Margins (RCOM) in the frame of several projects. Here the main interests are gas emission sites, where mainly methane bubbles ascent from the seafloor into the water column. It is known from other sites, that those bubbles emanating from the seafloor within the gas hydrate stability zone are protected by thin gas hydrate skins from being dissolved in the seawater.Those emissions of bubbles on the seafloor within the gas stability zone are always associated to near-seafloor gas hydrate deposits. Up to now, gas hydrates in the Eastern Mediterranean are only known from the Anaximander area, which was explained by the absence of Messinian evaporites. We used the gas hydrate presence in the Anaximander area to postulate that gas emissions should exist. Up to know such gas emissions could not yet be proved despite of several expeditions. The documentation of gas emissions was the main subject of our expedition, whereas besides the ROV QUEST also a certain number of further seafloor instruments and analysing techniques were planed to be deployed.

The R/V METEOR could sail after a three days port call in the port of Iraklion when the scientific crew and the main part of the scientific tools had been changed. The ROV QUEST was already on board since end of September and was the main tool on our cruise. The scientists from Germany, France, Turkey and Macedonia embarked on Saturday November 25. The port time was used to unload the scientific equipment, to install the labs as well as to have first scientific meetings on board. After a one days transit to the Turkish working area we started with a detailed survey at the Amsterdam mud volcano on Monday November 27 followed by an overview survey covering three further mud volcanoes.

Our new survey showed much more detailed than earlier surveys the structure of the mud volcano which enabled us a better applications planning of the submarine ROV QUEST. During the first three dives on Tuesday, Wednesday and Thursday we collected data in the general spreading of the emission locations in the mud volcano. It was highly interesting and unusual that we could prove carbonate seeps inhabited by vestimentiferan tube worms along the outer wall. Vestimentiferan tube worms live in perfect symbiosis with endosymbiontic bacteria and are a safe indicator for active fluid emission. While one end of their tube is fixed in the sediment the other end grows into the water column. Besides the tube worms the cold seeps are also

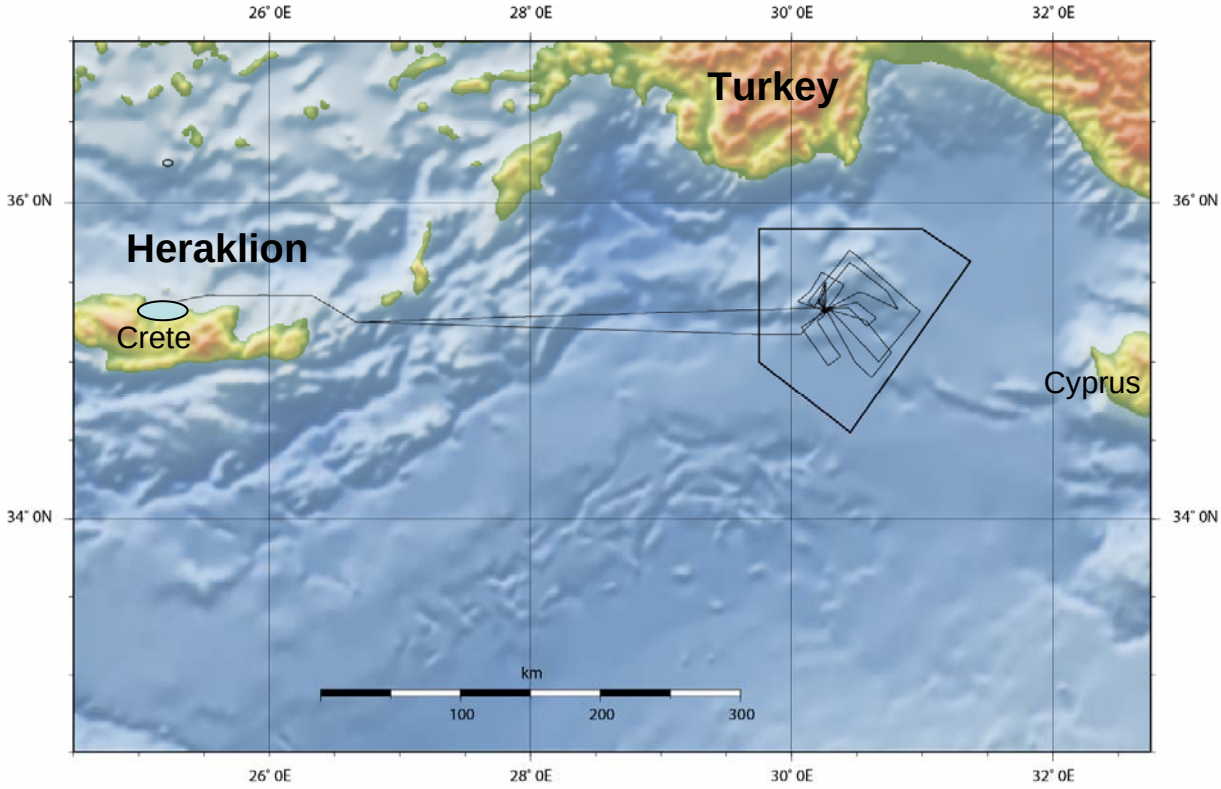
populated by chemoautotrophe bivalves - mytilid, thyrasid and licinid groups. During our ROV dives we found many dead shells of the chemosynthetic clams. At the eastern wall, where our French colleagues observed in the past more massive vestimentiferan tube worms, we only found single tube worms distributed in larger areas. Within the caldera of the Amsterdam mud volcano the detailed morphology of the seafloor varies. In the area of the “ring depression” plateau-like areas often alternate with depressions showing fresh edges of sediment fractures. In the centre of the mud volcano a morphologically chaotic seafloor was found, where we recovered several gas hydrate samples by gravity coring.

With the second dive we already could prove the postulated gas bubble emission at the seafloor. First of all the bubbles had been identified and localized as an acoustic anomaly in the water column, by means of the forward looking ROV-sonar. After moving the ROV to the anomaly, the ROV followed the bubbles down to the seafloor where the emission sites could be documented in detail with the new HDTV-camera. The bubbles continuously leaked out at several points from the seafloor appearing in rather different speed and leaving the seafloor. This image reminded us very much to soap bubbles. The emission locations were limited to a small area < 1 square meter and the seafloor was definitely dark coloured by hydrogen sulfide, darker than outside this area. In the gas seep we found very small worms (pogonophora), bivalves, snails and crabs. Besides the dives we mostly applied successfully the gravity corer and the autoclave piston corer. Furthermore a new seafloor vehicle named MOVE had been applied the first time in the deep water, with only some initial problems which could be settled thanks to the ROV QUEST.

During the second week of our cruise we already had to think to finish our station work by Thursday around 06:00 a.m. Therefore, we discussed the results which we obtained up to now on Sunday during an extensive meeting and defined the priorities for the next days. A very important point in our Sunday program was the dive down to the central part of Amsterdam mud volcano. During the first week two gas seeps had been investigated by ROV QUEST on the seafloor. The colonisation of these cold seeps by pogonophora as well as by small clams initiated our French colleagues to deploy two colonisators at the seeps until next year. The idea is that the seep organisms will accept the substrate of the colonisators and will settle there. The French research vessel “Pourquoi pas” is planning to recover the colonisators next year so that the living chemosynthetic organisms can be transported in a save way to the laboratory to do further experiments. Deployments of the heavy devices were successfully completed and the remaining dive time was used for exploration of some other gas seeps. A further gas seep which clearly provided large amounts of free gas was found. There we used for the first time a recently developed pressure-tight gas sampler. Gas bubbles were collected in an upside-down funnel. Under the high pressure in the water depth of 2000 m and with 14°C gas bubbles turned immediately to porous gas hydrate. Thus the gas hydrate was drawn into the pressure-tight container which enabled us to sample the original gas stored in the gas hydrate and later into the sample container. This was successfully done and the gas analyses revealed that beside methane ethane occurs in small amounts. The gas hydrates sampled from sediments show a clearly increased ethane content.

On Monday December 4 we applied the submarine vehicle MOVE a second time. During the device autonomously made its measurements on the seafloor we performed ROV dive number 7 on Athina mud volcano. Although it originally was

planned to have a long profile above both peaks of the mud volcano we could only perfom the first half of the planned dive. Large areas covered by authigenic carbonates and dense populations of vestimentiferan tube worms where revcovered which were unknown to occur in such densities in the Eastern Mediterranean up to now (Fig. 1). During the night the vehicle MOVE could safely be recovered and the analysis of the registered data showed that the system worked successfully for the first time in 2000 m water depth. Prior to the next dive during which the autonomous French camera system was deployed for the one year on the seafloor the autoclave piston corer was used to take a pressure core.
In the following night we applied special parasound measurements for registration of acoustic plumes in the water column. The last dive was performed on Thessaloniki mud volcano and after a core program the station work of METEOR cruise M7/3 was finished on Thursday December 7 at 06:00 am. Although this cruise was very short it was very successful with its 9 ROV-dives, 10 gravity cores, 2 multi-cores, 5 autoclave samples, 2 MOVE deployments and additional EM 120 and Parasound profiling.



Track lines of R/V Meteor during cruise M70/3 (March 15 – April 25, 2006;Iraklion - Iraklion)

Scientific work/station work during 11 days:

ROV dives	9 dives
MOVE deployments	2 stations
Gravity corer	10 stations
TV-multicorer	2 stations
Dynamic autoclave piston corer stations	5
Parasound and swath bathymetry mapping	