Magmatic Deposits of the Kodar-Udokan Area, Southern Siberia, Russia: Geology, Geochemistry, and Modeling

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To understand the origin of unique metal concentrations in the lithosphere it is necessary to study super large metallogenic provinces. Kodaro-Udokan region is an optimal target for this purpose due to its extraordinary resources. Many giant deposits of different genetic types are concentrated in the region: Udokan (Cu), Katugin (Ta, Nb), Sulumat (Fe), etc. The Chineysky mafic-ultramafic pluton is unique in distinct layering and rhythmic structure. It contains enormous vanadium reserves (with 30 Bt of ore). The large Magnitny and Etyrko Fe-Ti-V deposits, as well as Ni-Cu- PGE mineralization, are also known in the region. The ore formation in this gabbro massif is one of the vital problems of geology of this area. Ultramafic-mafic intrusions in the Kodar-Udokan area have been studied by XRF and ICP-MS methods. They belong to the Chineysky intrusive complex comprising Chineysky, Lukturskiy, and Mylovsky stratified massifs, sills, and radial dikes centered in the Mylovsky massif (i.e., Great Udokan Dyke). Their geochemical features (major, REE elements, and isotope composition) are very similar and demonstrate their genetic similarities (the origin from common primary magma with crustal characteristics (Gd/Yb)N = 1.87–2.06, $^{86}Sr/^{87}Sr$ = 0.711–0.716, ƐNd = –4, 4–5). Analysis of various isotope systems (U-Pb, Sm-Nd, Ar-Ar) of rocks and minerals from gabbro massifs gives 1884 ± 31 to 1845 ± 65 Ma. We have reconstructed the process of crystallization of primary melt and determined the conditions of crystallization of Chineysky magma based on mineralogical and geochemical data (T=1150°C, $\log f_{O_2}$= –9).We have modeled the morphology of the crust structure inside this block based on gravity and magnetic fields. According 3-D models the layered massifs exposed on the surface represent merely the heads of magmatic columns that extend downward as deep as 20 km or deeper. Weight of evidence suggests that these columns merge at depth and make up an intermediate magma chamber or the upper boundary of a Paleoproterozoic mantle plume. So high reserves of Fe-Ti-V ores in small volume of gabbro rocks is a result of differentiation of huge volume primary magma intruded in ancient rift basins. This result raises the question of discoveries of new Fe-Ti-V deposits and intrusions with chromite ores in this area. Udokan-Chineysky ore district is a unique metallogenic taxon, which combines large and giant deposits of sedimentary, hydrothermal, and magmatic origin and is a model of the formation of a complex multi-stage ore-magmatic system associated with the manifestation of the Proterozoic mantle plume. Ores of the Kodar-Udokan area were formed within a significant period of the Late Paleoproterozoic. Redistribution of ore components and telescopic effects during this period of time took wide place in the forming of the large metallogenic province in the Northern Transbaikalia. Under conditions of growing continental crust, the mantle melts hardly could have penetrated freely through the crust. The magmas were detained there, often forming an echeloned system of transitional magma chambers where magmatic differentiation took place during the formation of Fe-Ti-V deposits.