Formation and primordial differentiation of the Earth

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The formation of Earth's core, the crystallization of its magma ocean, the formation of early crust, and the outgassing of Earth's atmosphere are natural consequences of planetary accretion. The environment within which these events occurred appears to have been a deep magma ocean. This conclusion derives from the observation that the abundances of moderately siderophile elements in Earth's mantle appear to be set by equilibrium with metal at the base of a deep magma ocean. Highly siderophile elements are in chondritic relative abundances and may point to their delivery in an oxidized "late veneer" followed by very efficient mixing into a by now metal-free (the metal had segregated into Earth's core) magma ocean.

A terrestrial magma ocean was almost certainly hydrous, a conclusion that derives from modelling, D/H observations of comets, and Os isotope measurements of meteorites. This conclusion suggests that H is dissolved in Earth's core. It also raises the possibility of the progressive oxidation of the magma ocean as Earth grows, H is segregated into the metal phase, and OH is liberated, thus accounting for the observation that the upper mantle of Earth is about 3 log units more oxidizing than required for equilibrium with metal.

The magma ocean also provides an environment for radioactive heat-producing elements such as K to dissolve in Earth's core. Two groups find that K is more soluble in S-bearing metallic liquids than in pure Fe metallic liquid and C-bearing metallic liquid, but it is unclear how big a contributor to the energy budget of Earth’s core K (and possibly U and Th) can be.

Fractionation of crystallizing silicate and oxide minerals from a deep magma ocean is suppressed because the fluid dynamical properties of the magma ocean are more akin to a dusty atmosphere than a sludgy silicate liquid, with the exception of density.

The preservation of different $^{129}Xe/^{132}Xe$ ratios in MORB and the atmosphere indicates that the atmosphere was outgassed very early in solar system history. Water released from a cooling magma ocean is an effective vehicle for fractionating I from Xe to create these reservoirs, suggesting seas or oceans by about 4.4 Ga.