IFM-GEOMAR KAU-FMS

Short summary of Project 1 activity during research cruise with RV Poseidon (P408-2b)

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After exchanging scientists at Jeddah Port on the 12th of February we finished most of our scientific work at Atlantis II Deep. For the following two days we sampled brine and sediment from Port Sudan Deep (19° N). One day was then spent on searching the site which showed shallow gas in the seismic recording. Two more days in the Atlantis II Deep finished the second part of research cruise P408-2 in the Red Sea.

Reflexion seismic/Multibeam data acquisition

Three main areas were successfully mapped by multibeam echosounder during P408-2a and 2b. High resolution bathymetry (~20 m resolution) was recorded within area 1 (Jeddah transect), area 2 (Atlantis II Deep), and area 3 (Port Sudan Deep). The compiled maps are shown in figure 1.

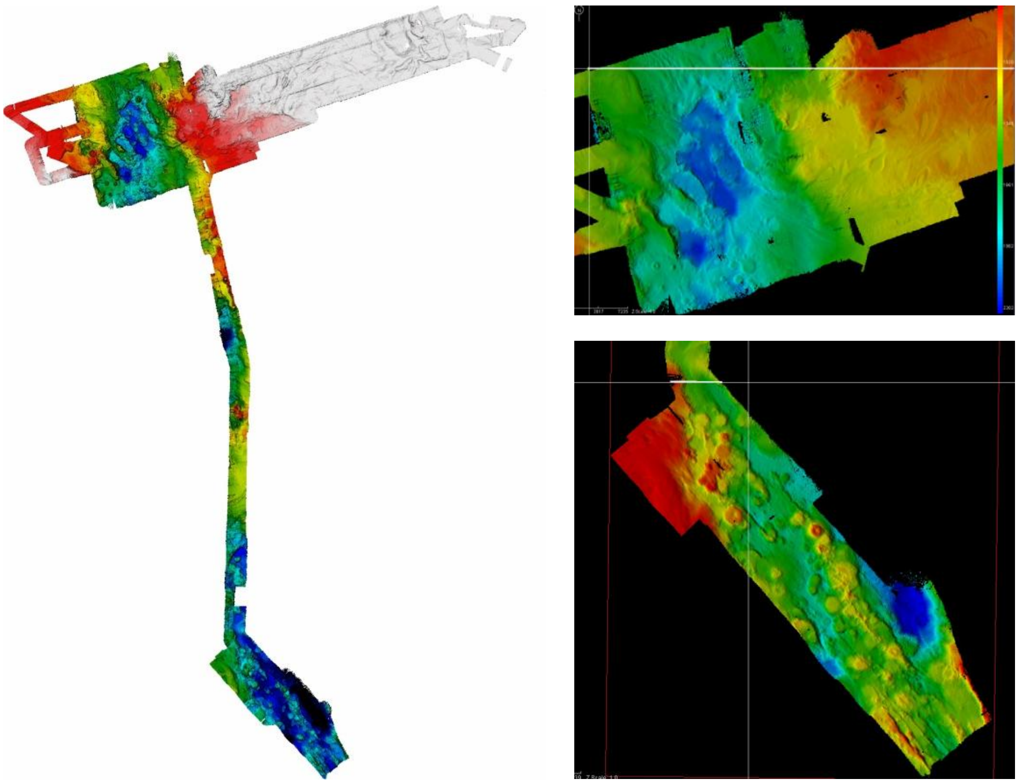

Fig. 1: High resolution bathymetric map of the Jeddah transect, Atlantis II Deep area, and Port Sudan area. Hydro-acoustic multibeam data was recorded during research cruise P408-2a/b.

Additional seismic profiles were recorded in the Atlantis II area and along the Jeddah transect by sparker seismic during night-time (Fig. 2). This technique is able to indicate the upper salt layer of Miocene evaporites and thus determines the post-Miocene sedimentary history (Fig. 3).

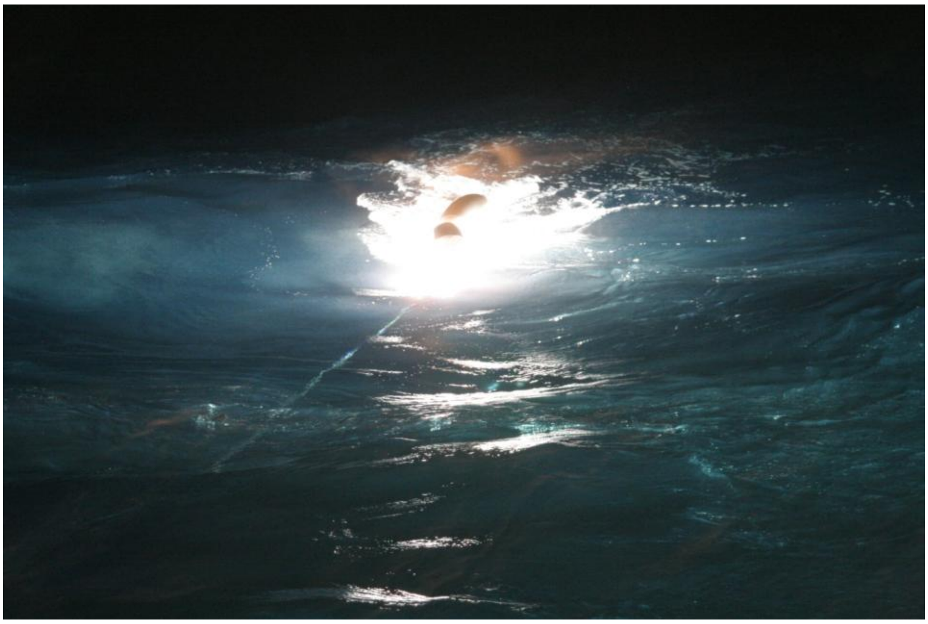

Fig. 2: Delta Sparker (Applied Acoustics) firing at 10 kJ.

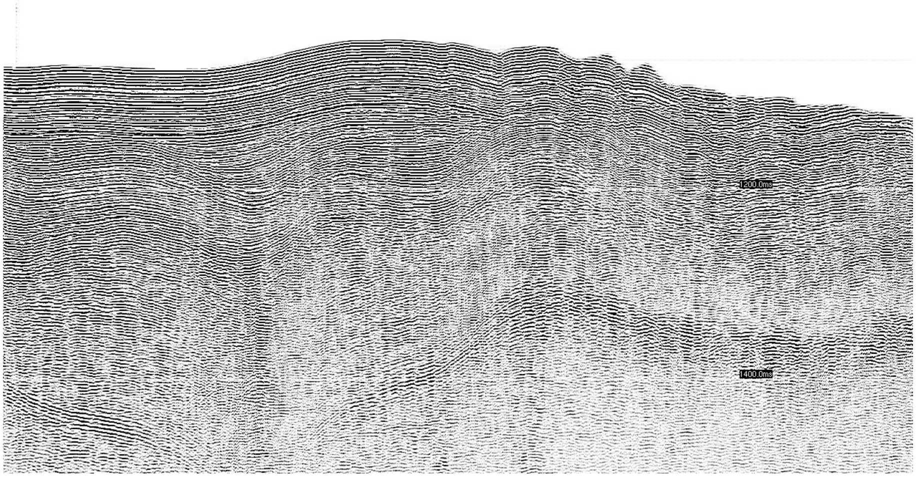

Fig. 3: Rough morphology recorded in the reflexion seismic data along the Jeddah transect. The deep layer probably indicates the upper subsurface salt layer.

Sediment sampling

Sediment cores were retrieved from the northern basin of Atlantis II Deep and from Port Sudan Deep by gravity coring (Fig. 4). The Atlantis II Deep sediment showed the same metalliferous mud as it was recovered from the southern basin of Atlantis II (Fig. 5). However, the sulfidic iron-phase was less abundant in the upper 4 m of the sediment core. The Port Sudan Deep showed a mixture of hemipelagic mud deposited in a brine environment with detrital sediment (probably slumps from the steep slope). Compared to the sediment from Shaban Deep (Red Sea), a paleostratigraphic story (2 sapropels, authigenic carbonates) could possibly be derived from the core (Fig. 6).

Fig. 4: A 4 m sediment core is cut into 1 m segments before splitting the segments.

Fig. 5: Metalliferous mud (oxidic facies) recovered from Atlantis II North.

Fig. 6: Hemipalgic mud, detrital sediment, and authigenic carbonates in Port Sudan Deep sediment.

Video-CTD/Water sampler rosette

The so called "gas site" which was indicated by seismic reflection data as a potential seepage site was monitored by the Video-CTD. We could only spend time for 2 Video-CTD tracks in this area. Nevertheless, we found a big recent fracture parallel to the central axis of the Red Sea (captured photography in fig. 7). This fracture is possibly the migration pathway for seeping gases. A bubbling site could not be found during the short tracks, however, this site is a potential target for further research.

Fig. 7: Recent fracture at the seafloor ("Gas site").

We also conducted a really exciting and challenging near-seafloor Video-CTD track in the Atlantis II Deep, starting at the western flank of Atlantis II Deep (1850 mWD) down to the brine covered deep at 2050 mWD. Although the slope did look gentle in the bathymetry, we had to make our way through an area dominated by ~10 m high cliffs, pillows, and several meters wide fractures (Fig. 8).

Fig. 8a, b: About 12 m steep cliff (a), and a small fracture at Atlantis II Deep.

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Micro-structure CTD

The microstructure profiling program on P408-2 yielded spectacular results. The program exceeded our expectations in terms of both scientific insight as well as the shear volume of data that were collected during day and night-time (Fig. 9, 10). Despite delays due to rough sea conditions, we collected 33 microstructure profiles (e.g. Fig. 11). This amounts to over ~66 km of data with a 1-mm resolution!

Fig. 9: Deployment at night-time.

Fig. 10: Recovery at day-time.

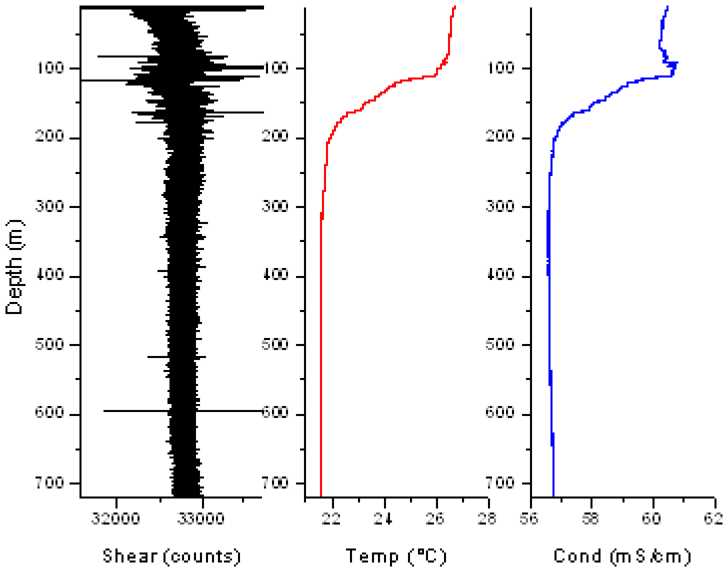

Fig. 11: Microstructure data of Red Sea surface and Red Sea deep water.

The program focused on two components – profiling in the upper water column, and resolving the temperature fine-structure within the interface. The former profiles were performed with the free-falling probe descending at 60 cm/s to enable us to resolve the shear (a measure of the kinetic/mixing energy). This will allow us to determine mixing coefficients and subsequently resolve the flux profiles of methane, CO_2 and oxygen. For the latter profiles, it was necessary to increase the probe decent rate to around 1 – 1.3 m/s so that the microstructure probe could penetrate the extremely dense brine layers. As far as we know, this is the first time such measurements were performed in these types of brines. The extreme pressure, temperatures (up to ~68°C) and salinity took their toll on the instrumentation and sometimes caused minor setbacks - 4 destroyed shear sensors, compromised buoyancy controls (due to extreme heat), spooled/broken cable, and winch malfunctions. Nevertheless, with the kind help and support of the captain and crew of P408-2, we overcame these obstacles and obtained, we believe, a very unique and high quality data set.

Microbiology

This study will be focusing on different goals like using new techniques and a variety of medium compositions to classify culturable and unculturable bacteria in brine and surface sediment (Fig. 12). This information will be compared with geochemical data which then could give valuably information if these bacteria could act as a biological indicator of hydrocarbons. On the other hand, such (brine derived) bacteria could be important to be used as antimicrobial producing sources against human, animal and plant diseases, if it is studied by using novel cultivation methods.

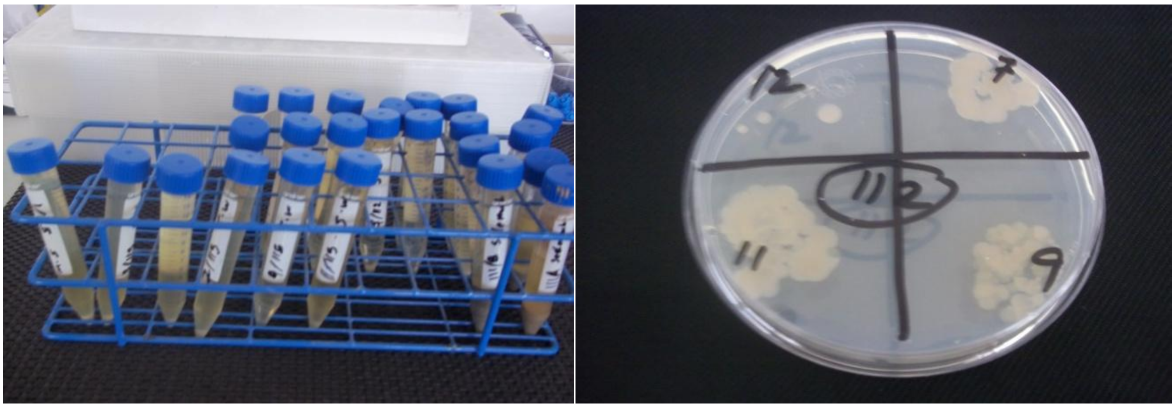

Fig. 12: Different cultivation methods for bacteria in brine and surface sediments.

Summary

Looking back to both legs P408-2a and 2b, we are grateful for the chance to work in such a unique area like the central Red Sea graben and in particular the Atlantis II Deep area. Within the next few month data evaluation and laboratory analyses will keep us busy and hopefully we come out with some spectacular results soon.