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Active convection and magma dynamics at mid-ocean ridges

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The role of buoyancy-driven, "active" upwelling beneath mid-ocean ridges has been long debated [1,2,3], with the naysayers holding sway in recent years. Recent work on tomographic imaging of the sub-ridge mantle has revealed patterns in velocity variation that seem inconsistent with what we expect of passive upwelling and melting [4]. The irregular distribution, asymmetry, and off-axis locations of slow regions in tomographic results are suggestive of time-dependent convective flow. Using 2D numerical simulations of internally consistent mantle and magmatic flow plus melting/freezing [5,6], I investigate the parametric subspace in which active convection is expected to occur. For low mantle viscosities, convection can break the symmetry of corner flow. This may help to explain the asymmetric distribution of shear-wave velocity beneath the MELT region of the East Pacific Rise.

References: [1] Rabinowicz, et al., EPSL, 1984; [2] Buck & Su, GRL, 1989; [3] Scott & Stevenson, JGR, 1989; [4] Toomey et al., Nature, 2007; [5] McKenzie, J.Pet., 1984; [6] Katz, J.Pet., 2008;