MORPHOLOGY AND COMPOSITION OF MINERAL INCLUSIONS IN CHROMITE MACROCRYSTS FROM KIMBERLITES AND LAMPROITES

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Mineral inclusions in the main indicator minerals of kimberlites and lamproites are considered significant source of information on parageneses and PT conditions of formation of deep seated minerals. This is especially important for a comparison with mantle xenoliths which are very often severely, altered or absent in particular pipes.

Chromite macrocrysts (more than 0.5 mm) have attracted not much attention in attempts of inclusions study because of small size of grains and very rare and minute inclusions comparable with those from diamonds. The first visual approach to identification of inclusions in chromites was attempted by Rovsha (1962).

Logvinova and Sobolev (1991) reported preliminary results of morphological and chemical study of about 70 inclusions extracted from 1700 crushed chromite grains from kimberlites and lamproites. We report here the results of a study of 185 unaltered silicate inclusions extracted from 2550 grains of chromite macrocrysts from a number of kimberlite (1503 grains) and lamproite (1047 grains) pipes from different regions of the globe (Table 1), including Yakutia (1-4), Arkhangelsk (5), South Africa (6,7), Australia (8) and USA (9).

Table 1. Abundance of mineral inclusions in chromites from kimberlites and lamproites

Kimberlite (1-7) and lamproite (8-9) Pipes	n	ol	cpx	opx	ga	phl	sf	alt
1. Aikhal	337	15	1	3	4	2	-	15
2. Udachnaya	279	23	2	1	-	-	-	8
3. Mir	132	5	3	-	2	-	3	9
4. International	96	3	1	-	1	-	-	5
5. Pionerskaya	230	14	-	-	2	-	-	1
6. Newlands	347	21	6	14	1	5	-	43
7. Koffifontein	82	-	2	-	4	-	-	-
8. Ellendale-4	742	16	2	2	1	2	-	37
9. Prairie Creek	305	22	1	1	-	-	-	23
Total	2550	119	18	21	15	9	3	141

Note: n= number of studied chromite grains.

Three types of morphology are typical of extracted inclusions. The first type is represented by crystals with well developed octahedral faces similar to most inclusions in diamonds by their negative morphology. Tabular appearance is typical of the second type and completely rounded or heavily resorbed inclusions mainly from lamproitic chromites belong to the third type.

Olivine is the most abundant inclusion in all chromites studied and represents more then 60% of all unaltered inclusion grains. Olivines from kimberlitic chromites contain 89-94 mol.% Fo, however olivines from lamproitic chromites have narrower range of Fo: from 88 to 90 mol.%. CaO contents in lamproitic olivine inclusions (0.07 wt.% av.) is significantly higher compared with those kimberlitic (0.02 wt.% av.).

Pyrope presence in 15 chromite grains from 7 out of 9 examined pipes indicates several types of peridotite parageneses for kimberlitic chromites including harzburgite-dunite, lherzolite and wherlite. Lherzolitic pyrope presence as an inclusion in lamproitic chromite is of special interest (see Table. 2).

At least two samples (A-45, A-8) containing coexisting Cr pyropes and Cr-rich spinels (Sobolev, 1971, 1974) relate to the diamond-facies (see Table 2).

Table 2. Selected analyses of Inclusions and host chromites from kimberlites and lamproites.

Sample	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO	MnO	MgO	CaO	Na_2O	NiO	Total
Chromites											
A-45	0.07	0.37	5.28	64.0	16.9	0.34	11.6	nd	nd	0.09	98.65
A-8	0.06	0.44	6.01	61.2	19.1	0.29	11.8	nd	nd	0.11	99.01
New-183	0.03	1.97	1.51	63.7	19.3	0.26	12.0	nd	nd	0.13	98.90
In-33	<0.02	0.56	8.60	56.3	23.0	0.24	10.5	nd	nd	0.02	99.22
El-4/86	0.09	1.56	7.90	48.2	30.5	0.22	11.3	nd	nd	0.16	99.93
PC-8	0.19	0.26	14.6	41.0	29.6	0.17	12.7	nd	nd	0.20	98.72
Garnets											
A-45	40.3	0.13	13.9	11.9	6.41	0.42	18.3	7.48	0.05	nd	98.89
A-8	41.5	0.08	18.2	7.14	6.82	0.41	22.0	3.44	0.03	nd	99.62
In-33	41.9	0.16	21.5	1.98	7.25	0.55	16.7	9.62	0.07	nd	99.73
El-4/86	41.0	0.18	16.8	7.33	8.71	0.54	18.9	6.43	0.02	nd	99.91
Clinopyr.											
New-183	54.6	0.19	0.54	4.15	1.69	0.06	15.7	19.3	2.50	nd	98.73
PC-8	54.8	<0.02	0.36	0.32	1.40	0.06	17.7	24.5	0.16	nd	99.3
Enstatites											
PC-8	57.7	<0.02	0.51	0.19	5.17	0.14	35.4	0.18	0.05	nd	99.34

Notes: 1. nd - not determined; 2. FeO calculated as total FeO; 3. Aikhal - A; Newlands - New; International - In; Ellendale - El; Prairie Creek - PC.

Pyroxenes have a wide range in Cr_2O_3 contents represented in two clinopyroxene analyses (see Table 2). Enstatites are most typical as inclusions in Newland■s chromites. Their Al_2O_3 varies from 0.08 to 0.62 wt.% and Cr_2O_3 varies from 0.24 to 0.58 wt.%.

All three types of peridotitic assemblages based upon compositional features of pyropes and pyroxenes (Sobolev, 1974) might be recognized for inclusion bearing chromites, harzburgite-dunitic, lherzolitic and wherlitic.

Temperature estimate for 30 kbar pressure (O'Neill, Wall, 1987) shows a range from 780 to 1040°C for 73 samples of kimberlitic chromites and from 1010 to 1144°C for 32 samples from lamproites. Such a difference in temperatures correlates with a difference in Ca abundance in olivines. Prairie Creek chromites combine two different trends with a range of 950-1150°C for 12 samples. This is in agreement with data by Griffin et al. (1991).

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