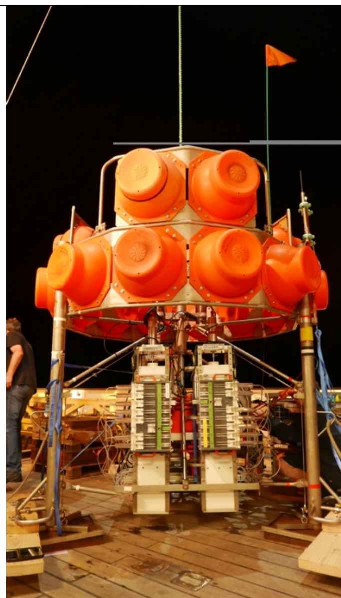
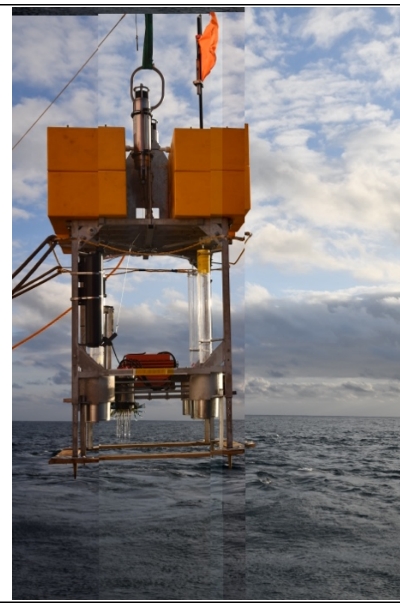
3. Weekly Report FS Sonne So261
Expedition „HADES“
12.03. – 18.03.2018

The third week of our expedition was completely dedicated to our work in the Atacama Trench. We finished our Lander program at our second site at 7890m with the successful recovery of all our lander systems in the morning of Monday March 12. Some of these lander systems are used to perform measurements directly at the seafloor. They are part of our subproject to quantify and characterize the diagenesis along the trench axis versus the abyssal plain. Recent investigations have shown that hadal trenches act as hotspots for deposition and turnover of organic material and therefore are more important for regional element cycling than previously anticipated. The activity is presumably driven by specialized microbial communities that are adapted to the extreme hydrostatic pressures in the trench – communities that are unknown to science. The Atacama Trench is underlying one of the most productive water columns in the world and is situated in a very seismic active region - we thus hypothesize that this trench in particular, due to elevated delivery of food, will host enhanced diagenetic activity.
To quantify the benthic mineralization activity the Danish (SDU, Odense) and German (MPI and AWI, Bremen and Bremerhaven) group uses three benthic lander systems (Fig. 1) and complementary investigations on recovered sediment cores. The landers are autonomous and are released form the ship, sink to the bottom where they completed a preprogrammed measuring routine before returning with samples and data to the surface where they are recovered by the ship. This procedure is developed to avoid recovery artifacts of samples recovered from great depth. Our P-lander is developed to measure benthic microprofiles of O_2 and H_2S all the way to the trench bottom. This provides key measures on the distribution and consumption rate of O_2 in the sediment. In addition - the S-lander – can measure process rates of using injection of different tracers. During this expedition we focus on nitrogen cycling by injecting 15N labelled nitrate, nitrite and ammonia into the sediment, to directly quantify the nitrification, denitrification and anammox activity in the sediment. The third lander – the flux lander – can measure total exchange of oxygen and solutes, but only to 6000 m water depth and this instrument is primarily used at the shallower sites. Measurements are repeated in the laboratory in order to assess the importance of recovery artifacts – but also to quantify other process rates such as sulfate, iron and manganese reduction. Furthermore, we do detailed sampling for characterizing the microbial communities in the sediment – including bacteria, archaea and virus. This will allow us to identify the communities being responsible for the diagenetic activity at the respective sites. Finally we wish to characterize the sediment to understand the origin of the organic material that make it to the trench and to what extent organic pollutants have reached the greatest depths in the world.

The preliminary data confirm that indeed the trench axis host very high digenetic activity – that is far above what would be anticipated form simple extrapolation of activity –depth relations that previously have been published. The efforts of the present expedition should be seen in the context of the overall aim of the HADES-ERC project (an ERC advanced grant) that wish to explore and compare conditions in three different hadal trenches of the Pacific underlying different productivity regimes; the Kermadec Trench, the Japan Trench and the Atacama Trench – this expedition is the second larger expedition within the frame work of the project.





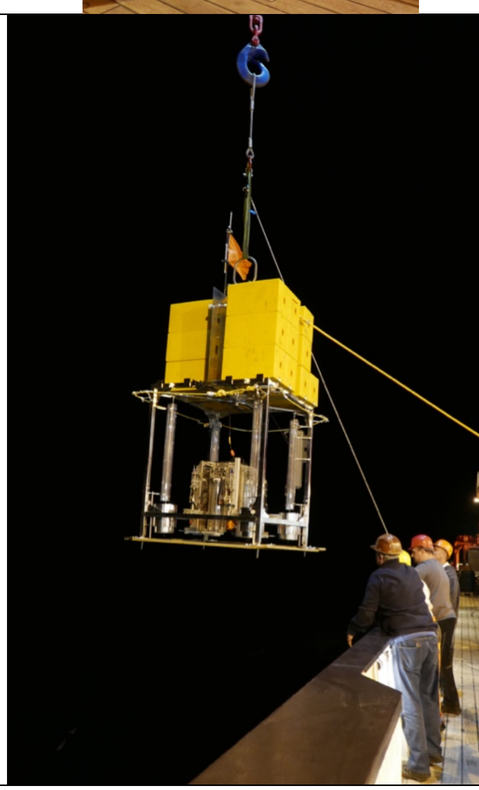


Fig. 1: Flux-Lander, P-Lander and S-Lander being deployed (Fotos: Manfred Schlösser & Anni Glud)

Our next targeted site was Richards Deep (site 4), the deepest point in the Atacama Trench with a water depth of 8065m. Here we performed an intensive water column and seafloor program for almost three days. The last gears recovered were the two camera-baited-trap lander systems to study hadal fishes.

One of the objectives of the Newcastle University's participation in SO261 is to collect and observe fish from the Atacama Trench. We have a particular interest in hadal fish (fish deeper than 6000 metres). Furthermore, we are interested in snailfish which are small, semi-transparent fish that we have found in many trenches of the Pacific Ocean, normally between 7000 and 8000 metres deep. These fish are interesting in that it appears that each of the big deep trenches host one or two species of snailfish unique to that individual trench. By studying these fishes across multiple trenches we can learn about how the shape and habitat of the seafloor influences evolution and other things likes how closely related these fish are, how they have adapted to high pressure, their life history, diet and behaviour. This also allows us to ask important science questions about biological and ecological trends that cross many trenches and not necessarily just one place. The Atacama trench is particularly important as we have found hadal snailfish in multiple trenches in the western Pacific Ocean and the Atacama Trench is 11,000 kilometres away.
We know there are snailfish here because in 2010 we surveyed this area using baited cameras and managed to photograph a small blue snailfish at 4000 and 5000 metres and a larger pink snailfish at 7000 metres (Fig. 2). However, in 2010, we did not have video systems or fish traps and there was only opportunity to undertake 5 deployments. On SO261, we have two video systems and two fish traps and enough time to deploy these system across the entire depth range of the trench giving us much better data and therefore ultimately a much better understanding of fishes in this trench and provides context to hadal fish populations across the Pacific Ocean.

Figure 2: The Atacama snailfish, photographed at 7000m in 2010 (Foto: Alan Jamieson)

So far we have managed to obtain a great amount of video footage of what we call the 'Atacama snailfish' which has extended its known depth range by nearly 1000 metres (Fig. 3). Surprisingly, we have also found a second snailfish, a blue one, which may well be like the second fish we saw in 2010. If so, then we have again extended its known depth range by over 1000 metres. Our plan for the next two weeks is to start deploying the cameras and traps at decreasing depths to establish the minimum depth of the hadal fish and how this fits against the shallower abyssal fish in the area. These data will be used in combination of what we have collected over the last 10 years, and with more cruises to other trenches in the next year.

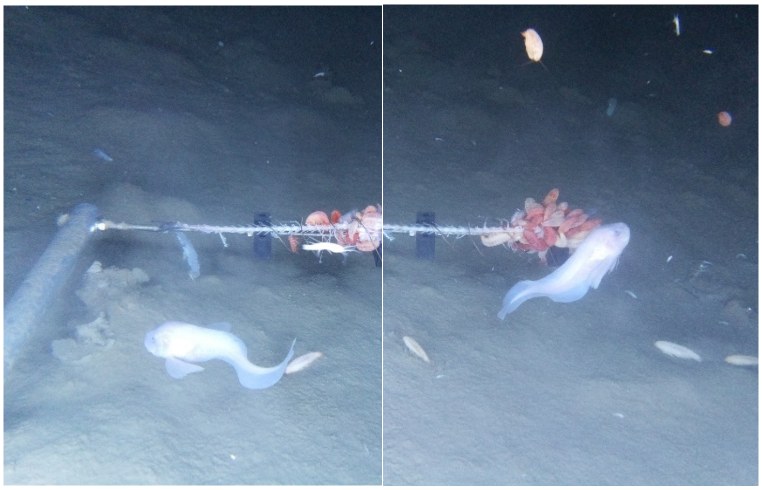


Figure 3: Video frame grabs of the Atacama snailfish filmed during SO261 at 7493m (Foto: Alan Jamieson)

During our transit from Richards Deep to our next trench station (site 3 at 7994m) further north we used the MOCNESS net to collect zooplankton. In the morning of March 16, the 14-hour deployment brought huge amounts of samples to the surface. All nets worked perfectly and the samples can now be used to discriminate the zooplankton communities collected in different water depth (5000-4000m, 4000-3000m, 3000-2000m, 2000-1000m, 1000-0m).

After finishing our work at site 3 we are now half way into the cruise and we have completed work at 5 sites (4 hadal sites and one reference site at the continental slope). So far, the cruise has been very successful; we have realized 23 lander deployments, collected 96 sediment cores and retrieved several hundreds of liters water from surface to hadal depth. During the second half of the cruise we will now focus more on our reference sites slightly off the trench at the abyssal plain.

All the best from the SONNE crew and the scientific party of So261,
Frank Wenzhöfer

(with support of Ronnie N Glud, Alan Jamieson and Thomas Linley)

You can also follow our cruise at https://www.mpi-bremen.de/en/Blogpost-3-SO261.html