

SO-267: ARCHIMEDES I Expedition with RV SONNE

Weekly Report No. 5 (7 to 14 January, 2019)

A break in the weather finally came on week 5 after cyclone Mona passed the working area. On Wednesday 09 January we had our first full day of sunshine since December 28. Daytime temperatures quickly rose to 28°C on deck, with the humidity making it feel 40°C. Week 5 was spent exploring the Niuafu'ou plate boundary in the transfer zone between the Fonualei Rift (FRSC) and the Central Lau Spreading Centre (CLSC). The mapping and sampling targets included a broad volcanic field SW of the FRSC, a large arc-like volcanic cone at the end of the Peggy Ridge transform, and an arcuate volcanic dome on the northeast arm of the CLSC. The inner arc high south of the FRSC includes at least three large calderas surrounded by an extensive field



of smaller cones, fissures, and dike complexes. Dredged material from one of the large pre-rift caldera volcanoes suggests that these are somewhat older structures cut by recent fissure eruptions. The area of inflated crust surrounding the volcanoes is cut by faults emanating from the tip of the rift. Many faults are partly concealed by volcanoclastic material but are clearly visible in backscatter, sidescan images, and in the seismic data. The volcanic field is an area of high magnetization, giving the impression that it is underlain by intrusions toward which the FRSC is now propagating. This is likely an area of weakened crust at the emerging Niuafu'ou plate boundary. We completed mapping in the area overnight, on Monday 07 January, with the towed magnetometer deployed to determine the fine magnetic structure of the inflated arc crust.

The next days were spent surveying two arc-like volcanoes on the west side of the Niuafu'ou plate, adjacent to Peggy Ridge and at the northeast arm of the CLSC. Both volcanoes showed high backscatter, suggesting that they are relatively young expressions of the CLSC volcanism. On Tuesday 08 January, we launched the AUV (Dive 311) to determine if they are hydrothermally active; this was the first survey for hydrothermal plumes in the area, covering nearly 100 line-km. Despite the very fresh appearance of dredged volcanic material, there was no evidence of hydrothermal activity. A final dredge in the transfer zone between the FRSC and CLSC sampled the deepest exposure of back-arc crust, at ~3100 m depth, in one of the failed rift basins at the inferred southern margin of the Niuafu'ou microplate. Fresh basalt but also strongly altered rocks were recovered, indicating past hydrothermal activity associated with the lowermost exposed rocks of the back-arc. On Wednesday 09 January we transited to the southernmost point of the working area to conduct MCS on line P6. The BGR streamer, air guns, and magnetometer were deployed in the afternoon and the MCS was completed overnight. This line was chosen to image the buried ridges and failed rifts at the northern end of the ELSC where it approaches the Niuafu'ou plate boundary.

Late on Thursday 10 January, we concluded operations in the southern working area, recovering the guns and streamer near the island of Late. The entire survey is one of the most comprehensive studies of an emerging microplate boundary in an arc-backarc setting, including almost 30 days of seismic imaging, magnetics, gravity, heat flow, multibeam mapping, sampling, AUV-based sidescan, and even earthquake monitoring. The second part

of SO-267 will explore the northern boundary, beginning with our next major OBS deployment on line P2, 170 nm north of P6. AUV Dive (312), our first night-time launch, started mid-way to P6 and followed the vessel along the axis of the FRSC, searching for evidence of hydrothermal activity along the way. Although several sites were already known from CTD casts, the AUV survey was the most comprehensive and continuous search for hydrothermal activity in the rift, employing temperature, redox, and magnetics from a “flight height” of 100 m above bottom. The dive continued while we deployed 20 of our 30 OBSs planned for P2. Operations were interrupted at 18:00 on Saturday 12 January, when the vessel received notice from the RCC (Rescue Coordination Centre) in NZ of a distress signal 90 nm SE, and we were dispatched to investigate. The AUV was left to continue its dive, as it was not scheduled to leave the bottom for another 6 hours and would be safe floating at the surface until it could be recovered.

After ~13 hrs attending to a disabled fishing vessel, we returned to P2 to recover the AUV on early Sunday morning, 13 January, and resume the deployment of OBSs. Thirty instruments were deployed on P2, and the MCS survey was started at mid-day. Profile P2 is a ~150-km line that crosses the thinning arc crust at the northern termination of the FRSC where it overlaps with the east arm of the MTJ. The seismic line is intended to reveal what part of the MTJ-FRSC overlayer is likely to be abandoned, creating a new northern boundary of the Niuafu’ou microplate.

With best regards, after another eventful week aboard RV SONNE,
Mark Hannington and Heidrun Kopp



Left: Tools in use during SO-267 on a busy deck, showing the rock dredge, gravity corer, heat flow probe, a selection of OBSs, and the AUV Abyss in the background. **Right:** Deployment of BGR’s 4-km long streamer cable behind the vessel in preparation for MCS on line P6.