



Native gold and platinum in stream sediments from Dvoynitsa River and right tributaries of Kamchiya River, Bulgaria

Самородно злато и платина в речните наслаги от р. Двойница и десните притоци на р. Камчия, България

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Introduction

The alluvial gold and platinum in the water-catchment basins of Dvoynitsa River and the right-bank tributaries of Kamchiya River is still very poorly documented, although the significant volume of geological surveys done in the eastern parts of Eastern Stara Planina Mountain. A preliminary study of placer gold and platinum grains recovered from both river systems has been carried out.

Geological setting

The studied area is composed mainly of the Dvoynitsa and Dolni Chiflik Fms and situated in the easternmost parts of the Eastern Forebalkan and Balkan tectonic zones (Ivanov, 1998). The Dvoynitsa Fm comprises wide spectrum of redeposited rocks that consist of low- to high-density sandy turbidites, matrix- to clast-dominated sandy debrites and olistostromes with Paleocene–Middle Eocene age. The Upper Eocene Dolni Chiflik Fm is composed of medium-grained to gravelly sandstones with large-scale cross bedding, deposited in shallow-marine paleo-environment. The both units contain lithoclasts from the Srednogorie volcanics and rare igneous and metamorphic rocks, transported from the southern source area to the North.

Materials and methods

A total number of 12 heavy mineral concentrate samples from stream sediments were obtained from 2 sample sites – middle riverbed of Dvoynitsa River and her tributaries and the right-bank tributaries of Kamchiya River nearby the village of Goren Chiflik. About 150 gold and 30 platinum grains were recovered by panning and/or sluicing stream sediments. Gold or platinum grains have been observed in 2 sample points from right-bank tributary (Velikovska River) of the lower course of Dvoynitsa River, which

water come from outside the Dvoynitsa Fm. Selected gold and platinum grains were examined by means of JEOL-JSM 5510 Scanning Electron Microscope (SEM) at Sofia University (Faculty of Chemistry and Pharmacy) for grains size and morphology estimations. After mounted in epoxy and polished, gold and platinum particles were analyzed by means of two SEM with Energy Dispersive X-ray Spectrometry System – JEOL JSM-6010 PLUS/LA at the University of Geology and Mining (Bulgaria) and Zeiss EVO 60 MA 25 (Manheim, Germany) to obtain their chemical composition. Mineralogical determination of magnetic and non-magnetic fraction from heavy mineral concentrate was performed by using standard X-ray powder diffraction method employing XRD TUR M-62 with goniometer HZG-3 in Sofia University (Faculty of Geology and Geography).

Results and conclusions

The grain size of SEM studied gold and platinum grains from Dvoynitsa and Dolni Chiflik Fms varies between 100–400 μm . In most cases both display a high degree of mechanical processing. According to Zingg's shape classification (Zingg, 1935) gold and platinum grains are discoidal and bladed, which are typical shapes for alluvial and piedmont fan sediments (Wierchowicz, 2002). The calculated Flatness Index (FI, defined as $(L + b)/2t$, where L is length, b – width and t – thickness; Cailleux, 1947) of the gold grains displays ranges from 3.5 to 10.5. According to Hérail et al. (1990) most of the gold grains from the studied formations display signatures of relatively short fluvial transport (<2 km at FI=2–4), while few of them show long distance of fluvial transport (~30 km at FI=9). This recent study in addition to missing of ore deposits, geological setting and paleoevolution of the study area suggests that the clastic sedimentary rocks from both formations could be considered as a secondary source of placer gold and platinum.

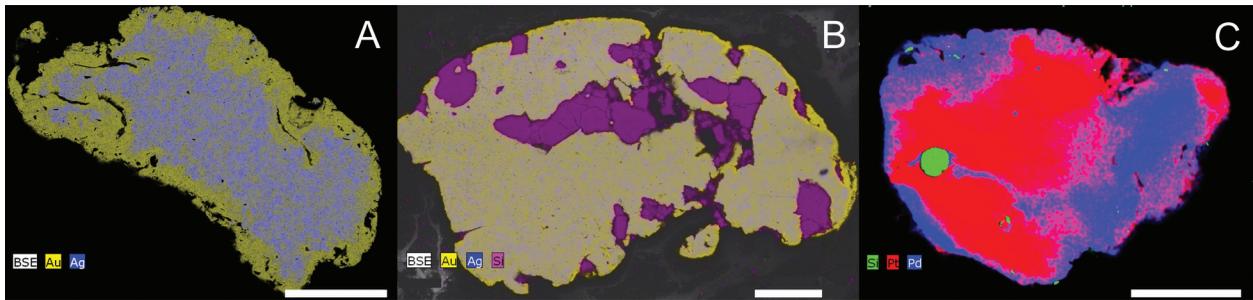


Fig. 1. Back-scatter images with element distribution map of: *A*, gold grain from Dvoynitsa River shows well-developed porous Ag (blue) leached rim with high Au (yellow) purity (>99 wt.% Au); *B*, electrum grain from Goren Chiflik sample site, which shows very thin Ag depleted rim and quartz (magenta) inclusions; *C*, platinum grain (red) with quartz inclusion (green) from Dvoynitsa River and distribution of palladium (blue). Scale bar: 200 μm

The gold grains from both formations display variable proportions of Au and Ag with trace amounts of Fe and Cu (<1 wt.% in total). Most of them have well developed, or partial Ag leached rims, with very high gold (>95 wt.% Au) and low silver (<5 wt.% Ag) contents, while their cores contain average 89 wt.% Au and 11 wt.% Ag (Fig. 1A). Despite few electrum grains (≥ 20 wt.% Ag, Fig. 1B), no significant difference in grains cores gold fineness from both formation have been observed. Quartz and pyrite inclusions are observed in single grains.

The platinum grains are composed mainly of Pt (avg. 93 wt.%), Fe (avg. 5 wt.%) and trace amounts of Rh and Pd (<2 wt.% in total). All platinum grains are homogeneous with two exceptions from the both sampling sites. The first one shows higher variations of Pd (4–12 wt.%) in peripheral grain parts (Fig. 1C), while rod-like, probably Os-rich bright inclusions have been observed under microscope in the other one.

The mineral composition of heavy mineral concentrate from both formations—consists of quartz, magnetite, garnets (mainly pyrope and almandine), ilmenite, feldspar and plagioclase, which are presented in all samples, while zircon and barite are subordinate. Calcite, monazite, pyrite and wüstite are rarely observed. The observed mineralogical assemblage indicates that besides sedimentary, magmatic and metamorphic rocks have also been

involved during the Paleogene sediments formation in the study area.

After the discovery of alluvial gold and platinum in the middle river bed of Dvoynitsa River, additional field studies and vertical pit sampling have been carried out in order to outline area ($\sim 1.2 \text{ km}^2$) for platinum-gold placer prospecting.

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