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Coupled magma/mantle dynamics in a heterogeneous mantle beneath mid-ocean ridges

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Global magmatism segregates the products of melting from their source; plate tectonics and convection stir those products back into Earth's mantle. In this context, it is not surprising that the mantle is chemically heterogeneous, even if the details remain poorly known. What happens when the heterogeneous mantle melts beneath a mid-ocean ridge? Is chemical variability created or destroyed? What are the implications for magmatic transport and focusing? How does consideration of heterogeneity affect our ideas about reactive channellisation of magma? We present new results from computational models that incorporate chemical heterogeneity in the context of conservation of mass, momentum, and energy for the two-phase system of magma within the mantle (e.g. McKenzie 1984). The simulations build on those of Katz (2010), who considered only large-scale gradients in temperature and composition. Results presented here demonstrate that sharper variations in composition, whether discrete blobs or a more distributed pattern of variability, may lead to magmatic channellisation, melt trapping beneath the lithosphere, and even the creation of new chemical heterogeneities. Our results underscore the importance of accounting for conservation of energy in models of coupled magma/mantle dynamics.

Katz, R.F. (2010) Porosity-driven convection and asymmetry beneath mid-ocean ridges. Geochem. Geophys. Geosys., doi: 10.1029/2010GC003282. http://foalab.earth.ox.ac.uk/