

Melting of Hadean continents and its influences on the environment by Late Heavy Bombardment

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Hadean is considered to be the eon of origin of life and so understanding of the Hadean environment is important. Although there are no Hadean rocks on the Earth, some Hadean zircons those are considered to be evidences of the existence of continental crusts were found. Therefore, it is considered that some Hadean continents existed and some process deleted the continents. There is a hypothesis for the delete process; destruction and/or melting of Hadean continents by Late Heavy Bombardment (LHB), which is a concentration of impacts in last phase of Hadean. LHB must have influenced on the Hadean environment.

In this study, we verified this hypothesis quantitatively and systematically, and showed there are few possibilities for LHB to delete the whole Hadean continental crusts. We approximated the size frequency distribution (SFD) of impacts with a power-law scaling, and gave a power index α as a parameter. Then, we derived semi-analytical expressions for the effects of LHB to the crust. We calculated the total volume and area of destruction /melting by LHB from two independent traces on the Moon; the maximum mass hit the Moon during LHB and the density curve of lunar craters larger than 20 km. Then, where α is smaller than 1.5, LHB had a chance to melt the whole Hadean continents. However, where α is 1.61, the SFD fulfills both the two traces, LHB could cover only half of the Earth's surface area by melts. In this estimate, we consider the flood melt from under the crust. It is considered that the flood melt was formed where the impactors diameter was larger than 100km. On the other hand, including the effects of pre-LHB impacts, more surface area of Hadean Earth was likely to be covered by these melts.

The flood melt must have been composed of mixture of crusts and mantle like the magma ocean and formed a lot of magma pools, local version of the magma ocean. In such magma pools, KREEP-like components may have been formed on surface of the Earth by differentiation of the melt, and they were likely to be the source of potassium and phosphorus, essential elements for birth of life. In this presentation, we discuss such possibilities of impacts influences on the Hadean environment.

Keywords: Late Heavy Bombardment, Hadean, Asteroid, Impact, Origin of life, Continental crust