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Thermochemical Evolution of Mantle Plumes Observed Spatially

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Basaltic lavas erupted at intraplate ocean islands can provide insight into the long-term thermal and chemical evolution of the underlying mantle plumes that they sample. Combining geochemical and geodynamic observations, we evaluate the thermochemical characteristics of mantle plumes using lavas of selected, long-lived hotspot tracks fed by plumes. To calculate olivine-liquid equilibration temperatures along each hotspot track, we leverage previously published geochemical data for magmas that fall on olivine-control lines. To assess temporal trends, we combine mantle potential temperatures calculated for lavas along long-lived hot spot tracks with distance along the hotspot track. From these geochemically derived temperature trends and published data on volcanic flux over time, we constrain temporal variations in buoyancy flux for individual hot spots. This study focuses on the Hawaii hotspot track, which was used as a test case for our methodology, with preliminary results also presented for the Louisville Ridge and the Canary Islands. Our findings indicate that the mantle potential temperatures do not vary substantially (<50 °C) along the Hawaii hotspot track, nor are there systematic differences between the Loa and Kea tracks. In the absence of significant thermal variations, the volcanic flux increase of about a factor of three evident along the young end (<30 Ma) of the Hawaiian Ridge has to be supported by a plume pulse (i.e. increase in plume buoyancy flux). As both buoyancy flux and plume flux strongly increase through time, with little correlation to mantle potential temperature, this necessitates a geodynamic mechanism that can support near-constant plume temperatures while giving rise to significant variations in plume (buoyancy) flux.