MELT INCLUSIONS IN OLIVINES FROM ULTRAMAFIC ROCKS OF THE NORIL'SK REGION

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Introduction

The main problem of the origin of endogenic deposits is the relation of magmatism and ore-forming processes. Two opposite hypotheses of the formation of Pt-Cu-Ni deposits differ in terms of the estimation of the role of their parental melts: did they have normal or specific composition? The melt composition of ultrabasic-basic massives with mineralization was calculated so far as a weighted mean from the chemical compositions of the rocks. For the first time for Noril'sk massives (Russia) a direct determination of major, trace and volatile elements in the melts was carried out. It was based on a complex study of magmatic inclusions in olivines. This approach has not been applied for Cu-Ni deposits in the world.

The Noril'sk intrusions are excellent objects for discovering specific features of ore magmas due to their different composition, internal structure and ore potential. Moreover they belong to the Siberian trap province and help understanding the place of mineralization in plume magmatic sistem in general. Magmatic inclusions and composition of host-olivines as from picritic gabbrodolerites of Talnakh, Kharaelakh intrusions with super large deposits and Low Talnakh and Zelenaya Griva ore-free intrusions so from picritic basalts of Tuklonskaya and Gudchikhinskaya lavas formations were studied. Major elements were analyzed by EPMA (analyst N.N. Kononkova) while trace elements, H_2O, F were measured by SIMS (analyst S.G. Simakin). The melt inclusions were heated in high-temperature quick-response optical aaparatus of Slutsky-Sobolev system in a helium medium.

Results

The following types of inclusions in olivines were found. 1. Melt inclusions are either glass with fluid phase (often with ilmenite), sizing from 1-2 to 40 mk, or partially or completely crystallized ones composed of orthopyroxene, ilmenite, magnetite, apatite, glass, sizing up to 120 mk; 2. low-density fluid inclusions (5-30 mk); 3. crystalline inclusions are plagioclase, orthopyroxene, shpinel, apatite, clinopyroxene (up to 80 mk); 4. combined inclusions from all mentioned phases.

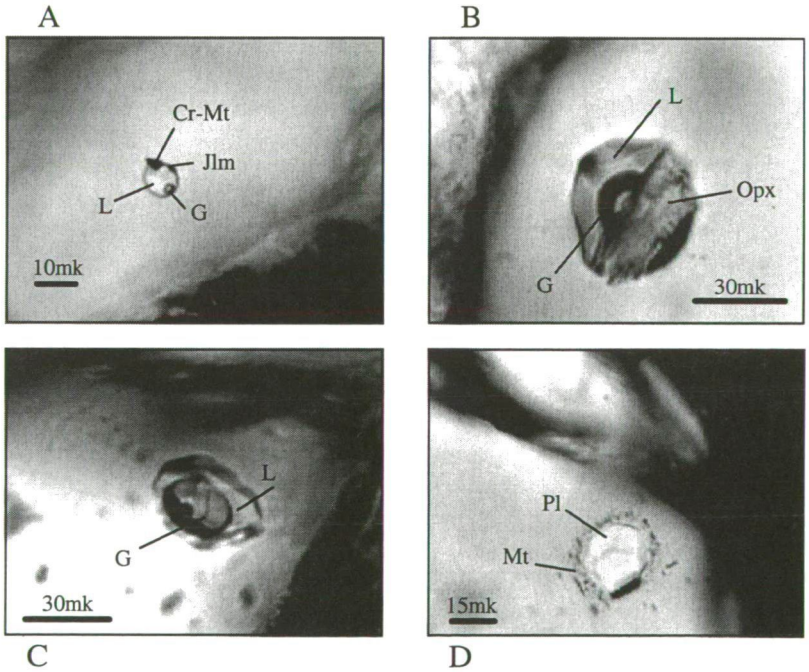

Fig.1. Magmatic inclusions in olivines from different rocks of the Noril'sk region

A, B, C – melt inclusions (A,C – glassy; B – partially crystallized);
D– crystalline inclusion (plagioclase).

L – glass, G – gas, Opx – orthopyroxene, Cr-Mt – Cr-magnetite, Mt – magnetite.

The proportions of these types of inclusions in olivines from different intrusive and effusive bodies varies essentially. Crystalline inclusions dominate very often in Talnakh, Kharaelakh, Low Talnakh intrusions and in picrites of Tuklonskaya Formation whereas they are rare in Zelenaya Griva massive and Gudchihinskaya formation.

Composition of melt inclusions (Tabl.1) changes strongly in olivines from intrusions located in Talnakh ore junction (Talnakh, Low Talnakh, Kharaelakh) and almost constant in South-Norilsk junction (Zelenaya Griva massive). Volatiles and alkaline components vary dramatically. K_2O+Na_2O contents can reach up to 9 mass.%.

Table 1. Typical composition of the experimentally quenched glasses from the Noril'sk intrusions

N analysis	1	2	3	4	5	6	7	8	9	10	11
N sample	4051/18	4051/13	4051/13	3018-1	OP4/192	TG31/8	TG31/,8	F/33/343	F/233/34	F233/34	F233/3
Size , mk	15	40	35	16	20	25	35	30	45	18	20
SiO_2	55.54	55.10	56.03	54.68	58.37	57.61	58.66	50.37	49.52	49.95	53.91
TiO_2	1.32	1.11	2.09	2.30	1.61	2.18	2.07	0.99	0.53	1.11	1.62
Al_2O_3	11.52	11.17	10.09	10.88	12.69	11.94	14.87	11.98	16.74	15.2	12.24
FeO	13.04	12.78	17.53	10.20	10.77	12.97	12.4	13.62	12.26	10.05	11.77
MnO	0.08	0.24	0.34	0.17	0.15	0.25	0.2	0.22	0.23	0.25	0.18
MgO	11.52	10.39	8.99	5.89	7.75	7.57	6.84	11.40	9.36	8.99	9.47
CaO	2.89	3.42	1.26	2.22	3.52	4.25	1.27	8.99	8.95	9.94	6.32
Na_2O	1.83	4.07	3.50	2.77	3.13	3.32	1.53	2.32	1.55	1.61	3.06
K_2O	2.97	0.81	0.25	1.06	1.06	1.14	1.08	0.83	1.42	0.61	1.02
P_2O_5	n.d.	0.36	n.d.	0.26	0.11	0.31	0.14	0.10	0.08	0.3	0.25
Cl	0.10	0.01	0.12	0.02	0.22	0.03	0.02	0.01	0.02	n.d.	0.01
F	0.08	n.d.	n.d.	n.d.	0.09	0.19	n.d.	0.15	0.03	n.d.	n.d.
S	0.02	0.07	0.17	0.04	n.d.	n.d.	0.02	0.03	0.01	0.01	0
Sum	100.91	99.53	100.37	99.78	99.47	101.76	99.1	100.82	100.63	98.02	99.89
Fo, mol.%	72.48	73.29	68.06	78.65	78.55	79.75	79.19	79.58	78.13	78.42	79.30
$T_{quen.}$,oC	1250	1300	1270	1235	1260	1270	1260	1240	1240	1290	1270

Notes: elements are given in wt.%; N analysis: 1-4 –Talnakh, 5-7- Low Talnakh, 8-11- Zelenaya Griva intrusions; n.d. – not determined.

Melt inclusions from the first group are characterized by high SiO_2, trace elements and low CaO concentrations in comparison with the ones in the rocks but the inclusions from the second group close to tholeiitic basalts and bulk rock composition.

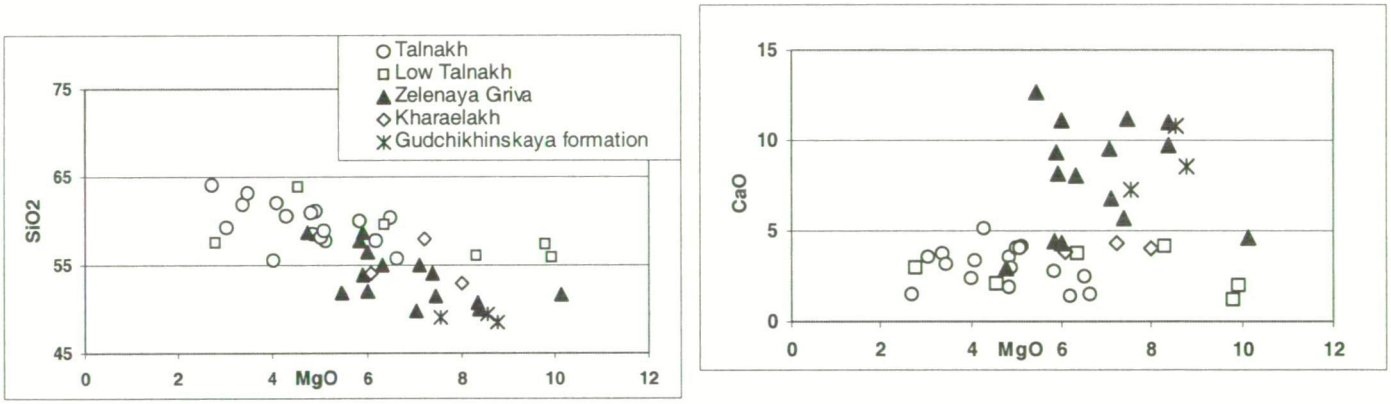

Fig. 2. Diagrams SiO_2 – MgO and CaO – MgO for melt inclusions from different ultrabasic rocks

Olivines from different intrusions and picritic basalts have their own specific features of composition correlated with inclusions' data. The contents of trace elements - Cr, Ti, V, Y, Dy, Yb, Li, Na, Zr – have been studied by SIMS in 150 granes. There is a strong correlation between concentration of HREE, Y and Fo in high-Mg rocks. Olivines of Zelenaya Griva and Gudchikhinskaya Formation differ from ones of other intrusions and picrites of Tuklonsky formation by very low concentrations Y, Dy and Y and unsteep slope trend, which can be explicated by crystallization differentiation. Tuklonsky olivines and Talnakh, Kharaelakh, Low Talnakh intrusions are similar and have a higher concentration level of REE and steeper trends slopes.

Conclusions

The differences between two groups of olivines and trapped inclusions do not reflect the ore potential of host intrusions. Possibly, they are a result of specific formation and placement conditions of the magmas under various geologic-structure conditions.

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