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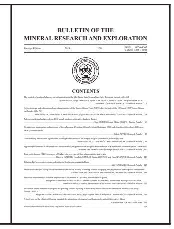

Typomorphic features of the quartz of various mineral paragenesis from the gold mineralization in Karakshatau Mountains (West Uzbekistan)

Svetlana KOLOSKOVA[a] and Jakhongir MOVLANOV[a*]

[a]*Institute of Mineral Resources State Enterprise of the State Committee of the Republic of Uzbekistan on Geology and Mineral Resources, Tashkent*

Research Article

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ABSTRACT

As a result of complex studies - geological-structural, morphostructural analytical, mineralogical mapping of quartz formations, detailed geochemical work and analysis of geochemical fields – forecasting prospecting features of gold ore taxon's: ore zone; ore field; deposit and ore body. They are characterized by groups of criteria: morphostructural, stratigraphic-lithological, structural-tectonic, magmatic, geophysical, metasomatic, mineralogical, geochemical factors and attributes, and a geological-genetic model of the gold-bearing ore-forming system in the collapse zone. Favorable geological and structural conditions for the localization of gold mineralization in the mountains of Karakchatau are associated with the areas of long-term tectonic-magmatic activation in metalliferous sediments of Є-O contrast lithological composition. The coincidence of manifestations of gold mineralization to the blocks formed by transverse faults at the sites where they intersected the Karakchatau crush zone was noted. To the channel-localizing parts inside are blocky and unextended interblock tectonic structures with positions in favorable "structural traps" in their azimuthal curvatures of executed productive types of hydrothermal, sulfidizing quartz. The results of mineralogical mapping of quartz formations along the Karakchatau crush zone (Western Uzbekistan) are considered. Five genetic types of quartz are distinguished. The most productive of them is hydrothermal quartz of types 3 and 4 associated with pyrite,arsenopyrite and gold, which forms vein fields in areas of kinks and expansion of the zone of crushing. Identification of any goods and services that can be used for commercial purposes, including in the geological structure, other regions of Western Uzbekistan.

1. Introduction

The Karakchatau mountains are taken place among the areas with the potential of covered ore-grade gold in Nurata region. The purpose of this study is to expand and reveal the mineral resource base of the Republic of Uzbekistan for gold, covered, inaccessible depths, mineralization in areas with operating mining enterprises.

With modern definition, typomorphism is a phenomenon in which a number of minerals and their paragenesis are formed in strictly defined, relatively narrow in the range, thermodynamic conditions, clearly recording the nature of these conditions. Theory of the typomorphism of minerals mainly include - general geological, crystal and morphological, chemical, structural, isotopic and thermal and barometric characteristics. A mineralogical study of the rock samples from vein quartz formations of various genetic types of the Karakchatau shear zone focused on the features of the external appearance of

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* *Corresponding author: Jakhongir MOVLANOV, jahongir79@mail.ru*

quartz, the mineral composition of paragenesis, and the interrelationships of minerals and the morphology of quartz (Babaev, 1951; 1985).

2. Regional Geology

The Karakchatau mountains are located in the Zarafshan-Turkestan structural-formation zone, where the prevailing part of the industrial gold potential of Western Uzbekistan is associated with (Figure 1). The regional ore controlling structures of the first order are the branches of the South Nurata Fault - the North and South, the component link of the last Karakchatau and Karatau fault zones (Koloskova, 2007). During collisional stage, the shear zones are important structures for ore-bearing hydrothermal systems and ore-controlling structures and also variety of mineralization is so common in these zones. Shear zones are outcropped in Pre-Mesozoic basement rocks along 90 to 180 km, respectively, the width of them from 1-2 to 5-6 km. On the bearing of these zones, local shear zones are revealed, representing individual branches of the general structure.

The features of the geological structure and ore content, that developed in intensively deformed Pre-Mesozoic basement rocks are represented with two main rock types: sedimentary - terrigenous, siliceous and carbonate rocks; and intrusive – dikes. The sediment covered-folded structure of the mountains of Karakchataus, as well as of the South Nuratau region as a whole, was formed because of prolonged processes of sedimentation (Koloskova, 2007; 2008; Yanovsky, 1990).

3. Material and Method

Study of the typomorphism of quartz minerals is based on visually observed signs, polished thin sections investigation, scanning electron microscope (SEM), and spectral data analysis. Mineralogical mapping study was completed by using 2000 points of random distributed quartz minerals which are located in outcropped part of pre-Mesozoic basement rocks. Quantitative indicators identify anomalous areas identified within the individual segments of the zone.

4. Distribution of the Quartz Bodies

The index of "silicification", represents average length and thickness of quartz bodies in higher values, indicates the level of ore bearing quartzolite in the

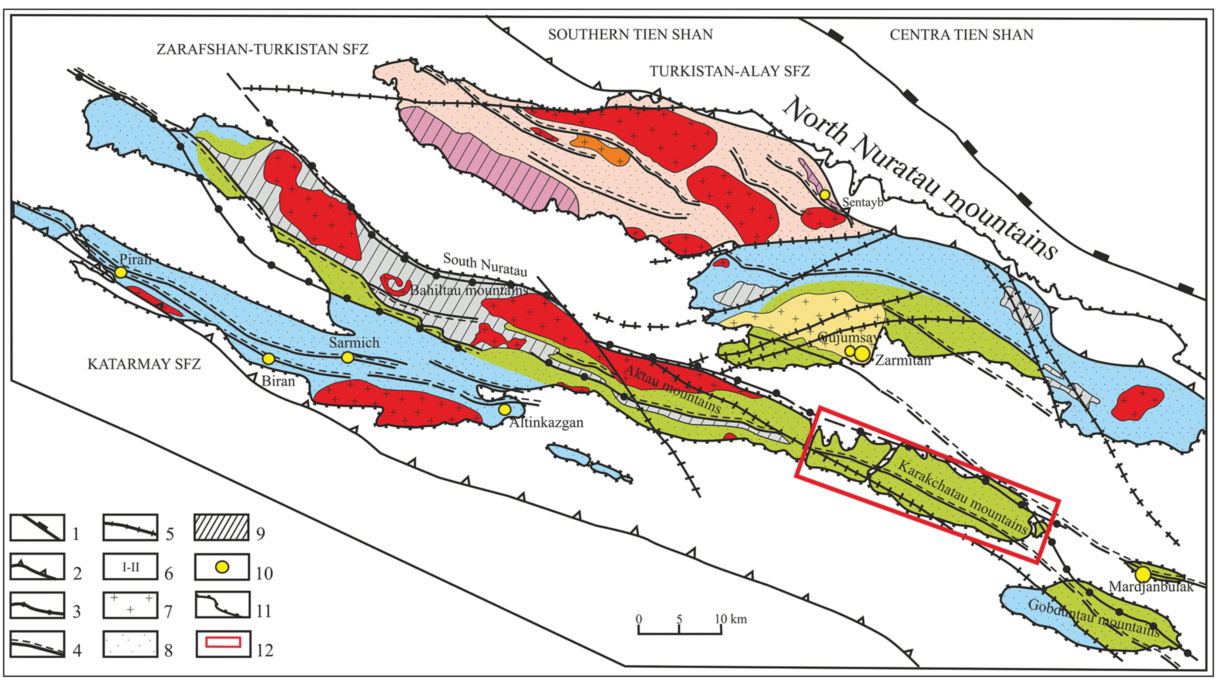

Figure 1- Geological map of study area. Structures: 1 - boundary of folded systems of the Middle and Southern Tien Shan; 2 -4 boundary of structural and formation zones; mainly intra-block, with functions of ore-bearing and ore-distributing; 5-block forming faults with functions of ore-destroying, 6 – shear zones: I-South-Nurata (1-southern branch, 2-northern branch), II-Karatau; 7 - 9 - rock complexes of the Zarafshan-Turkestan, SFZ: 7 - intrusive, 8 - terrigenous, 9 - carbonate; 10 - gold ore deposits; 11 - the boundaries of the outcrops of pre-mesozoic formations; 12 - the boundary of the research area.

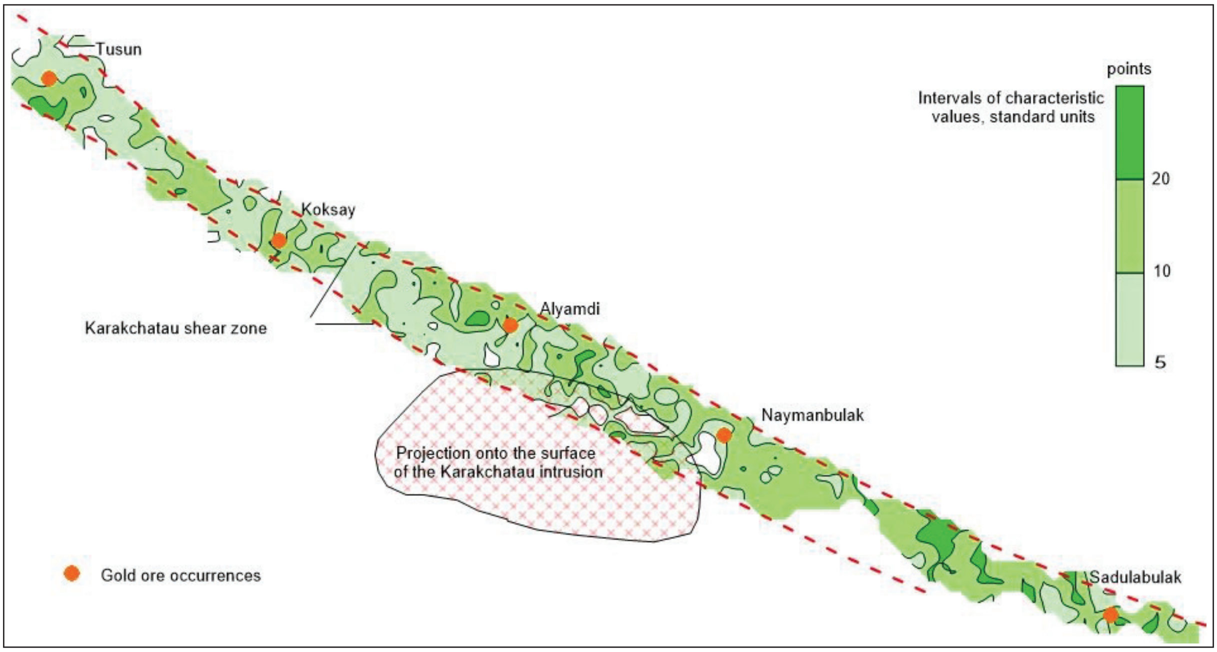

Figure 2- (Extension) Distribution of vein silicification at observation points. Extensity is the prevalence of quartz mineralization from the observation point (10x10 m area): 1 - within the observation point; 2 - beyond the boundaries of the point (up to 25 m); 3 - can be traced at a considerable distance (up to 50-75 m).

above- and near-intrusive position of the non-eroded granitoid body and disparate anomalies in other parts of the zone (Figure 2). The morphology of quartzolite bodies depends on the intensity and nature of the ductile and brittle deformation, and the mechanical properties of the rocks: veins intensity, both individual and accompanied , which follow the distribution are linear veins, quartz nests, and differently oriented interlacing veins are negligible. Quartz crystal or quarzolite has the ability to respond to stress by changing the internal structure, under the ductile or brittle deformation. In some areas, changes predominate without disrupting the continuity of the crystal bending deformations; in others, deformation is expressed in the mosaic disintegration of crystals into inhomogeneous areas (Koloskova, 2007; Yurgenson, 1984).

Extensive development of quartz mineralization, correlated in the observation point and at a distance from it to 50-75 m, fixes the high saturation of the Karakchatau shear zone of crumpling by quartz veins (Figure 2).

5. Deformation Degrees of the Quartz Crystals

With bending deformation, gradual and unidirectional turns of (frame) structure predominate. The degree of deformation is determined by the magnitude of the maximum deviation in the orientation of extinction of different parts of the same grain, referred to the diameter of this grain, which characterizes, as it was, the “curvature of the bend” of the lattice. Intensive deformation is seen only in crystals of primary quartz - about 6-8° per 0.1 mm. In secondary ones, it is about 2-3° per 0.1 mm. Among the deformation of bend, stages of deformation; simple deformation (in the form of extinction by one wave), complex-striped (several parallel waves), spotted (areas of heterogeneous orientation) are distinguished. This is the first degree of deformation.

With mosaic texture, the large grain of quartz does not get a general bend, but as if broken into parts. The degree of deformation is expressed by the angle of the relative rotation of the mosaic blocks, (fixed in a polarized light) defined under polarized microscopy by their non-simultaneous extinction. This is the secondary degree of deformation.

Brittle deformation is defined in the appearance of microcracks along the boundaries of crystals and mosaic blocks. The extreme degree of deformation is represented by the breccia texture of quartz grains. In the early stages, recrystallization is closely intertwined with granulation. Fine-grained sugary crystals, consisting of pure and distorted crystals, are products of recrystallization with a partial reprecipitation of deformed veined-filling quartz.

There is an increase in the intensity of brittle-ductile deformations of quartz, as well as other minerals as they approach large deformation zones (Petrovskaya, 1956). The peak degree of bending deformation in quartz are observed along the contacts of the veins and environments close to inclusions in the veins.

6. Mineralogy

Five genetic types of quartz crystals are distinguished according to the features. Metamorphogenic quartz (Q-1): Macroscopically it is white or grayish in color, glassy, often translucent and folded with the surrounding rocks.. Under the microscope, this type of quartz is characterized by heterogeneity with the predominance of coarse crystals measuring 0,1-2,0 mm and larger. The mineral boundaries are irregular and broken. Ductile and brittle deformation are characterized by the microgranulation, and recrystallization along the crystals boundaries and microcracks along the feldspars, chlorite, muscovite, sericite, biotite, rare cubic pyrite mineral boundaries. The extinction of the crystals is predominantly undulatory simple or mosaic- undulatory, in addition, there are a band-gap undulatory and undulatory extinction converging toward the center. The angle of propagation of the undulatory extinction (APEW) is about 2-30 by 0,1 mm. Brittle deformation occurred in the form of cracks, is heterogeneous. In fine veins, it is noted that small-medium-grained hypidiomorphic quartz crystals are poorly ductily deformed which is defined under microscope by the determination undulatory, irregular or wrinkled extinction of individual grains of quartz.

Feldspar minerals, especially orthoclase, in white and cream coloured samples, are formed up to 1-2 mm in size and rarely more, the form is usually isometric or slightly elongated. In thin sections, dust like appearance is interpreted as pelitization, weak kaolinisation. Microcline is rarely observed. Late-ordered, fine-grained albite-quartz minerals are hexagonal shaped and overlap the below ones.

Pyrite is observed in the form of disseminated impregnation of small cubic crystals or pseudomorphs of iron hydroxides in pyrite. It is possible to observe brownish, reddish, and dark yellow-colored iron hydroxides along microcracks.

The gold content of metamorphogenic quartz is usually lower than the sensitivity of gold-spectral analysis, sometimes it increases up to 0,1-0,2 g/t, but usually, in quartz the Au content does not exceed 0.0n g/t.

Metamorphogenic-hydrothermal quartz with inclusions of feldspar (Q-2): Feldspar-quartz formations of this type often form cutting veins, sub-coarse small lenticular veins, nests of metamorphogenic quartz and metamorphosed sandy-schist rocks. A characteristic feature of this type is an increased amount of cream and pinkish colored feldspars, reaching up to 50-60% of the volume of mineral content. During the vein formation and development process, pseudo-breccia texture may form and the granular matrix of pink feldspar contains relatively isomorphic crystals of quartz.

Quartz minerals are seen in white to grayish, translucent, sugar-like and vitreous. Under cross-polarized microscope, undulatory extinction and the initial stages of the mosaic texture are observed but more often the crystals are almost undeformed. The texture is hypidiomorphic, grained, with grain sizes in the range 0,02-2,0 mm. Length of creamy and pinkish-colored feldspar is up to 2-3 cm in size and granular feldspar crystals are in between quartz minerals. Feldspar is usually replaced by sericite and kaolinite, which is from single scales to 20-25% of the volume of feldspar outcrops.

The main typomorphic feature of this type is a large amount of feldspar, saturated with clay-like particles. The crystals of feldspar (albite and orthoclase, predominate albite) have good-developed cleavage and are distinguished by irregular shape of faces. Among them, sections of large crystals up to 1-1,5 mm and zones of fine-grained crystals up to 0,1 mm in length are allocated. Among the crystals of quartz, large differences up to 2 mm or more are of primary importance. However, along with them, a large volume of the section is occupied by medium- and fine-grained albite crystals of the metasomatic appearance, which forms intergrowths with quartz. On the surface of quartz, there dust-like inclusions, and possibly kaolinite, are found much lesser amount than on the surface of feldspar. Forms of crystals are very diverse - from angular elongated to irregular and slightly rounded.

In general, the gold grade is measured as 0,0015 g/t one of the locations, it increases up to 0,8 g/t with an increased content of iron hydroxides in quartz.

Pneumatolytic-hydrothermal quartz (Q-3): Macroscopically quartz from white and light gray to dark gray, coarse-grained, from translucent to transparent in shallow cracks. This type of quartz minerals are characterized by matte luster. There are veins with a patchy uneven random distribution of color from almost transparent to dark gray, rarely reddish. The external appearance in the field, quartz minerals are observed as sugar to vitreous is both opaque and translucent. The texture of vein filling is medium- and coarse-grained, cryptocrystalline. In the large quartz veins, a rhythmic banding was observed, caused by alternating of 1-2 mm of translucent and opaque quartz. The veins contain small isometric and elongated inclusions of muscovite, transparent, slightly greenish and brown iron, white and cream-colored feldspar up to several mm in size. Individual crystals of pyrite, iron hydroxides and manganese are observed along cracks up to 0,5-1 cm.

Under microscope, medium-coarse-grained crystals idiomorphic or hypidiomorphic texture. In some cases, grain boundaries are irregular and sinuous. Quartz crystals are characterized by the absence of dust-like inclusions, which distinguishes it from other types of quartz. The outflow has normal characteristics of undeformed quartz or weak cloudy and undulatory. It is possible to observe fine-grained, recrystallized quartz crystals and related chlorite and carbonate. Single rutile crystals of isometric and elongated sections up to 0,01-0,01 mm in size, apatite of irregular shape up to 0,2 mm in size are observed (Ivankin and Nazarova, 2001)

Some of the veins that filled by white and grayish pneumatolytic-hydrothermal quartz, also contain broken and supergene sulfide mineralization, represented by pyrite and iron hydroxides. Under the microscope, broken and allotriomorphic-grained quartz minerals, with optical signs of bending deformation, are overlapped by sulfide minerals are observed. The fine-granied and granular texture of quartz develop intensively along microcracks and grain boundaries. This quartz is characterized by intensive fracturing both unsystematic and oriented lamellar. The nonmetallic minerals, fine-grained ferrous carbonate, sericite, kaolinite, hydromica, chlorite are developed along the fissures. Often these minerals are associated with the occurrences of ore mineralization. There are crystals of feldspar up to 2-3 mm in size.

Ore minerals are observed as disseminated, lens, nests in quartz veins are intensively replaced by secondary minerals of the oxidation zone. Iron hydroxides are disseminated, nests and widespread in quartz veins and cracks.

Hydrothermal gold mineralization in Alyamdi region is, developed along the veins and related pneumatolytic-hydrothermal quartz. In the samples selected of gold-bearing quartz veins, are dark yellow-colored, brittle, branched and 5-6 cm in size, colloform-texture, consist of limonite, inclusions of reddish-brown goethite, veins of jarosite with a thickness of up to 2-3 mm, rare primitive scorodite (Figure 3-4).

Hypidiomorphic medium and coarse-grained quartz minerals are intergrowths with albite. Quartz has a weak cloudy-undulatory extinction and albite is represented by colorless tabular crystals with polysynthetic twinning (Sample 1017, Figure 3c, d). Cracks develop fine-grained idiomorphic-grained quartz, apatite grains are up to 0,2 mm, short-prismatic rutile crystals up to 0,02 mm in size. The distribution of ore mineralization is controlled by cracks in the albite-quartz crystals and is also associated with later cutting quartz-carbonate (ankerite, calcite) veins. Post-ore veins are filled by calcite (Mikhailov et al., 2004).

In the heavy fraction of the sample of Alyamdi, rare pyrite, malachite, cerussite and native gold are observed (Figure 3b). The color of gold varies from light yellow to reddish-yellow. Gold grains are mostly less than 0,1 mm and represent a thin dust-like form. The texture of gold is granular, rounded, elongated and irregular. Gold is interlocked with quartz. Larger golds have nodular surface (Figure 4).

Probably the presence of bismuthinite, scheelite, molybdenite within quartz, as indicated by the increased contents of Bi, W, and Mo in the samples, as is the case for As, Ag, and Cu in some other samples are increased in some samples.

Hydrothermal quartz associated with pyrite, arsenopyrite and gold (Q-4): Hydrothermal gold-bearing quartz is macroscopically white, grayish and light gray, in some parts, is randomly spotted and a bluish-colored, represented by cryptocrystalline opaque crystals of porcelain or sugar-like texture (Figure 5a). Q-4-grouped quartz minerals contain inclusions of creamy-pink feldspar from 0,1-0,2 mm to 2-2,5 mm, veins and micro-allocation of carbonate, chlorite, sericite, kaolinite. Under the microscope, quartz is characterized by large-crystal with abundant

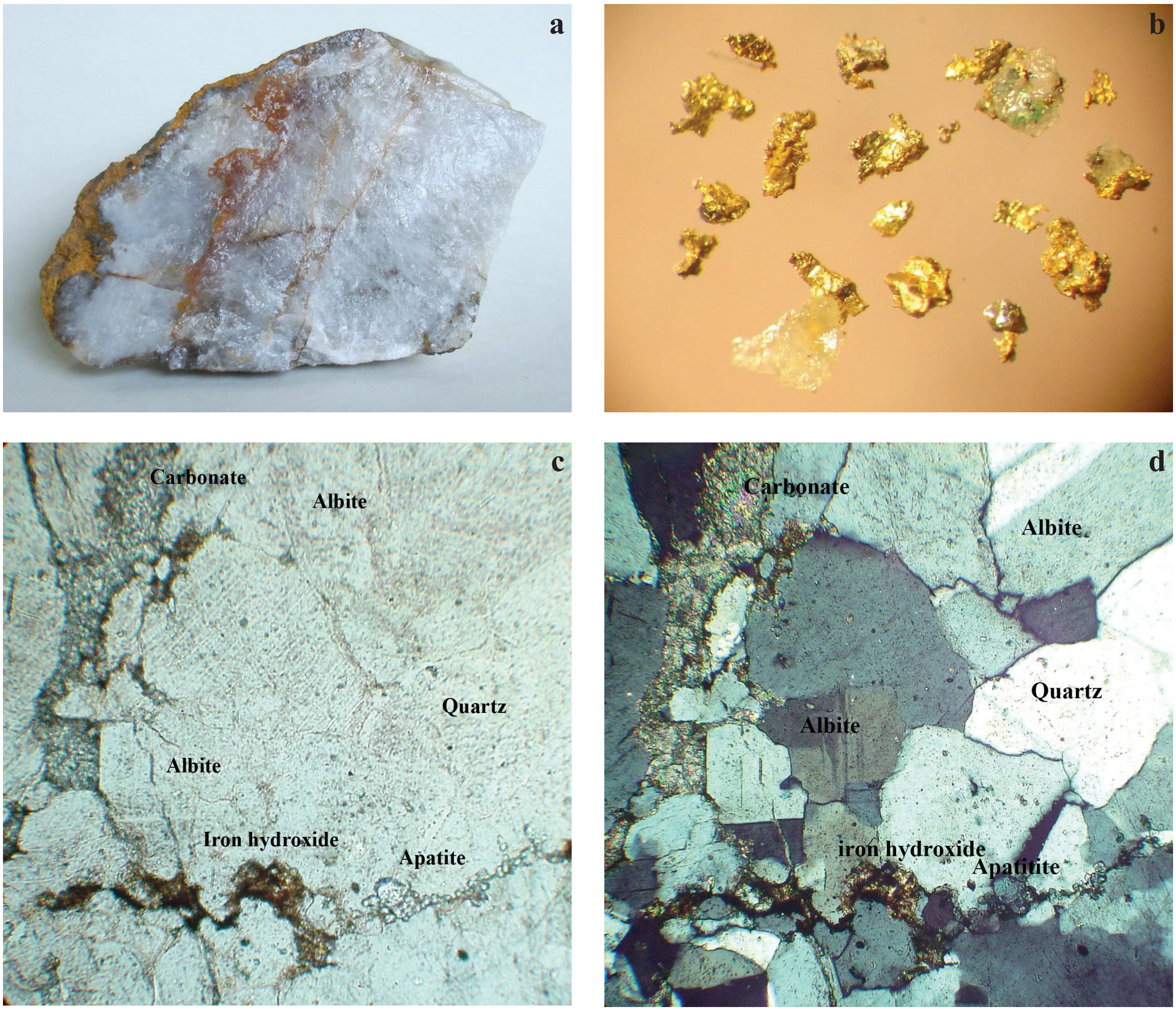

Figure 3- a) View of gold-bearing quartz from the Alyamdi Gold Deposits:b) View of gold, c, d) view of mineral compound under the microscope.

pulverous inclusions forming “wrinkles” apperance. Hydrothermal quartz is characterized by intense brittle-ductile deformation, characterized by irregular cloudy-undulatory extinction, the mosaic texture of crystals, formation of granular quartz along cracks and grain boundaries (Figure 5b), transparent, without inclusions. A fine-grained-quartz crystals with carbonates, sericite, kaolinite, chlorite, pseudomorphs of iron hydroxides through pyrite, jarosite, and native gold develop along the fissures (Figure 5c). Rare nests and impregnations of pyrite are observed in some sections of quartz veins up to a few mm in size; accumulation of iron hydroxides are widespread in the veins, and cracks.

In the concentrates of the crushed sample from the limonitized quartz veins, the Tusun mineralization contains native gold, pyrite, chalcopyrite, arsenopyrite, galena, malachite, scorodite minerals. Native gold in the heavy fraction of crushed sample 1209 are characterized by free gold of light-yellow color and in intergrowths with quartz, and by dusty inclusions in quartz. The size of the gold is from 0,01 to 0,75 mm. The texture of gold is: cloudy, lamellar, complex interstitial, elongated and isometric (Figure 5d). The surface of the native gold is smooth, as well as tuberculate, and turbinate, as occurred more often. In polished sections of the same quartz vein, the individual elongated, vein-like and isometric lumpy and dusty gold are confined to microcracks in quartz (Figure 5c). Accumulations of gold from 0,005 to 0.1 mm in size are associated with microcracks that contain quartz-sericite-hydromica-kaolinite and gold inclusions are also observed in iron hydroxides.

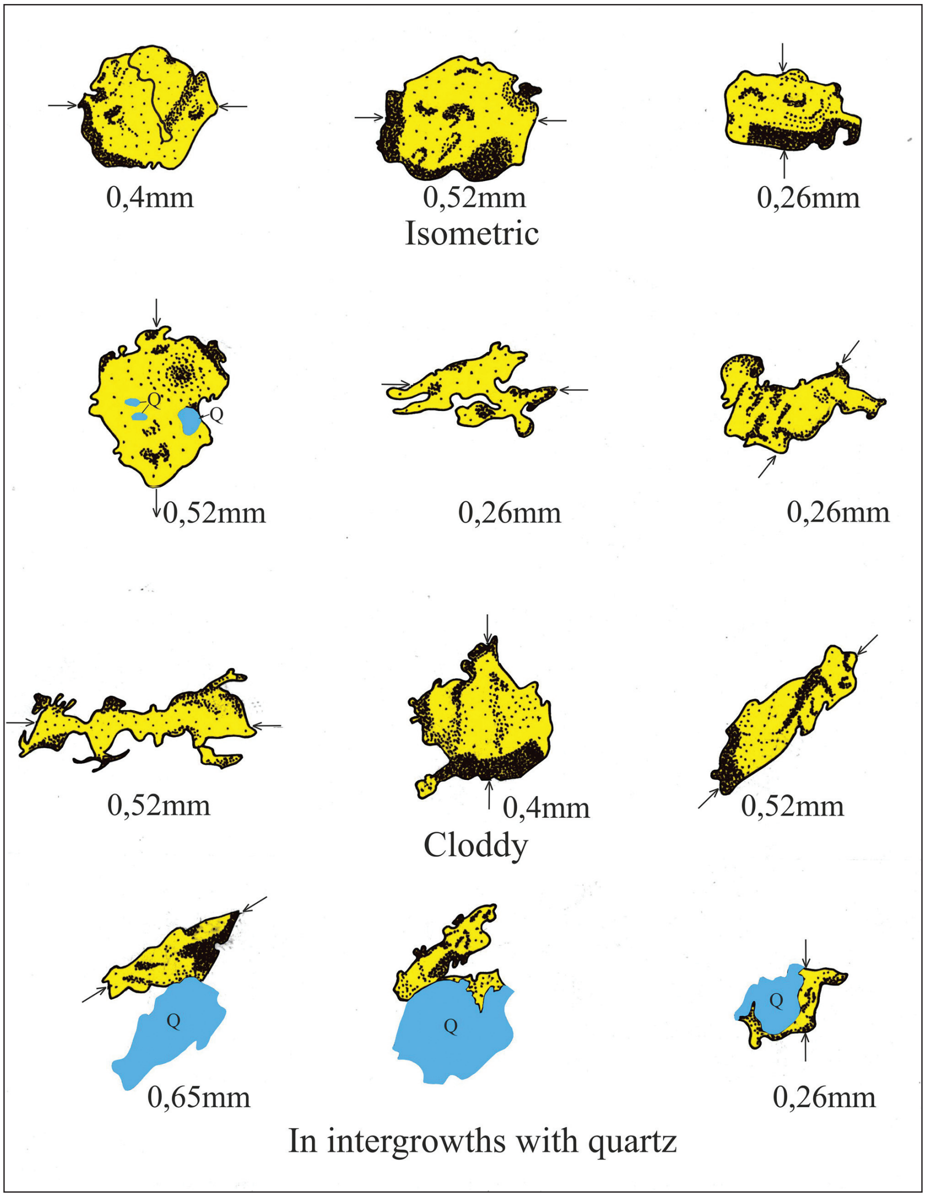

Figure 4- View of gold minerals in hydrothermal feldspar-quartz veins from Alyamdi Gold Deposits.

According to the results of the semi-quantitative spectral analysis, the lead content in this same vein is increased by 0,48%, arsenic 0,1%, copper 0,1%, silver 415 g/t, gold 26,25 g/t. High Pb contents suggest the presence of galena.

In Naymanbulak and Tusun area, veins are filled by porcelain quartz (Q-4), and in Ingichkasay, west of Naymanbulak area, quatz veins with gold content of 0,1-0,8 g/t are covered by loose material. In Tusun region, some parts of porcelain quartz veins contain dark yellow colored iron hydroxides up to 10-12 cm in thickness, have high gold concentration. Post-ore, hydrothermal low-temperature quartz (Q-5): It forms in veins which developed in tectonic zones and the breccia texture is observed in quartz minerals. Macroscopically it is white and grayish in color, sugar-like, sometimes finely-grained and metasomatic in appearance.

The fine-grained quartz breccia contains intensely silicified rock fragments as observed point 836. Intensely silicified rocks are between 1-2 mm and 3-5 cm in size, usually acute-angled, contain from 5-10 to 40-50% of quartz. Under the microscope, amorphous quartz crystals are hypidiomorphic (a combination of xenomorphic crystals and crystalline forms) and 0,05-0,1 to 0,5-0,6 mm in size, and weakly deformed. In

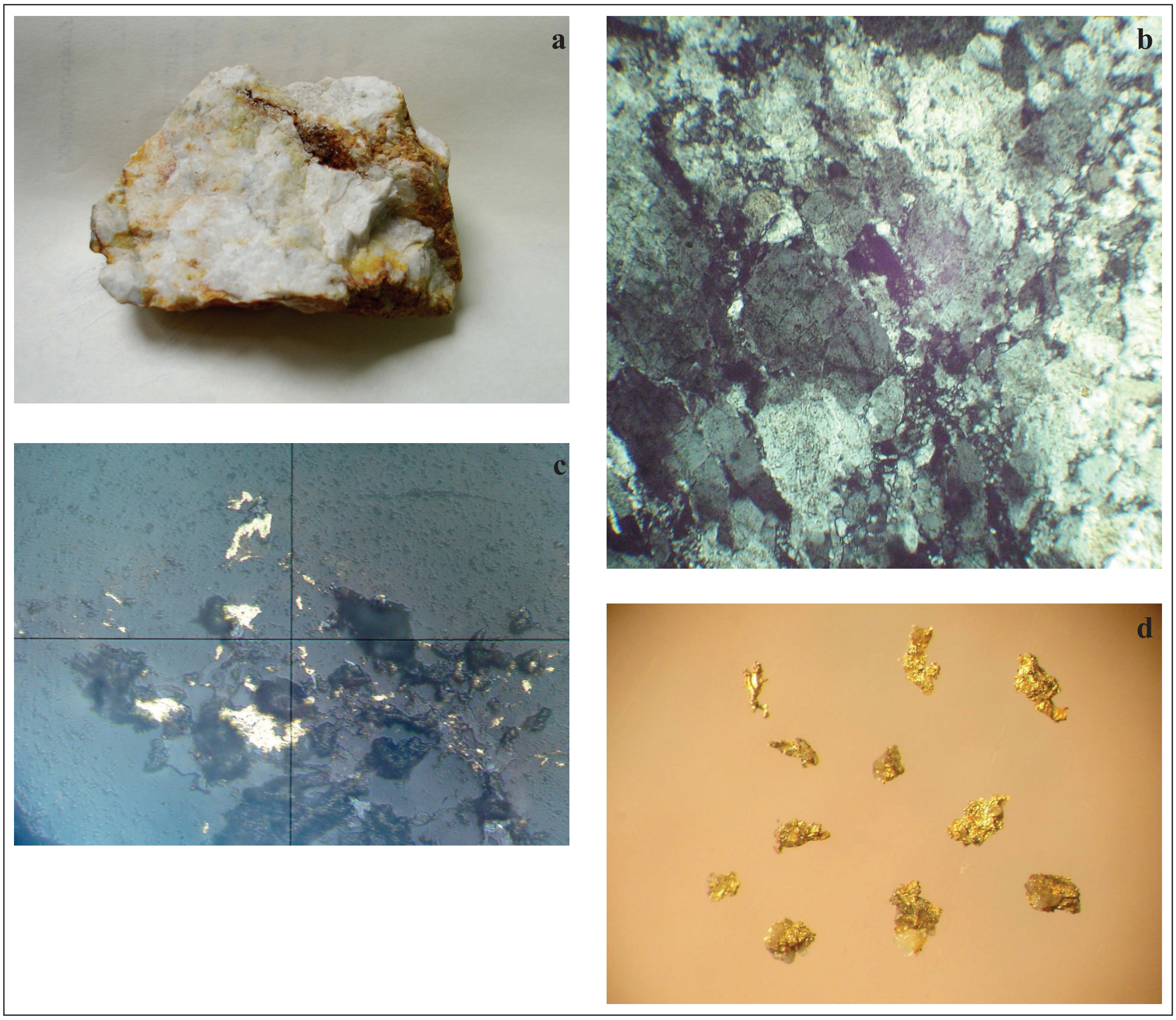

Figure 5- Gold-bearing veins in Tusun region; a) a sample of white porcelain quartz (Q-4) from the core (sample 1209, 0.9g/t concentrated gold); b) compressional deformation and the mosaic texture of quartz crystals and micrograins in cracks (sample 1209, cross-polarized light, X56); c) native gold (light-colored) in quartz-kaolinite-carbonate microfractures (dark) (sample 1209, X60); d) 0.15-0.55 mm in size gold in quartz vein (sample 1209, X36).

association with post-ore quartz formation, formation of chlorite, sericite, albite, calcite, kaolinite flake, gypsum are also observed.

The results of mineralogical mapping of quartz vein along the Karakchatau Shear Zone show that quartz veins are most intensively developed in the central part of the zone. They form linear zones and fields, concentrated in local geological blocks; vein fields develop in the areas of expansion of the Karakchatau shear zone, and in the areas of its clamping the intensity of quartz mineralization decreases; the location of the fields and their morphology depend on the nature of the block deformation of the shear zone.

The typomorphic mineralogical-geochemical features of quartz veins from different genesis, defined as a result of research, are comparable with the available data from other shear zones with the same geological features, which allows them to determine target area for gold prospecting projects.

6.1. SEM (Scanning Electron Microscope) Study Results

Under the SEM, vitreous metamorphogenic quartz (Q-1) (sample 1140) of a cryptocrystalline structure with a grain size range from about 0,1 to 0,2 microns and a banded, lace-like texture contains scattered impregnation of ore minerals up to several microns in size. As a result of replacement processes, quartz minerals are recrystallized and get sugar-like texture that contains small gaseous-liquid inclusions of 1 to1.5 microns in size. A comb texture of quartz is observed at the background of a thin-globular surface with precipitates of a presumably carbonaceous substance which has an isometric and elongated shape ranging from 0,1 to 2 microns in nodes. Some crystals have radial-radiant structure.

Q-3 type quartz show idiomorphic crystals under SEM (Figure 6a). (Figure 6a). Random distribution of irregular-shaped gaseous-liquid inclusions are located on the edges of crystals, are probable indicated as secondary origin (Figure 6b).

Under the SEM, presence of isometric and 15-20 microns in size gaseous-liquid inclusions are observed in the cleavages, developed in fine-grained porcelain hydrothermal quartz (Q-4). In coarse-grained quartz crystals there are disseminated ore minerals, there are hexagonal quartz crystals and largely elongated gaseous-liquid inclusions over quartz growth zones. The “wrinkle texture” of quartz is observed in crystal growth zones by pulverized gaseous-liquid inclusions and fracutures along the microinclusions of ore minerals which are (Figures 7a,b).

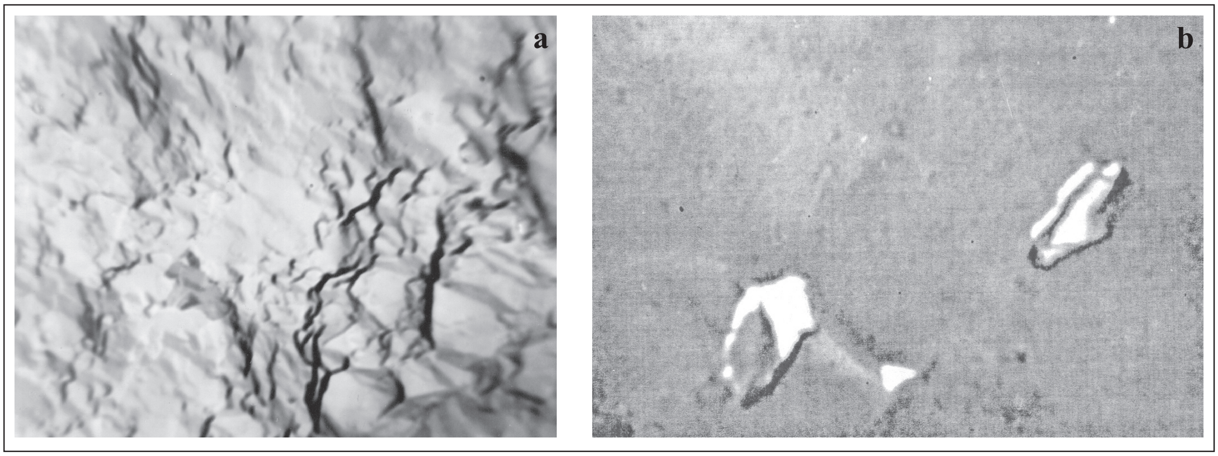

Figure 6- a) View of high-temperature quartz (Q-3) fom sample 1187; b) View of 2 micron-sized gaseous-liquid inclusions in high-temperature quartz (Q-3) minerals from Sample 1017.-

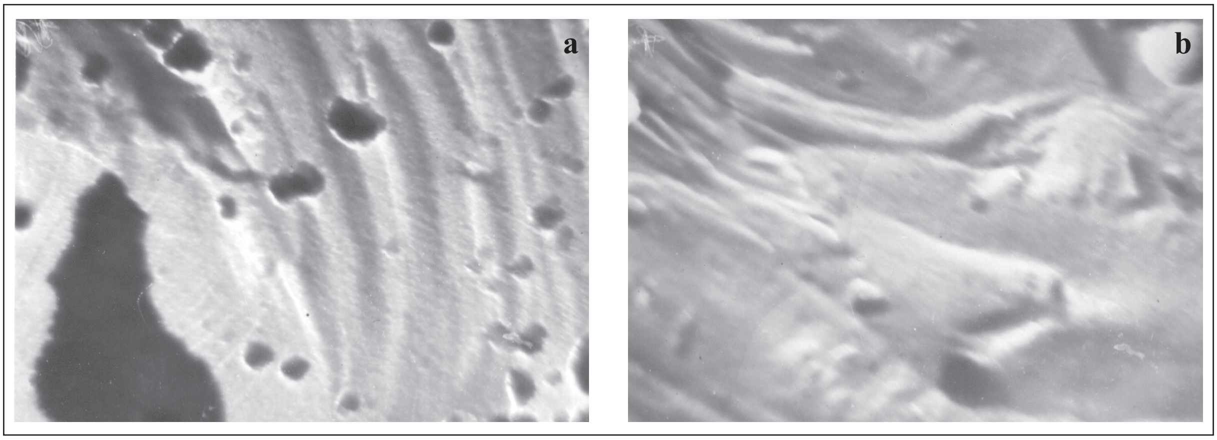

Figure 7- SEM images of the sample 371. Zonal structure of hydrothermal quartz crystals (Q-4); a) sulfide impregnated “Wrinkled” quartz crystals. (X6000); b) the same with gaseous-liquid inclusions by growth zones (X6000).

7. Discussion

The evolution of ore-forming processes in the gold-bearing quartz veins of crushing in terrigenous sequences of the cover-folded regions of Western Uzbekistan is controlled by geological, metasomatic, mineralogical and geochemical features. In this research, the typomorphic features of quartz minerals in the Karakchatau shear zone are studied, since quartz varies by properties and properties of mineral-forming processes (Yurgenson, 1984, Babaev, 1985). The obtained data makes it possible to clarify geological evolution of ore forming conditions in the studied area.

Gold mineralization is formed as a result hydrothermal fluid circulation in fractures and faults in the early stage of development of the shear zone, pneumatolytic-hydrothermal processes associated with granitoids, and telethermal processes with late stage of deep structures (Koloskova, 2007). Late Silurian processes of movement of lithospheric plates provided suitable environment for the migration of ascending fluid flows from the subduction zone. Pre-Devonian regional metamorphism is considered by most researchers as one of the earliest processes of concentrating gold in sedimentary strata. In the early-collision stage, during the middle Carboniferous, complications of early over thrust along the borders of the covers occur and large plates, which in the late- and post-collision period took the form of shear zones conformal cover-fold structure. At first, the period of collision, when the granite-gneiss layer was not yet formed, the deformation zones were the structures of migration of mantle fluids, which contributed to the formation of metamorphogenic-metasomatic rocks with a high background metal content, including gold content (Ivankin and Nazarova, 2001): 1) carbonate-sulphide-carbon metasomatites; 2) albite-quartz metasomatites and vein-veinlet formations of a similar composition. The formation of polygenic collision granitoids of the S-type need to be explained was accompanied by a large-scale migration of gold and a number of ore-bearing elements in the geothermal gradient field of intrusions with a concentration in favorable positions. Dislocations of this period control the placement of dyke and vein type quartz mineralization. With periods of post-collisional tectonic activation of the associated formation of quartz breccias, gold-bearing quartz.

8. Conclusions

In this article, we considered the practical application of one of the geological phenomena defined by the term “typomorphism of minerals”. Field mineralogical mapping of quartz formations was performed along the ore-saturated Karakchatau fault zone with potential of hidden gold mineralization.

Mineralogical study of rock samples from different genetic type quartz veins of the Karakchatau Shear Zone paid attention to the peculiarities of the external appearance of quartz, the mineral composition of paragenesis, and the interrelationships of minerals and the morphology of quartz crystals.

Five genetic types of quartz formations are distinguished by a complex of characters that include metamorphogenic quartz (Q-1); metamorphogenic-hydrothermal (Q-2); pneumatolytic-hydrothermal quartz (Q-3); hydrothermal quartz with sulfides and gold (Q-4); hydrothermal low-temperature quartz, post-ore (Q-5). Mineralogical mapping was carried out in that mapping: in the Karakchatau Shear Zone, quartz veins are most intensively developed in its central part.

Result of typomorphic mineralogical-geochemical features of different genetic type quartz veins are provided and allows to compare with other shear zones from similar geological backgorund, that may help to determine new target areas for gold mineralization.

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