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Chemical evolution of planetesimal cores during the early history of the solar system

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According to current models of Earth's core formation, the bodies that accreted early to the Earth should have undergone core-mantle differentiation under highly reducing conditions, such that significant amounts of Si and Cr partitioned into their metallic Fe-Ni cores [1]. In contrast to these predictions, however, the Si and Cr contents of iron meteorites, which are derived from the metallic cores of early-formed planetesimals, are surprisingly low (e.g. < 1 ppm) [2]. We propose that molten planetesimal cores originally contained high concentrations of Si and Cr but that these elements became increasingly lithophile during cooling and partitioned back into the overlying molten mantle (magma ocean) at a rate controlled by diffusion through core-mantle boundary layers. We are testing this hypothesis by determining the chemical diffusivities of Si and Cr in molten iron both experimentally (1-25 GPa, 1828-2523 K) and theoretically using molecular dynamic simulations over a larger pressure range.

[1] Rubie et al. (2011) EPSL 301, 31-42. [2] Pack et al. (2011) MAPS 46, 1470–1483.

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