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# The composition of Earth's core from equations of state, metal-silicate partitioning, and core formation modeling

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The Earth accreted in a series of increasingly large and violent collisions. Simultaneously, the metallic core segregated from the silicate mantle, acquiring its modern composition through high pressure (P), high temperature (T) partitioning reactions. Here we present a model that couples these aspects of early planetary evolution, building on recent accretion simulations and metal-silicate partitioning experiments, constrained by density measurements of Fe-rich alloys.

Previously, the equations of state of FeO, Fe-9Si, Fe-16Si, and FeSi were measured to megabar pressures and several thousand K using a laser-heated diamond anvil cell. With these equations of state, we determined that the core's density can be reproduced through the addition of 11.3 +/- 0.6 wt% silicon or 8.1 +/- 1.1 wt% oxygen to an Fe-Ni alloy (Fischer et al., 2011, 2014). Metal-silicate partitioning experiments of Ni, Co, V, Cr, Si, and O have been performed in a diamond anvil cell to 100 GPa and 5700 K, allowing the effects of P, T, and composition on the partitioning behaviors of these elements to be parameterized (Fischer et al., 2015; Siebert et al., 2012).

Here we apply those experimental results to model Earth's core formation, using N-body simulations to describe the delivery, masses, and original locations of planetary building blocks (Fischer and Ciesla, 2014). As planets accrete, their core and mantle compositions are modified by high P-T reactions with each collision (Rubie et al., 2011). For partial equilibration of the mantle at 55% of the evolving core-mantle boundary pressure and the liquidus temperature, we find that the core contains 5.4 wt% Si and 1.9 wt% O. This composition is consistent with the seismologically-inferred density of Earth's core, based on comparisons to our equations of state, and indicate that the core cannot contain more than $\sim$2 wt% S or C. Earth analogues experience 1.2 +/- 0.2 log units of oxidation during accretion, due to both the effects of high P-T partitioning and the temporal evolution of the Earth's feeding zone. This modeling can reveal the relative importance of various accretion and differentiation processes to core composition, highlighting targets for future experimental and numerical studies.