# Seismological evidence for residual core material from the late impactor

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Dynamical models of planetary accretion indicate that Earth was assembled from a wide range of precursor materials whose source regions were distributed throughout the early solar system (e.g (O'Brien et al., 2006)). Models of their assembly into the planet rely on timing constraints from short-lived radioisotope systems ($^{182}$Hf-$^{182}$W,$^{107}$Pd-$^{107}$Ag), constraints on physical conditions (pressure, temperature, oxygen fugacity) from metal-silicate element partitioning (W, Mo, Co, Ni, Cr, V, Si etc), and orbital parameter constraints from impact modelling. One class of current models invokes multi-stage core formation with the last stage corresponding to oxidized, volatile-rich material added during the moon-forming impact. This leads to the question of whether or not convection in the core would mix material from different periods of core formation or if there might be long-lived domains of different composition corresponding to the different compositions accreted to the growing Earth.

We show from recent inversions of outermost outer core travel times that a compositionally distinct layer exists at the top of the core. The volume of this layer is approximately the size of the core of Mars. Thus, this outer core layer could plausibly be remnant core material from a Moon forming Mars-sized late impactor. We present a model for wavespeeds with varying amounts of S and O in liquid iron that suggests that the layer contains up to 3 wt% enrichment in S (and 1 wt% enrichment in O) relative to the bulk composition of the liquid core. This supports the idea that materials accreted at the latest stage of Earth formation were both more oxidized and sulfur rich, physically documenting the early-earth process that formed the core and set trace element abundances in the mantle.

[1] O'Brien, D.P., Morbidelli, A., Levison, H.F., 2006. Terrestrial planet formation with strong dynamical friction. *Icarus* **184**, 39-58.