The Mineral Composition and Textural-Structural Peculiarities of the Ore, and Mineral Formation Stage of the Gedabek Gold-Copper Deposit (Lesser Caucasus)

G.S. Guseynov

Azerbaijan State University of Oil and Industry (Azadlig ave. 16/21, Baku, AZ 1010, Azerbaijan)

For correspondence:
Guseynov Gamed / e-mail: huseynov.qamet@asoiu.edu.az

Abstract

The mineral composition and textural and structural characteristics of ores are studied, also the phases and stages of mineralization, which are an important source of information on the conditions of formation of the deposit, time allocation of gold and its spatial association with certain mineral assemblages and associations. Consideration of these issues can come to an understanding of the factors behind the differences in the scale and extent of gold deposits of various types, as well as to form a mineralogical search features gold-bearing mineralization.

Keywords: mineral composition, textural, structural, gold, guns.

DOI: 10.52171/2076-0515_2021_13_02_121_130

For citation:
Guseynov G.S.
[The Mineral Composition and Textural-Structural Peculiarities of the Ore, and Mineral Formation Stage of the Gedabek Gold-Copper Deposit (Lesser Caucasus)]
Herald of the Azerbaijan Engineering Academy, 2021, Vol. 13. № 2. Pp. 121 – 130 (in English).

Gədəbəy qızıl-mis-kolçedan yatağının mineral əmələgəlmə etapı və filizin tekstur-struktur xüsusiyyətləri (Kiçik Qafqaz) metodlarının analizi

Q. S. Hüseynov
Azərbaycan Dövlət Neft və Sənaye Universiteti (Azadlıq pr.. 16/21, Bakı ş., AZ1010, Azərbaycan Respublikası)

Yazışma üçün:
Hüseynov Qamet / e-mail: huseynov.qamet@asoiu.edu.az

Annotasiya

Filizlərin mineral tərkibi, tekstur və struktur xüsusiyyətləri, həmçinin yatağın əmələ gəlməsi, qızılın vaxt bölgüsü və müəyyən mineral birləşmələri ilə məkan birləşməsi şərtləri haqqında mühüm məlumat mənbəyi olan minerallaşma mərhələləri öyrənilir. Bu məsələlərin nəzərdən keçirilməsi, müxtəlif növ qızıl yataqlarının öyrənilməsinə və axtarış amillərinin hazırlanmasına səbəb ola bilər.

Açar sözlər: mineral tərkibi, teksturası, quruluşu, qızıl, filiz.

DOI: 10.52171/2076-0515_2021_13_02_121_130

УДК: 553.8.441

Минеральный состав и текстурно-структурные особенности руды, этапы минералообразования Гедабекского золотомедного месторождения (Малый Кавказ)

Г.С. Гусейнов
Азербайджанский государственный университет нефти и промышленности
(пр. Азадлыг 16/21, г. Баку, AZ1010, Азербайджан)

Для переписки:
Гусейнов Гамет / e-mail: huseynov.qamet@asoiu.edu.az

Аннотация

Изучены минеральный состав и текстурно-структурные характеристики руд, а также стадии минералообразования, которые являются важным источником информации об условиях формирования месторождения, временном распределении золота и его пространственной ассоциации с определенными минеральными ассоциациями. Рассмотрение этих вопросов может привести к пониманию факторов, лежащих в основе различий в масштабах и протяженности месторождений золота различных типов, а также к формированию минералогических поисковых признаков золотоносного оруднения.

Ключевые слова: минеральная композиция, текстурная, структурная, золото, оруднение.

Introduction

Gedabek gold-copper deposit located in the Azerbaijan part of the Lok-Karabakh suture zone. Gedabek gold-copper pyrite deposit was discovered in the first quarter of the 19th century, and due to the uniqueness of the geological structure and the high content of minerals, including precious metals (Au, Ag), for more than one and a half centuries has attracted the attention of many researchers and practitioners. Development of the field began in 1864 by the German concession Siemens brothers and lasted until the end of 1917. During this period, was produced 1,720 thousand tons of ore from which copper smelted about 58,047.5 m and simultaneously removed more than 3 tons of gold and 57 tons of silver.

Since 1917 in the field exploration conducted intermittently until 1989. From 1989 to 1997 research works were carried out by of the SCGSRI. In 1997, he signed a contract with the American company "RV Investment Group Servises LLC" and on the basis of this contract from 2009 to the present field is operated.

Geology. Gedabek deposit is located within the Shamkir raise Locke Agdam metallogenic zones of the Lesser Caucasus.The geological structure of the deposit involves deposition Middle and Upper Jurassic. Middle Jurassic volcanic rocks represented by the lower and upper Bajocian, Bathonian and Callovian. Volcanics of the Lower Bajocian-basalt, andesite and tuff, in the halo of the same name intrusion homfelsed intensively. Upper Bajocian presented by rhyolites, which cover the deposits of the lower Bajocian-rhyolites, hydrothermal quartzite. Breed Bathonian Stage transgressivly overlap the thickness of rhyolite and stacked basalt, andesite and partly their tuffs and tuffs breccias. In turn overlap sedimentary-tuffaceous and carbonate sediments of Callovian-Oxfordian stages (fig.1).

Work methods. Mineral composition of the ore is set in a result of field documentation, microscopic study of polished sections, interpreting the chemical analytical data. For the minerals diagnosis used the of X-rays, measurements sectors of reflection, and a laser and X-ray microanalyses.

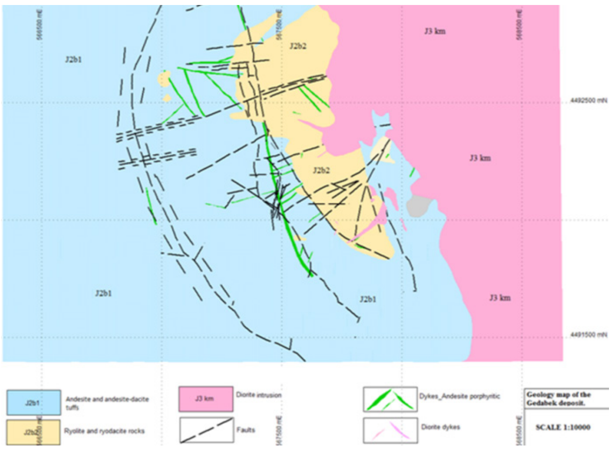

Figure 1. Geology map of the Gedabek deposit

The solution of the problem. The ore mineralogical composition of the Gedabek field at different times were studied by several researchers (Efendiyev, 1957 Kerimov, 1963 Süleymanov 1982, Guseynov, 1989). Results sets, that in this field the main ore-forming minerals are pyrite, chalcopyrite, sphalerite, minor - galena, molybdenite, bomite, rutile, native gold, native silver, of vein-quartz, calcite, barite, of supergene-hydroxides, chalcocite, covellite, malachite, azurite, cuprite, native copper.

In connection with the start of mining activities in this field, there is a need for a detailed study of the mineral composition. To this end, field documentation of open workings microscopic study of polished sections, the interpretation of chemical analytical data. Minerals used for the diagnosis of X-ray and laser microanalysis. As a result of these studies, in addition to previously established for the first time we have found some new minerals for Gedabek field [4] (Table 1).

Table 1. List of minerals, ores diagnosed Gedabek field

The extent of	Hypogene		supergene
	Ore	nonmetallic	
The main	pyrite, chalcopyrite, sphalerite,	quartz,barite	
secondary	arsenopyrite, pyrrhotite, galena, tetrahedrite, Mushketov, magnetite, hematite, magmeit * Waller Minne *, cubanite, molybdenite *, marcasite, pentlandite, bravoite, bomite, Linnaeus *, rutile, native gold, native silver	calcite, sericite, chlorite, heulandite *	hydroxyls, iron, chalcocite, covellite, malachite, azurite, cuprite native copper

* - Minerals first discovered by the authors

The main sulfide minerals characterized as follows:

Pyrite. Quantitatively dominant ore mineral, common in massive and disseminated ores, as well as near-ore metasomatic. He is represented by two generations (pyrite-I, pyrite-II). Pyrite I forms embedded in sericitized and silicified rocks, and characterized by a high degree of idiomorphism. Also found in malachit. (Fig. 2a, b).

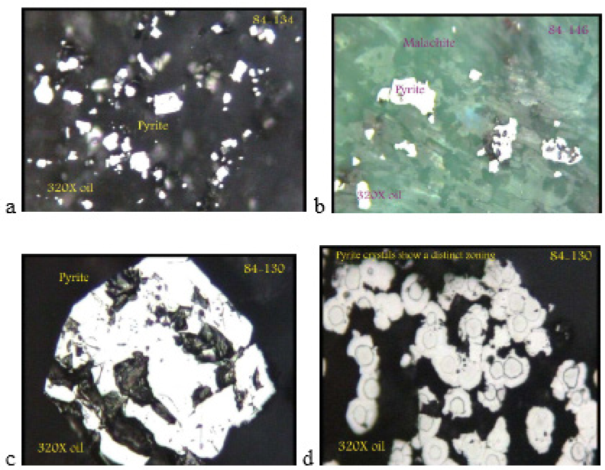

Figure 2. Varieties of pyrite aggregates

In massive pyrite ores forms continuous granular aggregates (Fig.2c). Etching it in crystals revealed concentric-zonal structure (Fig.2 d). Pyrite II in the form of single crystals and isometric rozetchatyh aggregates found in chalcopyrite. This generation is viewed as a product sulphidation chalcopyrite, apparently formed by metasomatic. Microscopic visible dissolving gold in pyrite II were detected. Perhaps the presence of fine gold.

Chalcopyrite. The average content of chalcopyrite ores pyrite-chalcopyrite- sphalerite type is about 0,2%, but in some areas can be observed prevalence of chalcopyrite and grouting them euhedral crystals and scattered grains of pyrite II. Yet bowl chalcopyrite is subordinate to fill the interstices between pyrite crystals, replacing them with the periphery, getting them to cracks. Closely associated with chalcopyrite ore tetrahedrite and sphalerite also bomite, covellite (Fig. 3a). Covellite observed as fringes, on the periphery of the developing chalcopyrite grains (Fig. 3b). Unlike pyrite II, in chalcopyrite appears visible gold. This is probably due to the redeposition of gold in the formation of the second stage of ore deposition. Microscopically visible isolation of native gold are presented in Figure 3 c, d.

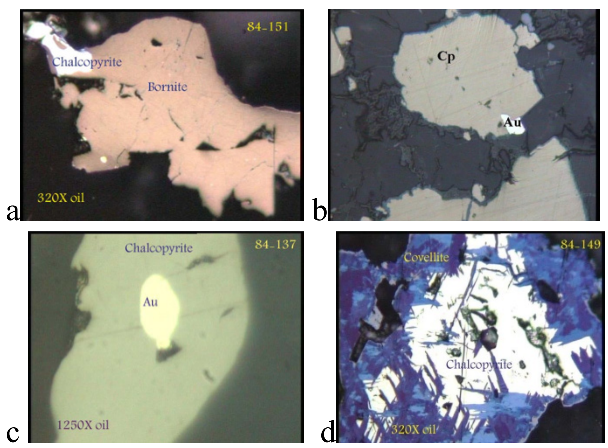

Figure 3. Variety of aggregates of chalcopyrite

Sphalerite. Enjoy wide spread distribution, although the average mineral content does not exceed a percentand only in some local areasreaches 2- 5%. Sphalerite usually develops in the interstices of pyrite crystal sand quartz II as xeromorphic selections. Always contain scoarse sphalerite disseminated chalcopyrite. Allocation chalcopyrite dominantsiz e3.0 microns distributed unevenly sphalerite matrix, forming a cloud clusters nearcracksand twinjointsthat act as diffusion flows. Peripherals sphalerite grains free of chalcopyrite inclusions, butthe latter forms Kai 10-20 microns thick around the grains of sphalerite. All this allows us to assume that, chalcopyrite in sphalerite is the product of the loss of high-solid solution. Is often inter grown with covellite and chalcocite (Fig.4a).

Galena. Galena is in great development in ore Gedabey field, but always quantitatively inferior to the other main sulphides. The content in the ores galena does not exceed 3-5%, and usually occurs in the form of isolated grains of irregular shape, filling the spaces between sphalerite and chalcopyrite, indicating a later his education in relation to the latter, is often associated with chalcopyrite (Fig. 4 b).

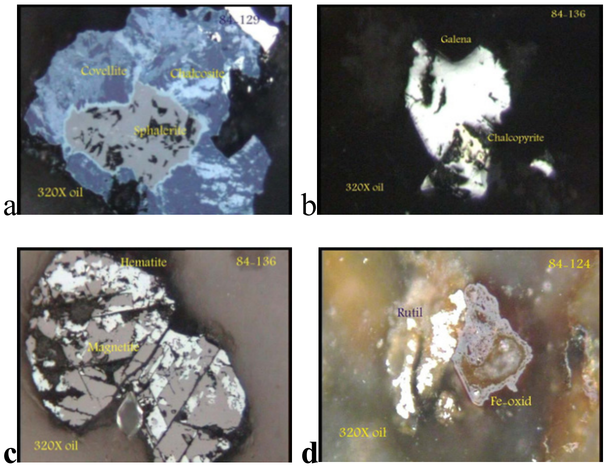

Figure 4. Variety of aggregates of a) sphalerite, b) galena, c) rutile and d) magnetite

Bornite. Bornite is distributed unevenly hi the ore, forming in some cases, large clusters, cementing pyrite crystals and aggregates. The regularly oriented lamellar of chalcopyrite and chalcopyriterims inclusions are characterized for bomite, which is presented asselection product of the solid solution and point to the relatively high temperature of formation. Therefore, the primary nature bomite, along with the implication that there are signs of bomite chalcocite, who had a secondary origin, often associated with chalcopyrite (Fig. 3a).

Native gold. Visible gold in the Gadabay ore deposits found in chalcopyrite (Fig. 3, d). The thin dispersion gold founded pyrite and arsenopyrite by analytical studies. There is the insignificantly Native silver in this field. Not funded in polished section

Rutile. Rutile is a rare mineral in the ores of the deposit occurs as single small isometric grains, the size in hundredths or tenths of a millimeter. Associated with sulphides early pyrite mineralization. Rarely associated with iron hydroxides (Fig. 4c). Hydroxides as the main product of oxidation of sulphide ores are very common in the field. The formation of iron hydroxides occurred as a result of various implication iron minerals pyrite, chalcopyrite, hematite and magnetite (Fig. 4d) in oxidized conditions. **Chalcocite.** Chalcocite in small numbers in the ore deposit and are distributed only in the oxidation zone of copper pyrite ores, where it fonns thin rims and pallets around the selection of chalcopyrite, bomite less, due to which it was formed. Often fonns chart chalcocite and covellite intergrowths, which is closely associated.

Covellite. Covellite enjoys relatively more extensive development than chalcocite, but does not form large aggregates. The only exception is the northern flank Gedabek deposit, which have accumulated considerable congestion kovellin ore, consisting of pyrite kovellin mixed with chalcocite, cuprite and native copper. Covellite observed under the microscope in the form of fringes, stacks on chalcopyrite (Fig. 3 b).

Malachite, azurite, cuprite. These minerals are often associated with each other and form different rims, shells, sinter forms in sulfide ores, the oxidation of which they were formed.

Native copper is very common mineral in the ores of the deposit, but does not create large clusters, found in almost all openings, forming his characteristic dendrites irregular. The formation of copper, apparently results from the interaction of copper sulfate and iron.

It should be noted that the article focuses on the first found minerals that give the opportunity to supplement mineral composition.

Maghemite in their optical data between intermediate mineral hematite and magnetite, and first discovered by us in Gedabek field.

Usually associated with hematite and magnetite, sulphides of iron, cobalt, nickel, copper, lead and zinc.

Color of the mineral magnetite in the presence of blue - gray, in the presence of hematite and hydroxyls takes pink. Reflectivity maghemite significantly lower than that of magnetite, anisotropic, gives brown internal reflexes, develops magnetite all varieties. In contrast to the nature of hematite magnetite maghemite a replacement, it develops in the center predominantly magnetite grains (characterized by irregular grains), which are rare remnants of constant * brownish magnetite.

Linnaeus first set us Gedabek ore deposit. It is associated with chalcopyrite, sphalerite, arsenopyrite, galena, quartz, calcite and supergene minerals. Forms irregular shape of a selected size from 0.011 to 0.2 mm.

Pinkish-white color, depending on the isomorphic impurities ranging from red to cream. Reflectivity is very close to chalcopyrite. The results of measurements of the reflection linneita shown in Table 2.

Linneit teetched HCL (1:1) here is its zonal structure. Micro hardness linneit a Hcp =5351kg/mm2at loadP =20-50gaussshared =470± 0,002g/cm3; linneitachemical composition was determined by electronmicroprobe (Table) MS-46 "CAMECA"(weight%): Co-45, 0; 2,0; Fe-4, 0; Cu-7, 0,42.0.

Table 2. The results reflect the changes in the spectra(Rm,%) Linneit a of Gedabek deposit

Wavelength, α, nm	Sam.Г.200
440	57.3
460	*56,1*
480	55,0
500	53,0
520	50,0
540	47,0
560	46,0
580	45,0
600	44,2
620	46,1
640	46,0
660	45,5
680	47,0
700	47,1
720	45,5
740	44,7

Note: Themeasurements were performedon the "ПИОН" (portable pulsednano second single block) in the laboratory by L.N.Vyalsov MTEMPAH (Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of Russian Academy of Sciences)

Molybdenite was first installed by us in Gedabek field.lt is found in the form of small phenocrystsnestssize 0,001-0.1mm, rarelyup to 1.0 mm. Sometimes forms large radiating, scale selection, also in places meet its crystals like plate intergrown with pyrite.

In reflected light,white andoff-whiteishighly reflective. Double reflectionis very stronganisotropic. The reflection spectra ofmolybdeniteare shown in Table 3.

Table 3. The results reflect changes impectors (Rm,%) Molybdenite from Gedabek deposit

Wavelength, *a,* nm	Sam.F.201
440	46,7
460	46,0
480	46,7
500	47,0
520	47,5
540	48,3
560	49,4
580	50,4
600	51,4
620	52,5
640	53,0
660	53,8
680	53,9
700	53,8
720	55,2
740	55,2
760	55,4
780	56,2
800	57,5
850	58,8
900	59,6
950	61,0
1000	52,4
1050	63,6
1100	64,6

Note: The measurements were performed on the "ПИОН" (portable pulsed nanosecond single block) by L.N.Vyalsovin the laboratory НТЕМРАН (Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of Russian Academy of Sciences)

Microhardness of molybdenum Hp =59±0,05 kgf/mm^2

The chemical composition of Gyzylbulag molybdenite deposit determined by microprobe - 46 "Sateka"

Spectral analysis of molybdenite shows a small amount of impurity following (in%): iron (0.01-1.0), copper (0.05-0.1), bismuth -0.1), titanium (0.002-0.005), magnesium (0,0001-0,07), barium -0.02).

Heulandite first installed by us in Gedabek field. It is a significant part of calcite veinlets presented translucent light-colored tabular unit, composing near-bandage areas. Sometimes fills voids in rocks, forming a brush tabular crystals.

Indices of refraction for heulandite Npl = 1,502 0,001; Ngl = 1,493 0,001. optical data and forms crystals typical heulandite.

Textural-structural peculiarities of ore. Principle factors, causing to formation of different textural types and structural interrelations are: morphologic peculiarities of ore minerals, character of ore solutions and mineral covering cavities, interrelation of ore minerals and so on, alterations, which the minerals imposing at the result of post-hard tectonic processes. Distribution of textural types of minerals of Gedabek deposit in vertical sections conforms to the laws: upward successively replaced vein-disseminated ores, localized in secondary quartzite, massive copper- sulfur and disseminated ores in mono quartzite [3]. There are spot, brecciated, venous, disseminated, vein-disseminated cement texture. There are dominancy of disseminated and vein-disseminated texture in volume of ore deposit, characterizing with significant dominancy rock forming and vein minerals on sulphides. In relation sulfides among them are the types of pyrite, pyrite-chalcopyrite and pyrite-chalcopyrite-sphalerite ores.

Phenocrysts presented by pyrite, ehalcopyrite, sphalerite, sometimes galena. There are pyrite, pyrite- ehalcopyrite composition with thickness to 5-8 mm in the transition zone, especially intensive apparent in expositive brecciate, characterizing of high transmissivity.

Spotty texture (fig 5.a) small-scale spreaded and developed only in area of contacts of ore bodies with lateral rocks. It forms by fine grain aggregates of pyrite developed in areola of secondary quartzites and quartz.

Vein texture refers to so-called non-homogenous texture and has gradual transitions to disseminated ores. This texture characterizes by timing spread of mineral aggregates, constituent of vein and principle mass of ores. Such textural forms characterize for pyrite, frequently with composition of chalcopyrite. In this case lately formed pyrite vein cements with chalcopyrite (fig 5.b). Sometimes these veins have loop structure.

Brecciated texture has great similarity with loop structure according to external image. It has limited spreading at deposit and usually composes peripheral parts of ore bodies. It formed at the result of penetration of ore liquid with purely pyrite composition to secondary quartzites with disseminated pyritisation on net of cracks of possible directions (fig 5.c).

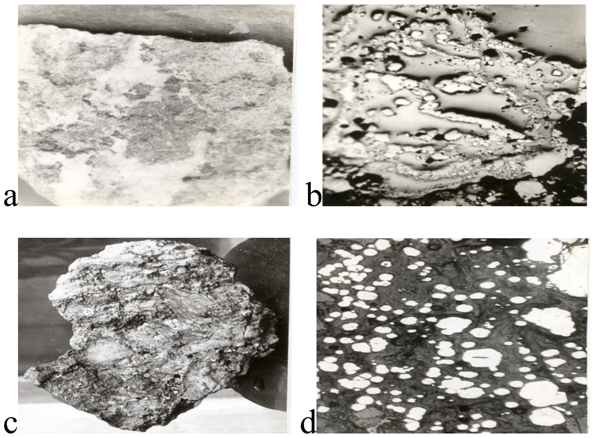

Figure 5. a) Spotted texture. Fine-grained pyrite aggregates in secondary quartzites. 90 x b) Vein texture. x 165, c) Brecciated texture. d) Interspersed texture. x 130.

Cement texture is peculiar for three mineral associations where ore forming minerals, in this case chalcopyrite and pyrite, cements fragments of intervening quartz rocks. It should be noted cementation of well-formed crystals of quartz with chalcopyrite, beside, latter dominates quantitatively on first.

Disseminated texture wide spreaded in the region and is peculiar for pyrite. Depending on scale of grain and density the disseminated texture presents significant diversity. It founds with direct contact with massive ore bodies and quartzites (fig 5.d). This texture forms from chalcopyrite, sfaleryte in addition to pyrite.

There are spread structure, cellular and migrating-shell textures in hypergenesis zone of Gedabek deposit the characteristic feature of which is the development of concentrically zoned aggregates of oxides and hydroxides of iron and manganese, as well as complex combination of relict sulfides in cavities filled with secondary minerals.

Structural peculiarities of ores of Gedabak deposit differs with great differences [2].

There are initial structures, regarded directly to processes of ore deposition and secondary-formed at the result of fragmentation of ores and in zones of oxidation under effect of external aggregates.

Ores of deposits, characterizing mainly with grain structures, which are extremely different on their morphologic peculiarities (fig 6.a).

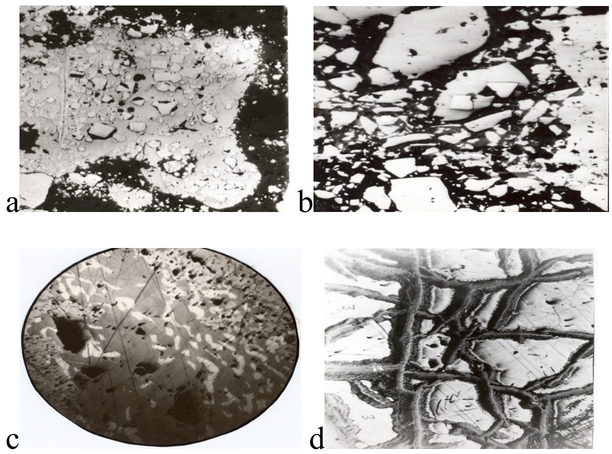

Figure 6. a) The granular structure formed pyrite grains in combination with chalcopyrite. 90 x b) Subgraphic structure. Accretion of bornite with galena. x 90, c) Cataclastic structure x90 d). Looped structure. Chalcopyrite is replaced by cracks hydroxides of iron. x 130.

Structure of destruction of hard liquid mainly wide development and found in ores of Gedabek deposit and more characteristically for chalcopyrite and shpalerite, where always interventions of cubanite, valerite, sphalerite are found, in second turn chalcopyrite and pyrotine. Product of destruction of hard liquid is fire like allocation of pentlandite in pyrotine. Subgrahic structures (fig 6.b) arise at the result of destruction of hard liquid (decomposition faded ore with forming the oriented intergrowths of pyrite, sphalerite, arsenopyrite, chalcopyrite) and in zone of hypergenesis-legitimate accretion of bornite, chalcosine, coveline with chalcopyrite, sometimes with halenyte. Structures of substitution observed in location of chalcopyrite, gray copper ore on early formed minerals, mainly in pyrite.

Cataclastic structures developed signify-cantly less in complete ores in comparison with structures of deposits and substitution, but relatively it frequently stated near contacts of diabase, cutting sulfur ore bodies. Cataclastic structures are found mainly in zones of post ore fragmentation-on lines of tectonic violations (fig 6.c).

And different corrosion structures broadly developed, which in more intensity reached the edge side parts of ore rods in maximal copper - zinc ore development spaces.

Loop and concentric zonal structure are stated in described deposit (fig 6.d).

Staged and phases of mineral forming ores. Study of phasing of mineral forming allows determine dynamicity of formation of deposit, important genetic aspects and zone distribution of ore agent. As a reliable criteria for identifying the stages of mineralization are the intersection of the earliest communities of mineral veins and veinlets later stages of brecciation and previously deferred ore, accompanied by cementation of mineral masses of debris arising from more recent solutions [1].

The basis of allocation of mineral phases in the study focuses on: changes in the composition of mineral associations and structural textural features of ores, featured intraoral metamorphism, accompanied by crushing, cementation, the intersection of the earliest associations later, temperature parameters. Character of presentation of metacrystals of ore and non-ore minerals is examined for proper interpretation of sequence.

Study of mineral composition and textural-structural parameters of the Gedabek deposit allows us to define in their formation two non-equal stages of mineralization: hypogenous and hyperegenous.

Hypogene mineralization stage is a long process, which established several stages of mineralization (quartz-pyrite, pyrite-sphalerite, quartz-carbonate) characterized by certain mineral assemblages and separated by tectonic shifts (intersection and cementation) and a relatively short intervals of time, during the change of the composition and concentration of the ore-bearing solutions.

Gold stated in quartz-pyrite ores in thin-disperse condition. Thin dissemination of gold is concentrated in early generation of pyrite.

Productive pyrite-chalcopyrite-sphalerite stage of mineralization, which widely deve-loped directly under channel in type of stock-work deposited to early formed sulfuric-sulfur ores after period of inter stage fragmentation, schistosity and metamorphism of ores.

Process finishes with deposition of pro-ducts of quartz -carbonate stage. They bear significant signs of deposited, lately character of mineralization. There is small-scale of gold.

During hyperegenous stage of mine-ralization formed secondary minerals at the expense of alteration of initial sulfides ores in zone of oxidation.

Thus, ores of described deposits formed during short period of geologic time and in this case stated zoning could not be conditioned with stratigraphic or other factors. It apparently regards with sum of acting reasons: 1) multiple opening of cracks during migration of front in space; 2) staging coming of ore forming solutions, changing their composition on time on background of general reduction of temperature; 3) several diffuse penetration of ore forming agents.

Talking about role of ore-covering rocks in formation of zoning it should be noted that it arise in weakly expressed zoning in distribution of vein minerals around-ore- altered rocks relatively to parameters and so on, ore controlling fractures [4].

Staging of ore formation and sequence of secretion of minerals, stated in scheme.

The solution of the problem. The mineral composition and texture-structural features of the ores of the Gadabay deposit were established as a result of microscopic examination of polished sections, interpretation of chemical and analytical data. To diagnose minerals, X-ray diffraction, measurement of reflection sectors, X-ray spectral and laser microanalysis were used.

The study of the mineral composition and textural-structural features of the ores allowed us to determine the stages of ore formation and the sequence of minerals extraction in this deposit.

Conclusions.

The results of the work on the mineral composition of ore deposits Gedabek concluded the following conclusions:

A microscopic study of the huge amount of polished sections and Interpretation chemical analytical data of the ore deposit was first discovered following minerals, maghemite, lynn, rninna, molybdenite, heulandite.

Set the tune of separation of gold and its paragenetic relationship with certain minerals (pyrite, chalcopyrite).

The results of mineralogical and analytical studies have shown that the main carrier of gold in Gedabek field is the early pyrite. Gold in this mineral is thin dispersion condition. In chalcopyrite observed visible gold, which is probably related to the second stage of ore deposition.

Established structural-textural features of ores, which have scientific and practical importance in the study of the ore formation conditions of the Gedabek deposit.

The results have a great practical importance in the right choosing.

REFERENCES

1. **Aliev M.I., Gusejnov G.S., Abbasov A.G.** Zolotonosnost stadij mineraloobrazovaniya Goshinskogo mestorozhdeniya (Malyj Kavkaz) //Vestnik Azerbajdzhanskoj inzhenernoj akademii. Tom 10, № 4, s. 98-102.
2. **Veliev G.A., Gusejnov G.S., Ahmedov A.M**. Veshchestvennyj sostav i teksturno-strukturnye osobennosti rud Gedabekskogo mestorozhdeniya (Malyj Kavkaz // zhurnal “Bilgi”. Ser. geol., fiziko-matematicheskih nauk. Baku, 2001, №4, s.85-92.
3. **Gusejnov G.S.** Zolotonosnost medno-kolchedannyh mestorozhdenij Somhito- Karabahskoj strukturno-formacionnoj zony Malogo Kavkaza. Avtoreferat. Baku, 1989, 40 c.
4. **Gusejnov G.S., Mobili R.B.** Zolotonosnost kolchedannyh mestorozhdenij Loksko-Agdamskoj metallogenicheskoj zony Malogo Kavkaza. – Baku: “Zardabi TTD”, 2010, 286 s.

Received: 20.11.2020
Revised: 17.06.2021
Accepted: 21.06.2021