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Research Article

GEOLOGICAL-STRUCTURAL AND GEOCHEMICAL CHARACTERISTICS OF THE EASTERN PART OF THE OKJETPES ORE FIELD

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ABSTRACT Gold mineralization is controlled by a chain of brachioform carbonate structures of Devonian-Carboniferous age (autochthon) stretched along a deep fault, standing out in the presence of structural-tectonic erosion windows in the sediments of the Proterozoic flyschoid formation (allochthon). The article presents the results of geological, structural and geochemical studies carried out in the eastern part of the Okjetpes ore field. The features of the manifestation of gold and associated elements in ores and around ore zones have been determined, and their indicator indicators have been substantiated in the search for promising gold ore positions. As a result of geological and geochemical studies in the area, mineralized zones 12, 13, 14 were identified as promising areas and they are described separately.

Keywords: *Geochemical Research, Okjetpes Ore Field, Gold, Hydrothermal-Metasomatic, Mineralization, Gold, Geochemical Halos, Mineralized Zone*

INTRODUCTION

The Okjetpes ore field is located in the southern part of the Bukantau uplift and is the southern end of the Boztau-Kokpatas-Okjetpes brachyanticline, traced in the northwest direction for more than 60 km (Figure 1). The position of the ore field is determined by its position in the zone of influence of the "ore-bearing" Kokpatas deep fault and its boundaries are considered to be: from the south - the main suture of the Yangikazgan fault; from the north - the North Okjetpes fault (partially confirmed by drilling data - *Shapkin, 1974*); from the east - a NE-trending fault, passing between terrigenous deposits of the Middle Carboniferous and rocks of the Kokpatas suite; in the west - conditionally passes, west of the 9th mineralized zone (Sedelnikov *et al.*, 2006; Pirnazarov *et al.*, 2022).

Gold mineralization in this area is controlled by a chain of brachioform carbonate structures of Devonian-Carboniferous age (autochthon) stretched along a deep fault, standing out in the presence of structural-tectonic erosion windows in the sediments of the Proterozoic flyschoid formation (allochthon). Their structural position is reminiscent of the well-known Carlin-type gold mineralization, confined to the zone of large thrusts along the western edge of the Paleozoic North American continent (Djenchuraeva R.D., 2010; Isakhodjayev *et al.*, 2013). Here, during the Atler orogeny (D-C_1), coeval deep-sea siliceous-terrigenous sediments with a displacement amplitude of about 100 km (analogous to the structural position of the Kokpatas ore field) were thrust onto the Early Paleozoic apron, mainly carbonate deposits. Gold mineralization is hosted in autochthonous carbonate rocks, exposed as tectonic erosion windows among allochthonous rocks. The formed systems of faults that bound tectonic windows determine their internal structure and have ore-controlling significance.

MATERIALS AND METHODS

The ore content of the Okjetpes area, according to the evidence of ancient copper workings, attracted the attention of miners back in the middle of the 9th-13th centuries. Once again, the eyes of geologists were turned to the mountain uplift in 1954, when, during a geological survey on a scale of 1:100000 (Pyatkov, 1956), copper mineralization was discovered in a quartz vein in the west of the area (Medny site). In the early 70s, when conducting a geological survey on a scale of 1:50000 (Shapkin, 1974; Zakinov, 1974), copper and gold ore occurrences were identified (Mednoe, Vostochno-Okjetpes) (Pirnazarov *et al.*, 2012). Attention was drawn to the similarity of the internal structure and common development of the Kokpatas and Okjetpes structures.

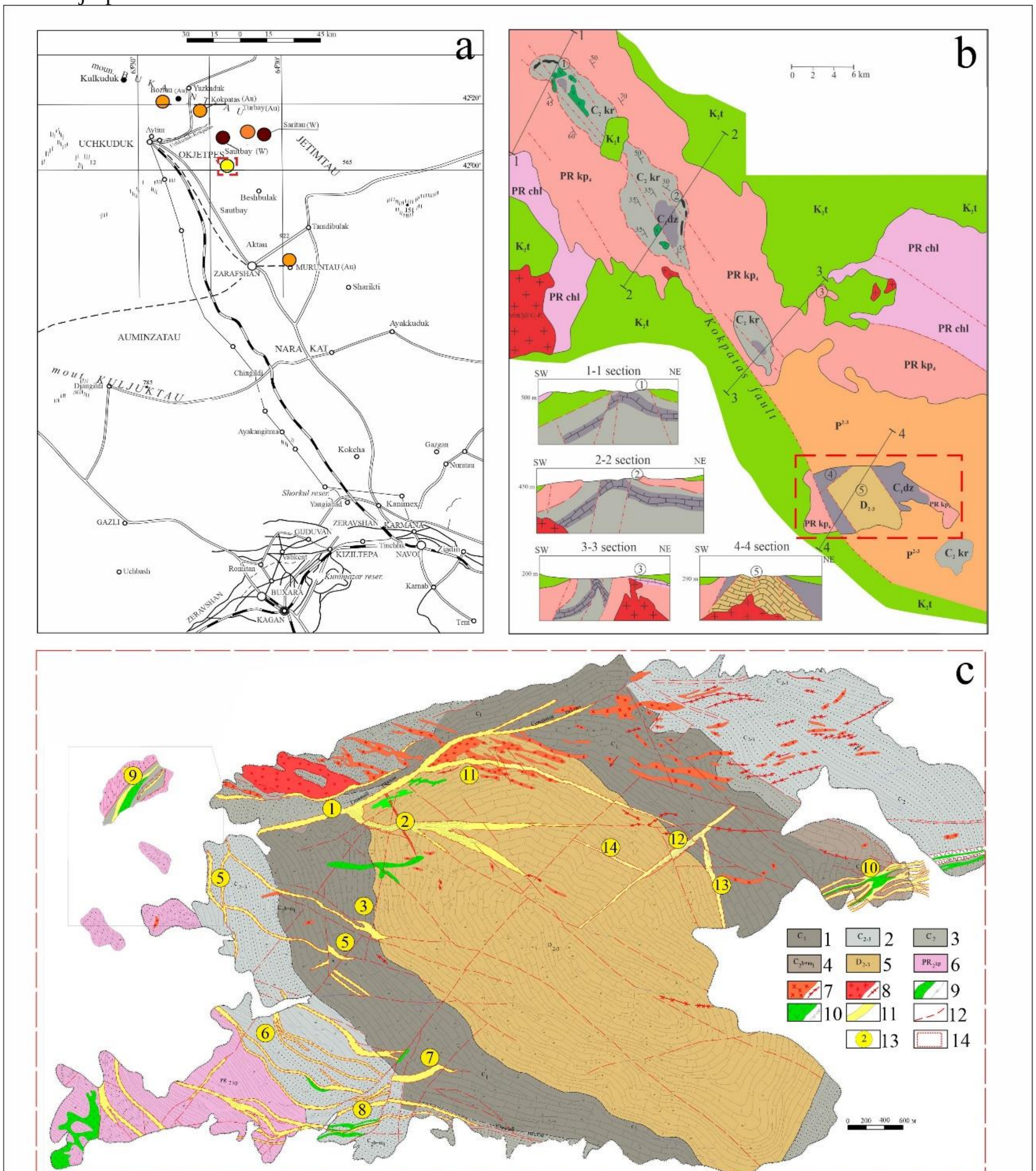

Figure 1: Survey map of the Okjetpes mountain uplift. a-location of the work area on the physical-geographical map of the Republic of Uzbekistan; b-position of the Okjetpes mountain uplift in the

composition of the Boztau-Kokpatass-Okjetpes trend (Pirnazarov *et al.*, 2012); c-position of mineralized and ore zones (Sedelnikov *et al.*, 2015): 1 (Okjetpes), 2, 3, 5, 6, 7, 8, 9, 10 (Barkhanli), 11 (Sardor), 12, 13, 14. 1 - lower department, undivided. Massive and medium layered fine-grained limestones; 2-middle section-undivided. Sandstones, siltstones, mudstones, interlayers of siliceous rocks, limestones; 3-middle section-undivided. Sandstones, siltstones, mudstones, limestone interlayers; 4-Bashkirian stage, Lower Moscow substage - combined limestones with flint lenses; 5 Devonian system. The middle-upper sections are undivided, medium-layered fine-crystalline limestones with interlayers of marbles and dolomitic limestones; 6-Upper Proterozoic. Kokpatas suite. Siliceous rocks and microquartzites, sandstones, siltstones, carbonaceous-quartz, sericite-chlorite-quartz shales, dolomites; 7-kersantites; 8-granodiorite porphyry; 9-syenogranodiorite porphyry; 10-diorites (syenodiorites); 11-zone mineralization; 12-discontinuous violations; 13-numbers of mineralized zones; 14-area of works.

According to the stratigraphic division scheme, the area of the Okjetpes ore field, in general, is: a dome uplift, composed in the core part of massive dolomites (D_{2-3}) and medium-thin-layered limestones (C_1), attributed (as in the standard Kokpatas deposit) to Djuskuduk Formation (C_1dz) (Sedelnikov *et al.*, 2006). According to the description, the total thickness of the Devonian and Carboniferous deposits is 900 m. However, the only well that crossed the carbonate core encountered metamorphosed basement rocks at a depth of 450 m (Skv. 3 in the area of ore zone 5) (see Figure 1).

As noted above, systems of faults, which often limit the spread of tectonic windows, have ore-controlling significance in these conditions.

The Barhanli deposit, for example, located on the eastern flank of the Okjetpes anticline, is characterized, like the 2nd zone, by an advantageous geological and structural position: confined to the conjugation of tectonic sutures of the NW, NE and sublatitudinal directions (Sedelnikov *et al.*, 2006).

During the period of ore deposition, NE and sublatitudinal faults were, respectively, detachment and cleavage cracks (“sliding” during the release of tectonic stresses). Therefore, the largest number and thickness of dikes are confined to NE detachment fractures (as in the ore field as a whole), but the most significant gold ore bodies still gravitate towards more favorable structural conditions in separation-cleavage fractures.

The determination of the ore potential of promising areas of the Okjetpes mountain uplift was carried out based on geochemical, mineralogical, structural and lithological factors, involving, if possible, indirect signs - geophysical and geochemical (secondary scattering halos) anomalies, as well as satellite image interpretation materials Direct search features, as a rule, were not used in full and, moreover, were represented by rare significant samples. This is often explained by incomplete coverage of mineralized zones by sampling at a low degree of exposure. To search for convincing arguments for ore bearing, it was included in predictive studies on “white spots” in the Okjetpes mountain uplift. In the study area, their own mineralogical and geochemical standards were selected (objects explored to date), where it was possible to study the mineral composition and placement conditions of the ore bodies directly exposed by underground and surface mine workings: Ore zone 2 (main standard); Barkhanli deposit and Ore zone 9 (comparison standards).

RESULTS AND DISCUSSION

Primary anomalous geochemical halos

To construct endogenous geochemical halos along the Eastern flank of the Okjetpes ore field, a consolidated areal database has been created with an emphasis on collecting available information on sampling ditches and wells that exposed the pre-Mesozoic basement in semi-closed and closed areas.In total, in the areal database there are 28,395 samples for gold, 14,830 samples for silver and 13,830 samples for the remaining 19 elements, a statistic al analysis was performed for them. For areal constructions, all these samples are taken into account. Each sample was checked for accuracy of display in comparison with the author’s

QPMs. Quite complete information has been collected on closed territories that are objects of expert assessment and forecasting.

The areal construction of monoelement halos was made using Surfer programs. During automated processing, attention was paid to the distribution of primary geochemical halos to the 3 ore-forming elements - Au, As, Ag, which have a significant number of samples (10-20%) in the accumulation area, which was determined by analyzing the frequency histograms of the distribution of element contents. The remaining ore-forming elements Sb, Zn, Bi, Mo, Sn, Be, can be shown as geochemical points with anomalous concentrations above the minimum anomalous threshold. The main control processing parameters were selected experimentally; the processing method was kriging (kriging). The program calculates the average element content in a grid cell and performs interpolation between an adjacent cell, or extrapolation within a given radius.

Gold. Contrasting and intense gold anomalies ranging from tenths of a g/t to a few g/t are developed within mineralized zones with sulfide mineralization. In closed areas, gold anomalies of low intensity and contrast predominate; with the exception of a few positions, they characterize samples from individual wells. Gold halos are developed in the southeast with a shift to the south. A large halo is observed in the northwest. Small halos are observed in the west with a shift to the north (Figure 2).

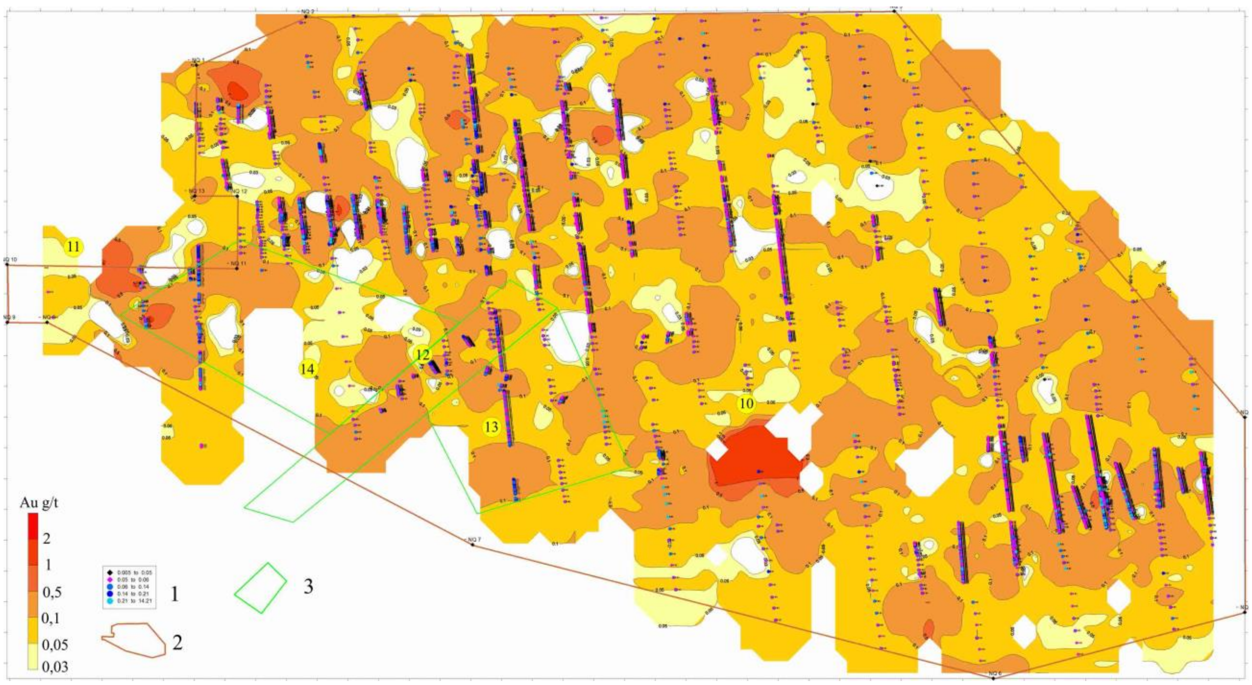

Figure 2: Geochemical gold halos on the eastern flank of the Okjetpes ore field. Scale 1:10000. 1 – gold content; 2 – work area; 3 – forecast area.

Arsenic. Primary geochemical arsenic halos are similar in spatial distribution to gold halos, but the area of development of low-intensity arsenic halos is wider. Intense and contrasting halos are confined to open areas and accompany gold mining objects everywhere. In closed areas, low-intensity halos predominate in contents of 0.0015-0.01%. The development of arsenic halos is noted in the southeast with a shift to the east. Large halos are observed in the center of the area and extend to the northwest. In these positions, gold contents ≥ 1 g/t coincide with arsenic halos. Also, single gold contents are distributed throughout the entire area of arsenic halos (Figure 3).

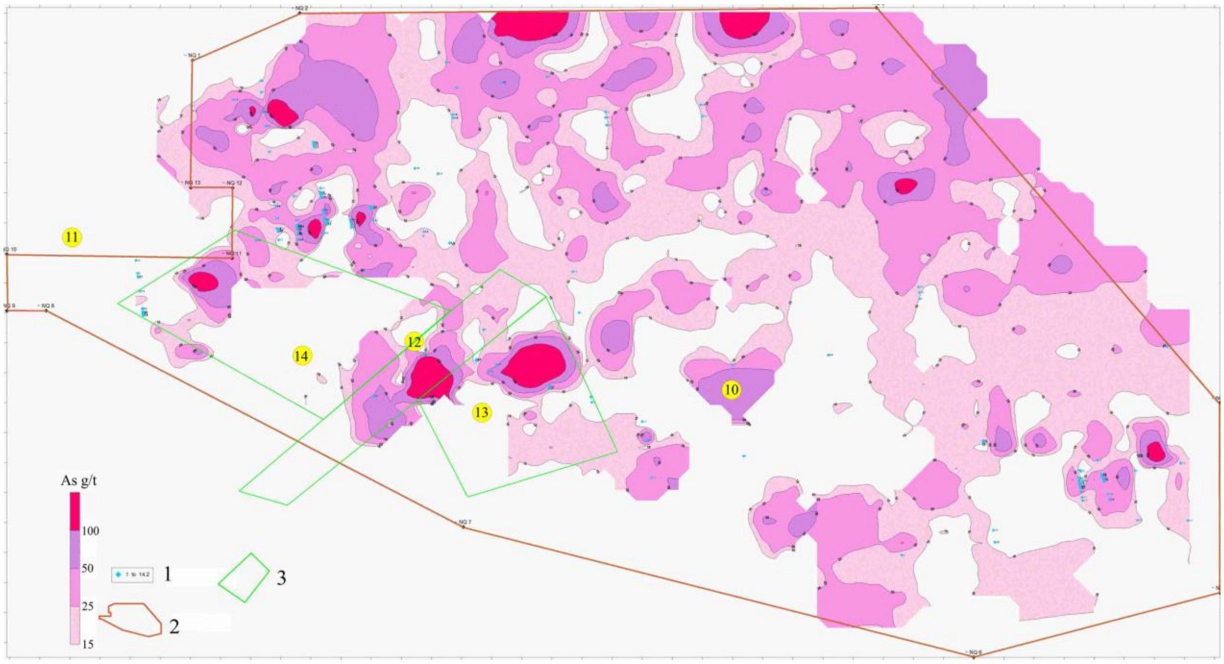

Figure 3. Geochemical halos of arsenic on the eastern flank of the Okjetpes ore field. Scale 1:10,000. 1 – arsenic content; 2 – work area; 3 – forecast area.

Silver. The database contains two sensitivity levels of s/c spectral analysis: 0.01 and 0.05 (·n 0.001%), therefore, when constructing halos, a stable anomalous level of 0.05·0.001% or 0.5 g is taken as the lower value /T. Almost all silver anomalies are developed within the southeast and northwest of the area and coincide with gold contents ≥ 1 g/t. Single coincidences are observed in the center of the area with a shift to the north (Figure 4).

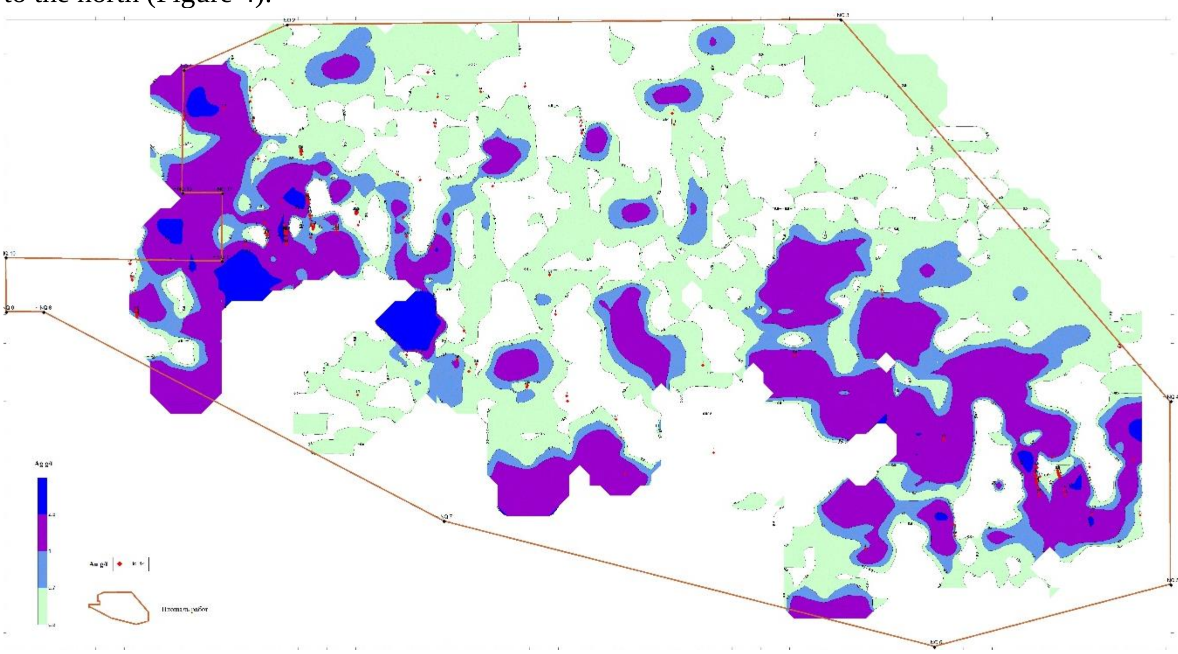

Figure 4: Geochemical halos of silver on the eastern flank of the Okjetpes ore field. Scale 1:10,000. 1 – silver content; 2 – work area; 3 – forecast area.

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Mineralized zone 12. The promising position of Mineralized Zone 12 was previously identified for further study based on the results of field observations by employees of the Local Forecasting Sector (IMR). The prospecting work carried out on the area of the Eastern flank of the Okjetpes ore field confirmed its prospects for carrying out assessment work: 12 sections with interestingly significant Au contents were obtained from ditches and boreholes, of which in 10 sections the Au content was from 0.5 to 1.4 g/t. A mineralized zone of NW-sublatitudinal strike with a length of up to 1.8 km and a thickness of up to 40 m was outlined along them (ditch No. 159: 2 sections of 5.3 and 5.7 m each). The zone is accompanied along the strike by a dike of diorite composition, and the host rocks and exocontacts of the dike are intensively hydrothermally worked, and in general the zone in plan on the surface is painted in bright brown-yellow and red tones. It should be noted that on the constructed map of primary geochemical anomalies Au with values ≥ 0.1 g/t, the zone is traced by linearly elongated halos almost along the entire strike (Figure 5).

Overlay with a map of geochemical primary As anomalies shows that 85-90% of the mineralized zone is underlined by halos of ≥ 15 g/t. On more than half of the western flank of the zone, two large halos (0.4 and 0.6 km across) of arsenic with values ≥ 100 g/t (0.01%) are recorded. In the extreme southeast of the zone, against the background of a halo of 15 g/t, small halos with As content values of 25 and 50 g/t appeared. Relatively rarely, but clearly along the entire strike of the zone, anomalous As positions are emphasized by remote sections with Au content > 0.9 g/t. They trace the strike of the zone in the northwestern direction.

Another promising position is identified in the continuation of the explored Sardor zone with the same latitudinal strike. It should be noted that earlier, based on the analysis of the “deformation ellipsoid”, for the formation of the Okjetpes brachyanticline, the direction of regional tectonic compression efforts was determined at an azimuth of~42°. With such compression in the fold, during its formation and the subsequent process of ore formation, the resulting tectonic disturbances of latitudinal-sublatitudinal strike are defined as “sliding” faces and having favorable conditions for the entry and deposition of ore-bearing hydrothermal solutions. This is manifested in the position of the described section: on the geological map, a series of diorite dikes (4-5 branches) is revealed along the entire strike of the position, and in endocontacts and exocontacts along their entire strike (2.2 km) mining workings (ditches and roller-cone wells) revealed 42 sections in the zone with interestingly significant Au contents (0.3-1.69 g/t and one hurricane: at 4 m thickness 30.4 g/t) along which the same series of ore-bearing mineralized branches with a horizontal thickness of up to 20 m is planned.

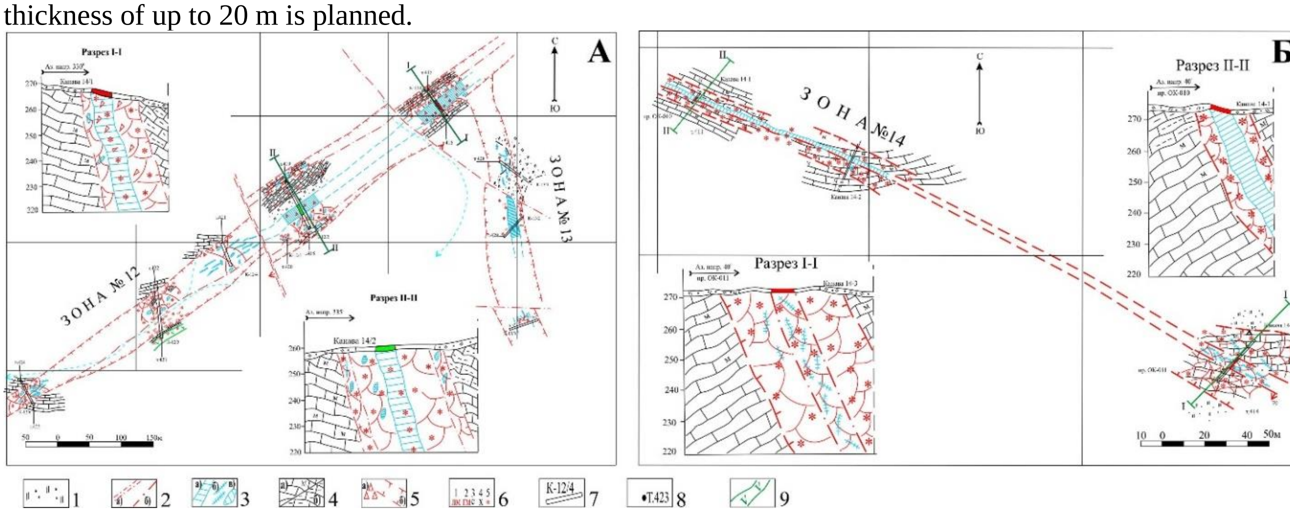

Figure 5: Schematic geological forecast map of promising mineralized zones 12, 13 (A) and 14 (B) of the Okjetpes mountain uplift (Compiled by Movlanov, Sedelnikov, Omonov, 2015). 1 – overlying sediments (loam, sandy loam); 2 – faults identified: a) during geological survey; b) during geological research; 3 – quartz formations: a) veins and b) veinlets c) inclusions on ditches and on the surface; 4 – limestones: a) marbled, b) in fault zones; 5 – a) crushed and brecciated zones; b) contours of mineralized rocks; 6 –

hydrothermalites: 1) limonitization; 2) hematization; 3) sericitization; 4) chloritization; 5) ferruginization; 7 – ditches and their numbers; 8 – numbers of observation points; 9 – diorite porphyrite dikes.

On the reconstructed map of the primary geochemical gold halos, the described promising position on ~80% of the area is reflected, also latitudinally elongated, by an Au distribution anomaly with a value of ≥ 0.1 g/t. On the map of the primary geochemical halos of As, somewhat less clearly, but quite confidently, a series of anomalies of latitudinal strike with a value of ≥ 15 g/t is outlined in which a chain of local As anomalies tied to ore-bearing branches with a value of 25 and 50 g/t and 2 (size ~ 100m across) with a value ≥ 100g/t. The sections with Au content ≥ 0.6 g/t included on this map naturally emphasize the latitudinal extent of the ore-bearing zones most clearly in the western and central parts of the position, but the extreme east of the area is expressed by isolated manifestations of increased Au contents, which can be explained by a more sparse exploration network of workings.

Mineralized zone 13. On the eastern flank of the main outcrop (outcrop) of Paleozoic rocks (Okjetpes ore field), at a distance of ~ 250 m, there is another small outcrop (0.4-1.1x3 km) represented by rocks of terrigenous-shale composition. Here, a series of ditches (every 200-300m) and wells (mainly roller drilling) revealed mineralized intervals (>0.2 g/t Au) with a thickness of 1-20m (k-134, etc.) in 30 sections, linking into 2 subparallel branches: Northern length is more than 2 km; and southern - about 1 km. In them, along sections with a gold content of more than 0.5 g/t (~ 22 sec.), ore bodies of the same extent were outlined. Maps on a scale of 1:10000 were compiled of the Eastern flank of the Okjetpes ore field based on primary geochemical halos (sampling of ditches and wells) of ore and associated elements. A more informative and visual map looks like constructions based on As halos contoured by the content value of 15 g/t (0.0015%), which cover 70-80% of the entire area under consideration. This value of halos also covers a significant part of the identified branches of Mineralized Zone 13. But halos with values of 0.25 and, more rare, -50 g/t look more obvious. Thus, the first ones are chain-shaped and extended in the NE direction and spatially trace along the entire length the two branches of the mineralized zone described above. At the same time, on the eastern and western flanks of the zones, 2 branches of local As anomalies with increased values are outlined. It should be noted that the anomalous gold values (≥ 0.9 g/t) shown on this map clearly highlight the mineralized branches of the zone only on the eastern flank, and fragmentarily on the rest of the area. Apparently, here the lower threshold of Au contents should be lowered (~ to 0.1 g/t), then they more clearly and clearly show the entire ore-mineralized zone and are emphasized by As anomalies of increased values. In addition, we note that the main patterns for the ore field are manifested in the zone under consideration: the spatial accompaniment of ore-bearing zones by dikes of subalkaline and, more often, intermediate composition and developed in tectonically weakened zones with hydrothermal development of rocks. It should be added: the diorite dike recorded on the western flank was traced on the surface of zone 13 at 2/3 of its length along the strike, and in the extreme east it was opened in ditch 145.

Mineralized zone 14. Identified in the far north of the Okjetpes ore field, 2 km northeast of the explored Sardor deposit, with a latitudinal, favorable as already noted, strike of about 1 km. The position is characterized by its location between two blocking faults of NE strike with a total thickness of the tectonically weakened mineralized zone up to 100 m. In the center of the zone, a dike of diorite porphyrites was recorded, and in both its endo- and exocontacts hydrothermal development of the rocks was revealed, and the host rocks here are of terrigenous-shale composition. The mineralized zone was traced along the strike in seven industrially significant sections (from 0.5 to 1.6 g/t Au) using roller drill holes; the ditches were not penetrated; sediment thickness > 2 m. The true thickness of industrially significant sections of the ore-bearing zone is up to 4-5 m.

On the map of primary geochemical halos As, the area of the selected area is completely covered by a latitudinal anomaly with a value of ≥ 25 g/t and up to 50% of the area with a value of ≥ 50 g/t. Both flanks and the center of the mineralized ore-bearing zone are emphasized along one section with an Au content of 1-1.6 g/t.

It should be noted that the somewhat less clear expression of the zone by sampling data is explained by a more sparse exploration network - 320 m between profiles and 40 m between wells. The latter is not enough

for steeply dipping zones, and with the concentration of workings, Mineralized Zone 14 clearly claims to become comparable to the Sardor site.
The research results confirmed the low erosion of the Paleozoic productive strata and the high efficiency of using geological-structural and mineralogical-geochemical methods when identifying promising positions for mineralization in low-mountain steppe areas. The work also revealed good preservation in the 12, 13 and 14 mineralized zones of the predicted gold mineralization and zones of their oxidation, as well as, despite the small size of the predicted areas (less than 1 km^2), a high probability of development of the identified gold-sulfide-quartz mineralization at depth.
The discovery of new mineralized zones, despite the high degree of detail of geological knowledge, indicates the presence of new resource potential in the area. The coverage of geological exploration works similar to industrial sites, such as Sardor, Barkhanli, 2-ore zone, positions (zone 3-, 5-, 6-, 6a-, 12-, 13- and 14) is insufficient, and there is also an urgent need deployment of targeted prospecting and appraisal work at deep horizons.

CONCLUSION

1. The northeastern tectonically disturbed zone of intensely fragmented and altered rocks is identified as the main controlling structural factor of mineralization in the area. In most cases, magmatic (as a barrier to mineralization of dikes of basic and intermediate composition) and hydrothermal (bodies of quartz veins and zones of vein silicification) factors appear in a single space with it.
2. Within the field, in the ore zones, a high level of clarke concentration with gold, antimony, arsenic, silver, and molybdenum has been established. In ore zones, gold has a significant and stable positive correlation with such elements as cadmium, molybdenum, beryllium, antimony, arsenic, copper and tin, and silver with such elements as cadmium, molybdenum, beryllium and copper.
3. Based on the results of the application of the developed geological-structural factors and mineralogical-geochemical prospecting and forecasting complexes in the geological exploration process, in the north-eastern part of the Okjetpes ore field, mineralized zones 12, 13 and 14, promising for gold mineralization, were identified, where it was recommended to intensify geological exploration work.

REFERENCES

Djenchuraeva RD (2010). Geodynamics, metallogeny and ore genesis (using the Tien Shan and adjacent territories as an example) – Bishkek: *Ilim*, 152-154.
Isakhodjayev BA, Tangirov AI, Urunov BN (2013) Boztau-Kokpatas-Okjetpes trend. Tashkent. *Geology and Mineral Resources* **6**, 23-30.
Pirnazarov MM, Omonov OG, Abdullayev LA, Saidkhodjayeva MM (2022). Ore-controlling factors and significant signs of mineralization of the Okjetpes ore field (Central Kyzylkum). Tashkent. *Geology and Mineral Resources* **1**, 51-58.
Pirnazarov MM, Pirnazarov Ma'mur, Movlanov JJ, Rajabov AR (2012). Predictive-exploratory models and complexes of gold-ore and gold-bearing tungsten, silver and copper deposits and manifestations of the Sautbai-Sarytau ore cluster. Tashkent. *Geology and Mineral Resources* **6**, 30-39.
Sedelnikov LV, Tusmetov AA, Jumayev SO, Turayev TN (2006). Prospects for expanding the mineral resource base of oxidized gold-bearing ores in the deposits of the mountains of Central and Southern Bukantau. *Navoi. Gorny Vestnik of Uzbekistan*. **1**(24), 3-6.