RV SONNE

SO289 - South Pacific GEOTRACES

18th February - 8th April 2022

Valparaiso (Chile) - Nouméa (New Caledonia)

3rd Weekly Report

(7th - 13th March 2022)

Sampling the hydrothermal plume on the East Pacific Rise and first results of our on-board analysis

Progress: We have had a successful week, with daily station occupations with smooth CTD casts and in situ pump deployments. We have made steady progress west towards Noumea along our 31.5°S latitude cruise track. We have speeded up progress by combining our CTD casst with in situ pump deployments at the super stations, which occur every fourth station. At the superstations we take samples for a range of isotopes (Pb, Fe, Cd, Zn, Nd, Ba, Si, Th Pa) and also collect particles on filters in the water column using a total of 11 in situ pumps. The pumps are deployed up to a depth of 2500 m, and pump for a period of 3 hours before being recovered. The weather has been kind to us, but the last few days the wind has increased, and so have the waves. Today we had 6-7 Bf winds and waves up to 4 m. This is no problem for the deployments of the CTD frames on the Sonne, but we postponed the in situ pump deployment until tomorrow when winds will be down to 2-3 Bf.

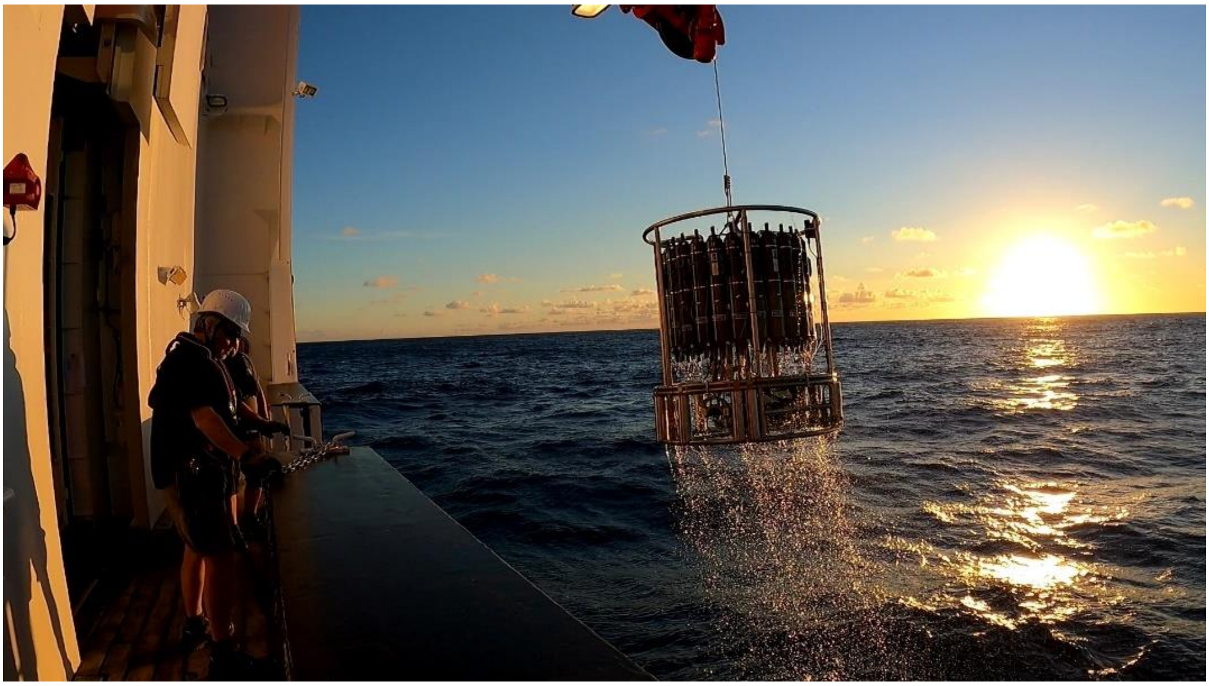

Figure 1: CTD recovery on Sonne during sunrise. Photo: Lea Blum

Nutrient and dissolved oxygen observations. Andre Mutzberg with assistance by Tabea von Keitz and Lea Blum are very busy in the Sonne lab with the analyses of nutrients (auto analyser) and oxygen (Winkler titrations), and also working up the data. Fig. 2 shows a section of oxygen, salinity, silicic acid and nitrate along our cruse track. The key feature in the oxygen section are the low oxygen waters (<50 micromole per kg) emanating from the Chilean shelf. The oxygen depletion is caused by sinking of large amounts of phytoplankton debris that are remineralised at depth with an associated consumption of oxygen. Strong phytoplankton blooms occur on the eastern boundary of the South Pacific due to upwelling of deep nutrient rich waters. The salinity section indicates fresher surface waters towards the Chilean shelf, with increases in surface water salinity towards the centre of the South Pacific gyre, as a result of net evaporation over precipitation. The nutrient sections show very strong depletion in surface waters due to uptake by phytoplankton and low supply rates, with nutrient enrichment in subsurface waters related to remineralisation of sinking organic particles with a release of nutrients, and also the presence of Antarctic Intermediate Waters (800-1500 m).

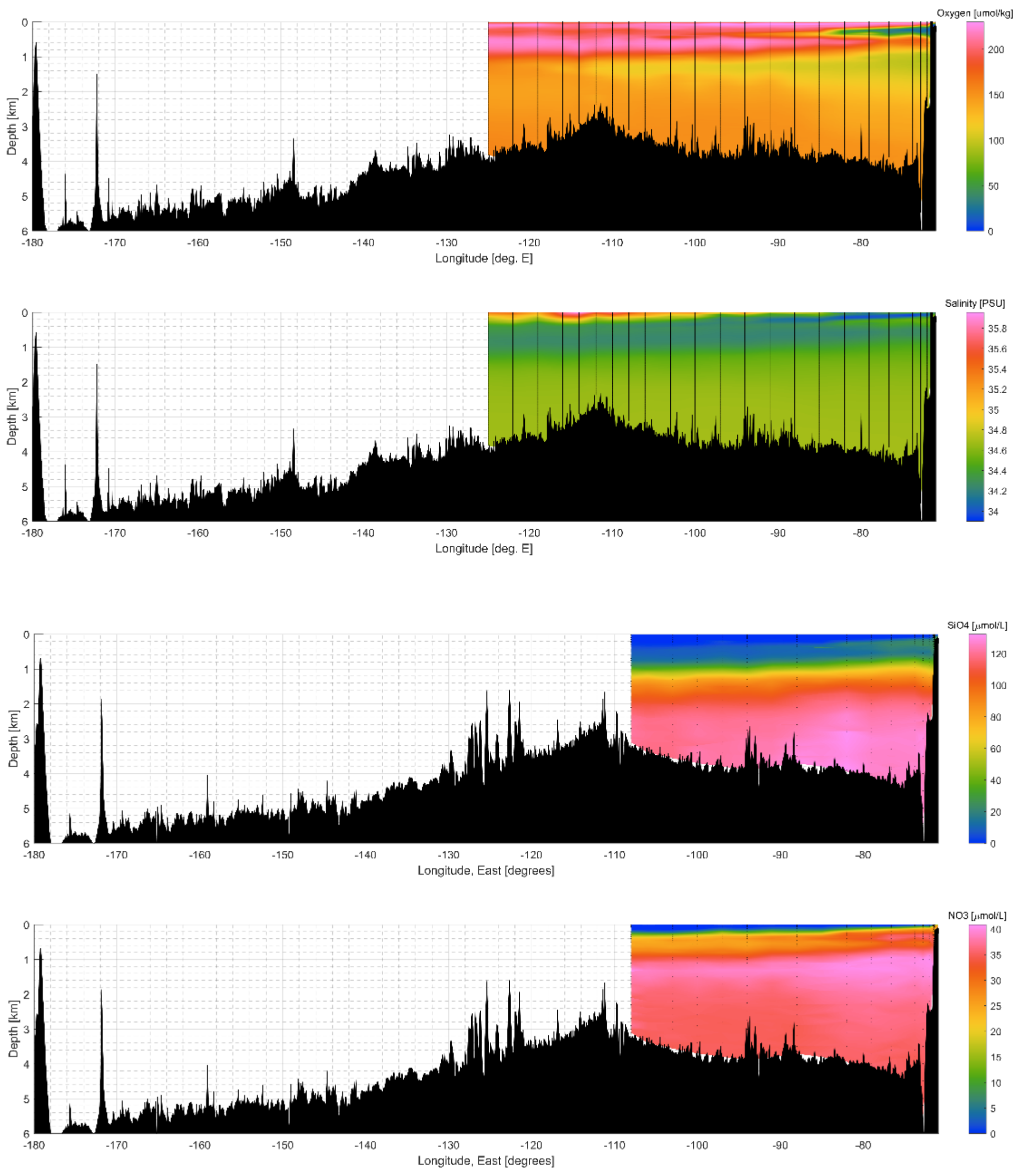

Figure 2: Section plots of dissolved oxygen, salinity, silicic acid and nitrate in the South Pacific. Nutrient analysis by Andre Mutzberg. Figure produced by Chris Galley.

East Pacific Rise: The South Pacific hosts large underwater volcanoes and hydrothermal vents along the East Pacific Rise, an underwater ridge in the middle of the ocean situated between spreading tectonic plates where magma from the earth's mantle rises. The vents emit hot fluids into the deep ocean at about 2500 m water depth. They contain high concentrations of iron and other elements that are required by phytoplankton for their growth. The plumes of iron in the deep waters are thought to be transported southwards and to reach the surface waters in the Southern Ocean, which is the largest region in the world's ocean where phytoplankton growth is limited by iron. The expedition will assess the hydrothermal iron inputs and use tracers and modelling approaches to determine their impact on Southern Ocean productivity.

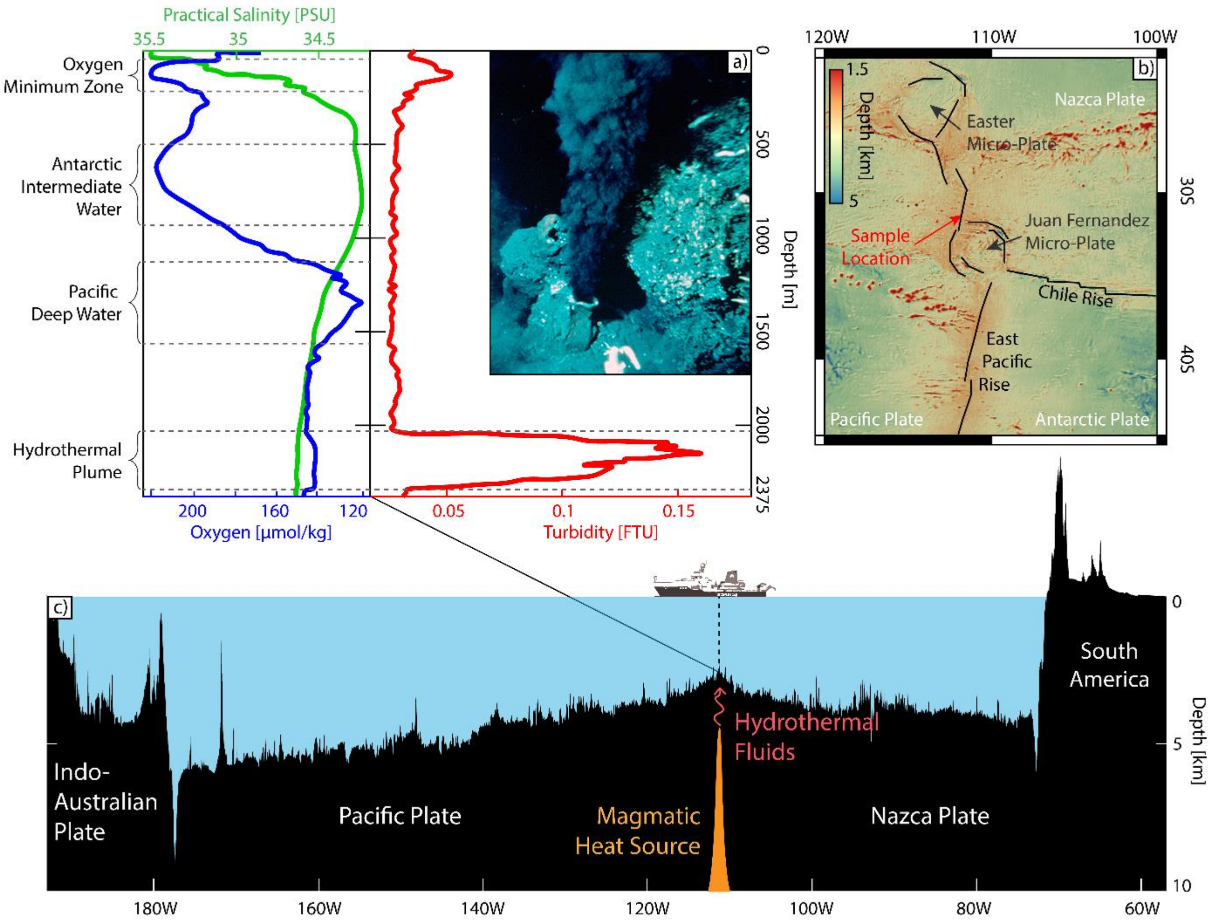

Figure 3a: Vertical profiles of particles (as indicated by or turbidity sensor), oxygen and salinity, library photo of black smoker on the East Pacific Ridge at 21°S; Fig. 3b position of the station on the EPR north of the microplate, and Fig. 3c the bathymetry of the cruise section with the EPR station indicated with a schematic of the magmatic heat source and hydrothermal fluids. Figure by Chris Galley and Sarah Moriarty. Black smoker photo: U.S. Geological Survey, Department of the Interior, W.R. Normark.

In hydrothermal systems, seawater penetrates the permeable oceanic crust, and is heated during its passage down. The seawater will react with basalt that overlies the rising magma at depths of 1-2 km (Fig. 3c), and rises and is expulsed as hot altered seawater at the seafloor (Fig. 3a). The emitted fluids are acidic, sulfur-rich and enriched in metals like iron, manganese, copper. Iron sulfide and oxide particles will rapidly form in the buoyant plume upon mixing with oxygen rich deep ocean waters, and a large part of the particles will sink. The plume will rise a few hundred meters above the seafloor before being transported away from the vent site by deep ocean currents. A fraction of the dissolved metals will remain in solution, and ultimately reach the surface ocean

On Wednesday March 9, we conducted a super station on the East Pacific Rise at 31.5°S, 111.9°W, just north of the Juan Fernandez microplate (Fig 3b). The EPR station was positioned between the Pacific and Nazca tectonic plates. The region is well known for its hydrothermal plumes, and we were very much looking forward to finding them.

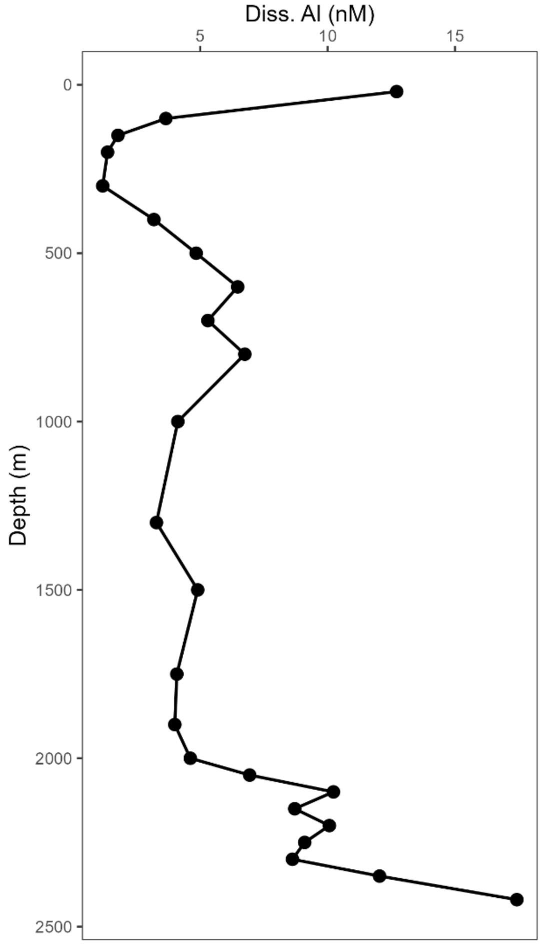

Figure 4: Dissolved aluminium profile for station above the East Pacific Rise. Graph by Te Liu.

The team on board identified a very distinct plume in the signal of the turbidity sensor that measures particle concentrations in the water column (Fig. 3a). The particles will be made up of iron sulfides and iron oxides, with other metals adsorbed onto them. In-situ water pumps were deployed at the stations and collected the iron-rich particles in the hydrothermal plume at a depth of 2200 metres. The filters from the pumps will be brought back to land for chemical, biological and mineralogical (EDX and synchrotron) analysis.

On board of SONNE, GEOMAR PhD student Te Liu is conducting measurements of dissolved aluminium in the water column. Results for the station above the hydrothermal vent at the EPR is shown in Figure 4, and shows enhanced concentrations in surface waters associated with atmospheric inputs of aluminium (derived from lithogenic dust deposition). The profile also shows increased concentration towards the seafloor which are associated with inputs from the hydrothermal systems, and perhaps also release from seafloor sediments

RV SONNE at sea 31.5°S/125.0°W

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