M197

(30.12.2023 – 06.02.2024)

4th Weekly Report (15.01.2024 – 21.01.2024)

Over the last week we have been sailing west, occupying a sequence of stations between ca. 30–25 °E and are currently around 150 km south of Crete. Our transit west was slowed on 16.01.2024 due to strong opposing winds and 3m swell, but otherwise we have made good progress.

We are currently undertaking a sampling station above an underwater mud volcano (the Napoli mud volcano), which extrudes mud, fluids, brine and gases. This likely has a strong influence on the deep-water chemistry and biology. For example, this geological feature might release high concentrations of trace metals into seawater (denoted 'trace' metals as they are typically at very low concentrations in seawater). Many of these trace metals have critical biological functions. For example, iron and manganese are essential for photosynthesis undertaken by phytoplankton, which are the basis of almost all ocean life. A major challenge with measuring the concentrations of these metals is that they are present almost everywhere on the ship, so contamination of seawater samples with these metals is very easy. To prevent contamination, we have a specialized titanium-frame CTD that is operated with a dedicated winch system equipped with Kevlar cable (Figure 1 left). To prevent contamination when sampling from the CTD bottles, we transport them into a purpose-built laboratory container (Figure 1 right). This container is over-pressurized with filtered air, to minimize the chance of contamination of the samples by dust particles. We will then transport the collected samples back to GEOMAR for concentration analysis.

Figure 1. *Left: Sampling for trace metal concentrations in seawater using a titanium-frame CTD and winch with Kevlar cable (yellow). Right: Sampling from the trace metal CTD bottles inside a dedicated sampling container (white container at the aft of the ship in the photo on the left).*

At the mud volcano station we are currently occupying, we are also taking samples for helium isotopes, which can help us identify if the trace elements are originating in hydrothermal fluids. Specifically, we collect seawater samples in copper pipes (copper is used as this is effective at retaining the dissolved helium), that are then analyzed for helium-

3 concentrations (Figure 2). Helium-3 is enriched in hydrothermal fluids relative to the atmosphere and can therefore be used a fingerprint of inputs from this source.

Figure 2. *Collecting samples for helium-3 analysis in copper tubes at the Napoli mud volcano station.*

A major component of the Earth's carbon cycle is the sinking flux of organic matter in the ocean. When organic matter produced in the sunlit surface layer by photosynthesis sinks into deeper waters, it effectively sequesters the carbon from the atmosphere. On this cruise we are measuring the sinking flux of particles using an interesting chemical approach via the element thorium. Specifically, thorium is very particle-reactive, meaning it sticks easily to particles. Therefore, when particles are produced in the surface ocean, for example by phytoplankton growth, thorium atoms stick to them. When these particles sink out of the surface waters to depth, they bring the thorium with them. This results in a thorium deficit at the surface ocean. From the size of this deficit, we can work out how much particulate carbon, nitrogen and other elements have been exported from the surface to depth. Ultimately, this will enable us to quantify how important sinking particles are in this region for sequestering carbon and if we observe geographic differences across the study area (for example inside and outside of the eddies we have been sampling).

To determine the chemical and biological composition of sinking particles, a key approach we are using on this cruise is so-called 'in situ pumps'. At each of the daily stations we lower these devices into the water column at specific depths, which then pump high volumes (1000-2000 L) of seawater through filters over several hours (Figure 3). The particles in the water are collected onto the filters and can subsequently be used for different types of chemical and biological analyses. On this cruise, collected particles are being analysed for particulate organic carbon, nitrogen and phosphorus, amino acids and amino sugars (important food sources for bacteria), particulate biogenic silicate (mostly originating from the glass shells of particular types of microbes called diatoms), and particulate inorganic carbon (calcium carbonate).

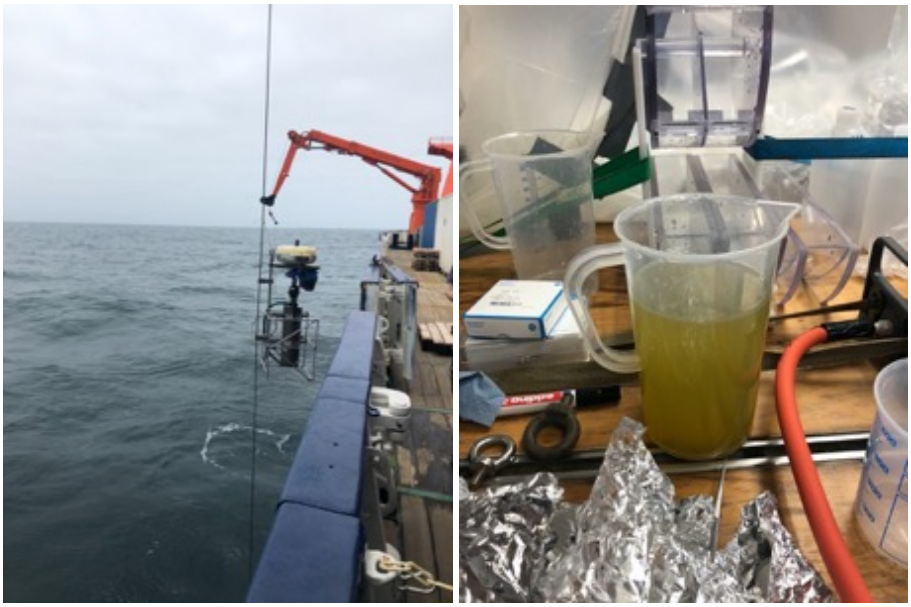

Figure 3. *Deployment of an in-situ pump (left) and suspended seawater particles concentrated by a factor of ~1000 by the pump (~2000 to 2 L; right).*

During the week we also had our first full science meeting. It was fantastic to see some of the preliminary results from the first part of the cruise and the scientific team is motivated to push on and make the most of the remaining two weeks on the cruise. The cooperation with Captain Apetz and crew remains excellent, the chefs and stewards have been continuing to serve delicious food, and overall, we are being very well looked after.

With best regards from 24.68 °E, 33.72 °N,

Tom Browning and the M197 research cruise participants