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Geochemical characteristics of copper-polymetallic mineralization of the Elbeydash field (Murovdag ore district)

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Abstract: ***The article deals with the geochemical characteristics of copper-polymetallic mineralization of the Elbeydash field. Three ore intervals represented by six ore lenses were identified by studying the structural and morphological peculiarities of copper-polymetallic ore masses in the field. According to the results of correlation analysis, it is shown that the close relationships (Pb–Zn–Cu–Au–Ag) between the elements are associated with sulfide minerals (galenaite, sphalerite, pyrite, chalcopyrite). A statistical analysis of the determination of the major and adjacent elements at different levels of copper-polymetallic mineralization was carried out and it was found that Cu and Pb are the major ore components of copper-polymetallic mineralization. 3 levels of mineralization were determined on the field: 1) Cu-Pb-Zn mineralization on the lower level; 2) Pb-Cu-Zn mineralization on the middle level; 3) Cu-Pb-Zn mineralization on the upper level.***

Key words: *Elbeydash, copper-polymetallic, geological and geochemical, level of mineralization, major components, correlation relationship*

Geological and structural peculiarities of the field. The field corresponds structurally to the southwest end of the Dashkasan synclinorium, and is located 10-12 km southwest of the Chamillibulag-Kizilarkhach area on the northeastern slope of Elbeydash mountain (2190m) in the junction zone of the Dashkasan and Touraghachai synclinoriums on the one hand, and the Murovdag and Aghdam anticlinoriums on the other. It is controlled by a premineral semi-circle transverse fault on the southeastern flank of the Murovdag ore cluster [2]. The area of the field is mainly represented by reefogenic limestones complexed with Upper Jurassic volcanomictic rock such as tuff sandstones, tuff breccias, tuff gravelites, tuff conglomerates, etc.

The Kimmeridgian basaltic porphyries from igneous rocks are involved in the geological section of the field [1,4]. The general bedding of the rocks is from southwest to northeast, their bedding is from 10-15º to 20-30º to the northwest.

The reverse fault-type dissocations among the dissocation structures usually prevail within the field. The two large ones are observed along the Elbeydash plateau at a distance of 3-3.5 km parallel to the Murovdag upthrust at an angle of 30-40º in the alternating with volcanogenic formations. These faults form the Elbeydash synclinorium as a step-like block structure. Here, the Touraghachai synclinorium is bounded from the north by the Murovdag upthrust, the Aghdam anticlinorium by the abovementioned semi-circle fault, and the Murovdag anticlinorium by the Murovdag-Zod transverse fault [2, 5, 12].

Copper-polymetallic mineralization occurs mainly in dissociation zones with regional reverse fault-upthrust type, in the intersection interval of these zones with near-meridional faults. Here, the main ore-controlling elements are considered to be second-order reverse faults and reverse fault-upthrusts.

The veinlet-vug-impregnated quartz-carbonate-dolomite-polymetallic mineralization, controlled by semi-circle faults, is developed along the interlayered dense fracture systems in the horizon of volcanomictic rock within the field. Copper-polymetallic mineralization is mainly represented by veinlets and impregnated veinlet types and is adapted to the Kimmeridgian limestone layers alternating with volcanogenic formations. The distribution of ore mineralization throughout the entire thickness of the limestone layer is uneven. So, the amount of copper varies from 0.1-1.0 to 15-20% (1.8% on average). Besides copper, lead (0.05-0.1%, sometimes 4.1-% up to 5.0%), zinc (up to 0.01-1.58%) and silver (0.1-2.0 g/t, sometimes up to 5.0-9.0 g/t) occur in ores. 0.001-0.084% boron was observed in a series of tests [2,7,8].

The lower limit of endogenous mineralization is defined in black porphyrites and tuff breccias covering limestones. The amount of copper in these rocks does not exceed 0.2%, and the amount of lead does not exceed 0.57%. Separate intervals of the stratiform (stratified) ore horizon, characterized by rich ore concentration, are observed at a distance of about 7km from the surface with a thickness of 1-20m to 60-120m. The main minerals of the ore horizon are considered to be chalcosine, bornite, chalcopyrite, pyrite, and sometimes galena and sphalerite [6,12].

Structural and morphological peculiarities of ore masses. In general, three ore intervals have been identified within the Elbeydash copper-polymetallic field. The first interval of these represents four ore lenses, and the second one represents two ore lenses.

The I-ore interval – is located on the northwestern side of the field and is observed with a thickness of 5-10m to 40-50m at a distance of up to 400m. The parameters of ore lenses in this interval are as following:

The length of *lens No. 1* is up to 300 m, and its thickness is from 1-3 m to 5-10 m. Here, the amount of Cu varies from 0.10-1.0 to 3.0-9.65%, the amount of Pb from 0.05-0.5% to 1.0-3.0% and the amount of Zn is 0.01-0.10%.

The length of *lens No. 2* is up to 100 m, and its thickness is 3-6 m. It was studied on 2 sections with a distance of 50 m from each other. The amount of Cu is 0.13-0.36% (0.25% on average), the amount of Pb is 0.05%, and the amount of Zn is 0.01%.

The length of *lens No. 3* is up to about 50m, and its thickness is 8m on average. It is studied on one section on the surface. The amount of Cu is 0.20-1.21% (0.57% on average), the amount of Pb is 0.05-0.06%, and the amount of Zn is 0.01-0.03%.

The length of *lens No. 4* is shorter than other lenses and is 20m. Its maximum thickness is 2m. The amount of Cu is 0.28%, the amount of Pb is 0.05%, and the amount of Zn is 0.02%.

The II-ore interval is located 400m outside the first ore interval, in the southwest of the ore horizon. Two ore lenses are bordered here.

The length of *lens No.1* is about 80m, and its thickness varies between 5-15m. It was studied on two sections with a distance of 50 m from each other. The amount of Cu is 0.10-0.46% (0.36% on average), the amount of Pb is 0.05-0.50%, in some intervals 2.0-4.50%, the amount of Zn is 0.05-0.10%, sometimes 0.27%.

The length of the *lens No. 2* is about 90m, its thickness is 4-10m, and was studied on two sections with a distance of 40m from each other. The amount of Cu is 0.10-0.80% (0.36% on average), sometimes 1.0-1.85% (0.40% on average), the amount of Pb is 0.05-0.10% , in some intervals is 1.0-2.50%, and the amount of Zn is 0.01-0.11%.

The III-ore interval is located in the southwest of the ore horizon and 300m from the second ore interval. The length of ore lens was identified up to 70 m and its thickness 10 m here. The amount of Cu is 0.17-0.99% (0.33% on average) here and the amount of Pu is 0.05%. The amount of Zn is 0.01-0.02%. It should be noted that all the mentioned ore lenses are mainly adapted to the brecciated limestones along the Layaras crush zone. It should be stated that all the abovementioned ore lenses are mainly adapted to brecciated limestones along the interlayered shear zone.

The copper-polymetallic ores of the Elbeydash field include the main minerals – bornite, chalcosine and galena, secondary – pyrite, sphalerite, sometimes tennantite, tetrahedrite, marcasite and rutile, vein – quartz, calcite, barite and chlorite, hypergene – limonite, malachite, azurite, cuprite, covelline, chalcosine and anglesite. The mineralization process took place in two stages: copper and lead-zinc [6,12].

Lithochemical testing was carried out in drill hole cores and underground drillings, and lithochemical testing of wallrocks and ores was carried out for the separation of geochemical aureoles. As a result, primary geochemical aureoles consisting of Pb, Zn, Au and Ag elements were observed within intensively altered wallrocks, especially near polymetallic ore masses.

Geochemical peculiarities of copper-polymetallic mineralization. In order to determine the distribution peculiarities of the major ore components in copper-polymetallic mineralization, the analysis results of major and adjacent components from Cu, Pb, Zn, Au and Ag and group tests were used in tests taken from drill holes and vertical surface drillings. Mathematical statistical processing of analytical data was carried out to study the distribution peculiarities of major, noble and other accompanying elements (Table 1). Based on the statistical peculiarities of the major ore components, the geochemical peculiarities of copper-polymetallic mineralization were clarified and point dependency diagrams were drawn (Fig.1).

Table 1

The average amount of chemical elements in ores of Elbeydash copper-polymetallic field

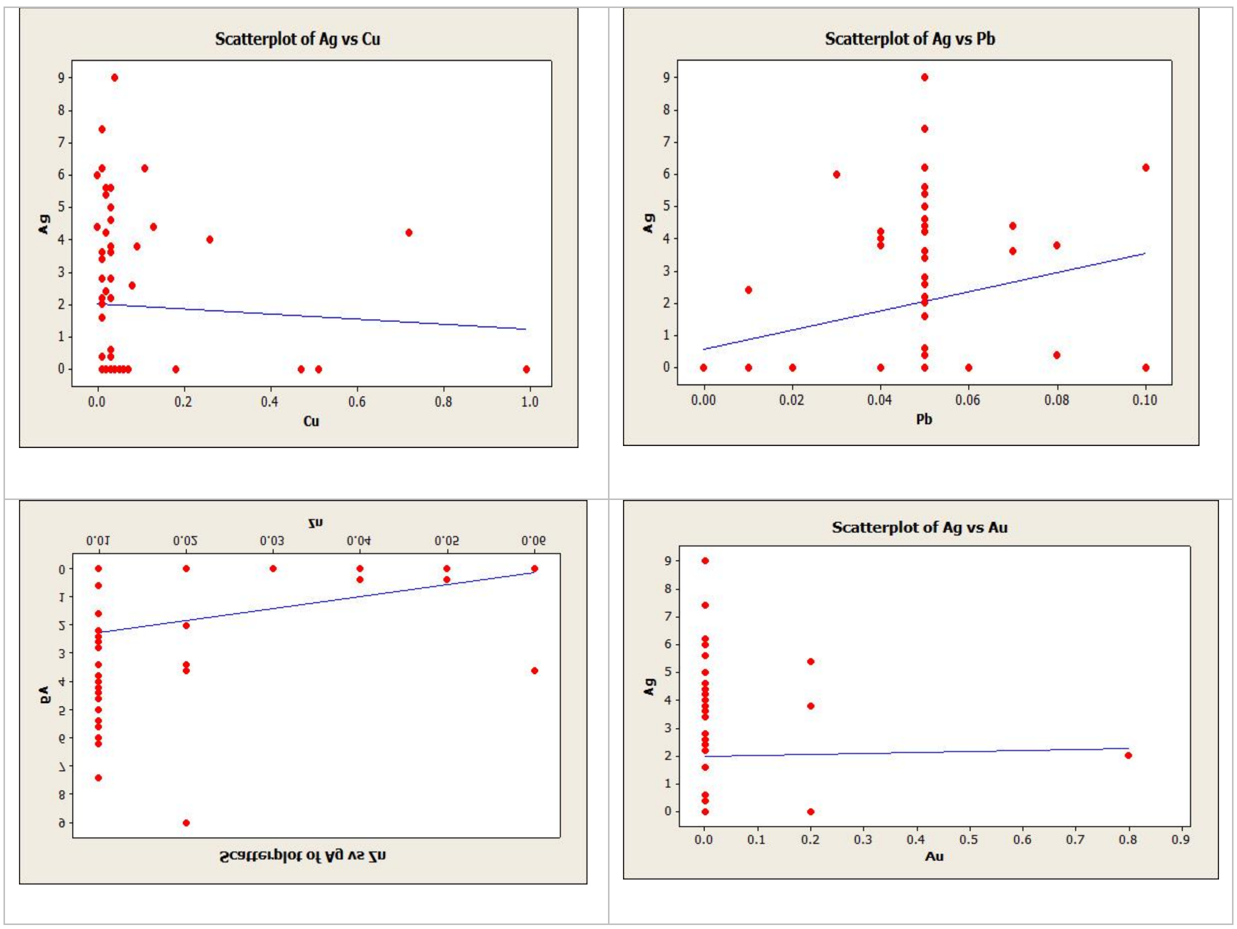
Elementlər Sınaqların Nº-si	Zn,%	Pb, %	Cu, %	Au, q/t	Ag, q/t
1184	0,01	0,05	0,13	0,001	4,4
1185	0,01	0,05	0,03	0,001	0,5
1186	0,04	0/06	0,03	0,001	0,4
1187	0,02	0,07	0,04	0,08	2,0
1188	0,01	0,04	0,02	0,002	2,8
1189	0,03	0,04	0,01	0,002	-
1221	0,01	0,03	0,01	0,001	2,2

1222	0,02	0,07	0,01	0,001	-
1223	0,02	0,07	0,01	0,01	-
1224	0,01	0,05	0,01	0,02	3,4
1225	0,01	0,06	0,01	0,02	2,2
1226	0,03	0,04	0,02	0,01	-
1227	0,03	0,07	0,06	0,001	-
1228	0,05	0,04	0,07	0,003	-
1229	0,06	0,05	0,06	0,002	5,4
1230	0,02	0,05	0,05	0,02	5,6
1231	0,05	0,08	0,04	0,02	7,4
1234	0,03	0,06	0,04	0,02	2,8
1235	0,05	0,07	0,04	0,03	2,4
1177	0,03	0,06	0,01	-	-
1178	0,01	0,03	-	0,001	6,0
1179	0,01	0,08	0,01	0,001	3,8
1180	0,05	0,08	0,03	0,001	0,4

Continuation of Table 1

Elementlər / Sınaqların №-si	Zn,%	Pb, %	Cu, %	Au, q/t	Ag, q/t
1181	0,04	0,01	0,01	0,001	-
41182	0,01	0,01	0,01	0,001	6,2
1183	0,01	0,07	0,03	0,002	3,8
1270	0,02	0,05	0,02	0,001	0,4
1271	0,01	0,05	0,03	0,002	-
1272	0,02	0,06	-	0,001	6,2
1273	0,01	0,07	0,05	0,01	4,4
1274	0,01	0,04	0,02	0,02	0,9

1275	0,03	0,01	0,01	0,01	4,6
1276	0,02	0,03	0,03	0,001	3,4
1277	0,04	0,03	0,02	0,01	5,6
1278	0,06	0,02	0,01	0,01	4,2
1279	0,05	0,02	0,03	0,02	5,0
1180	0,01	0,03	0,04	0,001	2,6
1281	0,04	0,07	0,01	0,01	3,6
1182	0,02	0,02	0,01	0.01	5,8



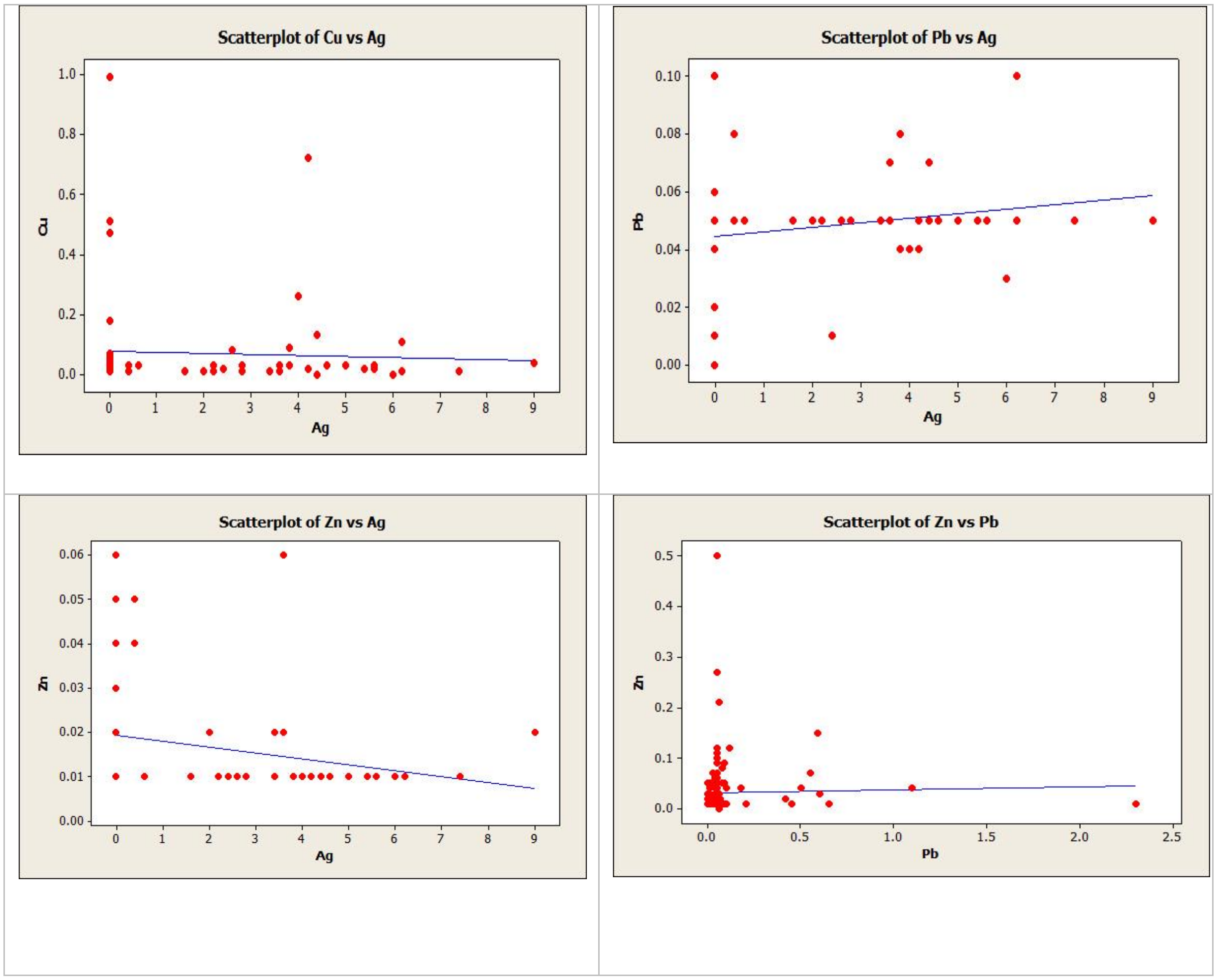


Figure 1. Point dependency graphs between the major ore elements of copper-polymetallic ores

A coupling correlation matrix was calculated for all options. At this time, the amount of the major ore components (Cu, Pb, Zn, Au, Ag) was used. Point dependency diagrams were drawn for each option (Fig. 2). According to the statistical analysis of the conducted research, it can be stated that the heterogeneity of all samples is unambiguously reflected. Correlation analysis for the given samples shows that element associations and closer relationships between elements can be observed: Pb–Zn–Cu–Au–Ag. In this case, the correlation coefficient between element associations is greater than 0.7. For example, the positive relationship between Cu – Zn (0.515), Cu – Pb (0.971), Pb – Zn (0.717), Au – Zn (0.887) and other elements can explain that the main associations of lead and zinc were represented by sulfides (galena, sphalerite, pyrite, chalcopyrite) [7,13].

Table 2

Correlation matrix between chemical elements in primary sulfide ores (R-0.5%)

Elementes	Zn	Pb	Cu	Au
Pb	0,051			
Cu	0,029	-0,003		
Au	- 0,011	- 0,025	- 0,025	
Ag	-0,236	0,217	-0,056	0,017

As can be seen from the table, the positive correlation level was determined between Pb-Zn (r = 0.051), Cu-Zn (r = 0.029), Ag-Pb (r = 0.217) and Ag-Au (r=0.017), a negative correlation level was determined between Cu-Pb (r = - 0.003), Au-Zn (r = - 0.011), Au-Pb-Cu (r = - 0.125), Ag-Zn (r = - 0.236) and Ag-Pb (r = - 0.056) have a certain level of negative correlation has been done.

Almost all of the abovementioned statistical methods were implemented with the same scheme for the interpretation of the obtained results. This can also be seen in the dendrogram example. The elements form two groups in the dendrogram of the cluster analysis (Fig. 2): Zn-Au-Cu and Ag-Pb. The analysis of the results of the statistical processing of the determination of the major and adjacent elements at different levels in the Elbeydash field shows that Cu and Pb are considered the major components of copper-polymetallic mineralization. For the correct interpretation of the cluster analysis, it is considered more important to analyze the geological situation around the test points. For example, if the certain tests are located near a copper-polymetallic ore mass, under loosened sediments in the northwest of it, they are most likely sulfide ores [8,12].

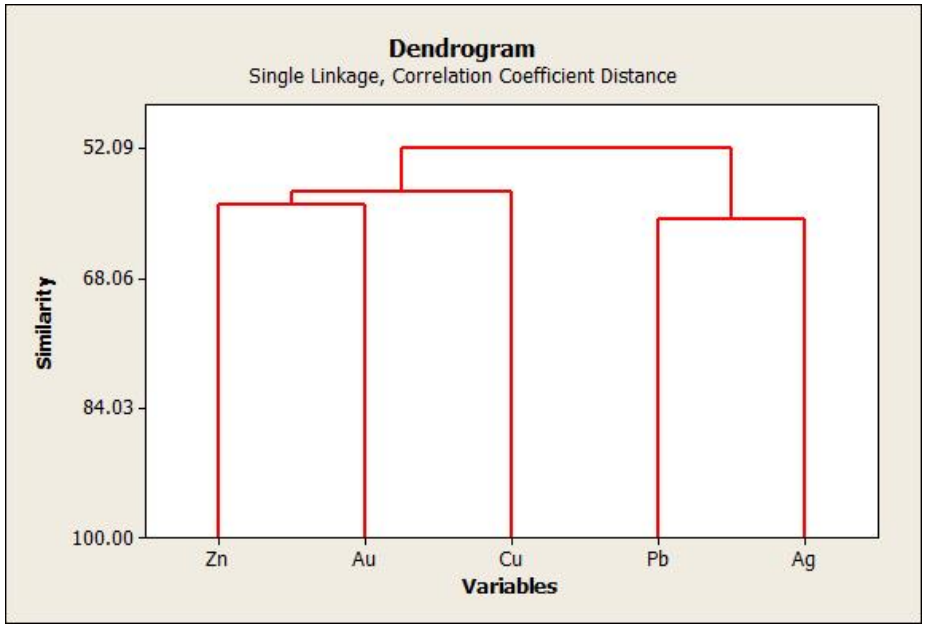
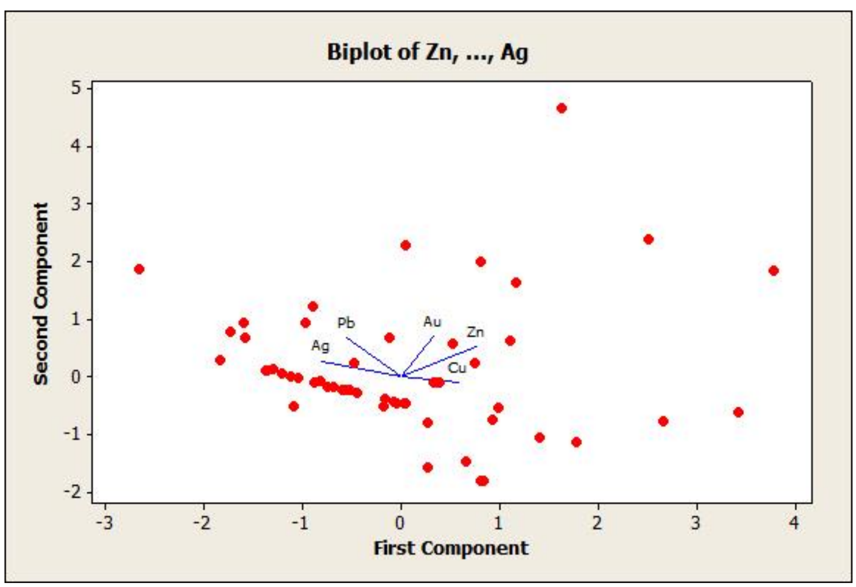


Figure 2. Dendrogram of the cluster analysis of major components

Besides the statistical analysis of geochemical data, graphs of the spatial distribution of the amount of chemical elements were constructed according to the geochemical profiles along the section line (Fig. 3).



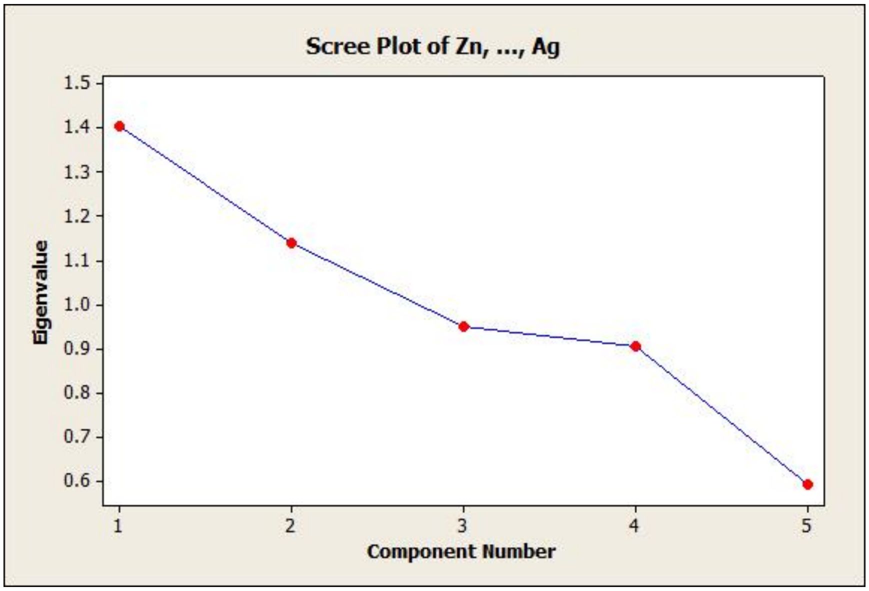


Figure 3. Graphs of spatial distribution of elements

When comparing the graphs constructed using the new and previous data, it is revealed that the entire central and western part of the ore lens within the field is surrounded by a single positive anomaly of Cu, Pb and Zn. However, after the interpretation of the well data, the structure of the geochemical field was observed to be significantly different. So, the single structure is divided into three local (at least 15-30 m in diameter) minima and maxima, which replace each other by lateral contrast.

According to the comprehensive analysis of the geochemical analysis of the data, the following ideas can be put forward about the geological and geochemical peculiarities of the copper-polymetallic ore layers in the Elbeydash field. Here, a change is observed in the composition, ranging from copper-pyrite-zinc mineralization to lead-zinc mineralization, covering 3 ore levels, in the ore intervals. In general, all three levels of mineralization are observed in only 10% of the field, and elsewhere either two levels of mineralization or only one level of mineralization are observed [13].

According to the abovementioned notes, it can be concluded that there are 3 mineralization levels within the boundaries of Elbeydash copper-polymetallic occurrence: 1) Cu-Pb-Zn mineralization on the lower level; 2) Pb-Cu-Zn mineralization on the middle level; 3) Cu-Pb-Zn mineralization on the upper level. As it can be seen, Cu and Pb are considered to be the major beneficial components and Zn has a subordinate peculiarity in all three mineralization levels mentioned in the field.

Conclusion:

1. Copper-polymetallic mineralization is mainly represented by veinlets and impregnated veinlet types and is adapted to the Kimmeridgian limestone layers alternating with volcanogenic formations.

2. Structural-morphological peculiarities of copper-polymetallic ore masses in the field are represented by three ore intervals represented by six ore lenses.

3. Statistical analysis of the determination of major and adjacent elements at different levels of the field shows that Cu and Pb are the major components of copper-polymetallic mineralization.

4. A positive correlation between the elements shows that the main associations of lead and zinc are represented by sulphides (galena, sphalerite, pyrite, chalcopyrite).

5. A change in composition covering 3 ore levels is observed from copper-pyrite-zinc mineralization to lead-zinc mineralization in ore intervals: 1) Cu-Pb-Zn mineralization on the lower level; 2) Pb-Cu-Zn mineralization on the middle level; 3) Cu-Pb-Zn mineralization on the upper level.

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