Geophysical Research Abstracts, Vol. 9, 04028, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04028

Successful and failing plumes: the Icelandic case

I. Kumagai (1), A. Davaille (1) and K. Kurita (2)

(1) IPGP/ UMR7154, 4, Place JUSSIEU, 75252 Paris cedex 05, France, (2) ERI, Univ. of Tokyo, 1-1-1, Yayoi, Bunkyo, 113-0032 Tokyo, Japan (kumagai@ipgp.jussieu.fr)

Reconstructions suggest that the Icelandic melting anomaly has been active for at least 100 Myr. However its characteristics are not constant in time. Volcanic episodes with moderate temperature from Ellesmere Island to Greenland predate the major episode of mafic magma emplacement containing picrite (˜60Ma), while present Iceland shows again a moderate temperature anomaly. These observations cannot be explained by the classical model of mushroom-shaped plume out of a localized heat. We have systematically studied the more realistic case of thermochemical convective instabilities (TCIs) developing in a heterogeneous mantle. Fluid mechanics results show that: (1) TCIs of large extent (˜1000km) are expected to develop from the bottom of the mantle with a characteristic spacing of 3000-4000km. (2) They should be hotter than purely thermal convective instabilities since their temperature-derived density anomaly must be sufficient to counterbalance the stabilizing chemical density anomaly. (3) Upon reaching the 660km transition zone, a hot TCI could pond long enough to generate moderately hot (˜100C) thermal plumes in the upper mantle. (4) The TCI could eventually cross the 660 interface and reach the surface, producing hot traps (˜300C) on a wide area. (5) The TCI material would also cool down, until its thermal buoyancy is not sufficient to counterbalance its compositional anomaly, and sink back into the mantle. But, since this "failing plume" is still hotter than the ambient mantle, it will generate moderately hot thermal plumes. (6) The thermal plumes sample primarily the bulk (or upper) mantle and entrain only thin filaments of the TCI material. This sequence could explain the Icelandic observations, namely the hot traps as well as the mild temperature anomalies pre- and post-traps, the upper mantle component in the present-day Iceland lavas as well as its rare gas anomaly, and the apparent disconnection between slow seismic anomalies in the upper and lower mantle. More generally, this study shows that a) all slow seismic anomalies are not upwellings, b) convective features in the mantle are strongly time-dependent, and c) we need to include time in the models.