9th International Kimberlite Conference Extended Abstract No. 9IKC-A-00077, 2008

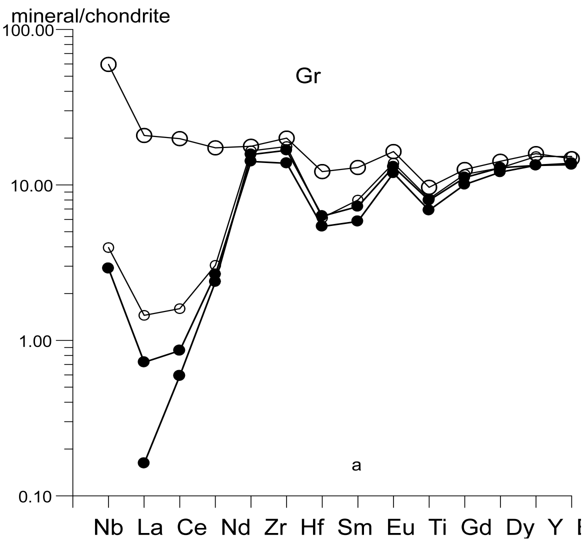
THE GEOCHEMICAL MODIFICATION OF THE SUBCONTINENTAL UPPER MANTLE OF THE SIBERIAN CRATON DUE TO INFLUENCE DEEP PLUME DURING MIDDLE PALEOZOIC KIMBERLITE CYCLE

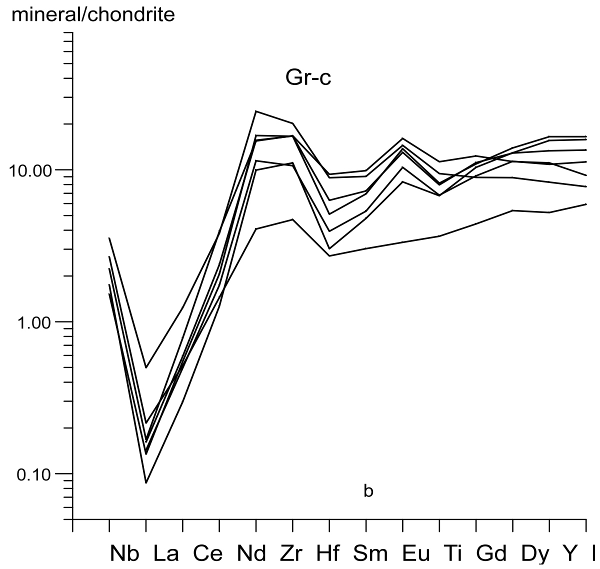
L.SOLOVJEVA [1], K. EGOROV [1], S. KOSTROVITSKY [2].
[1] *Institute of the Earth's crust SB RAS, Russian Federation, Irkutsk, Russian Federation,*
[2] *Institute of Geochemistry SB RAS, Irkutsk, Russian Federation*

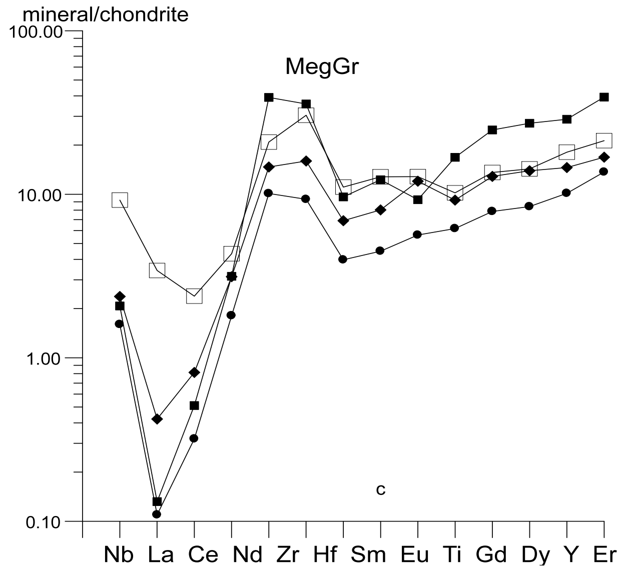
The Upper Devonian kimberlite magmatism the most promising for diamond potential within the Siberian Craton is due to upwelling of the Yakutian deep plume [Ernst, Buchan, 1997; Kiselev et al., 2006]. The plume approached to the base of rigid continental plate produces asthenospheric melts, parent to associations of Cr-poor megacrysts and carried out singular magmatic substantiation of matter in the upper part of asthenospheric layer and in lower lithosphere [Burgess, Harte, 2004; Solovjeva et al., 2008].

The distribution peculiarities of incompatible rare elements (Nb, Zr, Hf, Ti, Y, REE) in the garnet and clinopyroxene grains from high-temperature deformed peridotites and garnet megacrysts (asthenospheric substance) and from low-temperature coarse-grained Gr and Sp-Gr peridotites (lithospheric substance) from the Udachnaya kimberlite pipe have been studied using SIMS method.

The distribution of incompatible rare elements in Gr from high-temperature deformed Gr lherzolites of coarse-porphyroclastic type agree with magmatic trend and are similar to Gr megacrysts (Fig. 1).







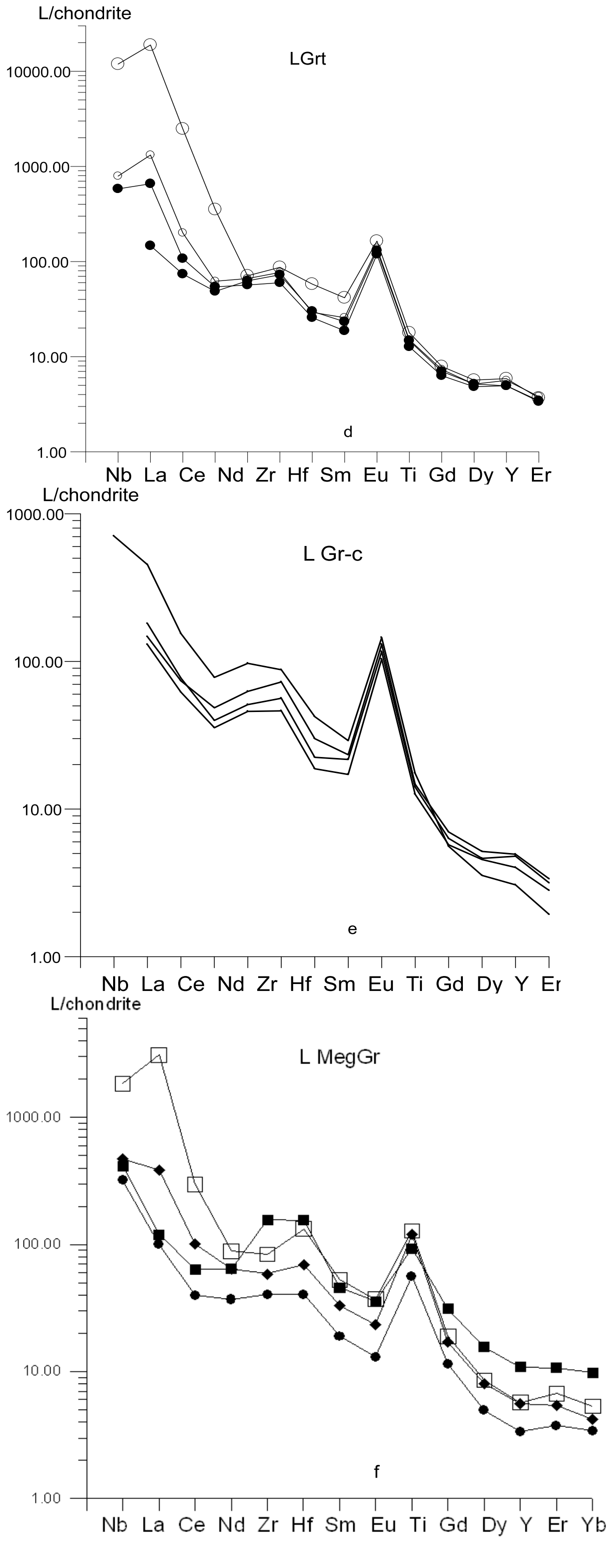


Fig. 1. C1 chondrite normalized [Sun, McDonough, 1989] REE + HFSE in Gr from coarse-porphyroclastic lherzolites (a - b), Gr megacrysts (c) and in calculated melts equilibrated with garnets (d - f). (a) - black circles mark grain core, and open circles mark grain rims of single Gr grain. (b) and (c) - different grains (cores) from coarse-porphyroclastic lherzolites (Gr-c) and Gr megacrysts (MegGr). (d) - melts (LGrt) equilibrated with different zones Gr grain (a). (e) - melts (LGr-c) equilibrated with different Gr grains (cores) (b). (f) - melts (LMegGr) equilibrated with different Gr megacrysts (c).

Maxima of HFSE (Nb, Zr+Hf and Ti) against REE are characteristic of Gr from the rocks and megacrysts. The same feature is proper to the melt compositions calculated from the most representative distribution coefficients of garnet/melt. The calculated melts equilibrated with Gr are similar to fresh basaltoid kimberlites from the Udachnaya pipe in contents of rare elements and differ in HFSE maxima on curves. Melts calculated for Cpx are similar to the same kimberlites both in contents of rare elements and the general character of distribution. Gr from deformed peridotites of fine-porphyroclastic type show the sinusoidal REE curves and minima HFSE against REE on the spidergrams. The latter rocks are thought to be lower lithosphere slices trapped by plume [Solovjeva et al., 2008]. The obtained data fit the model of modification of asthenosphere and lowermost lithosphere by the plume melts and agree with the mechanism of percolative fractional melt crystallization [Burgess, Harte, 2004; Harte et al., 1993]. The material of the plume source is belived to be enriched in majorite and silicate-perovskite or ancient oceanic crust in transition zone.

Distribution of incompatible rare elements in garnet and clinopyroxene grains from low-temperature coarse-grained Gr and Sp-Gr peridotites suggests that lithospheric mantle located above the infiltration zone of asthenospheric melts was “washing out” by reduced fluids deriving from chambers of asthenospheric liquids [Solovjeva, 2007]. It is evidenced by sharp depletion of garnet and clinopyroxene in incompatible rare elements from rocks with late pale-green Fe^{3+} free olivine (Fig. 2).

On the contrary, Gr and Cpx from coarse-grained peridotites with orange and brownish-pink olivine (with 1 – 3.5 % Fe^{3+} from Fe_{tot}) demonstrate high contents of incompatible rare elements. It seems that pale-green, colourless olivines change the hue due to reduction of Fe^{3+} by reduced fluids at early stage of kimberlite-forming cycle. The reduced character of fluids may be explained by the development of an advanced hydrogen front in asthenospheric melts formed beneath the lithospheric plate in this period [Solovjeva et al., 1997]. These fluids vigorously extracted incompatible rare elements from rocks and minerals. Probably, they were also responsible for the development of the metasomatic reactions at oxidizing geochemical barriers and the growth of the metasomatic minerals – Mg-phlogopite + Cr-diopside + cromite [Solovjeva et al., 1997]. The native graphite (possibly diamond) formed in reaction metasomatites at the same stage.

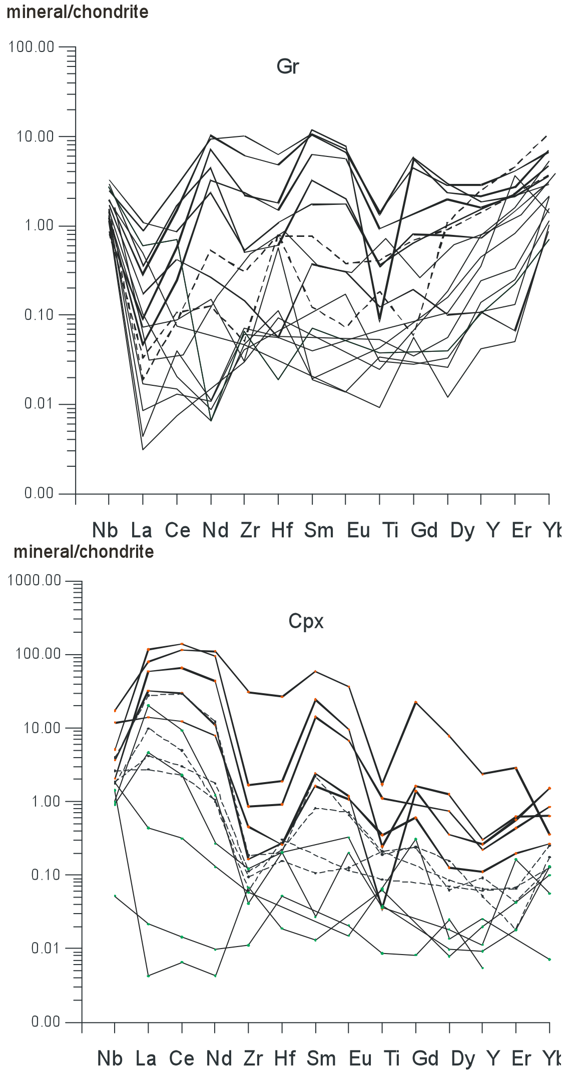


Fig. 2. C1 chondrite normalized [Sun, McDonough, 1989] REE + HFSE in Gr and Cpx from coarse-grained peridotites with olivines of different colours. Samples with 50 – 90 % orange, yellow olivine grains are shown by thick lines; with>90 % palegreen, colorless olivine grains, by thin lines; intermediate samples, by dashed lines.

References

Burgess S.R. and Harte B., 2004. Tracing lithosphere evolution through the analysis of heterogeneous G9/G10 garnet in peridotite xenoliths. II: REE Chemistry, 2004. J. Petrol., 45, 609-634.

Ernst R.E., Buchan K.L., 1997. Large igneous provinces: continental, oceanic and planetary volcanism. Am. Geophys. Union. Monogr., 100, 297 – 333.

Harte B., Hunter R. H., Kinny P.D., 1993. Melt geometry, movement and crystallization, in relation to mantle dykes, veins and metasomatism. Philosophical Transaction of the Royal Society of London, A 342, 1 – 21.

Kiselev A.I., Yarmolyuk B.V., Egorov K.N. et al., 2006. Middle Paleozoic basic magmatism in the north-west part of Vilyuy rift: composition, sources, geodynamics. Petrology, 14, N 6, 626–628.

Solovjeva L.V., 2007. Reworking of the lithospheric mantle of the Siberian Craton by reduced fluids in the Middle Paleozoic kimberlite event: geochemical consequences. Doklady Akademii Nauk, 412, N 6, 804–809.

Solovjeva L.V., Egorov K.N., Markova M.E. et al., 1997. Mantle metasomatism and melting in mantle-derived xenoliths from the Udachnaya kimberlite; their possible relationship with diamond and kimberlite formation. Russian Geol. Geophis., 38 (1), 172-207.

Solovjeva L.V., Lavrentyev Yu.G., Egorov K.N., et al., 2008. The genetic relationship of the deformed peridotites and garnet megacrysts from kimberlites with asthenospheric melts. Russian Geol. Geophis., 49, N 4, 207–224.

Sun S., McDonough W.F., 1989. Chemical and isotopic systematics of ocean basalts: implications for mantle composition and processes. Magmatism in the ocean basins. Geol. Special. Publ., 42, 313-345.

This work was supported by Russian Foundation for Basic Research (Grant 06-05-64756).