LOCALIZATION CONDITIONS AND BASIC GEOCHEMICAL CHARACTERISTICS OF APOGRANITOID TUNGSTEN MINING IN THE LOWER TIER OF THE YACHTON DEPOSIT

[1]Juraev Mekhroj Nurillaevich, [2]Jumagulov Aydos Bayram uli, [3]Muhammadiyev Bayramali Uyg'un o'g'li

[1]Tashkent State Technical University named after Islam Karimov

[2]Competitor of the department "Geology, prospecting and exploration of mineral deposits", Tashkent State Technical University named after Islam Karimov

[3]Competitor of the Department "Geodynamics and Tectonics", National University of Uzbekistan named after Mirzo Ulugbek

https://doi.org/10.5281/zenodo.7558720

Abstract. *The article describes new types of tungsten mineralization for the Chakylkalyan-Karatube mining region, the main features of which are: aluminosilicate (granitoid) substrate, along which silicon-alkaline ore-bearing metasomatites are formed; significant addition of Ca, Si, Mg and Fe to the near-ore space; poly-stage and discrete nature of the ore process; a complexly constructed halo of ore-bearing elements.*

Of particular importance for understanding the geological structure and metallogeny of the central part of the Chakylkalyan megablock are products of alkaline-basalt magmatism, which make up the Early Mesozoic formation of trachydolerites and camptomonchits, which form single dikes on the Yakhton ore field, and in neighboring territories of southern Uzbekistan and diatrums and diatrums.

Keywords: *tungsten mineralization, deposits, Zarafshan-Alai, Karatyube-Chakylkalyan ore region, Yakhton, aluminosilicate rocks, metasomatites, geological-industrial types of ores, quartz diorites, ore control structures, crushing, cataclasis, dikes, Apogranitoid, megablock, primary halo, ore-bearing element, scheelite.*

The Yakhton deposit is located in the watershed part of the ridge. Chakylkalyan within the eponymous megablock, which is the western fragment of the Zarafshan-Alai structural-formational zone. Administratively, it belongs to the Urgut district of Samarkand region. The deposit was discovered by S.N. Popenko and A.A. Konyuk in 1946. [5].

Tungsten mineralization at the deposit is confined to the exo-, endo-contact zone of a stock-like intrusive body. For many years, the Yakhton deposit was considered a classic single-stage representative of the skarn-scheelite formation with the formation of tungsten mineralization in the contours of calcareous skarns of contact, interstratal, stockwork and secant morphotypes, formed on various volcanogenic-terrigenous-carbonate rocks of the frame of the Yakhton intrusion [1].

In recent years, employees of the State Unitary Enterprise "Gissargeologia" have identified tungsten mineralization in the lower tier of the deposit, represented by rocks of the Yachthon quartz-diorite-granodiorite collision complex C_3. Its formation occurred in the following chronological sequence: fine-grained weakly porphyritic pyroxene-amphibole-biotite and biotite-amphibole quartz diorites and quartz syenite-diorites; fine-medium-grained porphyritic biotite-amphibole (mesocratic) granodiorites (main intrusive phase); fine- and medium-grained porphyritic amphibole-biotite (leucocratic) granodiorites; vein rocks of the first stage: granites, aplite-granites, aplites, pegmatites; vein rocks of the second stage: diorite porphyrites; granodiorite porphyry; granite porphyries [2].

Quartz diorites and syenite-diorites occur as xenoliths, less often as small independent bodies. Mesocratic and leucocratic granodiorites have a relatively similar mineral composition.

The petrochemical features of the complex are low acidity of the main types of rocks, moderate iron content (usually not higher than 60%); sodium-potassium subtype - alkalinity in most massifs.

Characteristically, the melano- and mesocratic rocks of the Yachthonsky complex, on the basis of quantitative mineral ratios, are defined as essentially plagioclase granitoids, but they have an increased content of potassium, which is recorded in abundant biotite.

Complexes of regional distribution include the complex Almalysai gabbro-monzonite-syenite and South Tien Shan complex of dikes of subalkaline gabbroids and lamprophyres [7].

Dikes of the Almalysai complex (Permian–Triassic) occur both within the Yakhton ore field and in adjacent areas. The strike of the dikes is predominantly northeastern, rarely northwestern, with single latitudinal dikes. The fall is steep (65° – 80°). The thickness varies from 0.2 m to 3 m, the length is up to 3 km. The dykes of the Almalysai Complex cut through the entire pre-Mesozoic section, all granitoid complexes, and in many cases intersect sharyag structures.

Peculiarities of the petrochemical complex are: undersaturation of rocks with SiO_2 and Al_2O_3; increased alkalinity with the leading role of potassium. The total glandularity increases from 48% in the early divisions to 76% in the later ones. The rocks of the complex are characterized by elevated contents of rubidium, fluorine, boron, vanadium, and chromium. The type of accessory mineralization is apatite-magnetite (with fluorite).

The South Tien Shan dike complex of subalkaline gabbroids and lamprophyres (T_{2-3} *jut*) was identified by I.V. Mushkin (1977) as a complex of dikes and explosion pipes of regional distribution. In the study area, the complex is represented by rare dikes described as essexite-diabases, camptonites, campto-dolerites, and monchikites. Monchikites and camptonites have a similar composition, differing mainly in structural features (t/g in camptonites and glassy in monchikites, ophitic in essexite-diabases). Monchikite phenocrysts contain olivine (chrysolite), often replaced by chlorite-serpentine, basaltic hornblende, and titanium-augite. The camptonites contain olivine and titanium-augite phenocrysts, the groundmass is composed of labradorite, titanium-augite, and barkeveckite. The structure of the rock is microporphyritic, glomeroporphyritic, the groundmass is intersertal. The rocks of the complex are characterized by SiO_2 undersaturation and low total iron content, combined with high alkalinity. The rocks of the complex have elevated (relative to clarks) contents of *Pb, Sn, Cr, Ni*, and sometimes *Hg*. The complex is the latest igneous taxon of the region, breaking through all its Paleozoic subdivisions. Data on measuring the absolute age in Southern Gissar characterize the time interval of 223-245 million years, which does not contradict the idea of the Middle and Upper Triassic age, geologically substantiated in the territory of Tajikistan.

In terms of chemistry, the rocks of the complex are characterized by a reduced content of silica, alumina, alkalis (with a predominance of sodium over potassium) and an increased content of titanium, magnesium and iron. Based on the presence of analcime and normative nepheline, the rocks of dikes (and diatremes in adjacent areas) can be assigned to the formation of alkaline basaltoids of the potash series.

SCIENCE AND INNOVATION
INTERNATIONAL SCIENTIFIC JOURNAL VOLUME 2 ISSUE 1 JANUARY 2023
UIF-2022: 8.2 | ISSN: 2181-3337 | SCIENTISTS.UZ

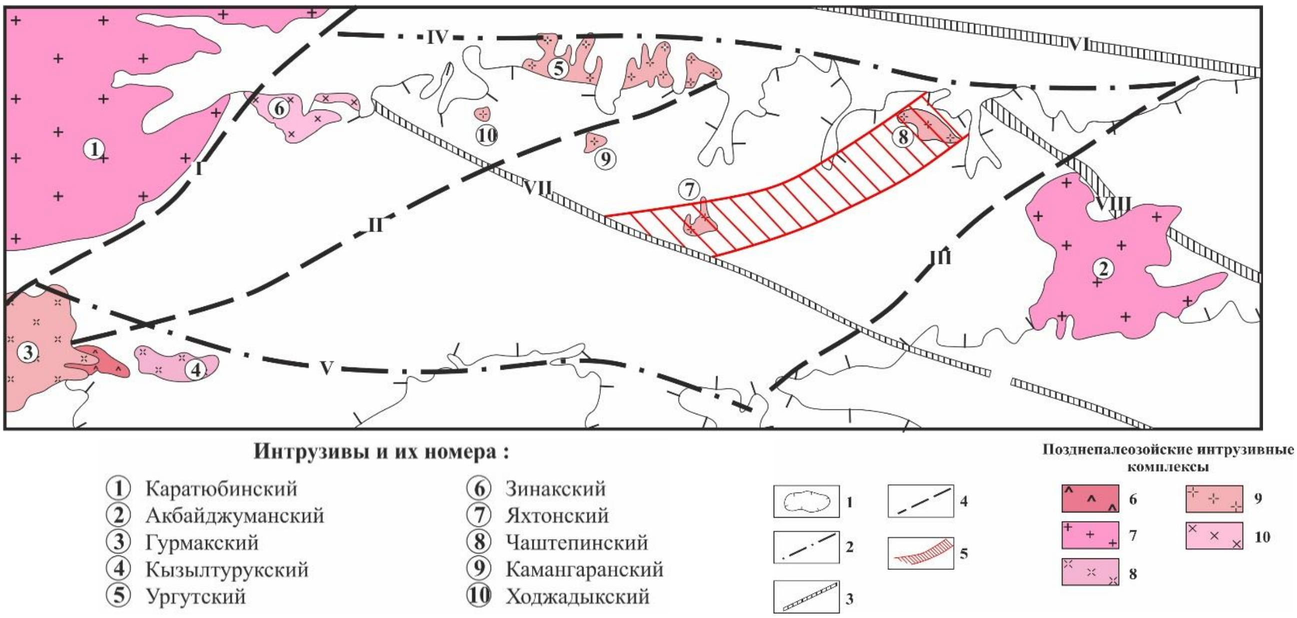
The rocks of the complex have elevated (relative to the clarks) contents of *Se, Re, As, Ag, W, Mo, Ni, Au* and, like the rocks of the early stages of magmatism, are accessoryly specialized in tungsten (scheelite contents in unaltered camptonites are frequent signs).

Of particular importance for the geochemical characteristics of the described ore process can be *Se*, which is considered as a geochemical indicator of processes of deep magmatism [6] and is a characteristic element of deep basalt and peridotite magmas. The data presented may indirectly indicate the unity of the magma-generating chamber during the formation of dikes of lamprophyres and alkaline basaltoids.

Apogranitoid tungsten mineralization in the northern part of the Chakylkalyan megablock (Fig. 1) is controlled by a late (in relation to the Yachthon intrusive complex productive for skarns) tectonic zone of northeast strike. The structure is expressed by linear zones of brecciation and cataclase, subparallel zones of fine fracturing, dikes of granodiorite-porphyry, diorite porphyrites and lamprophyres, linear dike-like apophyses of granodiorites, quartz and pegmatite veins, chains of polarizability anomalies and geochemical halos of typomorphic elements of tungsten mineralization.

Figure 1.

The main elements of the tectonic structure of the Chakylkalyan megablock



1 – Contour of exposed Paleozoic; 2 - Sublatitudinal deep faults activated in Pz-Mz: VI - North Chakylkalyan, V - Kashkadarya; 3 - Paleozoic consedimentary faults: the first order VI - Zarafshan, the second order VII - Central Chakylkalyan, VIII - Chashtepa-Tangisai; 4 - Northeastern faults: First order I - Guzaro-Jizzakh, second order II - Kyrktau, III - Turpaklin; 5 - Chashtepa-Yakhtonskaya tectonically weakened zone. Late Paleozoic intrusive complexes: 6 - gabbro-diorite; 7 – adamellite-granite; 8 - Potassium granites; 9 – Quartz-diorite-granodiorite; 10 - Two-mica granites.

The post-collision ore-feeding deformation structure (Chashtepa-Yakhtonskaya tectonically weakened zone) of northeastern strike crosses the entire pre-Mesozoic section, all Upper Paleozoic granitoid complexes, in many cases crosses thrust structures and controls the position of two ore fields: Yakhtonskoe and Chashtepa located 10 km to the north-east of it (Fig. 1).

In the Yakhtonskoe ore field, zones of submeridional faults form two ore-controlling structures, the Ore and West faults (Fig. 2), which are represented by systems of cleavage cracks with separate crushing and cataclase seams.

Tungsten ore bodies of the lower stage of the Yakhton deposit are located in zones of polycomponent metasomatites formed after granodiorites. The ore bodies are mainly ribbon-shaped with an average thickness of 4-5 m. They are traced along the strike for hundreds of meters. The main industrial component of ores is tungsten (average content in ordinary ores is 0.3–0.5%, in rich ores 1.5–2.0%). Of potential interest (in g/t): *Au* up to 3–4 (in separate samples), *Mo* up to 500–800, *Ag* up to 115.

The main tungsten mineral, scheelite, is represented by two generations - early, associated with molybdenite and gold, forming disseminated impregnation (with individual grains 2–3 mm in size) and nests (up to 0.5–1.0 cm in diameter), and late, which is characterized by sulfosalts (probably formed in the process of telescoping various mineral associations), as well as the veinlet form of segregations (with the thickness of the veinlets from filiform to 2–3 mm.). Scheelite of the first generation is characterized by bright blue luminescence, the second - bluish and yellowish-white.

Within the ore-bearing zones, scheelite mineralization is accompanied by widespread pyrite-arsenopyrite mineralization; confined to narrow linear zones of sulfosalt mineral (with a combination of antimony-silver and lead-antimony sulfosalts in it) and scattered molybdenite and locally manifested lead-zinc mineral associations. An important feature of ore-bearing zones is the presence in them of thin veinlets of brownish-black resinous carbonaceous matter (anthraxolite type), filling microcracks and intergranular space and, apparently, fixing the introduction of juvenile carbon in the near-ore space.

Selenium and tellurium act as indicators of the mineral-forming process, forming an isomorphic admixture in a wide range of ore minerals.

The main rocks hosting tungsten mineralization in the lower stage of the Yakhton deposit are uneven-medium-grained porphyritic biotite-amphibole granodiorites of the main intrusive phase.

The process of formation of the near-ore space consisted of two successive stages. At the first stage, granodiorites hosting mineralization were subject to acid leaching, which was replaced by alkaline metasomatism - the main rock-forming minerals of granodiorites underwent changes, which led to the removal of a number of petrogenic elements from the near-ore space [4].

Hornblende in ore-bearing granodiorites forms mainly tabular, rhomboid, and small-cluster intergrowths, preserved only in some places. Basically, it is completely replaced by chlorite with leucoxene, and in some nests its epidotization is clearly manifested, accompanied by microgranular accumulations of leucoxene and zoisite.

Plagioclase in the original rock forms tabular and isometric sections of prismatic (sometimes polyzonal) crystals 0.5–1.5 mm long along the long axis. During acid leaching, the plagioclase is intensely pelitized and spotty sericitized. However, the leaching process is developed extremely unevenly. In individual grains, sericite makes up to 40–45% in their areas. At the same time, many of its other grains remained completely pure [3]. Biotite of the original rocks is intensively replaced by chlorite with muscovite and leucoxene.

The final stage of acid leaching in the formed silicic metasomatites was the deposition of magnetite and sulfides (arsenopyrite, pyrite, and pyrrhotite). In the process of alkaline metasomatism, most plagioclase grains are replaced by cloudy-spotty accumulations of non-twinned fine-grained albite, among which microrelicts of intensely sericitized primary plagioclase are common; less often, albite rim is observed in some plagioclase crystal grains. Porphyritic grains of plagioclase are almost completely replaced by microgranular calcite with small spotted albite segregations. Sometimes plagioclase and hornblende crystals are completely pseudomorphically replaced by calcite.

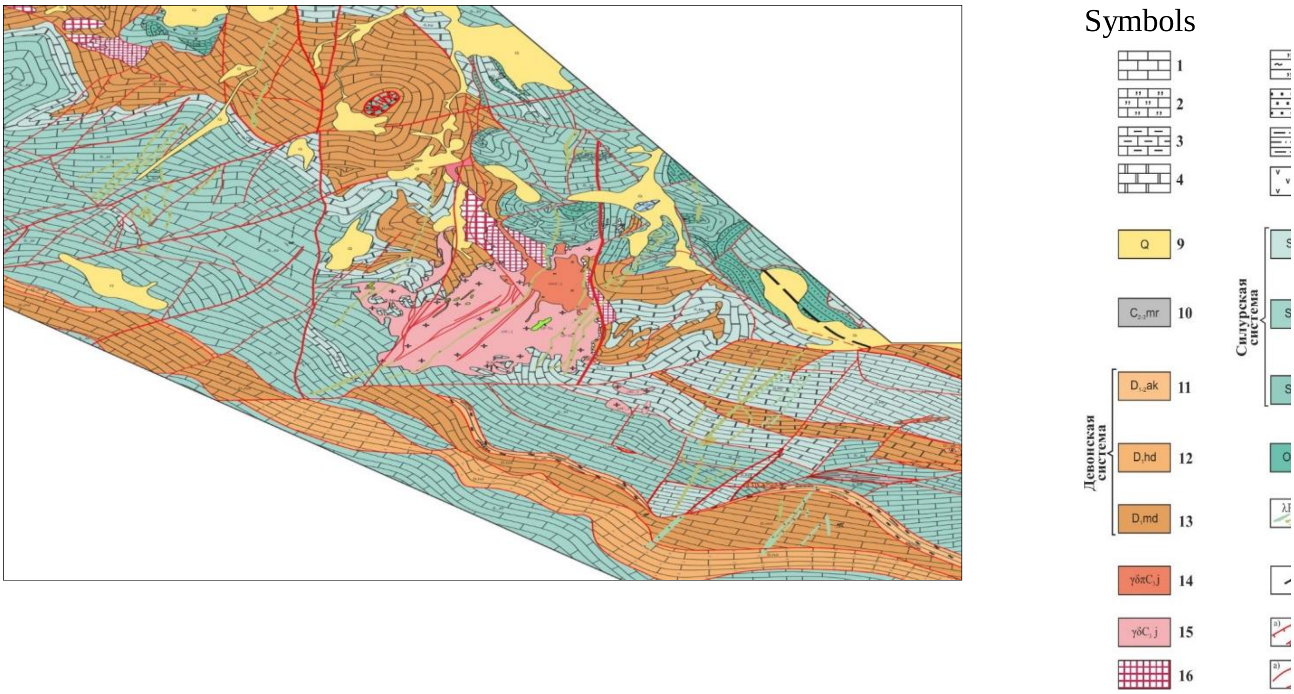
Metasomatic quartz usually forms isometric grains no larger than 0.5 mm, often grouped into small nests, and, together with potassium feldspar and rare grains of chlorite, fills interstitium between plagioclase and hornblende grains along biotite. Other areas are dominated by quartz with tremolite, chlorite, and sphene. Separate areas of metasomatites are composed of almost pure fine-grained calcite.

The result of integral silicicolic metasomatism was rocks represented by a residual matrix of original granodiorites, consisting of primary quartz, albitized (sometimes completely saussuritized) plagioclase and hornblende relics, completely replaced by chlorite with leucoxene and newly formed minerals, forming various combinations, which are based on metasomatic quartz and calcite, with a wide participation of potassium feldspar and albite and locally manifested epidote, tremolite, monoclinic pyroxene, sphene and apatite.

The described model of the formation of the near-ore space clearly fits into the nature and dynamics of the behavior of the main petrogenic elements in it. In the process of pre-ore metasomatism, a stable trend is formed for the removal of *Na, Al, P* and the addition of *K, Ca, Si* with variable dynamics of the behavior of *Mg* and *Fe*. [nine]. In mineralized zones containing tungsten ore bodies, the trend of Na and P removal increases while maintaining the level of Al removal, and a significant input of *Ca, Si, Mg*, and *Fe* is observed. Attention should be paid to the removal of *K* from the mineralized zones in relation to the host wall metasomatites (Table 1).

Fig. 2.

Schematic geological map of the Yakhton ore field



1 - Limestones; 2 - Limestone-siliceous; 3 - Marl-calcareous; 4 - Dolomites; 5 – silicified schist; 6 - Sandstones; 7 – micaceous-quartz-feldspar hornfelses; 8 - Andesites; 9 - Quaternary deposits undivided; 10 - Carboniferous system. Middle-upper sections undivided, Marguzar Formation; 11 - Devonian system. Lower-middle sections, Akbai Formation; 12 - Devonian system. Lower section, Khodzhakurgan Formation; 13 - Devonian system. Lower section, Madmon Formation; 14 – Yakhton quartz-diorite-granodiorite complex; 15 – biotite-amphibole porphyritic granodiorites, fine-, medium-grained; 16 – Mineralized breccias intensely skarned; 17 - Silurian system. Upper section, Kupruk Formation; 18 - Silurian system. Lower-upper sections, Kuturak Formation; 19 - Silurian system. Lower section, Shing Formation; 20 - Ordovician system. Middle-upper sections, Shakhriomon Formation; 21 – Almalisai gabbro-monzonite-syenite complex; 22 - Elements of rock occurrence; 23 - Thrusts, reverse-thrusts: a) traced, b) inferred; 24 - Reverse faults, discharges: a) traced, b) expected.

The multi-stage and discrete nature of the ore process with telescoping of scheelite, pyrite-arsenopyrite, sulfosalt, lead-zinc and molybdenite mineralization in the near-ore space forms a complex-structured common aureole field of ore-forming elements, which has an internal linear heterogeneity.

At the first stage of studying the tungsten mineralization of the lower stage of the Yakhton deposit, the near-ore space can be conditionally divided into 5 zones, characterized by different clarke concentrations (CC) of tungsten and different behavior of the main ore-forming elements.

The ore bodies are mainly ribbon-shaped with an average thickness of 4-5 m. They are traced along the strike for hundreds of meters.

In general, the entire zone is characterized by above-background contents of *W, Au, Bi, Mo, Ag, Sb, As, Se, Te, Ba* (introduced into the near-ore space at the pre-ore stage): near-background - *Pb, Sn, Cu, Zn, Cd, Mn , U, V*, low background - *Li, Be, Zr, Nb, V, Co, Ni, Ti* and Σ REE.

The mineralized zone containing industrial tungsten ore bodies (with CC *W*>50) is characterized by a significant input of *W, Bi, Ag, Sb, As, Cu*, moderate input of *Mo, Pb, Se, Te, Mn, Co*, neutral behavior of *Sn, Zn, Be, Zr, Cd, Ni, Mn, U, B, Cr* and removal of *Li, Ba, Nb, V*.

Table 1

Model of the formation of the near-ore space and the dynamics of the behavior of the main petrogenic elements in it

Zones in the near-ore space	Elements, g/t						
	Na	Mg	Al	P	K	Ca	Fe
1. Conditionally background granodiorites	22 799	8860	64 827	968	33 904	32 531	28 899
2. External	20 804	9284	62 917	932	33 637	38 910	28 745
3. Remote near-ore	18 775	9633	57 827	668	31 635	42 617	27 593
4. Close near-ore	18 735	11 862	64 675	694	30 201	54 713	33 697

5. Ore-mineralized	15 420	15 740	57 187	627	22 071	82 182	43 705
Clark elements in granodiorites	27 800	11 000	86 000	1100	25 200	24 000	33 000

For tungsten mineralization of the lower tier of the Yakhton deposit, the generalized series of relative intensity has the form *Bi-Te-W-Au-Sb-As-Ag-Se-Mo-Sn-Cu-Be-U-Cd-Cr-B-Ba-Co-Mn*. The first 9 elements are considered as a typomorphic geochemical complex of the object.

To delineate the zones of ore localization in the near-ore space of the lower stage of the Yakhton deposit, a number of intensity factors were calculated (the ratio of the main ore-forming elements to the elements of local removal, normalized to the background). $Ku=W \times Bi \times Te/V \times Nb \times Ni$ has the highest resolution for identifying productive levels of tungsten mineralization, increasing by 5-7 orders of magnitude from conditionally unaltered granodiorites to mineralized zones hosting tungsten ore bodies (Table 2). Quite accurately, the indicated Ki also outlines the near-ore zones with a range of values of 3-5 orders of magnitude.

Normalized through the background: Ki-1 - *W/V;* Ki -2 - *Bi/Nb;* Ki -3 - *Te/Ni;* Ki -4 - $W \times Bi \times Te/V \times Nb \times Ni$.

Table 2

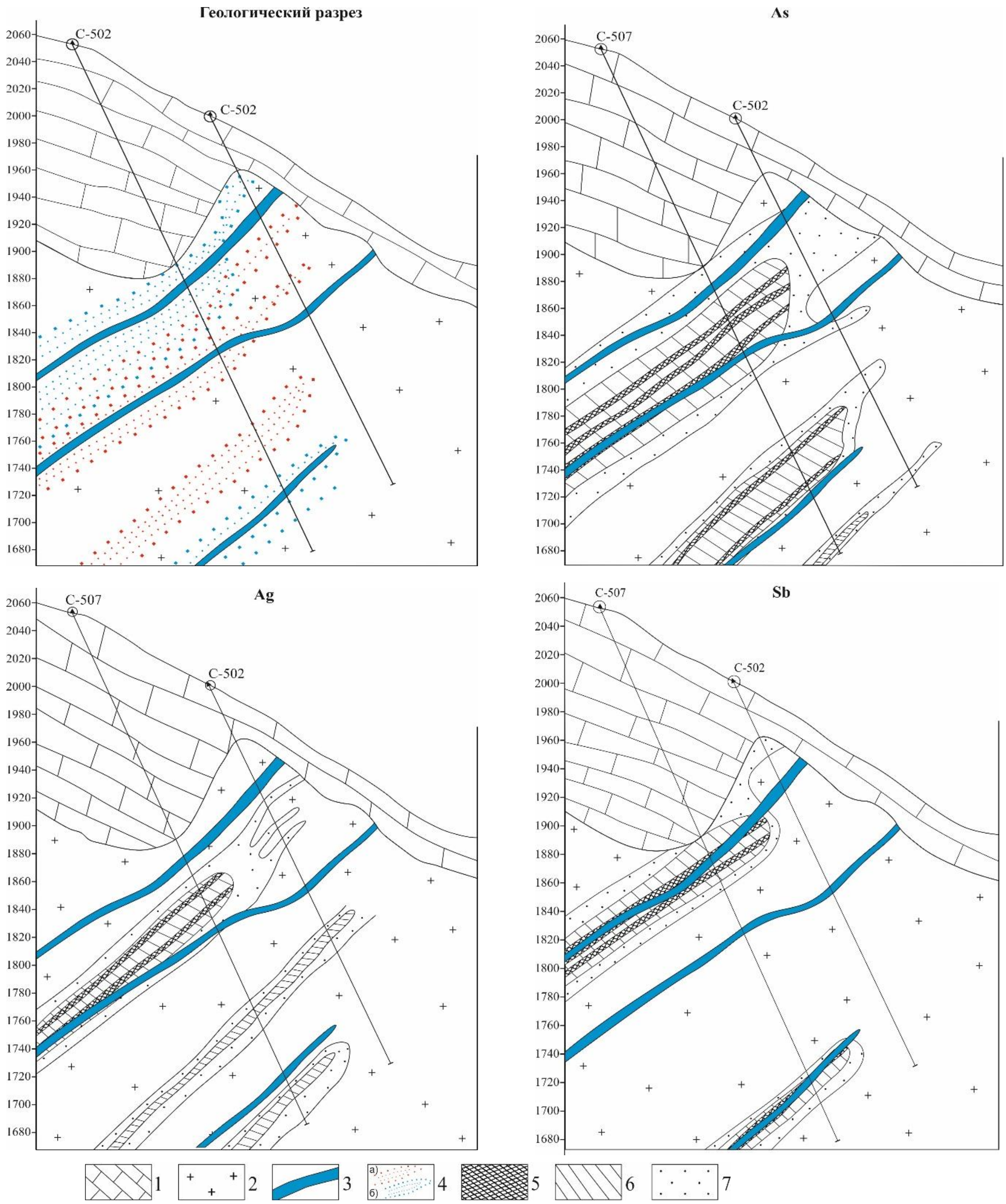
Values of different intensity coefficients in separate zones of the near-ore space of the lower tier of the Yakhton deposit

Zones	Ki-1	Ki -2	Ki -3	Ki -4
Ore-mineralized zone (with CC W > 50)	145–20 323/7278	450–122 877/13 989	314–33 714/5150	$5{,}87 \cdot 10^7$–$2{,}6 \cdot 10^{13}$/ $139\ 966 \cdot 10^6$
Close near-ore zone (with CC W 26–50)	94–250/162	378–237 778/12 085	320–10 936/2873	$3{,}2 \cdot 10^6$–$5{,}13 \cdot 10^{11}$/ $20\ 489 \cdot 10^6$
Remote near-ore zone (with CC W 11–25)	25–222/71	162–57 522/65 919	211–4919/6222	$1{,}99 \cdot 10^6$–$8{,}3 \cdot 10^{11}$/ $15\ 537 \cdot 10^6$
Conditionally background granodiorites (with CC W 1–5)	7–57/31	356–4271/1567	164–2840/964	$2{,}44 \cdot 10^6$–$5{,}33 \cdot 10^8$/ $96{,}9 \cdot 10^6$
Zones of polysulfide mineralization (with telescoping of pyrite-arsenopyrite and sulfosalt mineralization)	15–85/35	124–19 226/2754	400–32 759/4942	$1{,}12 \cdot 10^6$–$9{,}56 \cdot 10^9$/ $608 \cdot 10^6$

Additionally, multiplicative coefficients were calculated that fix the spatial position of gold-bearing and sulfosalt mineral associations. $Au \times Bi$ is a geochemical indicator of gold-bearing mineral associations, the values of which $0,5 - 5 \cdot 10^4$ fix sub-background areas of the near-ore space; $1,4 \cdot 10^5 – 6,7 \cdot 10^6$ – local redistribution fields; $1,2 - 6,8 \cdot 10^7$ - mineralization zones with high gold content (0.1 - 4.0 g/t).

Fig. 3.

Distribution of primary halos of the main ore-forming elements



1 – Carbonate rocks of the frame of the Yakhton intrusion; 2 – Granodiorites of the main phase of the Yakhton Complex; 3 – Tungsten ore bodies; 4 - Zones of mineralization: a) pyrite-

arsenopyrite, b) sulfosalt. Content of elements, g/t: 5 - W - 100-1000, As - 150-500, Ag - 50-250, Sb - 30-100; 6 - W - 50-100, As - 50-150, Ag - 15-30, Sb - 10-30; 7 - W - 20-50, As - 10-50, Ag - 1-5, Sb - 3-10;

$Ag \times Sb \times Pb$ is a geochemical indicator of sulfosalt mineral associations, the range of values of which $2{,}2 \cdot 10^6 - 1{,}4 \cdot 10^8$ has an increased frequency of occurrence in zones of mineralized metasomatites with various sulfosalts; $2 - 6{,}2 \cdot 10^5$ - in zones with scattered sulfosalt mineralization; $2 - 9 \cdot 10^2 - 1{,}1 - 2{,}5 \cdot 10^4$ - in practically unmineralized metasomatites with relic structures of parent granodiorites.

The distribution of primary halos of the main ore-forming elements is illustrated by the example of a section representing the central typical section of the lower stage of the North area of the Yakhton deposit (Fig. 3). The most intense halos in the near-ore space of the lower stage of the Yakhton deposit form elements that are part of the typomorphic association of tungsten mineralization.

The morphology of aureoles as a whole reflects the structure of mineralized zones and their significant internal heterogeneity, emphasizing the metasomatic nature of mineralization.

Stable connections (significant at the level of 5%) in the correlation graphs form blocks: *V-Pb-W-Li; Bi-Au-Te; Ag-Sb-Cu; Pb-Sb-As-Te; Cu-Ni-V-Cr-Zn.*

Analysis of the correlations between the elements made it possible to identify the following patterns [8]:

the presence of *W* in a single block with elements of the “mafic” group (*V*, which, in turn, exhibits close relationships with *Cr* and *Ni*) and the “granitoid” group (*Li*, *Pb*) may indicate different sources of ore matter and the polygenicity of the object;

the absence of correlations between *Mo* and ore-forming elements proves the scattered nature of early molybdenite mineralization in the zone of ore-bearing metasomatites;

various associative chains with the central position of *Sb* in them confirm the presence of two types of sulfosalts in the mineralized zones - antimony-silver with copper and antimony-lead with arsenic and tellurium, which are indicators of the final stages of mineral formation;

the different position in the correlation graphs of *W* and *Au* confirms their autonomy in the formation of the ore space and the possibility of identifying isolated rare-metal and gold-bearing ore bodies.

Based on the article, the following **conclusions** can be drawn:

1. Integral metasomatism of the lower stage of the Yakhton deposit has a silicic-alkaline orientation with the introduction of *Ca*, *Si*, *Mg*, and *Fe* into the near-ore space.

2. A typomorphic complex of elements of apogranitoid tungsten mineralization was revealed, represented by the series *W-Bi-Te-Au-Sb-As-Ag-Se-Mo*.

3. On the basis of the analysis performed, a number of geochemical coefficients were created and tested, fixing the contrast values of various parts of the near-ore space.

4. The studied geochemical field clearly shows the echelon structure of mineralized zones in the general ore-bearing structure.

5. The supra-ore-upper-ore level of primary aureoles makes it possible, on the basis of geochemical constructions, to predict new ore bodies to a depth.

6. Correlations of the main ore-generating elements reflect the multi-stage nature of the ore process in the lower tier of the Yakhton deposit and additionally emphasize the telescoping of mineral associations in the near-ore space of tungsten-bearing mineralized zones.

7. The presence of such elements as *Cr, Ni, Mg, Fe*, and *C* in the ore process indicates a subcrustal (mantle) source of ore matter, the derivatives of which are also dykes of subalkaline gabbroids and lamprophyres (alkaline-basaltoid formation of activated orogenic regions).

8. Polygenicity and polychronism of ore concentrations of the lower tier of the Yakhton deposit is probably the key to the significant scale of this object.

REFERENCES

1. *Атлас* моделей рудных месторождений Узбекистана / Под ред. И.Б.Турамуратова. – Ташкент: ГП НИИМР, 2010.
2. *Даутов А.* Минералого-геохимические критерии условий формирования и потенциальной рудоносности Кошрабадского и Яхтонского интрузивов (Западный Узбекистан) // Дис. … канд. геол.-минер наук. – Ташкент.: ИГГ АН РУз, 1974.
3. *Жураев М.Н., Тураев Т.Н.* Новые типы вольфрамового оруденения Каратюбе-Чакылкалянского рудного района // Горный вестник Узбекистана. 2017. № 3. С. 63–67.
4. *Раскин В.Е., Жураев М.Н.* Особенности локализации скарново-шеелитового орудинения Каратюбе-Чакылкалянских гор // Республиканская научно-практическая конфиренция «Актуальные проблемы геологии, геофизики и металлогении». – Ташкент, 2017. С. 273–276.
5. *Рудные* месторождения Узбекистана / Под ред. Н.А.Ахмедова. – Ташкент: ГИДРОИНГЕО, 2001. 611 стр.
6. *Бородин Л.С., Лашин А.В., Пятенко И.К.* Петрология и геохимия даек щелочно-ультраосновных пород и кимберлитов. – М.: Наука, 1976. 256 стр.
7. *Рафаилович М.С., Шевкунов А.Г., Колоскова С.М., Ежков Ю.Б.* Вольфрамовая минерализация в крупных месторождениях золота в углеродисто-терригенных толщах Средней Азии. // Геология и минеральные ресурсы. 2013. №3.
8. *Жўраев М.Н., Тураев Т.Н., Мухаммадиев Б.У.* Геохимические особенности апогранитоидного вольфрамового оруденения (на примере нижнего яруса месторождения Яхтон) // Региональная геология и металлогения. - Санкт-Петербург, 2018. - № 75. - С. 104-111.
9. *Жураев М.Н. Акбаров Х.А. Тураев Т.Н. Рахмонов А.У.* Магматические образования Яхтонского рудного поля и их роль в формировании вольфрамового оруденения (Чакылкалянские горы) // Геология и минеральные ресурсы. – Ташкент 2019. - № 4. – С. 16-23.