

Imperfect equilibration of Hf-W system by giant impacts: mechanisms and consequences

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Hf-W chronometry provides constraints on the timing of planetary accretion and differentiation, as segregation of a metal core from silicates should induce strong fractionation of Hf from W. In previous studies, it was assumed that a giant impact raise up perfect resetting on Hf-W chronometer. In this presentation, we will show the difficulty of achieving perfect equilibration of Hf-W system by giant impacts. To achieve perfect equilibration, iron must be split into small droplets less than meter-scale. However, since the sedimentation velocities of small droplets are slow, the Rayleigh-Taylor instability between the upper metal-containing and the lower metal-free layers results in quick overturn of the layers. Thus, the lower metal-free layers cannot be equilibrated. We calculated the isotopic evolution of Hf-W system in consideration of partial resetting of this chronometer. Our study provided three implications: (1) collision conditions and the number of the giant impact events affect the age estimation of the core formation, (2) the Earth's W isotope ratio indicates that more than two-tenth of the volume of protoearth's mantle must be equilibrated at each giant impact, and (3) Mars should have experienced a late extensive equilibration event that involve metal-silicate more than three-tenth volume of Mars' mantle, which is potentially a single giant impact.