

Along-arc geochemical variation of the southern Izu-Bonin arc –Transition from the Izu-Bonin to Mariana arc

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We present new isotopic and trace element data for lavas from the southern Izu-Bonin arc (24-30°N) including high-precision Pb isotope measurements. The southern Izu-Bonin arc is cut by the Sofugan Tectonic Line (Yuasa, 1985) and is characterised by intra-arc rifting. The volcanoes studied are mostly submarine basaltic and andesitic cones at the volcanic front. Most of the volcanoes have been active in late Quaternary.

These volcanoes share some geochemical characteristics with the frontal volcanoes in the northern part of the arc, e.g., enrichment of fluid-mobile elements and depletion in HFSE relative to MORB. However, isotopic and chemical tracers show significant variation along the length of the arc. A southward decrease of ⁸⁷Sr/⁸⁶Sr and increase in radiogenic Pb is observed in the northern section of the arc and this continues into the southern arc. The $\Delta 7/4$ and $\Delta 8/4$ of the Pb isotopes decrease towards south and appear to approach the isotopic composition of the Iojima volcano at the boundary of the Izu-Bonin and Mariana arc. The trace element signature changes significantly south of Sofugan Tectonic Line. The southern arc has higher Nb contents and higher LREE/HREE and Nb/Zr compared to the relatively constant values of the northern arc. These geochemical variations strongly suggest the existence of the source heterogeneity in along-arc direction.

Correlation between ⁸⁷Sr/⁸⁶Sr and fluid-mobile element enrichment and decreasing ⁸⁷Sr/⁸⁶Sr and Ba/La towards south imply that the slab-derived fluid contribution becomes less significant towards south. Instead, low ¹⁴³Nd/¹⁴⁴Nd associated with elevated Th/LREE and low Ce/Ce* for the volcanoes in the southern part of the studied area might indicate the contribution of the bulk sediment to the source. However low $\Delta 7/4$ in the south precludes the possibility of simple addition of pelagic sediments.

The possible mechanisms of the geochemical along-arc variation of the lavas to be examined include: 1) along-arc variation of the slab-derived component, 2) along-arc variation of wedge mantle composition prior to the addition of slab-derived component, 3) low degree of partial melting associated with smaller input of fluid from slab in the south.

Diffusion and dissociation behavior of H₂O and OH species in a volcanic glass at super-critical conditions

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Introduction

Behavior of volatile phases is one of primary factors to determine magma pressure in volcanic eruptions. At high temperature and pressure, super-critical water interacts with rocks and minerals surrounding magma. In this study, hydration experiments of a volcanic glass at super-critical conditions are carried out to elucidate initial processes of hydration reactions in the volcanic glass.

Starting material of the experiments is a rhyolitic obsidian. A cube of the obsidian with 3mm in dimensions is sealed in a silver capsule with distilled water. Experimental conditions are 400-550 °C, 25-75 MPa, and 24-168 hours. Run products are observed by SEM and micro FT-IR.

Hydration processes of volcanic glass

Hydrated layers were observed at surface of run products. Thicknesses of the layers are approximately proportional to square root of run durations at constant temperature and pressure. Pressure dependency of the thickness of the layers are also observed at constant temperature and run durations. Diffusion of water is considered to be rate-determining process of growth of hydrated layers.

Micro FT-IR measurements of run products were carried out to analyze depth profile of water species. Molecular H₂O and OH profiles indicate that surface layers of the run products are saturated with these species. A boundary between hydrated layer and unhydrated central area was observed at the maximum of total H₂O concentration gradient.

Calculated diffusion coefficients were 10⁻¹¹⁻¹³ m²/sec, and these were larger in one or two orders than that observed dehydration processes of rhyolitic glass by Zhang et al. (1991). Activation energy calculated from temperature dependency of the diffusion coefficients was 80±14 kJ/mol at fluid density of 0.3 g/cm³. Super-critical water intruding into volcanic glass has higher apparent diffusion coefficient than that in the dehydration processes.

Dissociation coefficients of H₂O and OH in the hydrated layers were constant. Then, the dissociation coefficients decrease and finally increase to the unhydrated region. Decrease of dissociation coefficients indicates that apparent diffusion rate of H₂O molecule is faster than that of OH and production rate of OH by dissociation of H₂O, that reaction has to break Si-O-Si network to product Si-OH bonding.

References

Zhang Y., Stolper E.M., and Wassenberg G.J. (1991),
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