In-situ trace element and bulk-mineral rb-sr and sm-nd isotope ratios of peridotites from horoman massif, japan: implications for isotopic evolution of mantle rocks

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Abstract

Peridotite is the major rock type of which Earth's upper mantle consists and exposed at the Earth surface due to volcanic and orogenic processes. Such exposed peridotites provide access to study geodynamic processes of the mantle. Horoman from Northern Japan is an orogenic peridotite formed by partial melting of the depleted mantle at a mid-ocean ridge at ~1 Ga. Samples from this orogenic peridotite contains Pargasite (Prg), a Ca-amphibole, which have been formed as a result of fluid/melt-peridotite interaction or mantle metasomatism subsequent to the formation of peridotite. Insitu trace element, and trace element and Rb-Sr and Sm-Nd isotopic composition of bulk-mineral fractions of constituent minerals (Prg, Cpx and Opx) separated from two samples were measured using SIMS, ICP-MS and ID-TIMS.

Chondrite normalized REE patterns of Prg show similar trends regardless of its two modes of occurrence (patchy and interstitial) in a single sample. Nevertheless, it shows two main REE patterns as (1) nearly flat heavy REE and middle to light REE depleted pattern and (2) enriched middle REE relative to light and heavy REE among samples. The REE patterns of Prg are almost parallel to those of coexisting Cpx. The primitive mantle normalized trace element patterns of all the Prg show similar trends characterized by Sr and Li negative anomaly and Nb positive anomaly. $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$, and $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios for Prg, Cpx and Opx in each sample measured are plotted individually on isochron diagrams. Rb-Sr data from one sample (HR±0) form a well fitted isochron.

Whereas Rb-Sr data from the other sample (HR-70) are randomly distributed and do not fit for an isochron. All Sm-Nd data from individual samples are randomly distributed and do not fit for an isochron. The isochron obtained for sample HR±0 gives an age of 58.8 ± 5.5 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.702452 ± 0.000007 (2σ).

The well fitted mineral isochron obtained for Prg, Opx and Cpx from HR±0 indicate that minerals were in isotopic equilibrium. This further indicates that the isotopic re-homogenization of the system occurred after formation of the Prg. Thus, the age obtained should represent the time-integrated isotopic variation with different parent/daughter ratios after isotopic re-equilibration by the metasomatic mineral phase, Prg. In addition, the drill core sample of the HR±0 used for separation of these minerals (2.5 cm x 7 cm core) suggest that the isotopic re-homogenization of the system occurred at least within a sphere of 2.5 cm diameter. The sample, however, with randomly distributed $^{87}Sr/^{86}Sr$ isotope ratios with no isochron suggest that isotopic re-equilibration among mineral phases has not achieved in HR-70. Previously published whole-rock Sr isotope data showing no meaningful isochron also suggest that the system has not achieved isotopic re-homogenization in m scale. The Sm-Nd isotopic disequilibrium between minerals suggests that this system has been disturbed only locally implying contrasting isotopic behavior to Rb-Sr.

Key words: Peridotite, mid-ocean ridge, metasomatism, , Sm-Nd isotopes, Mineral Isochron