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The phosphorus and sulfur in the lunar core, learned by high pressure-temperature experiments on the Fe-S-P phase diagram

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Seismic data from the Apollo missions and long-term geophysical observations suggest that the Moon has a solid inner core and a liquid outer core [1], where some light elements (e.g., C, S, and P) may exist affect the state and evolutionary history of the core. The abundance of phosphorus and sulfur in the lunar core has rarely been investigated using a complicit compositional model. Here, we performed high-pressure-temperature experiments at relevant conditions for the lunar core (3-5 GPa and 1273-1873 K) and extensively discussed the influence of phosphorus on the Fe-S phase diagram. According to our experimental results and partitioning model, under the scenario of high S content in the lunar core, less than 8 wt% and 0.1 wt% bulk content of S and P are estimated in the lunar liquid outer core and solid inner core, respectively.

In addition, an early geochemical model predicts a possible transition on the core growth path when the core adiabat crosses the liquidus curve [2]. We got the new liquidus for a Fe-S-P ternary system from our experimental results. Integrating the observed lunar core adiabat and the pressure dependence of the Fe-S-P liquidus temperature, we propose that the solidification regime in the lunar core will switch from bottom-up to top-down once the abundance of (S + P) in the liquid outer core exceeds 3.5 wt% as the core evolves.

References:

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