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Gold Mineralization in the Eastern Tannu-Ola Ore District of the Altai-Sayan Folded Area (Russia)

A.I.Chernykh

FGUP SNIIGGIMS, Novosibirsk, Russia

The Eastern Tannu-Ola iron-copper-gold ore district is located in the central Altai-Sayan folded area, about 70-100 km southeast of the Kyzyl city, on the Russian-Mongolian border. In recent years the author have obtained new data on the district metallogeny as well as on a gold mineralization features.

1 Geological Structure and Metallogenic Zoning

The Eastern Tannu-Ola ore district is confined to the large tectonic block of the Upper-Yenisei folded system and is composed mainly of Vendian(?)–Ordovician rocks. They are represented by Vendian(?)–Early Cambrian island-arc volcanogenic-sedimentary complexes, metamorphosed at the level of the greenschist facies and contorted into folds of various orders (Mongush et.al., 2011). A characteristic feature of the Eastern Tannu-Ola district is a wide development of massifs of the intrusive rocks, intruded volcanogenic-sedimentary rocks. Such massifs are constituted by the Late Cambrian diorites, granodiorites, granites and plagiogranites. Intrusions of the Ordovician granite-leucogranite composition and of Early Devonian granite composition (Rudnev, 2013) are less common.

Occurrences of iron, gold and copper are known within the Eastern Tannu-Ola ore district. Gold mineralization belongs to gold-skarn and gold-sulphide-quartz types. Its formation is connected with granitoid massifs of Late Cambrian age. Indications of gold-containing polymetallic mineralization, associated with the Early Cambrian vulcanites are revealed in the western part of the district. Besides, there are identified features of molybdenum-copper-porphyry mineralization with gold within the district. This mineralization formation is concerned with the Ordovician and Early Devonian granites and leucogranites. Gold mineralization is controlled by

fractured zones in near-contact and over roof parts of granitoid massifs, intruded Early Cambrian volcanogenic-sedimentary rocks. According to the information available, direct and indirect indicators of gold mineralization are concentrated in south and north-eastern ore district, where the Despenskiy and Elegest-Mezhegeiskiy iron-copper-gold ore clusters are allocated. These clusters are characterized by similar geological structure and combination of ore control and ore parent minerogenetic factors. Besides, the Irbiteiskiy gold-containing polymetallic cluster is distinguished by the author in the western part of the region.

Despenskiy and Elegest-Mezhegeiskiy gold ore clusters are stretched in sublatitudinal direction and confined to the South Tannu-Ola and Bai-Dagskiy faults respectively. A characteristic feature of geology of both clusters is the presence of numerous, various rank, differently directed and uneven-aged faults. Crushing and fractured zones in igneous-sedimentary rocks and granitoids provided a favorable environment for unloading of hydrothermal solutions and generation of large vein-veinlet and stockwork gold-sulfide-quartz zones. Numerous zones of skarnization, sulfidization, epidotization, silicification, sulphide-quartz veins and veinlets with gold, copper, plumbum, sulphosalt, and silver mineralization are observed in endomorphosed and exomorphosed zones.

2 Characteristics of Gold Mineralization

As of today the most studied is the Despenskiy cluster. Its western, central and eastern parts are specified by distinguished concentrating sites of gold mineralization with potential minable significance. Here several linear ore zones confined to faults are located. Gold mineralization is localized in near-contact part of small massifs, constituted mainly by plagiogranites and granites, intruded basalts, limestones and tufas of basic and acid compositions. The gold content is 1-4 g/t, given that the

* Corresponding author. E-mail: chernykhai@mail.ru

thickness of ore bodies makes up 3 to 20 m. High gold content is confined to the zones of silicification, sulphide-quartz veins and sulphidization. Quartz veins are 1 to 3 m thick. The peak gold contents up to 30-90 g/t occur when sulphide-quartz mineralization is overlaid on calcareous garnet-pyroxene skarn. Sulphides are represented by chalcopryrite, bornite, and pyrite. Skarnized rocks often contain magnetite and gematite. In the oxidation zone of crushed veins there is malachite, chalcocine, covellite, and limonite mineralization.

Gold was discovered in quartz veins, silicified skarns, in schlich of diluvial deposits, crushed samples and polished sections. The extracted gold is 0.01 to 3-4 mm. Typical is a wide range of gold fineness from 790 up to 1000 ‰. The most widespread is gold with fineness of 820-840 ‰ and 870-920 ‰. This gold is associated with formation of gold-bearing quartz veins, and fineness changes possibly show different stages of their formation and different erosion level of the ore-forming system. The gold with higher fineness of 990-1000 ‰ may be the result of thermal effect on the gold that had formed earlier, which was connected with intrusion of numerous Devonian dykes. Most common admixture here is silver (0.1 to 19%), and sometimes mercury with 0.1-0.4 % and in certain cases 2.7 %. The gold from the Despenskiy cluster is characterized by admixture of Cu from 0.1-0.3 % and sometimes up to 0.77 %. Correlation of gold with copper and silver occurs in the primary and secondary geochemical fields of the crushed veins in the Despenskiy cluster. The gold mineralization in the east of the cluster is characterized by its association with tellurium minerals – hessite, altaite, and petzite.

3 Outlook for Gold Mineralization Finding

Besides gold manifestations and placers there are other indications of gold mineralization in Despenskiy and Elegest-Mezhegeiskiy clusters as well as in the remaining part of the Eastern Tannu-Ola district. There are numerous schlich gold haloes, geochemical and hydrogeochemical anomalies of Au, Ag, Cu, As, Pb, Zn, Sb, and Hg, quartz veins with chalcopryrite-bornite mineralization, zones of silicification, sulphidization, and skarnation of rocks with unknown gold content. Thus, the possibility to discover

new gold ore mineralization areas within the Eastern Tannu-Ola district is great and it isn't confined to these two clusters.

Analysis of available and new data shows similarities in metallogeny of the Eastern Tannu-Ola iron-copper-gold ore district and other ore-bearing districts of the Altai-Sayan mineragenic province – Kommunarovskiy, Olkhovsko-Chibezhskiy, Kaa-Khemskiy etc. Exploration background in the districts proves the high quality of gold ores and possibility of heap leaching (Tardan deposit)

4 Conclusions

The Eastern Tannu-Ola ore-bearing district is characterized by poorly explored, but diverse mineral resource base. At the moment there are Despenskiy and Elegest-Mezhegeiskiy clusters, where a number of sites with gold-sulphide-quartz and gold-skarn mineralization have been discovered. The district or adjacent areas embrace promising objects with nonferrous, noble, and rare metals. Study of the Eastern Tannu-Ola district will raise the mineral resource base of gold, iron, copper, molybdenum and provide new data on gold mineralization genesis in the Altai-Sayan folded area.

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