MAJOR, TRACE AND RARE EARTH ELEMENT CHEMISTRY OF CUMULATIVE XENOLITHS IN MIOCENE PICRITE BASALTS: THE VITIM VOLCANIC FIELD, TRANSBAIKALIA, RUSSIA

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Deep-seated xenoliths from Miocene picrite basalts of the Vitim volcanic field are spinel and garnet lherzolites of various degree of depletion, including the most fertile, metasomatically modified peridotites, containing amphibole, phlogopite and glass; pyroxenites of Cr-diopside and Al-augite series; intermediate types of pyroxenites; cumulative garnet-bearing granulites, pyroxenites and gabbroids. Megacrysts are formed by clino- and orthopyroxene, garnet, Fe–Ti oxides, micas and alkali feldspar. Composition of clinopyroxene allows to relate the cumulative xenoliths to Al-augite series and distinguish two groups of xenoliths: (1) "black" garnet and pseudo-garnet granulites and clinopyroxenites, and (2) "green" spinel websterites (typical of Al-augite series), garnet–spinel granulites and gabbroids.

(1) Clinopyroxene in the "black" group corresponds to cpx of megacryst trend. Xenoliths of this group contain cpx, garnet (strongly kelyphitized), ilmenite, plagioclase, and rare Ti-magnetite, amphibole, scapolite, sanidine and silicic glass. Clinopyroxene is a major constituent in xenoliths of this group. Its composition tends to augite with high Al_2O_3 (8.2–9.7 %) TiO_2 (1.7–1.9 %), and low Na_2O (1.4–2.1 %) as well as Cr_2O_3 (0–0.01 %). The cpx is characterized by REE patterns with LREE enrichment and light HREE depletion, and the absence of negative Eu anomalies (Ashchepkov et al., 1996). CI-normalized $(La/Yb)_N$ = 16–50, $(Sm/Yb)_N$ = 23–50. The most fractionated cpx megacrysts (MFM) contain nearly 8.8 % Al_2O_3, 1.6 % TiO_2, and 3.0 % Na_2O, with $(La/Yb)_N$ = 5.2–5.7 and $(Sm/Yb)_N$ = 12.0–13.4.

(2) Clinopyroxene in the "green" group corresponds to the cpx of Cr-diopside "green" series pyroxenites (CDGS). The xenoliths contain clinopyroxene, orthopyroxene, amphibole, phlogopite, spinel, and rare plagioclase, kelyphitized garnet, cpx–opx–sp and opx–cpx–plag symplectites and glass patches. The cpx contains less Al_2O_3 (5.1–8.2 %), TiO_2 (0.3–1.2 %), Na_2O (1.1–2.0 %) and more Cr_2O_3 (0.1–0.4 %) except the cpx from ferriferous norites with very low Al, Ti and Na contents. The REE patterns show significantly higher HREE than in the "black" group, similar LREE and distinctly negative Eu anomalies (Eu/Eu* = 0.74–0.78) at the $(La/Yb)_N$ = 1.0–2.1 and $(Sm/Yb)_N$ = 4.5–5.6. The CDGS cpx has 5.2–7.2 % Al_2O_3, 0.5–1.2 % TiO_2, 1.6–2.3 % Na_2O, 0.3–1.4 % Cr_2O_3, $(La/Yb)_N$ = 2.7–2.9, $(Sm/Yb)_N$ = 3.9–9.2.

Trace-element variations indicate the influence of lower crust material. For example, Ta/Th ratio for host picrite basalt is 1.6 and for the liquid coexisting with cpx 1.8 (MFM) and 1.6–4 (CDGS). The values range between 1.0 (MORB) and 2.3 (primitive mantle). The values for both groups of cumulates (4.5–7.1) are higher than for the continental crust (3.5). However, cpx chemistry shows very low Pb contents. The Ce/Pb ratio in the liquid coexisting with cpx ranges from 47–120 (group 1) to 30–33 (group 2), whereas Ce/Pb in the liquid coexisting with cpx of MFM is 44–60, and 11–23 in cpx of CDGS. All values are close or higher than Ce/Pb = 20–30 in MORB and much higher than in the continental crust (Ce/Pb = 4).

Pressure and temperature estimates for garnet-bearing assemblages (P — Wood, 1974; Nickel & Green, 1985; T — Wells, 1977; Ellis & Green, 1979) are 820–1000 ^oC and 12–14 kbar, respectively. Seismic Moho beneath Vitim is assumed at about 35–40 km (12–13 kbar). We believe that pyroxenites and granulites form a heterogeneous, more than 10 km thick layer at the Moho depths and are underlain by spinel lherzolites. At the top the pyroxenite lenses are covered by granites of the Angara–Vitim Batholith (Litvinovskii et al., 1992).

The obtained data indicate that xenoliths of the first group could be related to residual magmas, which resulted from differentiation of a basaltic melt producing clinopyroxene megacrysts. The xenoliths of the second group are related to the differentiation of Cr-bearing magma which was contaminated by lherzolite material. At an early stage of development, this magma produced the Cr-diopside pyroxenites. The relatively large body of the intruding magma and its high temperature resulted in melting of intermediate and felsic granulites, forming the lower crust beneath the Vitim volcanic field.

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