Mixing Systematics in the Mantle beneath Mid-Ocean Ridges

V.J.M. Salters, S. Mallick and A. Sachi-Kocher (NHMFL and FSU, Geology)

Introduction

Plume related volcanism from both continental and oceanic settings show very good correlations between Hf and Nd-isotopes. The correlations of the individual ocean island chains are even better in Hf-Nd isotope space. However, mid-ocean ridge basalts (MORB) do not show a good correlation between Hf and Nd isotopes [1]. However, the coverage of the ocean ridge system is at relatively low density. It is unknown whether when sampled at higher resolution Hf and Nd isotopes are correlated. However, higher resolution sampling results in a smaller variation in isotopic composition and consequently requires higher precision analyses.

Experimental

We analyzed suites of MORB from the Atlantic and Pacific ocean basin for Hf and Nd isotopic composition. Regular dissolution and separation techniques were used to prepare Hf and Nd separates. Separates were analyzed on our multi-collector inductively coupled plasma mass spectrometer (Thermoquest NEPTUNE) in static mode. Reproducibility of mass fractionation corrected $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ is routinely better then 4 ppm, which is better then our previous techniques.

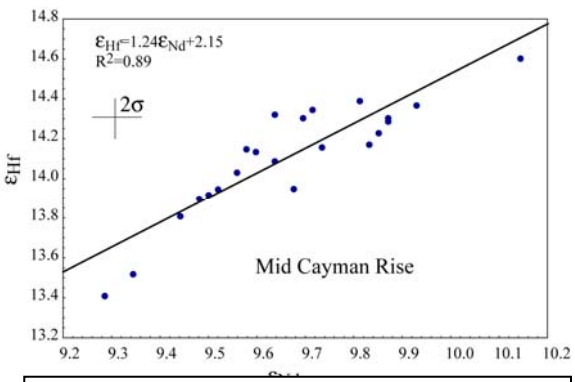

Figure 1. Hf vs Nd isotopes using ε-notation (parts in ten thousand deviation from chondritic values).

Results and Discussion

Figure 1 shows the Hf-Nd isotope variation of basalts from the Mid Cayman Rise and shows very good correlation between the two isotope systems. Figure 2 shows the variation in Hf and Nd isotopes for several MORB suites, each suite showing a good correlation between Hf and Nd isotopes. Suites from the Indian, Atlantic and Pacific basins all show good correlation between Hf and Nd isotopes on a "local' scale. These parallel arrays in indicate the order of mixing in the asthenospheric mantle. On a "local" scale the variations are binary between a depleted endmember (radiogenic Hf and Nd) and an enriched endmember. However, the global scale requires a different component. We propose that this component is recycled depleted oceanic lithosphere. Previous studies have shown that this depleted lithosphere will develop a radiogenic Hf isotopic composition for moderately radiogenic Nd-isotopic composition

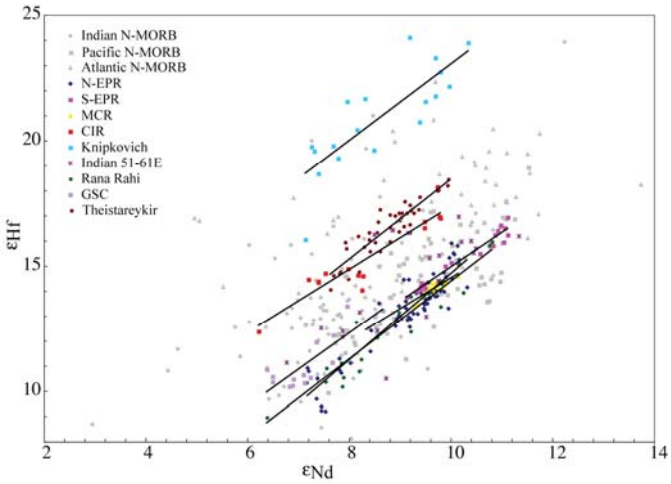

Figure 2. Hf-Nd isotope variation of MORB, indicating suites from this study. MORB suites form parallel arrays indicating an order of mixing.

Conclusions

High precision Hf and Nd isotope analyses of MORB from limited geographic areas show systematic variations between the two isotope systems. These systematic differences provide information about the order of mixing in the mante and the creation of isotopic provinces.

Acknowledgements

This work was supported by grant NSF OCE 0648484.

References

[1] C. Chauvel, and J. Blichert-Toft, Earth Plan. Sci. Lett. 190 (2001) 137-151.