The Model PGE Location in the Ultramafic Rocks of Kingash Deposit (New Nickel–Platinum-Bearing Province of South Siberia)

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Adequate materials on mineralogy and geochemistry of noble metals have been obtained at the reference Kingash deposit of Precambrian greenstone belt. The ore mineralization belongs to the great stratified wehrlite-pyroxenite-gabbro lopoliths, located among the gneisses of AR_2 of Kansk greenstone belt (KGB). The ultramafites belong to a ferriferous geochemical type of rocks. They have the increased contents of Pd (to 1 ppm), Ni (>4000 ppm), total FeO (8-9 wt. %), Al_2O_3 (1-2 wt. %). The average composition of ultramafites is very similar to the regional mantle substratum, insignificantly enriched by Pd, Fe, Ti, La and depleted by Eu. The horizons of the ore wehrlite with schlieren of olivinites and peridotiites prevail at the bottom of the geological sections; gabbro predominates in the top.

The mineralization is of primary-magmatic character and represented by the paragenesis of pentlandite, chalcopyrite impregnated in peridotiites and pyroxenites. Sulfide minerals are included and form vein accumulations or cement breccia of ultrabasic rocks.

The maichenerite, kotulskite, merenskyite were for the first time described. The maximum platinum-bearing capacity (about 14 ppm) appears to be characteristic of ores of breccia-vein pentlandite-pyrrhotite-chalcopyrite type in which in addition to kotulskite and sobolevskite, frudite, paolovite, Sb, As and Au are accumulated. It formed PGE critical horizon (Fig., Table). The near – bottom part of the intrusive is enriched with PGE, Ni and Cr.

A contrast pattern of PGE distributions is the following: Os-Ir are distinguished in early phases with Cr; Bi-Te in association with Pd are found in subsequent ones. The final phases of ore-magmatic system are marked by similarity of Pt with As and Sn. Hg is included into Au-Ag compound. Distribution as inclusion of the moncheite in stratum of wehrlites of Kingash deposits and Pt in the pyroxenites (sperrilite) stipulates not only various solubility of PGE but also their possible participation in fluid- transport responses, as shown experimentally. These thermal properties of PGE help forming of (Pd + Bi + Te) - (Pt + Os + Ru) - (Pt + As + Sn + Sb) - (Pt + Au + As + Ag) assotiations.

PGE are reconcentrated under the influence of metasomatic and hydrothermal processes. Metamorphism is also marked by the redistribution of platinum-group elements (PGE).

Minerals-carriers of dispersion form of PGE include clinopyroxene, serpentine, chlorite, amphibole. As known, the pyroxene accumulates PGE better than olivine, garnet because the pyroxenites result in ore-bearing potential of PGE. Platinum group elements normalized to chondrite C1 indicate that the behavior of Pd reflects the magmatic process of enrichment melt by sulfides. The similarity of fractionation trends with the trends of Sudbury, Monchegorsk massifs and difference from the komatiites are found.

The Kingash deposits are a good source for Pd-Ni-Cu industry with full absorption of the minor elements in technology of Pechenga (Kola peninsula). It should be noted that ore element distributions of Ni-Pt province of Siberia and the ways of element accumulation are typical of deposits of greenstone belts.

Table. PGE composition of critical the stratum (Kingash deposit), in wt. % and ppm

№	c-32-127.1	C-32-133a	C-32-135a	C-32-136	C-32-140a
SiO_2	37.52	38.76	42.25	34.90	36.27
TiO_2	0.425	0.445	0.367	0.455	0.563
Al_2O_3	5.41	5.89	5.17	5.49	6.42
Fe_2O_3	12.35	13.10	10.16	17.10	17.65
MnO	0.135	0.146	0.325	0.154	0.145
MgO	29.723	29.932	30.253	26.739	25.639
CaO	4.223	2.759	3.607	3.460	3.892
Na_2O	<0.20	0.25	0.30	<0.20	<0.20
K_2O	0.043	0.070	0.753	0.062	0.054
P_2O_5	0.038	0.041	0.028	0.040	0.050
S				3.99	3.66
Ba+Ce	<0.020	0.023	0.048	<0.020	<0.020
Sr	0.0334	<0.0030	<0.0030	<0.0030	<0.0030
Zr	<0.0080	<0.0080	<0.0080	<0.0080	<0.0080
LOI	9.59	8.24	6.55	7.01	6.19
Total	99.64	99.68	99.84	99.61	100.75
Cr	2700	4200	5100	4000	2900
Ni	4200	6700	3300	12000	8100
Co	140	170	120	300	210
V	180	240	320	180	180
Mn	910	990	4100	1400	880
Sc	Cu	12	30	Cu	Cu
Zr	31	27	31	37	42
Cu	220	180	190	220	4000
Ti	1500	1800	1500	1600	1500
Pt	0.04	1.608	0.1	3.472	0.95
Pd	0.338	0.145	0.405	1.124	1.1

Notes: The interval 114-124.1 м: Pt - 0.73-7.01 (middle 1.91), Pd - 1.01-5.42 (middle 2.04), (Pt+Pd) - 1.74-12.43 (middle 3.95).

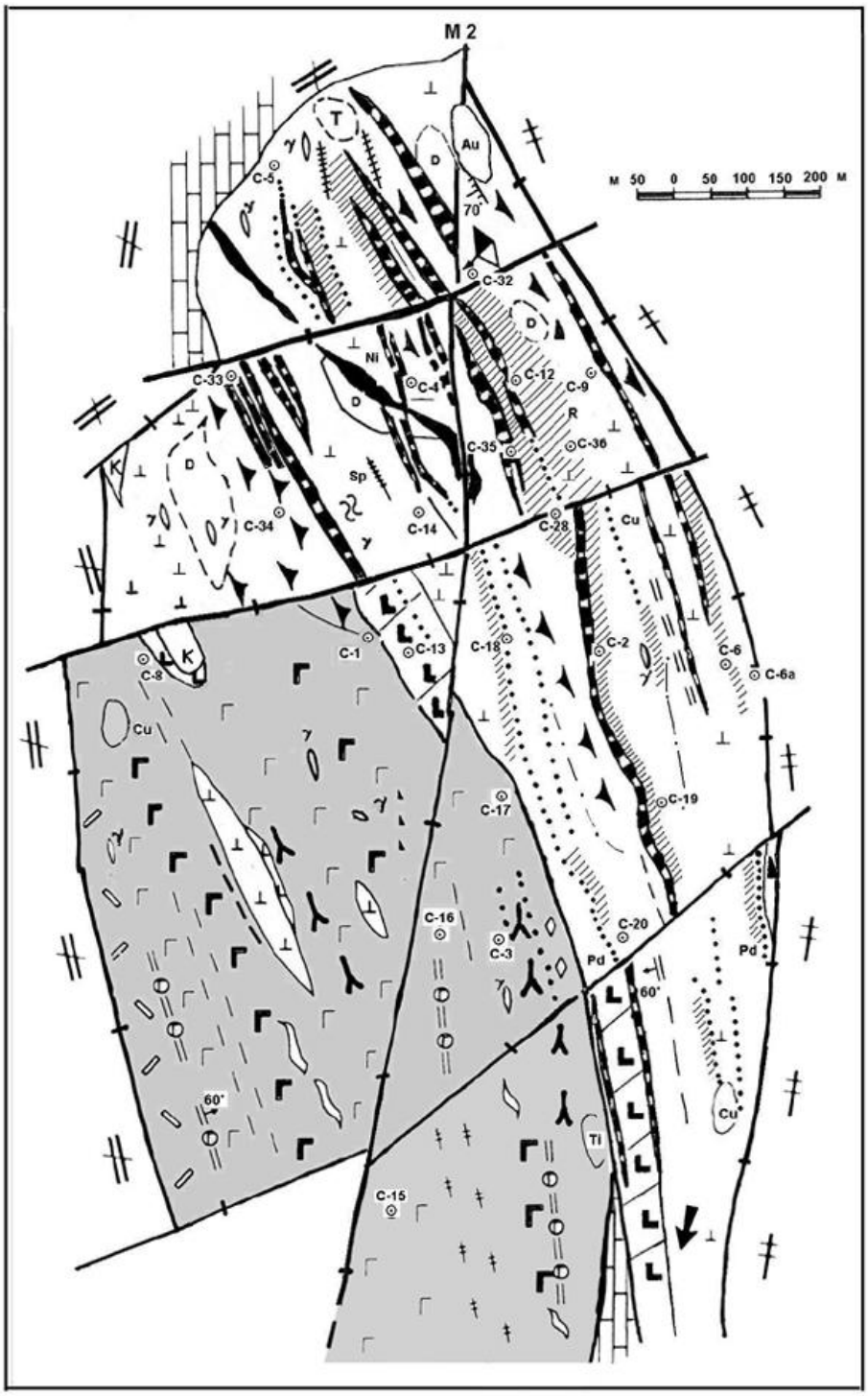
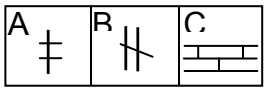


Figure 1. "*Geologic-geochemical map of Kingash sulfide copper-nickel and platinum-palladium deposits". Made by O.M. Glazunov by materials of Kingash GMT and IGC SB RAS.*

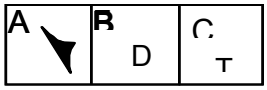
Figure 1 (cont.) *Legend*

1 

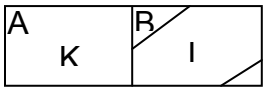
1: Biryusa suite (AR_2)

A – amphibolites, B- gneisses and crystalline schist; C – marble interlayer

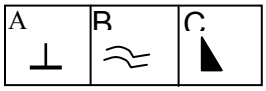
2 – 4: "Ultrabasic "Megalayer"

2 

A - wehrlite, B - dunites and olivinites, C - lherzolite and harzburgites

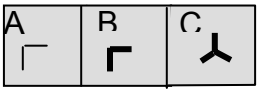
3 

A - cortlandite, B - clinopyroxenite

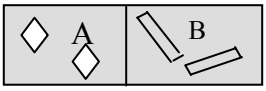
4 

A - serpentinite, B - serpentine-chlorite-talc rocks, C – hornblendite

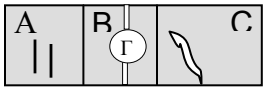
5-6: Gabbro "Megalayer"

5 

A - fine-grained gabbro, B – pegmatoid taxitic gabbro (tilaite), C- gabbro with directive structure

6 

A - olivine, B – schlieren banded gneiss-like gabbro

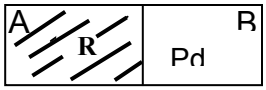
7 

A - banded gabbro; B – gabbro-amphibolite, C – basic migmatites

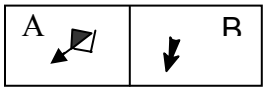
8 

A - Early magmatic poor disseminated ore (pyrrhotite-petlandite); average contents Ni - 0.37 %, Cu - 0.20 %, Co - 0.018 %; B – rich disseminated ores (pentlandite-pyrrhotite-chalcopyrite), average content Ni - 0.65 ppm, Cu - 0.4%, Co - 0.023 %, Pd - 0.85 ppm, Pt - 0.5 ppm; C - epimagmatic breccias-veined ores with anomalies content of Ni – 1% and higher, Cu- 0.3 %, Co – 0.05 %, Pd >3 ppm, Pt – 1.6 ppm and higher.

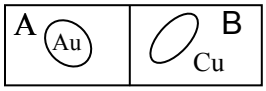
9- 14: "Platinoid Reef"

9 

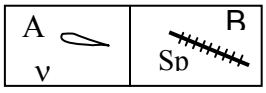
A – with visible metals of the platinum group, B – horizons of heightened concentrations of platinoids

10 

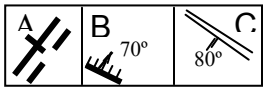
A – shifting centers of ore concentrations from the surface to the depth; B – direction of ore zone pitch

11 

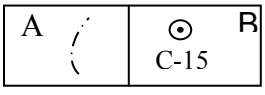
A – perspective secondary anomalies of ore elements, connected by injections of plagiomigmatites, amphibolization and chloritization (Au, Cu, Ti); B – zones of copper-sulfide mineralization

12 

A – veins of plagiogranites and albitites, B – zones of amphibolization and serpentization

13 

TECTONIC DISLOCATIONS: A – revealed and supposed; B – chain-like pattern of sulfide impregnation; C - elements of rock and ore banding

14 

A – electric-prospecting anomalies; B - drilled bore holes