Open-system submarine volcanoes: dynamics and phase state

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The discovery and subsequent exploration of active submarine volcanoes along convergent plate margins (de Ronde et al., 2001) raises questions of the persistence of their eruptive activity and the phase state of gaseous discharges from them. Several have been shown to host molten sulfur lakes (e.g. Macauley cone, Kermadec Arc, Diakoku, Mariana Arc) while NW Rota-1 (Mariana Arc) has maintained Strombolian eruption activity for at least six years. Some are known to discharge significant quantities of hydrothermal fluid (e.g., Brothers volcano, Kermadec arc), while others have sustained hydrothermal activity for up to 18,000 years, (e.g., Clark volcano, Kermadec arc) while others, such as Giggenbach volcano (Kermadec arc), persistently discharge gases (especially CO2) more vigorously than others.

However, based on observations from spreading volcanic environments, it has been suggested that that drilling into submarine arc volcanoes could not penetrate beneath a two-phase fluid regime. Here, we show from first principles that the normal state of magmatic gas discharge through an active volcanic system, whether submarine or subaerial, is single phase, forming a low density, high enthalpy core regime Two phase conditions are constrained to flank regimes with only surficial mixing and cooling in vent areas.

de Ronde, C.E.J.,et al., 2001, Intra-oceanic subduction-related hydrothermal venting, Kermadec volcanic arc, New Zealand:Earth Planet. Sci. Lett.193, 359-369.