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Structure and Composition of the Mantle beneath the Minusa Region SW of the Siberian Craton: A Sr-Nd Isotope and Trace Element Study

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Garnet-spinel and spinel peridotite and pyroxenite xenoliths from three upper Cretaceous basanitic explosion pipes in the Minusa region, southern Siberia (Malkovets et al., 2000) have been studied to characterise off-cratonic upper mantle near the southwestern boundary of the Siberian craton. A lithospheric mantle section was constructed based on electron microprobe and LAM-ICMPS analyses of minerals in representative xenoliths. Garnet-bearing xenoliths have been found in one pipe only (Tergesh). Their P-T estimates using Brey and Kohler's (1990) Ca-in-opx thermometer and Nickel and Green's (1985) barometer define an elevated geothermal gradient with estimated pressures for the garnet-spinel lherzolites as low as 16-18 kbar. These Minusa xenoliths are some of the most shallow basalt-hosted garnet-spinel lherzolites in southern Siberia (Ashchepkov et al., 1989; Ionov et al., 1993). Garnet-spinel and spinel lherzolites from the Tergesh pipe yield a fairly narrow T range (1030-1070°C). Clinopyroxene in the majority of the Tergesh lherzolites has moderately high HREE, Sr and Y contents typical of fertile peridotite mantle and shows slight to moderate depletion in LREE, Th, U and Nb, with La/YbN and La/SmN ratios from 0.4 to 0.9. HREE contents in clinopyroxene from the garnet-spinel lherzolites are similar to those from spinel lherzolites probably because of low modal contents of garnet in the lherzolites. This is consistent with their location at the uppermost level of garnet-spinel lherzolite transition zone (16-18 kbar and 1030-1070°C).

Only spinel lherzolites were collected from two other pipes, Krasnoozersk and Kongarovsk. Their temperature range (910-1050°C) is wider than that for the Tergesh lherzolites, with the majority of samples showing T values below 1010°C. Clinopyroxene in most of those xenoliths has HREE and Y contents in similar to those for the Tergesh xenoliths. By comparison, the clinopyroxene in all those samples is enriched in LREE, Th, U, Sr and has negative Nb-Ti-Zr-Hf anomalies relative to REE with similar compatibility. The La/YbN and La/SmN ratios range from 2 to 10 and from 0.5 to 7 respectively. Because those xenoliths equilibrated at lower temperatures than the Tergesh peridotites we believe they were located at shallower levels in the mantle. The major and trace element data indicate that the upper mantle beneath the Minusa region has a two-level structure. (a) The deeper garnet-spinel and spinel lherzolites from the Tergesh pipe have nearly fertile modal compositions and slightly depleted trace element patterns. (b) The shallower spinel lherzolites from the Krasnoozersk and Kongarovsk pipes have a wider range of modal compositions and are commonly less fertile than the Tergesh lherzolites. Their clinopyroxene are typically enriched in highly incompatible trace elements and have negative HFSE anomalies indicating a complicated history which may have involved repeated depletion and metasomatic events by a variety of fluids/melts (Malkovets et al., 1998).

Sr and Nd isotope ratios were determined in 17 basanites and 11 clinopyroxene separates from spinel peridotites to characterise the source regions of the basanites and metasomatic fluids. The analyses were done on a Finnigan MAT262 instrument at the Hokkaido University, Japan. The $^{143}Nd/^{144}Nd$ initial ratios in the basanite range from 0,51278 to 0.51292, $^{87}Sr/^{86}Sr$ range from 0.70333 to 0.70402. On the Sr-Nd isotope correlation diagram they plot as a tight cluster within the mantle array (close to PREMA) indicating a geochemically similar source for initial melts in all the pipes. Clinopyroxene in metasomatised spinel peridotites from the Kongarovsk and Krasnoozersk pipes have $^{143}Nd/^{144}Nd$ (0.51283 to 0.51327) and $^{87}Sr/^{86}Sr$ (0.70292-0.70378) values similar to those for the basanites. It is likely, therefore that the fluids responsible for the metasomatism were derived from the same source as the magmas hosting the xenoliths. The LREE-depleted clinopyroxene from spinel lherzolites of the Tergesh pipe have Sr-Nd isotope compositions ($^{143}Nd/^{144}Nd$ = 0.51323-0.51358, $^{87}Sr/^{86}Sr$ = 0.70250-0.70295) similar to the model DMM source. The high $^{143}Nd/^{144}Nd$ ratios (exceeding those in the MORB) have been earlier reported for other LREE-depleted xenoliths south of the Siberian craton (Ionov et al., 1995), particularly from the Vitim region (Ionov & Jagoutz, 1989). Our results further suggest that the strongly depleted, DMM-like Sr-Nd isotope compositions are common in the lithospheric mantle south of the Siberian Craton.

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