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GEOCHEMISTRY

The First Find of Silver Nuggets in Gold Placers of the Subpolar Urals

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Abstract—In the gold placers of the Subpolar Urals, silver nuggets have been found for the first time. Galena, cassiterite, wolframite, cosalite, tetradymite, ferberite, cobaltine, tellurojoseite, and native bismuth are associated with silver. The silver is generally represented by subrounded and angular gray particles of up to 2–2.5 cm in size. The particles have a lumpy, slightly flattered, elongated shape. Sometimes, Au and Hg admixtures are detected in the composition of the silver. Inclusions of fine particles of gold and mineral phases of bismuth and tellurium are encountered. The results of studies show the widespread development of Au–Ag–Bi–Te mineralization, original occurrences of which are currently unknown. The relatively poor roundness of the silver nuggets and the presence of the coarse-grained gold, which is also poorly rounded, point to the proximity of the original sources to the gold-bearing placers.

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In the Northern Urals, silver nuggets are encountered as small single segregations in ores of polymetallic, volfram–molybdenum, and copper deposits [1–4]. On the western slope of the Subpolar Urals, there is the Yasnoye uranium–silver–rare-earth occurrence. This is the only occurrence in the region where silver plays a major role in ores [5–6].

We encountered, for the first time, the silver nuggets in the gold placers on the eastern slope of the Subpolar Urals, in the Lyapinskii region. The mineralogical features of the silver were determined by modern analytical methods. The silver nuggets associate with bismuth and tellurium minerals indicating the widespread development of Au–Ag–Bi–Te mineralization, original occurrences of which are currently unknown.

The Lyapin placer involves the basins of the Maniya, Shchekuriya, and Naroda rivers. The central part of the region is composed of highly metamorphosed rocks of the Early Proterozoic Nyartin complex, which is a tectonic block elongated in the northeastern direction. The complex is composed of garnet and garnet-bearing gneisses, crystalline schists, and amphibolites. The Nyartin block is surrounded by schist formations of the Mankhobeyu, Shchekuriya, and Puiva suites of the Early and Middle Riphaean. Numerous dislocations are traced. The northeast- and northwest-striking dislocations are the largest ones. There are small massifs of granitoids and gabbro and sheetlike bodies of acidic and basic effusive rocks. Hydrothermal formations, which are represented by heterochronous quartz veins, often with chlorite, carbonates, feldspar, hematite, ilmenite, and sulfides, are widespread. Late Paleozoic pure quartz veins are very common.

In the Lyapin region, there are gold–sulfide, gold–sulfide–quartz, and gold–quartz occurrences and points of mineralization. The northeast-striking Nyartin and Khobeiz ore zones are distinguished. The sphalerite–pyrite–galena mineralization predominates in the ore occurrences of both zones. In the Subpolar Urals, to the north and northwest from the area studied, there are the well-known original gold–sulfide and gold–sulfide–quartz occurrences (Sosnovoye, Sinilga, Karavannoye, and Katalambinskoye); fuchsite–gold–palladium occurrences (Chudnoye and Nesterovskoye), and the Yasnoye uranium–silver occurrence, which was mentioned above. The Torgovskoye tungsten–molybdenum–bismuth occurrence is located further south. Gold is widespread in the Quaternary deposits of channels and terraces. The industrial placers are related to those deposits.

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Table 1. The chemical composition of silver nuggets from the gold placers of the Lyapin region (Subpolar Urals), wt %

Sample no.	Ag	Au	Hg	Total
Khobeyu River placer				
KhB-30	101.44	–	–	102.04
id.	96.25	–	–	96.24
id.	103.44	–	–	103.95
Nadezhd Creek placer				
H-1	90.89	1.42	–	93.60
H-2	97.47	–	2.47	99.94
the same	99.56	–	1.88	101.44
H-1/1	98.83	–	–	98.83
the same	99.93	–	–	99.93
H-1/3	95.44	–	–	95.44
the same	96.65	–	–	96.65

The analyses were performed on a JSM-6400 scanning electronic microscope with the "Link" attachment in the Yushkin Institute of Geology, Komi Science Center, Ural Branch, Russian Academy of Sciences. A dash indicates that an element was not revealed.

We encountered silver nuggets while studying the heavy-mineral concentrate from the gold placers, which are situated in the valleys of the Khobeyu River and Yarotashor Creek running into the upper reaches of the Maniya River.

The mineral composition of the samples of the heavy-mineral concentrate from the Khobeyu River is characterized by a large amount of galena, which is represented by coarse grains with distinct chips along cleavage planes. In some cases, we found Bi admixtures (up to 4.5 wt %) in galena. Sometimes, pyrrhotine is recognized in the intergrowths with galenite. Magnetite, cassiterite, wolframite, and galena are found in the samples of the heavy-mineral concentrate. Single micro-inclusions of gold, native bismuth, and Ag and Ta compounds, which are not exactly indicated, are observed in grains of cassiterite. Pyrite, sphalerite, cosalite ($Pb_2Bi_2S_5$), tetradymite (Bi_2Te_2S), ferberite ($FeWO_4$), and yttrocolumbite are represented in small quantities. Tetradymite contains sections that are close to tsumoit (BiTe) in composition. In the heavy-mineral concentrate from Yarotoshor Creek and its left tributaries (Nadezhd and Zhilnyi creeks), galena also predominates; pyrite, cobaltine (glaucodot), and single grains of arsenopyrite are registered. Tellurojoseite (Bi_4Te_2S), native bismuth, and cosalite are often encountered. In the native bismuth, micro-inclusions of busmuthine (Bi_2S_3) and hedliite (Bi_2Te) are indicated.

The size of the gold particles varies widely, up to 3–5 mm. Larger particles, up to small nuggets, have been found. Gold with a fraction of 0.25–1.0 mm predominates. The shape of the gold particles is generally isometric (lumpy) or laminated. Particles with rod-like, flaky, and complex shapes are subordinated. Partly bounded grains and idiomorphic, almost completely-bounded crystals of a cubic–octahedral and rhombic–dodecahedral habitus are rarely encountered. The gold particles are angular and subrounded. Many gold grains with complex and lumpy shape have cube-shaped hollows, which are probably the imprints of pyrite and galena crystals. Intergrowths of gold with tellurojoseite and native bismuth are also revealed. The chemical composition of gold varies. The Ag content ranges from 0.14 to 32.6 wt %. In some cases, along with Ag, we established Hg, the content of which is up to 4.85 wt %. The gold fineness varies from 674 to 998‰; the average value is 911‰. Extremely high-grade gold is predominant.

The silver nuggets, which were indicated on the basis of the external characteristics and the results of the X-ray crystal and microprobe analyses, are represented by gray particles, which have a lumpy, lightly flattered, elongated shape (Figs. 1a, 1b). The largest particles—nuggets—are 2–2.5 cm in size. The surface of the nuggets is generally uneven, foveolate–tuberculate. Small deep cavities with a complex slot-like shape are often observed. The degree of nugget roundness is mostly poor. Almost nonrounded fine particles and nuggets are encountered. Table 1 shows the results of the microprobe chemical analysis of the silver nuggets. Most of the time this is fine silver. In single cases, the admixtures of Au (1.42 wt %) and Hg (2.47 wt %) are determined.

Almost all silver particles and nuggets studied contain mineral inclusions (Figs. 1c, 1d, 1e, 1f). Primarily, these are the inclusions of gold that we observed on both the nugget surface and the cut surface within the nuggets. Sometimes, there is a large number of the finest inclusions of gold, the size of which is 0.5–1 μm and less. These inclusions are located in close proximity to each other. Along with gold, the silver nuggets contain inclusions of the Bi and Te mineral phases, which are not distinctly indicated and characterized by a variable ratio of the main components, corresponding approximately to the Bi_3TeS and BiTeS compositions. Micro-inclusions of native bismuth with a needle-like shape up to 1.5 μm length and about 0.1 μm thick were revealed in one of the small nuggets of silver.

In the placers of the Subpolar Urals, the findings of silver nuggets, which are closely associated with gold, minerals of tungsten, bismuth, and tellurium, are very important in terms of metallogeny. They indicate the wide development of the Au–Ag–Bi–Te mineralization, original occurrences of which are still unknown in the region. This mineralization is rather related to the Late Paleozoic hydrothermal processes, when gold–sulfide and other ore deposits and occurrences were formed. The relatively poor roundness of the silver nuggets and grains of other minerals point to the

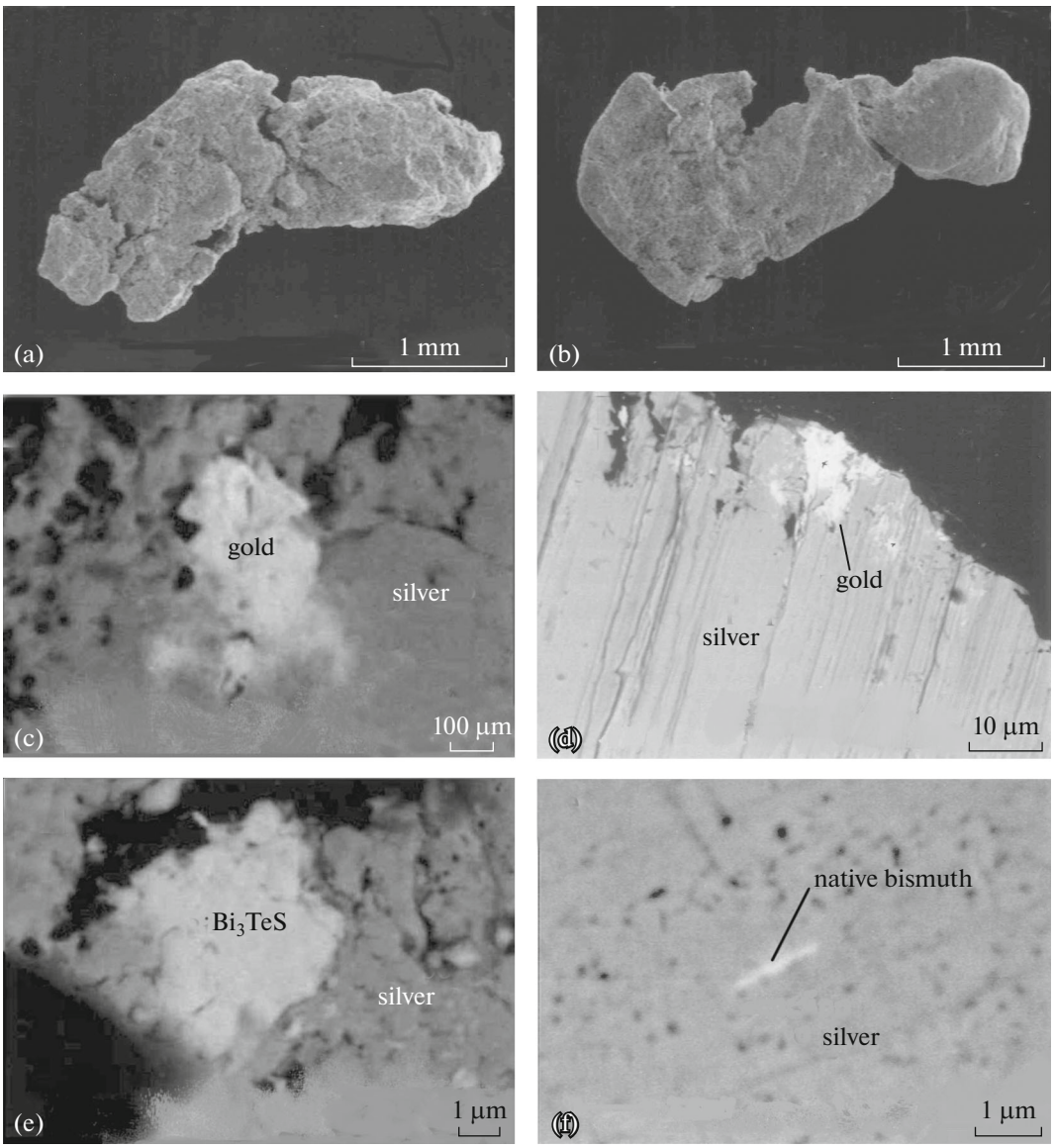

Fig. 1. Native silver with inclusions of gold and bismuth and tellurium mineral phases from gold placers of the Lyapin region (Subpolar Urals). (a, b) SEM images; (c–f) BSE images.

closeness of the original sources to the gold-bearing placers.

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