Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05775, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05775
EGU General Assembly 2008

Mantle plumes from the transition zone: triggered by lithospheric instability ?

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A number of major thermal plumes, e.g., Hawaii, are thought to originate at the core-mantle boundary. Other smaller plumes, e.g., Massif Central or Eiffel, may be restricted to the upper mantle. If the mantle convects as a single layer, it is not obvious how thermal plumes can originate from the transition zone. It has long been recognised, however, that there is a large viscosity contrast (a factor on the order of 30 to 100) between upper and lower mantle layers. The positive Clapeyron slope of the spinel to perovskite phase transition, also discourages vertical transport across the 670 km boundary. One consequence of these properties is that subducted oceanic slabs are in most cases thickened, deflected and/or retarded as they pass from upper to lower mantle. Subducted slabs, however, are large structures with a long life-time, so one may expect that even with these obstacles the slab may pass through the 670 km boundary. The upper mantle circulation is affected also by tectonic activity in the continental mantle. There is evidence from a number of environments, e.g. Tibet, Andes, Pannonian Basin, that continental mantle lithosphere may be destabilised by continental collision. Removal of continental lithospheric mantle by gravitational instability (either by convective thinning or by delamination) has been invoked in many continental environments where convergence has occurred. This process is thought to explain heating and uplift of the lithosphere, onset of extension, magmatism and surface volcanism. When such events occur, the cold mantle lithosphere that is removed may sink rapidly through the upper mantle, but be blocked (at least temporarily) by the phase change and the high viscosities below 670 km. Evidence from seismic tomography indicates that large volumes of cold material have accumulated beneath the Mediterranean above 670 km, linked probably to surface tectonic activity in this re-

gion since the Miocene. It seems very likely that rapid deposition of cold mantle in the transition zone above 670 km will displace hotter mantle upward on the perimeter of the region, and thus provide a mechanism for producing mantle plumes that originate in the transition zone.