Geophysical Research Abstracts
Vol. 13, EGU2011-5444, 2011
EGU General Assembly 2011

Extreme mantle depletion identified by Hf isotope ratios in abyssal peridotites

Andreas Stracke (1,2), Jon E. Snow (3), Eric Hellebrand (4), Anette von der Handt (4,5), Bernard Bourdon (1), Karin Birbaum (6), and Detlef Günther (6)

(1) ETH Zürich, Institute for Geochemistry and Petrology, Switzerland, (2) Westfälische Wilhelms Universität, Institut für Mineralogie, Münster, Germany (stracke.andreas@uni-muenster.de), (3) Department of Geosciences, University of Houston, Houston, Texas 77204, USA, (4) Department of Geology and Geophysics, University of Hawaii, Honolulu, Hawaii 96822, USA, (5) Institute of Geoscience, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany, (6) Laboratory of Inorganic Chemistry, ETH Zürich, 8Zürich, Switzerland

Depletion of the Earth's mantle by partial melting governs the chemical differentiation of our planet. The isotopic composition of the Earth's mantle has mostly been inferred from analyses of mid-ocean ridge basalts (MORB), which are thought to provide an adequate time-integrated record of mantle depletion. Far fewer isotope analyses of actual oceanic mantle rocks (i.e. abyssal peridotites) exist, owing to their scarcity and often altered state. Here we present new Hf and Nd isotope analyses from abyssal peridotites from the Gakkel ridge in the North Atlantic. Coupled depletions in Nd and Hf isotope ratios in the Gakkel ridge samples range to εHf and εNd values of 60.4 and 20.5, respectively, and hence considerably extend the MORB and ocean island basalt (OIB) Hf-Nd isotope array to more depleted values. In addition to such highly depleted Hf and Nd values, some samples from the Gakkel ridge range to extreme Hf isotope values up to εHf of 104, but lack the corresponding depletion in Nd isotopes (εNd of about 8), similar to what is observed in Hawaiian peridotite xenoliths from Salt Lake Crater, Oahu [4, 5]. The εHf ratios in the Gakkel Ridge peridotites thus range up to about three times higher values than previously inferred from the highest εNd ratios in abyssal peridotites measured to date. Moreover, the Hf rather than the Nd isotope ratios of the Gakkel ridge peridotites correlate with major and trace element indices of depletion (e.g. Al_2O_3 and Yb content, spinel Cr#) and their previously determined Os isotope ratios [6]. Hence the Hf and Os isotope compositions of these samples preserve a record of ancient mantle depletion, whereas the Nd isotope signatures generally do not. Most, but not all, Sm/Nd and Nd isotope ratios are at least partially reset by melt-rock interaction during ancient or recent melting events at the ridge and thus only few Nd isotope ratios in abyssal peridotites preserve ancient mantle depletion to a similar extent as the Os [6] and Hf isotope ratios. The oceanic mantle consequently ranges to much more depleted Hf-Os isotope signatures and is isotopically much more variable than would be inferred from the Nd isotope analyses of abyssal peridotites to date [1, 2, 3], but especially those of the basalts (MORB). MORB alone are therefore unsuitable to estimate the average isotope composition of the depleted mantle (DM) presenting an, as of yet, unrecognized obstacle for global mass balance models of Earth's differentiation. If the average DM is more depleted than MORB suggest, these models generally overestimate its mass fraction and would permit prolonged timescales for early Earth differentiation (> 30 m.y.).

[1] Snow et al., 1994, Nature 371, 57-60; [2] Salters & Dick, 2002. Nature 418, 68-72; [3] Cipriani et al., 2004. Geology 32, 657-660; [4] Salters, V. J. M. & Zindler, A., 1995. EPSL 129, 13-30; [5] Bizimis et al., 2007. EPSL 257, 259-273; [6] Liu et al., 2008. Nature 452, 311-316; [8] Patchett, 1983, Lithos 16, 47-51; [9] Salters, 1996, EPSL 141, 109-123; [10] Chauvel & Blichert-Toft, 2001, EPSL 190, 137-151. [11] Salters et al., 2008, GCA 72, 820.