

Investigating past eruptive activity of a silicic submarine volcano using FTIR volatile analyses

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Eruptions of silicic magmas like rhyolite are controlled by the rate and extent of bubble growth that occurs when magmatic volatiles, chiefly H₂O and CO₂, exsolve into the vapour phase during magma ascent. When erupted magma cools quickly enough to form volcanic glass, the dissolved volatile contents of this glass form a geochemical record that can be used to interpret degassing and eruption processes. However, silicic volcanic glasses are vulnerable to secondary hydration (i.e. slow diffusive addition of water from the surrounding environment in the time since eruption), which overprints the eruptive volatile record. Silicic submarine eruption products are especially vulnerable to this hydration. Moreover, the relative lack of material suitable for radiocarbon dating means that it is difficult to obtain ages for late Quaternary submarine eruptions. Using new Fourier Transform Infrared spectroscopy (FTIR) methods for vesicular and hydrated glasses, we demonstrate that it is possible to use this volatile record to investigate past eruptive activity of submarine volcanoes. We present data for Oomurodashī, an active, shallow, silicic submarine volcano only 60 km from the entrance to Tokyo Bay. Geochemistry confirms Oomurodashī is the source of a ~11.5 ka subaerial tephra deposit on the nearby inhabited islands of Izu-Oshima and Toshima. We infer on the basis of pumice volatile contents and tephra characteristics that this deposit was formed by explosive submarine phreatomagmatic activity that produced the shallow central crater in the submarine edifice. Volatile contents of in situ submarine lavas are lower than expected for their current water depth and comparison with past sea level implies that these effusive eruptions occurred at ~8-9 and ~12 ka during times of lower sea level. Although all matrix glasses have experienced hydration, water speciation data suggest this is consistent with low temperature secondary hydration following eruption rather than hydration during cooling within a submarine plume. Oomurodashī has also erupted submarine pumice with different densities, quench depths and dispersal histories; however, any pumice sufficiently buoyant to produce floating pumice rafts will have been lost from the local geological record. FTIR volatile analyses of distant marine pumice will be invaluable for understanding how potentially hazardous pumice rafts form.

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