Effect of thickness of lithosphere beneath a hotspot on melting condition of heterogeneous plume: implications for the origin of FOZO

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Isotopic variation of OIB, which expresses chemical heterogeneity in the Earth's mantle, is commonly explained by mixing of four end-member components with extreme isotopic signatures, i.e., DMM, EM1, EM2 and HIMU. In addition to these four end-member components, some researchers have proposed the existence of components with intermediate isotopic compositions between the end-member components, among which FOZO can be a representative of the intermediate reservoirs. An important feature of FOZO, and also other intermediate reservoirs, is its high $^{3}He/^{4}He$ ratios compared to DMM. Thus the intermediate components represented by FOZO may contain material derived from primitive mantle or early formed reservoir.

One of the difficulties of interpreting the $^{3}He/^{4}He$ isotopic composition of OIB is that individual hotspots exhibit a wide range of $^{3}He/^{4}He$ ratios, in some cases ranging from below the DMM ratio (<8 *Ra*, where *Ra* is the atmospheric ratio) to ratios typical of mantle plumes (>20 *Ra*). In addition, Shimoda and Kogiso (2019) has pointed out that Pb, Nd and Sr isotopic composition of FOZO can be explained by recycling of oceanic crust. Therefore, if the $^{3}He/^{4}He$ signatures of OIB in the FOZO are genetically linked, and if the FOZO is produced by recycling of subducted oceanic crust, then there should be processes linking recycled crust to the high-$^{3}He/^{4}He$ component.
One argument for a link between a high-$^{3}He/^{4}He$ component and recycled oceanic crust is that a heterogeneous plume beneath thick lithosphere would tend to preferentially melt enriched components due to their lower solidus temperature, whereas a plume beneath thin lithosphere would yield melts closer in composition to DMM owing to its higher degree of partial melting. In this study, we will evaluate the effect of thickness of lithosphere beneath hotspots to evaluate contribution of primitive or less degassed material to melting region of FOZO.

Keywords: Mantle reservoir, FOZO, helium

