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3D models of plume-lithosphere interactions

C. Thoraval (1), M.P. Doin (2), A. Tommasi (1)

(1) Géosciences Montpellier, CNRS & Université Montpellier II, France (thoraval@gm.univ-montp2.fr), (2) ENS Paris, France

We use 3D cartesian model to investigate the behaviour of mantle plumes beneath a fast moving plate. Numerous numerical experiments have been carried out for various Rayleigh numbers, plume diameters, and thermal anomalies. The plume-lithosphere interaction is described in terms of spreading of plume material, erosion expressed as the uplift of isotherms, and ability to produce melting. In all cases, plumes ascend almost vertically throughout the mantle and impact the basis of the lithosphere. However the flow induced by a 200km wide plume with 200 degrees thermal anomaly overwhelms the large scale flow induced by plate motion at high Rayleigh numbers (4.75e6), while the « same » plume spreads out at the base of the lithosphere like a narrow parabola for a 10 times smaller Rayleigh number. These values seem to be higher and lower bounds, corresponding to viscosity at the base of upper mantle between 1e20 and 1e21 Pa.s. As the behaviour of mantle plumes highly depends on the Rayleigh number, the knowledge of the size of realistic mantle plumes could put strong contraints on upper mantle viscosity or, conversely, precising the value for upper mantle viscosity would be very helpful to constrain the size of plume conduits.