Nd isotopic evolution of deep-water recorded by fossil manganese nodules

T. Ito — Faculty of Education, Ibaraki University, Mito, Ibaraki, 310-8512, Japan

C.-K. Na — Department of Environmental Engineering, Mokpo National University, Chonnam, 534-729, Korea

T. Nakano — Institute of Geoscience, University of Tsukuba, Tsukuba, Ibaraki, 305-0006, Japan

A. Usui — Marine Geology Department, Geological Survey of Japan, Tsukuba, Ibaraki, 305-0046, Japan

Evolution of deep-water has been constructed actively by Nd and Pb isotopes in marine manganese oxides from sea-floor surface during recent years (e.g. Abouchami and Goldstein, 1995; Albarede *et al.*, 1997; Ling *et al.*, 1997). Here we adopt fossil manganese nodules studied by Usui and Ito (1994) and Ito *et al.* (1998) as a proxy preserving Nd isotopic compositions of ambient deep-waters, instead of previous surficial manganese oxides, and reconstruct the history of deep-water circulation, especially recent 40 m.y. in the Atlantic.

Samples

All of the studied samples was from the DSDP/ODP cores. 20 samples in the totally 22 samples were composed of vernadite which is hydrogenous manganese mineral, and two of them were contained trace of buserite indicating influence of oxic diagenesis. Remaining two samples (E19 and E20) from the north Atlantic were composed of pyrolusite and manganite, respectively, which are typical in hydrothermal manganese deposits, though there is no geological evidence of hydrothermal activity in their cores bearing the fossil nodules (Usui and Ito, 1994) and both of samples have identical $^{87}Sr/^{86}Sr$ ratios with coeval seawater values (Ito *et al.*, 1998).

In addition, most of the samples show the rare-earth element (*REE*) pattern with distinct positive Ce anomaly, suggesting also hydrogenous origin consistent with mineralogical data. Only Sample E20 has parallel *REE* pattern with shale.

Results and discussion

The following specific features were shown from Nd isotopes of HCl leachate fractions in the fossil nodules: (1) Pacific Ocean: Fossil nodules from the late Miocene to Quaternary have epsilon Nd values of −3.2 to −5.2, except one of the Quaternary fossil nodule having unradiogenic value of −7.5. (2) Indian Ocean: An early-middle Eocene fossil nodule from northwest off Australia has a value of −7.7, which is within those of the surficial nodules from the Indian ocean (Albarede *et al.*, 1997). (3) Caribbean Sea: Four of the fossil nodules from the early Miocene have a wide range of epsilon Nd from −5.7 to −8.0, despite of their occurrences from nearly same horizons of same core. (5) Atlantic Ocean: In the north Atlantic Ocean, three of fossil nodules from Tertiary have epsilon Nd values of −9.4 to −11.6. They are within the range of literature values for the north Atlantic nodules from sea-floor surfaces. E19 from late Cretaceous has slightly radiogenic value of −8.7. On the other hand, E20 from Tertiary shows unradiogenic value of −13.2 more than typical surficial, hydrogenous nodules from the north Atlantic.

Epsilon Nd values of the fossil manganese nodules from the Argentine basin, southwest Atlantic, increase gradually from −8.2 of the latest Eocene to −5.4 of the Quaternary. The later value is identical with those of surficial manganese nodules from the same basin, as shown by Albarede *et al.* (1997). These secular changes could either be a result of increasing supply of radiogenic Nd derived by diagenesis of volcanic materials from the South Sandwich arc or adjacent volcanoes (Albarede *et al.*, 1997), or addition of Pacific seawater to the Argentine basin through the Drake Passage (Abouchami and Goldstein, 1995). Because of rare occurrence of volcanic materials in Site 328 (Elliot

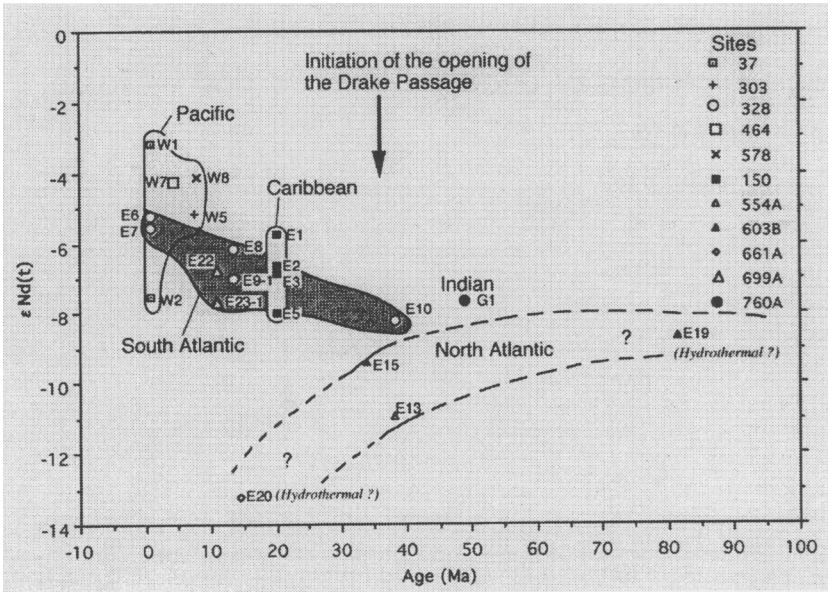

FIG. Nd isotopic evolution of fossil manganese nodules.

and Emerick, 1977), no evidence of Sr isotopic alteration in the fossil nodules from the Argentine basin by diagenesis of volcanic materials (Ito *et al.*, 1998), and also simultaneity between the opening of the Drake Passage and the Nd isotopic divergence in the Atlantic fossil nodules (Fig. 1), the input of Pacific seawater to the Argentine basin provides a plausible alternative to the increasing of epsilon Nd in the fossil nodules after the latest Eocene.

References

Abouchami, W. and Goldstein, S.L. (1995) *Geochim. Cosmochim. Acta*, **59**, 1809–20.

Albarede, F., Goldstein, S.L. and Dautel, D. (1997) *Geochim. Cosmochim. Acta*, **61**, 1277–91.

Elliot, D.H. and Emerick, C.M. (1977) *Init. Repts. DSDP* **36**, 871–6.

Ito, T., Usui, A., Kajiwara, Y. and Nakano, T. (1998) *Geochim. Cosmochim. Acta*, (in press).

Ling, H.F., Burton, K.W., O'Nions, R.K., Kamber, B.S., von Blanckenburg, F., Gibb, A.J. and Hein, J.R. (1997) *Earth. Planet. Sci. Lett.*, **146**, 1–12.

Usui, A. and Ito, T. (1994) *Mar. Geol.*, **119**, 111–36.