Chemical heterogeneity of suboceanic mantle source as a main cause of its isotopic heterogeneity

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I present a model explaining isotopic variations in mantle for Sr, Nd, Pb and Hf rather as a result of long living chemical heterogeneity of mantle source then a direct involve into the mantle of isotopically anomalous material.

Worldwide MORB tholeiites show well evident, regular multidimensional correlations of trace elements Rb, Sr, Sm, Nd, U, Th, Pb, Lu, Hf and their ratios Rb/Sr, Sm/Nd, U/Pb and Lu/Hf in log-log scale, extending up to two orders in concentrations of some of them. This suggests that the chemical variations in the high-degree melting derivatives were inherited to some extent from their source rocks. It is possible that the mantle dispersed chemical heterogeneity was produced by previous magmatic or metasomatic processes.

If there exists a long living chemical heterogeneity in the mantle source, we must take into account its influence on isotopic composition of Sr, Nd, Pb and Hf there.

Above considerations lie in a base of a Monte-Carlo model of the related chemical and isotopic heterogeneity evolution of the mantle material. This model:

1. Splits a mantle source on a number of domains, homogeneous in trace element and isotopic composition.
2. Splits the 4.5 Gy time span on a number of steps.
3. On every step in every domain contents of Rb, Sr, Sm, Nd, U, Th, Pb, Lu, Hf is changed by a random number generator to get at the finish a statistical distribution of every element ratios and their pair correlations like in MORB.
4. On every step all isotopic ratios are changed in according with a decay law.
5. On every step domains from a random group are pairwise equilibrated with another randomly selected domain. This procedure models remixing and partial homogenization of heterogeneous material.

The model is well rigorous in terms of used parameters. It shows that the known mantle isotopic heterogeneity in Sr-Nd-Pb-Hf isotopic multispace is in a good statistical agreement with a global chemical heterogeneity of MORB. It explains a negative correlation of Nd and Sr isotopic ratios (mantle array), $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ isotopes correlation, corresponding to an age 1.7-1.8 Gy, and some other details. Particularly it explains a HIMU-shift in lead isotopic composition of some of simulated rocks despite such a special anomalous source was not involved in the model.