

Composition of the Hadean oceanic crust and its hydrous melting experiments: Investigation for the composition of the Hadean oceanic and continental crust

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The process of the mantle-crust differentiation and the composition the oceanic and continental crust in the Hadean era (before 4.0 Ga), just after the formation of the Earth, are essential to understand the chemical mantle evolution due to the extraction and recycling of the crust, and the effect of the nutrients supplied from crust to hydrosphere, on the birth and evolution of the early life. From the analyses of the Hadean zircon, the existence of liquid water and granitic-andesitic melt have been implied (Trail et al. 2007; Hopkins et al. 2010), but the process to generate such granitic-andesitic melt and the composition of the melt are still unclear. Previous studies have suggested that the Hadean mantle would have had high potential temperature, and that the oceanic crust generated at high mantle potential temperature (MPT) has komatiitic composition (Takahashi 1985). Because the hot Hadean mantle could have generated steep thermal gradient in the crust, this komatiitic oceanic crust could have experienced hydrous melting upon subduction, and generated granitic-andesitic melt which could have formed the continental crust. However, the hydrous melting of komatiite and the possibility for the komatiitic oceanic crust to have contributed to the generation of the Hadean continental crust have been scarcely investigated. This study aims to determine the major element composition of the melt generated by hydrous melting of komatiitic oceanic crust, and constrain the composition of the probable Hadean continental crust and the process of its generation.

We estimated the style of the igneous activity in Hadean and the composition of the oceanic crust, referring previous mantle convection models at high MPT (Korenaga 2009; Foley et al. 2014). The Hadean oceanic crust would have formed from the melt generated at small melt fraction under a thick (~200km) lithosphere before the onset of the plate-tectonics, and after the onset of the plate-tectonics, formed from the melt generated at large melt fraction under oceanic ridges. Then, the composition of the oceanic crust was estimated from high pressure and high temperature melting experiments (Kondo et al. Submitted) in the case before the onset of the plate-tectonics, and from calculations with pMELTS in the case after the onset of the plate-tectonics. The compositions of the melt were estimated to be komatiitic in both cases, though the MgO and FeO contents are significantly different between the two cases. We synthesized starting powders of these komatiitic compositions from oxide and carbonate powders, and performed hydrous melting experiments using the piston-cylinder high pressure apparatus. In experiments, the oxygen fugacity was carefully analyzed and assessed. In this presentation, we report the estimated compositions of the probable Hadean oceanic crust and progress of the hydrous melting experiments.

Keywords: Hadean, continental crust, komatiite, hydrous melting experiment