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Ultrabasic-basic differentiation of the mantle nagmas and diamond-partental melts on evidence of physico-chemical experiments

Yu. Litvin

Institute of Experimental Mineralogy, Mantle Processes, Chernogolovka, Russian Federation (litvin@iem.ac.ru)

1. Melting relations of the upper-mantle peridotite-eclogite system.
Garnet peridotites and eclogites are the major upper-mantle rocks. Mineral phases of peridotite and eclogite parageneses represent most of primary inclusions in natural diamonds. Petrochemical trends demonstrate continuous transitions between the rocks and inclusions. But direct petrogenetic relations of peridotites and eclogites are physico-chemically poorly substantiated. Formation of primary ultrabasic magma in garnet peridotite system Ol-Opx-Cpx-Grt is under control of quasi-invariant peritectics Ol+Opx+Cpx+Gr+L (Litvin, 1991). The Ol-Opx-Cpx-Gr-peridotite and Coes-Opx-Cpx-Gr-eclogite peritectics are physico-chemically bounded up by univariant curve Opx+Cpx+Grt+L that has a temperature maximum on the boundary plane Opx-Cpx-Grt. The maximum represents a thermal eclogitic barrier [2] that is an insuperable obstacle for ultrabasic-basic differentiation in case of equilibrium so fractional crystallization of ultrabasic magma. Another univariant curve Ol+Cpx+Grt+L links the Ol-Opx-Cpx-Grt peridotite peritectics and the eutectics of rarely occurring olivine eclogites in temperature-lowering way without a thermal maximum. This circumstance is of interest in view of the fact that Ol can disappear in reaction with Jd components while Grt, Opx and Na-Mg-silicate are formed above 4.5 GPa [3].

2. “Peridotite-to-eclogite tunnel” mechanism.
Fractional crystallization of primary komatiitic magma is accompanied by increasing concentration of jadeite component at residual melts. This activates the mechanism of ultrabasic-basic magma differentiation with formation of continuous peridotite-eclogite series. By experimental evidence, “peridotite-to-eclogite tunnel” mechanism is under control of reaction between Ol- and Jd-components. Over liquidus surface of the peridotite-eclogite system, reaction point Ol+Jd-Cpx=Grt+L [4] operates effectively in Ol elimination along the univariant curve Ol+Cpx+Grt+L. The reaction brings figurative points of residual melts compositions onto Cpx-Grt join that is a commonplace for all the peridotite and eclogite systems (simplexes). Thus, the “peridotite-to-eclogite tunnel” mechanism makes the round the thermal eclogitic barrier and, correspondingly, paves the way for continuous fractional crystallization of ultrabasic-basic magmas with transfer in formation from Ol-bearing peridotite to Coes-bearing eclogite rocks.

3. Differentiation of silicate-carbonate melts parental for diamond and minerals of peridotite and eclogite parageneses.
By experimental evidence, a changeable composition of the peridotite-eclogite-carbonatite parental melts for diamond and mineral inclusions therein is based on the peridotite30carbonatite70-eclogite35carbonatite65-carbonatite system [5]. It was found that differentiation of the parental melts is under control of the “peridotite-to-eclogite tunnel” mechanism associated with the effects of carbonatization of peridotitic Mg-components. Fractional differentiation is responsible for formation of diamond-hosted mineral inclusions for both the peridotite and eclogite parageneses. Support: RFBR grant 11-05-00401.

[1] Litvin (1991) Physico-Chemical Study of Melting Relations of the Earth’s Deep-Seated Matter. Moscow: “Nauka” Publishing House, 312 p. [2] O’Hara (1968) Earth-Sci. Rev. 4, 69-133. [3] Gasparik, Litvin (1997) Eur. J. Mineral. 9, 311-326. [4] Butvina, Litvin (2010). Geophys. Res. Abstr. 12. EGU2010-3717-1. [5] Litvin et al. .(2012) Geochem.Internat.7.