

IODP Expedition 351 Izu-Bonin-Mariana Arc Origins: Temporal evolution of arc volcanism inferred from melt inclusions

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International Ocean Discovery Program (IODP) Expedition 351 (June-July 2014) cored 1611-m-long cores composed of 1461-m-long sediments and 150-m-long igneous basement rocks from Site U1438 in the Amami Sankaku Basin (ASB), west of the Kyushu-Palau-Ridge (KPR) which represents a remnant part of the now active Izu-Bonin-Mariana (IBM) arc. Based on lithostratigraphy, the sedimentary section is divided into four units. The uppermost Unit I (160.3-m long) is composed of Neogene hemi-pelagic sediments with interspersed discrete ash layers derived from explosive volcanism probably from the Ryukyu and Kyushu arcs. Unit II (139.4-m long) is composed of late-Oligocene turbidites. Unit III (1046.4 m long) is composed of Oligocene to Eocene coarser-grained turbidites. Unit IV (99.7-m long) is composed of siliceous pelagic sediments interbedded by tuffaceous sandstones.

In order to study the temporal evolution of island arc volcanism at an earlier stage of the IBM arc, we analyzed major and volatile elements (Cl and S) of melt inclusions collected from Unit III (30-40 Ma based on onboard biostratigraphy) using electron probe microanalyzers (EPMAs) installed at JAMSTEC and ANU. Most of the host minerals of melt inclusions are clinopyroxene and plagioclase and the compositions of melt inclusions are diverse, ranging from basalt through rhyolite, and also ranging from low-K to medium-K series. In terms of major elements, low-K series melt inclusions are consistent with the melt compositions reported from forearc region and volcanic front of the IBM arc. Major element composition of medium-K series melt inclusions overlaps with the melt composition reported from the IBM rear-arc, such as volcanoes on the KPR and/or near the ASB. These observation suggests that the turbidites accumulated at the ASB originate not only from the IBM rear arc, but also from the IBM forearc and/or frontal-arc.

Both low-K and medium-K melt inclusions older than ~35 Ma are basaltic and andesitic melts. Rhyolitic melts suddenly occur at ~35 Ma and afterward. The number of melt inclusions containing intermediate composition (66-74 wt.% SiO₂) is smaller, suggesting that such intermediate melts represent mixtures of mafic and rhyolitic melts. We infer that the middle crust beneath the arc volcanoes would have been growing and thickening until ~35 Ma after subduction had been initiated at ~50 Ma, and that the rhyolitic magmas would have been generated by partial melting of the middle crust at ~35 Ma and afterward.

Keywords: IODP, IBM arc, Kyushu-Palau ridge, Amami Sankaku Basin, melt inclusion