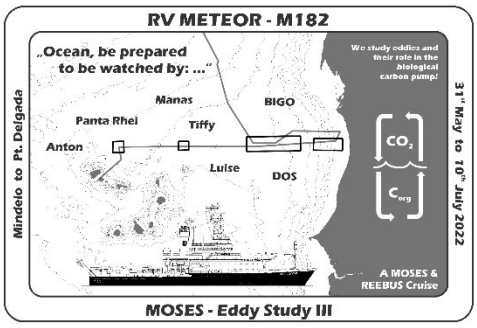
RV METEOR – M182

31.05 – 10.07.2022, Mindelo – Pt. Delgada

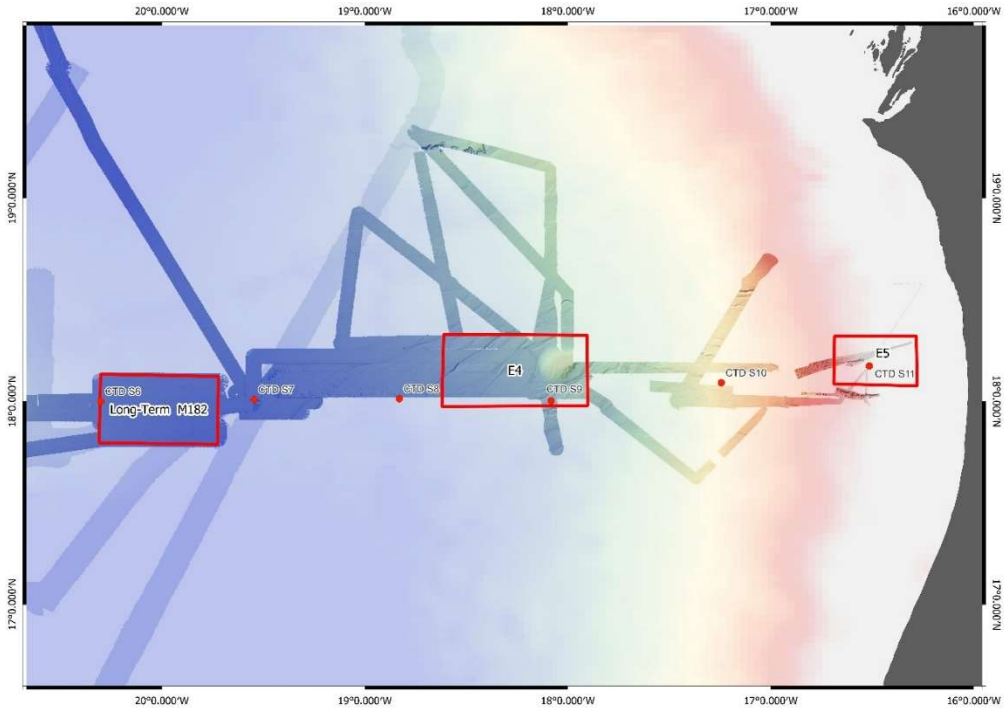


4th Weekly Report

20. - 26.06.2022

The fourth week of the cruise is over. Today (26th June) we are 26 days at sea and we all feel these days with less sleep than normal and constant movements of the ship. Last week we had two days of flat sea with only 2 to 3 Beaufort, on Monday and Tuesday. We took the opportunity of a calm sea and the need to thoroughly map the 'long-term' area for celebrating a combined birthday of eleven people on board (scientists and crew) and the middle of the cruise by having a BBQ on deck. The fish that was caught a few days before as well as a new big catch of a Mahi-Mahi ended up on the BBQ together with meet, corn vegies and other salads the kitchen prepared. Almost everybody could enjoy some time off, despite continual working to acquire multibeam data along east-west lines. The chosen area of the mapping in Cape Verde waters was selected for deploying the BBL lander and the Panta Rhei rover for a longer period until mid-January 2023. During a RV M.S. MERIAN cruise both systems will be recovered and, hopefully, will have recorded the influence of an eddy on the carbon export from the sea surface towards the seafloor. The BBL lander (Bottom Boundary Layer) will be equipped with a time-lapse camera, a CTD, an ADCP and a sediment trap. The rover will work in its current configuration with an ADCP, a CTD and two benthic chambers that measure the oxygen change for 16 hours after the chamber have been placed on the ground. Currently all three landers and the rover are on the seafloor and will continue to measure for two more days.

With half of the cruise over, the planning for the end of the cruise and logistics in Pt. Delgada started already. The list of who needs be transported when to the air port or a hotel is hanging in the corridor, and planning of the container transport back to Kiel with the logistics company in Hamburg is already ongoing and dangerous goods declarations have been sent. A plan until the end of the station work exists that includes sediment sampling at Cape Blanc at 21° 6' N; a long-term monitoring site 190 nm towards the north in international waters. The last work at about 18°N will be the deployment of the BBL lander and the Panta Rhei Rover, but before that we are heading further east to very shallow water where a set sediment cores, BIGO deployments and dives with the small Girona AUVs are planned. After this view ahead, below is a short summary of what we have achieved in the past week.



Bathymetric data acquired during M156 and M182 of the western working areas. On Tuesday night, we will extend the mapping towards the east.

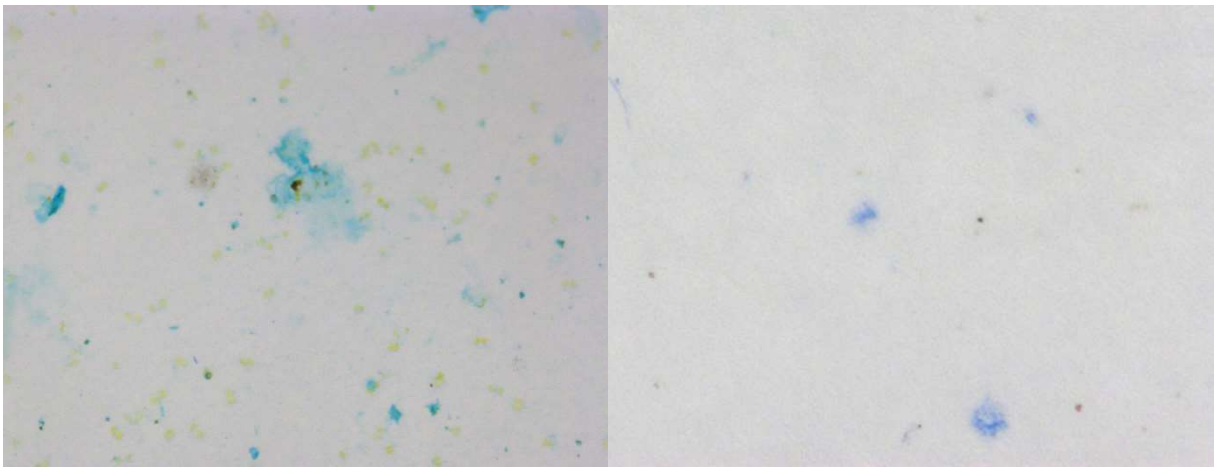
Work of the last week

After mapping the long-term area from 20th to 21st in the morning we started sampling a central, very flat area using first the multi-corer, followed by a CTD, a BIGO deployment, AUV Abyss, another CTD, two XOFOS deployments (one surveying the bottom, the other looking at biology in the water column) and AUV Abyss. After recovering the LBL transponder from the AUV we started our way further towards the east into Mauritanian waters. On the way towards an area previously investigated during M156 we added multibeam data to the existing map and took another CTD for our long E-W transect. Upon arrival at the E4 study site that shows much more morphological features than the other areas, we took a GC in a rather flat part between a larger cushion-shaped seamount and a channel and canyon area to the west. After the GC, the BBL lander was dropped to the seafloor in free-fall mode (just slipped at the sea surface) about 600m west of the GC site. The idea was to deploy the BBL, the Rover and the second BIGO rather close to each other to characterize this site with regards to the biogeochemical processes in the sediment, the turnover of carbon as well as the biological activity. An XOFOS dive and additional MUC sampling completed the studies at this location. A short AUV Anton deployment in the morning of the 24th shed some light into the underwater communication between the top-side unit on the ship and the AUV itself. As Anton is not designed to work in open water without the seafloor in hydroacoustic reach, he needs to get updates of its position from the ship (USBL navigation). Getting and accepting these updates is something we will further explore in the E5 area. On the evening of the 25th we left the E4 area in eastward direction to retrieve the BIGO lander in the long-term area. Unfortunately, the sea-state upon arrival was so bad that we decided to cancel the recovery (8 to 9 Beaufort and 3 m waves) as the risk of damaging the lander when it is hoisted on board in such conditions is rather high. We steamed back to E4 where we

started taking additional MUCs within different parts of the channel and canyon system and also deployed Tiffy again for another multibeam and sidescan mission.

Further results from the scientists

Water column microbiology: During the last week, we were able to finish our sampling efforts of the cyclonic eddy. Subsequently, we continued to take CTD profiles and collected additional water column samples on our way towards working area E4. These samplings included the long-term area, stations S7, and S8, and reached down to 3000 m depth with a focus on the upper 800 m of the water column. As anticipated, with decreasing distance to the Mauritanian coast, we noticed slightly increasing phytoplankton biomass and overall productivity compared to the earlier stations, for example, CVOO. Phytoplankton photosynthesis encompasses the fixation of inorganic carbon (i.e., carbon dioxide) and its conversion into organic carbon compounds (e.g., carbohydrates). However, under nutrient-limiting conditions, phytoplankton release polysaccharides and amino acids into the water. These organic compounds tend to abiotically assemble into gel-like aggregates called transparent exopolymer particles (TEP) and protein-containing particles known as Coomassie-stainable particles (CSP) due to sticky surface characteristics (see Fig. 1). Both types of these microgel particles are important nutrient sources for bacterioplankton and play an important role in nutrient export fluxes from the euphotic zone to the deep sea. Eddies might profoundly impact the distribution pattern of TEP and CSP particles in the ocean, as they mix the upper water column by affecting primary production in the area. However, the distributing of TEP and CSP inside and around eddies and the processes involved in the assembly and degradation are largely unknown. The analysis of microgel particles includes vacuum filtration of water samples to collect the gel-like particles on filters (0.45 µm pore-size) and subsequent staining with either Alcian Blue or Coomassie Brilliant Blue for TEP and CSP, respectively. Once stained, the particles are ready for microscopic or colorimetric analyses to obtain particle counts, size distribution, and concentrations. Preliminary microscopy analysis of TEP and CSP onboard showed a higher abundance of CSP than TEP. These results can be expected given the relatively low phytoplankton biomass and could be a result of the dominating phytoplankton species.



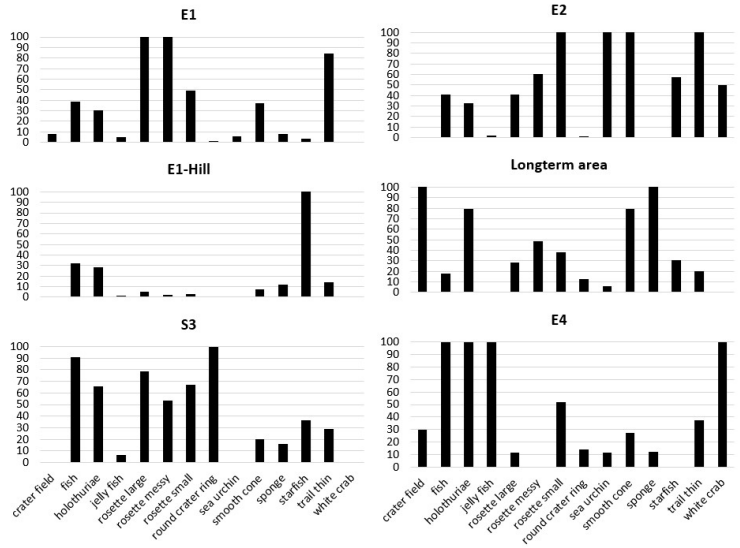
Microscopy image showing polysaccharide containing transparent exopolymer particles (TEP) on the left and protein-rich Coomassie-stainable particles (CSP) on the right.

Moreover, we noticed that the TEP particle counts increases while approaching the Mauritanian coast, likely as a result of an increase of TEP producing phytoplankton and or increasing nutrient stress. Detailed analyses of the biogeochemical and genomic data in the home laboratory will shed light on the role of TEP and CSP inside and around eddies and will allow us to address some of the raised questions.

Geochemistry: Geochemical analysis of the sediment is in full swing, with successful deployments of the multiple-corer (MUC) and gravity core along the transect. The gravity corer consists of a heavy weight that pushes a long 5 m barrel into the sediment. The longest core we recovered so far was 4.6 m. The MUC houses up to 7 Perspex core liners, each of which recovers ca. 30 – 40 cm of surface sediment when the device lands on the seafloor. Video images from a camera mounted on the MUC give an idea of the surface sediment structure at our sampling sites. Even in the deep-sea, the sediment surface is not featureless, but is covered with small mounds and trails due to burrowing fauna and long worms have been observed down to 15 cm in the sediment. Geochemical analysis of sediment porewaters performed on board give an indication of the amount and reactivity of organic matter settling out of the water column. As the cruise proceeds, we hope to see the effect of km-scale differences in seafloor topography on carbon and nutrient recycling in the sediment. This will help us to understand how and where organic carbon produced by plankton at the sea surface is finally buried in the sea floor across our sampling transect.

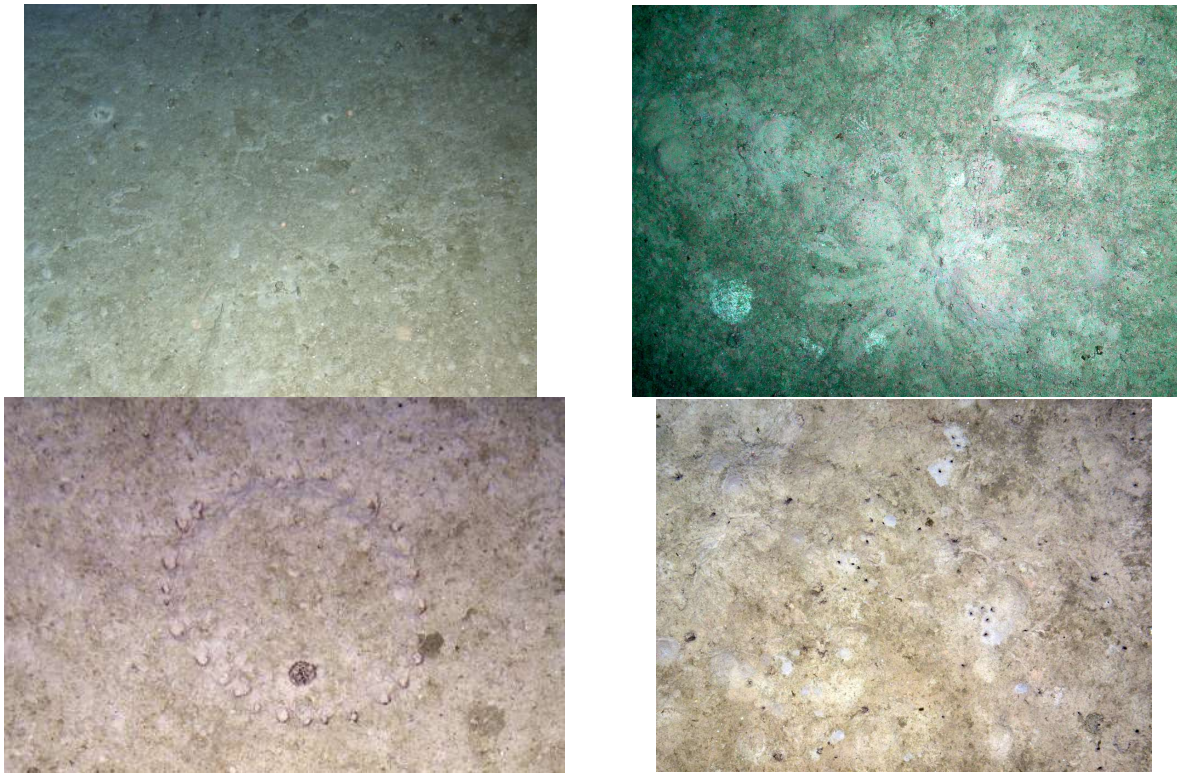
Sampling of a ca. 4 m long gravity core recovered from 3212m water depth. The cores will be stored at GEOMAR's central core facility and made freely available for further investigations.

Optical seafloor studies: While we do XOFOS transects, we directly annotate the video footage and log what we can identify on the seafloor. The annotations are written together with a position and timestamp in a table and can be used for a preliminary area characterization. The differences in between the research sites are mostly related to the abundance of different kinds of Lebensspuren. It is quite distinct, that in the E1-Hill area far less Lebensspuren occur compared to the other areas. On the other hand, the abundance of starfish is the highest. Most sea urchins were observed at station E2, but with very few round crater rings, which were very abundant in S3.



Abundances of different fauna and seafloor structures in the different areas.

Our first analysis already emphasizes that the deep-sea floor is heterogenous, even though the terrain is even and flat. At E1-hill, we crossed the top of a small seamount and went downhill. Contrary to our expectations, the plateau appears less active with far less bioturbation. Especially the long-term area shows overlaying bioturbations of light colors, which might indicate fresh sediments and could be an indication for younger activity. It is the same area, we finally spotted one of the burrow inhabitants! We caught a light-purple worm on video, sticking out of its burrow and feeding on the sediment.



Different types of seafloor structures and bioturbation activities.

Right now, we are running another MUC in a deep-sea canyon of 46 m depth (relative to the surrounding plain) and 998 m width. Earlier the day we had some connection problems of the video system installed on the MUC, but that was solved by re-terminating a new plug to the coaxial cable. These are things that once in while happen and may delay the sampling plan for an hour or a bit longer. Besides such issues the cruise is running very smoothly, everybody is well and happy about the amount of data that we collected so far.

With best regards from all on board,

Mareike Kampmeier & Jens Greinert

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