Forward modeling of the magma genesis for the deepest lithostratigraphic unit at Site U1437, IODP Expedition 350

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Site U1437 is located in the Izu rear-arc region, approximately 330 km west of the Izu-Bonin Trench axis and about 90 km west of the submarine Myojinsho volcano, 2117 meters below the sea level (mbsl). The stratigraphic Units VI and VII of this site, 1320–1806.5 meters below the seafloor (mbsf), contain volcaniclastics and hyaloclastites with coarse lava clasts. One of the research objectives of the IODP Expedition 350 is the analysis of the geochemical characteristics of Izu rear-arc magmas, which are not accessible by dredging (Tamura et al., 2015).

The geochemical characteristics of the Unit VII volcaniclastics (1459.8–1806.5 mbsf) are expected to reflect the mantle source of the magmatism soon after the opening of the Shikoku Basin, which occurred between 24–15 Ma (Okino et al., 1994). Major-element and trace-element compositions of the Unit VII lava clasts differ from those of the Neogene rear-arc seamounts or Quaternary arc-front volcanoes. Most lava clasts from Unit VII have trace-element characteristics indicating weak influences from the slab (fluid or melt) (Sato et al., in preparation). Sr-Nd-Pb-Hf isotope ratios of the same samples are consistent with the trace-element characteristics.

In this study, ABS4 (Arc Basalt Simulator version 4) by Kimura et al. (2014) and PRIMACALC2 (Primary Magma Calculator version 2) by Kimura and Ariskin (2014) were used to model the source conditions of the magma genesis based on the major and trace elements, and Sr-Nd-Pb-Hf isotope compositions. Compositions of the primary magmas were estimated using PRIMACALC2 for one lapilli-tuff sample from the upper part of Unit VII and two volcaniclastic samples from the lower part of Unit VII. The forward modelling using ABS4 was performed on the primary magma compositions.

The model results suggest that the slab flux (fluid/melt) were derived from mixtures of the liquids from altered oceanic crust layer (50–52 %), sediment layer (18–32 %), and mantle-wedge base peridotite layer (17–32 %). These slab liquids were generated at depth of 3.7–4.5 GPa with slab surface temperature 775–804 ˚C. The conditions of fluxed melting of the mantle wedge showed large differences between the lower part (F = 1.4–4.2 %) and the upper part (F = 25 %) of Unit VII, but the melting depth is limited within the depth range 1.5–1.8 GPa. The flux fraction of the slab-derived liquid also differs between the lower part (0.4–0.6 %) and the upper part (2.5 %) of Unit VII.

Using the previously published Quaternary basalt compositions from the volcanic front, active rift, back-arc knoll, and rear-arc settings, source conditions were compared with that of the Unit VII. The Unit VII magmas were generated from the conditions similar with those in the active rift, back-arc knoll, and rear-arc environments, except for their higher degrees of melting with higher flux rate of the slab liquids. These characterize the source conditions of the upper part of Unit VII.

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