Paper Number: 210

The Sc-Nb-TR Tomtor deposit and its genesis

Lapin A.V.[1],Tolstov A.V.[2], Levchenko E.N.[1], Kulikova I.M.[1]

[1] The Institute of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements (IMGRE), Moscow, Russia, lapin@imgre.ru.
[2] The Institute of Geology and Mineralogy (IG&M SD RAS), Novosibirsk, Russia.

The Tomtor deposit of a unique complex of rare metal ores in the carbonatite crusts of weathering (CCW) exceeds the known world deposits both in the level of content and in unprecedented collection of ore components. Some quality parameters of the ores, in which the main minerals are pyrochlore, monazite and mixed goyazite-florencite phase, are the following (in %): Nb_2O_5 – 4.7-6.73; TR_2O_3 – 9.0-12.0; Y_2O_3 – 0.5-0.8; Sc_2O_3 – 0.04-0.06; TiO_2 – 6.0-8.0; V_2O_5 – 1.0; P_2O_5 – 12.0-15.0; Al_2O_3 – 12.0-14.0; U – 0,00092; Th – 0.11.

According to the available data, the unique properties of the Tomtor deposit and its abnormal parameters are explained by a more complex, in comparison with other CCW deposits, history of formation, in particular, by sequential manifestation of two stages of hypergenesis – lateritic weathering and reducing epigenesis and the summation of their ore-concentrating effects.

Ore-concentrating mechanisms of two stages of hypergenesis are universal and based on different resistance of minerals and different migration ability of components in the hypergenesis zone. They are most effective in carbonatite crusts of weathering due to unprecedented scales of migration processes resulted from good solubility of the main ore-forming minerals and high mobility of their components; and at the epigenetic stage - by high mobility of Fe and Mn products of weathering under reducing conditions.

The main ore-concentrating mechanism at the stages of lateritic weathering of carbonatites is the residual accumulation of inert rare metals (Nb, La, Ce, and others) together with lightly hydrolyzed Fe and Mn resulting from solution and evacuation of ore-forming minerals. The degree of inert rare metals concentration in the residual products of weathering (lateritic ochres), compared to initial carbonatites K_{in}=4-7. The second, epigenetic, stage is set up after overlapping of the crust of weathering with carboniferous sediments, which contain thick coal beds; it is associated with the impact of reduced oxygen-free waters, draining carboniferous sediments, on the products of weathering. At this stage a strong ore-concentrating effect is achieved because Fe and Mn inert at the first stage and accumulating up to extremely high concentrations, are reduced, become mobile and are evacuated, thus providing repeated sharp residual concentration of rare metals and other inert components. K_{in} in the residual products of epigenesis is equalized 2-3 as regards to ochres. As a result, the total degree of rare metals concentration in this type of ore, in relation to initial carbonatites, achieves 15^{th}-20^{th} multiple value. As this takes place, the ore components, such as Nb, La, Ce, characteristic for carbonatites, reach abnormally high concentrations, typical for rock-forming oxides and content of the whole number of secondary and minor components, which usually are of no interest (P, Ti, V, Sc, Y, Sr, Ba, Pb, Ga and oth.) increase up to the commercially important level.

The final geochemical appearance and potential of Tomtor ores is a result of the prolonged operation of epigenetic solutions, which introduce a number of components from the overlapping sedimentary rocks

and enrich separate ore blocks along the late zones of schist-forming and recrystalization, with yttrium, scandium, heavy lanthanides, zirconium, thorium and some other components.

Thus, the unique Sc-Nb-TR ores of Tomtor deposit present the final products of the efficient natural technology of the two-stage “hydrometallurgical conversion” of rare metal carbonatites in the zone of hypergenesis. The deposit belongs to the genetic type of epigenetically alternated lateritic crusts of weathering of carbonatites.