Supplementary Materials

S1

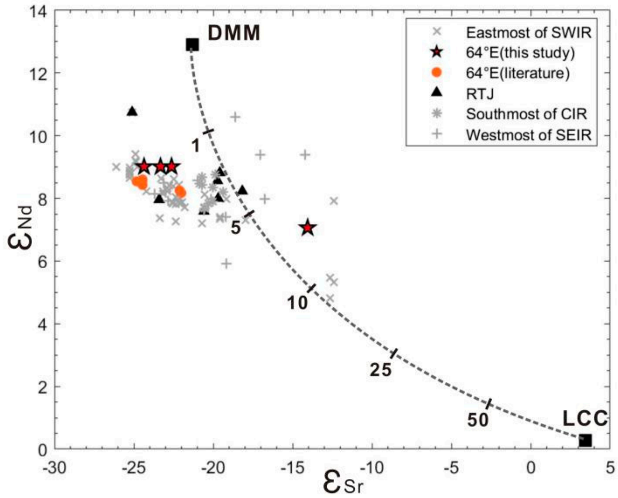

Figure S1. Plots of εSr vs. εNd showing data for DMM and LCC end-members. Data sources are the same as in Figure 5. Isotopic data sources for the depleted MORB mantle (DMM) are from [1,2] and for the lower continental crust (LCC) composition they are from [3,4]. From this figure, we considered that the DMM was variously contaminated by the LCC. Furthermore, most of samples were below the trend line, which implies the existence of a third component.

PCA S1. Principal Component Analysis (PCA)

The MORBs from 64°E are proposed to represent a ternary mixing among a DMM end-member, an EM2 end-member, and an LCC end member, and similar observations were made for the E-SWIR, RTJ, S-CIR, and W-SEIR basalts. In order to test these hypotheses, a principal component analysis (PCA) was performed on the Pb isotope data of the 64°E samples (this study and data from the literature).

As only three end-members are involved in that mixing processes, the data should plot on a single plane in the three-dimensional data ($^{206}Pb/^{204}Pb$ vs. $^{207}Pb/^{204}Pb$ vs. $^{208}Pb/^{204}Pb$). Furthermore, this plane is supposed to pass through the three end-members. This means that no more than two vectors (principal components) are necessary to explain the selected data.

To perform the PCA, the covariance matrix is calculated on the reduced data:

$$\mathrm{cov}(data) = \begin{bmatrix} 0.0249 & 0.0031 & 0.0249 \\ 0.0031 & 0.0026 & 0.0074 \\ 0.0249 & 0.0074 & 0.0380 \end{bmatrix} \tag{1}$$

This matrix has three eigenvalues and three associated eigenvectors:

$$\lambda_1 = 0.0584; \quad \lambda_2 = 0.0065; \quad \lambda_3 = 0.0007 \tag{2}$$

$$\vec{v}_1 = \begin{pmatrix} 0.6002 \\ 0.1386 \\ 0.7878 \end{pmatrix}; \vec{v}_2 = \begin{pmatrix} -0.7682 \\ 0.3743 \\ 0.5194 \end{pmatrix}; \vec{v}_3 = \begin{pmatrix} 0.2229 \\ 0.9169 \\ -0.3311 \end{pmatrix} \tag{3}$$

Those three eigenvectors define the three-dimensional coordinate system in which our data can be plotted (Figure 10a).

The data variability is mainly expressed by the first two principal components (98.9%), thus showing the extent of inhomogeneit0y of the mantle: the mantle source gradually undergoes binary or ternary mixing from the 61°E of SWIR eastward to the RTJ.

The second covariance matrix is

$$\operatorname{cov}(data)=\begin{bmatrix}0.0368 & 0.0029 & 0.0359\\ 0.0029 & 0.0015 & 0.0046\\ 0.0359 & 0.0046 & 0.0450\end{bmatrix} \tag{4}$$

The associated eigenvalues and eigenvectors are

$$\lambda_1=0.0774;\quad \lambda_2=0.0050;\quad \lambda_3=0.0009 \tag{5}$$

$$\vec{v}_1=\begin{pmatrix}0.6635\\ 0.0704\\ 0.7448\end{pmatrix};\vec{v}_2=\begin{pmatrix}0.7385\\ -0.2212\\ -0.6370\end{pmatrix};\vec{v}_3=\begin{pmatrix}-0.1199\\ -0.9727\\ 0.1988\end{pmatrix} \tag{6}$$

When the Pb isotope data from E-SWIR, RTJ, S-CIR, and W-SEIR are considered (Figure 10b), the first two principal components explain 98.9% of the total dispersion. The remaining 1.1% may be explained by the analytic uncertainties.

The third covariance matrix calculated on the reduced data for these data is

$$\operatorname{cov}(data)=\begin{bmatrix}0.0538 & 0.0046 & 0.0457\\ 0.0046 & 0.0017 & 0.0057\\ 0.0457 & 0.0057 & 0.0770\end{bmatrix} \tag{7}$$

The three eigenvalues and associated eigenvectors are

$$\lambda_1=0.1130;\quad \lambda_2=0.0183;\quad \lambda_3=0.0013 \tag{8}$$

$$\vec{v}_1=\begin{pmatrix}0.6126\\ 0.0652\\ 0.7877\end{pmatrix};\vec{v}_2=\begin{pmatrix}0.7891\\ 0.0074\\ -0.6143\end{pmatrix};\vec{v}_3=\begin{pmatrix}0.0459\\ -0.9978\\ 0.0469\end{pmatrix} \tag{9}$$

The data all plot on a plane described by the eigenvectors v_1 and v_2. This is in agreement with what was expected for a ternary mixing process. Data may now be represented on a two-dimensional graph (Figure 11). This and the triangular shape of the data in the figure confirm that only three end-members (DMM, LCC, and EM2) are necessary to explain the dispersion of the data in the Pb space. Figure 11 also shows that the mantle source beneath E-SWIR, RTJ, S-CIR, and W-SEIR have a certain similarity.

References

1. Hart, S.R.. A large-scale isotope anomaly in the Southern Hemisphere mantle. *Nature* **1984**, *309*, 753-757.
2. Escrig, S.; Capmas, F.; Dupre, B.; Allegre, C.. Osmium isotopic constraints on the nature of the dupal anomaly from indian mid-ocean-ridge basalts. *Nature* **2004**, *431(7004)*, 59-63.
3. Rudnick R.L.; Goldstein S.L.. The Pb isotopic compositions of lower crustal xenoliths and the evolution of lower crustal Pb. *Earth and Planetary Science Letters* **1990**, v*36*, p203-225.
4. Chen W.; Arculus R.J.. Geochemical and isotopic characteristics of lower crustal xenoliths, San Francisco Volcanic Field, Arizona, U.S.A. *Lithos* **1995**, v*36*, p203-225.