ADMIXTURES-ELEMENTS AS GEOCHEMICAL INDICATORS OF BURIED PYRITE MINERALIZATION SEARCH (Greater Caucasus)

Novruz A.Novruzov

Geology Institute of Azerbaijan National Academy of Sciences

AZ 1143 Baku, av. H.Javid 29 A; e-mail: nnovruz@rambler.ru

Stratiform pyrite fields of the Greater Caucasus Eastern segment located in Lower-Middle Jurassic sandy-clay deposits can be characterized by a big variety of texture-mineralogical types of ores and mineral associations, by rich mineral composition and rather wide geochemical spectrum. Here belong the following fields: Filizchai, Katekh, Katsdag, Jikhikh-Sagator in Azerbaijan area of Greater Caucasus South slope, Kizil-Dere deposit in South Dagestan, numerous oremanifestations. These studied deposits ores are called Filizchai type and combine the properties of Ural, Cyprus, Kuroko and Bessi types.

In wallrock sandy-clayey deposits of pyrite deposits of Greater Caucasus South slope which were subjected to different metasomatic transformations such as quartzing, carbonatization, sericitization and chloritization one can found the following: there are the same chemical elements which are typical for ore mass, i.e. one geochemical spectrum exists. However, these elements are less by many times than in ores itselves, excepting gallium, germanium and nickel. Multicomponent ores deposits of pyrite-polymetallic deposits in region are accompanied by polyelement geochemical areola. Hydrothermal-metasomatic transformations spatially and genetically connected with mineralization are mainly found in lying side of deposits. Here systematic spatial distribution of metasomatites can be observed by approaching to them.

Geochemical peculiarities of components distribution in ore-container rocks of pyrite deposits were studied in many works where study focuses mainly on orecompound components (Cu, Zn, Pb). In our research conducted along with the basic elements a big attention is paid to distribution peculiarities of ore admixture-elements and also alkaline and radioactive elements in lithological facies of sandy-clay rocks. It has been defined that clayey composition of rocks has a positive effect on concentration of some admixtures-elements: Tl, Ag, Co, Mn, Sn, Hg, B, Li, Th, U(see table). This is due on the one hand – their considerable sorbtion volume and on the other hand – negative charge of their colloids. Concentration levels of many components depend upon extent of nearby-ore change of rocks, location of them in vertical metal bearing colomn relatively ore deposit, upon the closeness and mineral composition of contacting ore.

A clear mineralogical-geochemical zonation of deposit is defined in pyrite deposits of region, first in Filizchai deposit. It is expressed by systematic location of some texture-mineralogical ores types (bedded-foliated and massive pyrite-polymetallic, massive sulfur-pyrite and copper-pyrrhotine, spotted-breccia-like) and appropriate change of concentration levels and a number of other geochemical indicators of orecompound and admixture components on fall, thickness and deposit strike [3,4] in space. It is reflected also in structure of geochemical zonation of studied admixture components in ore containing series; in their location in above-ore and under-ore series where areolaforming admixture-elements are prevailing. So, one can see general patterns (concentration increase of zinc, lead, silver, thallium, mercury and so on in the upper part of deposit and above–ore series enriched by copper, cobalt, manganese, tin, molibden of lower part of ore deposit and under-ore series) and this is reflection of general geochemical zonation [3].

According to L.N.Ovchinnikov and E.N.Baranov ideas [5] zonation of geochemical areola in Filizchai is typical for pyrite deposits and according to distribution peculiarities of typomorphic chemical elements refers to the second type of vertical zonation of authors classification as concentration of their most amount is confined to ore deposit. Considering the data of these researchers to be not completely substantiated on endogenic geochemical areolas of Filizchai deposit A.Z.Akimidze [1] defined asymmetric distribution of geochemical areolas: anomalous concentration of elements-indicators in underore series and their lack in above-ore part of deposit. On this base the author makes the following conclusion of volcanogenic-sedimentary origin of industrial precious metals (Cu, Zn, Pb and so on) deposits. However, many years' research conducted by different authors including ourselves in area of copper-pyrite-polymetallic deposits of the Greater Caucasus Eastern segment shows incorrect idea of A.Z.Akimidze [1] relatively structure of endogenic geochemical areola and especially conditions of ore deposit formation.

Zonal structure of areola reflects more contrastly multiple coefficient of zonation, the value of which varies 2,0Ç10^{1} in ore containing rocks of Filizchai pyrite-polymetallic deposit, in above-ore zone of areola-up to 4, 2Ç10^{-1} and in under-ore zone, Katsdag copper-zinc-pyrrhotine 7,1Ç10^{-1} and 3, 1Ç10^{0} correspondingly, by several orders.

To define relationship between components of containing rocks and process of ore formation the following has been done: samples from main deposit across strike on Filizchai stream were analyzed for several elements (Tl, Ga, Ag, Pb, K, U, Th). It is defined by remoting from ore body concentration of components changes. For thallium and silver this pattern is expressed clearly, i.e. by remoting from ore deposit with pyrite-polymetallic composition the content of these elements in containing rocks is gradually reduces: thallium – from 29,1 ppm to 2,5 ppm (nearly by 12 times) and silver from 3,4 to 1,4 ppm (by 2,5 times). A sharp increase of lead concentration is found only in clayey shale from ore horizon (500 ppm), and relatively high increase of potassium, uranium and thorium contents – from contact zone. Uranium and thorium content is very low in ores it- selves and this shows that these elements were not brought by mineral-forming solutions and likely were evacuated from wallrock rocks in ore formation zone at initial stages of pyriteformation by solutions under conditions of low acidity [6, 7]. As a result of it they relatively more were accumulated in hydrothermal-modified rocks.

Location of bedded-foliated pyrite-polymetallic ores in composition of whole bed-like deposit of Filizchai and area of high contents of thallium coincide in space: both are drawn towards the upper part and western flange. Such kind of independence can be observed well by approaching to contact between ore deposit and rocks-containers. In this case thallium concentration in clayey shales with high thallium content strictly increases (sometimes more than by 20 times) by approaching to ore deposit (drill hole №№ 379, 602). Filizchai deposit allows us to define factors which are favourable for thallium accumulation in orecontaining sandy clayey deposits: clayey composition of sericitisized rocks and their location in above-ore series or ore horizon: nearness of ore body and pyrite-polymetallic composition of contacting ore [4].

As a whole among the studied admixtures-elements Tl, Ag, Hg and also B, Li, Rb one can found accumulating tendency in above-ore series, near ores with pyrite-polyme tallic composition. Other group of elements – Co, Sn, Mn, Mo and also Bi is represented by accumulation in under-ore series, just the same as pyrite deposits of Ore Altay and Ural where the last are typical elements for back zones of lithochemical anomalies [2]. Deeper horizons of sandy-clayey rocks enrich by uranium and potassium and higher horizons – by thorium above ore deposit.

Increase of silver concentration by several tens ppm in samples from zones with quartz veins and smashed clayey shales sampled from different wells and mountain production of Filizchai deposit (drill hole №№ 558, 610, 613, 616, 617, 619, gallery №50) can be observed. In several cases it accompanies by considerable increase of gold (up to 1 ppm) and lack of correlating connection with lead. Nearly in all samples the main components content (Cu, Zn, Pb) is small. Undoubtedly, this is a positive influence on this process of contacting pyrite-polymetallic ore which is more silver bearing and also gold – bearing among texture-mineralogical types of ore deposits. Data concerning silver presence zones with quartz veins and crumpled clayey, shales allows to use them as geochemical criteria for pyrite deposits search in sandy-clayey deposits of region. Lighted rocks of zones with pyrit-epolymetallic deposits oxidation are of great importance.

More or less stable indicators of gold and silver concentrations in lower horizons of Filizchai deposit along with ore-compound components such as, geochemical criteria show the continuation of pyrite-polymetallic mineralization, i.e. perspective of deeper horizons of deposit. Some concentrations increase of above-ore-upper ore components (Ag, Tl, Hg) in lower horizon and not systematic behavior of some typical elements of back (Co, Sn) and frontal (Zn, Cd) zones in some deposits and rocks-container of Katsdag and Jikhikh-Sagator copper-zinc-pyrrhotine deposits are of indicator importance and show a possible presence of new ore bodies at depth.

So, distribution peculiarities of such components as (Tl, Ag, Hg, Sn and also Mo and Bi) in ore containing rocks of pyrite deposits of Greater Caucasus South slope allow to refer them along with orecompound components (Zn, Pb, Cu) to indicator elements for buried ore accumulations search in Lower-Middle Jurassic sandy-clayey deposits of region. Close dependence between uranium and potassium concentrations in rocks-container of Filizchai deposit and also space combining of relatively higher contents of radioactive elements with zones of wallrock hydrothermal-metasomatic changes contacting with bedded-foliated and massive pyrite-polymetallic ores, vertical, zonation in distribution of their contents and values Th/U allow to use these elements as geochemical criteria for search of pyrite-polymetallic mineralization.

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Table
Average contents of admixtures – elements in ore-container rocks of pyrite deposits in Azerbaijan area of Greater Caucasus South slope (ppm)

Elements	Clayey shales				Aleurosandstones			
	Filizchai	Katekh	Katsdag	Jikhikh-Sagator	Filizchai	Katekh	Katsdag	Jikhikh-Sagator
1	2	3	4	5	6	7	8	9
Tl	7,3 (28)	1,8 (25)	0,9 (34)	2,5 (13)	2,2 (16)	1,6 (14)	0,3 (13)	1,5 (10)
Ga	25 (19)		27,8 (5)	15 (13)	19,6(12)		26,7 (6)	12 (10)
Ge	2,2 (8)	1,4 (9)		2,3 (13)	2,1(2)	0,8 (6)		2,1 (10)
Ag	2,5 (45)	4,0 (16)	0,84(29)		1,6 (21)	2,4 (7)	0,38 (9)	
Bi	6,5 (17)	1,1 (13)	1,9 (29)		6,0 (7)	1,0 (7)	2,9 (9)	
Co	52,9(285)	31,2(24)	13,3(34)	9,2(12)	46,3(41)	31,7(6)	10,6(13)	8,4(12)
Ni	42,5(36)	29,3(6)	31,4(34)	13,1(12)	29,4(15)	22,5(5)	26,8(13)	11,2(12)
Mn	350,3(35)	455(6)	451(34)	1600(12)	327,3(15)	350(5)	729(13)	1475(12)
Sn	9,3(36)	3,8(6)	4,4(29)		2,8(8)	2,5(5)	3,6(8)	
Hg	0,028(111)	1,3(29)			0,013(15)	0,7(14)		
Mo	2,5(18)	1,4(6)	1,5(34)	1,8(12)	1,1(5)	1,2(5)	0,7(13)	1,2(12)
Li	34,5(42)	74(46)	23,4(5)		34,9(7)	60,4(11)	23,6(5)	
Rb	77,9(43)	135,7(46)	112(5)		90,0(7)	60,9(11)	50(5)	
K,%	1,67(46)	2,91(46)	2,58(5)		1,87(7)	1,50(11)	1,08(5)	
Na,%	0,80(45)	1,07(46)	0,22(5)		1,73(7)	1,26(11)	0,09(5)	
U	1,4(16)	2,5(9)			1,4(7)	1,9(9)		
Th	13,1(15)	6,1(9)			8,4(6)	3,9(9)		

Note: in the brackets – the quantity of analyses.