学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

Hf-B-Li-Mg isotope systematics of late Cenozoic volcanic rocks from the Chugoku district, Southwest Japan: Implications for the property and transport mechanism of slab-derived fluids in the subduction zone

西南日本中国地方の後期新生代火山岩のハフニウム・ホウ素・リチウム・マグネシウム同位体システマティクス：沈み込み帯で発生するスラブ由来の流体の特性と輸送メカニズムの解明

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Fluids released from subducting lithosphere play an essential role in the production of island-arc magmas. However, the sources, properties, and transfer of subduction-zone fluids remain poorly constrained by studies of island-arc magmas, yet experimental studies have demonstrated that variable types of fluids (aqueous solution, supercritical liquid or melt) can be produced from subducted oceanic lithosphere (slab) consisting of various lithologies (sediment, oceanic crust, or slab mantle). In this study, I investigated the Hf, B, Li, and Mg isotope compositions of late Cenozoic volcanic rocks, well characterized by geochronological and geochemical analyses, from the Chugoku district in SW Japan to trace the evolution and variation of fluids beneath this region. These research background and the motivation of this study is given in **Chapter 1**.

The dissertation first investigated the Hf isotope compositions in the Chugoku volcanic rocks (**Chapter 2**). The Hf isotope compositions show a clear temporal variation, from lower (ε_{Hf} = +2.0 to +5.0) values in early-stage (12–5 Ma) samples to higher and more variable values (ε_{Hf} = –0.6 to +12.5) in late-stage samples, suggesting sediment contribution occurred through all episodes but the relative proportion of AOC component gradually increased with time. Our modeling also suggests that subducted basalt-derived fluids may be supercritical fluids in the early stage and transited to hydrous melt in the later stage, owing to the shallowing of the oceanic lithosphere.

The next chapter (**Chapter 3**) reported the systematic B isotopic data of the high-Sr andesite and dacite (i.e., adakitic) lavas. The adakitic lavas show a significant variation in $\delta^{11}B$ from –7.2‰ to +0.3‰, which roughly correlated with Sr-Nd-Pb isotopic ratios. Numerical modeling involving slab dehydration and mixing among slab-derived components suggest that boron isotope signature points to the involvement of major two components with distinct $\delta^{11}B$; (1) a high-$\delta^{11}B$ component, which is composed of a serpentinite-derived fluid from slab mantle and a melt from dehydrated oceanic crust, and (2) a low-$\delta^{11}B$ melt from the dehydrated sediments. Our modeling shows that, in the hotter subduction zone, fluids could have been released from deeper section in the slab (i.e., serpentinites). Those fluids migrate upward and facilitate the melting of the upper crustal section in the slab, which was dehydrated at shallower depths but re-hydrated by addition of serpentinite-derived fluids.

The fourth chapter (**Chapter 4**) presented the newly developed methods for chemical purification of Li and Mg and optimization of Li-Mg isotope analysis using MC-ICP-MS. To demonstrate the reliability of the methods, analytical results of the international reference standard materials are also provided.

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The fifth chapter (**Chapter 5**) aims to constrain the process responsible for Li-isotope variation in arc magmas. The Chugoku volcanic rocks show large δ^7Li variation (–1.9 to +7.4‰), and thus are ideal candidates for Li-isotope study of arc magmas. I have developed the models for which the effect of slab dehydration and a diffusive exchange between slab-derived melt and mantle are examined. Using the models, I have demonstrated that slab-derived δ^7Li features in arc magmas can be preserved if slab-derived fluids/melts have distinct δ^7Li values from mantle and ascend rapidly.

The sixth chapter (**Chapter 6**) investigated Mg isotope fractionation during melting of garnet-bearing lithologies in the subducting oceanic lithosphere. The Chugoku volcanic rocks have homogeneous Mg isotopic compositions, with a mean δ^{26}Mg value of -0.23 ± 0.08‰ (1σ), which is well within the range of the δ^{26}Mg value of mantle peridotite. The modeling developed in this study demonstrates that slab-derived melts may have δ^{26}Mg higher than their sources by up to +0.31‰, owing to the presence of residual garnets during slab melting, however, the heavy Mg isotopic features in melts can be easily erased via interaction with overlying mantle during the ascent of melts.

Collectively, this dissertation reaffirms the temporal variation of slab-released fluids beneath the Chugoku district, highlights the importance of serpentinite-derived fluids to promote the hydrous melting of subducted slab, confirms the potential of Hf and Li isotopes to trace the slab signals, and clarifies the role of Mg isotope fractionation during slab melting and subsequent melt-mantle interaction. The results from this dissertation contribute to the overall development of using fluid-mobile and -immobile isotopic system to trace crustal recycling and fluid properties in the subduction zones.