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Features of Geological Structure and Mineragenic Specialization of Sheikhdzheyli-Zengiboba of the Sultan-Uvais Ridge Area

Mukaddaskhon Khabibkhon kizi Khodjaeva[1], Atxam Minakhmadovich Zamanov[2]
[1]Master, University of Geological Sciences Tashkent, Uzbekistan
[2]Senior geologist, State Unitary Enterprise "Regionalgeologia" of the State Committee for Geology of the Republic of Uzbekistan, Tashkent, Uzbekistan

ABSTRACT: The productive mineralization of the Sheikhdzheili-Zengiboba area is associated with metamorphogenic transformations of the rocks of the Urusai, Karauzyak, Kuyanchik, Sheikhdzheili suites, metamorphosed under conditions of green schist facies. The mineralized zones of the site are confined to narrow faults in the tectonic zones of the northeast and northwest directions. The main form of manifestation of gold-bearing mineralization is small steeply dipping veins, lenses, nests, non-extended systems of conformal and secant quartz veinlets containing dissemination of pyrite, arsenopyrite, chalcopyrite and pyrrhotite, which are represented by gold-arsenopyrite-pyrite, gold-arsenopyrite-chalcopyrite-pyrite natural type of ores.

KEYWORDS: Karakalpak Autonomous Republic, Sultan-Uvais Ridge, Sheikhdzheili trains, Sheikhdzheyli-Zengiboba area, stratigraphic units (Sheikhdzheyli fragment), Urusai, Karauzyak, Kuyanchik, Sheikhdzheylinskaya suites, Sheikhdzheylinsky subvolcanic complex, Zengebobinsky hypabyssal complex, Kubatau leucogranite complex, metasome hydrothermal and supergene processes, petrographic composition, mineral composition, gold, pyrite, mineralization, sulfide-gold mineralization, arsenopyrite, copper, nickel, cobalt, silver.

INTRODUCTION

The Sultanuvais Ridge, located in the extreme southwestern part of the Kyzyl-Kum, is administratively part of the Karakalpak Autonomous Republic. It is characterized by an exceptionally wide occurrence of deeply metamorphosed Phanerozoic rocks (Fig-1).

The study of the geological structure of the ridge began with the work of Barbot De Marni (1874) and then continued by A.E. Voznesensky, K.A. Popov, I.A. Preobrazhensky (1912), A.I. Churakov, A.V. Pek (1936) and Ya.S. Visnevsky (1940). In these works, titanomagnetite ores associated with basic rocks were noted. Subsequent studies on searches, geological surveys were carried out by G.Yu. Naferov, A.A. Kulesh, R.I. Burtman and others (1953-1956), A.P. and etc. (1966-1967), D.T.Boyonov, Sh.T.Toshpulatov (2011-2020). Thematic research work was carried out by V.V. Baranov, K.M. Kromskoy, A.F. Sviridenko and others. (1963-1972), A.A.Kustarnika (1971), O.I.Kim (1971), S.S. Baranov et al. (1982), K.A. Keshishyan (1983), A.K. Bukharin et al. (1990), G.R. Yusupov (2012), O.N. Nikitinai and V.K. Panasyuchenko (2007), Boyenova. D.T. (2009), R.I. Koneev et al., 2010, V.D. Tsoi et al. (2011) and many others.

MAIN PART

According to recent studies (Zamanov A.M., Nikitina T.N., 2021), from the standpoint of geodynamic constructions (tectonic zoning), four large tectonic structures, fragments of terranes have been identified in the Sultanuvai (Sultanuizdag) mining region: Sheikhdzheili, Jamansay, Karakuduk and Kazansay. The tectonic boundary between the first and second terranes is the Urusai fault filled with mixtite; between Dzhamansay and Karakuduk, and the latter with Kazansay - there are sutures made of ophiolite melange (Fig-2).

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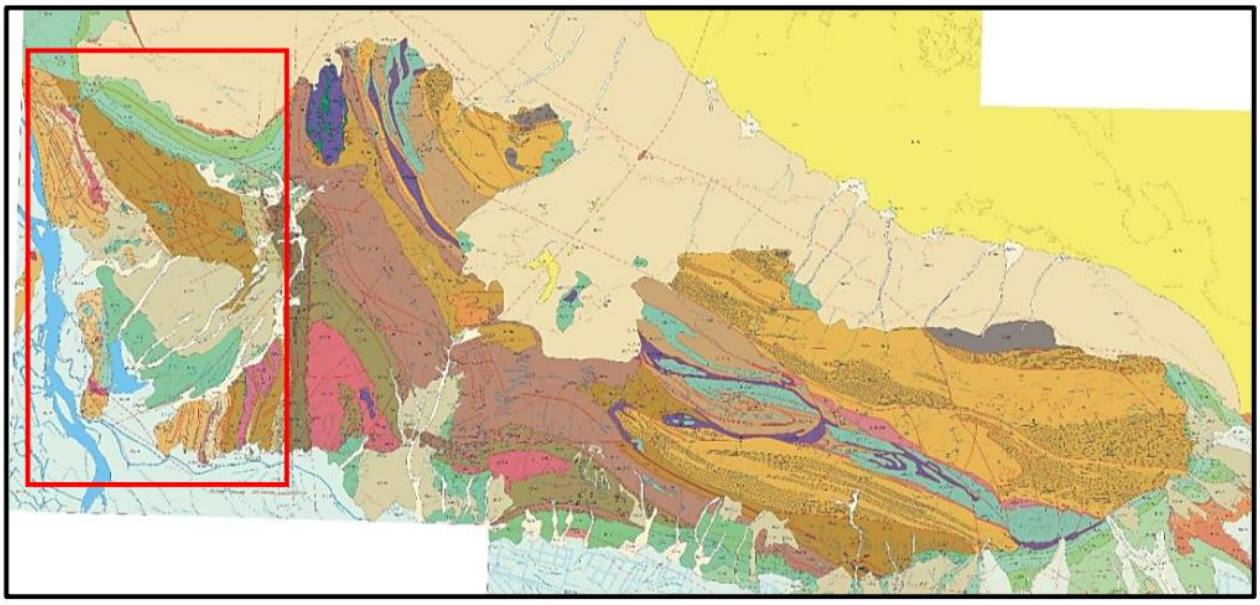

Fig.1. Geological map of the Sultan-Uvais mountains scale 1:50000. Nikitina O.N., 2007
(the selected area is the location of the Sheikhjeyli-Zengibobinskaya area.

In turn, these fragments of terranes, for example, the Sheikhdzheili terrane is the extreme southeastern part of the Ustyurt microcontinent; Dzhamansay, Karakuduk belong to the larger alpine-type fold-thrust belt of the Southern Tien Shan (STS) - the Katarmai belt and the Turkestan ophiolite terrane; Kazansay in the Middle Tien Shan - Beltau-Kurama volcano-plutonic belt; Istemessky, in turn, is the northernmost part of the Southwestern Tien Shan (SWTS) - in the Baysun microcontinent. Some researchers attribute the volcanogenic complexes of the Berkuttau Formation, located in the northernmost part of the Sultanuvais Mountains, to the Middle Tien Shan (MTS) fold-and-thrust belt.

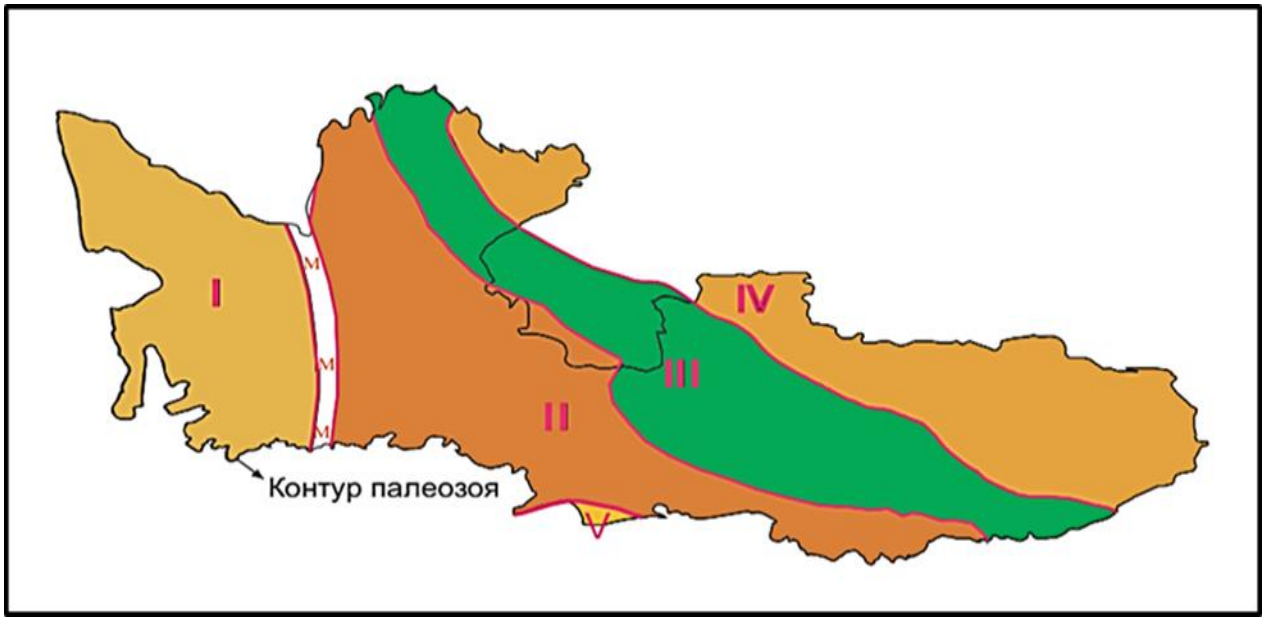

Fig-2. Scheme of structural-tectonic zoning of Sultanuvais mountains
(Zamanov A.M., Nikitina T.N., 2021)

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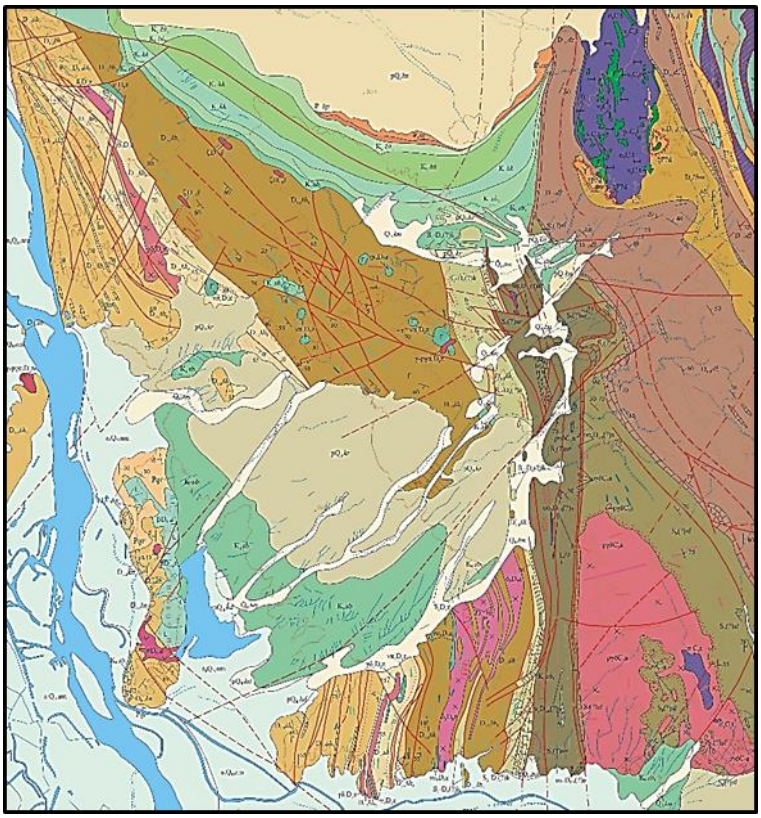
Terrain name (SVK): I- *Ustyurt (Sheikhdzheili),* **II**- *Katarmai (Jamansay),* **III**- *Turkestan ophiolite (Karakuduk),* **IV**- *Beltau-Kuraminsky volcano-plutonic belt (Kazansai),* **V**- *Afghan-Tajik (Baysun),* **M**- *Mixtite of Urusai.*

Stratigraphic subdivisions of the Ustyurt microcontinent (Sheikhdzheili fragment).

The Sheikhdzheili fragment is composed of Paleozoic deposits of the following Paleozoic strata and formations: Urusai, Karauzyak, Kuyanchik, Sheikhdzheili and Gaurkala, as well as Buronskaya, Beshtamskaya deposits penetrated by boreholes (Fig-3).

Karauzyak strata – **S_2-D_1(?) *k*** Upper Silurian - Lower Devonian (?)

It is named after the Karauzyak railway station. Distinguished from the composition of the Sheikhdzheili Formation in the volume of carbonate-terrigenous (black shale) strata (Baranov, 1982). The sediments of the sequence are exposed in the central part of the Western Sultanuvais, at a distance of 11 km from the village. Aktau in the south to the Tebinbulaksay valley in the north.



Rice. 3. Schematic geological map of the western part of the Sultan-Uvais Ridge. Sheikhjeyli-Zengibobinskaya area.

It has tectonic submeridional contacts with the Urusai strata and the lower part of the Sheikhdzheili stratum, located in the hanging wall of the Urusai fault, dipping west at angles of 65-80^0. Sediments of the Sheikhdzheili Formation, the main formations of the Sheikhdzheili terrane are pushed over the formations of the Karauzyak Formation (Nikitina T.N. 2007). By position in space and by the nature of contacts with the listed suites, the Karauzyak suite has the same nature as the Urusai suite.

According to the lithological composition, the sequence is divided into three members.

The first (eastern) pack adjacent to the zone of the Urusai faults, tectonically in contact with the deposits of the Urusai suite, consists mainly of metasandstones with interlayers of metasiltstones and marbled limestones (250 m).

The second pack - carbonaceous shales, phyllites and phyllite-like shales, marmorized limestones with lenses of metasandstones and metasiltstones (270 m).

The third pack – phyllites, phyllite-like shales with lenses and interlayers of carbonaceous shales, metasiltstones, metasandstones, and limestones (215 m).

The total thickness of the strata is 735m.

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The rocks of the sequence have undergone uneven melanging, silicification and dolomitization.

The sequence is characterized by sulfide-gold mineralization with arsenic.

In pyrite and arsenopyrite, an increased content of gold was noted (in pyrite - up to 56 g / t, in arsenopyrite - up to 328 g / t), as well as copper, nickel, cobalt, silver (V.V. Baranov, Yu.N. Kornienko and others. , 1982). Gold is also noted in carbonate metasomatic neoformations (A.B. Kholikov, O.A. Nikitina, 2005; R.I. Koneev et al., 2010, V.D. Tsoi et al., 2011).

Sheikhdzheylinskaya stratum **D_{1-2}*šh***. Lower-Middle Devonian Upper Emsian Substage - Lower Eifelian

Named after the mountains of Sheikhjeili. It was identified as the Sheikhdzheili Formation by a group of geologists of the Uzbek Geological Administration (Alferov, 1965). It is developed in the west of the Sultanuizdag mountains, where it forms the Sheikhjeili, Karatau, Dzhimurtau, Zengebobo, Kekiliktau uplands.

The Sheikhdzheili stratum is divided into three substrata. In the Sheikhdzheili Mountains, the lower substratum is composed of effusive basalts, basaltic andesites and their lithoclastic and lithic-vitroclastic tuffs of psephytic, psammite, aleuropelitic, pelitic, and rarely fine-lapillitic, containing lenses of tuff gravel sandstones along the periphery. The basalts contain small xenoliths, lenses, and large remnants of marmorized Devonian limestones. The thickness of the lower thickness is up to 500 m.

Medium underlay. Andesitic lavas, tuff lavas, tuffs, tuffites, limestones with pyroclastics. At the base are spherical andesitic lavas and hyaloclastites. In the roof gravel sandstone, limestone lenses (olistoliths?) with gastropods *Pseudorigopleurasp., Euphemitessp., Bayleasp., Junnamasp,* thickness up to 755 m.

Upper underlay. Lavas, tuff lavas of dacites, rhyodacites, rhyolites and their tuffs, with lenses of limestones, tuff siltstones and tuff gravelites, thickness 285 m.

The age of the sequence, based on the species of brachiopods and corals, is considered in the range from the Emsian stage of the Lower Devonian to the Eifelian of the Middle Devonian (Stratigraphic Dictionary, 2001).

Kuyanchik stratum **D_{2-3}*kn***. Middle-Upper Devonian, Eifelian-Famenian stages. It is named after the Kuyanchik Mt. Sultanuizdag.

Highlighted by S.S. Schultz Jr. in 1968

The sequence includes limestones exposed in the western foot of the Kuyanchik ridge for 5.5 km.

Bottom-up section is:

1. Limestones are gray and light gray, fine-grained and micro-grained thick-layered organogenic and organogenic-detrital with remains of tabulatomorphic corals. Visible power up to 38m.

2. Limestones are gray, bluish-gray thin- and micro-grained, thickly bedded. They contain shells of large brachiopods and gastropods. The seam thickness is 12m.

3. Above the thick-layered limestones there is a member of light-gray and gray thin-layered limestones with remains of rugoses and tabulatomorphic corals. Pack capacity up to 35m.

The thickness of the Famennian part of the section is 85m. The lower part of the section is exposed by erosion valleys at the northern end of the Kuyanchik Ridge.

Urusai stratum **C_2*ur*.** Medium carbon. Named after Urusai, Sultanuizdag mountains. Highlighted by K.A. Keshishyan in 1965 (Kulesh, 1974). The formations of the sequence extend along the western exocontact of the Aktau granodiorite intrusion from the south (from Aktau settlement) to the north (to the southern and northern closure of the Tebinbulak ultrabasic massif), and further north at a distance of about 11 km, do not have stratigraphic relationships with the adjacent Karauzyak and Sultanuizdag strata retinue except tectonic.

According to A.I. Kim, Z.M. Abduazimova, R.Kh. Mirkamalova, F.K. Divaeva et al., the Urusai sequence is not a stratigraphic subdivision, but is a mixtite sequence, consisting of tectonic blocks and plates, among which are fixed both serpentinite lenses and dike-like bodies of strongly altered albitophyres.

The sequence is composed of volcanogenic-carbonate-terrigenous formations. Carbonate-terrigenous formations predominate in the section of the suite and are represented by carbonaceous phyllite-like, quartzite-like shales with interlayers of metasandstones, marmorized limestones, and dolomites.

Volcanites are represented by high-alumina metadacites, metaandesites, metabasalts of the potassium-sodium series, metatuffs and metatuffites.

The thickness of the Urusai stratum is 476-600 m.

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Age of the Urusai sequence based on finds in crinoid limestones.

Magmatic, subvolcanic and metamorphogenic formations of the Sheikhdzheili-Zengiboba area

Magmatic and metamorphogenic formations are described with exhaustive completeness by S.S. Schultz (1972), O.I. Kim (1974), Z.A. Yudalevich (1975), V.V. Baranov (1992), S.I. Logvin (2000), L.I. Dementeenko (Artykov, 2003), whose works form the basis for the description of units.

Within the limits of the studied horse, according to the features of the material composition, internal structure and position in the structure of the region, the following were distinguished:

1. Sheikhjeyli subvolcanic complex **β-α-λ D_{1-2} šh**
2. Zengeboba hypabyssal complex **υ-δ-pγ D_{2-3} z**
3. Kubatau leucogranite complex **lγ Pkb**

1. Volcanogenic and plutonic complexes of the Ustyurt microcontent (Sheikhdzheili fragment)

Sheikhjeyli subvolcanic complex **(β-α-λ D_{1-2}šh)**

Formation type - subvolcanic basalt-andesite-rhyolitic

Separated into an independent complex by Divaev F.K. and others as a result of geological surveys at a scale of 1:10,000 in 2005.

It is developed on the heights of Sheikhdzheili, Kekliktau and Zengebobo. It unites basalts, dolerites, basaltic andesites, andesites, dacites, rhyodacites, rhyolites and plagiorhyodacites of a continuous basalt-andesite-rhyolite formation. Early basaltoids form meridional fissure bodies, dikes, and shallow vents. Their fissure bodies on the northwestern slopes of Karatau reach a width of 80-350 m with a length of up to 1 km. Andesite, dacite, rhyodacite, and rhyolite dikes occur in NW-trending fractures and are a few meters thick.

Basalts, basaltic andesites, and andesites cut through the Devonian carbonate substrate.

The basalts of the complex belong to the tholeiitic series. They are characterized by normal (moderate) alkalinity of sodium and low potassium types, moderate alumina content.

The rocks are propylitized, sericitized, slightly silicified.

Rocks of the calc-alkaline series, sodium profile of the normal series, low-potassium moderately and high-alumina.

2. Zengeboba hypabyssal complex (υ-δ-pγ D_{2-3}z)

Middle - Upper Devonian

Formation type - gabbro-diorite plagiogranite

S.S. was first identified. Schultz (1972) as a complex of granodiorites and diorites. The name is given by the mazar of the same name, where these rocks are exposed.

The complex consists of four phases:

- the first - gabbro, leucocratic gabbro, gabbro-diabase;
- the second - diorites, quartz diorites;
- the third - porphyritic granodiorites, plagiogranites;
- fourth - dikes and dike-like bodies of albitophyres, quartz porphyries, and granite-porphyries.

The vein rocks are represented by dikes of syenite-diorite and diorite porphyrites, syenite-porphyry, and pegmatoid syenites. The rocks of the complex are characterized by a homodromic evolution of composition from early manifestations to late manifestations with a gradual increase in acidity. The content of SiO2 (Kustarnikov, 1971; Keshishyan, 1983; Baranov, 1987) increases from 48% in gabbro to 70-73% in quartz albitophyres. The alkalinity of the rocks has a pronounced sodium specialization.

Gabbro fine and medium-grained crushed, cataclased, biotitized, leucoxenized.

Phase II diorites and quartz diorites are exposed as linear submeridional intrusions in the Zengebobo massif and the Sheikhdzheili mountains, as a small stock in the south of the Dzhimurtau ridge (the intrusions are weakly eroded.

Phase III rocks - porphyritic granodiorites, fine-grained plagiogranites are exposed in the central part of the Sheikhdzheili and Zengebobo mountains as linear bodies of submeridional and northwestern strike, cutting the volcanic rocks of the Sheikhdzheili Formation.

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Dikes and dike-like bodies of phase IV (albitophyres, quartz porphyries, and granite-porphyries) cut through massive Devonian limestones, effusive and pyroclastic rocks of the Sheikhdzheylinskaya sequence, phyllite-like shales of the Karauzyakskaya sequence, and are also intruded into tectonic zones of submeridional strike.

All rocks of the complex have been largely altered by metamorphic (green schist facies) and hydrothermal processes.

Diorites of the complex are associated with gold-molybdenum-copper mineralization of porphyry copper (Boshchekul) type. The mineral type of ore is chalcopyrite-pyrite-magnetite, chalcopyrite-pyrite-molybdenite, gold-chalcopyrite-pyrite. Manifestations of copper, partly platinoids and gold are associated with gabbroids and diorites, and with rocks of the fourth phase - gold.

3. Kubatau complex (lγ Pkb). The formational type is leucocratic granites. Highlighted by S.S. Schultz Jr. (1972). It is represented by the intrusive of the same name, which forms the Kubatau Upland, located on the left bank of the Amu Darya. The main body of the intrusive is composed of medium-grained leucocratic biotite and biotite-muscovite granites of dark pink, meat- and brick-red color, slightly gneiss-like composition. In the petrotype, granites cut through intensely dislocated crystalline schists, marbles, andesitic tuffs, calcareous schists, and greywackes, forming deep apophyses in the enclosing strata, and contain a significant amount of xenoliths. In the southeastern exocontact of the intrusion, the hosts are hornfelsed. In all directions, the granites are penetrated by aplite and pegmatite veins.

In the Sultanuvais mountains south of the Darbazatau ridge, two-mica microclinized coarse-grained granites of the Kubatau complex are exposed in dike-like apophyses and small dome-shaped bodies, tearing gneisses and amphibolites of the Istemes migmatite-granite-gneiss complex and phyllonitized black silty sandy shales in the thrust zone.

Pinkish and light gray fine- and medium-grained granites with variable content of biotite and muscovite. In the composition in%: potassium feldspar - 30-40, quartz - 30-35; plagioclase - 15-20; muscovite - 5-10; biotite - up to 2-3. Accessory minerals include zircon, apatite, tourmaline, and garnet; ore minerals include magnetite, ilmenite, zincite, sphalerite, galena, and pyrite.

Dikes of leucocratic two-mica granites, tearing plagiogranites of the Aktau complex, are observed in the western part of the Aktau intrusion. They cut through both intrusive plagiogranites and early quartz diorite dikes. The thickness of the dikes is 2-20 m, the length is from several tens of meters to 1 km. Light pink, medium- and fine-grained slightly gneissed granites. Composition in %%: quartz-35-40, plagioclase-25-30; potassium feldspar-20-25; muscovite-10-15; biotite - in rare laths. Grains of the ore mineral and xenomorphic grains of transparent apatite are rare.

In the sands of Shavashkum on the p / b river. Amu Darya, 6-7 km south of the Darbazatau ridge, biotite and two-mica leucogranites of the Kubatau complex were discovered by wells 14, 15, 17 (Artykov et al., 2003). At depths of 90-145 m, apophyses of leucogranites, having a thickness of 3-5 m, cut through garnet-bearing two-feldspar granite-gneisses. Leucogranites are characterized by sodium-potassium alkalinity of the normal series and a very high alumina content. They have sphene-zircon-apatite (sometimes with garnet and tourmaline) type of accessory mineralization, contain slightly elevated concentrations of molybdenum, tin, gallium, yttrium and lanthanum. The ratio Na / K~1 and the values Ca ≥ Na indicate the manifestation of the process of autometasomatosis (greisenization). The ratio Ni/Co ≥ 1 indicates the position of the exposed apophyses of leucogranites in the uppermost part of the marginal zone of the intrusive occurrence.

The vein rocks of the Kubatau complex are represented by pegmatoid and aplite-like garnet-tourmaline-muscovite granites and granite-pegmatites. Rare-metal granite-pegmatites can be traced in an extended latitudinal zone from the foot of the Darbazatau ridge to the valley of the brook. Mumiyokansai, and are accompanied by veins of biotite-muscovite-quartz-albite-microcline composition (with orthoclase, tourmaline, beryl, tantalite, garnet). Beryl and tantalite contents close to commercial values are observed in partially albitized granite-pegmatites.

The geological age of the complex is determined by the intrusion of dikes of leucocratic two-mica granites into the plagiogranites of the Aktau complex and by the structural position of the intrusion of granite bodies and associated veins of transparent smoky icy quartz into the sublatitudinal upthrust-slip-slip zone south of the Darbazatau Ridge. The northern endocontacts of the granite bodies retained the hardening zone, the southern contacts were cataclased under the pressure of the regional Istemes thrust. The thrust zone separates the Sultanuvai Paleozoic volcanic arc and the Southern microcontinent (a fragment of the Baysuntau terrane), the base of which is composed of the Riphean migmatite–granite–gneiss complex. In the eastern part of the fold-thrust belt, such structural relationships are characteristic of Late Carboniferous-Early Permian leucogranites.

Absolute age of granites in the southern foot of the Darbazatau ridge according to K-Ar (from biotite): 252+7 Ma. years (Kulesh, 1972).

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The rocks are low-potassium, moderately ferruginous, non-magnetic. Increased content of bismuth, molybdenum, vanadium, chromium, cobalt, nickel, copper.

CONCLUSION

The collected and analyzed material of previous researchers allows us to draw the following conclusions on the geological structure and geochemical specialization of the Sheikhdzheili-Zngibobinskaya area of the Sultan-Uvais ridge.

1. From the standpoint of geodynamic constructions (tectonic zoning) in the Sultan-Uvai (Sultanuizdag) mining region, four large tectonic structures, fragments of terranes were identified: Sheikhdzheili, Dzhamansay, Karakuduk and Kazansay. The tectonic boundary between the first and second terranes is the Urusai fault filled with mixtite.

2. The Karauzyak sequence is characterized by sulfide-gold mineralization with arsenic. In pyrite and arsenopyrite, an increased content of gold is noted (in pyrite - up to 56 u / e, in arsenopyrite - up to 328 u / e), as well as copper, nickel, cobalt, silver.

3. All rocks of the Zengeboba hypabyssal complex are largely altered by metamorphic (greenschist facies) and hydrothermal processes. The manifestations of copper, partly platinoids and gold are associated with gabbroids and diorites.

4. The metamorphosed subvolcanic, effusive and pyroclastic facies of the Sheikhdzheili basalt-andesite-dacite-rhyolite association contain gold-silver-copper mineralization. The mineral type of ores is gold-arsenopyrite-pyrite, gold-arsenopyrite-chalcopyrite-pyrite.

5. Diorites of the Zengeboba hypabyssal complex (complex) are associated with gold-molybdenum-copper mineralization of the porphyry copper type. The mineral type of ore is chalcopyrite-pyrite-magnetite, chalcopyrite-pyrite-molybdenite, gold-chalcopyrite-pyrite. Ore-bearing rocks are propylites, sericitolites and biotite metasomatites.

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