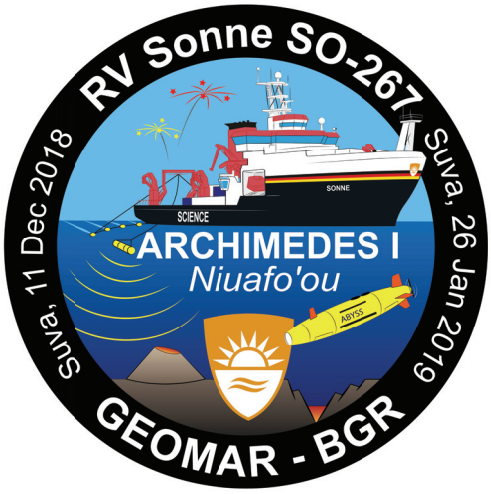
SO-267: ARCHIMEDES I Expedition with RV SONNE

Weekly Report No. 4 (31 December to 6 January, 2019)



Week 4 of SO-267 ushered in the New Year and, unfortunately, bad weather. The first tropical depression passed through the working area on New Year's Eve with periods of heavy wind and rain almost every day thereafter. Gales typically lasted a number of hours with only minor interruptions in the program until 06 January with the arrival of cyclone "Mona".

After completing almost all of our seismic work in the southern part of the study area (P3, P4, and P5), we began an intensive sampling program in the complex transfer zone between the Fonualei Rift (FRSC) and the Central Lau Spreading Center (CLSC). The purpose of the sampling was to determine where (and when) rifting and then back-arc spreading may have started in relation to the Niuafo'ou microplate, and in particular the nature of the magmatism associated with the different stages of opening of the basin. The sampling targeted i) small volcanic cones in the area of intense fracturing at the southern tip of the FRSC, ii) larger inner-arc volcanoes in the area of inflated arc crust south of the FRSC, iii) north-south-trending volcanic ridges in the near back-arc southwest of the FRSC, iv) intraplate cones in the back-arc region, v) major fault scarps and horst blocks among the failed rift basins in the easternmost CLSC, and vi) areas of high backscatter (new volcanism) along the northeast arm of the CLSC. With these dredges a nearly complete history was obtained of the fossil and nascent magmatism in the transfer zone between the FRSC and CLSC. Of note is the range of lithologies dredged from the young volcanoes at the tip of the FRSC, including in just 4 dredges: i) dacite from a small mound in a heavily sedimented portion of the rift, ii) young basalt from a small cone on a rift bounding fault, iii) very fresh, glassy, non-vesicular basalt from a ridge of small volcanoes (presumed fissure eruption) on the inflated portion of the arc in front of the rift, and iv) older Mn-encrusted basalt from a much larger caldera volcano at the edge of the inner arc. The large variety of rock types (aphyric to coarsely porphyritic, felsic to mafic, old and recent) in such close proximity suggests that numerous small batches of magma from different sources underlie the area near the rift tip.

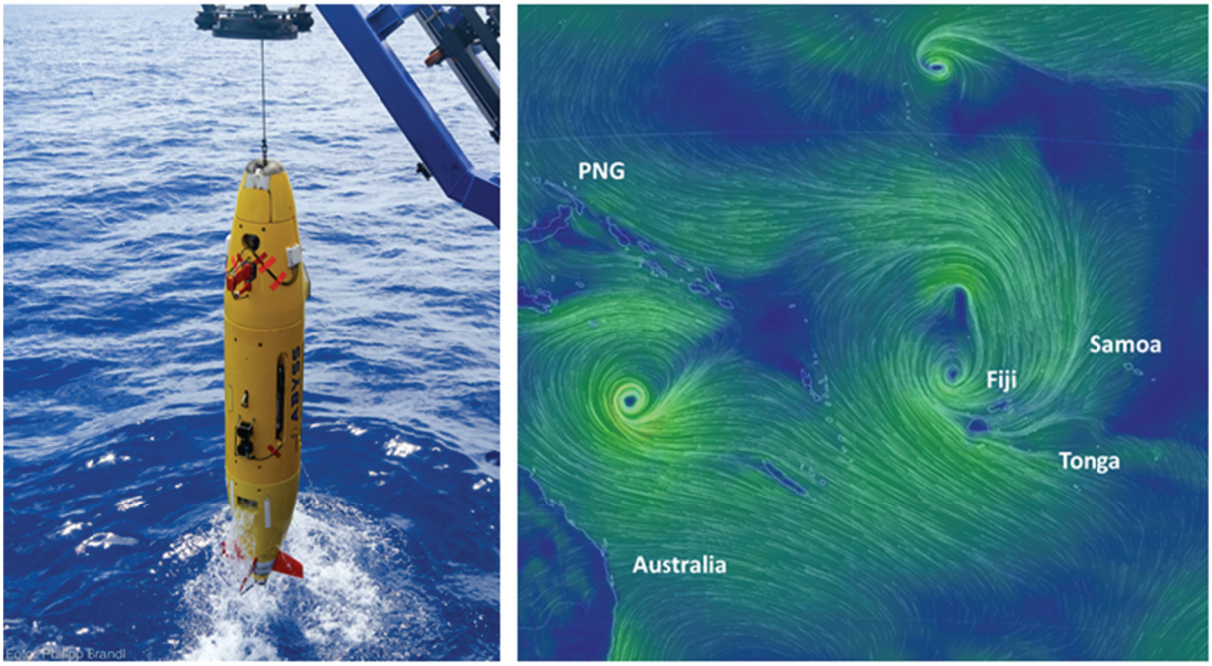
Heat flow and gravity coring to determine the nature of sedimentation and thermal structure of the arc-to-backarc transition has been a challenge. Only 3 heat flow measurements were possible, yielding very low heat flow values, and sediment was recovered only from one deep (>3,000 m) basin nearest the CLSC in the west. The unexpectedly low heat flow has been a subject of discussion, but may reflect cooling of the crust as a result of the very extensive deformation and fracturing. An important development was the decision to attach a small GoPro camera in a pressure housing (rated to 2600 m) under the head of the heat flow probe. This provided clear images of the seafloor where the probe landed and showed the penetration of the lance into the sediment. Despite sub-bottom profiles indicating thick sediment fill in all of the basins, those close to the arc contain abundant coarse volcaniclastic material, which could not be penetrated with the 3-m corer.

On Monday 31 December, heavy weather and poor visibility slowed the recovery of the OBSs from P5, and on Tuesday and Wednesday, 01 to 02 January, operations were limited mostly to mapping, with no chance for a planned AUV launch. A small window in the weather on Tuesday night permitted

dredging in the S-FRSC before another storm arrived in the evening. By Wednesday afternoon the waves moderated and we started the heat flow survey along P5, with stations on the inflated arc crust, outer rift flank, and the central portion of the arc-backarc transition zone. On Thursday 03 January, we were finally able to launch the AUV (Dive 310) for a sidescan survey of what appears to be the youngest volcanoes lining a fissure at the southernmost tip of the FRSC. The AUV Team took the unusual approach of flying the ridge of volcanoes twice, at different heights, to create a mosaic of sidescan images of the steeper slopes and pinnacles. Very youthful volcanic "landforms" were mapped, including scoria cones and "breadcrust" volcanoes, typical of fissure zones in mafic volcanic terrains on land. On the morning of Friday 04 January, we interrupted the dredge program to recover the AUV, and on Friday afternoon tried again to conduct heat flow and gravity coring in the deep basins near the CLSC. After one successful heat flow penetration and one (30 cm) gravity core in the westernmost basin, operations were stopped for ~9 hrs to ride out another gale. Dredging of the westernmost sub-basin on P5 resumed on Saturday evening and continued into Sunday 06 January.

After 4 weeks of hard work, we have conducted more than 1,000 km of seismic profiles, including reflection (320 nm) and refraction (270 nm) seismics at the southern and eastern boundaries of the Niuafo'ou microplate. We have covered about 18,000 km^2 of the basin with high-resolution multibeam, backscatter, and sub-bottom profiling, including 5000 line-km of mapping with more than 1800 km of towed magnetics. With the cruise only half over, we have completed 119 OBS and OBMT deployments, three AUV dives with 340 km of sidescan surveying, 20 dredges, 17 heat flow and 6 gravity corer deployments … and 5 blogs! (www.oceanblogs.org/so267)

With best regards from RV SONNE, after a week of stormy weather,
Mark Hannington and Heidrun Kopp



Right: Recovery of the AUV Abyss after a dive on the youngest volcanoes of the FRSC (in the calm before the storms). ***Left***: Screenshot of surface wind speed from earth.nullschool.net/ showing the approach of the first tropical depressions (cyclones) that passed through the working area during Week 4. RV SONNE is located in the triangle between Fiji, Tonga, and Samoa.