

# Mixing of Heterogeneities in Mantle Plumes

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The long standing idea that the source of oceanic island basalts includes ancient subducted oceanic crust is strengthened by recent geochemical data on Hawaiian shield lavas. The isotopic variations in the Koolau and Mauna Kea lavas document the presence of two distinct recycled components: 1) ancient oceanic crust and pelagic sediments, 2) altered ultramafic lower crust or lithospheric mantle. Lassiter and Hauri [1998] suggest that both components are from the same packet of recycled oceanic lithosphere, thus implying that chemical heterogeneities a few kilometers thick can be preserved in the convecting mantle.

Here I investigate the role of mantle plumes in mixing mantle heterogeneities, in particular I address the following questions: How are mantle heterogeneities entrained by mantle plumes? Which regions of the mantle are more efficiently sampled by plumes generated at the core-mantle boundary? Is mixing more efficient in the plume head or in the tail? Are the implications from geochemistry consistent with fluid dynamical models?

I use the three dimensional convection code (Stag3d) by Paul Tackley to model the formation and rise of plumes, while the flow trajectory of the heterogeneities is mapped using tracers. For a simple axisymmetric case the passive tracers can be advected forward or backwards in time. The results indicate that the bottom 200-300 km of the lower mantle are most efficiently sampled by a thermal plume, and that the heterogeneities are considerably stretched and mixed in the plume head. Further more realistic models include 1) a chemically denser recycled crust, 2) a more complex thermo-chemical boundary layer and 3) a background velocity field superimposed on the flow field associated with the mantle plume.