How to form a Basal Magma Ocean? Insights from two-phase flow numerical modeling

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In a recent paper Labrosse et al. (2007) have proposed that the sparse ultra low velocity zone observed at the base of the Earth's mantle, and generally interpreted as patches of dense partial melt (Williams & Garnero, 1996), could be the vestiges of a basal magma ocean once overlying the core mantle boundary.

To investigate the physical mechanisms involved in the formation of such a basal magma ocean, we have designed a two-phase flow model describing the early mantle of the Earth as a mixture of melt and viscously deforming solid matrix. More specifically our model takes into account the compressibility of melt with depth and the melting of the matrix via a coupling source term.

Because of its compressibility the melt eventually becomes denser than the surrounding matrix. Consequently, above this critical density cross-over depth, the melt is percolating upwards to form a magma ocean at the surface while symmetrically below this depth it is migrating downward to form a basal reservoir. Meanwhile the rocky matrix deforms as well inducing compaction and thermal adjustment.

References:

Labrosse S., Hernlund J.W. and Coltice N., A crystallizing dense magma ocean at the base of the Earth's mantle, Nature, 450 (7171): 866-869, 2007

Williams Q. and Garnero E.J., Seismic evidence for partial melt at the base of the Earth's mantle, Science, 273:1528-1530, 1996