

MAGMA MIXING AT OCEANIC TRANSFORM FRACTURE ZONES

by

M. F. J. FLOWER

Dept. of Geol. Sci., Univ. of Illinois
Chicago, IL 60680, U.S.A.

ABSTRACT

Ocean ridge eruptive chemistry reflects isochronic compositional «gradients», often attributed to the interaction of lithophile element-rich mantle plumes with the relatively depleted asthenosphere. Inspection of Atlantic and Pacific axial gradients shows lithophile-rich eruptions do not correspond exclusively to proposed loci for mantle upwelling. In contrast, transform fracture zones appear to mark the majority of lithophile-enrichment peaks, suggesting relatively superficial tectonic phenomena influence magma chemistry. A general association of lithophile and radiogenic isotope enrichment with increasingly frequent offset spreading culminates at major fracture zone-ridge axis intersections (e.g., Galapagos, Iceland, Azores, Jan Mayen, and Siqueiros, Oceanographer and Romanche fracture zones). Major element and normative compositions show that enrichment also coincides with increased depth of melt segregation in the mantle. This is of interest in view of independent

evidence for a vertical zonation of mantle lithophile and radiogenic constituents, such that magmas of deeper origin would reflect a downward transgression from depleted to enriched sources. On the basis of thermal models it is reasonable to postulate two preferential zones of partial melting at ocean ridge axes: one activated by «normal» rift dilation (high degrees of melting at shallow depth), the other activated by transform fractures (low degrees of melting at greater depth), each environment constrained by characteristic ranges of P & T and relative volumetric contributions to the accreting lithosphere. Deep basement drilling in the vicinity of fracture zones reflects such dual magma provenance and reveals evidence for the partial hybridization of disparate magmas within single offset spreading segments. This is consistent with evidence for extensive linear magma transport in rift-controlled environments. While reserving judgment on the surface effects of mantle plumes it is proposed that ocean ridge eruptives may reflect differential, tectonically controlled, sampling of a vertically zoned upper mantle, essentially as a secondary effect of the offset spreading pattern.

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