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An attempt to clarify the magma origin of Nishinoshima volcano using Ba stable isotope ratios

TAKASHI MIYAZAKI[1], YOSHIHIKO TAMURA[2] AND TOMOKI SATO[3]

[1]Research Institute for Marine Geodynamics (IMG), Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
[2]IMG, JAMSTEC
[3]Research Institute for Marine Geodynamics, JAMSTEC

Nishinoshima, in the Ogasawara Arc, is composed of a main andesitic edifice surrounded by three knolls. The NE and SE knolls are relatively old and basaltic in composition. The Nishinoshima South Knoll (NSK) is situated approximately 8 km south of the Nishinoshima main edifice (NME) and consists of basaltic andesite to dacite. Tamura et al. (2023) suggested that hydrous carbonatite fluid contributed to the magma that formed the NSK, whereas sediment melt contributed to the magma that formed the NME. Here we clarify the utility of Ba isotopes to discriminate among the two inferred origins. The Ba concentration in ocean floor sediments and altered oceanic crust (AOC) are much higher than in the mantle. Therefore, the Ba stable isotope ratios of island arc volcanic rocks should reflect the characteristics of subducted oceanic floor sediments or AOC. To confirm whether the Ba stable isotope ratio can reveal the difference in subducted materials, we analyzed the samples from the NME and NSK. The $\delta^{138/134}$Ba values of the samples from the NME are 0.046–0.072 ‰, whereas those of the samples from the NSK are 0.035–0.079 ‰. The average $\delta^{138/134}$Ba values are almost identical, but the range of variation in $\delta^{138/134}$Ba values of NSK is 1.7 times larger than that of NME. A compilation of Ba stable isotope ratios from core samples drilled around the world by the ODP and DSDP indicates that $\delta^{138/134}$Ba in marine sediments is -0.05–0.15 ‰, whereas that in AOC is -0.22–0.39 ‰ (Nilsen et al., 2018, 2020, Nan et al., 2023, Miyazaki et al., 2023). The AOC shows 3 times wider range relative to that of marine sediments. As the $\delta^{138/134}$Ba of the samples from NME and NSK are not affected by alteration or crystallization differentiation, the $\delta^{138/134}$Ba characteristics of the samples likely reflect the characteristics of the Ba isotope ratios of subducted materials. Combining the Ba stable isotope ratio with the elemental, Sr, Nd, and Pb isotope compositions is expected to provide a more detailed understanding of the subducted material, which can be different between two magma sources only 8 km apart.