Kimberlite Types IA, IB, and II as Series from Different Mantle Depths

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Kimberlites should be divided (Smith et al., 1993) into micaceous (II type) and basaltic kimberlites. The latter include two varieties - IA and IB types. The IB type is more rich in Ca- and Ti-contents. The above three types differ by mineralogy, chemical and isotope compositions. A component distribution in different kimberlite types depends on parental mantle magma compositions resulted from different formation conditions and mantle heterogeneities.

The linear trends of rock composition projections in different threefold diagrams and the directions of the trends to lower temperature fields prove the rocks belong to a series. To discriminate the above kimberlite types 0,1 MgO-K_2O-TiO_2 diagram was used since Mg, K and Ti are the elements of the maximum negative correlation (Kravchenko, 1993). All three types show linear trends, but it will be noticed that only the kimberlite type II represents a full-size series, which ends in low-temperature field of the diagram. The projection of kimberlite compositions from Gros-Brukkaros coinsides with this trend very closely. The other two kimberlite types (IA and IB) related to the coordinates represent only high-temperature parts of the series.

The scatter in K-, Ti-, and Ca-contents in kimberlites is respectively as great as 5-, 3-, and more than 2-fold. Kimberlites from Australian Platform contain 5-6% CaO, whereas some African and Siberian kimberlites - up to 13-16% (Edgar and Charbonneau, 1993; Lebedeva, 1986; Sobolev et al., 1980; Smith et al., 1985). Compositions of three kimberlite types on the Fo-Ln-Q plane of the normative tetrahedron Ln-Fo-Q-Ne (Yoder, 1979) demonstrate three series of different Ca-content, the lowest for micaceous kimberlites and the most enriched for kimberlites IB.

The Siberian kimberlite compositions are close to IB kimberlite compositions. The trend of melilite-bearing rocks, which stands out as the most Ca-enriched within single-ring alkaline-ultrabasic complexes, is an extention of Siberian kimberlite trend at this diagram (Kravchenko and Rass, 1985). The parental magma for melilite-bearing rocks should be more Ca, than that, usually accepted for all rocks, melilite-bearing and melilite-free. It may be of kimberlite-like composition (IB type), or of the similar composition as for IB kimberlite. To accomplish the melilite-bearing series from the mantle magma, the low-pressure conditions should exist during its differentiation.

Our previous investigations allow to suppose the Ca-content in mantle melts increases by increasing of melting depths (Kravchenko et al., 1992). The occurence of majorite garnet incclusions in some diamonds in the Monastery kimberlite pipe (Moor et al., 1989), high-pressure experiments on SiO_2-poor, CaO-rich kimberlites from Wesselton (Edgar and Charbonneau, 1993) confirm this presumption. The melting depth for basaltic kimberlites is currently evaluated to be as 400-650km (Ringwood et al., 1992). Isotope investigations of melilitites from the Central Europe show their parental magma should derive from depths of the thermal boundary layer (Wilson et al., 1995).

References.

Edgar, A.D., and Charbonneau, H.E., 1993, Melting experiments on a SiO_2-poor, CaO-rich aphanitic kimberlite from 5-10GPa and their bearing on sources of kimberlite magmas: Amer. Mineral., v.78, p.132-142

Kravchenko, S.M., 1993, Kimberlites: a combination of differentiated series from mantle magmas of different depths: Trans. (Doclady) Russian Acad. Sci., Earth Sci. Sections, v.332, N7, p.209-213

Kravchenko, S.M., and Rass, I.T., 1985, The alkaline-ultramafic association, a "paragenesis" of two comagmatic series: Trans. (Doclady) USSR Acad. Sci., earth science sections, v.283, N4, p.111-116
Kravchenko, S.M., Rass, I.T., Ryabchikov, I.D., and Dikov, Yu.P., 1992, Ca-content increasing in mantle alkaline-ultrabasic melts by increasing of melting depths: 29 IGC, Kyoto, Japan, 1992, Abstr., v.2 of 3, p.539
Lebedeva, L.I., 1986, Kimberlite magmatism and diamond fertility, in: Kimberlite and kimbrlite-like rocks, Abstracts, Irkutsk, (in Russian)
Moor, R.O., Gurney, J.J., Griffin, W.L., and Shimizu, N., 1991, Ultra-high pressure garnet inclusions in Monastery diamonds: trace element abundance patterns and conditions of origin: Eur. J. Mineral., v.3, p.213-230
Ringwood, A.E., Kesson, S.E., Hibberson, W., and Ware, N., 1992, Origin of kimberlites and related magmas: Earth Planet. Sci. Lett., v.113, p.521-538
Smith, C.B., Gurkey, J.J., Scinner, E.M.W., Clement, C.R., and Ebrahim, N., 1985, Geochemical character of Southern African kimberlites: A new approach based on isotopic constraints: Trans. Geol. Soc. S. Afr., v.88, p.267-280
Sobolev, N.V., Khar'kiv, A.D., and Pokhilenko, A.P., 1980, Kimberlites, lamproites and problems of upper mantle composition: Geol. Geophys., v.12, p.3-11 (in Russian)
Wilson, M., Rosenbawm, J.M., and Dunworth, E.A., 1995, Melilitites: partial melts of the thermal boundary layer?: Contrib. Mineral. Petrol., v.119, N2-3, p.181-196
Yoder, H.S., jr., 1979, Melilite-bearing rocks and related lamprophyres, in: Yoder, H.S., jr., ed., The evolution of the igneous rocks, Princeton, N.J., p.391-412