

# Features of Inner Structure of Placer Gold of the North-Eastern Part Siberian Platform

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**Abstract.** Mineral and raw material base of placer and ore gold is based on prognosis evaluation, which allows to define promising areas regarding gold-bearing deposit prospecting. But there are some difficulties in gold primary source predicting and prospecting at the North-east Siberian platform, because the studied area is overlapped by thick cover of the Cenozoic deposits, where traditional methods of gold deposit prospecting are ineffective. In this connection, detailed study of typomorphic features of placer gold is important, because it contains key genetic information, necessary for development of mineralogical criteria of prognosis evaluation of ore gold content. Authors studied mineralogical-geochemical features of placer gold of the Anabar placer area for 15 years, with a view to identify indicators of gold, typical for different formation types of primary sources. This article presents results of these works.

In placer regions, where primary sources of gold are not identified, there is need to study typomorphic features of placer gold, because it contains important genetic information, necessary for the development of mineralogical criteria of prognosis evaluation of ore gold content. Inner structures of gold from the Anabar placer region are studied, as one of the diagnostic typomorphic criteria as described in prominent method, developed by N.V. Petrovskaya [1980]. Etching of gold was carried out using reagent:  $\text{HCl} + \text{HNO}_3 + \text{FeCl}_3 \times 6\text{H}_2\text{O} + \text{CrO}_3 + \text{thioureat} + \text{water}$ . Identified inner structures wer studied in details by means of scanning electron microscope JEOL JSM-6480LV. Two types of gold are identified according to the features of inner structure of placer gold of the Anabar region. First type – medium-high karat fine, well processed gold with significantly changed inner structure. This gold is allochthonous, which was redeposited many times from ancient intermediate reservoirs to younger deposits. Second type – low-medium karat, poorly rounded gold with unchanged inner structure. Poor roundness of gold particles and preservation of their primary inner structures indicate close proximity of primary source.

## 1. Introduction

Using typomorphic features of placer gold as additional signs to geologic criteria at different stages of studying potentially gold-bearing areas allows obtaining new data in order to reconstruct history of formation of placer and ore manifestations. Inner structure is one of the most informative typomorphic features, indicating post-ore endogenetic changes and duration of gold occurrence in exogenetic medium. Classification of inner structures of placer gold was developed by N.V. Petrovskaya [1], later it was supplemented by L.A. Nikolaeva [3, 4]. We studied features of inner structure of placer gold (over 300 gold grains) from bulk and exploration samples, collected at alluvial deposits of Mayat, Ebelyakh, Udzha, Polovinnaya and Bolshaya Kuonamka rivers (Figure 1). The Anabar placer region belongs to the Lena-Anabar polymineraleic placer subprovince [5] and occupies basin of Bolashaya and Malaya



Kuonamka rivers, which drain the Eastern framing of the Anabar shield, and the Anabar-Udzhin interfluvium, mainly composed of the Cambrian carbonate rocks (Figure 1).

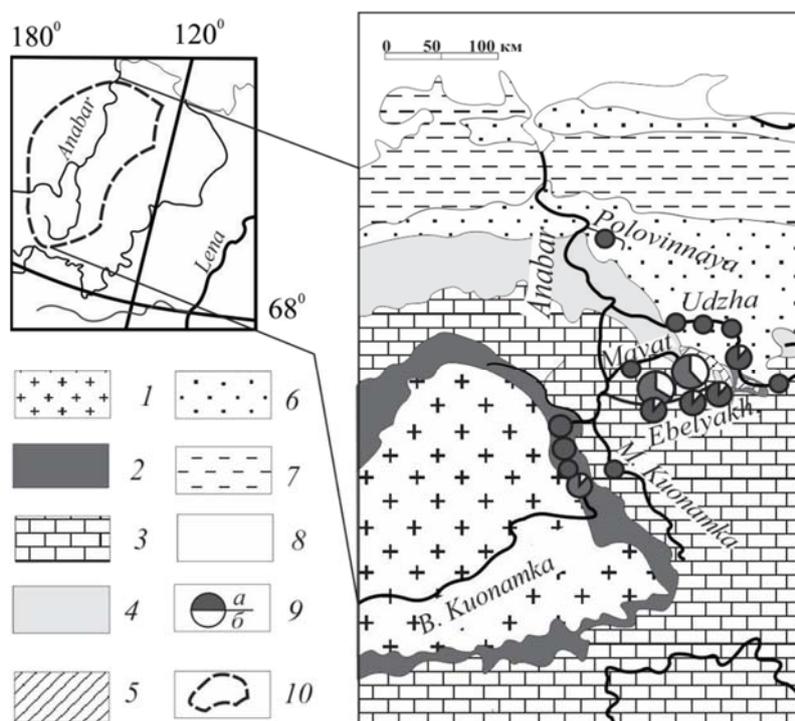


Figure 1. Geological structure of the Anabar placer area

Legend: 1 – Archean rocks, 2 – Riphean, 3 – Cambrian, 4 – Permian, 5 – Triassic, 6 – Jurassic, 7 – Cretaceous, 8 – Quaternary, 9 – types of gold and their ratio (%): - I type, b – II type; 10 – boundaries of the Anabar polyminerale placer area.

## 2. Methods and approaches

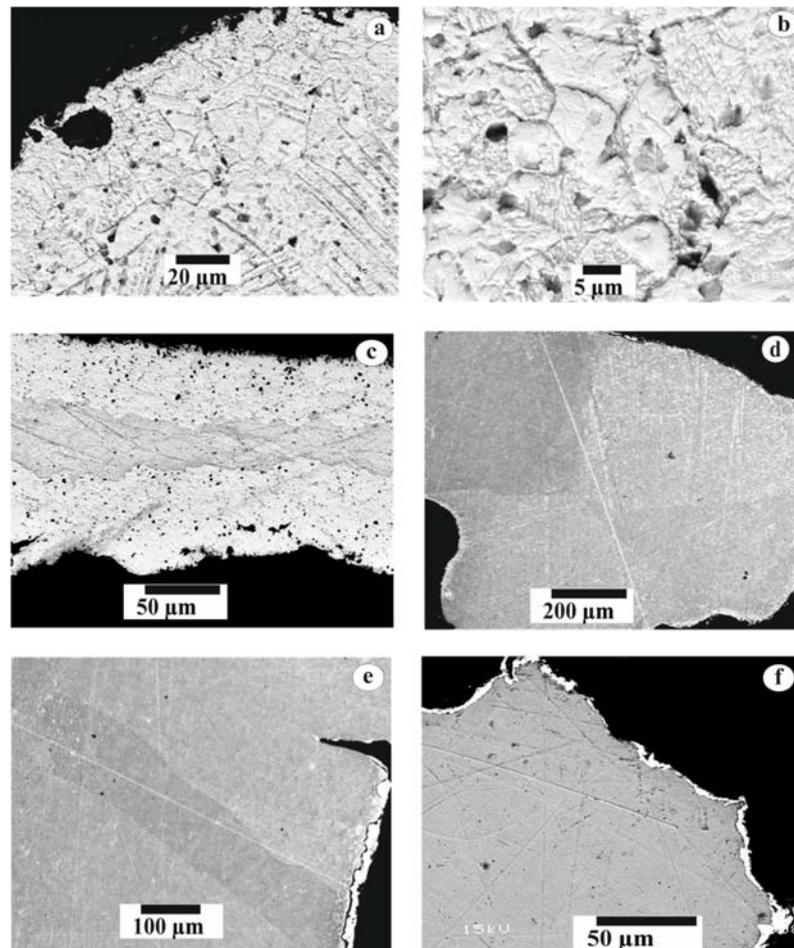
Structural etching of gold was performed according to the known method [2] using reagent:  $\text{HCl} + \text{HNO}_3 + \text{FeCl}_3 + \text{CrO}_3 + \text{thiourea} + \text{water}$ . Reagent was applied on the surface of polished gold, mounted into artificial polished section, made on the basis of epoxy adhesive. Gold grains were etched from 10 to 30 seconds, several times. After each procedure of etching, polished section was rinsed under running water and dried. After that, exhibited inner structures were studied in details using NEOPHOT ore microscope and JEOL JSM-6480LV scanning electron microscope. Features of inner structures were interpreted according to recommendations of N.V. Petrovskaya [1, 2], L.A. Nikolaeva [3, 4], N.E. Savva and V.K. Preis [6].

## 3. Results and discussion

Inner structures of placer gold of the region are quite varied and they depend on their composition, character and degree of transformations.

When considering inner structure of gold from channel alluvium of basin of Mayat river (right tributary of Anabar river), the following is established. Inner structure of high-grade gold, fraction  $<0.5$  mm, is mainly presented by structures of recrystallization (Figure 2, a). At high magnification ( $\times 2700$ ), mosaic-block structure of submicrostructures is revealed (Figure 2, b). These gold grains have thick ( $10 > \text{mkm}$ ) high-grade coatings (Figure 2, c). Such inner structure is typical for gold, which occurred in exogenous conditions for a long time. Medium-grained structure is typical for medium-grade gold.

Coarse-grained unchanged structure with grain clear boundaries is identified in low-grade coarse gold (+1 mm) (Figure 2, d). Simple twins sometimes occur (Figure 2, e). Along gold grain periphery, discontinuous very thin high-grade coatings are observed rarely (Figure 2, f). Discovery of such structures indicate quite short occurrence of gold in exogenic conditions.

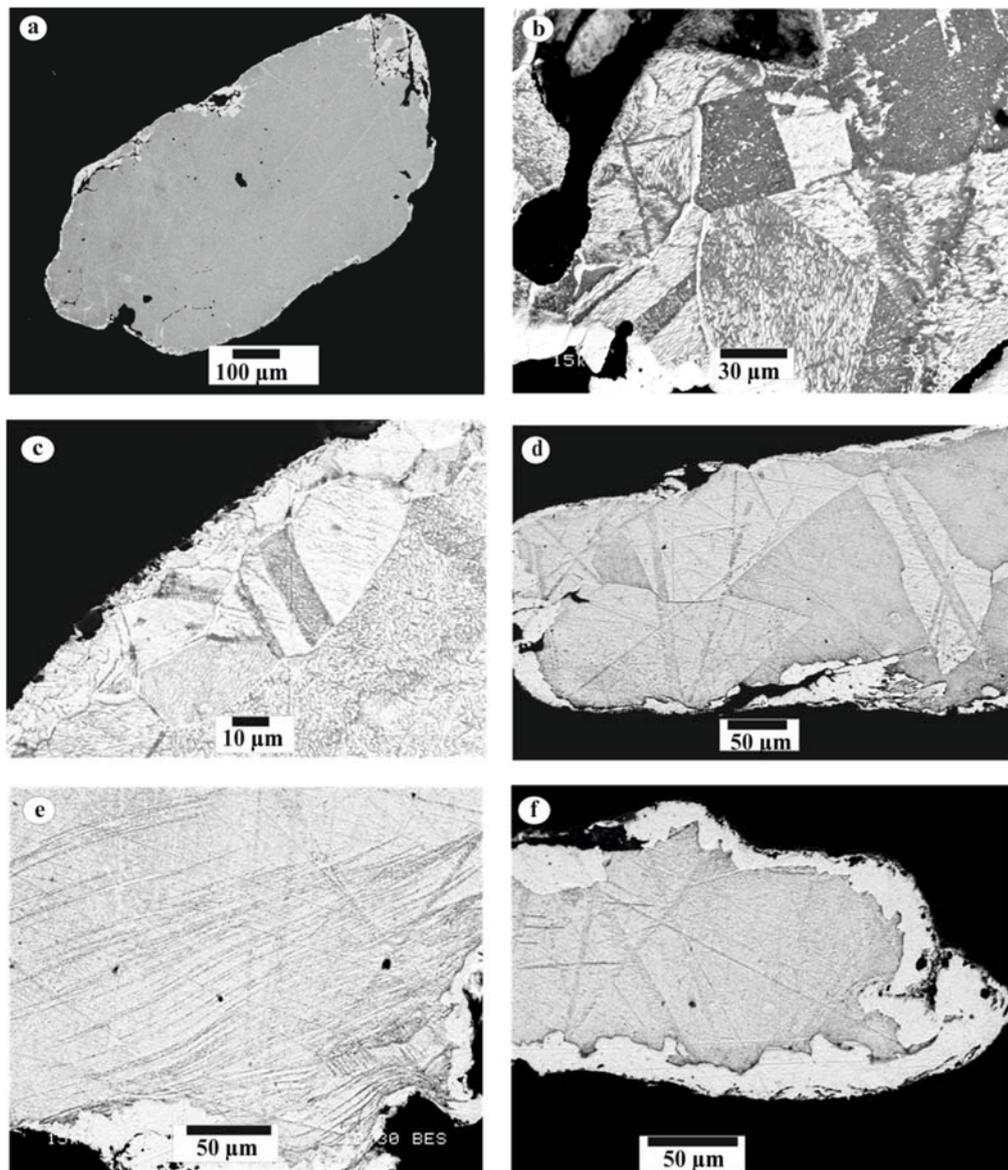


**Figure 2.** Inner structure of placer gold of the Mayat river placer (JEOL JSM-6480LV, SEI): structures of recrystallization in fine gold, fraction -0,5 mm (x800); b – mosaic-block structure of submicroscopic structure of fine gold, fraction -0,5 mm (x2700), c – thick highly fine gold shell of high-grade gold, fraction -0,5 mm (x500); d – coarse-grained structure of low-grade gold, fraction +2 mm (x75); e – twin in low-grade gold, fraction -2+1 (x200); f – thin discontinuous fine gold shell of low-grade gold (x450).

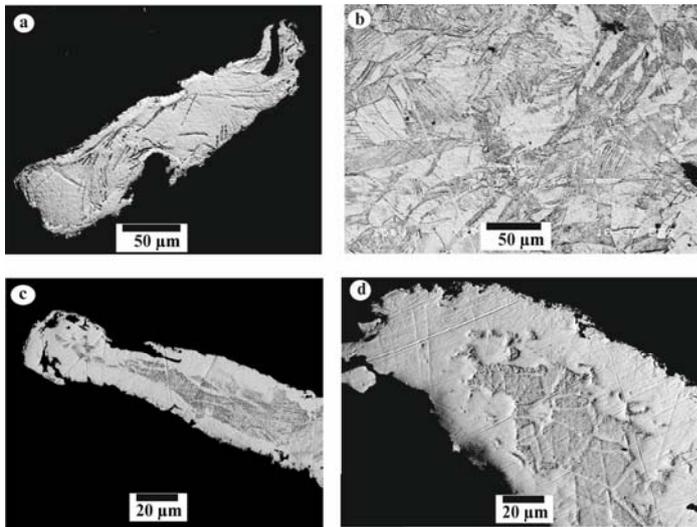
Low-grade poorly worn-out coarse gold (+1 mm) from channel alluvium of Ebelyakh river basin (right tributary of Anabar river) is mainly characterized by mono-grained, unchanged inner structure (Figure 3, a). Mono- and polygrained aggregates are typical for low-grade gold. Structures of recrystallization (Figure 3, b) and twins, often with intergranular high-grade veins and translation lines in peripheral parts, are observed in well worn-out medium-grade gold grains (-1+0,5 mm fraction). Thick high-grade coating is typical for them. High-grade gold (-0,5 mm fraction) is characterized by more complex inner structure. It records structures of recrystallization (Figure 3, c), twins (Figure 3, d), translation lines (Figure 3, e) and thick (15 > mkm) quite high-grade coating (Figure 3, f).

Fine well rounded particles of high-grade gold (-0,5 mm) from modern alluvial deposits of Udzha and Polovinnaya river basins have translation lines (Figure 4, a), structures of recrystallization (Figure 4, b), intergranular high-grade veins and thick (10. mkm) quite high-grade coating (Figure 4, c, d).

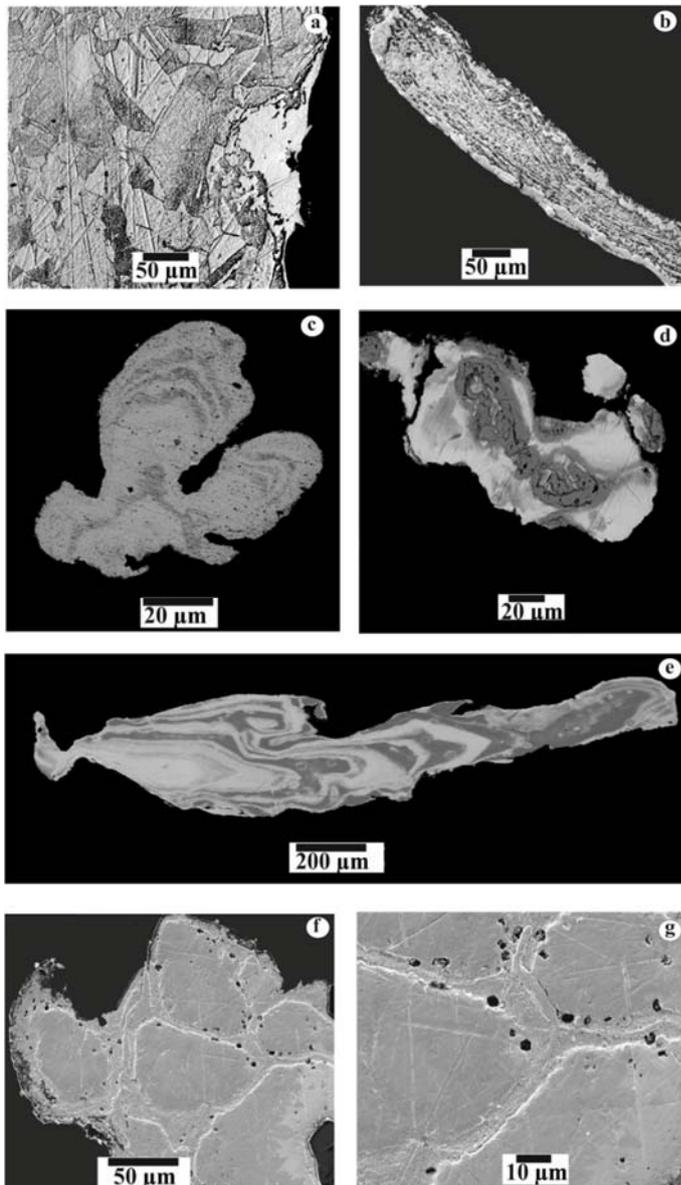
Structural etching of fine well rounded particles of high-grade gold from placer of Bolshaya Kuonamka river indicated that, it is also characterized by significantly changed inner structure. Structures of recrystallization (Figure 5, a), and translation lines (Figure 5, b) as well as thick quite high-grade coatings are identified in these particles. This indicates numerous redepositing of gold from ancient collectors to younger deposits.



**Figure 3.** Inner structure of placer gold of the Ebelyakh river basin (JEOL JSM-6480LV, SEI): a – mono-grained structure with thin fine shell of low-grade gold, fraction +2 mm (x120); b – structures of recrystallization of medium-grade gold, fraction -1+0,5 mm (x850); c – structures of recrystallization on peripheral parts of fine gold, fraction -1+0,5 mm (x1000); d – twin in fine gold (x300); e – translation lines in fine gold, fraction -1+0,5 mm (x450); f – thick highly fine shell in fine gold, fraction -1+0,5 mm (x350).



**Figure 4.** Inner structure of placer gold of the Udzha and Polovinnaya rivers basins (JEOL JSM-6480LV, SEI): a – translation lines in fine well-rounded gold, Udzha river (x450), b – structures of recrystallization of fine gold, Udzha river (x370), c – thick high-grade shell (x880) and d – fine intergranular veinlets (x700) on medium-grade well-rounded gold, Polovinnaya river.



**Figure 5.** Inner structure of placer gold of Bolshaya Kuonamka river (JEOL JSM-6480LV, SEI): a – structures of recrystallization of fine well-rounded gold (x370), translation lines in well-rounded fine gold (x300), c – concentrically zonal structure of sub-rounded relatively low-grade gold (x85), d – zonal structure of poor-rounded kustelite (x650), e – clear zonal structure of poor-rounded electrum (x65), f, g – low-grade intergranular veinlets in relatively low-grade gold of dendritic shape (x500, x1200)

Inner structure of high-argentiferous (electrum, küstelite) poorly rounded gold from this place is characterized mainly by zonal structures, which did not undergo endogenetic and hypergenetic transformations (Figure 5, c, d, e). Low-grade intergranular veins are identified in relatively low-grade gold of ore habit (Figure 5, f, g). According to N.E. Savva and V.K. Preis [6], good preservation of endogenic structures in gold indicates it was supplied from nearby primary sources.

#### 4. Conclusions

Thus, two types of gold can be identified according to features of inner structure of placer gold of the Anabar placer region.

First type – medium - high-grade fine particles of well worn-out gold (-1 mm) with significantly changed inner structure. According to typomorphic indicators, this metal belongs to the I<sup>st</sup> type gold, identified at the North-east Siberian platform earlier [7, 8]. I<sup>st</sup> type gold is characterized by fine fraction (-0,25 mm), high grade (>900‰), small set of trace elements, lack of mineral spots, mainly tabular and cloddy shapes, depressed minerals on surface. This gold was transported from its primary source, it underwent numerous redepositions from ancient intermediate collectors to younger deposits. Presumably, ore manifestations of gold-quartz-low sulfide type of the Pre-Cambrian age are primary sources of this gold.

Second type – low-medium-grade poorly rounded gold with unchanged inner structure. Poor roundness of gold grains and preservation of their inner structures indicate direct proximity to primary source. According to indicators, this metal belongs to II<sup>nd</sup> type gold, which is characterized by tubular and cloddy shapes, frequently of ore habit, and have mainly medium (800-900‰) and low (600-800‰) grade (less often 300-500‰). Wide range of trace elements (Fe, Sb, Pb and As), as well as inclusions of quartz, pyrite and arsenopyrite occur in gold of this type. This gold is autochthonous, which primary sources are presumably localized in fault zones and are related to the Mesozoic tectono-magmatic activation [7, 8].

#### Acknowledgment

Research is performed according to the plan of Scientific-research works of Diamond and Precious Metal Geology Institute, Siberian Branch, Russian Academy of Sciences: theme № 0381-2016-0004

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