The beginning of Earth history

DAVID J. STEVENSON

Caltech 150-21, Pasadena, CA 91125 (djs@gps.caltech.edu)

Earth accreted over tens of millions of years around 4.5 billion years ago. The lunar-forming Giant Impact may have been as late as 4.45Ga and plausibly defines the beginning of earth history in the sense that Earth was subsequently a closed system, secularly cooling and largely untraumatised. Core formation is spread over a period prior to this terminal event but the last significant addition to the core would have been immediately (thousands of years or less) after that event. Rapid cooling of a magma ocean in the lower mantle will also occur in this period, but the consequences of this are still somewhat uncertain because of the poorly known phase diagram. In the likely case of the downward drainage of melt to the core-mantle boundary (in the last percolative stage of magma ocean cooling just above the CMB), a reservoir may develop (possibly now part of D'') that will be compositionally different from the rest of the mantle, possibly including radioactive elements and volatiles. Tidal heating as the moon recedes may also be important in this epoch. However, surface cooling can be fast after the last giant impact, leading to rain-out of the steam atmosphere, so that there is no problem with the presence of zircons dating back to almost this epoch. However, there are still many questions concerning the role of later impacts, the interaction of core and mantle, stability of the whole mantle with respect to large scale convection, and the preservation of early crust.

Predicting solid metal – molten metal element partitioning using crystal lattice strain

A.J. STEWART[1], W. VAN WESTRENEN[2], M.W. SCHMIDT[1]* AND D. GÜNTHER[3]

[1]Institute for Mineralogy and Petrology, ETH Zurich, Switzerland (*correspondence: max.schmidt@erdw.ethz.ch)

[2]Faculty of Earth and Life Sciences, VU University Amsterdam, The Netherlands

[3]Department of Chemistry, ETH Zurich, Switzerland

Element partitioning between solid and molten metallic phases plays an important role in planetary core differentiation processes. Existing models of solid - molten metal partition coefficients (D values) ignore the solid metal as a possible controlling variable, focusing instead on the importance of melt composition and structure in determining D (in addition to the effects of pressure and temperature).

We present an alternative approach to model element distribution between solid and liquid metal phases, based on new high-pressure, high-temperature partitioning data for the first row transition metals V, Cr, Mn, Fe, Co, Ni, and Cu (symbols in figure). A modified lattice strain model (in common use for the interpretation of silicate mineral-melt partitioning data) describes variations in D values for these elements through the deviance in metal radius from the ideal site radius of Fe in solid metal (curve in figure, with corresponding best-fit lattice strain model parameters shown in left bottom corner). Previously published low-pressure data also conform to this model, as do data for elements other than the first row transition metals. Our study suggests that the structure of the solid metal is important in determining variations in partition coefficients of metallic atoms.