Gateway to the sub-arc mantle: Conditions for early life, Brothers Volcano, New Zealand

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Hydrothermal systems hosted in submarine arc volcanoes differ substantially from those in spreading environments in commonly containing a large component of magmatic fluid. This magmatic hydrothermal signature, coupled with the shallow depths of arc volcanoes and high volatile contents, strongly influences the chemistry of the fluids and the resulting mineralization, and likely has important consequences for the biota associated with these systems. Given the high metal contents and very acidic fluids, these hydrothermal systems are also thought to be important analogues of many porphyry copper and epithermal gold deposits mined on land.

Geological and geochemical studies have shown that hydrothermal systems in arc volcanoes differ substantially from those in spreading environments, such as backarc basins and mid-ocean ridges. Our primary scientific goal with IODP is to discover the fundamental, underlying processes that drive these differences. Through the recovery of cores and logging drill holes at Brothers volcano, we plan to pursue this goal by addressing the following four objectives: (1) Characterizing the sub-volcano, magma chamber-derived volatile phase to test model-based predictions that this is either a single-phase gas, or two-phase brine-vapor; (2) Exploring the sub-seafloor distribution of base and precious metals and metalloids, and the reactions that have taken place along pathways to the seafloor; (3) Quantifying the mechanisms and extent of fluid-rock interaction, and consequences for mass transfer of metals and metalloids into the ocean and the role of magmatically-derived carbon and sulfur species in mediating these fluxes; and (4) Assessing the diversity, extent and metabolic pathways of microbial life in an extreme, metal-toxic and acidic volcanic environment.