

SO-267: ARCHIMEDES I Expedition with RV SONNE

Weekly Report No. 1 (10 to 16 December 2018)

SO-267 (ARCHIMEDES I) is the first in a series of research expeditions to the outer edge of the Indo-Australian Plate, in the largely uncharted waters of the Kingdom of Tonga. The project, entitled “Arc Rifting, Metallogeny and Microplate Evolution – An Integrated Geodynamic, Magmatic and Hydrothermal Study of the Fonualei Rift System” aims to document the geological evolution of an emerging microplate mosaic in the NE Lau Basin to better understand the sequence of events leading to arc rifting and the emergence of magmatic-hydrothermal activity in a region with some of the fastest growing crust on Earth. Planned operations include large-scale reflection and refraction seismic surveys, and a dense program of gravity, magnetics, heat flow, sidescan and multibeam mapping



using the AUV Abyss and ship-based systems in coordinated transects across the plate boundary. This ambitious program is made possible by a close collaboration between GEOMAR and BGR scientists, bringing together their diverse expertise and state-of-the-art technologies to solve a single problem – to understand the large-scale tectonic processes that result in “runaway” crustal growth in dynamic arc-backarc systems and its relation to geohazards, magmatism, and hydrothermal activity.

39 scientists from GEOMAR, BGR, and partner institutions joined RV SONNE in Suva, Fiji, on Monday, 10 December. A total of 14 containers of equipment were eventually loaded/packed, including 6 rental containers that will return to Kiel from Suva and 3 AUV containers that will stay on board for the next cruise. The vessel left the port of Suva in the late afternoon of Tuesday, 11 December, and arrived on station to commence operations at 19:00 on Wednesday, 12 December, after a transit to the working area of 360 nm. The first operation was a releaser test for the 50 OBS instruments from 19:00 until 23:00, followed by a short transit to the first proposed seismic line (P3, 160 nm). 50 OBSs and 16 OBMTs were deployed between 24:00 on December 12 and 07:00 on December 15, with heat flow stations between the deployments. A total of 66 deployments and 8 heat flow stations, were completed with continuous EM122 multibeam data collection. On the morning of December 15, GEOMAR’s two large G-gun arrays were deployed for shooting of the OBSs on BGR2018-2R3 (east-to-west) across the arc front. A daylight watch was established before commencing operations with the air guns to ensure no mammals were near the ship, and a ramp-up procedure was followed to allow any mammals to depart the area before shooting started. Deployment of the magnetometer and air guns started at 07:30. Shooting of the line was started at 09:00 and is continuing until the Sunday evening, December 16.

Profile P3 extends from the active volcanic front in the east, across the deepest part of the Fonualei Rift Spreading Center (FRSC), and into the back-arc as far west as the Central Lau Spreading Center (CLSC) and Lau Extensional Transform Zone (LETZ), with a total length of ~300 km. This line will provide high-resolution images to depth of the rifting arc crust, the arc-to-backarc transition, and the internal structure of the Niuafou’ou microplate. The profile was chosen to reveal the optimal thickness of arc crust for initiation of rifting, the velocity structure under the rift, the styles of faulting and the role of pre-existing basement structures. A major question is why the most recent extensional faults have developed in the thickened arc crust and not at the thinned boundary between the arc and the backarc

basin. By combining the heat flow with the crustal sections, we will hope to be able to correlate the 2D structure with magmatism and hydrothermal activity and test the relationship between arc rifting and the development of large-scale melt and fluid flow pathways. A total of 19 OBMTs will be deployed along 60 nm of the central part of the profile to measure crustal resistivity from passive sources of electromagnetism in the crust. These instruments will be recovered at the end of the cruise, and the measurements will provide complementary information about the crust and upper mantle, including possible regions of melting and/or deep fluid upflow beneath the FRSC.

Besides the 26 GEOMAR scientists from the research Division Dynamics of the Ocean Floor, the cruise participants include 8 members of the BGR marine geophysics group and 5 guests from the Kingdom of Tonga, Australia, Canada, and our partner institution GFZ. The entire scientific crew worked around the clock during the first week of the cruise to deploy the nearly 70 instruments. This ambitious program could not have been completed on time without the excellent support of the ship's crew.

With best regards from RV SONNE,
Mark Hannington and Heidrun Kopp

