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Spatial and Temporal Variation of Back-Arc Volcanism in the Izu-Bonin Arc – Chemical Variation in Relation to Volcano-tectonic History

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The Izu-Bonin arc is an oceanic island arc located in the NE margin of the Philippine Sea plate. This arc has experienced repeated back-arc rifting, and has shown a wide variation in the mode and progress of rifting depending on time and space. In this contribution we present $^{40}Ar/^{39}Ar$ age and chemical data including isotopes on volcanics from the middle and northern part of the back-arc region of this arc and will discuss the spatial and temporal variation of chemical characteristics of mantle beneath the back-arc region.

The middle part of the Izu-Bonin Arc is composed of four bathymetric features. The active rift zone is located just behind the volcanic front. The back-arc knolls zone includes small knolls and ridges and is presumed to be a palaeo-rift zone. Back-arc seamount chains extend into the Shikoku Basin oblique to the trend of volcanic front from the back-arc knolls zone.

The age of volcanism in each bathymetric feature is clearly different. Volcanism in the back-arc seamount chains initiated at around 17 Ma slightly before the cessation of the back-arc spreading of the Shikoku Basin and ceased at ca. 3 Ma. Volcanism in the back-arc knolls zone initiated at around 2.8 Ma and continued until at least 1 Ma, and is presumed to be the earliest volcanism related to rifting. Volcanics from the active rift zone are generally younger than 1 Ma.

The chemical characteristics of volcanics from each topographic feature are also different to each other. Volcanism in the back-arc seamount chains is dominated by eruption of andesite and basalt lava and are characterized by enrichment in incompatible elements including both large-ion lithophile elements (LILE) and high field strength elements (HFSE) compared to MORB. On the other hand, basalts from the back-arc knolls zone show comparable or stronger enrichment in LILE, but clear depletion in HFSE compared to those from the seamount chains. Basalts from the active rift zone are similar to MORB.

On the other hand, in the northern part of the arc, development of rift basin and volcanism associated with rifting are unclear. The Mikura Basin, which is located north of active rift zone, has an indistinct basin structure. Structure-controlled volcanism observed in the active rift zone does not occur in this basin. Instead, large conical volcanoes are distributed in this basin. Furthermore, no basin structure is found in the Zenisu Ridge area, which is the northernmost part of the submarine portion of the Arc.

In the northern part, volcanism on the back-arc seamounts generally occurred in the same period as that in the middle part. However, volcanism younger than 2 Ma also occurs in the Zenisu Ridge area. Seamounts in the Mikura Basin are late Quaternary in age (<100 ka). Chemical characteristics of basaltic rocks from the back-arc seamounts are quite similar to those from the back-arc seamounts in the middle part of the arc. However, lavas from the seamounts in the Mikura Basin show chemical characteristics similar to the lavas from the volcanic front (strong depletion of HFSE) and different from those in the active rift zone in the south.

The volcanism and tectonic history in the middle and northern part of the Izu-Bonin arc show clear contrast. In the middle part, the mantle which shows more enrichment in incompatible elements than the source for volcanic front lavas had fed the volcanism until 3 Ma in the back-arc seamounts. At ca. 2.8 Ma, when the back-arc rifting initiated, upwelling of different type of mantle took place in the back-arc and chemically different volcanism in the back-arc knolls zone occurred. In the Mikura basin, volcanism associated with rifting did not occur, and incoming of new source mantle is not recognized. Recent andesitic volcanism is presumed to be fed by the source similar to front volcanoes. Further north, in the Zenisu Area, rifting did not occur, and volcanism on the back-arc seamounts continued to Recent. In the Izu-Bonin arc, currently-active back-arc rifting seems to be more active in the south, and become less obvious toward north. The mantle flow regime under the back-arc area appears to be quite different in places. This contribution will discuss possible genetic models which explain temporal and spatial variation of mantle beneath this arc.

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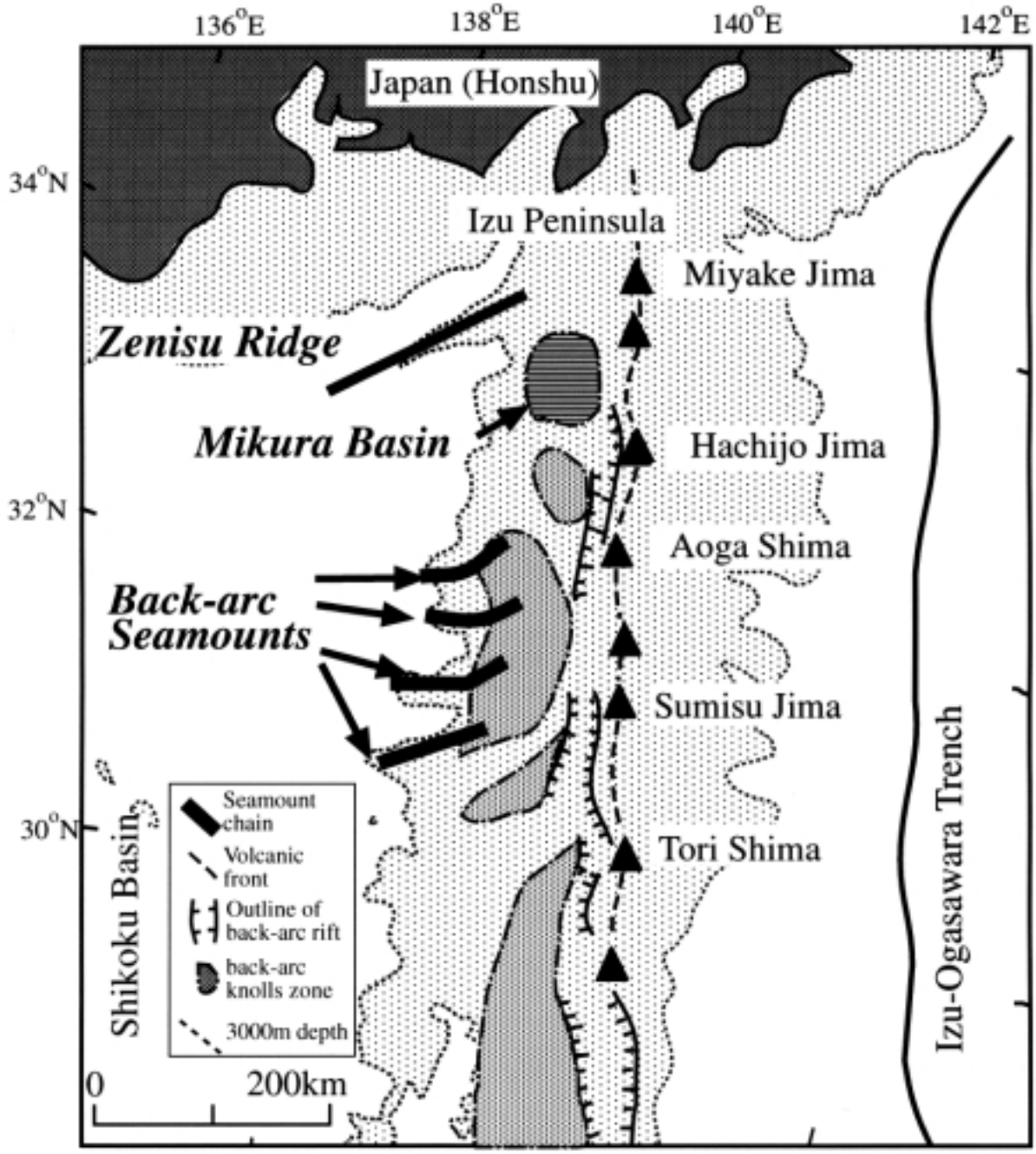

Figure 1: Simplified structure of Izu-Bonin Arc