

Significant uplift of the forearc at the subduction initiation inferred from volcanic glasses in the Bonin fore-arc (IODP Expedition 352)

KENJI SHIMIZU¹ AND TAKAYUKI USHIKUBO¹

¹Kochi Institute for Core Sample Research,
JAMSTEC, Kochi, 783-8502, Japan
(shimmy@jamstec.go.jp)

IODP Expedition 352 drilled a total of 1.22 km of igneous basement from four sites (U1439-U1442) at the outer Bonin fore-arc to elucidate the early subduction dynamics. Two sites (U1440 and U1441; water depth of 4775 m and 4446 m, respectively) located nearer to the trench (strati-graphically lower and older sequence than U1439 and U1442), recovered igneous rocks at the basement that are mostly fore-arc basalts (FABs). From other two sites (U1439 and U1442; ~3150m water depth) located ~15 km west from U1440 and U1441, boninites were recovered.

From all sites, we recovered fresh volcanic glasses manifest as chilled margins of pillow lavas, massive lavas, hyaloclastites and pyroclastic deposits. We analyzed volatile (H₂O, CO₂, F, Cl, S) and P₂O₅ concentrations of 100 volcanic glasses (31, 23, 1 and 45 samples from U1439, U1440, U1441 and U1442, respectively) using SIMS at JAMSTEC and paleo-eruption depths were evaluated by H₂O and CO₂ contents dissolved in glasses. Most glasses from the FAB sites (U1440 and U1441) have various H₂O (0.11-0.82 wt%) and CO₂ contents (54-151 ppm), reflecting vapour saturation pressure of 165 - 335 bars (average of 220±50 (1SD) bars; ~2200m water depth), comparable to those at mid-oceanic ridges (2500-3500m). On the other hand, glasses from the boninite sites (U1439 and U1442) are high in H₂O (1.5-2.1 wt%), and are remarkably low in CO₂ (< several ppm: below detection limit), reflecting vapour saturation pressure of 220 - 460 bars (average of 350±50 bars; ~3500m water depth).

Subduction zone of Izu-Bonin-Mariana arc initiated at the boundary of younger Philippine Sea Plate (PSP) and older Pacific Plate (PAC) at ~52 Ma. Presence of the Cretaceous (~120 Ma) plateaus adjacent to Amami-Sankaku Basin, where FABs are recovered during IODP Expedition 351 (Arculus et al., 2015, Nat. Geosci.), indicates the age of over-riding PSP at the subduction initiation should be older than 70 million years. Assuming normal subsidence rate of an oceanic lithosphere for PSP, water depth at the initial subduction zone should be > 5000 m. Our results suggest that Bonin fore-arc was significantly uplifted (2000-3000 m) and widely spread at the subduction initiation probably by mantle upwelling caused by the sinking PAC as in previous works, then subsided by ~1000 m before the boninite eruption stage.