SHORT CRUISE REPORT

METEOR cruise M72/3

Dates: March 17 – April 23, 2007

Port calls: Istanbul – Trabzon - Istanbul

Chief scientist: Prof. Gerhard Bohrmann

Institutions:

RCOM: Research Center Ocean Margins, University Bremen, Germany
IFM-GEOMAR: Leibniz-Institut für Meereswissenschaften, Kiel, Germany
AWI: Alfred-Wegener-Institute for Polar and Marine Research, Germany
TSU, Faculty of Geography, Seismometrical Laboratory, Tbilissi State University, Tbilissi, Georgia
IBSS, A. O. Kovalevsky Institute of Biology of the Southern Seas, Ukrainian Academy of Sciences, Sevastopol, Ukraine
MSU, UNESCO Center for Marine Geosciences, Moscow State University, Moscow, Russia
TPAO, Turkiye Petrolleri A.O., Ankara, Turkey
IMST, Institute of Marine Sciences and Technology, Dokuz Eylül University, Izmir, Turkey

Objectives:

The expedition was the third leg of cruise 72 of RV METEOR. Due to logistic reasons this leg 3 was split in two sub-legs 3a and 3b with a port call in Trabzon between the two sub-legs. The investigations of leg 3 were part of the BMBF collaborative project METRO, which is funded within the subject area “Methane in the geo/-biosystem” as part of the special programme “Geotechnologies”. METRO is also embedded in the German-Russian agreement on “Co-operations on the realm of marine and polar research”. The distribution and the dynamics of methane and gas hydrates at active fluid emission sites as well as in areas without seepage have been investigated. Near-surface marine gas hydrates in particular are of relevance for climate studies, stabilities of sediments and biogeochemical processes. They were explored by various high-resolution geophysical, geochemical and geological methods. Research topics have been different geological structures characterised by active gas and oil seepage, near-surface gas hydrate deposits, and mud volcanoes in various areas of the eastern Black Sea in Ukraine, Turkey and Georgia.

Cruise narrative:

RV METEOR sailed from the pier in Ambarli / Istanbul, Turkey at 8 a.m local time on March 17, one day later than planned. Before leaving Istanbul, RV METEOR stayed 4 days in the port of Ambarli where scientists and scientific equipment were exchanged. Scientists from Germany (from IFM-GEOMAR, AWI and the University of Bremen), USA, Canada, Turkey, Ukraine and Russia embarked during March 14 and 15, and the time before the ship left port was used to install all the new equipment in the laboratories of the vessel. Unfortunately, two containers had been delayed for two days which postponed the start of the cruise for at least one day. On Saturday March 17, everything went very quickly. After we passed the Bosporus Strait, we had a two-day transit along the northern Turkish Coast to the easternmost area of the Black Sea. We started station and mapping work on Monday March 19 at the continental margin of Georgia. After collecting new multibeam bathymetry data during the night we started our first ROV dive on Monday March 20 at Colkheti seep in 1100 m water depth. Beforehand, many repairs on ROV QUEST had been carried out by the ROV team during the last couple of days.

The first ROV dive on Colkheti Seep was successful and two further dives were run the following two days at locations in the area of Batumi seeps in 850 m water depth. After finishing the diving program with ROV QUEST and the geological work at the Georgian continental margin of the first week, RV METEOR sailed north on a 28-hour-long transit to Ukrainian waters. We took advantage of the transit to overcome a period of bad weather. We reached our area in the Ukrainian waters on Friday March 23 and started with a survey south of Kerch Strait. Kerch Strait connects the Black Sea with the Sea of Azov between the Kerch (Ukraine) and Taman (Russian) peninsulas. Free methane forms methane hydrate in water depths greater than 750 m (i.e. within the gas hydrate stability field) or the gas is escaping to the water column in areas shallower than 750 m. Therefore many sites, where gas escapes from the seafloor like in the Batumi area, have been detected by the 18 kHz signal of the Parasound system.

The dive on Sunday March 25 was on Dvurechenskii mud volcano in the central Sorokin Trough. This program includes a long-term experiment with a mooring on the seafloor in order to measure temperature changes. The mooring was deployed on March 7, and during our re-visit three weeks later we recovered one of the temperature data loggers. The second data logger is planned to measure temperature changes of the mud volcano over 3-4 years, in order to understand long-term variations in the mud flow activities of the Dvurechenskii mud volcano. The temperature data measured during the last 3 weeks already revealed temperature changes of the mud volcano and let us forecast interesting results on temperature variations of the mud volcano for the future.

Besides the recovery of the date logger, push cores and temperature measurements with the T-stick were taken along profiles over the mud volcano. In order to establish a geological map we performed video documentation continuously and searched for gas emission sites, which have not been found. In addition to the ROV work the sediments of the mud volcano were sampled by the autoclave piston corer. This tool takes a sediment core of up to 2.5 m length and keeps the gas and gas hydrate inside the sediments under in-situ pressure conditions. The autoclave tools keep free gas and gas hydrates still in the chamber and a controlled degassing of the cores allows quantifying the amounts of gas and gas hydrate in the sediments. A gravity corer on the Vodyanitskii mud volcano, which is located close to Dvurechenskii mud volcano, recovered the first gas hydrate specimen, and we decided to perform a one-day dive program on this structure on Wednesday March 28. This dive was exciting in many aspects. Among others the first images from bubble release in 2000 m water depth of the Black Sea have been taken.

After one day of sailing from the Ukrainian Sorokin Trough to the Georgian continental margin offshore Batumi we reached the area of Batumi seeps. In particular the EM710 multibeam system, was used during the first week for detecting gas bubble emanations over the entire 2-km wide swath. By using this method 150-250 individual gas seeps which cluster at 10 locations were identified in an area of 1.2 x 0.9 km which is named the Batumi Seeps. For the purpose of using the same names for locations we used numbers for these clusters (# 1 to # 10). During the dives in the Batumi Seeps area all ten clusters were inspected and at each of the ten clusters several active bubble streams have been detected Temporal changes in seepage activity have been obvious.

Besides regional mapping of bubble streams using all systems from the ROV or the hull-mounted echosounder systems of the ship, quantification of the gas amount from single bubble streams was only possible by using the ROV QUEST. We therefore used various sizes of plastic bags with known volumes. The bag was put on the bubble stream with the aperture facing down, so that the upward moving gas is collected in the bag. The nineth dive of the ROV ended the diving program of sub-leg M73/3a with a total bottom time of 80 hours. This successful diving program included many highlights and gave us essential new insights into the fluid and gas circulation on the sea bed of the Black Sea. The last two days of leg 3a were dedicated at sampling sediment cores from specific site of interest.

At the end of sub-leg M72/3a RV METEOR came to the port of Trabzon (Turkey) on Tuesday April 3, 2007, at 8:00 a.m. local time. Eighteen scientists, technicians, engineers and ROV pilots disembarked in Trabzon, and four containers containing ROV QUEST and its equipment were unloaded. Among the equipment we took on board was a 12-m-long, 4-m-high and 22-tons heavy trailer which contains two completely installed labs for running medical computer-tomography (CT) scanners. The CT-scanner was used for imaging small-scale structures of gas-hydrate samples within the autoclave chambers. The work in the port of Trabzon could be finished by the end of the day and RV METEOR could start sailing with a new scientific party at the end of that same day.

On the following day, Thursday, 5 April, mapping of sediments and bathymetry by Parasound and the EM120 started along the Georgian continental margin, followed by a first multi-channel seismic survey over the Gudauta Ridge. Acoustic anomalies (flares) had been detected in the water column during the previous leg 3a when bathymetric profiling was carried out in this area. Further mapping revealed numerous flares on the summit and partly along the flanks of a ridge named Gudauta Ridge. Flare locations and the bathymetric map of the area were used to establish a plan for seismic profiling. Beside the seismic equipment the deep-towed sidescan sonar from Kiel (DTS-1) was used and showed seafloor anomalies at the flare locations. We also recovered a sediment core highly saturated with gas from 690 m water depth, which based on temperature and pressure is not deep enough to form gas hydrate. Since all flares that have been found occur above the stability conditions of gas hydrates, we left Gudauta Ridge area on Friday evening and started to record an overview multichannel seismic profile on the way to the Batumi seeps.

The gravity corer and both autoclave piston corers were used to sample gas hydrates at distinct locations of flares clusters mapped during leg 3b. Gravity coring during the afternoon on the Iberia Mound was successful. During the night high resolution sidescan sonar mapping using the 410 kHz and 75 kHz frequencies were carried out in the Batumi seep area. On Easter Monday we sampled a further seep area, which is known as Pechori Mound. Pechori Mound is a pronounced seafloor elevation with a diameter of about 3 km and stands approximately 50 m above the seafloor in 1100 m water depth. Gravity coring succesfully retrieved seep sediments from Pechori Mound in which dispersed gas hydrates have been present. In contrast to pure white hydrate the staining of oil leads to a more yellowish colour of the Pechori hydrates. Sediment sampling of areas rich in gas hydrates was performed daily during day time, while seismic and sidescan sonar work was conducted during the night. A detailed, high-resolution seismic survey with profiles only 25 m apart started on Eastern Sunday for 30 hours. These seismic data will be an important base for a future drilling campaign in the Batumi seep area using the portable mobile drilling device MeBo developed at Bremen University.

On Friday April 13 a last comprehensive sampling program along the Georgian continental margin was run at Pechori Mound, at Colkheti and Batumi Seeps during this cruise.The second part of the expedition was planned to investigate areas in Turkish and Georgian waters of the Black Sea. On Sunday afternoon we reached the Sorokin Trough area, where we first planned to combine a sidescan sonar survey together with a multichannel seismic measurement over Dvurechenskii mud volcano. Since there was an increase in wind speed up to Beaufort 6 within a short time of only 2 hours, we had to cancel the sidescan sonar deployment and had to run alone the seismic lines. In contrast to previous seismic profiles these seismic records document very interesting details of the inner structure of the mud volcano.

The following day, April 16 was again dedicated to an extensive sediment sampling program on top of two mud volcanoes. After this working program was successfully finished we moved to the eastern Sorokin Trough south of the Kerch Peninsula. To date there is no

information on the presence of gas hydrates in this area. A first survey using the hull-mounted sonar systems of RV METEOR and seismic profiling found evidence for gas expulsion. Gas flares were found in varying numbers and densities along the entire continental slope above 750-m water depth. A maximum of flare activity occurred in the western part. In order to tackle our gas hydrate questions we were mainly interested in finding flares along the deeper parts of the slope below 750-m water depth. In the night from Wednesday, April 18 to Thursday, April 19 a flare of more than 400-m height above the sea floor was found in 900-m water depth.

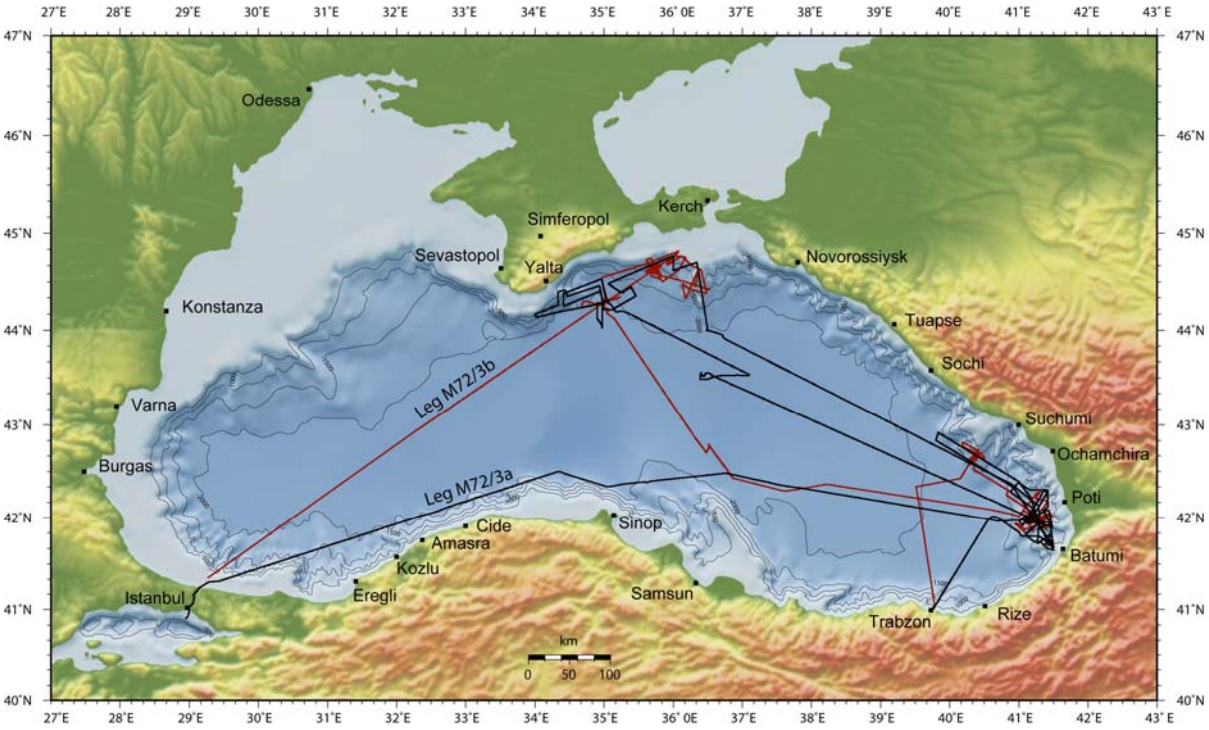
This location which we called Kerch Flare lies certainly within the gas hydrate stability field, so that methane hydrates can form in the sediments. A first attempt at sampling gas hydrates using the gravity corer was not successful, which can be explained by a non-homogenous distribution of gas hydrates at the seep site. On Friday, April 20 and the following Saturday we had a very busy program, because some scientific goals had not been reached yet, but needed to be reached before the return transit to Istanbul. Unfortunately gas hydrate sampling failed at the Kerch Flare site, and because of the short remaining time, we decided to sample hydrates on Vodyanitskii and Dvurechenskii (DMV) mud volcanoes.

There, we immediately have been successful. Besides gravity core sampling of gas hydrate specimen that will be analyzed later in the lab, both autoclave piston corers DAPC-I and DAPC-II were used. These coring systems keep the samples under in-situ pressure conditions and no gas is lost and no gas hydrates decompose on their way up through the water column. Besides DAPC-I which has been already successfully used in the past as well as during the current cruise, the DAPC-II is a new development which allows to sub-sample the 2,30m long sediment core into several segments while maintaining the pressure. The advantage sub-sampling the core is that the sub-samples allow quantifying the gas and gas hydrates for segments of the core. We were able to cut the core under pressure for the first time, which represents a valuable achievement of project METRO during the cruise. In addition the sub-samples could be analyzed under pressure within the CT-lab. The CT scanner which we loaded in the port of Trabzon was used intensively during the cruise. More than 10.000 scans of gas hydrate samples have been made.

Major goals for the CT-lab analyses were to review the internal fabric and the distribution of gas hydrates within natural marine sediments. In the past it was believed that gas hydrates are distributed more or less homogenously. In recent times there are more and more indications for different fabrics in hydrates, which are not yet well documented. RV METEOR cruise M72/3 obtained many new results in this field. Among others we could show vertical gas hydrate alignments over longer depth levels. These alignments probably formed by the rise of free gas vertical to the bedding planes. The gas hydrates filling the pathway of the gas ascent appear as long plates cutting through the sediments.

Furthermore in the night between Friday and Saturday we could use the sidescan sonar again, which had problems with one of its transducers after the first three deployments and was then in repair during the last couple of days. Thanks to the effort and experience of our sidescan sonar technician the instrument could be used again and we were able to map the DMV. Surprisingly, two flares have been detected by sidescan sonar on DMV in areas that showed no gas flares a day before on Parasound recordings. A new Parasound profile run after the sidescan sonar survey confirmed the presence of two active flares. The flare on the centre of DMV reached a height of 1100 m above the seafloor. The flares have not been active within the last 8 weeks, when RV METEOR visited the mud volcano several times, but and a major change in activity apparently happened just a day before. This new finding provoked many discussions among the cruise participants about the activity of the mud volcano in general, such as the intensity of mud flows, the frequency of gas expulsions, and many other questions.

Since we had to start our way back to Istanbul around midnight there was no more chance to extend our investigations of DMV. On Monday we left the Black Sea around 13:00 when we entered the Bosporus Strait under nice, sunny skies. We passed along the old city of Istanbul and entered the Sea of Marmara and the port of Ambarli



Track lines of R/V Meteor during cruise M72/3 (March 17 – April 23, 2007; Istanbul - Istanbul)

Scientific work/station work during M72/3:

ROV dives	9 dives
Gravity corer	29 stations
Multicorer	13 stations
Minicorer	21 stations
Dynamic autoclave piston corer	23 stations
Multichannel seismic profiling	156 profiles
Sidescan sonar mapping	4 profiles
Parasound and swath bathymetry mapping	