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Testing the volcanic record for evidence of broad hotspot melting anomalies

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The notion of a mantle plume has long been that of a mushroom-like 'head' and thin 'tail' structure rising from a deep thermal boundary layer, generally depicted as the core-mantle boundary. Drifting of tectonic plates over the narrow, presumably fixed, hotspots created by such plume 'tails' has long provided an elegant explanation for time-progressive lines of islands, seamounts and ridges. But a major problem cited for this 'standard' plume model is a lack of evidence in the volcanic record for head-and-tail upwellings.

However, recent thermo-chemical numerical modeling is exploring scenarios where upwelling structures are more irregular in shape and behaviour compared to a classic thermal plume 'head-tail' (Farnetani and Samuel, 2006). Furthermore, possible entrainment of a deep chemical boundary can vary greatly with strongly temperature-dependent viscosity from nearly stagnant large plumes in the lower mantle to fast episodic pulsations travelling up the pre-existing plume conduit (Lin and van Keken, 2005, 2006). Thus, the classic 'head-tail' may not be the only possible upwelling structure.

New age data show that the Galapagos Volcanic Province developed via the progression of broad regions of concurrent dispersed volcanism that we link to a correspondingly broad mantle melting anomaly (O'Connor et al., submitted, 2007). Thus, evidence from direct dating of the oceanic hotspot record is also suggesting that hotspot melting anomalies might be much broader than commonly inferred from the 'head-tail' plume model and the dimensions of individual seamount chains and aseismic

ridges.

New strategies are therefore needed for investigating the hotspot volcanic record in order to better test the plume hypothesis. To this end we have recently sampled multiple seamount chains and ridges scattered across a broad region of the southern South Atlantic. Our focus is on investigating multiple hotspot chains stretching across a very broad region of the South Atlantic seafloor as a potentially useful way of testing 1) the new thinking that plume upwellings may differ from the classic ‘head-tail’ structure and 2) our evolving hypothesis that hotspot melting anomalies are much broader than suggested by regions of active volcanism marking the young ends of individual hotspot trails.