Early evolution of Earth-Moon system using Hf-W isotopes

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Hafnium-Tungsten (Hf-W) is widely used systematics in cosmochemistry and geochemistry. Tungsten (W), a siderophile preferentially incorporates into the metallic cores of planetary bodies, whereas Hf, being lithophile strongly partition into their silicate portion. The refractory nature and contrasting geochemical properties of the Hf and W makes this system a robust chronometer of core formation and other early solar system processes. The continuous improvement in mass spectrometers and increasing availability of extra-terrestrial samples are significantly improving our spatial and temporal constraints on the sequence of events in planetary evolution [1].

The most accepted giant impact hypothesis is believed to initiate the final stage of Earth's core formation [2]. This core formation should have partitioned the iron loving siderophile elements (HSEs) onto the core making the Earth's primitive silicate mantle deficient in HSEs. However, the observed abundance is much more than expected [3]. Among various hypothesis to explain this overabundance, "Late Veneer" which late addition of primitive materials on the silicate Earth after the core formation, is most preferred [3]. Besides well explaining ^{182}W excess of the Moon, this hypothesis fails to explain the homogenous ^{182}W of the Earth and Moon i.e. no ^{182}W anomaly. Thus, the absence of ^{182}W anomaly, which was most expected as a result of giant impact, challenges the current model of Moon formation [4].

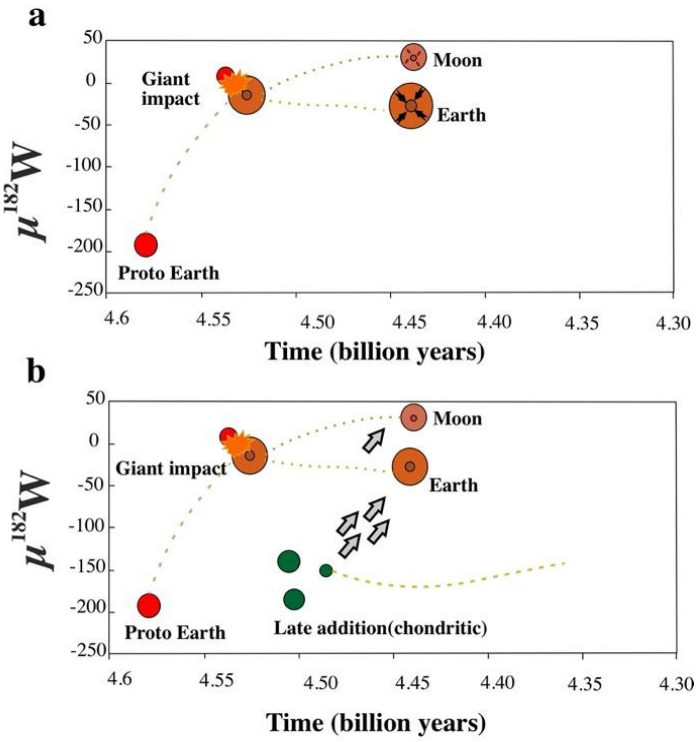

Figure 1 Possible scenario that can cause the 182W overabundance. **a)** The giant impact happened at the time of core formation, during ^{182}Hf lifetime and the final ^{182}W value is result of lunar core formation. **b)** Earth and Moon both had similar abundance after giant impact and present value is the result of variable late veneer material addition to Earth and Moon. (modified figure from [5,6])

This Earth-Moon ^{182}W homogeneity now constitutes a fundamental constraint on any model of lunar formation [4]. We need to look for more stringent evidences to explain this homogeneity or any heterogeneity that may be present in some lunar samples and meteorites, which are not analyzed so far. Also, a thorough check is required to assess the two possible scenarios of lunar origin as mentioned in **Figure 1**. Finally, a unified model is necessary to explain the observed difference in abundances of element between Earth and Moon as well as timing of these events.

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