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 km^2) 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).

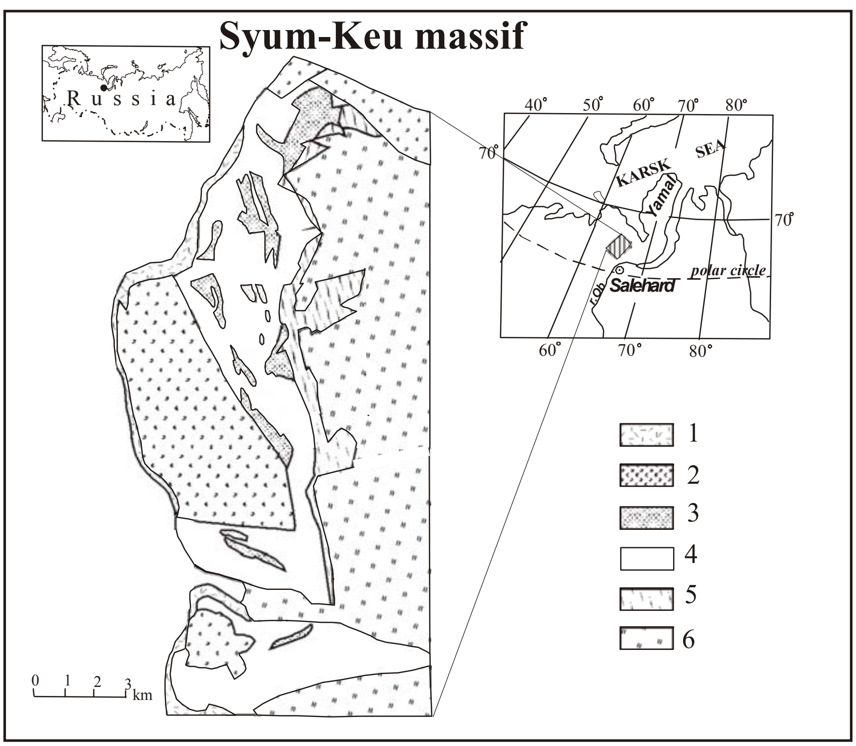

Figure 1. *Geological chart of the Syum-Keu Massif, the Polar Urals. Rock assemblages: 1 – marginal, 2 – lherzolite-harzburgite, 3-4 – dunite-harzburgite, (3 – dunites, 4 – harzburgite), 5 – dunite-vehrlite-clinopyroxenite (banded), 6 – gabbroid.*

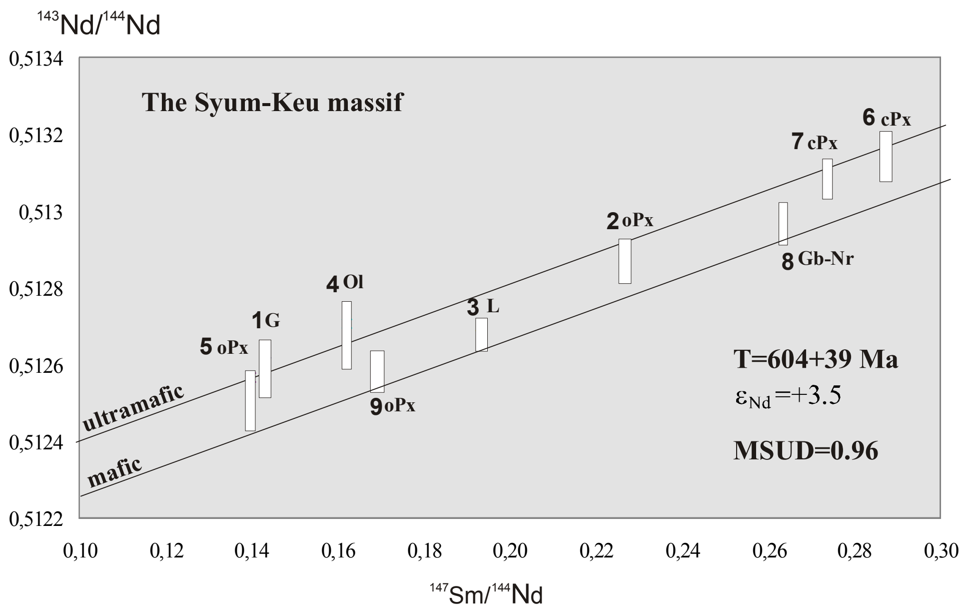

Figure 2. *Geochronological diagram of isotope Sm/Nd ratios in rocks of the Syum Keu Massif. 1-2 – harzburgite G (ortho-pyroxene oPx); 3-7 – lherzolite L (Ol, oPx, cPx); 8-9 – gabbronorite Gb-Nr (oPx).*

In the west are contacts with Kharbei gneisses (PR_1) and schists of the Nyarovei suite (R_1), and in the east it is surrounded by gabbroids overlapped to a considerable extent by Meso-Cenozoic sediments of the West Siberian Platform.

The massif is traditionally considered in the Urals to be a component of the ophiolite association formed in the process of initiation of the Caledonian-Hercynian eugeosyncline. At the same time, the analysis of geological and geophysical data and space images allowed revealing clear differences between the Syum-Keu Massif and type Paleozoic ophiolites of main hyperbasite belt of the Urals. These data showed that the ultramafic Syum-Keu Complex is only part of a large intrusive body of isometric shape of 100 to 120 km in diameter. The body, enclosing the Syum-Keu ultramafites (no more than 2 km thick) and surrounding gabbroids (more than 4 km thick) dips gently (30°) to the south-east, together.

Sm-Nd geochronology of the rocks showed age values close to ultramafic rocks and gabbroids (R_3): T=604±39 Ma at ε_{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 know earlier.

In the first type of ore main minerals are Laurite RuS_2 (65-70 % of all PGE minerals), Erlichmanite OsS_2 (20-25 %), Irarsite IrAsS and Kashinite Ir_2S_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_3Fe (80 %) with minor amount of Tetraferroplatinum PtFe, Tulameenite Pt_2FeCu, 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_8As_3, mercury minerals – Atheneite $(PdHg)_3As$, and Temagamite Pd_3HgTl_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 zonation 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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