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Igneous activity just after the crystallization of the magma ocean and conditions to generate the hidden reservoir

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Mantle-crust differentiation is one of the most important issues about the evolution of the Earth. Today's Earth's mantle and curst are considered to have differentiated from the Bulk Silicate Earth, which have CI Chondritic composition. However, it has been reported about ^{142}Nd/^{144}Nd (Boyet and Carlson,2005) and Nb/Ta (Nebel et al,2010) that the composition of the mantle and crust does not correspond to that of the CI Chondrite. This implies potential preserved reservoir inside of the Earth, having the composition that explains the differences between today's BSE and the CI Chondrite. . This preserved reservoir has not been found on the Earth, and it is called hidden reservoir.

The difference in ^{142}Nd/^{144}Nd requires differentiation occurring in the early period, because the parent element ^{146}Sm is an extinct radionuclide (half life = 68 Myr). And ^{142}Nd/^{144}Nd of the hidden reservoir is required to be lower than that of CI Chondrite in order to meet the mass-balance (Boyet and Carlson,2005). ^{142}Nd/^{144}Nd is low in melts and high in rocks, because ^{146}Sm/^{144}Nd become higher in rocks than in melts through differentiation. Therefore, the hidden reservoir is considered to have rich melt components. And previous studies have assumed this enriched reservoir to become hidden by its being denser than surrounding mantle and sinking to the base of the lower mantle, or by its being less dense and rising to form crust eventually going to sink into the mantle by plate tectonics (Caro et al,2005; Kemp et al,2010; Lee et al, 2007,2010; Labrosse et al,2007). These previous studies have not considered the melt density based on the major element composition. Moreover, these except Lee et al.(2010) have assumed the residual melts of the crystallizing magma ocean to become the hidden reservoir. And there is little examination about the potential source melts of hidden reservoir generated through partial melting just after the crystallization of the magma ocean.

Hence we presumed the source melts of the hidden reservoir to be generated through partial melting just after the crystallization of the magma ocean and aimed to constrain the conditions to generate the melts. Heat budget models and simulations of mantle convection have indicated the possibility of thick lithosphere (about 200km thick) on the top of the mantle just after the crystallization of the magma ocean (Korenaga,2006,2010; Solomatov,1995; Smrekar and Sotin,2012; Benesova and Cizkova,2012). Therefore, we presumed that just after the crystallization of the magma ocean plate tectonics could not start and melts could separate from mantle at the base of the about 200km thick lithosphere (about 7GPa). And we calculated Sm/Nd that explained the difference in ^{142}Nd/^{144}Nd between today's BSE and the CI Chondrite. Then, we calculated malt fraction in which melts having such Sm/Nd could be generated, using data from the high pressure experiments at 7GPa of peridotite (Walter,1998)

From this calculation, melt fraction F is proved to be $<$0.5%, given that at least upper mantle region is convective and participates in partial melting.

Hereafter, we will reproduce this partial melts through high temperature and pressure experiments. From the experiments, we will determine the major element composition of the source melts of hidden reservoir.

Keywords: hidden reservoir, magma ocean, ^{142}Nd/^{144}Nd, melt fraction