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Pb Isotopic Evidence for Coherent Mantle Domains Beneath the East Pacific Rise

S. J. G. Galer (sjg@mpch-mainz.mpg.de)[1], **W. Abouchami** (wafa@mpch-mainz.mpg.de)[1] &
J. D. Macdougall (jdmacdougall@ucsd.edu)[2]

[1] Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany
[2] Scripps Institution of Oceanography, La Jolla, CA 92093-0220, USA

We report Pb isotopic compositions of Mid-Ocean Ridge Basalt (MORB) glasses from ~6000 km along the East Pacific Rise (EPR) from 35ºS to 21ºN. The data were obtained with external precisions of <100ppm (2σ) using a triple spike (TS) to correct for instrumental mass bias. The aims of this study are to (1) search for the existence of linear array(s) in Pb isotope space in MORB, as has already been shown for single Hawaiian volcanoes (Abouchami et al., 1999), and (2) identify distinct Pb isotopic provinces in the mantle source along the EPR. Considerable Pb isotopic variability is observed along the EPR, the exception being samples from 12ºN which are isotopically very homogeneous. The total range of Pb isotopic variations, with the exception of older $^{207}Pb/^{204}Pb$ data, is similar to that of previously published data obtained without the TS (e.g. White et al., 1987). The ranges in $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ are: 17.8-18.9, 15.39-15.56 and 37.2-38.3, respectively, and are strongly correlated; the mean values are 18.453, 15.503 and 37.930. A principal component analysis shows that 95% of the dataset variance can be ascribed to a single eigenvector, with only 4% and 1% of the variance to the remaining two eigenvectors.

Taking the dataset as a whole, excellent negative isotopic correlations are seen between Nd and Pb isotopes, including $^{207}Pb/^{204}Pb$, while Sr and Pb isotopes are poorly correlated. This implies a strong coupling of U/Pb, Th/Pb and Nd/Sm fractionation in the EPR MORB source, and/or components therein, ultimately due to ancient magmatic differentiation processes - these data do not show evidence for preferential Pb mobility, a signature expected for recycled, hydrothermally altered oceanic crust.

In detail, the data display well-defined Pb isotopic arrays in both Pb isotopic spaces (apart from 12 ºN), with each array confined to a range in latitude along the EPR. The arrays are significantly different between each of these "domains" and do not indicate the presence of common end-members. Within each domain the position of samples along each array is unrelated to latitude. So far, we can divide the EPR into seven domains which are isotopically "coherent", in the sense of falling on one array, but distinct from one another: (1) 21ºN, (2) 12-13ºN, (3) Siqueiros Fracture Zone 8-9ºN, (4) 2-13ºS, (5) Garrett Fracture Zone 13ºS, (6) 18-23ºS, and (7) 30-35ºS. The length scales along the EPR vary from ~50 to ~1200 km. The boundaries are not well resolved based upon the sampling thus far, except for (4) to (5) which appears very sharp.

Each Pb isotope array can be interpreted in terms of mixing or as an isochron. It is entirely possible that each sample represents an agglomeration of primary melts with an even greater degree of Pb isotopic heterogeneity (Shimizu et al., 1999). But this, by itself, does not solve the fundamental problem of how such mixing relationships could be preserved over ~1000km and differ between domains. If the arrays are considered as isochrons, the ^{207}Pb-^{206}Pb slopes imply ages ranging from 0.9Ga to 2.5Ga (MSWD: 0.2-2.5). The ^{208}Pb-^{206}Pb slopes of the arrays, except for 18-23 S, correspond to a uniform κ (=$^{232}Th/^{238}U$) of ~3.1, if simply interpreted. A κ value of ~3.1 is considerably higher than the MORB source κ of ~2.5, and could imply that a strict "isochron" interpretation is wrong. Our preferred interpretation is that the ^{208}Pb-^{206}Pb slopes reflect long-term coupled Th/U and U/Pb fractionation in the source rather than a constant κ value (White et al., 1987). Thus, each domain contains components of recycled, relatively unaltered oceanic lithosphere, having a distinct differentiation age. These characteristics appear to be in agreement with the systematics of $^{187}Os/^{188}Os$ vs. Pt/Os observed in abyssal peridotites (Brandon et al., 2000).

Whatever the origin of these "domains" is, these results draw into question the notion of a shallow, depleted mantle that is convectively well mixed and relatively homogeneous. Rather, the domains must either retain a high degree of integrity during mantle overturn, or else be ponded, perhaps by intrinsic buoyancy, in the shallow mantle. We speculate that the domains are stabilized against mixing-in by having a higher viscosity (Manga, 1996), brought about by dehydration in a prior melting event(s) (Hirth and Kohlstedt, 1996).

Abouchami W, Hofmann AW & Galer SJG, *EOS, Trans. AGU 1999 Fall Mtg*, **80**, F-1183, (1999).
Brandon AD, Snow JE, Walker RJ, Morgan JW & Mock TD, *Earth Planet. Sci. Lett*, **177**, 319-335, (2000).
Hirth G & Kohlstedt DL, *Earth Planet. Sci. Lett*, **144**, 93-108, (1996).
Manga M, *Geophys. Res. Lett*, **23**, 403-406, (1996).
Shimizu N, Sobolev AV, Layne GD & Tsamerian OP, *In: Ninth Annual V. M. Goldschmidt Conf. , Abstract #7657, LPI Contrib. No. 971 (CD-ROM)*, (1999).
White WM, Hofmann AW & Puchelt H, *J. Geophys. Res*, **92**, 4881-4893, (1987).