# Experimental constraints on the core's Si and O contents from equations of state and metal–silicate partitioning

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The Earth's core is less dense than pure iron under the same conditions [1], implying the presence of one or more light element(s). Based on geochemical and cosmochemical constraints, this component likely consists of O, Si, and/or S [2]. Here we present results to constrain the Si and O contents of the Earth's core by combining experiments with both physical and chemical measurements.

The core's composition can be constrained by comparing seismic models with densities of candidate core materials under core conditions. Laser-heated diamond anvil cells were used for generating high pressures and temperatures (*P* and *T*), with in situ X-ray diffraction used for phase identification and density measurements. We have studied the phase diagrams and equations of state of FeO, iron–silicon alloys containing 9 and 16 wt% Si, and stoichiometric FeSi. This allows us to calculate plausible Fe–Ni–O and Fe–Ni–Si core compositions, or equivalently, to place bounds on the maximum oxygen and silicon contents of the Earth's core. We find that the outer core could contain a maximum of 8.1 ± 1.1 wt% oxygen, or 11.3 ± 0.6 wt% silicon [3–8].

We also ran metal–silicate reaction experiments up to 100 GPa and 5500 K. Following pressure and temperature quench, the samples were sectioned using a focused ion beam and analyzed chemically using a transmission electron microscope. We have parameterized oxygen and silicon partitioning as functions of pressure and temperature. At the highest *P-T* conditions investigated, we detect an estimated 7.5 wt% O and 9.3 wt% Si dissolved in the liquid metal, more than is allowed based on our equation of state measurements. These results constrain the range of *P-T* conditions necessary to produce a plausible core composition, and predict the light element composition of the core.

[1] Birch (1952) *J. Geophys. Res.* [2] Allègre *et al* (1995) *Earth Planet. Sci. Lett.* [3] Fischer & Campbell (2010) *Am. Mineral.* [4] Fischer *et al* (2011) *Earth Planet. Sci. Lett.* [5] Fischer *et al* (2011) *Geophys. Res. Lett.* [6] Fischer *et al* (2012) *Earth Planet. Sci. Lett.* [7] Fischer *et al* (2013) *Earth Planet. Sci. Lett.* [8] Fischer *et al* (in revision).