

Sensitivities of Earth's core and mantle compositions to accretion and differentiation processes

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The Earth and other terrestrial planets formed through the accretion of smaller bodies, with their core and mantle compositions primarily set by metal–silicate interactions in a magma ocean. The conditions of these interactions are poorly understood, but could provide insight into the mechanisms of planetary core formation and the composition of Earth's core. Here we present modeling of Earth's core formation, combining results of 100 *N*-body accretion simulations [1] with high pressure-temperature metal–silicate partitioning experiments [2]. We explored how various aspects of accretion and core formation influence the resulting core and mantle chemistry: depth of equilibration, amounts of metal and silicate that equilibrate, initial distribution of oxidation states in the disk, temperature distribution, and target:impactor ratio of equilibrating silicate. Virtually all sets of parameters that are able to reproduce the Earth's mantle composition also result in at least several weight percent of silicon and oxygen in the core, with more silicon than oxygen, implying that the core's light element budget is dominated by these elements with <1–2 wt% of other light elements (e.g., C, S, H). Reproducing geochemical and geophysical constraints requires that Earth formed from reduced materials at temperatures near or slightly above the mantle liquidus [3]. We find a strong tradeoff between the effects of the depth of equilibration and the amounts of metal and silicate that equilibrate, so these aspects should be targeted in future studies aiming to better understand core formation conditions. Core and mantle compositions are most sensitive to these factors as well as the planet's accretion history, so tighter constraints on these parameters will lead to an improved understanding of Earth's core composition.

[1] Fischer and Ciesla (2014) *EPSL* 392, 28–38. [2] Fischer et al. (2015) *GCA* 167, 177–194 and references therein. [3] Andrault et al. (2011) *EPSL* 304, 251–259.