The Syum-Keu Massif, the Polar Urals: First Data on PGE Mineralization and Implications for Petrogenesis of Layered Complexes

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The Syum-Keu Massif, the northernmost of ultramafic massifs known in the Urals, remains the least studied, though its area is large (600 km²) and remarkable for chromite specialization. Many researchers studied massifs of the Polar Urals, but they focused at southerner chromite-bearing massifs – Ray-Iz and Voikar - Syninsky.

The Syum-Keu Massif is of interest not only because of the necessity of searching for new chromite deposits, but also due to improved economic situation in this remote area: building of a new railway toward the Yamal Peninsula, which goes not far from the Syum-Keu Massif, high energy supply of the area with gas from the Yamal deposits.

Exploration for chrome has been recently commenced there that required the evaluation of chromite ore for PGE metals. Platinum content of the Syum-Keu Massif has been no studied, and data gained by the author are first published.

In the course of five years (1997-2001) we conducted detailed geological, petrological, and mineralogical studies in the massif, collected a lot of factual and analytical data, which allowed one a new insight into the Syum-Keu Massif and to show that it differs greatly from all ultramafic massifs known in the Urals both in structure and in composition and age.

The Syum-Keu Massif is depicted in all geological maps as a narrow meridional elongated body (60 km long and 10-15 km wide), mainly composed of ultramafic rocks (Fig. 1).

Figure 1. Geological chart of the Syum-Keu Massif, the Polar Urals. Rock assemblages: 1 – marginal, 2 – lherzolite-harzburgite, 3-4 – dunite-harzburgite, (3 – dunites, 4 – harzburgite), 5 – dunite-vehrlite-clinopyroxenite (banded), 6 – gabbroid.
The Syum-Keu massif

\[ \text{Sm-Nd geochronology of the rocks showed age values close to ultramafic rocks and gabbroids (R_3): T=604\pm39 \text{ Ma at } \varepsilon_{Nd}(T)=+3.5. It also demonstrated that this crustal segment had been formed 300 years prior to the collision resulted in the emergence of the Uralian belt (Fig.2).} \]

These facts suggest that the Syum-Keu Massif is an independent complicated and peculiar structure. The massif is confined to an area of intersection of three planetary rift zones, which divide geoplates of the Arctic paleoocean, East European and West Siberian continental plates (V. E. Khain, S. M. Kravchenko, 1999).

Three zones can be distinguished in the structure of the massif:
(1) Lower Ultramafite zone, which contains lherzolite-harzburgite and dunite-harzburgite assemblages;
(2) Transitional (Banded) zone of dunite-vehrlite-clinopyroxene composition, which forms a continuous band (1-2 km wide) between ultramafites and gabbroids;
(3) Upper Mafite (gabbroid) zone.

As one can see, the intra composition of the massif is characterized by magmatic differentiation, expressed in successive replacement of ultramafic rocks (in the footwall) by mafic (in the hanging wall). Studying the cryptic layering allowed revealing a trend of the alteration of chemical composition of main rock-forming minerals with gradual increase in ferruginosity upward: Ol 5→25 Fa %, oPx 20→45 Fs %, cPx 3→20 Fs %.

The recorded features of the Syum-Keu intra composition combined with geological, geophysical and petrological data suggest that the massif is rather similar to layered complexes.
elsewhere, which are characterized by chromite and PGE mineralization.

Detailed studying the platinum content in the massif revealed several types of PGE mineralization:

1. Ir-Os-Ru in initial (banded) chromite ores with PGE content of 0.1-0.3 ppm;
2. Ir-Os-Ru-Pt in sulfide-chromite (regenerated) ores, where PGE content increases up to 0.7-1.0 ppm;
3. Pt in coarse-grained dunites with scarce chromite impregnation and PGE content up to 7 ppm;
4. Pt-Pd type in sulfide-bearing pyroxenites of a Transitional (Banded) zone containing ca. 1.0-1.5 ppm of PGE.

About 30 various PGE minerals were found (together with N.S. Rudashevsky and V.V. Knauf) in these ores, four of them where not known earlier.

In the first type of ore main minerals are Laurite RuS$_2$ (65-70 % of all PGE minerals), Erlichmanite OsS$_2$ (20-25 %), Irlarsite IrAsS and Kashinite Ir$_2$S$_3$ (ca.10%).

In the second type the portion of iridium and platinum essentially increases; Ir minerals portion is 30-35 % of total PGE volume, platinum content is 8-10 %.

The third type is characterized by the development of Isoferroplatinum Pt$_3$Fe (80 %) with minor amount of Tetraferroplatinum PtFe, Tulameenite Pt$_3$FeCu, Awaruite FeNi, rhodium pentlandite.

The forth, Sperrylite type is the most promising, since sites of sulfide mineralization with platinoids are rather widespread throughout the Banded complex. Major PGE minerals here are Sperrylite PtAs$_2$ (60 % of all minerals), Braggite (PtPdNi)S, Mayakite PdNiAs, Stillwaterite Pd$_8$As$_3$, mercury minerals – Atheneite (PdHg)$_3$As, and Temagamite Pd$_3$HgTl$_3$. These minerals occur as individual grains (from10 to 60 µm across) inside chrome-bearing magnetite crystals or in intergrowth with pentlandite, millerite, heazlewoodite.

Lateral zoning elements in the PGE distribution are characterized by decreasing the role of the Ir-Os-Ru-(Pt) association south-eastward, where Pt and Pd prevail. The platinum content of the Syum-Keu calls for further investigation.

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