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

SGC55-P03 会場:コンベンションホール 時間:5 月 23 日 15:30-17:00

FOZO と HIMU の成因の違いは何か？
FOZO-HIMU connection: link to chemical heterogeneity of MORB

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One of fundamental concepts of the mantle geochemistry is a hypothesis called ‘mantle reservoir model‘ (White, 1985; Zindler and Hart, 1986), in which isotopic composition of the ocean island basalts (OIBs) are explained by mixing of distinct and isolated reservoirs in the Earth‘s interior. In early research on the mantle reservoirs, the isotopic compositions of OIBs were mainly explained by the mixing of depleted MORB mantle (DMM) and three enriched reservoirs (HIMU, EM1, and EM2) whose isotopic compositions are enriched extremes. In addition to these ‘extreme reservoirs‘, the importance of reservoirs whose isotopic compositions are common and intermediate has been pointed out, such as FOZO (Focal Zone, Hart et al., 1992), C (common component; Hanan and Graham, 1996), PREMA (Prevalent Mantle, Zindler and Hart, 1986) and PHEM (Primitive Helium Mantle, Farley et al., 1992). Although the existence of these ‘intermediate reservoirs‘ is still in debate, the isotopic compositions of these reservoirs, in particular FOZO, have been commonly used to describe the isotopic distribution of OIBs.

The origin of mantle reservoirs is considered to be recycling of oceanic crust with/without sediments. Thus recycling of pure oceanic crust is important because the oceanic crust is the major constituent of recycled material. As the recycling of pure oceanic crust is inferred to produce HIMU and FOZO components, elucidating the origin of these reservoirs should be important from the perspective of production of mantle heterogeneity (e.g., Stracke et al. 2005). A major question about the origin of these reservoirs would be the process that made the difference between HIMU and FOZO. Additional question about their origin is the process that can explain the rare occurrence of HIMU and ubiquitous presence of FOZO.

In the present study, we have conducted geochemical modeling for understanding the origin of HIMU and FOZO. For the model, MORB compositions from East Pacific rise and Mid-Atlantic ridge are compiled from published data. The results suggest that oceanic crust with various stages of magmatic evolution can produce U and Th enrichment that is suitable for the origin of HIMU and FOZO, i.e., less evolved common MORB can be the source for FOZO and strongly evolved rare MORB can be the source for HIMU. Although the magmatic evolution processes also produce high Pb concentration that is inappropriate for the origin of HIMU, sulfur enrichment during the evolution can erase the effect of Pb enrichment due to desulfurization and Pb loss beneath subduction zones. Depleted Sr isotopic composition of HIMU seems to contradict high Rb concentration of evolved MORB magmas. However, high degree of dehydration and Rb loss beneath subduction zones can produce depleted Sr isotopic composition of recycled crust. In this context, magma evolution at mid-ocean ridges and variable degree of dehydration beneath subduction zones play an essential role in producing the isotopic variations between HIMU and FOZO.

キーワード: FOZO, HIMU, マントル貯蔵庫, MORB, リサイクリング, 海洋島玄武岩
Keywords: FOZO, HIMU, Mantle reservoirs, MORB, recycling, OIBs