Seventeen years of exploring intraoceanic arcs

DE RONDE, CORNEL E. J.[1]

[1]GNS Science, PO Box 30-368, Lower Hutt, New Zealand (cornel.deronde@gns.cri.nz)

The 1999 NZAPLUME (New Zealand American PLUme Mapping Expedition) heralded a new chapter in deepsea research related to seafloor hydrothermal systems. That is, a hitherto unprecedented approach to systematically survey submarine arc volcanoes for their hydrothermal emissions. Two additional surveys along the Kermadec arc, another along the southern Tonga arc, one along the Tabar-Lihir-Tanga-Feni arc (PNG), one along the Aeolian arc (Italy) and similar expeditions along the Mariana arc by collaborators meant that 75% of the world's intraoceanic arcs have been surveyed for seafloor hydrothermal activity. In concert with these surface ship-based surveys, manned submersible (*Shinkai 6500*, *Pisces V*), ROV (*ROPOS*, *Jason II*, *Kiel 6000*) and most recently AUV (*ABE*, *Sentry*) cruises have focused on the Kermadec and Mariana arcs especially, and to a lesser extent the Tonga and Izu-Bonin arcs. This two-pronged approach to exploration has mean regional-scale surveys delivered 'targets' for deep-diving vehicles that provided ground-truthing of the seafloor hydrothermal systems.

A worldwide approach has enabled arc hydrothermal systems to be put into context with respect to global seafloor hydrothermal venting. For example, the ~6,900 km of intraoceanic arcs in the world equates to hydrothermal emissions equal to ~10% of that from the 60,000 km of mid-ocean ridges (MORs) (i.e., a similar incidence of venting). Arc volcanoes and their corresponding hydrothermal systems can occur atop cones, inside calderas and combinations thereof, and range in depth from near surface to ~2000 m below sealevel. However, arc systems are known to contain much higher gas concentrations than do those along MORs, which is reflected in the discharge of large amounts of CO_2, SO_2 and H_2S. Moreover, significant amounts of Fe are commonly discharged at arc vent sites; massive sulfide mineralization occurs in at least 10% of the arc seafloor vent sites where Cu/Au mineralization dominates at deeper depths (i.e., where there are higher vent fluid temperatures).

The introduction of AUVs in the investigation of arc seafloor systems has provided information at a scale that is relevant to the study of volcanic and structural processes, ore deposit formation and vent-related habitats. The combination of high-resolution bathymetric mapping with geophysical (largely magnetic) and water column (e.g., CTD, light scattering, pH, ORP) measurements, as co-registered data sets, has enabled advances in modelling these systems that in turn has shown a strong influence of magmatic gases in the chemistry of discharging fluids.