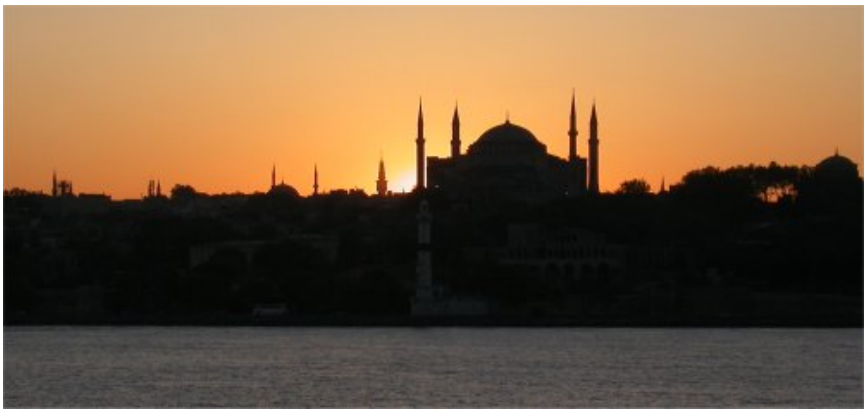
Meteor cruise M 72/5
First Weekly Report, period 14th – 21st May

On the 14th of May the German research vessel Meteor set out from Istanbul to the final cruise leg of Expedition M 72 in the Black Sea. Leg 5 is dedicated to investigations of microbiological, biogeochemical and paleo-climatological processes in the stratified water column and in the sediments. The scientific team is composed of 12 working groups from various institutions including the Max Planck Institute for Marine Microbiology in Bremen, Institute for Baltic Research in Rostock, University of Munich, BGR Hannover, RCOM Bremen, ICBM-Oldenburg, Geoforschungszentrum Potsdam, University of California, Riverside, Institute of Biology of the Southern Seas (IBSS), Sevastopol, GeoEcoMar Bucharest and TPAO, Ankara.

In the morning of the 14th, RV Meteor first headed a few miles into the Marmara Sea in order to calibrate the Multibeam echosounders that had been maintananced in the harbor. The test was successful and so we started our cruise by entering the Bosporus in the evening and passing Istanbul during sunset which presented to us a fabulous golden illuminated silhouette of the city. After the Bosporus passage we entered the Black Sea in the middle of the night and reached our first station in the next morning.

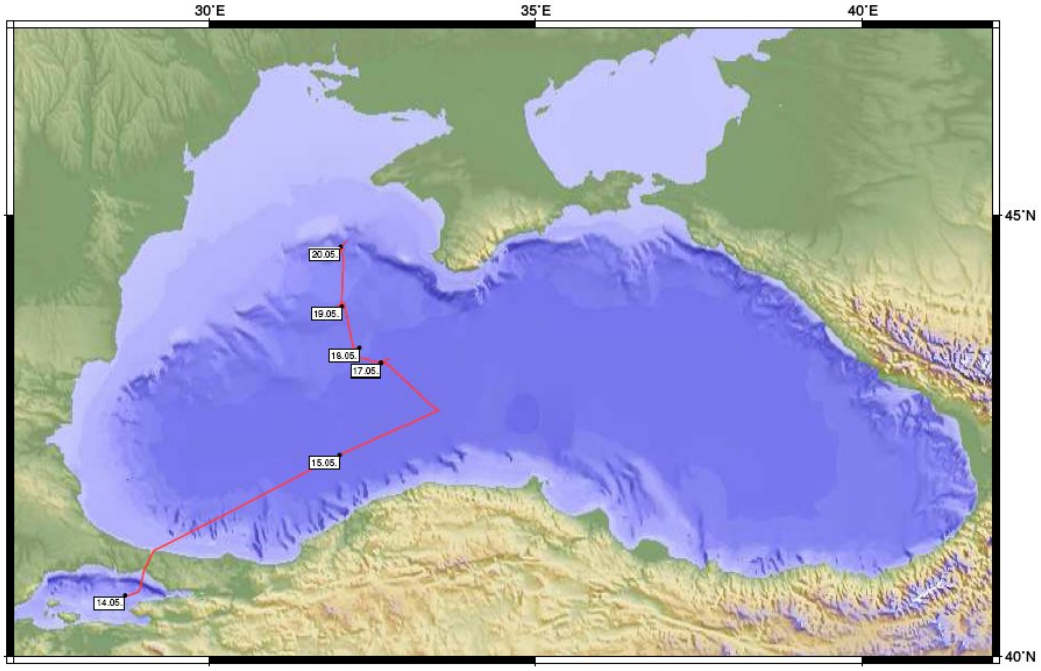


Istanbul in the sunset of 14. May 2007

A tight program of extensive water sampling, sediment coring and occasional Parasound profiling began, interrupted only by short transits between working areas. In the following three weeks, the cruise will lead us from southern central Black-Sea waters northwards into the Ukrainian sector west of Crimea, then to the eastern side of Crimea, and finally into Turkish waters between roughly 34° and 38°E.

One of the main objectives for the water-column work in this Meteor cruise is to investigate the effect of the Mediterranean waters entering the Black Sea by overflowing via the Bosporus strait. Due to the high salinity, these warm oxic Mediterranean waters sink into the anoxic layer of the water column where high concentrations of reduced compounds occur (e.g. sulphide, manganese, iron and ammonium). This intrusion into the generally well stratified water column of the Black Sea and thereby might stimulate microbial processes which usually do not occur in

the same layer elsewhere in the basin. As a result, a shift in the microbial community therefore is likely to occur.



M72/5 cruise track during week 1

The Bosporus overflow water is carried eastward with the circum-basin rim current. To track the effect of this water, we sampled the water column along a transect from east of the Bosporus strait into the central Black Sea. We use a pump-CTD system, with which we recover water in high resolution depth profiles from and around the oxic/anoxic interface which is also referred to as chemocline. Using the CTD sensors we precisely define layers from which we pump a continuous water flow that is analyzed on board in almost realtime with an autoanalzer and several electrochemical microsensors such as for oxygen and hydrogen sulfide. We started working on the central Black Sea portion of this transect between at 32°E and 34°E and obtained some promising preliminary results. As far as 33° E, we detected a clear second oxygen maximum that is probably related to the saline Mediterranean waters. However, towards the eastern edge of western basin at 33.5° E, this second oxygen maximum was less pronounced. Unexpectedly, oxygen and hydrogen sulphide showed overlapping profiles across the chemocline at 33°E, but not further

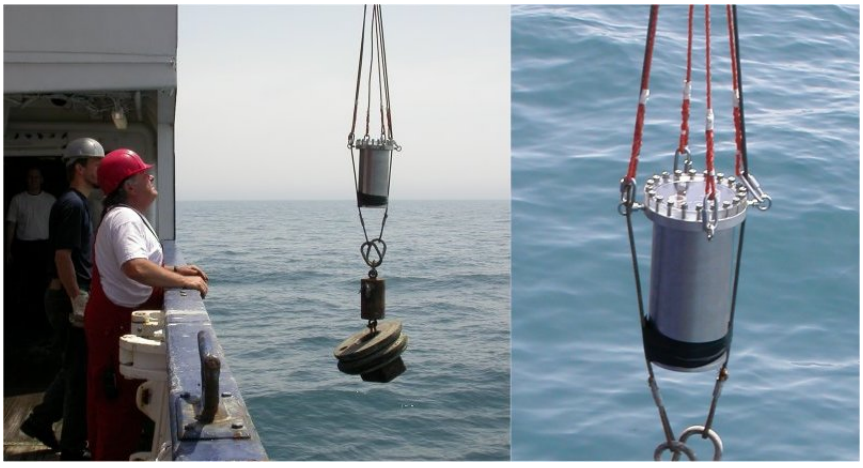
Deployment of the pump CTD. The cable is combined with a 300 m long hose through which the water is pumped on board.

west. We will complete this work by sampling the western part of this transect before we leave the Black Sea at the end of the cruise.

After this promising start, we moved to our second working area that stretches from the western central Black Sea basin up to the shelf in the paleo Dnepr area west of the Crimea Peninsula. Beginning in the central basin, we worked our way up the slope into the oxic zone by gravity and multi-coring, water sampling by CTDs and pump casts and by enriching microorganisms and particulate material from specific water depths around the chemocline with in situ pumps. Microbiological investigations in the water column revealed high morphological diversity below the chemocline.

The depth of the chemocline increases from the central Black Sea to its periphery, and we could observe along-going changes in the microbial activity. For example, one focus of the cruise lies on the investigation of photoautrophic bacteria that are known to persist in the chemocline. This population probably represents the most low-light-adapted phototrophic community worldwide. The in-situ light intensities in the chemocline environment are very low and the occurrence of anaerobic photoautotrophic bacteria is therefore limited to central Black Sea areas where the chemocline is shallow enough to obtain sufficient sunlight energy.

Measurements of the light quantum flux available to these microorganisms are thus far very scarce; only measurements at two stations in the western Black Sea measured at a single date in December 2001 are available. We now performed a series of measurements with an integrating type of quantum meter in order to obtain a better insight into the horizontal variations of the underwater light field of the oxic/anoxic transition zone. A LI-190SZ quantum sensor connected to a LI-1400 data logger was used which permits a highly sensitive detection of very low light intensities (detection limit (3.9 ± 2.3) 10^{-4} mol quanta m^{-2} s^{-1}). Using this setup, light could be detected down to a depth of 140 m, reaching well into the sulphidic zone. Pronounced horizontal changes of the underwater light field were found: near the center of the western basin, the light intensities reaching the anoxic water layers were found to be two orders of magnitude higher than the intensities determined towards the shelf areas.



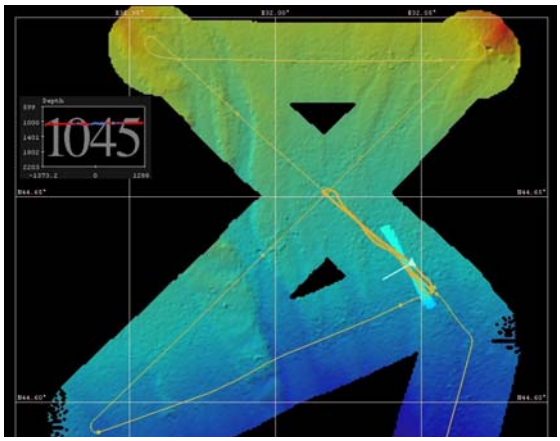
Deployment of the Luminometer.

Calm weather and air temperatures that are slowly but continuously rising since we entered the Black Sea support the success of our work. All sampling equipment and instruments are working fine and the progress of our program corresponds very well to our plans. The cooperation between ship's crew and scientists is excellent and we are all in a very good mood and are looking forward to two more weeks of successful work.

We are in good health and send our best wishes.
Christian Borowski and the M 72/5 shipboard party.
21. May 2007

Meteor cruise M 72/5
Second Weekly Report, period 22nd – 28th May

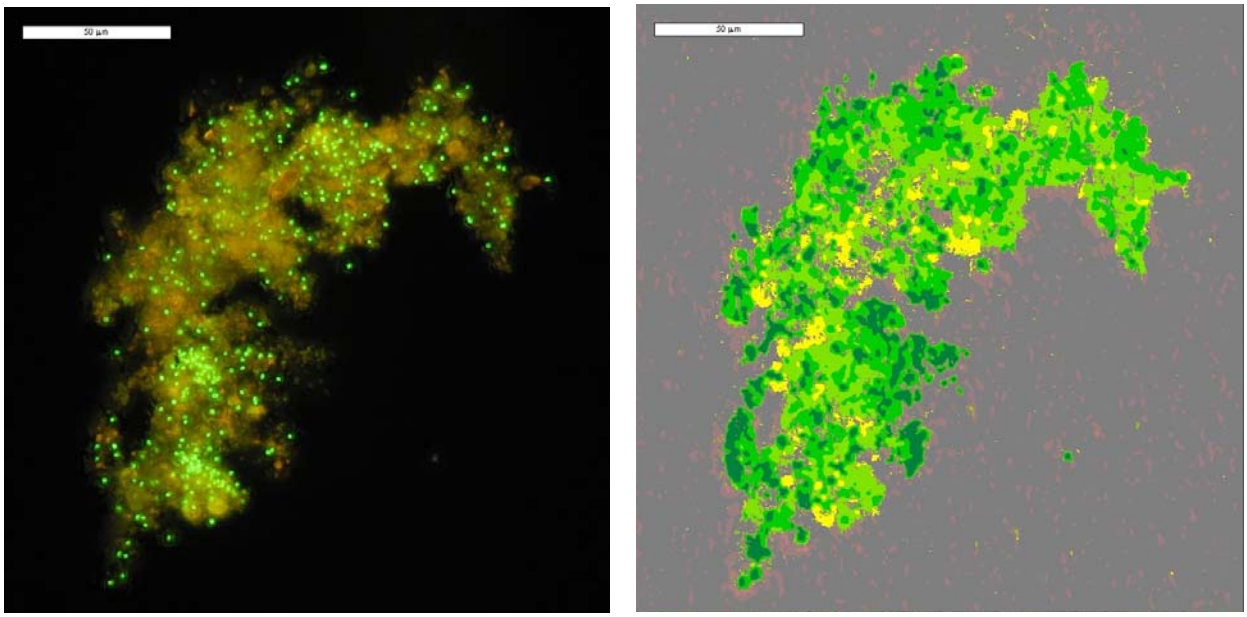
At the end of week one we had reached the upper slope of the paleo-Dnepr area where we continued with sampling sediments and the water column in the anoxic zone and around the chemocline. Here the chemocline meets the seabed in 160 m depth and we had the opportunity to sample sediments from adjacent anoxic and oxic areas. In the evening of the 22nd May we left this region and moved to our third working area on the eastern side of Crimea, where we followed the same strategy as before: We searched for coring locations by surveying the seabed with Parasound and swath bathymetry starting in the deep basin and going upslope into shallow shelf areas. Similar to the previous working area we found major proportions of the seabed furrowed by erosion channels and the Parasound survey suggested disturbed stratification over large areas, in particular in the deep basin and upper slope regions. This sometimes made it difficult to find suitable locations for sediment station work. We therefore decided to stay off the very central part of the basin and selected a number of coring locations along the depth gradient on the slope between 2000 and 70 m water depth.



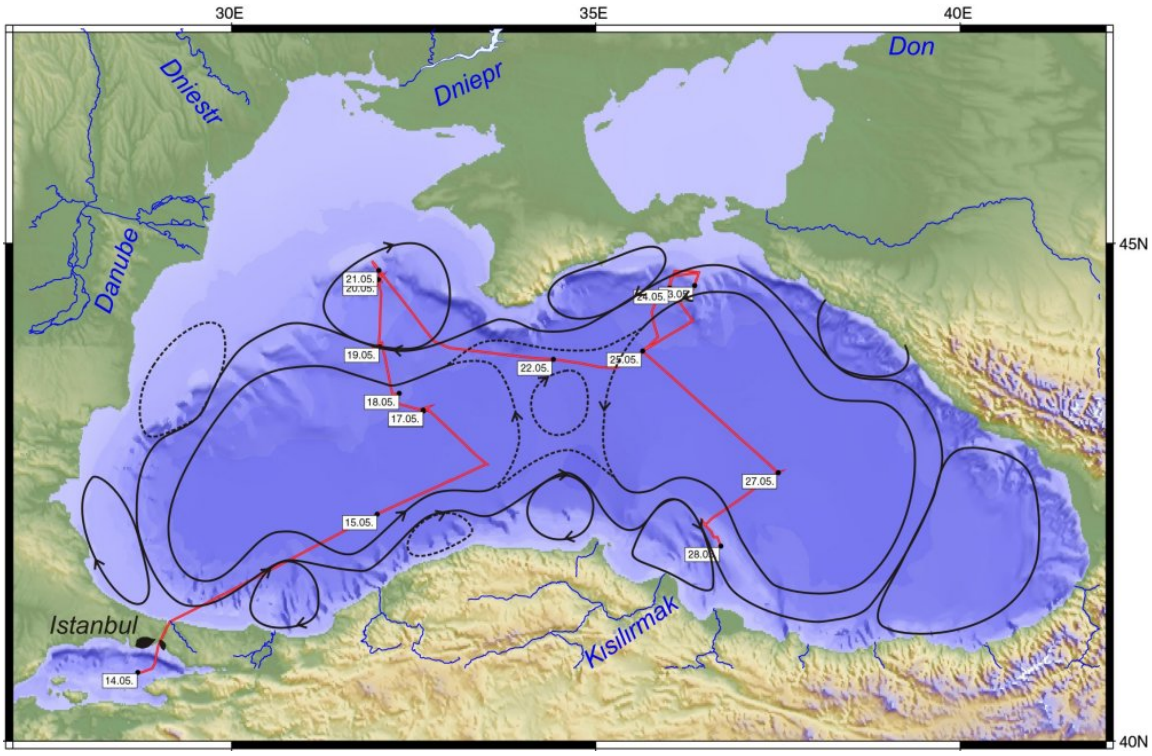
Snapshot of a bathymetric survey showing erosion channels in intermediate slope depths.

Three days of sediment coring and water column work followed. For the sediment work we use a 10-m long gravity corer and a Multi Corer (MUC). The two instruments complement each other very well because the gravity cores with average lengths of 7-8 m reach deep into lacustrine sediments but they usually lack the upper 20-30 cm of the very soft surface sediments, while the MUC recovers undisturbed sediment surfaces and serves excellently for sampling the fluffy top layer. Major objectives of the biogeochemical sediment investigations focus on the turnover processes of the Fe-S system and other metals and the various coupled biogeochemical processes. Other aspects concentrate e.g. on the fluxes of diluted porewater compounds such as hydrogen sulphide across the fluffy sediment-water interface.

Microorganisms are responsible for the biogeochemical processes in the oxygen-free parts of the water column and within the sediments. The microbiologists on board trace the occurrence of different microbial groups in the water column and sediments. Modern molecular biological and staining techniques are used to detect prokaryotes (Bacteria and Archaea). While in the water column there are already up to 1 million cells per cm^3 of water, their numbers even increase in the sediment. However, the distribution of cells is patchy, and they are not easy to separate from sediment particles. The pictures below show a sediment particle (from a sapropel layer) densely colonised by Bacteria or Archaea. The sample was stained with a specific dye for nucleic acids and photographed under UV light at different focus levels of the microscope. The bar length corresponds to 50 µm (about the thickness of a human hair). The cells appear as green dots. The second picture shows the three-dimensional structure of the particle indicated by a depth-colour scale.



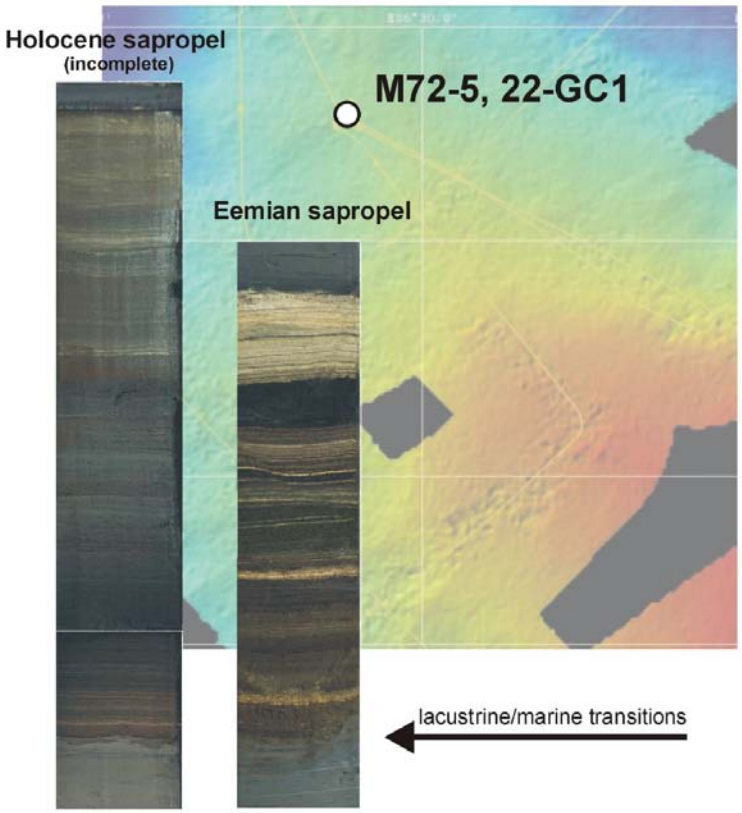
Sediment particle form a sapropel layer colonised by Bacteria or Archaea. On the right, a colour map representing the three-dimensional structure of the particle.



M72/5 cruise track until 28th May. The black loops indicate the major surface water circulation patterns.

We left working area 3 in the evening of 25th May and moved to a station in the central area of the eastern Black Sea circulation where we performed an extensive water column program including various CTD and pump-CTD casts, in situ pump casts and light measurements. This station represents an important counterpart to

the previous more peripheral stations because the chemocline is here relatively shallow (see weekly report 1) and also because the centres of the gyres are suggested to be unaffected by rim currents waters which transport the intrusions from the big rivers joining the Back Sea.



Holocene and Eemian marine sapropel units from sediment core 22-GC1. The back-ground shows a multibeam screen-shot of the investigated ridge structure.

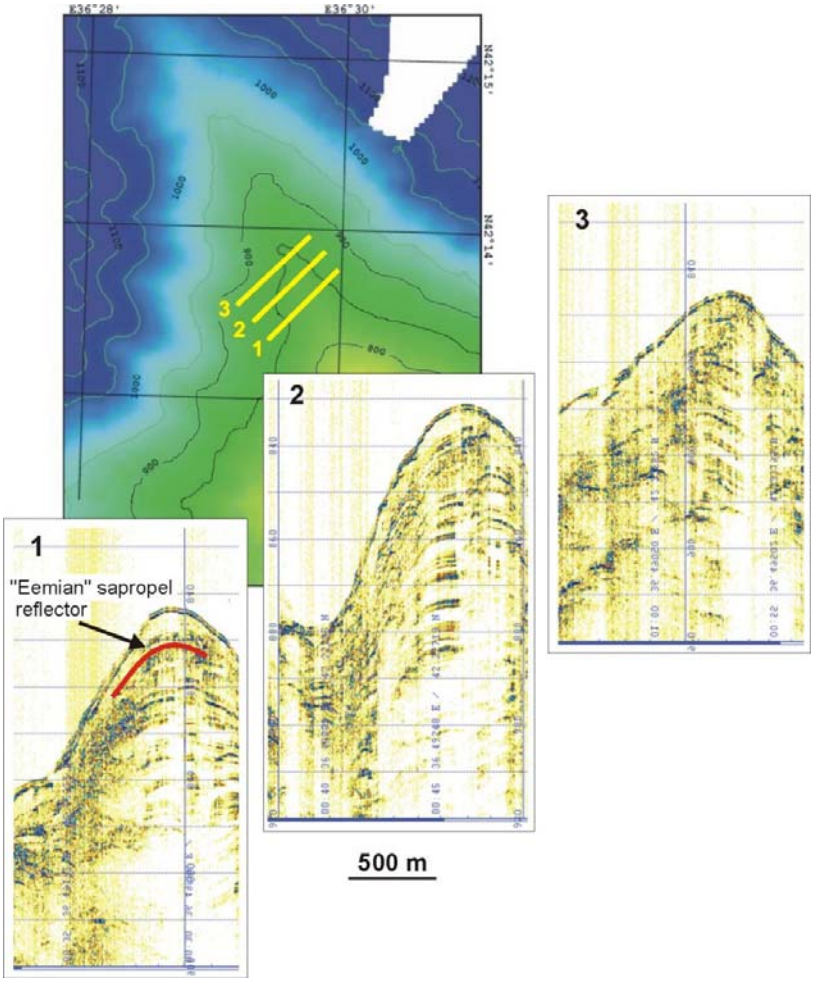
On the 27th May, after two days of water column work, RV Meteor headed toward the fourth working area in the southeastern Black Sea, where a depth transect of multi and gravity coring was planned along a tectonically formed ridge that extends far into the eastern Black Sea basin. During the night from the 27th to 28th, parts of the ridge were mapped by multibeam and Parasound echography in order to identify suitable coring locations. Next day, gravity cores were taken from around 850 m water depth. Surprisingly, the split sediment core provided a first view into a most probably complete section of the last glacial period. Coring efforts during the last years rather suggested an extensive glacial sediment cover on most of the Black Sea slope areas not reachable with conventional gravity and piston coring devices. To our all surprise, we could also identify at the base of the core the complete marine unit deposited during the last sea level highstand in Marine Isotope Stage 5. The intercalation of dark organic rich intervals and light layers of presumably coccolith ooze in this unit demonstrates that the last marine stage of the Black Sea must have had a more complex history than we know from the Holocene. Despite the fact that the exact dating of this sequence will be challenging, the „Eemian“ sapropel will provide the opportunity not only for a comparative study to the Holocene, but will also allow to understand how the marine Black Sea returned to a glacial freshwater lake.

The weather is continuously warm and calm, the forecasts are still promising and the mood is still excellent. We are therefore looking forward to another opportunity for coring the “2nd sapropel station” again in the next week.

We are all in good health and send our best wishes.
Christian Borowski and the M 72/5 shipboard party.
28. May 2007

Meteor cruise M 72/5
Third Weekly Report, period 29th May – 04th June

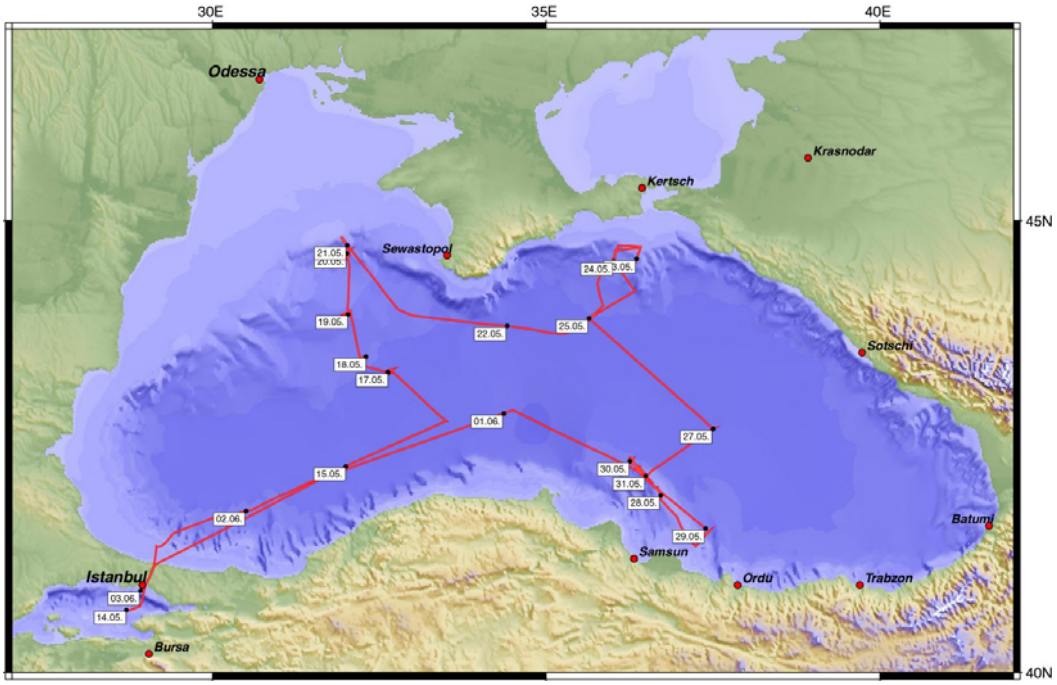
In the beginning of week three, we continued our regular program for working area four of leg M 72/5 in the south-eastern Black Sea. This meant more stations for water column work in the rim current and a number of sediment coring stations in various depths along a tectonically formed ridge extending from the shallow shelf into the deep eastern basin (see weekly report 2). After finishing this on Thursday 31st May, we returned to the 850 m station on the ridge where we took some 15 hours to specifically "hunt" for the "Eemian sapropel" that we had recovered in a gravity core on 28th May.



Bathymetry of the "Eemian sapropel location" and Parasound profiles across the ridge.

Initial Parasound profiles across the ridge showed a strong reflector in around 8 m depth below sea floor most probably indicating the target sapropel layer. The horizontal extension of this reflector was restricted to a small area on the top of the ridge, while it was absent on the slopes indicating that this layer may have slumped

away during earlier tectonic events. By using a 15 m long gravity core tube, we recovered two more cores containing the highly desired sapropel layer. In both cases, this layer was thinner than in the first core indicating that the newly recovered sapropel was incomplete. This matched the interpretation of the Parasound profiles. A third core located more towards the slope of the ridge in which the sapropel layer was only 5-cm thin confirmed this interpretation.



Complete track of M 72 cruise leg 5.

With this successful coring we finished our work on the ridge and headed into the central Black Sea for another water column station with CTD and pump-CTD casts. In the afternoon of 1st May, we ended our regular station work program and started our way back to Istanbul. During the transit, we stopped at five positions and completed the western part of the pump CTD cast transect which we had started in the beginning of the cruise (see weekly report 1). We passed the Bosporus at noon time of the 3rd June and waited in the Marmara Sea for harbor clearance in Ambarli port, were we finished our successful cruise in the next morning of the 4th June. Sample processing from the last transect continued to the last available second as the containers for return transport were simultaneously packed for shipping back to Bremen. We thank Captain Jakobi and the Meteor crew for their support which contributed significantly to our success.

We are all in good health and send our best wishes.
Christian Borowski and the M 72/5 shipboard party.
04. June 2007