Constraints on sulfur content in the Earth's core

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It is necessary to incorporate light elements (lighter than iron) in the Earth's core in order to explain the density and velocity discrepancies between the core and pure iron. Among the suggested light elements, sulfur (S) has always been considered as a key candidate in the core based on cosmochemical constraints, its chemical affinity for iron, and experimental data on melting, element partitioning, and physical properties at high pressure and temperature. However, the amount of sulfur in the core has been debated. Geochemical constraints usually place 2-3 wt.% S in the core [1], whereas a S-rich (9-10 wt.%) core would meet the geophysical constraints based on recent reasurements of density and sound velocity of Fe-S alloys [2, 3]. In this study, I examine the role of S in early planet differentiation and S partitioning during inner core crystallization to place addiitonal constraints on the amount of S that could be incoreporated in the core.

Planet differentiation could have proceeded through efficient liquid-liquid separation or by percolation of liquid metal in a solid silicate matrix, depending on the size and interior temperature of the planetary bodies. Fe-S melt is likely the first metallic liquid percolated in the silicate matrix because of the low eutectic melting temperature in the system. The process can be demonstrated through 3D imaging of liquid metal network in silicate recovered from simulation experiments [4]. Without the constraint of the volatility trend, the metallic cores of the differentiated small bodies likely contain much higher S content than that of the Earth assuming the same initial bulk S content. I explore the possible S evolution from small bodies to large planets such as the Earth.

I have also conducted experiments to determine S partitioning between the liquid outer core and the solid inner core, using both multi-anvil apparatus and diamond-anvil cell. The partitioning data coupled with density and sound velocity measurements provide additional constraints on the S content in the core because of the observed density and velocity changes at the inner core boundary.

[1] McDonough & Sun (1995) *Chem. Geol.* **120**, 223–253. [2] Huang et al. (2011) *Nature* **479**, 513-516. [3] Huang et al. (2013) *GRL* **40**, 687–691. [4] Fei (2013) *J. Vis. Exp.* **81**, e50778.