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КРУПНЫЕ ИЗВЕРЖЕННЫЕ ПРОВИНЦИИ В ИСТОРИИ ЗЕМЛИ: МАНТИЙНЫЕ ПЛЮМЫ, СУПЕРКОНТИНЕНТЫ, КЛИМАТИЧЕСКИЕ ИЗМЕНЕНИЯ, МЕТАЛЛОГЕНИЯ, ФОРМИРОВАНИЕ НЕФТИ И ГАЗА, ПЛАНЕТЫ ЗЕМНОЙ ГРУППЫ (КИП – 2019)

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GEOLOGY, MATERIAL COMPOSITION OF BREEDS AND ISSUES OF GEODYNAMICS OF MATYSKEN BASIT-HYPERBASITE MASSIF (KORYAKIA)

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***Keywords**: Matysken array, Ural-Alaskan type*

Concentrically zonal gabbro-clinopyroxenite-dunite massifs of Kamchatka and Koryakia in the region form an extended belt and are confined to the Achayvayam-Valaginsky terrain. The belt stretches in the North-Eastern direction from the sources of the river Lake Kamchatka to the bay of Natalia for 1400 km with a width of 30-50 km. (Sidorov et al., 2012). The Matysken array is located in the northeastern part of the platinum-bearing belt and is included in Vyvensky dunite-clinopyroxenite-gabbro complex of late cretaceous-paleocene age.

These Intrusive complexes have a high potential in the formation of platinum placers. For several typomorphic characteristics Matysken and similar arrays Vyvensky complex of identical concentrically zoned plutons of the Urals, which has been associated with large alluvial deposits of platinum. Within Koryakia, a similar example is also known – the Galmoenan array. Therefore, it is important to study the geological and material features of the root source (Matysken massif), which will allow us to answer a number of questions that interest us, which were raised a long time ago, by other researchers, but have not yet found a definite answer. One of the fundamental issues is the problem of determining the source of the substance of intrusives. It is believed that the formation of plutons is directly related to the evolution of the lithosphere in the zones of transition from ocean to continent (Lazarenkov, 2002). There is also an opinion that during the formation of the geostructures of Kamchatka, alternation of collisional and rift regimes took place (Filatova, 2008), which affected the composition of magmatites.

The Matysken array is located in the headwaters (ridge zone) of the river. Matysken and Snow. It is represented by the main body with an area of about 7 km2, and a number of its satellites. The internal structure of the body of the massif is concentric zonal. Most of the area of the massif is composed of dunite bodies (4.5 km^2). Each of the zones of the massif is separated from each other by a system of faults, tectonic contacts are observed along their entire length.

According to the latest state geological survey of 1: 50,000 scale (Reasonable et al., 2000), the Vyvensky complex was formed in two phases of implementation, each of which is represented by several subphases: the first phase (campan-maastricht of the late cretaceous): the first subphase is dunites; the second subphase - clinopyroxenite, verlite; the third subphase is represented by eucrites and gabbropegmatites; second subphase (paleocene early paleogene). The rocks of the phase are distributed sporadically in the form of dikes, lived mainly in connection with the main body of the massif, but they are also found at a distance from it. Composition: the first subphase is represented by the bodies of olivinite dikes; the second subphase is represented by gabbro, gabbro-dolerite, diorite, monzodiorite.

Petrochemical characteristic

The most characteristic petrochemical features of the rocks of the massif are in the bimodal distribution of figurative points in the diagrams. At the same time, the main continuous

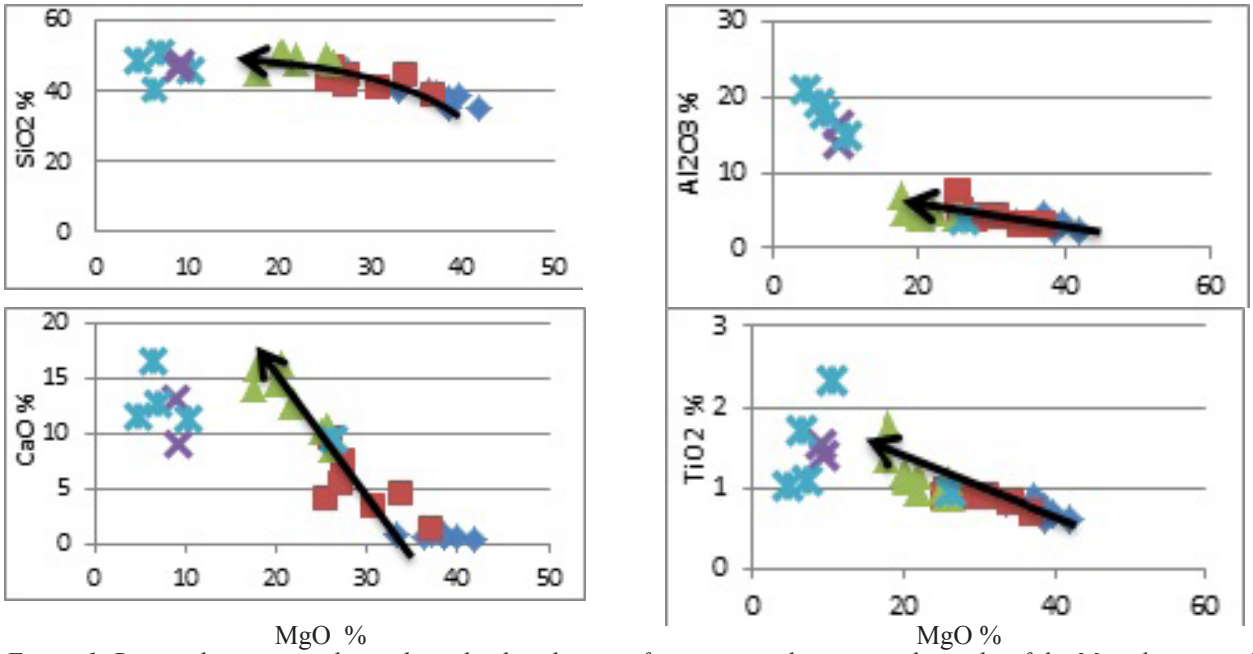

Figure 1. Binary diagrams with trends in the distribution of petrogenic elements in the rocks of the Matysken massif

dunites; verlite; clinopyroxenite; gabbro; veins

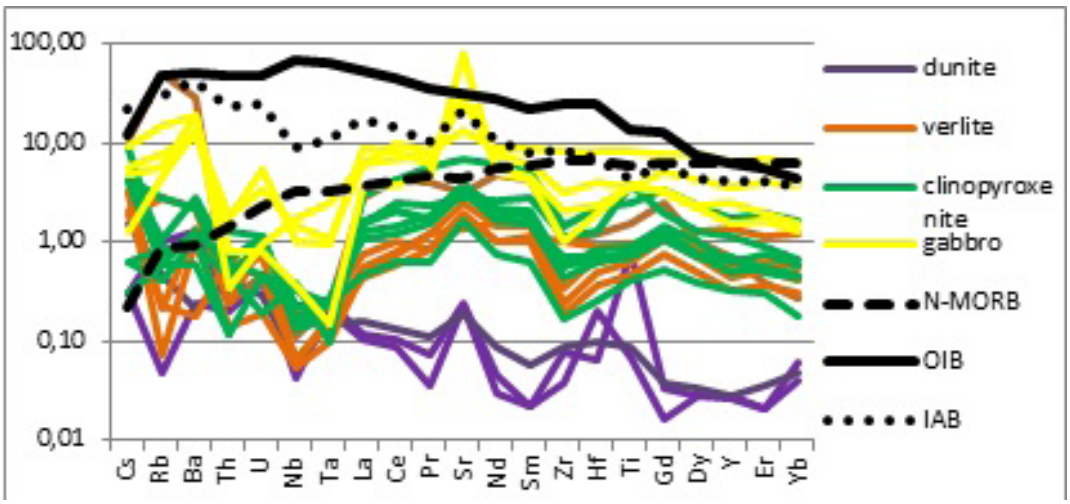

Figure 2. Multi-element spider diagram of distribution of trace elements in the rocks of the Matysken massif

trend is formed by the rocks of the phase (dunites => verlites => clinopyroxenites). They are characterized by a gradual accumulation of titanium dioxide, total iron and calcium from dunites to clinopyroxenes with a corresponding decrease in the magnesium content (olivine control, close to Fenner differentiation).

The gabbros and related vein formations with them form a separate group of contiguous figurative points. The tendencies of their material differentiation are either close (for SiO_2, CaO) or differ markedly from the rocks of the first phase (for TiO_2, $Al2O_3$), which indicates a certain originality of their origin relative to the rocks of the first phase.

The geochemical characteristic

Breeds are considered in accordance with the sequence of introduction established for them: 1) dunites (first subphase) => verlites, clinopyroxenites (second subphase) => eucrites (third subphase).

On the multi-element diagram, geochemical spectra of rocks are located along the ordinate axis in the sequence of their formation. In the lowest part (at the level of 0.1 and lower), dunites, above with a gap from Ta to Yb and verlites pyroxenites and the upper position are occupied by gabbroids. According to the configuration of the geochemical spectra, the rocks are related to each other, but significantly differ in the levels of trace element concentrations — low in dunites and maximum in gabbroids. For the rocks, positive peaks of Ba, U, Sr, Ti, and negative for Rb, Nb-Ta, Zr, and Hf are well pronounced.

With respect to geochemical benchmarks, the rocks most closely correspond to the N-MORB benchmark, gabbroids approach the IAB benchmark.

The geodynamic assessment of rocks was determined using well-known discriminant diagrams (Wood, 1980; Meshede, 1986; Cabanis, Lecolle, 1989). On the Th-Hf-Nb diagram, the figurative points of the dunites are located in the field B and near the field C (enriched with MORB COX and tholeiite intraplate basalts); pyroxenites and part of gabbroids formed in the center of the field D (basalts of the destructive margins and their differentials) and in the extreme upper part of the field D and A (normal MORB COX).

In the Zr-Nb-Y diagram, dunites are scattered in the A1, C, and D fields (intraplate tholeites, volcanic arc basalts, and normal MORB COX), while the remaining rocks are concentrated in field D and partially in the adjacent C field (volcanic arc basalts and MORB).

The diagram of La-Y-Nb shows that dunites are located in field 2 - continental basalts, and the rest in field 1B, 1C - island-arc tholeiites.

Conclusion

The Matysken array belongs to the concentric-zonal bodies of the Ural-Alaskan formation type. Among the many arrays of the Vyvensky complex, it is the most representative of the composition of the rocks, which determines its status as a petrotypic array. The next stage of the study of this massif is associated with the characteristic of its ore-bearing nature, the identification of patterns in the manifestation of indigenous platinum metal mineralization.

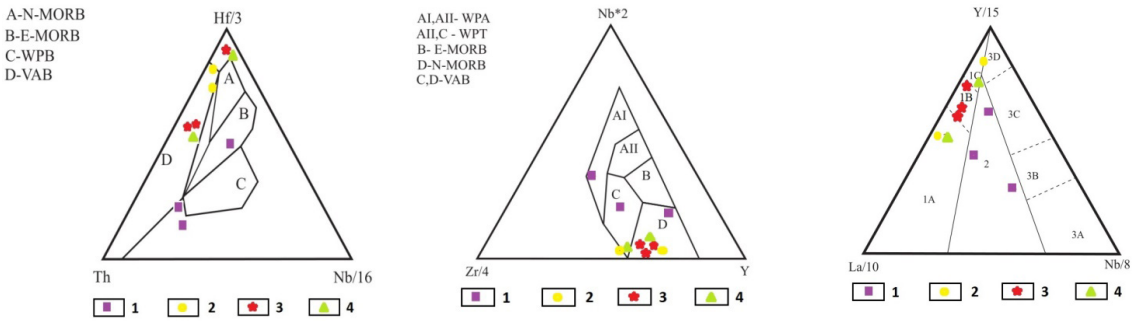

Figure 3. The position of rocks in the triple charts: 1- dunites, 2- verlites, 3- clinopyroxenites, 4-gabbro

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LIP RECORD OF THE URALS: RECOGNIZING PLUMES IN A FOLD BELT

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As it is widely accepted (e.g.Ernst, 2014), we regard LIPS (Large Igneous Provinces) as srong manifestations of plumes. Recognizing ancient plumes in history of fold belts such as Urals meets serious problems. Their plumes have cooled a long time ago, and therefore it is impossible to apply seismic tomography to unravel them. The magmatic complexes, as main manifestations of plumes, are partly eroded and partly concealed under younger sediments and thrusts; very often they are subjected to strong deformations. Such classical features of individual plumes as time-progressive volcanic chains are as a rule not revealed in orogens. Although the bulk of magmatic rocks of plumes is represented by flood basalts and dolerite dykes, plume magmatism is variable and may include trachybasalts, picrite-basalts, A- granites, layered mafic-ultramafic intrusions and also alkaline, carbonatite and kimberlite magmatic complexes. Fortunately, the properties of plume complexes distinguish them from spreading and subduction types, while many epicontinental rifts of active, volcanic type, may be plume-dependent. LIPs occupy wide areas and are characterized by short periods of activity (10−15 Ma). These features help to reveal ancient plumes even in foldbelts. The problem of a repeated plume activity in the Urals was raised only recently (Puchkov, 2010). A considerable progress was achieved recently in the study of geochemistry of magmatic rocks of the western slope of the Urals, and their isotopic ages became more accurate owing to the application of modern methods. The new data permit to correlate them with simultaneous magmatic events in some other regions. In addition, the identified even-aged magmatic complexes can be placed on reconstructions of ancient supercontinents, demonstrating their relatively compact primary positions above hypothetical superswells. Ten complexes can be established provisionally as material witnesses of plume episodes in the history of the western slope of the Urals (Puchkov, 2018).

1. Navysh episode. In the Southern Urals near the base of the Lower Riphean (Uppermost Paleoproterozoic and Lower Mesoproterozoic), covering the crystalline Taratash complex dated as Archean and Lower Paleoproterozoic, there are volcanic deposits of the Navysh Subformation, represented mostly by trachybasalts. The яшксог age of the unit was determined as 1752±11Ma. It is shown that volcanic rocks of the age range of 1750−1780 Ma are developed in some other places of Baltica, and also in the Northern Africa, Siberia, Laurentia, parts of the Nuna supercontinent at that time. Therefore, they may belong to a LIP.

2. Mashak episode. Higher up the section of the Riphean, at the Middle Riphean base, rhyolites of the Mashak Formation were dated in three isotopic laboratories ща the world as 1380−1385 Ma. The same ages have also basalts, rapakivi granites, layered gabbro (Kusa−Kopan Intrusion), carbonatites (Sibirka) and dolerite dykes and sills that widely eveloped in the Southern Urals and are encountered in boreholes of East European platform; magmatic rocks of the same age are traced to Greenland, Laurentia and Siberian cratons and represent the beginning of the Nuna supercontinent break-up.

3. Igonino episode. Recently, the stratigraphy of the upper part of the Riphean was reconsidered. A new straton, the Terminal (Uppermost) Riphean was established instead of the presumably Vendian Arshinian Series.The series was subdivided into four formations, mostly terrigenous in composition, but with a volcanic Igonino Formation among them. The study of zircons from this formation gave two peaks: 707.0±2.3 Ma and 732.1±1.7 Ma. Comparable ages have nearby granite massifs Barangulovo and Mazara, layered gabbro-ultramafic Sarana intrusion in the Middle Urals, and also Misaelga ferrogabbrodiabase-picrite differentiated intrusions in the Taratash uplift (726 ± 13Ma, Rb-Sr method). In the 1-Kipchak borehole, on the East European platform, lava flows are dated as 730 Ma (R−Sr method). All these magmatic rocks may belong to a hypothetical LIP with a median age 720 Ma, developed on a fragment of breaking-up Rodinia supercontinent.

4. Kiryabinka episode. Somewhat younger is the Proterozoic Kiryabinka layered peridotite-pyroxenite-gabbro intrusion, situated at the North-Eastern margin of the Bashkirian meganticlinorium (680±3.4 Ma, zircons, U−Pb method).The even-aged magmatic rocks are found toward North, in the Middle Urals − Schegrovitsk trachybasalt, Zhuravlik wehrlite-gabbro-granodiorite and Troitsk granitoid formations. In the East European platform, comparable ages belong to basites of the Onega graben. They may be the parts of a concealed LIP.

5. Mankhambo episode. In the North of the Urals, within the Central Uralian zone, A-type granites are widely developed, with a predominance of leucocratic rocks, associated with gabbro, making a contrast association; comagmatic volcanics belong to a basalt-rhyolite association. Petrochemical features are char-