The Pokrovskoe gold deposit is situated in the western part of the Uhlakano–Ogodzhinskii volcanoplutonic belt, localized in Cretaceous granitoids of the Sergeevskii massif and in younger volcanogenic formations of the Uhlanginskaya volcanotectonic structure [1]. Granitoids and volcanic rocks break Upper Jurassic terrigenous series enriched in interbeds of carbonaceous argillite. According to the level of gold ore in the structures of Mesozoic tectonomagmatic activation, the deposit corresponds to subvolcanic ones [2]. According to the peculiarities of the mineral composition, it is related to the gold–adular–quartz or poor-sulfide formation [3]. The deposit is characterized by great abundance of faults and rocks, which underwent propylitization, argillization, sulfidization, and silicification. Ore zones are represented by the totality of steeply and gently pitching quartz and quartz–carbonate veins, veinlets, and breccias of quartz composition located in the zones of jointing and tectonic dislocations. Five stages of ore formation are distinguished on the deposit: (1) quartz–hematite–pyrite; (2) productive gold–carbonate–quartz; (3) main productive gold–adular–quartz; (4) quartz–carbonate–sulfide; and (5) barren quartz–carbonate. Zones of vein–impregnation mineralization represented by a network of thin quartz veinlets with impregnation of pyrite, chlorite, and hematite were formed at the first stage. The second stage is characterized by thick veins of fine-granular quartz with a small concentration of gold. The third stage is the most productive and represented by two associations: gold–adular–quartz and gold–sulfide. Banded colloform textures of ores are typical of gold-bearing quartz–adular formations. In addition to the prevailing pyrite, the gold–sulfide association contains small portions of galena, sphalerite, pyrargyrite, proustite, polybasite, and other rare ore minerals. Quartz–sulfide and quartz–carbonate–sulfide veinlets with pyrite, arsenopyrite, chalcocpyrite, siderite, and apatite with rare elements were formed at the fourth stage. The post-ore, carbonate stage is represented by veinlets and thin veins of quartz–dolomite and calcite compositions. Accounting for the difficulties in extraction of gold minerals as a whole and especially nanominerals and the fragility of sulfides, the methodology of sample preparation without grinding was originally worked out for study of gold nanoparticles in mineral aggregates. For this purpose, a representative sample (50–300 km) is passed in a sparing mode through a jaw crusher with successive change of the hole size to –1 mm at the exit. The +1 mm fraction is returned for further crushing, and usually 3–4 cycles are required for separation of the whole sample into two fractions: –1+0.08 and –0.08 mm. Using such method, we divide natural gold into two classes: visible and invisible to the naked eye (nanosized by 90%). Then we obtain two concentrates of heavy minerals with gold, which are studied on a scanning microscope and analyzed by different methods. The solution formed during concentration of minerals together with suspended particles is successively passed through three filters: +10 µm, +3.5 µm, and ~1 µm. Later precipitates are analyzed on filters, and filtrates are subjected to separation of nanosized particles. We worked out the method of measurement of size and concentration of nanogold in aqueous solutions using an apparatus of vacuum filtration PVF-47B with a set of Vladipor microfiltration membranes of the MFAS type (average pore sizes are 450, 200, 100, and 50 nm). Precipitates on filters and all solutions are analyzed on a Solar-M6 spectrophotometer with a graphite atomizer on other instruments.

Gold nanominerals and minerals accumulating nanosized gold were studied in the primary ore of the Pokrovskoe deposit. The main minerals-concentrators are chalcedony–like quartz, adular (valencianite), and arsenic–bearing pyrite. There are two adular varieties: the first one is pale-brown to reddish-brown with an average gold concentration of 0.25 ppm; the second one is low-temperature light and nontransparent. The second adular variety is close to quartz by color and density, hardly diagnosed, and visually not distinguished from it. Valencianite is typical of the main

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productive stage, and the concentration of gold in it is ~5 ppm. Adular does not contain visible gold, but its presence is confirmed by different methods. By virtue of analytical scanning electron microscopy (ASEM), aggregates of spheroidal nanogold (“star sky”) with prevalence of particles with a diameter of 50–100 nm were found in adular (Fig. 1a). The distribution of nanogold spheroids in adular is heterogeneous. In some parts high portions of them are registered reaching 100 pieces per 10–30 µm², in other parts of the same area, there are a little more than 10 pieces, whereas in some areas they are absent completely [4]. The concentration of silver is higher than that of gold by a factor of 4.2, but the areas of the highest concentrations of spheroidal nanosilver and nanogold “stars” are spatially distant from each other. According to the data of thermobarogeochemistry, adular accumulating nanogold is different from nanosilver-bearing adular by the high concentration of carbon, phosphorus, sodium, arsenic, and chlorine and the low concentrations of potassium, lead, antimony, and mercury.

As is evident from investigation of minerals by the ASEM method, low-temperature adular is often characterized by cluster forms (Fig. 2). Pyrite replaced by hematite is formed after adular containing gold nanominerals (Table 2). This process is accompanied by further accumulation of gold in the Adl—Py—Hem—Au system with the formation of spheroidal and then cluster structures of gold. Cyclical changes in the environment parameters results in replacement of adular by low-temperature quartz and quartz, by adular. Quartz contains larger segregations of gold nanominerals than adular. This results from the fact that quartz as a polymer is a more favorable phase for self-organization and growth of gold nanominerals (Fig. 1b). Sulfides and sulfosalts (pyrite, arsenopyrite, chalcopyrite, pyrargyrite, and others) with nanominerals of gold are precipitated in interstitials between quartz and adular during generation of sulfur-bearing hydrothermal solutions (Fig. 1c, Table 1).

Galena is one of the latest sulfides on the studied deposit and, as a rule, is observed together with gold. Synchronous formation of nanogalena and nanogold

**Fig. 1.** (a) Nanogold in adular (“star sky”), magnification 30 000×; (b) nanogold in quartz, magnification 30 000×; (c) pyrite (Sp. 2) with inclusion of electrum (Sp. 1) intergrown with pyrargyrite (Sp. 3) in the intergranular space between quartz (Sp. 4) and adular (Sp. 5), magnification 1600×.