NO IRON ISOTOPE FRACTIONATION DURING HIGH-PRESSURE MOLTEN METAL-MOLTEN SILICATE EQUILIBRATION: IMPLICATIONS FOR PLANETARY ACCRETION.

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Introduction: Whether core-mantle differentiation of terrestrial planets fractionates iron isotope is currently a debated issue. This process could explain the variable in Fe isotope signatures observed among planetary materials: chondrites, iron meteorites, and the silicate portion of terrestrial planets. To evaluate the Fe isotopic fractionation associated with core formation, we carried out experiments, which reproduce the conditions inferred for core-mantle differentiation in a silicate magma ocean.

Method: Experiments were performed in graphite capsules at 1750 and 2000 °C, from 1.0 to 7.7 GPa and with run duration between 100 and 1800 s. The starting mixtures correspond to a devolatilized CI chondrite composition and oxygen fugacity conditions were about 2 log units below the iron wüstite buffer. Scanning electron microscopy observations, electron microprobe chemical analyses and plasma source mass spectrometric isotope analyses were performed to characterize the experimental charges, which consist of silicate melt surrounding blobs of molten Fe-Ni alloy.

Results: Our measurements show that chemical and iron isotope equilibrium was reached rapidly, within 100 seconds at 2000 °C. No Fe isotope fractionation was found between the molten alloy and the ultramafic silicate melt at this temperature. This result holds within the 1.0-7.7 GPa pressure range and is likely to remain valid at higher pressures and temperatures. The addition of sulfur to the system, hence to the molten alloy, does not alter this conclusion.

Conclusions: Our results suggest that significant iron isotope fractionation is unlikely during equilibration of molten core-forming materials in a deep magma ocean. This process therefore cannot explain the heavier Fe isotope composition of the Earth relative to Mars, Vesta and the chondrite parent bodies. Apparent variable bulk Fe isotope compositions may simply indicate contrasted accretion histories.

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