Carbonate inclusions in Cr-pyropes derived from the mantle beneath Central Aldan superterrane of Siberian craton

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Introduction

Here we present preliminary results of the micro-Raman spectroscopy, SEM-EDS and EPMA studies of carbonate-bearing mineral inclusions in mantle-derived xenocrysts of lherzolitic Cr-pyropes from magmatic rocks of Chompolo field located at the Central Aldan superterrane of the Siberian craton (Fig. 1). There are ten dikes (e.g., Aldan dike), pipes (e.g., Ogonek pipe) and vein bodies within the Chompolo field. The magmatic rocks of the Chompolo field were previously interpreted as kimberlites, however, recent studies re-classified their as lamprophyres (Kornilova, 1997).

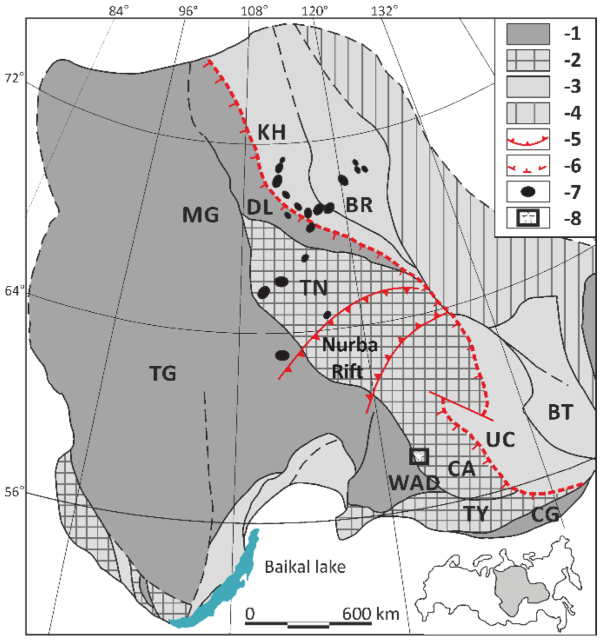

Figure 1: Tectonic structure of the Siberian craton (modified after Smelov and Timofeev, 2007). [1] Archean terranes; [2] Archean-Paleoproterizioc terranes (CA = Central Aldan superterrane); [3] Paleoproterizioc terranes; [4] Mesoproterozoic terranes; [5] Mesoproterozoic rift [1.2-1.0 Ga]; [6] Bilyakh-Fedorovskaya subduction zone [2.3-1.9 Ga]; [7] Kimberlite fields; [8] Location of the Chompolo field.

Results

The chemistry of the studied garnets, namely their high Cr_2O_3 contents and Mg#, clearly points to their mantle origin (Sobolev et al., 1973, Schulze, 2003). The host garnets are Cr-rich (0.4-6.9 wt%) pyropes with Mg# = 73.3-84.2, Ca# = [100·Ca/(Ca+Mg+Fe+Mn)] = 10.9-16.4 and TiO_2 contents below 0.4 wt%. They belong to lherzolitic paragenesis in terms of their CaO and Cr_2O_3 contents. The inclusions of olivine, clinopyroxene and Cr-spinel in Cr-pyropes (Table 1) also suggest the mantle origin of the parent peridotites.

Among studied samples seven garnet grains contain dolomite inclusions, ten – magnesite ones, and three – calcite ones (Table 1). All Cr-pyrope crystals contain from one to several individual, both single and/or composite (Fig. 1), mineral inclusions. Other minerals found along with carbonates within inclusions in the Chompolo garnets are olivine, clinopyroxene, Cr-spinel, phlogopite, amphibole, talc, rutile, Mg-ilmenite, minerals of crichtonite group, apatite, barite, graphite, and sulphides (Table 1).

Thermobarometric calculations yield PT conditions of residence of the garnets with carbonate-bearing mineral inclusions in the mantle as 2.9-3.6 GPa and 700-800 ºC. The residual pressure up to 2.1 GPa was inferred for graphite inclusions assuming pressure dependence of the graphite G-band upshift (Nikolenko et al., 2017).

Sample No.	Magmatic body	Inclusion mineralogy
s21	AD	Magnesite + Graphite + Olivine + Clinopyroxene + Phlogopite + CGM
1n11	AD	Magnesite + Graphite + Olivine + Clinopyroxene + Phlogopite + Amphibole + Rutile + Mg-Ilmenite + Rutile + Apatite + CGM + Chalcopyrite
s163	AD	Magnesite + BorniteSS + Chalcopyrite + Pentlandite
2n4	AD	Magnesite + Phlogopite + Rutile + Apatite + CGM
s258	OP	Magnesite + Phlogopite + Rutile
s291	OP	Magnesite + Olivine + Cr-spinel + Phlogopite + CGM + Amphibole + Mss + Pentlandite + Chalcopyrite
s317	OP	Magnesite + Cr-spinel + Phlogopite + Rutile + CGM + BorniteSS
s124	AD	Dolomite + Graphite + Clinopyroxene + Phlogopite + Cr-spinel
s139	AD	Dolomite + Rutile + Mg-Ilmenite + Talc+ Unidentified mineral
s206	AD	Dolomite + Talc
s61	AD	Dolomite + Talc + Unidentified mineral
s182	AD	Dolomite + Mg-Ilmenite + Phlogopite+ Unidentified mineral
s26	AD	Dolomite + Cr-Spinel + Rutile + Clinopyroxene + Unidentified mineral
s113	AD	Dolomite + Phlogopite + Chalcopyrite + Mss
s213	AD	Dolomite + Cr-Spinel + Chalcopyrite + Mss
s256	OP	Dolomite + Cr-Spinel + Unidentified mineral
s261	OP	Dolomite + Cr-Spinel + Unidentified mineral
s275	OP	Calcite + Cr-Spinel + Barite + Unidentified mineral
s337	OP	Calcite + Cr-Spinel + Rutile + Amphibole + Apatite + CGM + Unidentified mineral
S300	OP	Calcite + Unidentified mineral

Table 1: Carbonate-bearing mineral inclusion assemblages in mantle-derived garnets from Central Aldan superterrane of Siberian craton. AD – Aldanskaya dike, OP – Ogonek pipe, BorniteSS – bornite solid solution, Mss – monosulphide solid solution, CGM – mineral of crichtonite group.

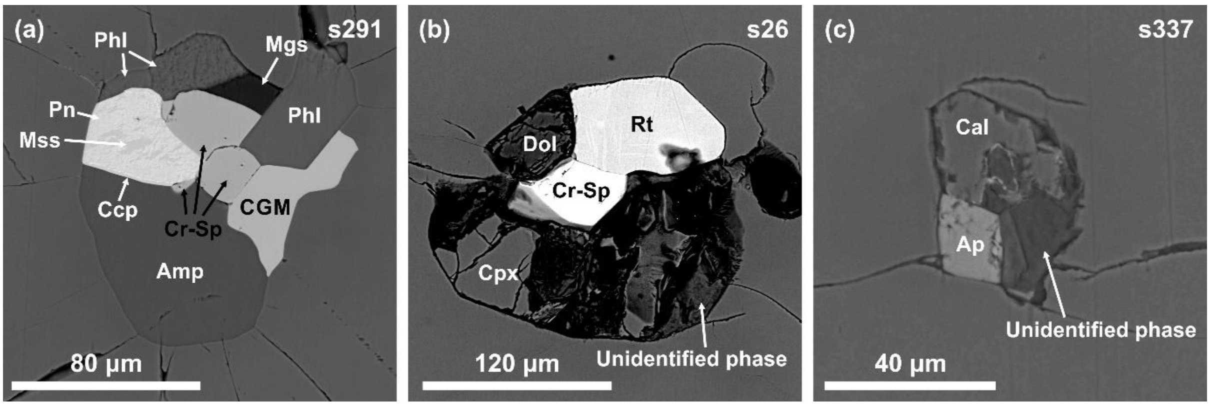

Figure 1: Back-scattered electron images of carbonate-bearing inclusions in mantle-derived garnets from Central Aldan superterrane of Siberian craton. Mgs – magnesite, Dol – dolomite, Cal – calcite, CGM – mineral of crichtonite group, Ap – apatite, Phl – phlogopite, Amp – amphibole, Rt – rutile, Cr-Sp – Cr-spinel, Cpx – clinopyroxene, Mss – monosulphide solid solution, Pn – pentlandite, Ccp – chalcopyrite.

Discussion

We interpreted the shape, composition, and distribution of carbonate-bearing mineral inclusions as evidence of their syngenetic origin with host garnets. For volatile-bearing minerals (mica, amphibole, and apatite) together with titanium-rich phases such as ilmenite, rutile, and minerals of crichtonite group in mantle rocks, there is a consensus for an origin by mantle metasomatism (Haggerty, 1991; Wang et al., 1999; Pearson et al., 2003; Konzett et al., 2013; Malkovets et al., 2016; Rezvukhin et al., 2016). Therefore, studied mineral inclusion assemblages suggest an episode(s) of metasomatism in the lithospheric mantle of the Central Aldan superterrane of the Siberian craton, contemporaneous with the formation of host Cr-pyrope crystals. The presence of carbonate and graphite within inclusions in Cr-pyropes indicates that metasomatic agent(s) was CO_2-rich melt (i.e., carbonatitic melt) or supercritical COH fluid.

Acknowledgements

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