Major element composition of the Hadean crust: constraints from Sm-Nd isotope systematics and high-pressure melting experiments

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The major element composition of the Hadean crust has essential role on the mantle chemical evolution and habitability in the early Earth, since the major element composition constrains the physical properties such as density and viscosity, that in turn constrain the formation and recyclling of the crust, and also constrains the concentration of primary elements for life (nutrients) such as phosohorous (P) and potassium (K) in the crust.

In this study, we first estimated melting condition (pressure, temperature, and melt fraction) of the Hadean silicate differentiation that is required to explain the $^{142}Nd/^{144}Nd$ anomaly in the Archean rocks relative to the $^{142}Nd/^{144}Nd$ range of the accessible silicate Earth (ASE). The obtained melting condition was 7 Gpa-1750 °C-<3.2%. Then, we estimated major element composition of the melt to be Fe-Ti-P-rich komatiite, by using data in our previous melting experiments of a primitive mantle peridotite [1]. Density and viscosity of the melt was estimated from the major element composition, and it was concluded that the Fe-Ti-P-rich komatiitic melt would have ascend in the Hadean mantle and formed the Hadean 'oceanic' crust.

Then, we investigated the major element composition of the crust generated from the hydrous melting of the Hadean 'oceanic' crust, that had been suggested form the initial Lu/Hf ratio and oxygen isotope latio of the Hadean zircons. We performed melting experiments of the synthesized hydrous Fe-Ti-P-rich komatiite at 1000-1300 °C, 1.0-3.0 GPa, and Ni-NiO buffer and at water content of 1.2%, with piston sylinder apparatus. As the result, experimental melts have Ti-P-rich mafic compositions. Density and viscosity estimated from the major element composition of the experimantal melts suggested that these experimental melts would have ascend in the lithosphere to form the Hadean 'continental' curust.

The Hadean 'oceanic' and 'continental' crust would have contributed to the habitability due to their high contents of Mg and nutrients, and fianally subductted to the Earth's interior due to their high density.

[1] Kondo et al. (2016) *Prog. Earth. Planet. Sci*. **3**, 25