Fractionation of Fe Isotopes in the Lunar Magma Ocean

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Recent high-precision isotopic measurements show that the isotopic similarity of Earth and Moon is unique among all known planetary bodies in our Solar System. These observations provide fundamental constraints on the origin of Earth-Moon system, likely a catastrophic Giant Impact event. However, in contrast to the isotopic composition of many elements (*e.g.*, O, Mg, Si, K, Ti, Cr, and W), the Fe isotopic compositions of lunar samples were reported to be significantly different from those of the bulk silicate Earth. Such a global Fe isotopic difference between the Moon and Earth, if real, was argued to be due to Fe evaporation as a result of a Giant Impact origin of the Moon. Such Fe evaporation seems unlikely from chemical modeling of the Moon formation [1]. Last year, we reported high-precision Fe isotopic measurements of one of the oldest lunar rocks (4.51 ± 0.10 Gyr dunite 72415), as well as more data for other lunar samples from the Apollo program and lunar meteorites. We found that the lunar dunite is enriched in light Fe isotopes, complementing the heavy Fe isotope enrichment in other lunar samples [2]. Thus, the earliest olivine accumulation in the Lunar Magma Ocean may have been enriched in light Fe isotopes. This new observation allows the Fe isotopic composition of the bulk silicate Moon to be identical to that of the bulk silicate Earth, by balancing light Fe in the deep Moon with heavy Fe in the shallow Moon rather than the Moon having a heavier Fe isotope composition than Earth as a result of Giant Impact vaporization.

[1] Petaev et al. (2016) *47th Lunar Planet. Sci. Conf.* Abstract #2468.
[2] Wang et al. (2015) *Earth Planet. Sci. Lett.* **430**, 202-208.