Spots yes, hot barely or not

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Sea floor heat flow data play a role in discussions of hotspots and plumes similar to that of the dog whose failure to bark helped Sherlock Holmes locate the missing racehorse Silver Blaze. The small size or absence of a heat flow anomaly at midplate hotspots such as Hawaii has been crucial for assessing possible mechanisms causing the volcanism and uplifted topography. The uplift was originally thought to reflect a hot mantle plume, rising from deep in the mantle, penetrating the approximately 100-km-thick oceanic lithosphere and causing heating to about 50-75 km of the surface (e.g., Crough 1983, McNutt and Judge 1990). The thermal perturbation from such thinning predicts heat flow significantly higher than that associated with unperturbed oceanic lithosphere, which cools with age as it spreads away from the midocean ridges where it formed. Although anomalously high heat flow was initially reported, subsequent analysis showed that most if not all of the apparent anomalies resulted from comparing the data to reference thermal models that underestimated heat flow elsewhere (Von Herzen et al. 1989, Stein and Abbott 1991, Stein and Stein 1993, 1994). Hence subsequent models generally assume that the uplift results from the dynamic effects of rising plumes (Liu and Chase 1989, Sleep 1994, and the associated compositional buoyancy, whose thermal effects are concentrated at the base of the lithosphere and hence would raise surface heat flow at most slightly, because tens of millions of years are required for heat conduction to the surface.

Given Foulger's (2003) challenge to the common model in which Iceland's formation is due to a deep mantle plume, we examined sea floor heat flow data from the region. We find (Stein and Stein, 2003) that heat flow values near Iceland on the North American (west) side of the mid-Atlantic ridge are comparable to those for oceanic lithosphere of this age elsewhere, and thus show no evidence for significantly higher temperatures associated with a mantle plume. Heat flow is significantly higher on the Eurasian plate, east of the mid-Atlantic Ridge, than to the west on the North American plate. This puzzling asymmetry, which appears to be real even given the limited data, is opposite that expected from models in which Iceland was formed by a fixed mantle plume.

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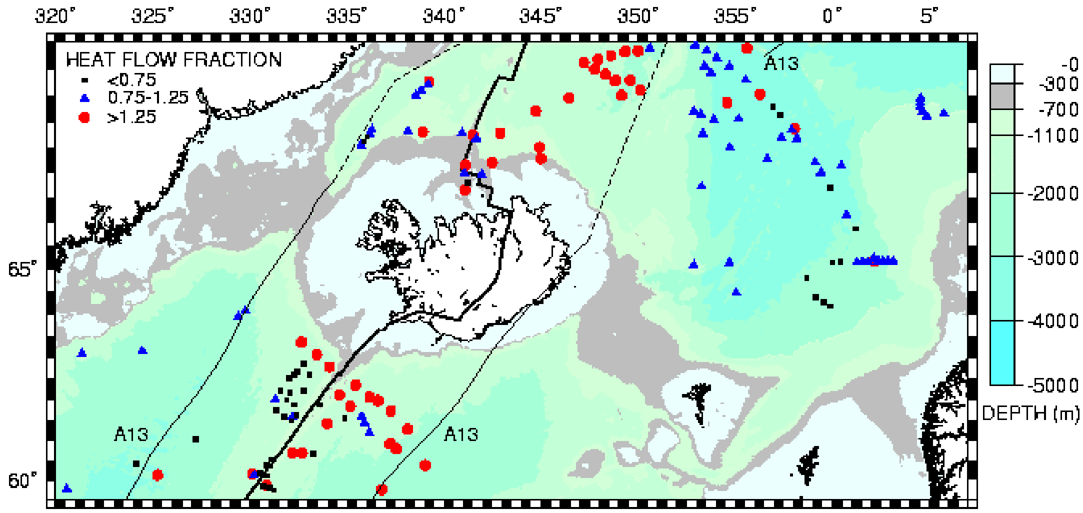

Figure 1: Bathymetry and heat flow for the Iceland region. Heat flow shown as heat flow fraction, observed values normalized by global average values for that lithospheric age (Figure 2). Lithosphere younger than about 35 Myr indicated by the positions of magnetic anomaly 13 (solid line) or approximated by dashed line.

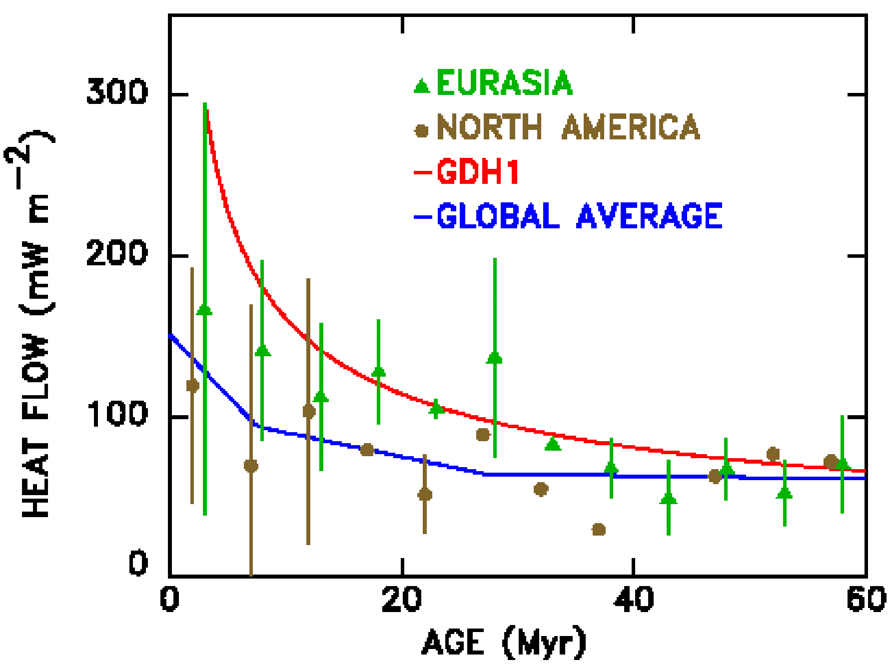

Figure 2: Heat flow data near Iceland (Figure 1) grouped in 5-Myr bins for the Eurasian and North American plates, compared to the predictions of the GDH1 thermal model which does not include the effect of hydrothermal circulation, and a linear fit to the global average values.