

Melt production at mantle plume.

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Three-dimensional numerical models of mantle convection with viscosity depending on temperature are used to study the melting and depletion rate caused by the plume-lithosphere interaction beneath a moving plate. We derived four empirical laws of the depletion rate as a function of some parameters which influence the plume convection. Those parameters are buoyancy flux, age of the plate, plume excess temperature and Rayleigh number.

We find out that plumes with buoyancy flux higher than 5000 kg/s are adiabatically rising through the upper mantle because the conduction is negligible. A parabolic scaling law for the depletion rate as a function of the age of the plate fits very well with our physical expectation.

We discover that the development of small scale convection (SSC) for high enough Rayleigh numbers cools the plume, causing a reduction of the depletion rate relative to the case without SSC.

Visualizations of depletion patterns at high Ra values suggest a melting pattern as an alternative explanation for the pattern of two parallel volcanic lines, as observed at Hawaii.