Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG62-04 会場:102B 時間:5 月 22 日 09:45-10:00

東北日本弧に産する第四紀火山岩類の Hf 同位体比組成の空間分布
Spatial variations in Hf isotopic compositions of Quaternary volcanic rocks in North-eastern Japan Arc

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The dual Quaternary volcanic chains of the North-eastern Japan (NEJ) Arc sit 100 km and 150-170 km above the top of the subducting Pacific Plate. We focus on a particular variation in the isotopic compositions of Quaternary volcanic rocks in the NEJ Arc because isotope data are useful for estimating the influence of subducting components on mantle wedges. In general, slab-derived materials from subducting plates add to mantle wedges, and these materials induce the generation of island arc magma.

In this study, we report a new spatial variation of Hf isotopic compositions in combination with Sr-Nd-Pb isotopes and trace element compositions. Although a high-field-strength elements (HFSE), Hf is one of them, rare earth elements (REE), and large-ion lithophile element (LILE) behave as incompatible elements during mantle-melting processes, they distinctively separate from each other into preferentially partitioned aqueous fluids due to the increased solubilise from LILE, REE to HFSE. Therefore, Hf isotopes in combination with other geochemical signatures serve as identification of metasomatic agents in subduction-related magma generation.

On the rear arc (RA) side, we collected samples from the Chokai, Sannome-gata, Moriyoshi, and Kampu volcanoes. On the volcanic front (VF) side, we collected samples from the north area (the Iwate and Akita-koma-ga-take volcanoes), the central area (the Zao and Azuma volcanoes), and the south area (the Nasu and Takahara volcanoes).

The RA volcanic rocks have limited and slightly enriched Sr-Nd-Pb isotopic ratios and trace element compositions as compared to those of mid-ocean ridge basalts (MORB) from the Japan Sea. In contrast, the compositions of the VF samples tend to be more enriched with wide variations. The Sr-Nd-Hf isotopes in the VF rocks tend to be more enriched as one goes from north to south, and the sample with the most enriched isotopic compositions is from the Takahara volcano. In the correlation diagrams of the Sr-Nd isotopic compositions, the trend from the RA to the VF samples appears as a mix of depleted MORB mantle (DMM) and enriched oceanic sediments or continental crust materials. However, the variation in the Hf-Nd isotopes in the VF samples could not be explained by a model of bulk-mixing between DMM and subducted oceanic sediments. Moreover, these isotopic ratios decrease with increasing SiO_2 content. These observations indicate that the variations in the VF samples were formed during processes of magmatic evolution, such as assimilation-fractional crystallization (AFC) or mixing with silicic magma, thus resulting in enriched isotopic compositions. Furthermore, the VF rocks have different Pb isotopic compositions in different area, which indicates that such a varied trend was probably caused by a variety of contaminated crust compositions. In contrast, the Sr-Nd-Hf-Pb isotopic ratios for the RA rocks suggest that their enriched isotopic compositions as compared to MORBs were most likely influenced by the enriched subducting components, and not the crustal material, because the values of the isotopic ratios become constant when their SiO_2 content increases.

キーワード: 東北日本弧, 第四紀火山岩, 同位体組成の空間分布, Hf 同位体比組成
Keywords: NE Japan arc, Quaternary volcanic rocks, Spatial variations in isotopic compositions, Hf isotopes