KAU-FMS

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

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The cruise started in Jeddah Islamic Port with 3 days delay due to logistic problems. The sampling program started at Sunday night ~10nm offshore Jeddah (6.2.2011). This first leg (2a) will end in Jeddah again with an exchange of four scientists on the 12th of February.

Reflexion seismic/Multibeam data acquisition

Multibeam (L3-Elac) and seismic (Applied Acoustics) data was recorded along 3 profiles within the Jeddah Transect area (orientation of profiles is perpendicular to the main Red Sea graben axis, Fig. 1).

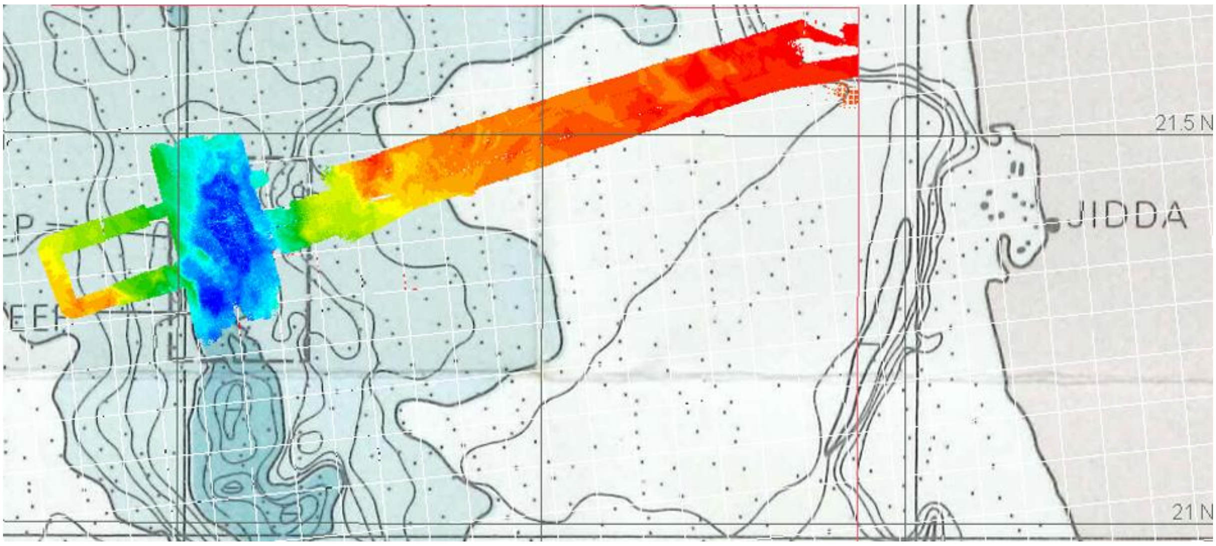

Fig. 1: Hydro-acoustic multibeam profiles along the Jeddah Transect obtained during cruise P408-2a.

The stratification of brine-seawater interfaces (LCL-UCL2) could be monitored in the seismic reflection data (Fig.2). Moreover, the upper layer salt layer could be indicated in the raw seismic data. Preliminary interpretation of reflection seismic data indicates also gas/fluid migration pathways from deeper sediment strata to the seafloor and bright spots near the seafloor (Fig. 3). Gas seepage has to be proven by water column imaging at a selected site (~700 m water depth).

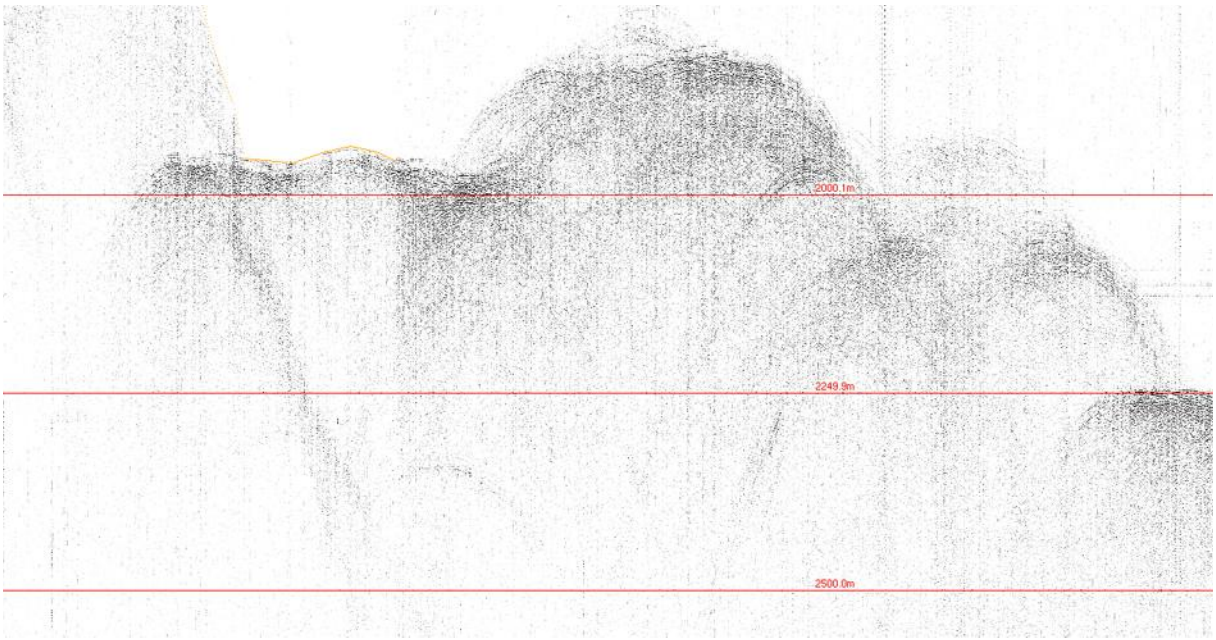

Fig. 2: Seismic reflection profile showing brine-seawater interfaces in Atlantis II Deep (right part) and probably a fluid migration pathway (left part).

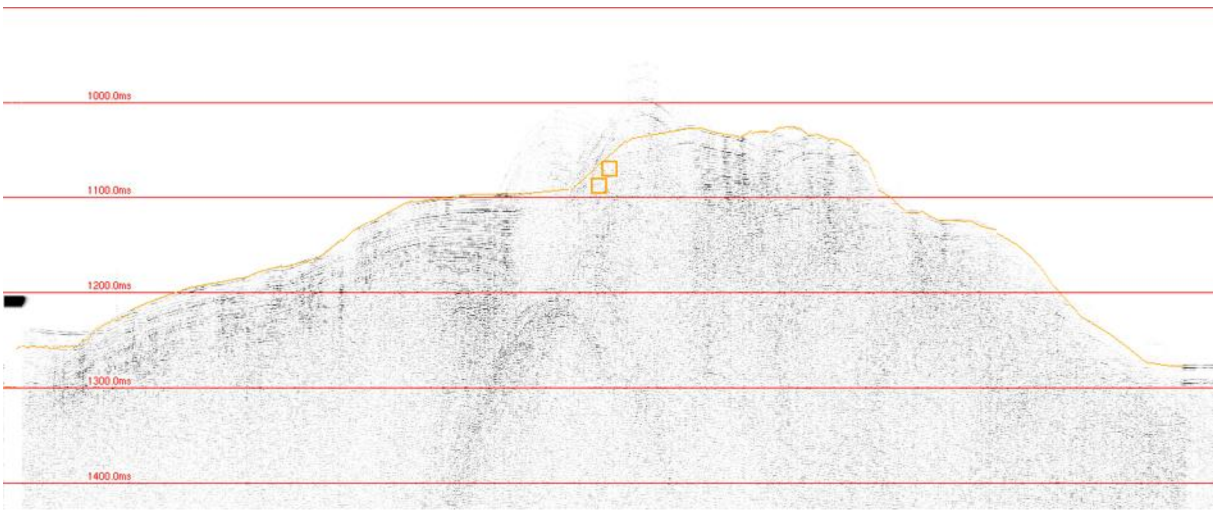

Fig. 3: Shallow gas indicated by bright spots in seismic reflection data of the Jeddah Transect.

Multibeam imaging of the seafloor was done by L3-Elac multibeam. The rough morphology of the Atlantis II Deep area and adjacent areas could be resolved and the seafloor below the brine could be determined by the Multibeam system. The bathymetric data combined with seismic data can provide the basis for geotectonic/sediment stratigraphic studies (including submarine salt flow studies).

Sediment sampling

Gravity cores (Fig. 4) were successfully recovered from areas dominated by hydrothermal mineral deposits (Atlantis II Deep SW-basin), and from more shallow areas near the coast of Saudi Arabia, respectively. Coring strategy was based on results of reflexion seismic data. Sediment and porewater was sampled onboard from the split cores (Figs. 5, 6 and 7). First results from porewater data (pH~5.5, S~270) indicate homogenous porewater composition within the uppermost 4 m of hydrothermal sediment in Atlantis II Deep.
Carbonate crusts were sampled from the core taken nearest to the shoreline (~700 mWD).

Fig. 5: Deployment of the 6 m long gravity corer (top). Fig. 7: Split cores from the Atlantis II Deep.

Fig. 6: Cutting of the core liner.

Video-CTD/Water sampler rosette

A newly designed Video-CTD (Sea & Sun Technology, Figs. 8 and 9) was deployed in the Atlantis II Deep (SW and N-sub basins). The online video showed spectacular videos during penetration of the various brine-seawater interfaces (UCL4 to LCL) in the brine-filled depression. It also gave us the opportunity to visually navigate the CTD/Niskin rosette 2 m above the seafloor to specific sampling sites (Fig. 10).

Fig. 8: Deployment of the Video-CTD with various sensors integrated in the water sampler rosette.

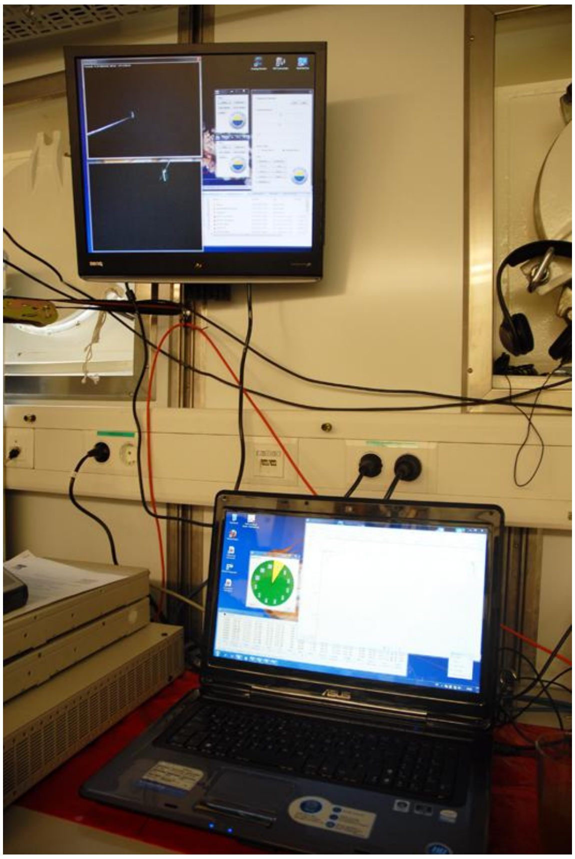

Fig. 9: Deck unit with on-line CTD data, water sampler control and video display of the two cameras.

Fig. 10: Navigation of the Video CTD close to the seafloor.

Concerning the expected flocculate bottom layer in Atlantis II Deep: the SW-basin shows more consolidated surface sediment than the N-basin. The maximum T-recording in the brine, measured with a calibrated high-temperature probe, was 68.2°C, which is slightly higher than the recording in 1997 (SO121 cruise). The attached Hydro-C/CH4 and /CO2 sensors (Contros) recorded a remarkably strong increase in gas concentrations in the transition zone above the brine. This gives us highly resolved concentration profiles of gases for density calculations and flux determinations.

Micro-structure CTD

The microstructure CTD (Sea and Sun Technology) was deployed in Atlantis II Deep to resolve the fine structure of the double-diffusive temperature structure (Fig. 11). The probe normally free-falls at 0.6 m/s and achieves this by balancing the buoyancy of the probe with the density of the sea-water (Fig. 12).

Fig. 11: Deployment of the MSS CTD at the aft of the vessel.

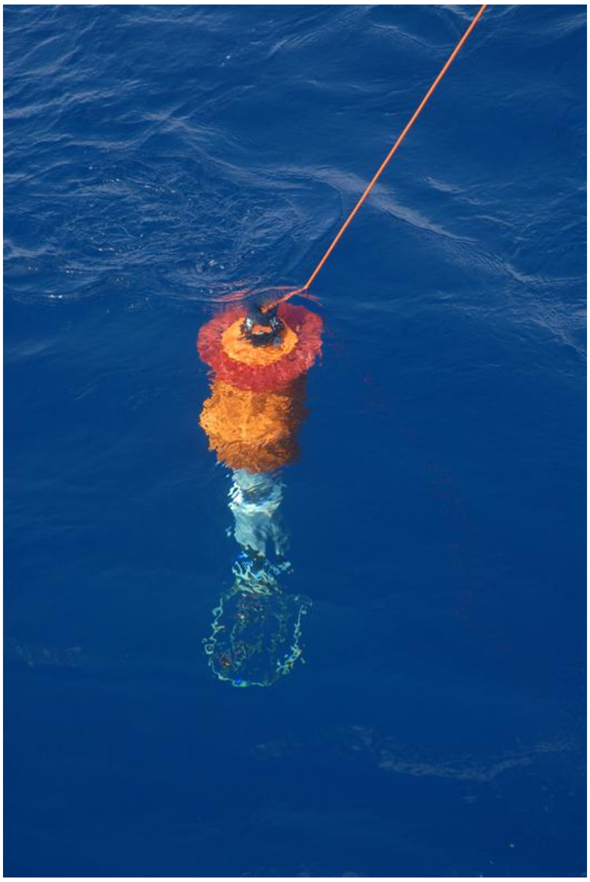

Fig. 12: MSS-CTD floating at the surface ready for the free-falling profiling cast.

To overcome the challenges of the extremely high density in the brine pools, additional weight was added to allow the probe to penetrate to the bottom zone (Fig. 13). This resulted in a probe decent rate of about 1.5 – 2 m/s.

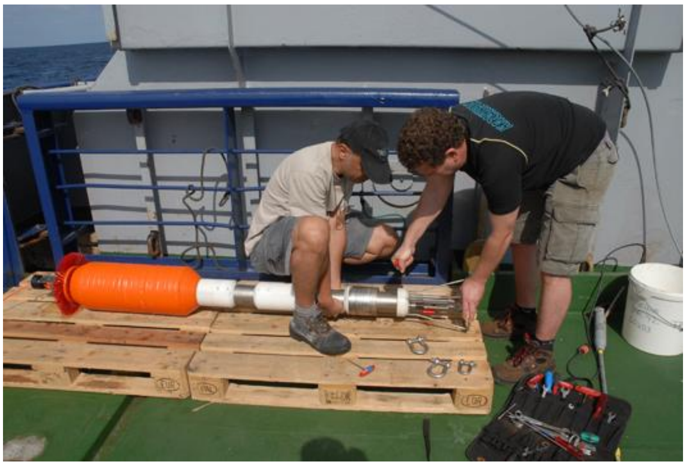

Fig. 13: Preparation of the MSS-CTD by addition of weight for the deployment in the Atlantis II Deep.

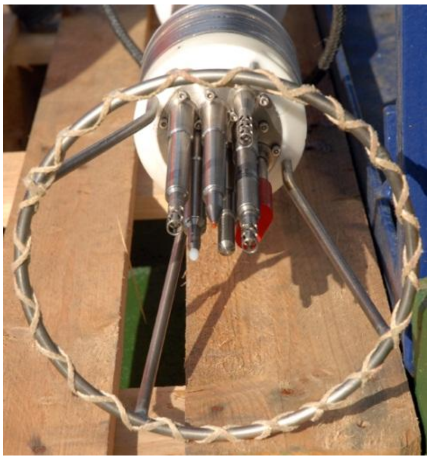

Fig. 14: Close-up view at the MSS sensors.

We were able to successfully profile to the bottom of the Atlantis II Deep (both North and South basins) with this configuration. The state-of-the-art MSS resolves data at 1024 samples per second with a temperature response time of 7 milliseconds. With the combination of the free-falling profiling strategy, together with the fast-responding and accurate sensors (Fig. 14) we were able for the first time to measure the true temperature structure of the Atlantis II deep brines. The data revealed an astounding structure of step-like temperature stratification. The major step-structures are defined by zones of uniform temperatures 10s of meters thick separated by extremely sharp temperature gradients (<1 m thick). We further discovered dozens of “baby” steps that range in the 10’s of centimeters thick. To date, no one was previously aware that these small steps existed.

Summary

Despite the reduction of working days, we already fulfilled several of our scientific goals from Project 1 proposal, and we already got exiting new insights into brine-seawater exchange processes by our recent data sets. The observed fluid/gas release site along the Jeddah Transect provides promising opportunities of sampling hydrocarbon-rich fluids and associated diagenetic products (authigenic carbonates?) from the seafloor during P408-2b leg. Furthermore, to extend our geochemical data set of Red Sea brine between 19° and 26°N we intend to visit the brine-filled Port Sudan Deep within Leg 2b.