CC/NUMBER 14
APRIL 8, 1991

This Week's Citation Classic ®

O'Nions R K, Hamilton P J & Evensen N M. Variations in $^{143}Nd/^{144}Nd$ and $^{87}Sr/^{86}Sr$ ratios in oceanic basalts. *Earth Planet. Sci. Lett.* 34:13-22, 1977.
[Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY]

This is one of several papers in the 1970s to report analyses of Nd isotopes in oceanic volcanics. The results established the depleted character of mantle sampled by magmas extracted at ridges, the less depleted character of many ocean islands. The covariation of Sr and Nd isotopes led to the establishment of the bulk or primitive Earth parameters. The results suggested that the generation of continental crust was responsible for mantle depletion, and this could be readily recognized using isotopic measurements by reference to this new framework. [The *SCI*® indicates that this paper has been cited in more than 400 publications.]

The Mantle Array

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I became interested in the possibility of measuring Nd-isotopes in oceanic volcanics while still at Oxford. However, it was after I left Oxford in the summer of 1975 to start a new laboratory at the Lamont-Doherty Geological Observatory that I decided to have a go. It was the first project that I completed in a new laboratory, with a new instrument, together with new colleagues. The establishment of a new laboratory went surprisingly fast, and we were making measurements toward the end of 1975.

The technology to measure ^{143}Nd, the daughter of ^{110}Ga ^{147}Sm, came just at the time that many suspected that the continental crust had developed by extraction of material from the mantle leaving a complementary and variably depleted residue. We were not the only group to spot the chance of tackling this problem. Groups in Paris[1] and at the California Institute of Technology (Caltech), Pasadena,[2] were simultaneously working on Nd isotope analysis of ocean ridge volcanics, and the first results from these three labs were all published in 1976 and 1977. The result was startlingly clear and simple—the spreading ridges sampled mantle that had been depleted in Nd relative to Sm and was indeed a well-mixed depleted residue.

The covariation of $^{143}Nd/^{144}Nd$ and $^{87}Sr/^{86}Sr$ in oceanic basalts showed that Rb and Nd were sympathetically depleted relative to Sr and Nd in the mantle and led to the identification of a bulk or primitive Earth composition. This covariation soon became known as the "mantle array." At long last, we had a framework within which depleted and nondepleted parts of the mantle could be identified from the magmas extracted from it. The subject of Nd-isotope geochemistry quickly blossomed,[3] but the initial estimates of bulk Earth have stood the test of time, despite the tendency to identify "disarray" within the "array" as more and more data became available.

In subsequent years, these data provided the basis for crust-element mass balance calculation that placed limits on the time of continent extraction as well as the portion of mantle involved in the process. Geochemical and geophysical observations nudged closer together in the quest for an understanding of the scales of mantle convection. Our own work on this subject[4] suggested that half or less of the mantle was involved in continent formation, that some portion must survive relatively undepleted, and that, convectively, a layered structure to the mantle seemed likely. Indeed, my present views[5] are essentially the same.

The citation of this paper over the years is particularly satisfying. First, it is a great tribute to the scientific value of these measurements made at Paris, Caltech, and Lamont and the start of serious efforts to use natural radiogenic tracers to study the deeper structure of the Earth. Second, it stirs happy memories of exciting days with two colleagues who were exceptionally good company, both scientifically and socially.

1. **Richard P, Shimizu N & Allégre C J.** $^{143}Nd/^{146}Nd$, a natural tracer: an application to oceanic basalts. *Earth Planet. Sci. Lett.* 31:269-78, 1976. (Cited 220 times.)
2. **DePaolo D J & Wasserburg G J.** Inferences about magma sources and mantle structure from variations of $^{143}Nd/^{144}Nd$. *Geophys. Res. Lett.* 3:743-6, 1976. (Cited 310 times.)
3. **O'Nions R K, Carter S R, Evensen N M & Hamilton P J.** Geochemical and cosmochemical applications of Nd isotope analysis. *Annu. Rev. Earth Planet. Sci.* 7:11-38, 1979. (Cited 40 times.)
4. **O'Nions R K, Evensen N M & Hamilton P J.** Geochemical modeling of mantle differentiation and crustal growth. *J. Geophys. Res.* 84:6091-101, 1979. (Cited 195 times.)
5. **Galer S J G, Goldstein S L & O'Nions R K.** Limits on chemical and convective isolation in the Earth's interior. *Chem. Geol.* 75:257-90, 1989.

*Received August 10, 1990