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# Application of a Volumetric Approach for Assessing Plume Buoyancy Flux

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Existing estimates of the global flux of heat carried by plumes into the uppermost mantle are approximately 2 TW. This value is small in comparison to both $\sim 45$ TW of total heat passing through the Earth's surface and 8–16 TW transferred from the core into the lower mantle. Upwelling plumes are therefore believed to play only a minor role in heat transfer through the mantle.

However, a series of independent geological observations around plume heads suggest that existing estimates of heat and mass transfer are probably underestimates. The North Atlantic region in particular contains evidence for V-shaped ridges of thickened oceanic crust, periodic uplift and subsidence of oceanic gateways and continental margins, and pulses of sedimentation into offshore basins. These phenomena are best explained by rapid lateral flow of plume material within an asthenospheric channel at velocities that are an order of magnitude faster than overlying plate motions. Accounting for this behaviour at Iceland indicates that the plume buoyancy flux may be as high as $27 \pm 4$ Mg s$^{-1}$, a factor of 20 larger than previous estimates.

The problematic assumption with pre-existing measurements of plume flux is that asthenospheric velocities do not exceed plate velocities. These North Atlantic observations suggest that it is desirable to develop an alternative methodology that is independent of observed plate motions. Our substitute approach uses swell volumes and an assumption of quasi-steady state, whereby heat supply is balanced by heat loss. This method is calibrated at Iceland and Hawaii where reliable independent constraints on plume buoyancy flux exist, before being expanded in a global analysis. Preliminary results suggest that up to 10 TW of heat is carried into the uppermost mantle by plumes. This value is more consistent with recent evidence for large-scale plume-like structures in seismic tomographic models of the mantle, and indicates a more important role for plumes in the Earth's heat transfer system.