

Overview of IODP Expedition 352 - Testing subduction initiation and ophiolite models by drilling the outer IBM fore-arcs

SHIMIZU, Kenji^{1*} ; MICHIBAYASHI, Katsuyoshi² ; SAKUYAMA, Tetsuya³ ; PYTHON, Marie⁴ ;
IODP, Expedition 352 scientists⁵

¹JAMSTEC, ²Institute of Geosciences, Shizuoka University, ³Dept. Geosciences, Osaka City Univ., ⁴Natural History Science, Hokkaido Univ., ⁵IODP

The Izu-Bonin-Mariana (IBM) arc is the ideal locality for studying subduction initiation, arc magmatism and the earliest stages of continental crust formation. To gain a better understanding of the evolution of subduction zones, three IODP expeditions (Expedition 350, 351 and 352) were conducted at the IBM arc system (rare-arc, proto-arc and fore-arc) between March and September 2014 by the JOIDES Resolution drilling vessel. Expedition 352 was targeted to drill the entire magmatic sequence comprising the outer Bonin fore-arc to elucidate early subduction dynamics and test ophiolite formation models posit formation upon subduction initiation. During the expedition, a total of 1.22 km of igneous basement related to subduction initiation and 0.46 km of overlying sedimentary rocks were cored from four sites (U1439, U1440, U1441, U1442).

Two sites (U1440 and U1441) located nearer to the trench, recovered igneous rocks at the basement that are mostly fore-arc basalts (FABs) manifest as pillow lavas, sheet flows and hyaloclastites. At the lowermost part of Hole U1440B, FABs are overlain by dolerites, which are interpreted as feeder dikes for the upper FAB lava units. Compositions of FABs are similar to those of mid oceanic ridge basalts, and exhibit little evidence of subduction influence.

From the two sites (U1439 and U1442) located ~15 km west from U1440 and U1441, pillow lavas, massive lavas, hyaloclastites and pyroclastic flow deposits of boninite were recovered. Boninites with doleritic texture were also recovered from the lowermost part of Hole U1439C, which may represent a dike complex. No FAB was found beneath boninite in these sites. Boninites are chemically distinct from FAB by virtue of higher SiO₂, MgO and K₂O and lower TiO₂. These chemical criteria dictate that boninites formed by partial melting of a more depleted mantle source enriched in slab-derived subduction components.

The presence of feeder dikes at the bases of FAB and boninite holes (U1440B and U1439C, respectively) indicates that the occurrence of boninitic and FAB lavas was offset horizontally as opposed to vertically. At a relatively early stage of subduction formation, conditions of magma genesis changed drastically from predominantly decompression melting (formation of FAB) to flux melting (formation of boninite).

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