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Tracing trace elements

SONNE expedition crosses the South Pacific to assess ocean nutrient supply

15.03.2022/Kiel/Bremen. Iron-rich fluids emitted by hydrothermal vents at the bottom of the ocean can boost life in the otherwise nutrient-poor surface waters of the open ocean. An expedition with the German research vessel SONNE is crossing the South Pacific Ocean collecting data on nutrient and trace element supplies and consecutive plankton productivity. Based on their measurements, the multinational team led by GEOMAR Helmholtz Centre for Ocean Research Kiel in cooperation with Jacobs University Bremen also aims to learn more about potentials and constraints of carbon dioxide uptake in the ocean.

The South Pacific Ocean is one of the most remote and least explored ocean regions of our planet. It also has the largest ocean area of ultra-low productivity, resulting in crystal clear blue waters – indicating very few phytoplankton. These microscopic plants live in the surface ocean and depend on nutrients such as nitrate, as well as trace elements like iron and cobalt for their growth. Therefore, their limited abundance in the South Pacific is thought to be caused by a low supply of these elements. The low productivity also constrains the uptake of atmospheric carbon dioxide (CO₂) by this part of the ocean. However, hydrothermal vents at the sea floor provide deep waters with nutrient boosts, and it is a big question whether the nutrients also reach the surface waters of this marine desert. Such vents have now been located and sampled.

For the expedition SO289, the German research vessel SONNE is currently crossing the South Pacific Ocean at 32.5°S from Valparaiso (Chile) to Noumea (New Caledonia), which is a distance of 6500 nautical miles. The seven-weeks long cruise is funded by the German Federal Ministry of Education and Research (BMBF) and takes place as part of the international GEOTRACES programme. Led by GEOMAR Helmholtz Centre for Ocean Research Kiel as part of a cooperation with Jacobs University, it also involves scientists from the Universities of Kiel, Marseille, Lausanne, Xiamen, Minnesota, South Florida and Vienna, the Alfred Wegener Institute (AWI), Royal Netherlands Institute for Sea Research (NIOZ), Swiss Federal Institute of Technology (ETH) Zürich, Memorial University of Newfoundland and the University of Chile. The cooperation of national and international research groups and the many different nationalities on board create an inspiring multicultural environment.

Researchers onboard the SONNE study the supply of trace elements and nutrients to the surface ocean and their impacts on productivity at the ocean surface, fixation of nitrogen by phytoplankton as well as carbon uptake in the ocean. They also determine in detail the sources, sinks and distributions of trace elements and their isotopes (TEIs) in the water column along this zonal section in the South Pacific Ocean. The sources of trace elements include Chilean and Australian dust, rivers such as the Maipo River in Chile, sediments on continental shelves as well as hydrothermal vents in the deep ocean. The work on board applies trace metal clean sampling and analytical methods approved by GEOTRACES.

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 metres 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 researchers assess the hydrothermal iron inputs and use tracers and modelling approaches to determine their impact on Southern Ocean productivity.

Over the last few days, plumes from the hydrothermal vents at the East Pacific Rise, just north of the Juan Fernandez microplate were located and sampled. "The region is well known for its hydrothermal plumes, and we were very much looking forward to finding them", says Professor Dr. Eric Achterberg, marine biogeochemist at GEOMAR and chief scientist of the expedition. The team on board identified a very distinct plume in the signal of the turbidity sensor that measures particle concentrations in the water column. In-situ water pumps brought iron-rich particles emitted by the hydrothermal plumes at a depth of 2200 metres onboard the research vessel. "This indicates that there are indeed oases in this marine desert – but we need to analyse our samples in more details to better understand the impacts of these nutrient boosts."

On a daily basis, the participants of the expedition also sample in detail waters and particles from the surface to the seafloor. Specialised equipment is used to sample trace metals in a clean manner, avoiding contamination from the instruments and the ship. In addition, the uptake of atmospheric CO₂ by the ocean is measured, microplastic abundance in the surface ocean assessed, and growth experiments with phytoplankton are conducted with a range of added metals and nutrients to assess which ones are present in insufficient quantities in the ocean for optimal phytoplankton growth. "We expect our findings to have global significance for understanding the chemical environment in which ecosystems operate, and how ocean productivity and the role of the oceans in atmospheric carbon uptake will change in a future warmer ocean", Professor Achterberg concludes.

Expedition SO289

18 February 2022 – 08. April 2022

Valparaiso (Chile) – Noumea (New Caledonia)

Links:

<https://www.oceanblogs.org/geotraces> Expedition blog SO289

<https://www.geomar.de/en/research/expeditions/detail-view/exp/360913?cHash=4531c90c281d91eb55d979014bf22e85> Expedition SO289 on the GEOMAR expedition portal

<https://www.lfd.uni-hamburg.de/sonne/wochenberichte.html> Weekly Reports SO289

<https://www.geotraces.org> GEOTRACES

<https://www.jacobs-university.de> Jacobs University Bremen

<https://www.geomar.de/en> GEOMAR Helmholtz Centre for Ocean Research Kiel

Images:

Images are available for download at <http://www.geomar.de/n8367-e>

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