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Cr-pyrope xenocrysts with oxide mineral inclusions from the Chompolo lamprophyres, Central Aldan

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A series of precise analytical methods (EMPA, LA-ICP-MS, Raman spectroscopy) was employed to investigate Cr-pyrope xenocrysts (n = 52; Mg# from 73.6 to 84.4) with associated inclusions of Ti- and/or Cr-rich oxide minerals from the poorly characterized lamprophyres of Aldanskaya dyke and Ogonyok diatreme (Chompolo field, Aldan province of alkaline magmatism, southeastern Siberian craton). The majority of pyrope xenocrysts are of lherzolitic paragenesis and have concave-upward (normal) chondrite-normalized REE patterns with increase in concentration from light to moderate-heavy REE (Group 1). Four Ca-rich (5.74-7.42 wt% CaO) pyrope crystals are low in Ti (220-350 ppm), Na (85-135 ppm), Y (< 2 ppm), and have sinusoidal chondrite-normalized REE spectra, thus exhibiting anomalous composition for lherzolitic garnets (Group 2). The sample ALD-3-5 shares compositional features with both Group 1 and Group 2 pyropes, likely being an intermediate link between these two garnet populations. The peculiar xenocryst s165 is the only sample to show harzburgitic derivation, whilst demonstrating normal (weakly sinusoidal) chondrite-normalized REE pattern and highest Zr (93 ppm) among the studied pyrope crystals.

Cr-spinel (chromite-magnesiochromite), rutile, Mg-ilmenite, and crichtonite-group minerals comprise a suite of recognized oxide mineral inclusions in the pyrope samples studied. Ti-rich oxides form abundant elongated needle-, rod- and blade-like grains associated only with the Group 1 pyropes. Cr-spinel is the most indicative to pyropes of the Group 2 and ALD-3-5 and occurs in these xenocrysts as isometric, occasionally octahedral inclusions, which are up to 300 μm in size. Joint associations of Ti-oxides and Cr-spinel are recognized in several Group 1 samples; in such cases Cr-spinel is smaller (10-50 μm). A series of Ti-oxide inclusions is characteristically enriched in chromium with 0.61-7.21 wt% $Cr2O_3$ in rutile, 0.73-3.59 wt% in Mg-ilmenite, and 7.1-18.0 wt% in crichtonite-group minerals. LILE-enriched complex chromium titanates of the crichtonite group are high in $Al2O_3$ (0.91-2.15 wt%) and ZrO_2 (1.54-5.41 wt%) and comprise a trend of compositions from Ca-Sr-specific varieties (which are similar to hitherto reported inclusions in pyrope crystals from other localities) to Ba-dominant species. Several grains of crichtonite-group minerals are exceptionally Ba-rich, containing up to 7 wt% BaO.

In the studied pyrope xenocrysts oxide minerals frequently coexist with silicates (clino- and orthopyroxene, olivine), hydrous silicates (phlogopite, amphibole, talc), carbonates (dolomite, magnesite), sulfides (pentlandite, chalcopyrite, MSS), apatite, and graphite. Intergrowths of oxides with each other and with silicates are ubiquitous; four xenocrysts enclose oxide-bearing complex polymineralic inclusions consisting of 5-8 minerals. PT-estimates imply the inclusion-bearing pyrope xenocrysts to have been derived from relatively low-T peridotite assemblages that resided at T = $\sim$650-800 °C and P = $\sim$25-35 kbar in the graphite stability field. Genesis of the pyrope crystals and associated inclusions is attributed to the metasomatic enrichment of peridotitic substrates by Ca-LILE-Zr-Ti-bearing impregnating liquid(s) which contained significant volatile components (H_2O, CO_2, S).