# Core formation in the terrestrial planets: constraints from metal-silicate partitioning of siderophile elements

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Earth, Mars, Venus and Mercury accreted on a timescale of 10-100 My through a series of violent collisions with planetesimals and embryos. The high energy of such impacts was sufficient to cause deep magma ocean formation which facilitated the segregation of metal and silicate liquids. Planetary cores thus formed as a multistage process that was inseparable from the accretion process. In order to better understand the formation and early differentiation of the terrestrial planets, we are integrating a multistage core-formation model [1] with N-body accretion simulations [2, 3]. Constraints on model parameters are the compositions of the Earth's primitive mantle and the mantles of Mars (FeO-rich) and Mercury (FeO -poor). We use a least-squares minimization to optimise model parameters. Elements currently considered include Si, O, Ni, Co, W, Nb, Cr, Ta and V.

The N-body accretion simulations typically result in 3-5 planets that broadly resemble the planets of the solar system. Here we concentrate on simulations that result in an approximately Earth-mass planet at ~1 AU. Results show that accretion was heterogeneous, with bodies originating in the inner part of the solar system (e.g. <1.5 AU) being highly reduced and those from further out being relatively oxidised. The constraints are best fulfilled when reduced bodies accrete to the Earth early with the more oxidised bodies accreting later. Metal-silicate equilibration pressures are high (e.g. ~0.75 × evolving CMB pressures). The model enables estimations of (1) the extent to which the metallic cores of impactors emulsify and equilibrate in a magma ocean and (2) the fraction of magma oceans that are involved in the equilibration process for both impacting planetesimals and embryos.

[1] Rubie D.C. et al. (2011) *EPSL* 301, 31-42.
[2] O'Brien D.P. et al. (2006) *Icarus* 184, 39-58.
[3] Walsh K.J. et al. (2011) *Nature* 475, 206-209.