Borisenko, A.S. Study of salt composition of solutions of fluid inclusions in minerals with cryometry // Geologiya i Geofizika, 1977. Vol. 8. P. 16–27 [in Russian].

Prokof'ev, V.Yu., Spiridonov, E.M. Composition of metamorphic fluids and transformation conditions of the Kochkar gold deposit, South Urals // In: II All-Russ. Petrographic Conf. Syktyvkar, 2005. Vol. 3. P. 88–90 [in Russian].

Faure, G. Principles of isotope geology. 2nd edition. John Wiley and Sons, Inc., NY, 1986.

Clayton, R.N., O'Neil, J.R., Mayeda, T. Oxygen Isotope Exchange between Quartz and Water // J. Geophys. Res., 1972. Vol. 77. No. 17. P. 3057–3067.

Jia, Y., Li I., Kerrich, R. Stable isotope (O, H, S, C, and N) systematics of quartz vein systems in the turbidite-hosted central and north Deborah gold deposits of the Bendigo gold field, Central Victoria, Australia: constraints on the origin of ore-forming fluids // Economic. Geology, 2001. Vol. 96. P. 705–721.

Hoefs, J. Stable isotope geochemistry. Springer, 2009. 285 p.

Goldfarb, R.J., Newberry, R.J., Pickthorn, W.J., Gent, C.A. Oxygen, hydrogen, and sulfur isotope studies in the Juneau gold belt, Southeastern Alaska: constraints on the origin of hydrothermal fluids // Economic Geology, 1991. Vol. 86. P. 66–80.

Kerrich, R. The stable isotope geochemistry of Au-Ag vein deposits in metamorphic rocks // In: Mineralog. Assoc. Canada Short Course Handbook, 1987. Vol. 13. P. 287–336.

Taylor, H. P. The application of oxygen and hydrogen isotope studies to problems of hydrothermal alteration and ore deposition // Economic Geology, 1974. Vol. 60. P. 843–883.

Zaykov, V.V, Lebedev, V.I., Tyul'kin, V.G. et al. Ore complexes of Tuva. Novosibirsk, Nauka, 1981 [in Russian].

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GOLD MINERALISATION IN PIILOLA AREA (EAST FINLAND)

Рассмотрена геологическая позиция и минералогия рудопроявлений золота площади Пиилола (Восточная Финляндия). Площадь находится в пределах зеленокаменного пояса Кухмо в архейском домене Фенноскандинавского щита. Минералогия руд характеризуется преобладанием пирротина и арсенопирита; золото выявлено в самородной форме и в форме мальдонита. В ассоциации с золотом часто наблюдается самородный висмут.

Komatiite-hosted Ni, VMS, and orogenic gold are the most common metallogenic components in Archaean greenstone belts. Canadian shield, Western Australia and other Archaean areas have well-known examples of orogenic gold deposits.

The main Au provinces in Finland are the Archaean greenstones in the east of Finland, Palaeoproterozoic greenstone belts in Lapland, and the Palaeoproterozoic Svecofennian schist belts in central and southern Finland. About 200 hard-rock gold occurrences are presently known.

These are short results of investigations of the Piilola area which is located in the Kuhmo greenstone belt in Eastern Finland. Works are carried out by Mineral Exploration Network (Finland) Ltd. Geophysical, geochemical methods, and drilling have been used.

The Finnish part of the Fennoscandian shield comprises three major domains. There are the Archaean cratonic nucleus (Karelian domain) and the Paleoproterozoic mobile belts of Kola-Lapland and Svecofennia.

The Archaean bedrock can be subdivided into TTG-type complexes, and a few major supracrustal belts: Oijarvi, Kuhmo-Suomussalmi and Ilomantsi. The Kuhmo-Suomussalmi volcano-sedimentary complex (Kuhmo, Suomussalmi and Tipasjarvi greenstone belts combined) was probably formed in an intra-plate, oceanic environment [Lahtinen et al., 2011]. Its central part (the Kuhmo greenstone belt) has a symmetrical syncline structure with a submeridional trend. The most voluminous rocks are mafic volcanic rocks [Papunen et al., 2009]. Several phases of the Archaean TTG granitoids have intruded the greenstone belt.

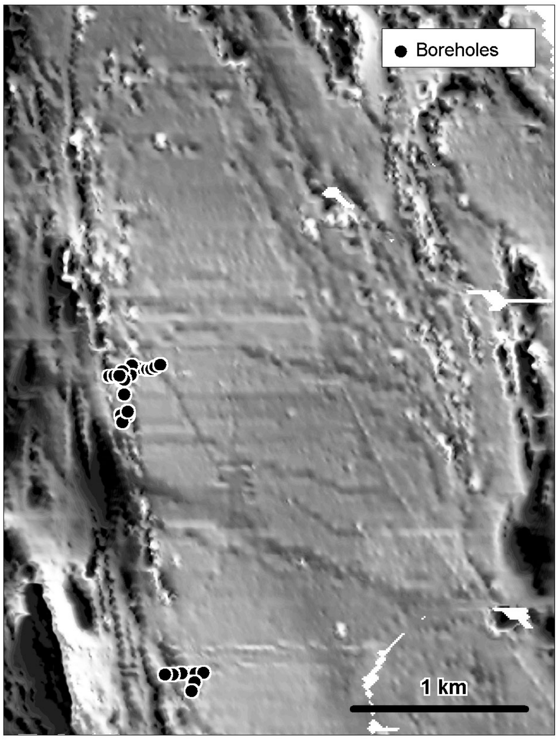

Fig. The map of magnetic field of studied area and boreholls position.

A number of drilling-indicated gold occurrences has been identified in the Kuhmo greenstone belt. On the basis of mineral assemblages in the gold occurrences and their host and adjacent rocks, the degree of regional metamorphism is from upper-greenschist to lower-amphibolites facies.

The Piilola area joins Piilola, Jousijarvi, Licasuo, Aittoranta, and some other occurrences.

Next greenstone rocks succession was observed in the Jousijarvi occurrence (from the west to the east):

1. Ultramafic rocks transformed to serpentinites, talk-carbonate, tremolite rocks. Aittoranta occurrence is hosted by these rocks.
2. Biotite schists with pyrrhotite dissemination.
3. Quartz-plagioclase schists.
4. Gneissic biotite-quartz-plagioclase rocks.
5. Biotite schists with pyrrhotite and arsenopyrite dissemination. These schists are ore-hosted for Piilola, Licasuo and Jousijarvi occurrences.
6. Gneissic biotite-quartz-plagioclase rocks.

Ore field structure has submeridional trend and subvertical dip. It is complicated by Palaeoproterozoic gabbro dykes with NW-trending. Magnetic and electric methods do show the structural features of the area, including those which control gold mineralisation (fig.).

The main ore minerals are, in a decreasing order of abundance, pyrrhotite, arsenopyrite, and pyrite. Only in a few locations, arsenopyrite forms visible grain aggregates. Chalcopyrite and pentlandite commonly occur as intergrowths together. Native gold has been observed at Piilola, Jousijarvi, and Mujesuo, and is predominantly associated with arsenopyrite. Native bismuth has been detected in the ore at Piilola, Mujesuo, and Jousijarvi. Native gold forms inclusions in arsenopyrite and silicate minerals. Inclusions in chalcopyrite or pyrrhotite are rare (e.g. Mujesuo). In spite of obvious structural relation between gold and arsenopyrite the Au-As correlation is not strong.

Till geochemistry shows an As and Au dispersion halo in the area.

It is suggested that Intrusion related gold system (IRGS) in combination with the previously applied orogenic shear zone hosted exploration model could be applied to the area of study.

References

Lahtinen R., Holtta P., Kontinen A., Niiranen T., Nironen M., Saalmann K., Sorjonen-Ward P. Tectonic and metallogenic evolution of the Fennoscandian shield: key questions within emphasis on Finland // Geol. Surv. Finland Spec. Pap. 49, 2011. P. 23–33.

Papunen H., Halkoaho T., Luukkonen E. Archaean evolution of the Tipasjarvi-Kuhmo-Suomussalmi greenstone complex, Finland // Geol. Surv. Finland Bull. 403, 2009. 68 p.

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FLORENCITE FROM KOPYLOVSKOE AND KAVKAZ GOLD DEPOSITS (BODAYBO ORE REGION, RUSSIA)

Флоренсит – главный минерал-концентратор РЗЭ на золоторудных месторождениях Копыловское и Кавказ (Бодайбинский район), локализованных в углеродистых терригенных породах. Образует идиоморфные кристаллы размером 0.1–1 мм, характеризуется оптической и химической зональностью, обусловленной главным образом примесью Ca и Fe. По составу РЗЭ флоренсит месторождения Копыловское отвечает схеме Ce>La>Nd, Кавказа – Ce>Nd>La. Наблюдаются вариации в содержании Th. Спектры распределения РЗЭ во флоренсите и вмещающих углеродистых породах сходны. Вероятно, флоренсит образовался в процессе катагенеза начальной стадии метаморфизма, при этом источником фосфора могло служить рассеянное органическое вещество, РЗЭ – глинистые минералы.

Introduction and geological setting. The Bodaibo ore region is located in the Patom highland and belongs to the northeastern part of Irkutsk administrative region, which is well-known as the largest gold placer province in Russia. The gold deposits in the Bodaibo ore region are confined to two main ore blocks: Kropotkin block with disseminated and veinlet deposits (e.g., Sukhoi Log deposit) and Artemovsky block with quartz vein deposits. The Kopylovskoe and Kavkaz deposits are located in the latter block and are confined to the near-latitudinal anticline fold composed of the rocks of the Dogaldyn Formation [Bendyuk et al., 1984; Ivanov, 2008].

The host rocks of both deposits include arkose and graywacke-arkose metasandstones, metasiltstones, and carbonaceous-clayey and clayey shales. The host rocks were metamorphosed under sericite-chlorite subfacies of green-schist facies and also are hydrothermally altered [Palenova et al., 2011]. Quartz, feldspar, muscovite, illite, chlorite, paragonite, and carbonates (breinerite, siderite, dolomite and rare calcite) are major minerals of the host rocks. Carbonates are observed as zonal euhedral crystals and concretions, which indicate their postsedimentary origin. Pyrite is a major ore mineral. Chalcopyrite, pyrrhotite, galena, and sphalerite are minor ore minerals. Gold forms free grains and inclusions in pyrite. Allotigenic tourmaline, apatite, zircon, monazite, and allanite form rounded or clastic grains. Florencite occurs in all types of host rocks but its maximal concentration is typical of the highly pyritized gold-bearing carbonaceous-clayey shales. In sandstones, florencite is found in clasts of carbonaceous shales.

Florencite was described as a typical accessory mineral of gold-bearing black shales of the Patom plateau [Buryak, 1998]. The placer gold from the Predpatom Mountains contains inclusions of florencite and monazite [Glushkova, Nikiforova, 2011]. However, in spite of numerous references, florencite from the Bodaibo region has not characterized yet.

Results. Florencite is observed as zonal and sectorial light yellow to brown (rarely greenish) sharp rhombohedral crystals 0.01–0.02 mm (up to 1 mm) in size or grains without crystal shape. The pores and inclusions of carbonaceous matter trace the boundaries between the growth sectors. Florencite hosts inclusions of monazite and zircon. Occasionally, goyazite $SrAl_3(PO_4)(HPO_4)(OH)_6$ epitaxially grows on florencite.

The chemical composition of florencite was studied using a SEM equipped with EDA. Florencite from both deposits have similar composition and belong to florensite $(Ce,La,Nd)Al_3(PO_4)_2(OH)_2$–crandallite $CaAl_3(PO_4)_2(OH)_2$ isomorphic series. The optical and chemical zoning in mineral coincide (Fig. 1). The zones enriched in Fe and Ca are porous. Florencite from the Kopylovskoe deposit is characterized by a Ce>La>Nd trend, admixtures of Th, Sr, rarely Pb and As, and inclusions of monazite in contrast to Ce>Nd>La trend and absence of Pb and As in florencite from the Kavkaz deposit.