Forming condition and major element composition of the hidden reservoir

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Solidification of the magma-ocean and subsequent mantle-crust differentiation could have significant influence on the evolution of the solid Earth and hydrosphere, but its detail is still unclear. Previous studies have suggested that the difference in $^{142}Nd/^{144}Nd$ between chondrites and bulk silicate Earth (BSE) resulted from the formation of an incompatible element-rich riservoir that had formed in the early Earth and then got hidden into the Earth's interior or lost outside the Earth. Althoufh various models for the composition and the origin of such a "hidden reservoir" have been proposed, they have not focused on the major element condition of the hidden reservoir. However, the major element condition is crusial to know the density of the hidden reservoir and to examine whether the hidden reservoir rised to form the proto-crust or sunk in the early mantle. In order to determine the major element composition of the hidden reservoir, we estimated the melthing condtion for the formation of the hidden reservoir with constraints of $^{142}Nd/^{144}Nd$ and $^{143}Nd/^{144}Nd$ systematics in the ancient and modern mantle.This study assumed that the hidden reservoir had formed at plessures less than 10 GPa, on the basis of previous studies that estimated the initial depth of melt segregation to be at this pressure range in the solidifying magma ocean. Then we calculated the Sm/Nd ratio that is conformable to the difference in $^{142}Nd/^{144}Nd$ between chondrites and BSE, and estimated the melt fraction that satisfies this Sm/Nd ratio. From this calclation, the melt fraction was estimated to be <5.2% at 1 GPa, <3.2% at 3 GPa and <1.4% at 7 GPa. From these calculated melt fractions and previous experimental data, we estimated that the major element compositions of the hidden reservoir were incompatible element-rich tholeiite, picrite, and komatiite. Ancient hotter mantle should have melted at higher pressure, but on the other hand, the melt fraction was estimated to be small. In order to satisfy the small melt fraction at deep melting, the lithosphere must be thick, as suggested by Korenaga (2009) who showed the possibility of thick lithosphere in the hotter mantle[1]. From these results, a likely composition of the hidden reservoir is picrite-komatiite.

[1] Korenaga (2009), *Geophysical Journal International*, **179,** 154-170