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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Since the establishment of plate tectonics, subduction zones have been recognized as the place where oceanic plates play a crucial role in the cycling of elements from the Earth's surface to the deep mantle. To elucidate global-scale elemental cycling, numerous studies have analyzed major and trace elements in various rock samples, along with isotopic compositions, including radiogenic isotopes (Sr, Nd, Hf, Pb) and noble gases. Among these, the molybdenum isotopic composition ($\delta^{98/95}Mo = [(^{98}Mo/^{95}Mo_{sample})/(^{98}Mo/^{95}Mo_{NIST\ SRM\ 3134}) - 1] \times 1000$) has gained attention as a tracer of global material cycles. However, significant uncertainties remain regarding geochemical variations across volcanic arcs, particularly in rear-arc volcanoes, where phase transitions in subducted slabs and fluid migration are active. The geochemical variations from the volcanic front (VF) to the rear arc (RA) provide insights into continuous phase transitions associated with subducting slab depth, enhancing our understanding of subduction-zone magmatism and material cycling. This thesis analyzes major and trace element abundances and Mo-Sr-Nd-Pb isotopic compositions from 17 volcanoes near the Japanese Islands to reassess the relationship between Mo isotopic variations and subduction processes. In Chapter 2, we investigated changes in the amounts of aqueous fluids and $\delta^{98/95}$Mo values from the VF to the RA in the northern Izu (N-Izu) Islands. The N-Izu basalt shows a gradual decrease in the contribution of aqueous fluids from the subducting slab, as indicated by systematic changes in some trace elements ratios (e.g., Ba/Th and Ce/Mo) with increasing depth in the Wadati-Benioff zone. Similarly, the $\delta^{98/95}$Mo values of the N-Izu basalts decrease with increasing depth in the slab. The simplest interpretation of the increase in $\delta^{98/95}$Mo values in the VF is that aqueous fluids derived from slabs rich in heavy Mo isotopes contributed to the mantle source of the VF volcano. In contrast, the $\delta^{98/95}$Mo values of the RA basalts are as low as the estimated depleted mantle (DM), suggesting that the slab-derived fluids in the RA region are depleted in heavy Mo isotopes as a result of continuous loss of heavy Mo isotopes due to dehydration of the VF volcano. In Chapter 3, we analyzed the across-arc variation of $\delta^{98/95}$Mo values in eight volcanoes from the Northeast Japan (NE Japan) region, together with the isotopic compositions of Sr, Nd, and Pb. The mean $\delta^{98/95}$Mo values of the NE Japan VF samples are higher than that of the DM, while the $\delta^{98/95}$Mo variation in the NE Japan VF samples is greater than that of other oceanic island arcs. The $\delta^{98/95}$Mo values of the VF samples show no clear correlation with crustal assimilation or magma differentiation but are highly variable. The observed variation most likely reflects the diversity of $\delta^{98/95}$Mo values in the primary magma associated with the heterogeneity of $\delta^{98/95}$Mo values in the slab-derived fluids. On the other hand, the RA region exhibits two distinct systems based on $\delta^{98/95}$Mo values and radiogenic Pb isotopes. Chokai and Oshima-Oshima volcanoes have lower $\delta^{98/95}$Mo values, while Kampu and Sannome-gata show higher values. The former show typical across-arc geochemical variations similar to VF, while the high $\delta^{98/95}$Mo values of the latter may be due to the addition of residual crust and recycled materials due to the expansion of Japan Sea, or the variations in the input of slabs along the arc. In Chapter 4, we analyze the $\delta^{98/95}$Mo values in volcanic rocks from three ultra-rear arc (URA) regions, Oki-Dogo, Fukue, and Changbaishan, to investigate the influence of recycled slab components, deep interior dehydration, and slab melts on the generation of URA magmas. The $\delta^{98/95}$Mo values are consistent with those of ocean island basalts (OIB), continental basalts, and RA volcanic rocks from the Izu and Mariana arcs, indicating a minimal contribution of slab-derived fluid components. Oki-Dogo and Changbaishan exhibit EM-1-like $\delta^{98/95}$Mo values, while Fukue shows EM-2-like values, reflecting heterogeneity of the mantle source influenced by different recycled materials. Finally, in Chapter 5, we integrated all the results from the analyzed volcanic rocks to explore the relationship between phase transitions in volcanic rocks within subduction zones and the subducted slab. The average $\delta^{98/95}$Mo values for VF and RA samples are determined to be -0.07 ± 0.44‰ and -0.19 ± 0.33‰, respectively, showing a general across-arc trend of decreasing $\delta^{98/95}$Mo values from VF to RA in subduction zone volcanoes. Furthermore, the variation in $\delta^{98/95}$Mo values increases with decreasing Ba/Th ratios, suggesting a possible classification into two groups according to the contribution of sediments derived from the subducting plate. The analysis results indicate that subduction zone volcanic rocks can be classified into two groups, the Izu type and the NEJ type, based on the contribution of sediments from the subducting plate. In addition to sediment contributions, the continuous phase transition of the slab's hydrous phase plays a crucial role in the origin of aqueous fluids in the subduction zone. The findings suggest that distinct models for aqueous fluid origins are required for each type of arc volcano.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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