Backarc volcanism along the en echelon seamounts in the northern Izu-Bonin

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Detailed petrological and geochemical analyses of sampled volcanic rocks from the en echelon seamounts has enabled the construction of a dynamic model for backarc volcanism associated with backarc spreading in an oceanic arc environment.

An overview of island arc tectonics, with a focus on backarc seamounts, shows that many seamount chains (or ridges) aligned at high angles to the arc trend are commonly found along island arcs associated with backarc basins or marginal seas. This leads to the hypothesis that the existence of a well-developed backarc basin is a key influence on the formation and evolution of backarc seamount chains.

The backarc en echelon seamounts in the northern Izu-Bonin arc, a typical example of backarc seamount chains, consist of three distinct volcanic rock suites. 'More Enriched Suites ' (MES) have enriched HFSE compositions (such as Nb, Ta), higher Nb/Zr values, and low Cr# in spinel. 'Less Enriched Suites ' (LES) have depleted HFSE compositions, lower Nb/Zr values, and high Cr# in spinel. These results suggest that geochemical differences between both series originate in the degree of fertility of source mantle. 'Depleted Suites ' (DS) have the lowest Nb/Zr values, and Nb and Zr contents, and have depleted LILE compositions (such as Rb, U, Pb). MDS lavas are also the most depleted in trace elements, and are distinguished from MES and LES lavas. HFSE enrichment and depletion of volcanic rock from the en echelon seamounts cannot be explained by differences in degree of melting and/or subduction inputs caused by slab melting. Instead, these results require distinct mantle sources for the different volcanic rocks constituting the en echelon chains. Mineralogical and geochemical analyses show that petrological variations (basalt to rhyolite) within volcanic rock suites are explained by fractionation with open system magma mixing.

Slab derived components, which contribute to the volcanism along the en echelon seamounts, are Ba-poor slab-derived fluids and sediment melts. The chemical influences of slab components are strongest in the DS rocks, followed by LES, with the MES rocks having the weakest signal. Furthermore, evidence for the influence of a fluid component tends to increase toward the volcanic front. In contrast, sediment melt signatures reach a maximum at a distance of about 120-130 km from the volcanic front, where Alkali-rich (K-rich) magmas were erupted.

The Nb/Zr values from the MES (Nb/Zr is more than 0.06), LES (Nb/Zr=0.05-0.02), and DS (Nb/Zr is less than 0.02) were compared to Nb/Zr values in rocks from the Kinan Seamount Chain, the Shikoku Basin, and the volcanic front, respectively. This comparison indicates that volcanic rocks from the en echelon seamounts were derived from three kinds of mantle source formed or emplaced during and after Shikoku Basin formation. I suggest that 'Fertile Mantle ' for the Kinan Seamount Chain, 'Less Enriched Mantle ' for the Shikoku Basin, and 'Depleted Mantle ' for the volcanic front correspond to mantle sources for MES, LES, and DS, respectively. Calculated primary magma compositions for each suite indicate that MES melt may be produced from 'Fertile Mantle ' under conditions of 1,300-1,350 degree and 1.5-2.0 GPa, and that LES and DS melts may be produced at lower temperatures and higher pressures than MES melt.

From the above lines of evidence, I suggest that backarc volcanism along the en echelon seamount chains was caused by eastward migration of a 'Hot Fertile Mantle ' source soon after cessation of backarc basin opening.