Geophysical Research Abstracts
Vol. 18, EGU2016-5543, 2016
EGU General Assembly 2016

Crystallization and Cooling of a Deep Silicate Magma Ocean

Dan Bower (1) and Aaron Wolf (2)

(1) Institut für Geophysik, ETH Zürich, Zürich, Switzerland (dan.bower@erdw.ethz.ch), (2) Earth and Environmental Sciences, University of Michigan, Ann Arbor, USA (aswolf@umich.edu)

Impact and accretion simulations of terrestrial planet formation suggest that giant impacts are both common and expected to produce extensive melting. The moon-forming impact, for example, likely melted the majority of Earth's mantle to produce a global magma ocean that subsequently cooled and crystallised. Understanding the cooling process is critical to determining magma ocean lifetimes and recognising possible remnant signatures of the magma ocean in present-day mantle heterogeneities. Modelling this evolution is challenging, however, due to the vastly different timescales and lengthscales associated with turbulent convection (magma ocean) and viscous creep (present-day mantle), in addition to uncertainties in material properties and chemical partitioning.

We consider a simplified spherically-symmetric (1-D) magma ocean to investigate both its evolving structure and cooling timescale. Extending the work of Abe (1993), mixing-length theory is employed to determine convective heat transport, producing a high resolution model that parameterises the ultra-thin boundary layer (few cms) at the surface of the magma ocean. The thermodynamics of mantle melting are represented using a pseudo-one-component model, which retains the simplicity of a standard one-component model while introducing a finite temperature interval for melting. This model is used to determine the cooling timescale for a variety of plausible thermodynamic models, with special emphasis on comparing the center-outwards vs bottom-up cooling scenarios that arise from the assumed EOS.