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Millimetre-precise data on a restless sea floor Ship expedition promises new information on earthquake risks off Chile

14.01.2022/ Guayaquil/Kiel. Since 2015, the GeoSEA measuring system has been monitoring the tectonically active sea floor off the coast of northern Chile. The equipment is now recovered on the expedition SO288 with the German research vessel SONNE and additional data obtained. The remotely-operated underwater vehicle ROV KIEL6000 is not only helping to retrieve the instruments, but will also – in combination with other new measurements – provide additional insights into the study area. The findings will contribute to a better understanding of the geological risks in the region and the further development of observation systems on the ocean floor.

The ocean floor is the outer solid shell for more than 70 per cent of our planet. Far from being rigid, it is continuously moved and deformed in the course of global plate tectonics, and tensions can grow in the seafloor. These tectonic pressures develop over long periods of time and can suddenly and usually unexpectedly discharge in an earthquake – which in the marine environment also poses risks of tsunamis. In our closely interconnected global society and economy, such events also have effects far beyond the region that is directly affected. For example, after the 2011 tsunami in Japan, a shortage of resources and economic goods was also felt in Germany. In addition, this led to the political decision to phase out nuclear power in the wake of the Fukushima disaster.

One region at high risk is the coast off Chile, where an oceanic plate submerges under the South American continent, causing tectonic tensions. To record these and better assess the risk of strong earthquakes, three marine geodetic networks were installed off northern Chile in 2015 during the expedition SO244 with the German research vessel SONNE to record the deformation of the seabed. The devices were developed as part of the Geodetic Earthquake Observatory on the Seafloor (GeoSEA) project funded by the German Federal Ministry of Education and Research (BMBF). About six years after their deployment, they are now being recovered as part of the SONNE expedition SO288. For this, the SONNE is returning to the Pacific after the pandemic-related break.

“The seafloor holds information on stress and elastic deformation, as well as on the origin and course of earthquakes and resulting tsunamis. We can record this information with almost millimetre precision thanks to the new field of seabed geodesy via acoustic distance measurements, slope and pressure change measurements,” explains Professor Dr. Heidrun Kopp. The geophysicist at GEOMAR Helmholtz Centre for Ocean Research Kiel was chief scientist of the expedition SO244 and also leads the current cruise to recover the equipment.

The measuring system deployed in 2015 consists of 23 autonomous seafloor transponders that communicate with each other and are attached to steel tripods about four metres high. They were deployed at three different locations to record changes in distance, slope, pressure and water temperature. A wave glider picked up the data from the depths and transmitted it to a satellite link, making the information directly available on land. “From the data obtained, we can see which processes take place in the seabed in the run-up to an earthquake. This information is essential for improved early warning of earthquakes and tsunamis,” Heidrun Kopp emphasizes.

The remotely operated vehicle ROV KIEL 6000 is on board for the current expedition to help retrieve the instruments from the sea floor. Its cameras will also provide detailed images of the areas monitored for six years. In addition, high-resolution seismic methods, such as from ocean bottom seismometers, will be used.

“The new information contributes to a better understanding of the geological risks in this region, for which a new earthquake has been expected for a long time. Besides the humanitarian component, it is also important to consider that northern Chile is home to two of the world's most important ports for copper exports that are highly relevant for the global production of many electrical goods,” summarises Heidrun Kopp. “In addition, we learn how to monitor the seabed in detail in particularly vulnerable areas and can further develop our methods. To this end, in a next step, we will install pressure sensors on the seabed together with our Chilean partners to be able to determine changes in water depth with high precision. This new approach in earthquake research makes it possible to quantify the tectonic stress build-up before an earthquake. Our research can later also be applied to other earthquake zones, such as the Mediterranean and southern Europe.”

The second topic of the cruise is biogeochemical processes in the open water: The region under investigation is influenced by the Humboldt Current, a cold surface current that brings nutrient-rich deep water to the surface and increases the productivity of the ocean. Experimental work on board will show how organic material is processed and how temperature, pressure and the availability of oxygen influence these processes.

The expedition in brief:

SONNE SO288

15 January – 15 February 2022

Guayaquil, Ecuador – Valparaiso, Chile

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

Blog: <https://www.oceanblogs.org/so288-combo>

Links

<https://www.geomar.de/en/research/expeditions/detail-view/exp/359760?cHash=a83f17b0764ca6bdf6cc60ec42984ac9> SONNE expedition SO288 in the GEOMAR expedition portal

<https://www.geomar.de/en/research/fb4/fb4-gdy/projects/geosea> Geodetic Earthquake Observatory on the Seafloor (GeoSEA)

<https://www.youtube.com/watch?v=1gyPWcsJ6Gk> Video about the SONNE-Expedition SO244 (German)

https://marineboard.eu/sites/marineboard.eu/files/public/publication/EMB_PP26_Marine_Geo_Hazards_v5_web.pdf Position paper of the European Marine Board „Marine geohazards: Safeguarding society and the Blue Economy from a hidden threat“

Images:

Images are available for download at <http://www.geomar.de/n8258-e> Video footage upon request.

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