

The origin of E-MORB

A. W. HOFMANN¹ AND C. HÉMOND²

¹Max Planck Inst. f. Chemistry, P.O. Box 3060, 55020
Mainz, Germany; hofmann@mpch-mainz.mpg.de

²Domaines Océaniques IUEM Place Nicolas Copernic, F-
29280 Plouzané, France; chhemond@univ-brest.fr

E-MORBs are thought to be atypical in that they are enriched in incompatible elements, unlike the common, depleted, “normal” N-MORBs. Sun and McDonough [1] in a classical paper, proposed specific compositions for “typical” N-MORB and E-MORB. Although the notion of “typical” within a continuum of enrichments/depletions is questionable, the concepts of N-MORB and E-MORB remain practically useful to the present day.

Actual enrichments/depletions in MORB vary widely, e.g. Ba abundances by factors of 100, La/Sm by 25. The enrichments are not just generated in situ by low degrees of melting (as is the case for alkalic OIBs formed under thick lithosphere), but are derived from enriched sources. Models for generating enriched sources fall in two classes. (1) Metasomatic enrichment mechanisms, proposed by Sun & Hanson [2], are still popular, not only for E-MORBs [3], but also for several types of OIBs (e.g. for HIMU [1]; EM-2 [4]). (2) An alternative enrichment mechanism [5] postulates source enrichment by subduction and recycling of alkalic ocean islands and seamounts. Both types of models account for the observed E-MORB enrichments equally well, because they share essential features, namely (1) an ancient melting event (to account for the correlations with radiogenic isotope ratios), (2) a low melt fraction during that ancient event (to account for the trace element enrichments), (3) relatively high, recent melt fractions at shallow levels (to account for the co-occurrence with depleted MORB and for the relatively high HREE abundances), (4) the absence of continental material (indicated by high Nb/U and Ce/Pb ratios, similar to nearly all MORB and most OIB and contrasting with respectively low ratios in continental rocks). Indeed, it seems quite possible that both mechanisms operate in parallel. For example, low melt fractions forming beneath oceanic lithosphere may metasomatize this lithosphere in addition to forming alkalic volcanoes. The main difference is that we can observe the volcanoes whereas the metasomatism itself remains largely hidden.

References

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