

The composition of the MORB source

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The composition of the mantle source of mid-ocean ridge basalts (MORB) has conventionally been thought to be the direct result of the extraction of the continental crust. This view is only partly correct, and it has led to seriously biased estimates of the size and composition of that source reservoir [1,2], partly because the differentiation and segregation of the oceanic crust have been neglected. As the uniformly elevated Nb/U ratios of MORB and ocean island basalts (OIB) demonstrate, both MORB+OIB source reservoirs are residues of the continental crust. Recent mass balance considerations based on Nb/U and Nd isotopes have shown that the combined MORB-OIB source is only moderately depleted, and occupies most or all of the mantle [3]. However, these considerations have not yielded a specific constraint on the composition of the MORB source *sensu stricto* until now. Here we estimate the composition of the MORB source using simple partial melting models. We model the composition of the primary MORB melts from the global MORB database [4] using methods given in ref. [5], estimating the mean melt fraction at 12%. The resulting average MORB source composition is significantly less depleted than current, widely used estimates [1,2]. The results also require that the MORB source occupies a much larger portion of the mantle than just the uppermost 670Km. The main uncertainty of the new estimate lies in the possibility that the average MORB composition is biased toward locally enriched portions of a generally more depleted mantle, because melts from enriched sources might preferentially ascend into the upper portion of the oceanic crust [6]. Evidence for such bias has been found in highly heterogeneous MORB regions, but so far, the evidence for more general biasing is sparse.

[1] Salters and Stracke, 2004, G-Cubed, 5, doi:10.1029/2003GC000597

[2] Workman and Hart, 2005, EPSL Vol. 231, 53-72

[3] Hofmann et al., 2022, G-Cubed, 23, doi:10.1029/2022GC010339

[4] Gale et al., 2013, G-Cubed 14, doi:10.1029/2012GC004334

[5] Klein and Langmuir, 1987, JRG 92, 8089-8115.

[6] Burton et al., 2024, Geochemical Perspectives Lett. 29, 9-13.

