Early stages in the Evolution of Izu-Bonin-Mariana Arc volcanism: new age, chemical, and isotopic constraints

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A remarkable record of early arc volcanism in the Izu-Bonin-Mariana (IBM) arc is exposed in and around the Bonin Islands, an uplifted segment of the IBM forearc. New 40Ar/39Ar dating results imply that the boninitic volcanism on Chichijima Island occurred in a brief period during Eocene time, between 46-48 Ma. A slightly younger volcanic succession is identified along the Bonin Ridge, including the 44.74+/-0.23 Ma high-Mg andesite from the Mikazukiyama Formation, the youngest volcanic sequence on Chichijima, 44.0+/-0.3 Ma tholeiitic to calcalkaline andesite from Hahajima Island, and 3 samples of andesite collected by the submersible SHINKAI 6500 from the Bonin Ridge Escarpment (BRE) that range in age from 41.84+/-0.14 to 43.88+/-0.21 Ma. Four SHINKAI 6500 dives (YK 04-05) on the BRE mapped an elongate constructional volcanic ridge atop the escarpment; we observed steeply west-dipping volcaniclastic debris flows shed from the summit of this ridge into the Ogasawara Trough to the west. These dives recovered fresh andesitic clasts from debris flows along the northern segment of the ridge, and high-Mg andesite lava blocks and Nummulitic limestone of middle Eocene age from the escarpment northwest of Chichijima. The chemical characteristics of early arc volcanism changed about 45-46 Ma, from boninite to arc-like (tholeiitic to calcalkaline) basaltic andesites and andesites. These data indicate that boninitic volcanism occurred nearly simultaneously along the entire length of the IBM arc system during the earliest stage of arc evolution. A process which enables melting of depleted mantle at shallow levels beneath the length of the arc with the aid of hydrous fluids from newly subducted slab is inferred from the volcanic history and chemical characteristics of boninite and associated volcanic rocks. BRE-Mikazukiyama Formation-Hahajima andesites represent a transitional stage from forearc spreading (represented by ODP site 786-Chichijima boninites) and the stable, mature arc that developed in the Oligocene. These OPX-bearing tholeiitic high-Mg andesites were erupted along the BRE, as the arc magmatic axis localized and retreated from the trench. The change from shallow near-trench hydrous melting of the mantle to more typical arc magma generation occurring further away from the trench and deeper in the mantle appears to have been well underway in the Bonin ridge area by about 43 Ma. Comparison between these transitional lavas and Oligocene arc lavas from the Kyushu-Palau Ridge will also be made in this talk.