Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SGC54-P13 Room:Convention Hall Time:May 20 18:15-19:30

Role of crystal fractionation and effect of degree of dehydration in producing FOZO and HIMU reservoirs

Gen Shimoda[1*], Tetsu Kogiso[2]

[1]National Institute of Advanced Industrial Science and Technology, [2]Graduate School of Human and Environmental Sciences, Kyoto University

It has been widely accepted that recycling of oceanic crust with/without sediments produced at least three enriched reservoirs in the mantle (HIMU, EM1 and EM2). This fundamental concept of the geochemistry is 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. The origins of enriched components are usually explained by recycling of oceanic crust (HIMU) with variable amounts of sediments (EM1 and EM2).

In early research on the mantle reservoirs, the isotopic composition of OIBs was 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 reservoirs, the importance of reservoirs whose isotopic compositions are intermediate has been pointed out, these are, 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 reservoirs is still controversial, the isotopic compositions of these reservoirs, in particular FOZO, have been used to designate the isotopic distribution of OIBs.

In the present study, geochemical modeling has been conducted to evaluate the origin of HIMU and FOZO reservoirs. For the modeling, MORB compositions from East Pacific rise and Mid-Atlantic ridge are compiled from published data (PetDB: http://www.earthchem.org/petdb). The results suggest that crystal fractionation at a mid-ocean ridge can increase U and Th concentrations relative to Pb content, producing high U/Pb and Th/Pb ratios in evolved MORBs. In addition, dehydration beneath a subduction zone can increase U/Pb and Th/Pb ratios of recycled oceanic crust, i.e., strongly dehydrated oceanic crust can be a suitable source material of HIMU magmas and less dehydrated MORBs can produce material with FOZO isotopic signature. Although depleted Sr isotopic composition of HIMU magma seems to contradict with high Rb concentration of evolved MORBs, high degree of dehydration beneath subduction zones can produce large Rb loss, producing depleted Sr isotopic composition of recycled crust that is suitable for the HIMU source. 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. Combination of crystal fractionation at mid-ocean ridges and degree of dehydration beneath a subduction zone can produced observed isotopic array of OIBs.

Keywords: Mantle reservoir, Recycling, HIMU, FOZO, Mid-ocean ridge, Subduction zone