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Geochemical connection between HIMU-FOZO-PREMA: two-stage dehydration of oceanic crust with layered structure

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Isotopic composition of the ocean island basalts (OIBs) can be explained by mixing of isolated reservoirs in the Earth (White, 1985; Zindler and Hart, 1986; Hofmann, 1997; Stracke, 2012). In early research on the mantle reservoirs, the isotopic composition of OIBs was explained by the mixing of depleted MORB mantle (DMM) and three enriched reservoirs, those are HIMU (high-u: u = 238U/204Pb) EM1 (Enriched Mantle 1) and EM2 (Enriched mantle 2). In addition to these reservoirs, importance of reservoirs whose isotopic compositions are common and intermediate has been pointed out, such as, FOZO (Focal Zone, Hart et al., 1992) and PREMA (Prevalent Mantle, Zindler and Hart, 1986). Although these intermediate reservoirs have been used to describe the isotopic distribution of OIBs, existences of the intermediate reservoirs, themselves, are still in debate. Therefore, elucidating the origin of the intermediate reservoirs should be also important from the perspective of production of mantle heterogeneity (e.g., Hofmann, 1997; Stracke et al. 2005; Stracke, 2012).

To elucidate the origin of mantle reservoirs, geochemical modeling has been conducted, in which origin of HIMU, FOZO and PREMA is discussed. The results suggest that MORBs with high frequency (common MORBs) without significant chemical modification during subduction have chemical composition that is suitable for producing PREMA. It suggests the importance of recycling of dry MORBs for the production of OIBs source. Dehydration of common MORBs in subduciton zones can produce FOZO isotopic signatures if amount of dehydrated water is close to the maximum amount (4 %) of dehydrated aqueous fluid in subduction zones. Thus, FOZO-PREMA isotopic array can be explained by recycling of common MORBs that release various amount of aqueous fluid during subduction. For the production of HIMU, additional dehydration (~2%) at high pressure is required. As high pressure dehydration release supercritical fluid with relatively high U/Pb and low Th/Pb ratios, chemical fractionation during dehydration is different from the sub-arc process. This difference can explain isotopic difference between HIMU and FOZO.

Keywords: HIMU, FOZO, PREMA, MORBs, OIBs