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Mineralogy and geochemistry of the Cu-sandstone deposits from Kodar-Udokan area, south Siberia, Russia

Bronislav Gongalsky*, Dmitry Krinov, Nadezhda Krivolutskaya, Larisa Magazina, and Elena Kovalchuk

IGEM RAS, Moscow, Russian Federation, *e-mail, brgon@mail.ru

The northern Transbaikalia region, south of the Siberian Craton, is one of the largest metallogenic provinces in Russia. Three world-class deposits are located here: Fe-Ti-V ore related to Chineysky layered gabbro pluton, the Ta-Nb Katugin deposit, and Udokan copper-rich sandstones. The last one has a great interest due to its large reserves containing more than 25 Mt of Cu. It is surrounded by many small deposits with Cu, Ag, Au, and U mineralization where metal ratios vary significantly. The role of different processes was established for this range of deposits. All the deposit were formed in the Paleoproterozoic, which is regarded as the most productive era for deposit formation in this block of crust.

We have studied the mineralogical and chemical composition of 457 samples from sulfide and oxide ores from different deposits. They are located in Kodar-Udokan Trough that consists of the Udokan Supergroup of terrigenous rocks, whose main features are: (1) great thickness, up to 12–15 km; (2) breaks in sedimentation; (3) pyrrhotite and pyrite mineralization throughout from lower to upper formations; (4) discrete localization of chalcocite-bornite sulfide ores from the Chitkanda to the Sakukan levels; (5) compositional diversity of sulfide and oxide minerals in ore (Fe, Cu, S, Ag, Au, U, REE); (6) significant difference in mineral composition of ores and isotopic composition of sulfur between the Udokan and its satellites sulfide deposits (Pravoingamakitsky, Saku, Klyukveny, Unkur, Krasny, Burpala); (7) stratiform ore lodes comprise crosscutting veins and orebodies concordant with bedding; and (8) breccia zones with sulfide cement.The giant Udokan sandstone-hosted copper deposit comprises four levels of Fe-Ag-Cu orebodies with magnetite-chalcocite-bornite mineralization. Several rare minerals were found including a new zone of oxidation inside the Udokan deposit that was formed during two stages: ancient and modern frost conditions. In some cases, orebodies exhibit features of hydrothermal sulfide mineralization. The same can be said about the other deposits, especially Pravoingamakitsky deposit where quartz-sulfides veins were discovered. This is a new type of Au-PGE-Cu mineralization. Inside many orebodies (Saku, Unkur), economic REE-U mineralization was identified. The occurrences of uranium mineralization have been noted in form of pitchblende and U-Th rims surrounding chalcopyrite grains (Unkur) and crystals (e.g.,fourmarierite, $PbU_4O_{13}*4H_2O$ at Krasny). The enrichment in U and Pb has been documented in crosscutting quartz veinlets with bornite mineralization at the Udokan deposit as well.

In conclusion, the aggregate of ore deposits localized in the Udokan-Chiney ore district is unique and is the result of multi-stage, polygenetic formation. The deposits of copper and other metals formed at various depths and occur within a limited area. Multielement and similarly diverse mineralogical composition of ores of different deposits in the Udokan-Chiney area reflect a long evolution of ore processes in very active block of the crust. The observed combination of

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magmatic, sedimentary, and partly hydrothermal deposits is a result of the telescoping of a wide range of metals into a limited area.