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The Chineysky layered massif (Siberia, Russia) and Upper Zone of the Bushveld Complex: resemblance and difference features

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Layered intrusions represent a small part of a large group of continental basic-ultrabasic complexes. They attract geologists' attention due to their unusual magmatic structures and associated PGE, Cr and V deposits. The outstanding example of this phenomenon is the Bushveld Complex in South Africa. The largest layered intrusion in Russia is the Chineysky massif (Transbaikalia, Siberia). It is characterized by excellent layering and accompanying titanomagnetite and sulfide mineralization. It hosts Russia's largest deposits of Fe–Ti–V ores which are also among the world's largest [1]. Origin of such huge metal concentrations in the crust is unsettled problem. Therefore the ore conditions' determination from different intrusions is very actually. We compared the structure, rock and parental magmas compositions for two plutons mentioned above.

The Chineysky massif consists of gabbronorites and anorthozites and the petrography of the rocks resembles that of the Upper Zone of the Bushveld [3]. Vanadium ores from these two intrusions are very similar: they are represented by massive and disseminated varieties. However, the small size of Chineysky massiv gives an opportunity to observe the number of petrological processes in a frame of one area, as opposed to Bushveld, where this is impossible. The separateness of the bodies and the scarcity of geochemical data on their rocks precluded the development of a comprehensive model for the evolution of magmatism in this part of the Kodar– Udokan trough. So one of the tasks of our research was to study the spatial and genetic relations between the ultrabasite–basite intrusive bodies and their possible grouping within a single magmatic system, with the Chineysky massif being its part. The second tasks was to determine the phase characteristics of the parental magma of the massif . An important aspect of this study was the examination of the inner structure of the Chineysky massiv.

The main features of the structure are following: 1) consecutive introduction of magmas of different composition; 2) stratification of different nature; 3) differently grade rhythmicity. The Chineysky massif is thought to have been produced by successive emplacement of magmas, which formed four rock groups. These are the pyroxenite of the first group, titanomagnetite gabbronorites and leucogabbro of the second group, gabbronorites of the third group, and lamprophyres of the fourth group The trace-element patterns of various rocks and the results of simulations by the COMAGMAT-3.5 computer program led us to believe that all four rock groups of the massif were generated by the successive emplacements of several portions of the initial magma, which was a complicatedly differentiated suspension of olivine, plagioclase, and magnetite crystals in ferroabsaltic melt at a temperature of approximately 1130°. The gravitational separation of these phases in the melt before its emplacement into the chamber and during the subsequent emplacement of various portions of the initial magma into the modern chamber predetermined the heterogeneity of the massif (its block structure). As a result, the bulk of the Chineysky massif is composed of compositionally principally different rocks of the second and third groups, with the predominance of intratelluric plagioclase and magnetite crystals in the former case (gabbronorite and leucogabbro series in the western and southeastern blocks) and orthopyroxene in the latter one (norite series, central block). The rocks of the third group were generated later.

The crystallization sequences of minerals modeled for the Chineysky massif can be classed into two major types [2]: (a) "high-Al", which is typical of the "leucogabbro" compositions and characterized by the occurrence of a magnetite–plagioclase cotectic, and (b) "high-Mg", which is typical of the noriteseries and is characterized by the early appearance of olivine on the liquidus or the concurrent crystallization of this mineral with magnetite or plagioclase. It is worth mentioning the early appearance of Ol-Mt and Ol-Pl on the liquidus and the cotectic crystallization of these minerals in the rocks of the Chineysky massif and in the gabbroids of the Udokan Dike, which highlights genetic links between them. The crystallization sequences of the minerals demonstrate that

olivine was in reaction relations with the melt, completely dissolved due to a peritectic reaction at temperatures T = 1110–1150°C, and was replaced (completely or partly) by pyroxenes and magnetite. These data testify that the initial melts were saturated or slightly oversaturated with SiO_2 and that the intercumulus systems had elevated SiO_2 concentrations.

They were close to the proposed parental magma to Upper Zone of the Bushveld [3] in term of SiO_2, CaO, Na_2O but enriched in FeO and TiO_2 and depleted in Al_2O_3 and MgO.

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