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Variations in compositions and genetic conditions of magmas through the Izu-Ogasawara subduction zone establishment

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Ogasawara (Bonin) Archipelago comprises the Eocene submarine volcanoes that represent initial stage of the Izu-Ogasawara subduction zone to a more matured arc magmatism along the present volcanic arc. We have discussed petrogenetic processes of the volcanic rocks of the Hahajima Island Group, southern Ogasawara Archipelago (Kanayama et al., 2010JGU Meet.). This study shows secular evolutions of composition and thermal structure in the wedge mantle through the Izu-Ogasawara subduction zone establishment.

When subduction of the Pacific plate beneath the Philippine Sea plate initiated at ˜50 Ma, the eastern edge of the Philippine Sea plate was started to extend, which led to upwelling of asthenosphere and producing depleted MORB-like basalt magma without slab contribution (Stern and Bloomer, 1992; Ishizuka et al., 2006, 2009; Reagan et al., 2010). As subduction proceeds, subducted slab-derived fluids and melts changed the magma composition from depleted MORB to boninite and arc tholeiite at 48 Ma pervasively along the Izu-Ogasawara-Mariana forearc (Ishizuka et al., 2009; Reagan et al., 2010). On the Ogasawara Ridge, boninite and arc tholeiitic magmas were replaced by low-Si boninite and calc-alkalic magmas at 45 Ma in the Chichijima Island Group and at 43-42-Ma on the western escarpment of Ogasawara Ridge (Ishizuka et al., 2006; Umino and Nakano, 2007) Arc tholeiite and calc-alkaline magmas after 44 Ma generated by melting of the asthenospheric counterflow that upwelled from deeper parts of the wedge mantle. By ˜35 Ma, the volcanic front shifted to the present position and formed the Eocene Izu-Ogasawara arc by arc tholeiitic and calc-alkalic magmatism with similar geochemical signatures to the Quaternary Izu-Ogasawara arc lavas. Since 35 Ma, position of the volcanic front remained unchanged during the splitting of the Kyusyu-Palau Ridge and the opening of the Shikoku-Parece Vela Basin, suggesting that the thermo-chemical structure of the wedge mantle has reached a stable condition for the first ˜15 million years since the subduction initiation.

The variation of magma compositions in time and space on the Ogasawara Ridge denotes the decrease in the melting region within the wedge mantle from broad areal and depth ranges (48-46 Ma-boninite and arc tholeiite) to a limited deeper part of the mantle (44 Ma-basalt).

Source mantle composition changed from highly depleted peridotite as the boninite source to relatively fertile MORB-source peridotite as the SHIs basalt source, strongly suggesting that fertile mantle upwelled from a deeper part and replaced depleted boninite source. This indicates that circulation of wedge mantle start around 44Ma, which the time SHIs magmatism began.

The change in slab component from melt-dominant Eocene boninites through less melt-enriched SHIs basalts to fluid-dominant Quaternary front lavas can be ascribed to cooling of the wedge mantle as the result of successive plate subduction for the last 50 Ma.

Keywords: Ogasawara (Bonin) Islands, wedge mantle, primary magmas, genetic conditions, degrees of meting, subduction zone