

K. Derevska<sup>1</sup>, Dr. Sci. (Geol.), Prof.,  
E-mail: zimkakatya@gmail.com;  
O. Aleksandrov<sup>2</sup>, Cand. Sci. (Geol.), Senior Researcher,  
E-mail: alex2ce@gmail.com;  
V. Berehovenko<sup>3</sup>, PhD student,  
E-mail: jkglok@gmail.com;  
M. Kovalchuk<sup>2</sup>, Dr. Sci. (Geol.), Prof.,  
E-mail: kms1964@ukr.net;  
K. Rudenko<sup>4</sup>, Cand. Sci. (Geol.), Senior Researcher,  
E-mail: rudenkoseniav@gmail.com;  
G. Silchenko<sup>5</sup>, Director,  
E-mail: sial202@gmail.com;  
R. Spytsia<sup>6</sup>, Cand. Sci. (Geogr.), Senior Researcher,  
E-mail: spytsyaroman@ukr.net;  
<sup>1</sup>National University of Kyiv-Mohyla Academy,  
2 Skovorody Str., Kyiv, 04655, Ukraine;  
<sup>2</sup>Institute of Geological Sciences of the NAS of Ukraine,  
55 b O. Gonchar Str., Kyiv, 01601, Ukraine;  
<sup>3</sup>State Scientific Institution "Center for Problems of Marine Geology,  
Geoecology and Sedimentology y Ore Formation of the NASof Ukraine",  
55b O. Gonchar Str., Kyiv, 01601, Ukraine;  
<sup>4</sup>The National Museum of Natural History at the NAS of Ukraine,  
15 B. Khmelnitsky Str., Kyiv, 01030, Ukraine;  
<sup>5</sup>Geological company "Geomandry",  
Ap. 115, 2 Entusiastiv Str., Kyiv, 02154, Ukraine;  
<sup>6</sup>Institute of Geography of the NAS of Ukraine,  
44 Volodymyrska Str., Kyiv, 01030, Ukraine

## PROSPECTS OF THE DNIESTER RIVER FLOODPLAIN TERRACES STRATA FOR GOLD MINERALIZATION

(Представлено членом редакційної колегії д-ром геол. наук, проф. В.А. Михайлівим)

Despite long-term geological study of the Dniester River basin, we still have no clear evidences about gold-bearing potentiality of this area as well as origin of gold. The leading role of geological, geochemical and mineralogical criteria is proved for defining the prospects of substantial gold deposits finding within the Dniester river basin. Gold was found here in the crystalline basement and in the sedimentary cover rocks. Study of mineralogy and lithology of the terraces above the flood-plain and typomorphic peculiarities of native gold shows that palaeogeographic conditions and alimentation zones of debris vary at the different tectonic stages of this area development. Gold-bearing potential of the Pliocene-Quaternary sediments in the Dniester River basin is related to the Pliocene (VI-IX terraces above the flood-plain) and Quaternary (I-V terraces above the flood-plain) terraces complex of the Dniester river, as well as this river and its inflows recent alluvia.

Our study of the Mid-flow part of the Dniester river basin allow to conclude that native gold was found in geological strata of all ages, from Proterozoic up to the recent alluvium. This fact points the necessity of further prospecting to find the mother lodes of gold. Our field study, samples analyses made as well as publications observation allow highlighting the principal directions of further prospecting and evaluation works. The main among that are: 1) comprehensive study of river Dniester alluvia and its terraces complex (previously VI-VII terraces), that will allow to specify their material composition, to assess real gold-bearing potential and to define the history of denudation areas changes; 2) lithogeochemical prospecting of primary and secondary dispersion haloes to clear the principal gold-bearing regularities; 3) definition of prospect plots within the area described; 4) modern analytical approach study of typomorphic peculiarities of native gold from alluvia and terrace deposits to define its ore formational affinity and mineral type.

**Keywords:** gold, Dniester river basin, floodplain terraces.

**Actuality.** Gold-bearing potential of the Dniester River and its left inflows alluvium as well as the Dniester terrace complex is an object of great interest to study. Sedimentary rocks contain native gold here and they can be indicators of the ways of gold palaeotransportation into the Dniester alluvium during various stages of the river system neotectonic history.

Terraces complex study is always very important task during geomorphological and palaeogeographic research. River terraces are indicators of climate conditions changes and tectonic movements. Alluvial deposits terraces are the principal instrument for stratigraphic correlation of distant continental deposits sections of different structural position and conditions of their formation. The latter can be reconstructed with the aid of deposits correlation.

**The purpose of our researches** is the study of VI and VII floodplain terraces alluvial deposits to clear these gold-bearing potential.

**A brief description of the territory studied geological structure.** Ancient Podolska fault zone of NW strike is the principal tectonic element that determines the structure of whole studied region. Width of this zone reaches 50 km, in contrast vertical movements are not exceed 50 m. Faults of this zone are indistinct on the surface and in the drillholes

core. These faults appear as intensive fracture areas and minor thick mylonite sows of slip type in the sedimentary cover. Mylonites and cataclastic rocks are prevalent along with contacts of Bugska series metamorphic rocks and granitoids of Lower Proterozoic Berdychivskyy complex. Other large faults are sublongitudinal Odesskyy (near Chernovoznamenka village) as well as NE zone of Nemyrivskyy fault (near Soroka town) and Pereddnistrovskyy (in vicinity of Yampol town). All the faults were re-activated many times during the platform cover formation. More comprehensive structure of studied region appears after geophysical and remote sensing data interpretation.

**Previous researches for gold-bearing prospects within the river Dniester basin.** Gold prospecting in the river Dniester basin upper flow started only after the World War II. Contribution of V.D. Salnikovin, 1964, V.V. Grytsykin, 1971, V.T. Kardashin, 1972, 1974, V.O. Ageevin, 1982, Yu.O. Averin, 1988, V.K. Iatsunin, 1997 deserve to be highlighted. Gols was found in conglomerates in the Truskavets base metal deposit, in contrast the alluvium of Dniester and its inflows show only 1-2 signs of gold.

New stage of geological study of the river Dniester basin mid flow started at 60's of XX century engaging drilling and geological mapping in 1 : 200 000 i 1 : 50 000 scales along

with prospecting, particularly for gold (Arkhanhelskaia, 1983; Bratslavskyi et al., 1983; Velykanov et al., 1968; Nechaevev and Afanasev, 1990; Latsun, 1997 and many other researchers). Generally geological studies revealed great prospect for various minerals within the Dniester Peri-Cratonic Belt.

Various aspects of stratigraphy, lithology, tectonics, metallogenesis of this region are highlighted in numerous papers and monographs, in part by V.V. Arkhangelska, O.O. Aseeva, P.D. Bukatchuk, M.F. Veklich, V.Ya. Velykanov, K.I. Derevska, R.M. Dovhan, A.Ya. Drevin, E.Ya. Zhovinskyy, V.S. Zaika-Novatskyy, M.S. Kovalchuk, G.S. Kompanets, L.I. Konstantinenko, L.V. Korenchuk, S.V. Nechaevev, V.M. Pavliuk, O.V. Pavliuk, V.A. Prysyazhnyuk, A.Ya. Radzivill, V.O. Shumlianskyi (Velykanov et al., 1968; Shumlianskyi and Derevska, 1995; Derevska, 1992, 2008; Dovhan et al., 2002; Pavliuk et al., 2008; Kovalchuk et al., 2001, etc.).

V.Ya. Velykanov firstly found gold placer in the Dniester river bed as well along the Derla and Nemiya rivers (Mohyliv-Podiskyy concentrate halo) using panning and geochemical method (Velykanov et al., 1968). Gold content reaches 2,8 g/m<sup>3</sup> in some samples (State geological map, 2007). M. Ianhycher also gave positive assessment of gold prospects for recent alluvium in the Mohyliv-Podiskyy area. He found association among gold, cinnabar and realgar in the heavy mineral concentrates. Thematic researches and searching for flint by Piyar et al. (1972) found gold in the alluvial deposits of II-III and V floodplain terraces.

V.K. Latsun (Latsun, 1997) found Naddnistryanskyy, Dereshivskyy and Rozdolivskyy gold occurrences in the

Pliocene floodplain terraces. R.M. Dovhan and V.M. Pavliuk (Dovhan et al., 2002; Pavliuk et al., 2008) gave great contribution to the gold-bearing study in the Dniester River basin mid-flow. They ascertained prospective plots for gold and described prospective geological formation units.

Prospects of Western Black Sea Area for gold were studied by Ye.F. Shnyukov in 1999, 2000 and O.O. Yushin in 1998–2005. Today this territory is considered as prospective for thin and dispersed gold. Prospects for gold of the *Dniester River lower flow (from Rybnitsa town to the Dniester estuary)* is not clear today.

Thus, studies in the region described reveal gold mineralization in the Pliocene-Quaternary alluvium of the river Dniester and its inflows along with significant distance – from Zalishchyky town to Mohyliv-Podiskyy town (Fig. 1). Two large prospective areas are ascertained – Melnitsa-Podilska and Mohyliv-Podilska. Inside these areas some plots are found, where native gold content in the Pliocene-Quaternary deposits is increased. Gold extent and its content in the alluvium grow from 13 mg/m<sup>3</sup> to 32,1 mg/m<sup>3</sup> in the meanders (Derevska, 2008).

Clastic gold in association with siver sulphosalts, galena, led tellurides and chalcopyrite is present in terrigenous deposits of Mohyliv series of Middle Dniester Vendian that overlays flood basalts or crystalline basement. More significant concentrations of native gold in association with galena, sphalerite, cinnabar and auripigment are found in the recent alluvium of the Dniester River and its inflows (Derevska, 2008).

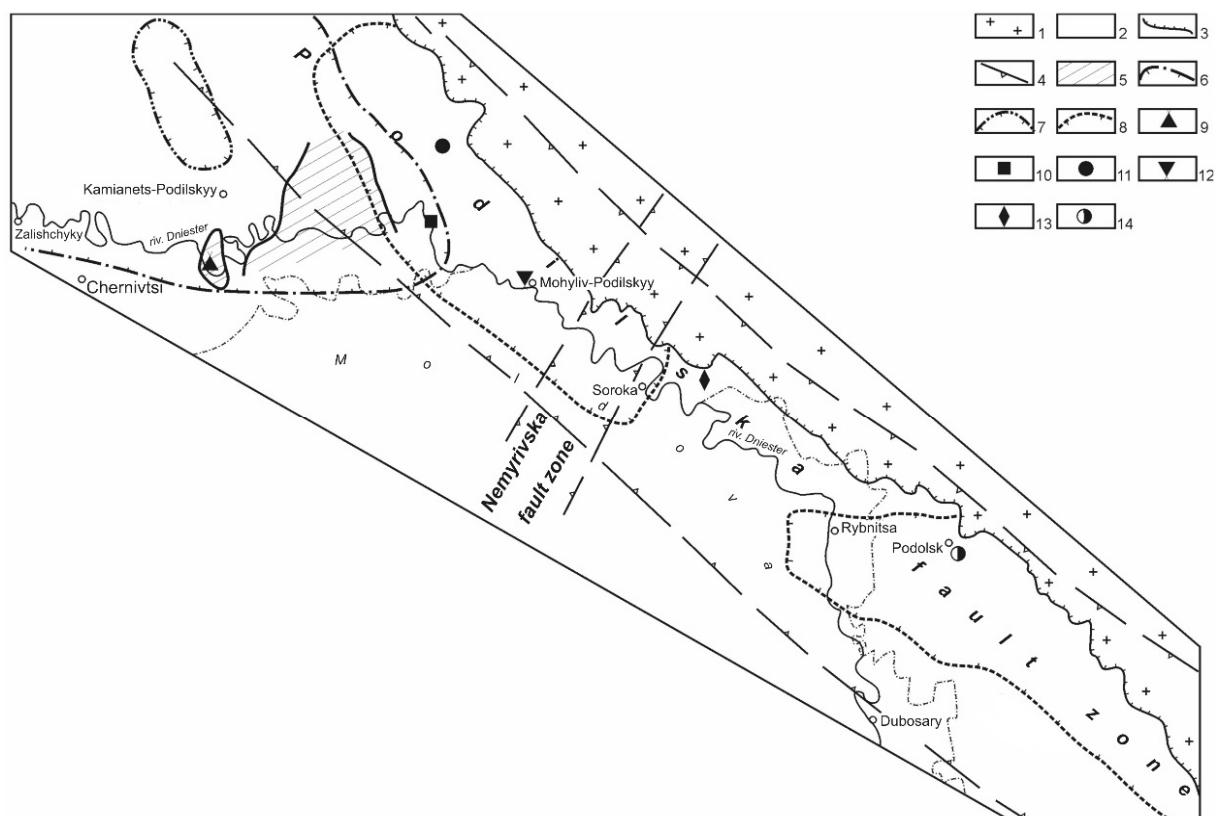


Fig. 1. The schematic map of minerals and ores distribution in the Dniester river basin mid-flow (using (Derevska, 2008)):

1 – crystalline rocks of the Ukrainian shield; 2 – sedimentary deposits of the platform cover; 3 – the platform cover boundary; 4 – edge faults of the Podilska and Nemyrivska fault zones; 5 – flint beds distribution in the Upper Cretaceous deposits;

6 – phosphorites distribution in the Vendian and Cenomanian deposits; 7 – area of lead, zinc and barite (fluorite) occurrences in the Cambrian, Ordovician and Silurian deposits; 8 – barite-fluorite-base metal ore formation occurrences in the rocks of the crystalline basement and Vendian deposits; 9 – Grinchutske flint deposit; 10 – Zhvanske phosphorite deposit; 11 – Bakhtynske fluorite deposit;

12 – maximum gold concentration in the Neogene-Quaternary alluvium of the Dniester river;

13 – the Velykokosnytskyy occurrence of bauxites; 14 – the Kotovskyy barite-base metal occurrence

Rocks of the Archean-Lower Proterozoic crystalline basement generally content a Clarke amount of gold (75 % samples content gold 3 mg/t and less). Detrital sediments of Riphean Soroksa suite are featured by increased gold content. The most stable content of gold show Riphean Kamianska suite basalts (up to 10 mg/t). Significant geochemical anomaly of gold is located between Rybnitsa and Kotovsk towns coinciding with the area of basalts extension. Here content of gold is up to 30 mg/t in all of the platform cover suites. Native gold of this plot show low content of silver (3,5–3,8 %) and led (0,05–0,15 %) (Derevska, 2008).

Native gold is found in all geological units, from Proterozoic to the recent alluvial deposits within the Dniester Peri-Cratonic Belt, so the necessity of further prospecting is evident.

**The problems that are still unsolved.** Despite long-term geological study of the Dniester river basin (deep geological mapping, searching for mercury, diamonds, thematic researches for gold etc.), we still have no clear evidences about gold-bearing potentiality of this area as well as origin of gold. The gold occurs both in the crystalline basement rocks and in the deposits of sedimentary cover, as well as in the floodplain terraces complexes and in the recent alluvium of the river Dniester and its inflows. Besides that, hydrothermal processes are widespread in the various range tectonic faults and on the contacts of different origin rocks. This derives from complex geological and tectonic structure of the region with multiple neotectonic movements.

**Presentation of the main material.** The territory of the Dniesterian depression has a complex geological and tectonic structure. It is distinguished by various stratigraphic formations, the presence of stratotypical sections and rare outcrops, and a wide range of metallic and non-metallic minerals.

The explored territory is located within the Podolian Upland, which is deeply dissected by the river valleys, ravines and gulches. The main water artery of the region is the Dniester river, which forms a canyon-shaped valley. Together with its inflows, this river interposes into the rocks

to a depth of 200 m. The inflow of the different age alluvial deposits can be explained by the complicated geological structure and a considerable length of the area.

The overall picture of exploration maturity of these territories is presented in the table of the prospective zones for the gold search (Table). The results of studies indicate the gold-bearing material distribution heterogeneity due to the different tectonic structure and the lithology of deposits.

It is worth pointing out that the main gold-bearing areas are confined to the territories of the Vendian terrigene deposits and the Upper Pliocene terraces of the Dniester River extension. In addition to the basic data on promising areas, information is also provided on test methods and concentration of gold in samples. According to the gold spectral analysis of the bottom sediments of the Dniester basin rivers, 17 gold haloes were found (Nechaiev and Afanasieva, 1990).

According to the given data, it can be asserted that the prospect of the Dniester basin mid-flow in search of industrial occurrences of gold is also related to the geochemical and mineralogical features: 1) the presence of gold with different typomorphic features in the alluvium of the Dniester and its inflows, which points to the diverse sources with distinct genesis and age; 2) the presence of associated minerals (realgar, auripigment, cinnabar, galena, sphalerite), which are unstable in exogenous conditions and cannot be transported over long distances, which indicates points to the local sources of indigenous gold or its interjacent collectors; 3) the presence of geochemical anomalies of gold and its indicator elements both in the crystalline rocks of the basement and sedimentary cover.

The gold-bearing of the Pliocene-Quaternary deposits in the Dniester basin mid-flow is related to the Pliocene (VI-IX floodplain terraces) and the Quaternary (I-V floodplain terraces) terrace complexes of the Dniester river and the modern alluvium of the Dniester river and its inflows.

Table

The features of the sites explored for gold in 1968–2002  
(compiled using (Bratslavskyi et al., 1979, 1983; Derevska, 1992; Dovhan et al., 2002; State geological, 2007; Velykanov et al., 1968; also Ishchenko et al. (2000); Kovalev (1990); Lavrov et al. (1972); Zhylytskyi and Zhylytskaia (1981)

No	Name of location	Location	Host rocks	Au content, g/t
1	Derlivskyy occurrence	The lower part of the Derlo river, Karpivka village	1. Alluvium of the river channel, Vendian terrigene deposits	0,1–0,2 to 1
			2. Argillites and siltstones of the Lomozivsky layers	0,175 0,005
			3. Yampil'skyy sandstone	0,01–0,07 0,01–0,02
2	Liadova river basin	Liadova and Derlo rivers basins	1. Alluvium of the river channel, Vendian terrigene deposits	0,005–0,5
			2. Conglomerates, multicolor breccia	Up to 0,175
			3 Grushkynska suite deposits	0,005–0,1
			4. Light gray feldspar-quartz sandstone of the Olchedayiv Beds	0,001–0,04
3	Nemyska area	Lower flow of the river Nemya, villages Nemya and Ozaryntsi	Crystalline rocks, sedimentary deposits of the Vendian	0,01–0,05
4	Dereshivskyy occurrence	Upper flow of the river Zhvan, Dereshova village	Alluvium of river channel, Vendian terrigene deposits	0,005–0,1
5	Naddnistrianskyy occurrence	Lower flow of the river Materka, near Naddnistrianske village	Terrigene deposits of the Pliocene terraces, Vendian rocks, crystalline rocks	0,05–0,2
6	Karaietskyy occurrence	Lower flow of the river Karaiets, toward the South from Perekoryntsi village	Alluvium of river channel	0,01–0,02
7	Mohyliv-Podilskyy region	Middle flow of the Dniester river	1. In basalts	0,005–0,007
			2. In chalcedony-like light gray pebble from the Cretaceous deluvium	0,3

The ancient Pliocene terraces of the Dniester are represented by the formations of the river bed (sandy lithotypes) and floodplain (clay lithotypes) facies and are distributed on the watersheds of Nichlava-Zbruch rivers (VI–VII terraces), in the interfluvia of Studenytsha-Zhvan and

Liadova rivers, Derlo river (VI–IX terraces) (Dovhan et al., 2002; State geological, 2007; Tomenyuk, 2012). In the bottom of the terrace deposits lie pebble-beds and boulders. Pebbles are represented mainly by sandstones, flint, limestone, quartz, jasper flint, and chalcedony. Below we present the

description of alluvial deposits of the Dniester terraces on the basis of data collected. Sands are from fine to coarse-grained, argillaceous, horizontally – and crossbedded, brownish-yellow, yellow-gray, sometimes contain layers and lenses of clay and pebbles in the size of 1–10 cm. The sands are overlapped by floodplain clays, which are aleuritic, dense, viscous, brownish-gray, red-brown, brown. The thickness of the Pliocene terraces is different: VI terrace – up to 10,0 m, VII terrace – up to 30 m. Alluvial deposits of the V terrace are represented by pebbles (well-rounded pebbles of sandstones, siltstones, limestones, and flint); inequigranular sands, horizontally- and crossbedded, gray, brownish-yellow, red-brown with pebbles, gravel, and, occasionally, clay lenses. The average thickness of deposits is 13 m.

Alluvial deposits of the IV floodplain terrace are represented by inequigranular sands, horizontally- and crossbedded, gray, yellowish-gray, with rare clay lenses and pebbles with sand aggregate (well-rounded pebbles of sandstones, limestones, and flints in the size of 5-10 cm) and sandy loams.

Alluvial deposits of the III floodplain terrace are represented by pebbles (well and slightly rounded pebbles of Silurian limestones and Cretaceous flints up to 5 cm in size); inequigranular sands, horizontally- and crossbedded, gray, heavily ferruginized, with the inclusion of fine pebbles, with clay lenses and sandy loams. The thickness of deposits is up to 15 m.

Alluvial deposits of the II floodplain terrace are represented by pebbles with grains of sandstones, siltstones, limestones, dolomites, sometimes flints, with layers and lenses of sand; inequigranular sands with gravel and pebbles; loams with layers and lenses of fine-grained quartz sand with pebbles. The thickness of deposits is up to 10 m.

Alluvial deposits of the I floodplain terrace are represented by pebbles (grains of limestones, dolomites, flints); fine to medium-grained sands, gray, sometimes ochred, with rare inclusions of pebbles and slightly rounded debris of limestones, dolomites and flints; loams yellow-brown, with a rare pebble and slightly rounded fragments of sandstones, limestones, flints, as well as sand and clay lenses. The thickness of sediments is up to 20 m.

Alluvial deposits of the Dniester and its inflows are represented by poorly sorted boulder-pebble and sand-clay slightly ferruginized deposits with humus. The thickness of deposits in the Dniester is up to 20 m.

The formation of the terraces of the Dniester river valley (according to A. Bogutsky, A. Yatsyshyn) occurs due to the periodic repetition of tectonic movements. They are subject to cyclic physical-geographical changes.

Analysis of pebbles and sandstones of terrace complexes allowed R.M. Dovgan to conclude that the sandstones of the ancient and young Dniester terraces are characterized by a set of chemical elements and have a different origin. Sandstones of young terraces are divided into three groups: brown, gray "strontium" and gray "lithium", among which the latter have an increased gold content; Vendian, Silurian, and Cenomanian sandstones differ from terrace sandstones and could not be a source of material for the terrace complex (except the youngest); the older terraces are, the more pebbles of metamorphic rocks they have (Dovhan *et al.*, 2002).

The sizes of gold grains from the Dniester and its inflows, ranging from Zalishchiky to Stara Ushitsya, are 0,1–0,3 mm. In the left inflows of the Dniester, the size of the grains of gold is more variegated: in the alluvium of the rivers Seret and Nichlava it is up to 0,15 mm, when in the rivers Zbruch, Zhvanchik, Smotrych and within the Mohyliv-Podilsky site – more than 0,3 mm; gold in the size of more than 0,5 mm was found within the Melnytsya-Podilska and Mohyliv-

Podilskyy sites, and the areas of crossing of the rivers Zbruch, Smotrych and the Dniester of Tovtrova ridge (Dovhan *et al.*, 2002).

The color of the majority amount of gold grains is yellow with reddish, rarely greenish shades. According to M.S. Kovalchuk (Kovalchuk *et al.*, 2001) the color of gold from the alluvium of the Dniester and its inflows firstly depends on the chemical composition. High karat gold has a golden-yellow color. Depending on the content of silver, the color changes from greenish-yellow to dark green-yellow, and from the content of copper – from greenish-yellow to reddish-yellow. In the segment from Zalishchiky to Stara Ushitsya, gold in the alluvium of the Dniester is mostly dark yellow, red-yellow. Also, there is gold with greenish shades, which has a significant distribution within the Melnytsya-Podolska site. In the left inflows of the Dniester river in the area from Seret to Smotrych, the color changes from red to green-yellow, while in the Mohyliv-Podilsky site globular and lumpy gold grains enriched with copper have a reddish-yellow color, while lamellar gold has a greenish tinge (Dovhan *et al.*, 2002).

Analysis of the materials regarding the lithologic and mineralogical composition of the floodplain terraces, typomorphic features of native gold allows us to assert that paleogeographic conditions and source areas of clastic material have been changed during development of the Dniester river valley at various tectonic-geomorphological stages.

It is noteworthy that the main gold-bearing areas are confined to the territories of the Vendian terrigene deposits extention and the Upper Pliocene terraces of the Dniester River.

Recent years, the use of natural building materials has become more intense. So-called "Carpathian pebble" of two oldest terraced levels – the VI and the VII terraces of the Dniester river valley – is actively mined (legally and illegally). This led to the formation of deep and branched quarries near Novosilky, Goligrady, Kulakivtsi, Synkiv, Isakivtsi, Tsviklivtsi villages. Mining works opened new outcrops, the study of which may serve as a basis for the continuation of the prospecting and evaluation works on placer gold.

To study the gold content, lithologic, mineralogical and geochemical features of the terrace deposits, we chose the strata in the Dniester middle flow, where the sixth terrace outcrop. The corresponding territory is clearly traced by an intermittent band from the village Novosilky (high left bank of the Seret river) to the village Tsviklivtsi (the left bank of the Dniester river). There are shallow excavations (up to 3 m) near the village Goligrady on the left steep high bank of the Seret River, in which the alluvial deposits of the sixth terrace outcrop. They are represented by the interlayers of pebble material and light sand with red-yellow to dark brown lenses. There are sandy deposits with well-rounded inequigranular, mostly light-gray "Carpathian" pebbles (often with traces of "desert tan") at the base of the excavation.

Near village Kulakivtsi (left side of the road to the village Synkiv), gravel-pebble construction material excavations reveal the outcrop of the sixth terrace of the Dniester (Fig. 2). The geological section is represented by a thick layer of pebble material with lenses or layers of light-gray sand. There are white and red spots at the top of the profile. Alluvial deposits are covered with a layer of gray-yellow sand with rare inclusions of pebbles and gravel (up to 25 cm), and higher in the profile river deposits are covered with loams (up to 15 cm). Above is a 10-centimeter layer of podzolized soil. The quarry with steep walls covers an area of about 3 hectares, has a depth of up to 3 m, is partially covered with garbage, overgrown with shrubs and weeds. Currently, the object is abandoned and not recultivated. Samples weighing about 80 kg were collected here for granulometric, heavy minerals concentrate and geochemical analyses.



Fig. 2. Outcrop of the sixth terrace of the Dniester near village Kulakivtsi

Alluvial deposits from the Dniester river were also studied near the village Isakivtsi between two inflows of the Dniester river – Zbruch and Zhvanchyk. Here, due to the extraction of gravel, a geological section of about 20 m height is revealed. In the base of this section there are dense conglomerates, which are cemented with clay material and contain fauna fossils. The well and slightly rounded fragments in the size from 2–5 to 10 cm are represented by flints, jasperoids, argillites, sandstones, coal shales, etc., as well as the remnants of Sarmatian shells. Above is the layer of coarse-grained, light, striped sand with layers of sand formations of brown color (IV–V terraces of the Dniester). Above, the strata of so-called "Carpathian" pebbles is determined, the deposits of which belong to the sixth terrace of the Dniester River. In the upper part of the profile, sedimentary deposits are brownish-red due to high iron content. Samples of about 60 kg total weight were taken for further research.

Analytical study of the sedimentary rocks was carried out in the laboratories of Kyiv and Kryvyi Rih.

Lithologic-mineralogic sampling with alluvium enrichment was held on in the laboratory of the Center for problems of marine geology, geoecology and sedimentary ore formation of the NAS of Ukraine, Kryvyi Rih (analyst V. Ivanchenko). Polymetallic sedimentary deposits of the Dniester mid-flow VI, V and IV floodplain terraces have high content of heavy minerals, such as almandine, ilmenite, zircon, monazite, iron oxides etc. So, this deposit was enriched with the method of multistage dry separation with subsequent withdrawal of several concentrates. These contain gold that appears as thin and dispersed gold (about 90 % of its total amount). Minor amount of mineralogical-geochemical studies was based on mineral composition of gravel-pebble, sandy and clay-carbonaceous material from Pliocene terraces and their basement. Analysis of clay-carbonaceous material of the Lower Sarmatian deposits basal level shows presence in the fine fraction of garnet, zircon, monazite, native gold and copper, apatite, pyrite, iron globules (Fig. 3).

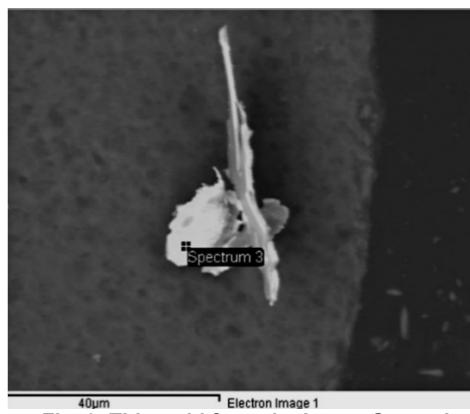
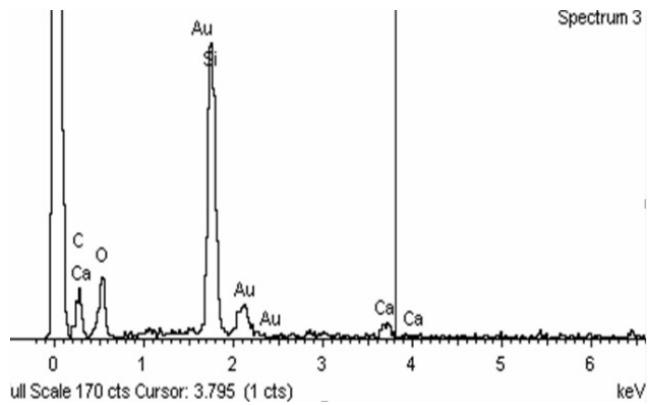


Fig. 3. Thin gold from the Lower Sarmatian deposits, silt. Basal level of the VI terrace, Dniester mid flow



**Perspective directions of research.** Our field and analytical studies, analysis of geological reports and scientific publications made it possible to distinguish the main ways of further geological work, mainly within the VI–IV terraces of the middle Dniester:

1. Study of alluvial formations of the Dniester river basin and its terrace complex will clarify their material composition,

find out the extent of gold-bearing, and define a change in the disintegration areas in time.

2. Geological-mineragenetic mapping of the Dniester left inflows of using the heavy minerals concentrates analysis.

3. Lithochemical and geochemical searches of gold mineralization after anomalies and elements dispersion halos, as well as the definition of general principles of gold

distribution for distinguishing prospective sites within the research territory.

4. Hydrochemical searches for hydrochemical anomalies of native and other metals in surface waters.

5. Study of typomorphic features of native gold using modern analytics for defining its ore-formational affiliation and mineral type.

The beginning of this research was started by the authors of this paper.

Outlined directions of further research allow focussing on specific search tasks.

**Conclusions.** Completed own field and analytical studies, analysis of geological reports and scientific publications in the context of studies of alluvium gold-bearing and terrace complexes within the Dniester river basin allowed to make the following conclusions.

1. Mid-flow Dniester area is the most comprehensive studied for gold bearing within whole Dniester river basin. This area is a potentially gold-bearing region that yet requires the detailed search work for the 6th and 7th terraces, and the buried ancient channel of the Dniester, as the golden occurrences are associated with the ancient alluvial river deposits (for example, Alaska deposits, Canada, etc.).

2. It is determined that the buried gold in the Dniester basin is distributed randomly and unevenly, thus, it is not possible to allocate prospective areas and forecast sites rich of gold ore. However, new data obtained, new methodological approaches and searching criteria will perform more efficient assessment of prospects for gold and prospecting works.

3. Prospects of the territory for detection of ore occurrences and deposits of gold are associated with: the geotectonic position of the territory and the history of its geological and tectonic development, paleogeographic conditions for the formation of gold-bearing and potentially gold-bearing sedimentary deposits, lithological rocks composition, conducive for concentration of gold (syn-sedimentary and hydrogene), as well as with the processes of eometamorphism and hydrothermal activity (due to the renewal of tectonic fault zones).

4. The main areas of further exploration and evaluation works are: a detailed study of the alluvial formations of the Dniester and its terrace complex (mainly VI-IV terraces), which will clarify their material composition, define the extent of gold-bearing and a change in the denudation areas in time; lithogegeochemical searches after primary and secondary dispersion haloes to find out the general principles of the distribution of gold content; selection of perspective sites within the territory of the research; the study of typomorphic features of native gold from alluvial and terrace deposits using modern analytics for defining its ore-formational affiliation and mineral type.

#### Список використаних джерел

Архангельская, В.В. (1983). Геологическое строение и свинцово-цинковое оруденение Подольско-Приднестровского рудного района. *Ізв. АН СССР, сер. геологическая*, 6, 35-38.

Брацлавский, П.Ф. и др. (1983). Отчет о результатах среднемасштабного глубинного геологического картирования юго-западного склона Украинского щита м-ба 1 : 200 000 в пределах листов М-35-XXVII, -XXVIII, -XXXIV, -XXXV (Подольская тектоническая зона). Фурсы.

Великанов, В.А. и др. (1968). Отчет Приднестровской ГСП Побужской ГЭ о работах по геологической съемке м-ба 1 : 50 000 и структурно-профильному бурению, проведенных в Среднем Приднестровье в 1964-1968 гг. (Территория листов М-35-115-А, -Б, -Г, -116-В, 128-А, -Б, -В (сев. половина).

Державна геологічна карта України масштабу 1 : 200 000. Волино-Подільська серія. Арукши: М-35-XXVIII (Бар), М-35-XXXIV (Могилів-Подільський) (2007). Пояснівальна записка. К. : Міністерство охорони навколошнього природного середовища України. Державна геологічна служба. УкДГРІ.

Деревская, Е.И. (1992). Минеральный состав и условия образования барит-флюорит-полиметаллической формации Подольской зоны разломов. *Автореф. дис. ... канд. геол.-мин. наук: 04.00.11. Киев.*

Деревська, К.І. (2008). Палеогеотермальний режим літогенезу та гіпогенного рудоутворення в межах Балтійсько-Дністровської перикратонної зони прогинів у ріфей-фанерозої. *Автореф. дис. ... д-ра геол. наук: 04.00.21. Київ.*

Довгань, Р.М., Павлюк, В.М. та ін. (2002). Складання прогнозно-мінерагічної карти масштабу 1 : 200 000 на золото Середнього Придністров'я. *Звіт Правобережної геологічної експедиції за 1992-2002 pp. Київ.*

Коваленко, Д.М., Латыш, И.К. (1973). О золотоносности фосфоритоносных отложений Украины. *Геол. журн.*, 6, 145.

Ковальчук, М.С., Квасниця, В.М., Довгань, Р.М., Павлюк, В.М., Деревська, К.І. (2001). Морфогенетична класифікація розсипного золота з алювіальних відкладів р. Дністер. *Геол. журн.*, 3, 30-40.

Мельничук, В.Г. (2012). Золото як перспективний ресурс у надрах Волинського регіону. *Природа Західного Полісся та прилеглих територій*, 9, 23-30.

Нечаев, С.В., Афанасьев, И.М. (1990). Золотоносность и рудная минерализация краевых зон УЩ и его обрамления. *Отчет. Киев.*

Павлюк, В.М., Довгань, Р.М., Павлюк, О.В. (2008). Золотоносность Могилів-Подільської площі (Середнє Придністров'я). *Записки Українського мінералогічного товариства*, 5, 84-95.

Томенюк, О. (2012). Геоморфологічні дослідження професора Юрія Полянського. *Матеріали і дослідження з археології Прикарпаття і Волині*, 16, 504-518.

Шумлянський, В.А., Деревська, Е.І., Квасниця, В.Н. (1995). Золотоносность ріфей-вендських образований Среднего Приднестровья. В кн.: Золотоносность осадовых и метаосадовых комплексов Украины. Київ. *Наукове видання ІГН НАНУ*, 34-37.

Яцун, В.К. (1997). Оцінка ступеню золотоносності піщано-глинистих відкладів кар'єрів будівельного каменю і піщано-гравійних сумішей Карпат та Придністров'я. *Звіт. Київ.*

#### References

Arkhangelskaia, V.V. (1983). Geologicheskoe stroenie i svintsovotsinkovoe orudenie Podolsko-Pridnestrovskogo rudnogo rayona. *Izvestiia AN SSSR*, 6, 35-38. [In Russian]

Bratslavskyi, P.F. et al. (1983). Otchet o rezulatah srednemasshtabnogo glubinnogo geologicheskogo kartirovaniya yugo-zapadnogo sklona Ukrainskogo schita m-ba 1:200 000 v predelakh listov M-35-XXVII, -XXVIII, -XXIX, -XXX (Podolskaya tektonicheskaya zona). Fursy. [In Russian]

Derevska, K.I. (1992). Mineral composition and condition of formation of barite-fluorite-polimetal ore formation. *Extended abstract of Candidate's thesis (Geol. Sci.: 04.00.11)*. Kyiv, Institute of Geochemistry, Mineralogy and Ore Formation, NAS of Ukraine. [In Russian]

Derevska, K.I. (2008). Palaeothermal conditions of Riphean to Phanerozoic lithogenesis and ore formation within the Baltic-Dniester peri-cratonic belt. *Extended abstract of Doctor's thesis (Geol. Sci. 04.00.21)*. Kyiv, Institute of Geological Sciences, NAS of Ukraine. [In Ukrainian]

Dovhan, R.M. et al. (2002). Skladannia prohnozno-minerahenichnoi karty mashtabu 1: 200 000 na zoloto Serednogo Prydnistrovia. *Zvit Pravoberezhnoi heolohichnoi ekspeditsii za 1992-2002*. Kyiv. [In Ukrainian]

Iatsun, V.K. (1997). Otsinka stupenu zolotonosnosti pishchano-hlynyistykh vikladiv karyeriv budivelnogo kamenu i pishchano-hravivnykh sumishey Karpat ta Prydnistrovia. *Report. Kyiv.* [In Ukrainian]

Kovalchuk, M.S., Kvasnytsia, V.M., Dovhan, R.M., Pavliuk, V.M., Derevska, K.I. (2001). Morfogenetichna klasififikatsia rozsypnogo zolota z aliuvalnykh vikladiv r. Dnister. *Geological Journal*, 3, 30-40. [In Ukrainian]

Kovalenko, D.M., Latyshev, I.K. (1973). O zolotonosnosti fosforitonosnykh otlozheniy. *Geological Journal*, 6, 145. [In Russian]

Melnychuk, V.G. (2012). Zoloto yak perspektivnyi resurs u nadrakh Volynskoho rehionu. *Nature of Western Polesie and surrounding areas*, 9, 23-30. [In Ukrainian]

Nechaev, S.V., Afanasiev, I.M. (1990). Zolotonosnost i rudnaya mineralizatsiya kraevykh zon USCh i ego obramleniya. *Report. Kyiv.* [In Russian]

Pavliuk, V.M., Dovhan, R.M., Pavliuk, O.V. (2008). Zolotonosnost Mohyliv-Podilskoi ploschchi (Serednje Prydnistrovia). *Notes of the Ukrainian Mineralogical Society*, 5, 84-95. [In Ukrainian]

Shumlianskyi, V.A., Derevska, E.I., Kvasnytsia, V.N. (1995). Zolotonosnost rifej-vendskih obrazovaniy Srednego Pridnestrovya. In: *Gold of the sedimentary deposits of Ukraine. Kyiv. Nauk. Vyddannia IGN NANU – Scientific Edition of the IGN NAS of Ukraine*, 34-37. [In Russian]

State geological map of Ukraine, scale 1: 200 000. Volyn-Podilsky series. Sheets: M-35-XXVIII (Bar), M-35-XXXIV (Mohyliv-Podilsky). (2007). Explanatory note. Kyiv: Ministry of Environmental Protection of Ukraine. State Geological Service. [In Ukrainian]

Tomenyuk, O. (2012). Heomorfolohichni doslidzhennya profesora Yuriya Polyanskoho. *Materials and Research on Archeology of the Precarpathians and Volynia*, 16, 504-518. [In Ukrainian]

Velykanov, V.A. et al. (1968). Otchet Pridnestrovskoy GSP Pobuzhskoy GE o rabotah po geologicheskoy s'emeke masshtaba 1:50 000 i strukturno-profilnomu bureniju, provedennyih v Srednem Pridnestrove v 1964-1968. (Territoriya listov M-35-115-A, -B, -G, -116-B, 128-A, -B, -V (sev. polovina). Kyiv. [In Russian]

Надійшла до редколегії 29.03.20

К. Деревська<sup>1</sup>, д-р геол. наук, проф., E-mail: zimkakaty@gmail.com;  
 О. Александров<sup>2</sup>, канд. геол. наук, старш. наук. співроб., E-mail: alex2ce@gmail.com;  
 В. Береговенко<sup>3</sup>, асп., E-mail: jkglok@gmail.com  
 М. Ковальчук<sup>2</sup>, д-р геол. наук, проф., E-mail: kms1964@ukr.net;  
 К. Руденко<sup>4</sup>, канд. геол. наук, старш. наук. співроб.,  
 E-mail: rudenkokseniav@gmail.com;  
 Г. Сильченко<sup>5</sup>, директор, E-mail: sial202@gmail.com;  
 Р. Спіца<sup>6</sup>, канд. геол. наук, старш. наук. співроб.,  
 E-mail: spytysyaroman@ukr.net;  
<sup>1</sup>Національний університет "Києво-Могилянська академія",  
 вул. Сковороди, 2, Київ, 04655, Україна;  
<sup>2</sup>Інститут геологічних наук НАН України,  
 вул. О. Гончара, 55, б, Київ, 01601, Україна;  
<sup>3</sup>ДНУ "Центр проблем морської геології, геоекології та осадового рудоутворення НАН України",  
 вул. О. Гончара, 55, б, Київ, 01601, Україна;  
<sup>4</sup>Національний науково-природничий музей НАН України,  
 вул. Б. Хмельницького, 15, Київ, 01030, Україна;  
<sup>5</sup>ПП Геологічна компанія "Геомандри",  
 вул. Ентузіастів, 2, кв. 115, Київ, 02154, Україна;  
<sup>6</sup>Інститут географії НАН України,  
 вул. Володимирська, 44, Київ, 01030, Україна

## ПЕРСПЕКТИВИ ВІДКЛАДІВ НАДЗАПЛАВНИХ ТЕРАС ДНІСТРА НА ЗОЛОТУ МІНЕРАЛІЗАЦІЮ

У межах басейну річки Дністер найбільш вивченою щодо золотоносності нині є територія середньої течії. Незважаючи на тривале геологічне вивчення, однозначно вирішити питання золотоносності території та корінних джерел золота досі не вдалося. Перспективність Середнього Придністров'я на пошуки родовищ золота встановлюється за геологічними, геохімічними і мінералогічними ознаками. У межах території досліджено золото віднайдено в кристалічних породах фундаменту та породах осадового чохла. Аналіз матеріалів з літологічно-мінералогічного складу надзаплавних терас і типоморфних особливостей самородного золота дозволяє стверджувати, що протягом розвитку річкової долини Дністра на різних тектонічних етапах її розвитку змінювалися палеогеографічні обстановки та джерела зносу уламкового матеріалу. Золотоносність плюцен-четвертинних відкладів Середнього Придністров'я поєднана з плюценовим (VI-IX надзаплавні тераси) та четвертинним (I-V надзаплавні тераси) терасовим комплексами річки Дністер, сучасним алювієм Дністра та його притоків. Проведені дослідження дозволяють стверджувати, що в межах Середнього Придністров'я самородне золото виявлено в усіх геологічних утвореннях, починаючи з протерозою і закінчуючи сучасними аллювіальними відкладами, що вказує на необхідність подальших пошукових робіт для визначення корінних джерел золота.

Здійснені нами польові, аналітичні дослідження і аналіз опублікованих даних дозволили виокремити основні напрями подальших пошуково-оцінювальних робіт. Серед них головними є детальне дослідження алювіальних утворень Дністра та його терасового комплексу (головним чином VI-VII терас), що дозволить уточнити їхній речовинний склад, з'ясувати масштаби золотоносності, установити зміну областей денудації в часі; літогеохімічні пошуки за первинними і вторинними ореолами розсіювання для з'ясування загальних принципів поширення золота; викоремлення перспективних ділянок у межах території дослідження; дослідження типоморфних особливостей самородного золота з аллювіальних і терасових відкладів з використанням сучасної аналітики для з'ясування його рудно-формаційної належності та мінерального типу.

**Ключові слова:** золото, басейн Дністра, надзаплавні тераси.

Е. Деревская<sup>1</sup>, д-р геол. наук, проф., E-mail: zimkakaty@gmail.com;  
 А. Александров<sup>2</sup>, канд. геол. наук, ст. науч. сотр., E-mail: alex2ce@gmail.com;  
 В. Береговенко<sup>3</sup>, асп., E-mail: jkglok@gmail.com;  
 М. Ковальчук<sup>2</sup>, д-р геол. наук, проф., E-mail: kms1964@ukr.net;  
 К. Руденко<sup>4</sup>, канд. геол. наук, ст. науч. сотр., E-mail: rudenkokseniav@gmail.com;  
 Г. Сильченко<sup>5</sup>, директор, E-mail: sial202@gmail.com;  
 Р. Спіца<sup>6</sup>, канд. геол. наук, ст. науч. сотр.,  
 E-mail: spytysyaroman@ukr.net;  
<sup>1</sup>Національний університет "Києво-Могилянська академія",  
 ул. Сковороди, 2, 04655, Київ, Україна;  
<sup>2</sup>Інститут геологічних наук НАН України,  
 ул. О. Гончара, 55, б, 01601, Київ, Україна;  
<sup>3</sup>ДНУ "Центр проблем морської геології, геоекології та осадового рудоутворення НАН України",  
 ул. О. Гончара, 55, б, 01601, Київ, Україна;  
<sup>4</sup>Національний науково-природоведческий музей НАН України,  
 ул. Б. Хмельницького, 15, 01030, Київ, Україна;  
<sup>5</sup>ПП Геологическая компания "Геомандри",  
 ул. Энтузиастов, 2, кв. 115, 02154, Київ, Україна;  
<sup>6</sup>Інститут географії НАН України,  
 ул. Владимирская, 44, 01030, Київ, Україна

## ПЕРСПЕКТИВЫ ОТЛОЖЕНИЙ НАДПОЙМЕННЫХ ТЕРРАС ДНЕСТРА НА ЗОЛОТУЮ МИНЕРАЛИЗАЦИЮ

В пределах бассейна реки Днестр наиболее изученной в отношении золотоносности сейчас является территория среднего течения. Несмотря на длительное геологическое изучение, однозначно решить вопрос золотоносности территории и коренных источников золота пока не удалось. Перспективность Среднего Приднестровья на поиски месторождений золота устанавливается по геологическим, геохимическим и минералогическим признакам. В пределах территории исследований золото найдено в кристаллических породах фундамента и породах осадочного чехла.

Анализ материалов по литолого-минералогическому составу надпойменных террас и типоморфных особенностей самородного золота позволяет утверждать, что в течение развития речной долины Днестра на различных тектонических этапах ее развития менялись палеогеографические обстановки и источники сноса обломочного материала. Золотоносность плюцен-четвертичных отложений Среднего Приднестровья связана с плюценовым (VI-IX надпойменные террасы) и четвертичным (I-V надпойменные террасы) террасовыми комплексами реки Днестр, современным аллювием реки и ее притоков. Проведенные исследования позволяют утверждать, что в пределах Среднего Приднестровья самородное золото обнаружено во всех геологических образованиях, начиная с протерозоя и заканчивая современными аллювиальными отложениями, что указывает на необходимость дальнейших поисковых работ для определения коренных источников золота.

Осуществленные нами полевые, аналитические исследования и анализ опубликованных данных позволили выделить основные направления дальнейших поисково-оценочных работ. Среди них главными являются детальное исследование аллювиальных образований Днестра и его террасового комплекса (главным образом VI-VII террас), что позволяет уточнить их вещественный состав, выяснить масштабы золотоносности, установить смену областей денудации во времени; литогеохимические поиски по первичным и вторичным ореолам рассеяния для выяснения общих принципов распространения золота; выделение перспективных участков в пределах территории исследования; исследование типоморфных особенностей самородного золота из аллювиальных и террасовых отложений с использованием современной аналитики для выяснения его рудно-формационной принадлежности и минерального типа.

**Ключевые слова:** золото, бассейн Днестра, надпойменные террасы.