SO268/2

6th Weekly Report

5 – 11 May 2019

After returning to our German working area on Tuesday, we had a brief ROV dive to pick up the left-behind elevator from the seafloor, because we needed it urgently for deploying the missing in situ benthic flux chambers and profilers in the German reference area. During the respective ROV dive on Wednesday, by incident we found an amphipod trap that we had lost four years ago during the SONNE cruise SO239. At the end of the dive we successfully recovered the device, which serves as a nice colonization experiment of deep-sea fauna and bacteria. While finishing the sediment sampling in the reference area with multiple and box corer, we also retrieved the moorings that we had deployed earlier on this leg across the German license area to witness the passing eddy. We have now moved to continue investigating our dredge sediment plume experiment. Of particular interest is to sample along the gradient of sediment redeposition covering the nodule habitat outside the dredge tracks. This will assist us in assessing the impact of nodule mining outside the mined nodule fields.

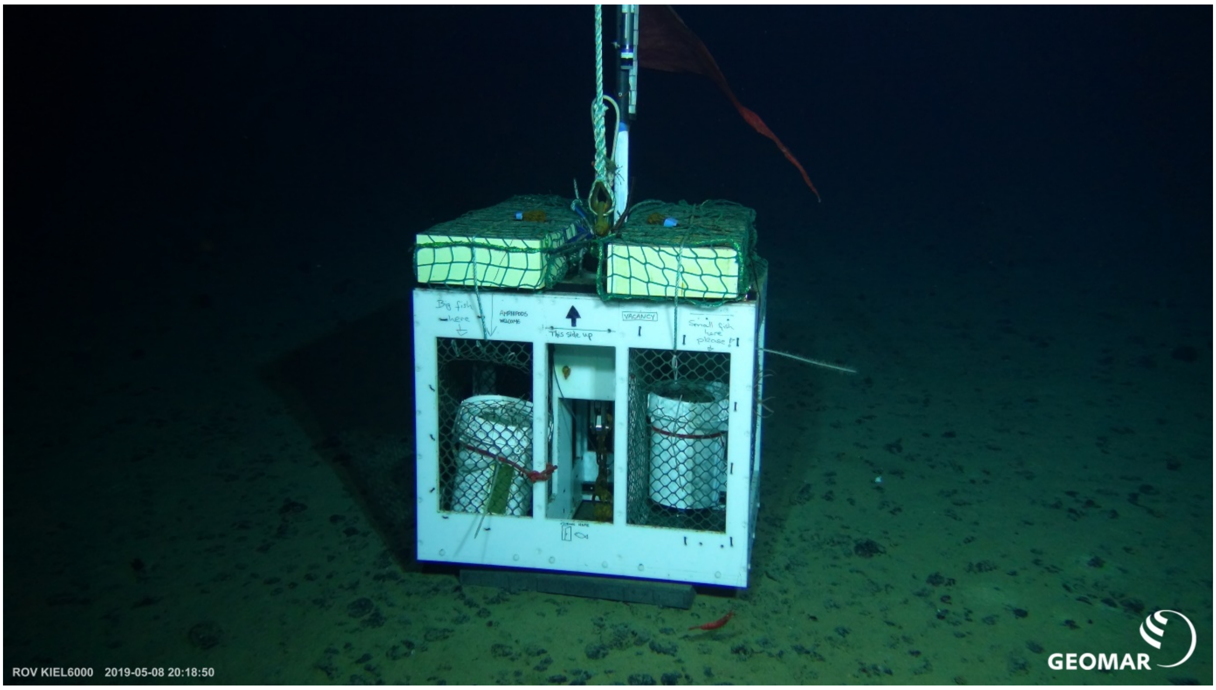
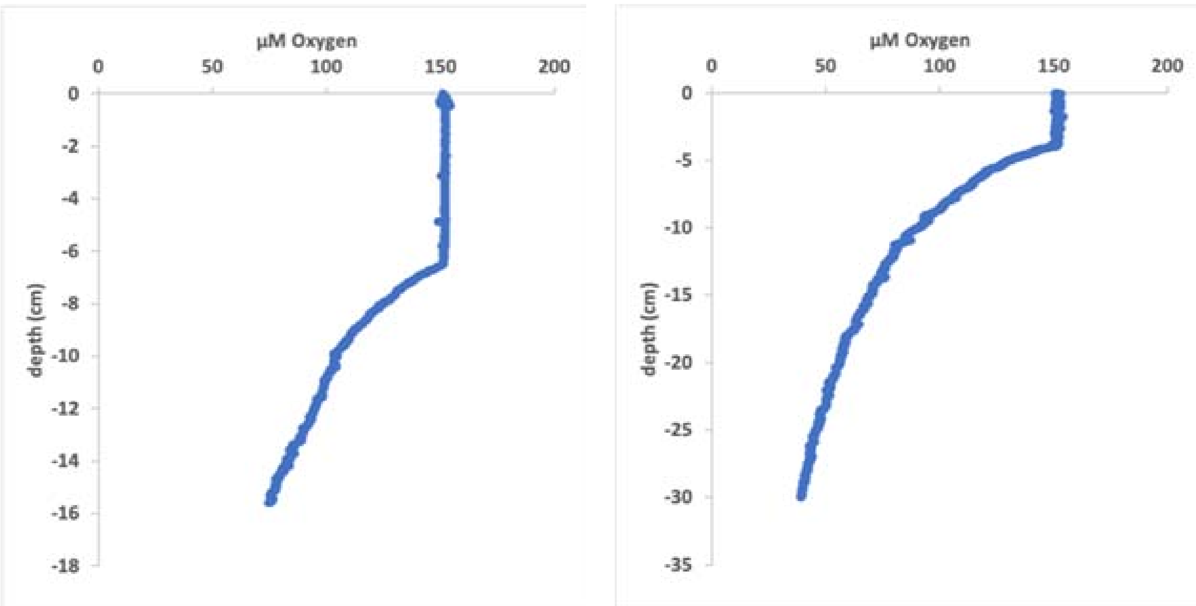


Photo (ROV Kiel6000): Amphipod trap that was lost in 2015 during our expedition SO239.

To obtain baseline information on the organic matter remineralization rates in the sediment the group from MPI performs in situ oxygen consumption rate measurements. These rates will be compared with rates from impacted sites. Three types of in situ modules, all manipulated by ROV have been used: (1) Benthic chamber modules are used to quantify total oxygen uptake ('TOU') in a small sediment patch enclosed by a circular acrylic chamber; (2) Electrochemical microprofilers and (3) Fiberoptical microprofilers (Fig. 1) were used for high-resolution measurements of vertical profiles of pore water oxygen concentration in the top 15 to 30 cm of the sediment. Diffusive oxygen uptake (DOU) is calculated from the slope of the oxygen gradient right above or below the sediment surface or from changes in slope of the entire depth gradient. This provides key measures on the distribution and consumption rate of O_2 in the sediment. To operate the in situ modules at the seafloor, an optical modem (Hydromea, CH) attached to the ROV and the modules was used for the first time during the cruise to communicate online with the instruments at the seafloor (Fig. 1). This offers a high amount of flexibility and provides significant capacities to work in these demanding environments.

Photos (ROV Kiel6000): (left) Fiberoptical profiler for measuring oxygen concentration profiles of 30-cm length in the sediment. (right) In situ online communication using a new underwater communication modem (Hydromea, CH).

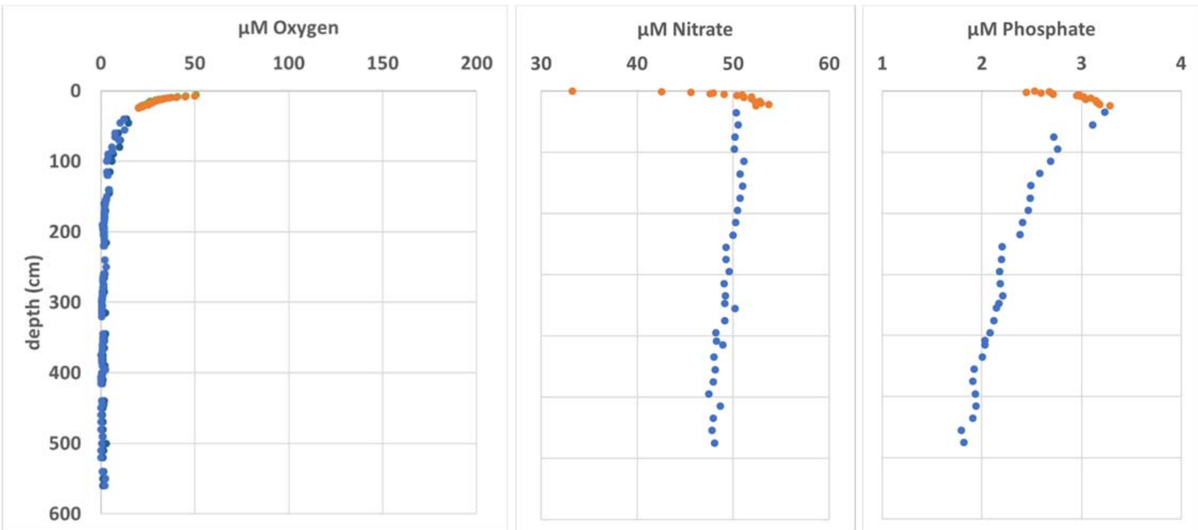


Graphs (Frank Wenzhöfer): Examples of in situ oxygen consumption measurements. Oxygen profiles obtained in the Belgian reference area with (a) the electrochemical microprofiler and (b) the new fiberoptical microprofiler.

Having a focus on baseline variability, measurements were carried out in both, the reference and the trial areas in the German and Belgian claim. The above graphs show an example of data obtained in the Belgian reference area with both, the electrochemical (left) and fiberoptical (right) profiler. A first analysis of the oxygen profiles shows pronounced oxygen consumption in the upper 10 cm below the seafloor. Due to the capacity of the new fiberoptical profiler to record long profiles, the data from both areas include the strongly curved upper part of the profiles, where most of the oxygen uptake is happening. During the next days will also perform measurements in an area where a small impact experiment was carried out. These data will allow us to compare the baseline and impact data with each other.

In order to get the full picture, in situ data will be combined with oxygen measurements and other biogeochemical variables, such as nitrate, ammonium, phosphate, and silicate, down to several meters sediment depth that are carried out onboard by colleagues from AWI and GEOMAR using a Seal Analytical QuAAtro39 segmented flow analyzer. The graphs below show that oxygen is consumed at about 1.5 meters sediment depth. While phosphate is released during the degradation of organic matter in the surface sediments, which is adsorbed with depth, nitrate is being consumed in oxygen-free sediments.

Photos (Jessica Volz): (left) Measurement of oxygen concentrations in long sediment cores using amperometric sensors. (right) Seal Analytical QuAAtro39 segmented flow analyzer used for the determination of nutrients in the pore water.



Graphs (Jessica Volz): Example of oxygen, nitrate and phosphate from a long sediment core obtained from the German reference area.

Since polymetallic nodule mining activities at the seafloor will induce metal fluxes from the surface sediment layer into bottom seawater, either in dissolved or in (nano)particulate form, which may include the release of bioavailable toxins, the groups from JUB and BGR study also metal concentrations in the sediment, i.e. solid phase and pore water, as well as in the bottom seawater. We focus on transition metals (Fe, Mn, Co, Cu, Ni, Zn), that can be micronutrients in small quantities but become potentially toxic in large quantities, as well as toxic metals, such as As and Cd, and rare earth elements and yttrium (REY). This involves sampling of different size pools: particulate, dissolved, colloidal, and truly dissolved ions.

After resuspension of surface sediments due to mining activities, the colloidal fraction between 0.2 µm and 1 nm is expected to remain in the water column for a longer period of time than larger particles that are likely to settle faster. With sampling before and after the dredge sediment suspension experiment, we want to see if higher metal concentrations are detectable in the bottom water afterwards due to release of metals from pore water and processes occurring with the suspended (nano)particles and colloids. Our dredge experiment simulates metal release during potential future polymetallic nodule mining activities, where the surface sediment is likely suspended by the nodule collector. Besides the bottom seawater, we also sample the surface sediment before and after the experiment to analyze the impact of sediment removal and concurrent redeposition of suspended particles on the geochemical fluxes and processes.

Sampling methods include bottom seawater sampling with trace metal clean GoFlo bottles mounted on the CTD and the bottom water sampler (BWS), as well as the multicorer (MUC) for sediment solid phase and pore water. Samples are processed immediately: seawater is filtered, including ultrafiltration, to distinguish the particulate, colloidal, and truly dissolved pool. Sample handling is largely conducted in a clean bench to ensure as little contamination as possible to allow determining the low metal concentrations in the water. Porewater from the MUCs is usually sampled in 2-cm layers in the upper 20-25 cm in the cold room at ca. 4°C to preserve in-situ conditions as long as possible. After centrifugation (also at 4°C), the supernatant is syringe-filtered in the clean bench. For the first time, we also use passive samplers which accumulate bioavailable metals from the porewater and seawater. They are left in the MUC liners for several hours and up to one year on the seafloor.



Photos (Sophie Paul, Katja Schmidt, ROV Kiel6000): (top row) Filtration techniques: (left) filter tower, (middle) ultrafiltration, (right) syringe-filtering under the clean bench. (center row) From sediment to clear porewater: (left) sampling in the cold room, (right) centrifugation. (lower row) Passive samplers for the water column at the seafloor (left) and for the porewater in a MUC liner (center and right).

We have five days left to finish our studies before we need to head to the final destination of our voyage: Vancouver.

On behalf of all SO268 participants,

Matthias Haeckel