Tectonic control on $^3He/^4He$ isotopic composition of OIB: an interpretation

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The isotopic variation of OIB is commonly represented by just 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 four end-member components, such as FOZO, C and PHEM mainly based on $^3He/^4He$ ratios of OIB and MORB. Namely, Hart et al. (1992) argued that FOZO is derived from the lower mantle, because OIB with FOZO-like isotopic compositions tends to have high $^3He/^4He$ ratios. Similarly, Hanan and Graham (1996) proposed component C based on $^3He/^4He$ ratios of MORB, i.e., C is situated in isotopic field where MORB arrays converge and $^3He/^4He$ ratios of OIB increase. Similarly, Farley et al. (1992) advocated a PHEM component that is characterized by high $^3He/^4He$ ratios, FOZO-like Pb isotopic compositions, and Sr-Nd isotopic ratios near that of the bulk Earth.

Although the Pb-Nd-Sr isotopic compositions of these intermediate components may be explained by simple mixing of the four end-member components, high $^3He/^4He$ ratios of intermediate reservoirs cannot be explained by mixing of the end-member components because all of end components are inferred to be derived from recycled crustal materials which necessary have low $^3He/^4He$ ratios. One explanation that can link a high-$^3He/^4He$ component and recycled crustal material, whose Pb-Nd-Sr isotopic compositions match to the isotopic composition of intermediate components, is a model in which the lithospheric thickness beneath a hotspot is a major factor in determining the chemical composition of OIB yielded by melting of a heterogeneous source. In this presentation, we will examine effect of thickness of lithosphere beneath a hot spot that should control degree of melting of a heterogeneous magma source to produce Pb-Nd-Sr-He isotopic composition suitable for the intermediate mantle components.

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