Mantle mixing processes revealed from HIMU basalts

JAMES M.D. DAY[1], RITA A. CABRAL[2], MATTHEW G. JACKSON[3] AND RICHARD J. WALKER[4]

[1]Scripps Institution of Oceanography, La Jolla, CA 92093-0244, USA. jmdday@ucsd.edu
[2]Boston University, Boston, MA 02215, USA
[3]UC Santa Barbara, Santa Barbara, CA 93106, USA
[4]Univerity of Maryland, College Park, MD 20740, USA

Extreme high-μ (HIMU; high time-integrated $^{238}U/^{204}Pb$) lavas from Mangaia and St. Helena have Pb isotopic compositions ($^{206}Pb/^{204}Pb$ >20.5) that set them apart from more common HIMU-type lavas occurring in locations like the Canary Islands or Cameroon line ($^{206}Pb/^{204}Pb$ ~19-20.5). New Os isotope and highly siderophile element (HSE) abundance data show that HIMU-type ocean island basalts (OIB) typically possess a larger range in initial $^{187}Os/^{188}Os$ (0.135-0.175) compared with extreme HIMU OIB (0.140-0.148). Lower Os isotope compositions in extreme HIMU lavas likely reflect melting of a hybridised incompatible-element enriched peridotite containing ancient (>2 Ga) oceanic lithosphere, where the Os isotope signature is dominated by the peridotite. In contrast, HIMU-type lavas originate from younger recycled sources (<1 Ga) that have not fully mixed with peridotite, resulting in a variable fraction of Os coming from high Re/Os pyroxenite. These differences require that lithological heterogeneities can only persist for <2 Ga before they are stirred back into the mantle, and are consistent with a peridotite source for Mangaia, versus pyroxenite-peridotite sources for El Hierro (Canary Islands), from olivine chemistry and more heterogeneous radiogenic isotope compositions. Preservation of pyroxenite lithologies in the mantle can explain the paucity of extreme HIMU localities, which require melting of peridotite, versus more common and diverse HIMU-type lavas formed through melting of younger fusible subducted lithologies in a surrounding peridotite matrix.