

Hydrothermal Activity in the Eastern Manus Back-arc Basin, Papua New Guinea, With Focus on Fluid Geochemistry

BAMBUS (*Back-Arc-Manus-Basin-Underwater-Solfataras*) Cruise Report R/V SONNE, Leg SO-216

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The primary goals for the BAMBUS cruise SO-216 were to obtain vent fluid and biota samples from hydrothermal systems in the eastern Manus Basin using the ROV *MARUM* Quest 4000m. Secondary objectives focused on geophysical mapping and echosound surveying of the basin as well as the collection of volcanic rocks and vent precipitates using a TV grab. Hydrothermal fluid sampling was accomplished using Isobaric Gas-Tight (IGT) fluid samplers that allow for quantitative analysis of dissolved gases and major/minor elements, as well as providing real-time temperature measurements (Seewald et al., 2002). Fluid analyses at sea consisted of measuring dissolved H₂ concentrations using gas chromatography and pH (25°C). Additional fluid samples were treated and stored for land-based analyses of other major and minor dissolved species (gases and inorganic anions/cations, sulfur species, arsenic species). End member fluid chemistry data collected from the SO-216 expedition will be compared with the 2006 MGLN06MV cruise (Tivey et al., 2006, Reeves et al., 2011) in order to document any temporal changes.

Two key vent sites were visited. The first was located at North Su neovolcanic dome (3°48.0'S, 152°06.05'E) where twelve dives took place in a water depth of ~1200 m. Black smoker systems located near the summit of the dome displayed maximum measured temperatures of 332°C and 313°C and were seen to be “flashing”, as previously observed in 2006 (Tivey et al., 2006; Reeves et al., 2011). Measured H₂ concentrations ranged from 24-50µM while measured pH values were between 3.2 and 4.8 at 25°C. Hydrothermal vents located on the flanks of the dome were clear/diffuse vents and white smokers. The white smokers were seen actively venting liquid CO₂ in the newly discovered ‘Sulfur Candles’ area, named for the spectacular molten sulfur chimneys. These fluids had maximum temperatures of 95°C and 103°C, respectively. Extremely low pH (25°C) values of 1.2-1.4 were measured at Sulfur Candles while H₂ concentrations were observed to be <5µM, with no H₂S odour present.

Ten dives took place in the PACMANUS vent field located on Paul Ridge at 3°43.5'S, 151°40.4'E in approximately 1700 m water depth. Significant temporal changes were observed in these high temperature black/grey smoker fluids compared to the end member fluids in 2006 (Reeves et al., 2011) and at the Satanic Mills area, liquid CO₂ venting was observed for the first time. Black smoker vents sampled at Paul Ridge showed considerably higher maximum temperatures of 345°C and 339°C when compared to 2006 measurements, while the pH ranged from 2.8-3.0 at 25°C. Furthermore, the exploration of two new high temperature vent fields discovered by Nautilus Minerals was carried out during this expedition. These new fields were on the flanks of Paul Ridge and were venting hot (up to 348°C) fluids, indicating highly active systems. Shore-based analyses will further elucidate the compositional variability of the collected fluids, as well as furthering our understanding of the magmatic fluid inputs to these systems. The SO-216 expedition results will also prove extremely valuable in understanding the temporal evolution of back-arc hydrothermal fluid compositions, which have traditionally received little attention.