SFB 574: Volatiles and fluids in subduction zones – highlights from the last field campaign

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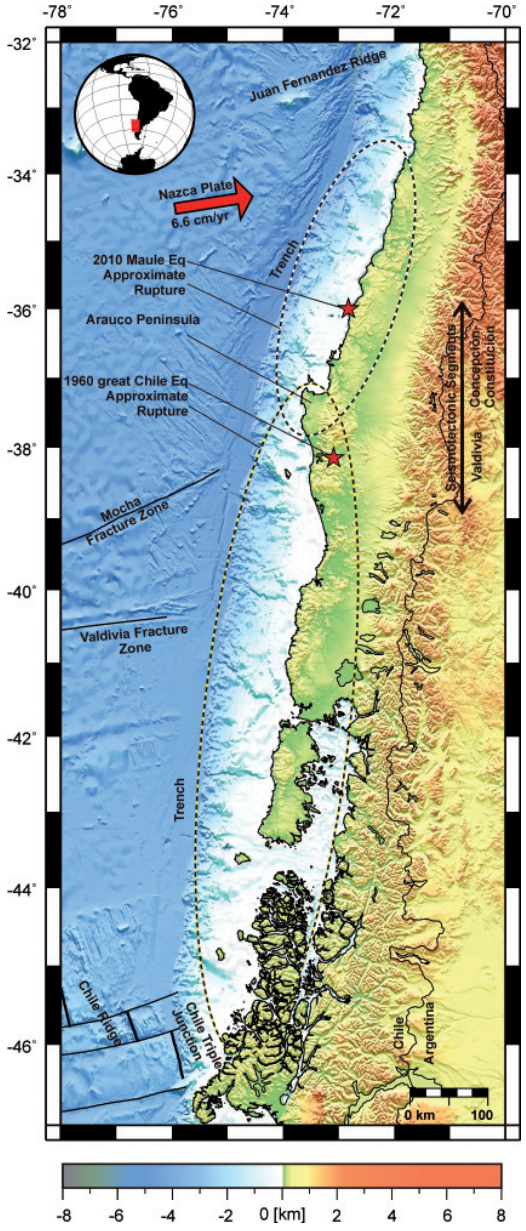
The Collaborative Research Centre 574: Fluids and Volatiles in Subduction Zones has the overarching goal to understand the role and fate of volatiles and fluids in the entire subduction system. The SONNE cruise SO-210 was the last major expedition of the 12-year programme.

The expedition SO-210 (23.09.-1.11.2010, Valparaiso – Valparaiso) to the continental margin of Chile (ChiFlux) was the last cruise in the framework of the joint Collaborative Research Centre (SFB) 574. The overarching goal of SFB574 is to understand the role and fate of volatiles and fluids in the entire subduction system. Volatiles and fluids have a major influence on, e.g., short- and long-term climate change, the geochemical evolution of the hydrosphere and atmosphere, as well as subduction-related natural hazards, such as earthquakes, volcanic eruptions and tsunamis, because they are cycled through the entire subduction system. During the first six years of the SFB 574, our investigations concentrated on the erosive Central American subduction system (Sahling et al., 2008). One of the major results of the SFBs forearc investigations was the development of a new model for the hydrogeological system of an erosional convergent margin and the effect of forearc dewatering on earthquake activity in Central America (Ranero et al., 2008; Worzewski et al., 2010). The hydrogeological conditions at the entrance to the subduction zone determine the influx of volatile components into the system. Our on-land investigations at the volcanic arc have revealed how the output of volatiles into the atmosphere varies along the subduction zone as a function of input flux and geometry and dynamics of the subduction process (e.g., Sadofsky et al., 2008; Kutterolf et al., 2008).
To determine whether this model is also applicable to accretionary margins, and if not



Left: RV SONNE, Photo, B. Grundmann.

Right: Morphologic and tectonic features of Southern Central Chile between 33°S, where the Juan Fernandez Ridge is subducting and the Chile Triple Junction at 46°30'S. Epicentres and rupture areas of the 1960 and 2010 megathrust earthquakes are indicated. The rupture areas define the seismotectonic Valdivia and Concepción-Constitución segments that overlap at Arauco Peninsula.

Working area on RV SONNE. In the front the new "elevator lander" system, in the back the ROV Kiel 6000. Photo: B. Grundmann.

how it needs to be modified, is a major goal for the remainder of the SFB.

The Chilean margin, which switched from erosion to accretion within the last several million years, has been chosen for this study. The extensive work offshore Central America has shown that fluid venting - mainly occurring at mounds, along faults and at submarine land-slip scarps in the mid-slope area of the continental margin – is controlled by the dewatering of subducted sediments. Morphological, geochemical, biological, geophysical and volcanological investigations of the forearc of the Chilean subduction system between 33-37°S were the main focus of the SO-210 expedition to test the model of the subduction hydrogeological system.

Major goals of the expedition were: 1) to investigate the dewatering processes in the forearc of the central Chilean subduction zone, in particular the origin and output flux of vent fluids and volatiles, 2) to study biological processes fuelled by the discharge of fluids and volatiles (e.g. methane), 3) to use cold seep carbonates as a geochemical archive of cold seep activity, 4) to evaluate the role of forearc fluids in triggering mass wasting events that could generate tsunamis, 5) to characterize geochemically the subducting sediments, in order to determine the input flux of climate-relevant volatiles (CO_2, sulphur and halogens) and a variety of trace elements, necessary for determining the mass balance of chemical fluxes through the subduction system, and 6) to investigate the distribution of volcanic ashes to improve estimates on the volume of material emitted by volcanic eruptions and to date distinct events within the sedimentary sequence. An additional goal was to detect recent changes in the morphology of the sea floor and the discharge activity of fluids and gases that may have been caused by the earthquake on February 27, 2010, and the associated tsunami. Due to this multi disciplinary approach the deck and laboratories of RV SONNE were crowded with instrumentation like the ROV KIEL 6000, a gravity corer, CTDs, TV-grab, multicorer, a video sled and 4 landers, which can be deployed video-guided. This suite of instrumentation obtained the first comprehensive data set from fore-arc sediments off Chile which were presented in an international workshop in Pucón, Chile right after the cruise.

Integration of these results with parallel amphibious geophysical observations and analytical studies of the volcanic arc on land will allow us to compare the Chilean and Central American subduction systems in terms of their volatile and fluid cycling processes in order to achieve a better understanding of how subduction zones operate, what are their controlling processes and process rates, and how these pre-determine associated geohazards.

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