Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11468

Revisiting Iron Isotope Systematics of the Earth-Moon system

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Iron is a multivalent element that plays a fundamental role in almost every step of planetary formation and evolution. Iron isotope measurements of terrestrial and planetary samples show rich variations. However, the causes of these variations remain elusive, even for the Earth-Moon system that has been extensively sampled compared with other planetary bodies in the Solar System.

The iron isotopic composition of the Earth's mantle was estimated to be near-chondritic based on early peridotite analyses, while more recent studies tend to support a terrestrial mantle that is slightly heavier than chondritic. Mid-ocean-ridge basalts, which are partial melting products of the Earth's mantle, appear to be heavier than chondritic by ~0.15‰ in δ^{57}Fe. But the estimated Fe isotope fractionation caused by partial melting is insufficient to explain such a magnitude of heavy isotope enrichment.

The iron isotopic composition of the lunar mantle, on the other hand, is even less well constrained because of the difficulty in explaining why the δ^{57}Fe values of low-Ti and high-Ti mare basalts are both heavier than chondritic and by differing amounts (~0.1‰ and 0.3‰). Picritic lunar glasses are thought to be primitive melting products from the deep lunar interior, but interpretation of their Fe isotope compositions is often hindered by evaporation and recondensation of elements on the surfaces of glass beads.

This work aims at achieving a better understanding of the Fe isotope systematics of the Earth-Moon system by combining diverse new results from: 1) our latest high-pressure experiments on Fe isotope fractionation during core formation; 2) new leaching and Fe isotope measurements of individual picritic lunar glass beads; 3) state-of-the-art evaporation modeling; and 4) partial melting modeling.