Uplift and Mantle Plumes

Ross Thompson

Causes

1. Dynamic Uplift
2. Hot Lithosphere Buoyancy
3. Lithosphere under-plating

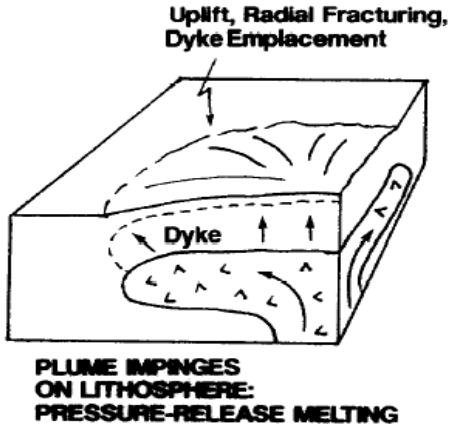
Uplift in Geological Record

E.g. Tertiary North Sea

- Uplift from Dynamic Uplift and Lithospheric buoyancy, no evidence of under-platting (***Nadin et al 1997)***
- Average uplift 400m, maximum 900m
- Shows timing, location, and magnitude similar to that of the plume currently under Iceland
- Supported by sediment studies ***(Mudge et al. 2004)*** and petrology studies of volcanics (***Thompson 1974; Maclennan & Lovell 2002).***

Uplift at Present

E.g. Giant radiating dyke swarms

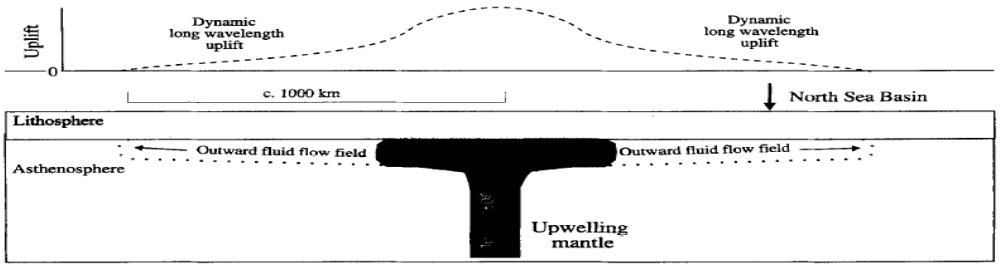


- Cause by plume impinging on lithosphere below
- Forming roughly circular mound with radial fracturing
- Dyke propagation, and influx of material sustain uplift

(Ernst, R.E., et al. 1995)

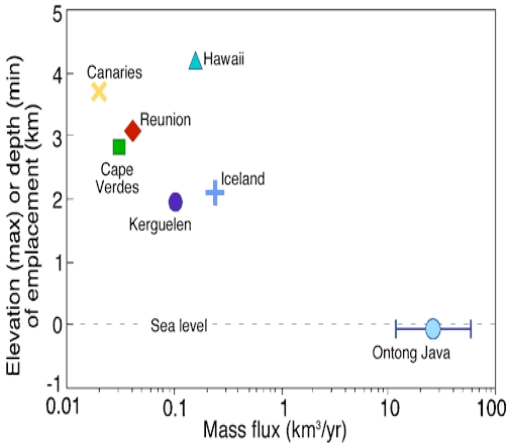
Problems with Plume Uplift

- Average sized plume of 1000m+ should produce equal amount of uplift in models ***(Campbell & Griffiths 1990)***
- Some of the biggest igneous provinces show no sign of this pre-volcanic uplift e.g. Ontong Java Plateau, Columbia River Basalts, Siberian ***(Czamanske, G.K., et al. 1998).***

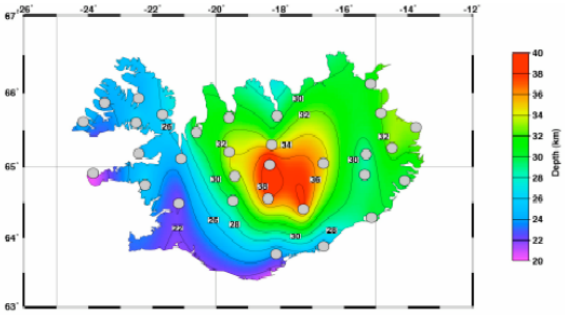


- Uplift which is seen in some LIPs is post volcanic ***(Ollier & Pain 2001)***; this however may have over-written pre-volcanic uplift.

OJP Plateau and Iceland



- Isostacy calculations show uplift form a plume of sufficient magnitude would have caused up lift between 1km and 4km depending on the model ***(Farnetani & Richards, 1994).***
- Should have caused large amount of sub-arial volcanism.
- But as shown here only negligible amount are seen.



- Icelandic plume which is migrating east ***(Lawver, L.A., and Muller, R.D., 1994)*** should have made the western side thicker.
- Not seen in drill cores. ***(Foulger G.R., Anderson D.L., & Natland J.H., 2003.)***

Other Possible Causes

- Changes in the stress field – e.g. crack propagation
- Geochemical changes – e.g. volume change
- Influx of magma – e.g. increase in volume due to magma injection

Summary

(1) Pre-Volcanic uplift did occur but decays and is then over printed by sub-sequent more recent uplift.

(2) Uplift never did occur and the plume model is false.

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