Investigating the formation of the Kikai submarine lava dome using matrix glass volatile contents

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The mostly submarine Kikai caldera contains an unusually large (~10 km diameter; ~32 km3) rhyolite dome structure. Based on the physical characteristics and geochemistry of rock samples recovered from this dome, it is interpreted to be a vast lava dome that formed sometime after the last caldera-forming eruption of Kikai at 7.3 ka (known as the Akahoya eruption, which produced the Koya pyroclastic flow). However, little is known about how this large dome was emplaced and its implications for understanding the Kikai volcanic system. For example, based on its surface features it has been hypothesized that some parts of the lava were emplaced endogenously (i.e. by inflation of the dome due to continuing injection of lava from below) whereas other areas were emplaced exogenously (i.e. by eruption of lava flows onto the seafloor/dome surface) (Tatsumi et al, 2018 Sci.Rep.). Because the concentration of dissolved volatiles (e.g. H2O, CO2) in a magma/lava is strongly controlled by the ambient pressure (corresponding to, e.g., depth within a magma body or depth below sea level), matrix glass volatile contents have the potential to be a valuable record of eruption and emplacement conditions.

Here we present H2O contents of matrix glasses from samples dredged at multiple locations and water depths across the Kikai dome by R/V Shinseimaru and R/V Kairei cruises KS-19-17, KR19-11 and KR20-11. Samples were analysed using Fourier Transform Infra Red spectroscopy (FTIR), which can quantify both H2O species that exist in hydrous magmas/glasses (i.e. molecular H2O and OH groups). Samples are weakly to moderately vesicular with pumiceous character, requiring analysis of thin glass shards utilizing imaging FTIR analysis and a species-dependent molar absorptivity coefficient for the H2Ot peak (McIntosh et al, 2017 Am. Mineral.). The majority of samples exhibit excess molecular H2O, indicating significant secondary hydration of matrix glasses since eruption. OH contents are assumed to be unaffected by low temperature secondary hydration and therefore indicative of eruption conditions. We show that almost all samples have lower OH concentrations than would be expected for an H2O-saturated magma at their current dredge (assumed ~emplacement) depths and explore the hypothesis that this is due to CO2 fluxing through the dome during emplacement.

Keywords: Kikai caldera, Submarine volcanology, Lava dome, Volatiles, FTIR spectroscopy

