

Martian core-mantle differentiation conditions constrained by FeO partitioning

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The knowledge of core-mantle separation is vital to understand the processes both before and after the core formation, such as the accretion, degassing and mantle crystallization. Core-mantle separation is likely to be a multi-stage event at multiple depths, but it can be modeled or interpreted with a single-state scenario at specific P, T and fO_2 . The metal-silicate partitioning data of moderately siderophile elements (Ni, Co, Mo, W, P and also Re) suggests that the Martian core formation occurred at 14 ± 3 GPa and 2100 ± 200 K¹. At such PT conditions, the oxygen partitioned into Martian core is likely below 1.1 wt.%²⁻⁵, which is much less than what is needed to explain the low density of Martian core revealed recently by the InSight mission^{6,7}. Such a large discrepancy requires a thorough understanding of oxygen partitioning behavior; therefore, we perform theoretical analysis on the FeO partitioning between liquid iron and silicate melt by using *ab initio* calculations in this study. We calculate the oxygen chemical potentials in both liquid iron and silicate melt at various PT conditions and sulfur concentrations, and derive the partitioning coefficients. Then, we discuss comprehensively the effects of pressure, temperature, oxygen fugacity and sulfur on FeO partitioning, and aim to find the P-T- fO_2 that conforms to the core-forming conditions and other constrains.

[1] Righter, K. & Chabot, N. L. *Meteoritics & Planetary Science* **46**, 157-176, (2011).

[2] Rubie, D. C., Gessmann, C. K. & Frost, D. J. *Nature* **429**, 58-61, (2004).

[3] Asahara, Y., Frost, D. J. & Rubie, D. C. *Earth and Planetary Science Letters* **257**, 435-449, (2007).

[4] Ricolleau, A., Fei, Y., Corgne, A., Siebert, J. & Badro, J. *Earth and Planetary Science Letters* **310**, 409-421, (2011).

[5] suno, K., Frost, D. J. & Rubie, D. C. *Physics of the Earth and Planetary Interiors* **185**, 1-12, (2011).

[6] Stähler, S. C. *et al.* Seismic detection of the martian core. *Science* **373**, 443-448, (2021).

[7] Khan, A., Sossi, P. A., Liebske, C., Rivoldini, A. & Gardini, D. *Earth and Planetary Science Letters* **578**, 117330, (2022).