

Heater size effect on generation of thermal plumes

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Mantle plumes from the CMB experience a filtering effect by the endothermic phase change at the 660-km phase transition. Fluid dynamics predicts that the hot mantle plumes stagnate at and locally heat the upper-lower mantle boundary, which causes generation of the secondary plumes in the upper mantle, and hence hotspots volcanic activities on the surface. To understand the effects of heater size on the plumes generation, we have experimentally investigated the behaviors of thermally buoyant plumes generated from a localized heat source (circular plate heater) using quantitative visualization techniques of temperature (TLC) and velocity (PIV) fields. Scaling laws for their ascent velocity and spacing of the plumes are experimentally determined. We also estimate the onset time of the secondary plumes in the upper mantle which depends on local characteristics of the thermal boundary layer developing at the upper-lower mantle boundary.

Keywords: plume, mantle, fluid dynamics, experiment