# PLATES VS. PLUMES: A GEOLOGICAL CONTROVERSY

GILLIAN R. FOULGER

University of Durham
Email: g.r.foulger@durham.ac.uk

Two radically different views exist of the origin of large-volume magmatism (as exemplified by flood basalts), and persistent, low-volume magmatism (as exemplified by volcano chains). These are the Plate-, and the Plume hypotheses. The Plume hypothesis envisages a large, thermal diapir that rises from the core-mantle boundary, actively penetrating the entire mantle and the lithosphere, to cause volcanism on the surface. It is envisaged to be fundamentally independent of shallow structures and processes, but to be driven by thermal energy derived from Earth's core. The Plate hypothesisis the conceptual inverse. It envisages magmatism to be driven by shallow processes that ultimately draw their driving forces from plate tectonics[Foulger, 2010, http://www.mantleplumes.org/; Foulger & Jurdy, 2007; Foulger *et alii*, 2005]. Magmatism is envisaged to occur as a passive reaction to lithospheric extension, and its quantity and chemistry are envisaged to reflect source fusibility and composition. Thus, "anomalous" magmatism, conventionally attributed to plumes, is expected to occur preferentially near extensional plate boundaries, e.g, the mid-Atlantic ridge, and continental rift zones. Where volumes are large, chemical signatures indicating high source fertility are expected. How can these two hypotheses be tested against one another? Scientific hypothesis-testing normally comprises stating the predictions of the hypothesis and then testing them against observations. The conventional Plume hypothesis predicts a) surface uplift some tens of Ma precursory to flood volcanism, b) initial flood volcanism lasting a few tens of Ma, c) a *plume tail* extending from the surface to the core-mantle boundary, d) a time-progressive volcanic chain, and e) high temperatures. These predictions are surprisingly rarely confirmed with confidence, and never all at a single volcanic province. The Plume hypothesis has undergone extensive ad hoc elaboration over the years to accommodate this prediction/observation mismatch. The Plate hypothesis predicts a) that volcanism is associated with extension, and b) that large-volume magmatism is related to source fusibility. Prediction a) is confirmed atsome volcanic provinces, e. g.; Iceland, and in the East African Rift, though observations are lacking from many, less accessible regions, e. g. in the interiors of oceanic plates. Prediction b) is manifest in the ocean island basaltic chemical signature of many lavas.