

Research Vessel SONNE

SO266:

Kaohsiung – Kaohsiung

Second weekly report: 22. – 27.10.2018



The second week at sea turned out to be very exciting as we started on Sunday evening with a MeBo drilling on the Formosa Ridge in our western working area on the Chinese continental margin, which is part of the Eurasian Plate. To the east of it lies the Taiwanese continental margin, which has a completely different geological structure as it is a convergence zone of the lithospheric plates. In this area southwest of Taiwan, we have the opportunity to conduct comparative investigations of the methane hydrate distribution at these different continental margins. We would like to understand by way of example the different tectonic influences on the gas hydrate distribution and dynamics. Geophysical surveys have been carried out in this area for many years, but up until now drilling for methane hydrates in the sediments has been lacking. Although drilling data are very important to calibrate the geophysical measurements.

The MeBo200 drill hole (Fig. 1 & 2) on Formosa Ridge was the first one we have drilled. Formosa Ridge is an elongated, submarine ridge about 40 km long and 7 km wide. It runs perpendicular to the continental slope and is bounded on both sides by deep canyons. With slope angles of more than 10 and up to over 30 degrees, it was difficult to find a stable landing site for MeBo that was interesting in terms of the geological structures that we had selected from the GEOMAR 3D seismic data. For MeBo we need a seabed dip of less than 5 degrees slope. In order to find such a place in 1,300 m water depth, we used an AUV-based micro-bathymetric survey from which we have converted the depth to a fairly accurate slope map. This allowed us to identify a flat plateau of 100 m in diameter on the narrow crest of Formosa Ridge. This turned out to be very suitable and after a safe landing on the seabed, MeBo could start drilling.



Figure 1: Research vessel SONNE with its large working deck is the ideal platform to deploy the MeBo200, which arrived from Bremen with seven blue / white containers now placed on the SONNE (© Christian Berndt).



Figure 2: After all the functions of the MeBo200 and its winch have been tested, the drilling rig on its launching system is driven aft over the edge of the ship before being rotated 90 ° to the seabed (© Gerhard Bohrmann).

With 33 core barrels, the sediment sequence was drilled down to a sediment depth of 109.91 m below the seafloor. The recovered sediments consist mainly of very fine-grained hemipelagic muds with low methane hydrate saturations in about 20-30 m sediment depths and higher methane hydrate concentrations at 98 m depth and below. The methane hydrates, which were very likely disseminated in the sediment, had decomposed on the way through the water column and onto the deck of the research vessel. But some data, such as the chloride content in the pore water, proved that we had penetrated methane hydrates. Based on

the chloride anomalies, we can also quantify the saturations of methane hydrate very well. At a sediment depth of 86 m, we penetrated a very prominent seismic reflector, which is caused by a carbonate cementation zone. In addition to abundant limestone shells numerous diagenetically-formed calcareous nodules were found. We suspect that this cementation zone constitutes a seal for ascending methane, which solidified below with the pore water to methane hydrate. Two borehole logging probes produced particularly valuable extra data during the removal of the drill string. Both the measured acoustic velocities and the values of the natural gamma radiation in the borehole are perfectly correlating with the drilled lithologies, so that a correlation of the drilling data to the 3D seismic data is possible.



Figure 3: After using MeBo200, the core barrels are removed from the magazines on deck and piled up for the scientists. First, a sediment sample is taken to determine the gases before the sediment-filled liners are pulled out of the core barrels (© Paul Wintersteller).



Figure 4: Due to the pressure relief of the sediment cores in the MeBo during ascent in the water column and in the laboratory as well as by gas hydrate decomposition, gas bubbles expand to create voids in the sediment cores. Voids have been taken into account by the scientists when working on the cores (© Paul Wintersteller).

The seabed drill was able to complete a second deep hole on "Four Way Closure Ridge" after just 14 hours on Thursday, 25 October. In contrast to the Formosa Ridge, the Four-Way-Closure-Ridge is an accretionary ridge, which was lifted up on the upper plate due to subduction. The compressional stress at this active margin generates different pathways for vertical methane ascent, which should also be expressed in the methane hydrate distribution. During mapping we found significantly more sea floor gas emissions in the form of acoustic water column anomalies than on and around Formosa Ridge. Drilling on Four-Way-Closure-Ridge sampled a sediment sequence of 126.35 m. After recovery of MeBo on board the ship the scientists had to deal with 32 core barrels of 3.50 m in length (Fig. 3). A detailed work plan for the scientists ensured a systematic and fast processing of the core liners. After gas sampling of the core catcher, the liners filled with sediment were scanned for temperature anomalies with an IR-camera and were then divided into individual sections and labeled. Since this Sunday morning, the sections were split into 2 halves lengthwise, described for details in sedimentology, photographed and sampled.

In the coming days, we will have to adapt our station work to the movements of the approaching typhoon YUTU from the east. With a western trail, the typhoon will cross the island Luzon of the Philippines and reach the South China Sea on Monday, where it is forecast to abate. A stable high pressure system above central China leads to a northeasterly winds causing a lee off Taiwan, where a significantly lower wave heights than in the rest of the South China Sea may be expected.

All participants are healthy and are happy to enjoy the good meals of our cooks. Greetings in the name of all cruise participants,

Gerhard Bohrmann

FS SONNE, Sunday, October 28, 2018