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Ultrabasic-basic evolution of upper mantle magmas: petrogenetic links between diamond-bearing peridotites and eclogites (on evidence of physico-chemical experiments)

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1. Upper mantle primordial and differentiated rocks. Present notion of primordial "pyrolitic" (Ringwood, 1962) and differentiated rocks is based on peridotite-pyroxenite and eclogite-grospydite xenoliths in kimberlites. Peridotites are dominant (∼95%) respectively to eclogites (∼5%) but Roberts-Victor mine is more eclogitic (80%) than peridotitic (20%). Bimineral Cpx-Grt eclogites present ∼63% of eclogites, that was explained by "eclogitic thermal barrier" stable over 27 GPa (O'Hara, 1968). This led to subduction version of eclogite formation contrary to mechanism of mantle peridotite differentiation that was expanding to relationship between diamond-bearing varieties. Nevertheless, Qtz/Coes-Opx and Ky/Crd eclogites exist. This stimulates experimental searching for physico-chemical mechanism of formation of all eclogite verieties from primordial peridotite during ultrabasic-basic magmatic differentiation.
2. Physico-chemical reasons for "eclogitic thermal barrier". Liquidus of primordial multicomponent peridotite (Litvin, 1991) is determined by univariant curves Ol+Opx+Cpx+L, Ol+Opx+Grt+L, Opx+Cpx+Grt+L linking together to form invariant peritectics Ol+Opx+Cpx+Grt+L (primary melt is komatiitic). Univariant curve Ol+Cpx+Grt+L emerges from the peritectics. Liquidus of peridotite-eclogite system includes "eclogitic" peritectics Coes+Opx+Cpx+Grt+L tied by emerging univariant curve Coes+ Cpx+Grt+L with another "eclogitic" peritectics Coes+Ky+Cpx+Grt+L. "Eclogitic thermal barrier" is located on Opx-Cpx-Grt plane (separating peridotitic and eclogitic compositions) as temperature maximum of univariant curve Opx+Cpx+Grt+L being connecting link between peridotitic Ol+Opx+Cpx+Grt+L and eclogitic Coes+Opx+Cpx+Grt+L peritectics. "Eclogitic thermal barrier" is insuperable obstacles for ultrabasic-basic magmatic differentiation for both equilibrium and fractional crystallization mechanisms.
3. Fractional crystallization of ultrabasic-basic magmas and continuous change-over from peridotite to eclogite formation. Continuous change-over from primordial peridotite to Coes-bearing eclogites formation results from high-pressure olivine-jadeite reaction forming garnet, orthopyroxene and Na-Mg-silicate (Gasparik, Litvin, 1997). Study of olivine - clinopyroxene system Fo (forsterite) – Di (diopside) – Jd (jadeite) at 7 GPa revealed invariant peritectics Fo+ Jd-Di-Cpx +Grt + L and transition from "peridotitic" Fo+Di- Jd-Cpx+L to "eclogitic "Grt+ Jd-Di-Cpx +L liquidus region (Butvina, Litvin, 2008). The "peridotite-to-eclogite tunnel" mechanism is effective during fractional crystallization of ultrabasic-basic magmas when residual melts become gradually richer in jadeitic component.
4. Formation of peridotite-eclogite rock series. Multicomponent peridotite (Ol60Opx16P-Cpx12P-Grt12) – eclogite (E-Cpx50E-Grt50) system with boundary pyrolite and typical eclogite was studied at 7 GPa. Ol is liquidus phase for all compositions. After loss of Opx in Ol+Opx+Cpx+Grt+L peritectics, univariant curve Ol+Cpx+Grt+L results. Two subsolidus assemblades Ol+Opx+Cpx+Grt and Ol+Cpx+Grt are formed. Based on equilibrium phase diagram, melting relations during fractional crystallization of peridotite (Ol60Opx16P-Cpx12P-Grt12) – eclogite (E-Cpx50E-Grt50) system are determined. At higher temperatures, sequence of equilibrium and fractional crystallization is similar: Ol+L, Ol+Opx+L or Ol+Grt+L, Ol+Opx+Grt+L and Ol+Opx+Cpx+Grt+L. At lower temperatures, sequence of fractional crystallization is as follows: Ol+Opx+Cpx+Grt+L (Grt-lherzolite), Ol+Di-Jd-Cpx+Grt+L (Ol-Grt-websterite), Ol+Jd-Di-Cpx+Grt+L (Grt-Ol-websterite), Jd-Di-Cpx+Grt+L (eclogite), Coes-Jd-Di-Cpx+Grt+L (Coes-eclogite), Coes-Ky-Jd-Di-Cpx+Grt+L(Coes-Ky-eclogite) and Coes-Ky-Jd-Di-Cpx+Grt (Coes-Ky-eclogite). The "peridotite-to-eclogite tunnel" mechanism operates, and continuous series of peridotite-eclogite rocks is realized. The mechanism is also effective in formation of diamond-bearing peridotites and eclogites as well as diamond-hosted minerals of peridotitic and eclogitic parageneses. Support: RFBR grant 11-05-00401.