Crystallization of the magma ocean

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We model the crystallization of the magma ocean using pyrolite as a proxy for its composition. We use diamond-anvil cell experiments to trace the chemical evolution of the magmas during cooling and crystallization. We employ first-principles calculations to determine the density changes of the magmas as a function of pressure, temperature and chemical evolution. We build a geodynamical model of the evolving magma fully taking into account the density and chemistry of the melts and of the crystals.

We show that the dynamics of the crystallization of the magma ocean is highly dependent (i) on extrinsic parameters, like pressure at the core-mantle boundary and temperature profile through the magma ocean, and (ii) on intrinsic parameters, like relative density relations between the melt and the crystals and vigour of the stirring. Formation of a solid layer in the middle of the magma ocean is possible, which can lead to the eventual formation of a basal magma ocean.