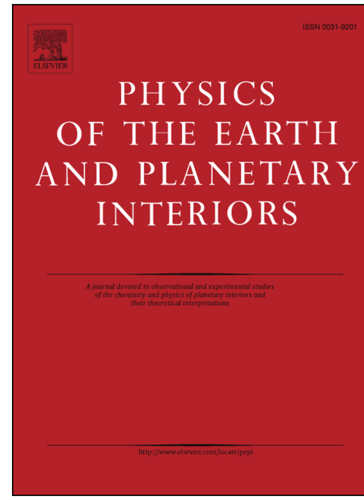
Accepted Manuscript



New numerical approaches for modeling thermochemical convection in a compositionally stratified fluid

Elbridge Gerry Pucket, Donald L. Turcotte, Ying He, Harsha Lokavarapu, Jonathan M. Robey, Louise H. Kellogg

PII: S0031-9201(17)30084-5
DOI: https://doi.org/10.1016/j.pepi.2017.10.004
Reference: PEPI 6093

To appear in: *Physics of the Earth and Planetary Interiors*

Received Date: 20 February 2017
Revised Date: 28 September 2017
Accepted Date: 17 October 2017

Please cite this article as: Pucket, E.G., Turcotte, D.L., He, Y., Lokavarapu, H., Robey, J.M., Kellogg, L.H., New numerical approaches for modeling thermochemical convection in a compositionally stratified fluid, *Physics of the Earth and Planetary Interiors* (2017), doi: https://doi.org/10.1016/j.pepi.2017.10.004

New numerical approaches for modeling thermochemical convection in a compositionally stratified fluid

Elbridge Gerry Puckett[a,*], Donald L. Turcotte[b], Ying He[a], Harsha Lokavarapu[c], Jonathan M. Robey[a], Louise H. Kellogg[b,c]

[a] *Department of Mathematics, U. C. Davis, Davis, CA 95616, USA*
[b] *Department of Earth and Planetary Science, U. C. Davis, Davis, CA 95616, USA*
[c] *Computational Infrastructure for Geodynamics, U. C. Davis, Davis, CA 95616, USA*

Abstract

Geochemical observations of mantle-derived rocks favor a nearly homogeneous upper mantle, the source of mid-ocean ridge basalts (MORB), and heterogeneous lower mantle regions. Plumes that generate ocean island basalts are thought to sample the lower mantle regions and exhibit more heterogeneity than MORB. These regions have been associated with lower mantle structures known as large low shear velocity provinces (LLSVPS) below Africa and the South Pacific. The isolation of these regions is attributed to compositional differences and density stratification that, consequently, have been the subject of computational and laboratory modeling designed to determine the parameter regime in which layering is stable and understanding how layering evolves. Mathematical models of persistent compositional interfaces in the Earth's mantle may be inherently unstable, at least in some regions of the parameter space relevant to the mantle. Computing approximations to solutions of such problems presents severe challenges, even to state-of-the-art numerical methods. Some numerical algorithms for modeling the interface between distinct compositions smear the interface at the boundary between compositions, such as methods that add numerical diffusion or 'artificial viscosity' in order to stabilize the algorithm. We

*Corresponding Author
Email address: egpuckett@ucdavis.edu (Elbridge Gerry Puckett)