Barium isotope evidence for global sediment recycling in the upper mantle

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The upper mantle - as sampled by mid ocean ridge basalts (MORBs) - exhibits significant chemical variability that cannot be explained by differences in the mechanisms of melt extraction at ridges [1]. Hypotheses to explain this compositional range from depleted to enriched MORBs broadly invoke either internal re-distribution through delamination, melting and metasomatism [2-5] or interaction with surface reservoirs like hydrothermally altered oceanic crust (AOC) and sediments [5-7]. Existing tools and approaches, however, have struggled to unambiguously distinguish between these models. We find that barium isotope variations in global MORBs vary systematically with radiogenic isotopes and trace element ratios that cannot be explained by internal redistribution processes. Instead, our data can only be explained by sedimentary contamination, which is strongly supported by demonstrable Ba-isotopic equivalence between core-top sediments and enriched MORBs. We show that addition of ~0.1% by weight of sediment components into the depleted mantle in subduction zones must induce low-degree melting [5] that produces the enriched MORB reservoir. Subsequently, these enriched domains convect towards mid ocean ridges and produce radiogenic isotope variation that is typical of enriched MORBs [5]. These data provide strong evidence for global sediment recycling in the upper mantle and can reconcile the chemical and isotopic features of enriched MORBs.

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