Symbiosis between caldera collapse and hydrothermalism at Brothers submarine volcano, Kermadec arc

C.E.J. DE RONDE[1*], S.E. HUMPHRIS[2], T.W. HÖFIG[3], A.G. REYES[1] AND EXPEDITION 376 SCIENTISTS

[1] Dept. Marine Geosciences, GNS Science, Lower Hutt 5040, New Zealand (*correspondence: cornel.deronde@gns.cri.nz)
[2] Dept. of Geology & Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
[3] International Ocean Discovery Program, Texas A&M University, College Station, TX 77845, USA

Hydrothermal systems hosted by submarine arc volcanoes commonly include a large component of magmatic fluid. The high Cu-Au contents and highly acidic fluids in these systems are similar to those that formed in the shallow parts of some porphyry copper and epithermal gold deposits mined today on land. Brothers volcano in the Kermadec arc hosts both magmatically-influenced and seawater-dominated hydrothermal systems within its caldera. Here we report results from a series of boreholes cored by the International Ocean Discovery Program into these two active hydrothermal systems. We show that the record of hydrothermal alteration of the host dacitic volcaniclastics and lavas reflects primary lithological porosity and contrasting spatial and temporal contributions of magmatic fluid, hydrothermal fluid, and seawater. We present a two-step model that links the changes in hydrothermal fluid regime to the evolution of the volcano caldera. Initial hydrothermal activity, prior to caldera formation, is dominated by magmatic gases and hypersaline brines. The former mix with seawater as they ascend towards the seafloor, and the latter remain sequestered in the subsurface. Following caldera collapse, seawater infiltrates the volcano through fault-controlled permeability, interacting with wall rock and the segregated brines, transporting associated metals towards the seafloor and forming present-day Cu-Zn-Au-rich chimneys. Such a two-step process may be common in submarine arc caldera volcanoes that host VMS deposits, with these sites particularly efficient at focusing mineralization at, or near, the seafloor.