REE+Y geochemistry of the 3.46 Ga Marble Bar Chert recovered by the Archean Biosphere Drilling Project (ABDP)

KOSEI E. YAMAGUCHI[1,2,3], YASUHIRO KATO[4], KENTARO NAKAMURA[2,5], KATSUHIKO SUZUKI[2,6], YUMIKO WATANABE[3,7], MUNETOMO NEDACHI[8] AND HIROSHI OHMOTO[3,7]

[1]Geochemical Laboratory, Dept. Chemistry, Toho University, Funabashi, Chiba, Japan (kosei@chem.sci.toho-u.ac.jp)
[2]Precambrian Ecosystem Laboratory, Japan Agency for Marine-Earth Science & Technology (JAMSTEC), Japan
[3]NASA Astrobiology Institute (NAI)
[4]Dept. Systems Innovation, Univ. Tokyo, Japan
[5]Frontier Res. Ctr. Energy & Resources, Univ. Tokyo, Japan
[6]Inst. Res. on Earth Evol. (IFREE), JAMSTEC, Japan
[7]Dept. Geosciences, The Pennsylvania State Univ., USA
[8]Dept. Physics, Kagoshima Univ., Japan

Diamond drillcores of the ~3.46 Ga Marble Bar Chert (MBC), Western Australia, were successfully recovered by the Archean Biosphere Drilling Project (ABDP). In order to constrain geochemical environments for deposition of the chert/jasper beds, a full spectrum of elemental analyses were performed on ~140 bulk-rock banded cherts from the drillhole ABDP#1. Sedimentary features indicating shallow- water deposition are apparently lacking from the chert.

Compared to clastic sediment-containing impure cherts, we have found that the least-contaminated cherts (jasper) possess higher and variable atomic Y/Ho ratios (55-120 vs. ~60), higher Fe_2O_3/TiO_2 ratios (>100 vs. <100), prominent positive Eu anomalies (Eu/Eu* up to ~2 vs. ~1), and modestly negative Ce anomalies (Ce/Ce* down to ~0.8 vs. ~1.0). Since these characteristics were most likely created during, rather than after, deposition of the sediments, they likely reflect the chemistry of seawater (or hydrothermal fluids) 3.46 Ga ago.

Variations of Y/Ho ratios are caused by different affinity of those elements for Fe-(oxy)hydroxides surface. Y/Ho ratios are typically ~50 in normal igneous and sedimentary rocks, but are increased to >90 in modern oxygenated seawater. Therefore, our findings of similarly high but variable Y/Ho ratios for the MBC suggest that the deep oceans were at least locally oxygenated to allow significant Y/Ho fractionation accompanying with Fe-(oxy)hydroxides precipitation. Such precipitates were formed by mixing of Fe^{2+}-rich submarine hydrothermal fluids (reflected in Eu anomalies) and O_2-rich deep seawater (reflected in Ce anomalies).

Mantle noble gas abundance ratios: Support for a less degassed lower mantle

JUNJI YAMAMOTO AND MARK D. KURZ

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 02543, USA

Oceanic basalts provide a view of heterogeneities in the Earth's interior. Contrast in noble gas isotopic compositions between mid-ocean ridge basalts (MORB) and ocean island basalts (OIB) requires the existence of two isotopically distinct mantle sources. Differences in noble gas abundance ratios between them also indicate that there are differences in noble gas concentrations. Recent experimental measurements of He partitioning in mantle minerals suggest that the possible occurrence of a depleted mantle source with primordial noble gas isotopic ratios. However, existing data do not yet exclude the existence of less degassed primordial mantle sources.

In this study we reviewed literature data for noble gas isotopic compositions of MORB and high $^3He/^4He$ OIB glasses, in an attempt to estimate the average noble gas abundance ratios of these two distinct mantle sources. We use measured end-member noble gas isotopic compositions to correct for degassing and air contamination (i.e. using Ar isotopes to trace atmospheric components). The figure below illustrates the magmatic noble gas abundance patterns of MORB and OIB. Assuming that these patterns represent the mantle source, they can be used to estimate the degree of degassing in the reservoirs. The contrast in the abundance ratios indicates that the MORB source mantle is depleted in Ne and Ar compared to that of OIB. The OIB source is more similar to C1 chondrite and air than MORB. The new estimates suggest that less degassed primordial OIB sources still exist in the Earth's mantle. Ancient depletion models for OIB sources are not easily reconciled with MORB or OIB abundance patterns, based on existing partitioning data.