

SO-267: ARCHIMEDES I Expedition with RV SONNE

Weekly Report No. 3 (24 to 30 December 2018)

Preliminary data of the seismic profiles are now coming in, sparking lively debate among the geophysics and geology teams about the significance for the origin of the Fonualei rift system. The first sections are testing different models of the crustal architecture and the history of opening of the Lau Basin – a key objective of the cruise. Christmas Eve was celebrated with a toast by the Captain and Chief Scientist and an exchange of gifts, during which a large-scale multibeam, magnetic, and gravity survey of the northwest corner of the S-FRSC was completed. The AUV Abyss (Dive 309) spent Christmas in the water surveying the southwest arm of the S-FRSC “rift tip”. The results of AUV mapping show that both arms of the southern FRSC are tectonic rifts (shallow extensional basins), mostly buried by volcanoclastic material from the nearby arc and with only a few small rift-related volcanic cones. The AUV maps in these areas give a clear picture of the very beginning of arc extension before the rift drops into a deep basin to the north (nearly 3000 m deep) and before significant rift-related magmatism started. The mapping also revealed the important role of mass wasting near the rift-tip, where the uplifted flanks of the FRSC are strongly incised by deep erosional channels. The coarse volcanoclastic material, which is the source of most of the sediment in the sub-basins adjacent to the arc, explains the difficulty experienced in week 2 during deployments of the gravity corer and heat flow probe close to the arc. The very low heat flow, despite the rifting and proximity to the arc, and the low thermal conductivity reflect the coarse nature of the sediments and their high permeability.



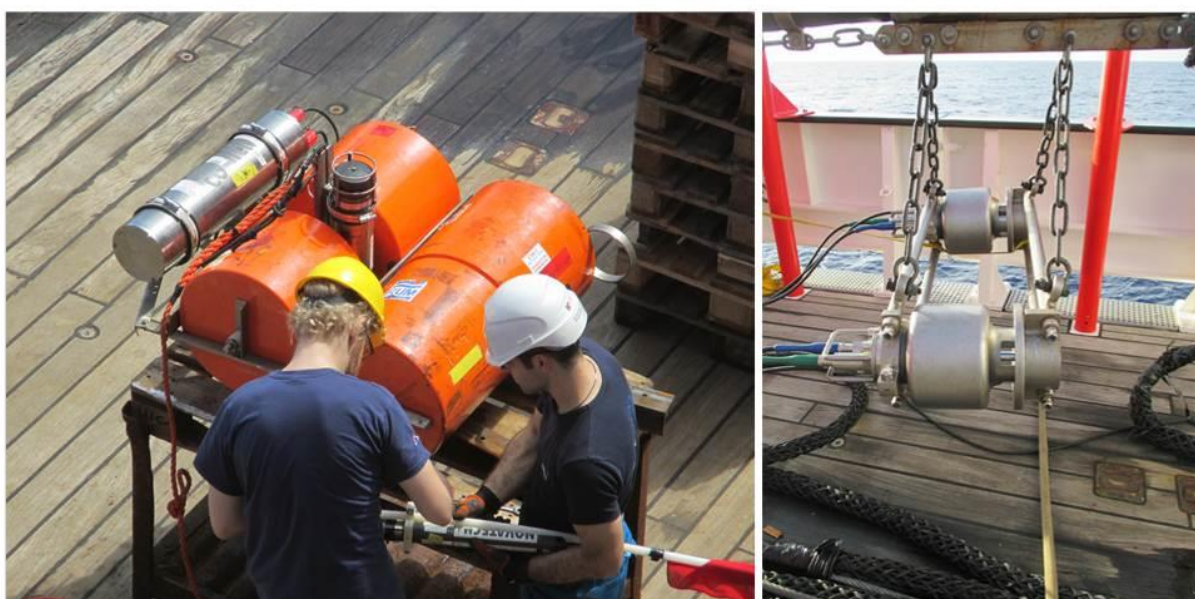
After retrieving the AUV in the afternoon on Christmas Day we proceeded to line BGR2018-204 (P4) to conduct MCS profiling with the BGR streamer across the southernmost extent of the FRSC and the adjacent back-arc. The MCS survey was completed in 12 hours, after which we transited to our next large OBS deployment on line BGR2018-3R5 (P5). 34 OBSs were deployed on line P5 during the next 50 hrs before commencing shooting at mid-day on Thursday 27 December. We completed the MCS survey of P5 late on Friday 28 December and, after recovering the streamer, turned and repeated the line (BGR2018-3R5) from west to east with a shotpoint distance adequate for the OBSs that were already deployed. The refraction profile was completed in the evening of Saturday 29 December. P5 is the second longest of the seismic lines in our program (108 nm), spanning the enigmatic transfer zone between the southern tip of the FRSC and the actively spreading CLSC. The goal was to identify the pattern of rifting and extension in the back-arc region just prior to the link-up of the FRSC with the CLSC and the final connection along the southern boundary of the Niufo'ou microplate. Over half of our proposed seismic program has now been completed, including 2 of 3 refraction lines (P3, P5) and 3 of the 6 multichannel reflection seismic profiles (P3, P4, P5). Recovery of the OBSs on P5 commenced on Sunday morning 30 December and is continuing.

A highlight of the week was a magnitude 6.4 earthquake immediately beneath the study area and our OBSs. It occurred on 24 December and was located 85 km north of Nuku'alofa and 100 km below our instruments, presenting an opportunity to use the energy from the earthquake for imaging of the Fonualei crust. A second event (Mw 5.8) occurred close to the OBSs on Wednesday 26 December.

Very little is known about such events, and the chance to measure them directly should provide a significantly improved picture of deep subduction-zone earthquakes in this region.

Week 3 of SO-267 saw the arrival of Christmas and the end of 2018. With so many experts in diverse fields on board, we have taken advantage of the opportunity to have weekly seminars on topics including the geodynamics of the Lau Basin, submarine arc-backarc volcanism, interpretation of high-resolution magnetics, geological mapping techniques in the Lau region, and comparisons with ancient volcanic belts. For the students and experts alike, SO-267 has become a university at sea. So far, we have been blessed with excellent weather, a very positive outlook by the scientific team and ship's crew, and two unexpected earthquakes(!) in our study area, all of which have contributed significantly to the research objectives.

With best wishes for the coming New Year, from RV SONNE
Mark Hannington and Heidrun Kopp



Right: Preparing one of 50 OBS stations for deployment. **Left:** Two of the 6 guns on the port-side array. Together the starboard and port-side G-Guns have a combined volume of 84 litres.