# The isotope topology of individual hotspot basalt arrays: melt extraction trajectories from a plum-pudding mantle?

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Arrays of basalts from the same hotspot usually plot within an elongate tube-like field in $^{87}Sr/^{86}Sr$-$^{143}Nd/^{144}Nd$-$^{206}Pb/^{204}Pb$ space (Hart *et al.*, 1992) . Each hotspot array tube (HART) is commonly interpreted as the result of melting multiple basalt sources that are variably-proportioned mixtures of the hotspot source components. We propose instead that a HART is the isotopic trace of a melt-extraction trajectory which starts from an initial source mixture characteristic to that hotspot. Melt-extraction trajectories are produced when the sources of individual basalts differ in the amount of prior melt extraction they underwent at the hotspot. This melting physics also provides straightforward explanations for the $^{187}Os/^{186}Os$ contrasts between mid-ocean ridge basalts and their presumed abyssal peridotite source, and for the enigmatic trace element and isotopic patterns of pyroxenite veins and peridotite exposed within orogenic lherzolites.

This idea can be extended to explain the generation and evolution of the various 'plum' and 'residue' components that make up this plum-pudding mantle. We explore a geochemical model for mantle evolution (Phipps Morgan and Morgan, 1997) where a progressive sequence of hotspot and ridge upwelling melts the mantle to make hotspot and mid-ocean ridge basalts and their residues, and plate subduction re-cycles and stirs all of these differentiation products back into the mantle. After billions of years this process has mixed various-age 'plums' of incompatible-element rich veins within a matrix made from the residues of melting that have been depleted in incompatible elements (Allegre and Turcotte, 1986; Polve and Allegre, 1980). Random variability within this process will then produce the distinct plum-pudding mixture that upwells and progressively melts beneath a given hotspot to make its distinctive isotopic hotspot array tube.

## References

Allegre, C.J. and Turcotte, D.L. (1986) Implications of a two-component marble-cake mantle, *Nature*, *323*, 123–7.

Hart, S.R., Hauri, E.H., Oschmann, L.A. and Whitehead, J.A. (1992) Mantle plumes and entrainment: isotopic evidence, *Science*, **256, 517–20.**

Phipps Morgan, J. and Morgan, W.J. (1997) Two-stage melting and the geochemical evolution of the mantle: A recipe for mantle plum-pudding. *Earth Planet. Sci. Lett.*, submitted.

Polve, M. and Allegre, C.J. (1980) Orogenic lherzolite complexes studies by 87Rb-87Sr: A clue to understand the mantle convection processes? *Earth Planet. Sci. Lett.*, **51**, 71–93.