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MAIN GEOCHEMICAL ASSOCIATION OF THE SULFIDES LEAD-ZINC MINERALIZATION IN TREPÇA MINERAL BELT- ARTANA MINE, KOSOVO

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ABSTRACT

This paper presented the distribution of average contents of major metals (Pb, Zn, Ag and Au) and accompanying metals in mineral deposit "Përroi i ngjyrosur", Artana mine. With special emphasis, we studied the main geochemical association of sulfides mineralization. Based on correlation and factorial analysis the results of these geochemical associated are as follows: Au-Cu-Pb-As (Zn-Ag-Sb); Ag-Bi-Pb-(Zn-Cu-Cd), and Sb, in antagonism with Cd-As-(Pb-Zn-Au-Ag).

Keywords: geochemical association, lead-zinc mineralization, "mineral deposit përroi i ngjyrosur", Artana, Kosovo.

INTRODUCTION

The lead-zinc mineral deposit of "Përroi i Ngjyrosur" located in the south-east of Prishtina airline about 18 km away (Figure-1), is part of the Artana ore field, and as a whole is located within Vardar tectonic zone (Figure-2). Have about 9 Mt ore reserves with average content of 2.30% Pb, 2.50% Zn, and 92 gr/t Ag (Radoslav *et al*., 1989; Klisič, 1995; Fetahaj, 2007; Durmishaj *et al*., 2010/11). Main metallic components in this deposit are Pb, Zn, Ag and Au, whereas other elements can be found in smaller quantities. The study is based on the date of mineral deposit "Përroi i ngjyrosur" taken during the years of exploitation. The contents of main metals of lead (Pb) and zinc (Zn) were analyzed in separate samples, whereas the contents of Pb, Zn, Ag, Au, Bi, Cd, Cu and Sb were analyzed only as composite samples. Chemical analysis of samples were done in the laboratories of "Kishnica - Artana" (Prishtina).

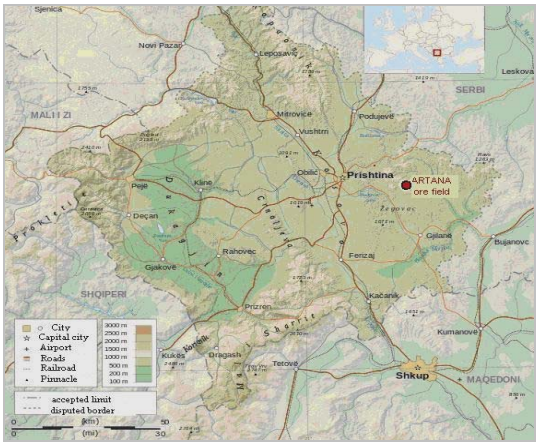

Figure 1. Geographical position of the Artana ore field.

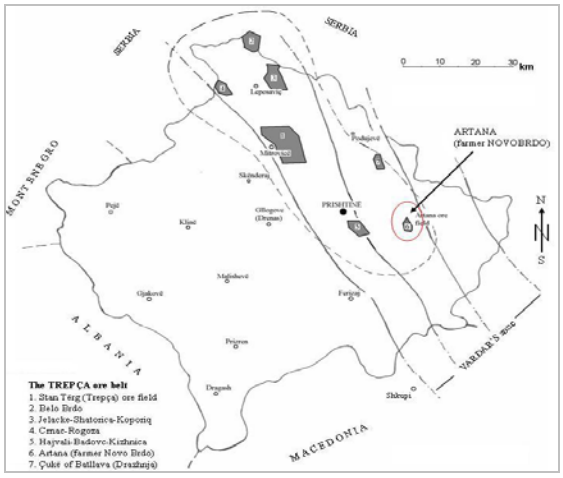

Figure-2. The leads and zinc sulfide mineralization in the region of Kosovo.

General geology of the Artana (former-Novo Brdo) ore field

The rocks in the surrounding of the Artana mine belong to the Series of Veles (Serbian-Kosovo-Macedonian) massif, mainly granite-gneisses, serpentinites, gabbroic rocks and granitoids as well as cretaceous and tertiary rocks, dominantly sediments, andesites and volcanoclastic rocks.

GEOLOGICAL SETTING OF THE "PERROI I NGJYROSUR" MINERAL DEPOSIT

The mineral deposit is composed of the gneisses, amphibolite rocks, marble/carbonates, phyllites and andesites (Radoslav *et al*., 1989; Hyseni *et al*., 2011). All rocks were intensively changed. In the southeast and central part of the mineral deposit "Përroi i ngjyrosur" the skarns and corneites are present, and their participation grows with the depth. Hydrothermal alterations are manifested as intensive pyritization, silification,

carbonatization, sericitization, kaolinitization, and argillitization of the host rocks (Klisič, 1990). The mineral deposit of "Përroi i Ngjyrosur" is located in the central part of the no. 2 ore structure (Makresh-Artane-Lagjia e Bullajve), Figure-3.

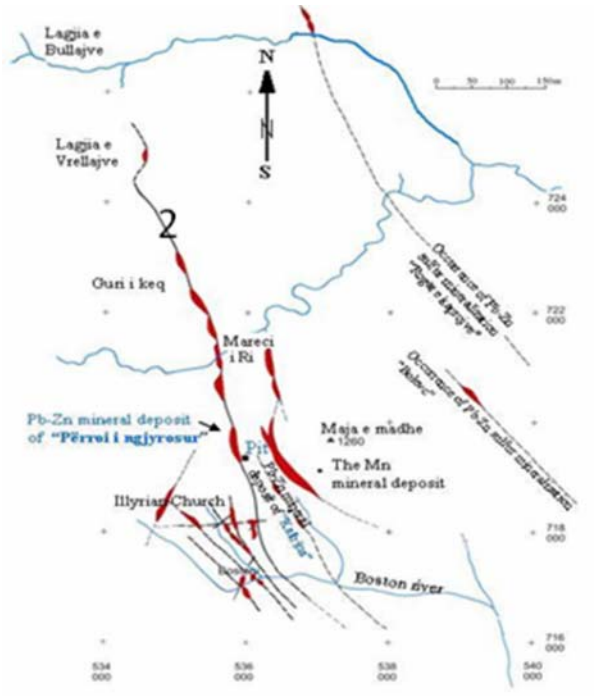

Figure-3. Sulfide mineralization in the Artana ore field. The main ore structure no.2, where is localized the mineral deposit of "Përroi i ngjyrosur."

The polymetallic mineral deposit of the "Përroi i ngjyrosur" belongs to the group of contact-metasomatic-hydrothermal deposits forming in close connection with Tertiary tectonic-magmatic processes. The deposit of mineralization was mostly done by metasomatic processes in the marble level, whose footwall is composed of gneisses and amphibolitic schist's and the hanging wall of phyllites. The ore was deposited in free space along the contacts of various rocks and smaller ore bodies were forming in fault zones. The deposit generally strikes from the submeridian to the NNW-SSE direction, with a dip into the western field at an angle of 30-80°, (Radoslav *et al*., 1989).

LOCATION AND MORPHOLOGICAL CHARACTERISTICS OF ORE BODIES

The sulfides mineralization of lead-zinc is located in the different rocks types. The mineralization located in carbonate rocks (limestone) is of economic importance in the mineral deposit of Përroi i ngjyrosur (Artana ore field). Different morphologies (veins, lenses and combined) of the ore bodies are observed in mineral deposit "Përroi i ngjyrosur" (Fetahaj B. *et al*., 2007). All ore bodies characterized by elongated shapes from 120 - 240m and a thickness which varies from 2 - 60m depending on the ore body.

MINERALOGICAL COMPOSITION

The polymetallic sulfides mineralization of the mineral deposit of Përroi i ngjyrosur belongs to the sub volcanic type of pneumatolytic - hydrothermal phase of tertiary metalogenesis.

Based on mineralogical studies (Smejkal *et al*., 1956; Smejkal, 1960; Rakič *et al*., 1978) distinguished this main mineral paragenesis:

- The mine paragenesis of sulfides minerals of the lead-zinc with pyrite, sphalerite, galena and pyrrhotite;
- The paragenesis of the zinc-iron carbonates with low sulfides content;
- The paragenesis of alumo-silicate minerals-group of kaolinite (halloysite), and paragenesis of oxide minerals like psilomelane.

Based on studies in 100 microscopic preparations (Mining Institute for Nuclear Studies, 1963) participation of minerals resulting as follows: pyrite >90%; sphalerite, galena and pyrrhotite (70-90%); chalcopyrite, arsenopyrite, marcasite, quartz and siderite (30-70%); tetrahedrite, boulangerite, calcite, oligonite (10-30%); bournonite, jamesonite, stannite, chalcocite, covellite, bornite, cubanite, vallerite and ancerite (under 10%).

The mineral deposit of Përroi i ngjyrosur is mostly composed of pyrite, sphalerite and galenite, as well as of pyrrhotite and magnetite in the deeper parts. All other minerals (chalcopyrite, arsenopyrite, tetrahedrite, boulangerite, cubanite, etc.) are present as mineralogical occurrences.

ANALYSIS OF MINERALIZATION AND METHODS FOR DETREMINING THE GEOCHEMICAL ASSOCIATION

Study of ore mineral was made by representative samples of deposit during the evidence phase of exploitation. The results of chemical analysis were taken from Kizhnica and Artana chemical laboratory. For this study, we have exploited the chemical analysis result for united samples (composite), analyzed a total of 29 samples. Distribution of major chemical elements contents and the associated elements in the mineral deposit "Përroi i ngjyrosur" presented through the statistical parameters in Table-1.

Based on the correlation analysis for the mineral deposit Përroi i ngjyrosur (Artana), Table-2, indicating these geochemical association (Durmishaj, 2007):

a) Pb-Zn-Ag-Au-Cu-As;
b) Zn-Pb-Ag-As;
c) Ag-Pb-Zn-Bi-(Cd-Cu-As) and
d) Au-Pb-Cu-As on antagonism with Bi.

Link of the contents of gold (Au) remains stable with the content of lead (Pb) and copper (Cu) as sulfides ore bodies as well as in the oxidation zone, while showing

a stable link with the arsenic (As) in the sulfide ore bodies but not even in the oxidation zone, also have an antagonism with the bismuth (Bi) content, whereas that in both cases have not correlated to the content of gold (Au) with zinc (Zn). These geochemical association corrupted chemically in the oxidation zone, where the lead (Pb), associated only by gold (Au) and copper (Cu), until the zinc (Zn) with none other element.

It shows the conditions in the oxidation zone with removal of zinc (Zn) and the possibility of getting the gold (Au) concentrations in this zone.

However, exact data on geochemical association except correlation analysis taken by factorial analysis presented in Table-3 and then in the Figure-4.

Table-1. Statistical parameters of the distribution of metals contents in the mineral deposit of Përroi i ngjyrosur (Artana ore field).

Parameters/elements	**Pb** (%)	**Zn** (%)	**Ag** (gr/t)	**Au** (gr/t)	**Bi** (%)	**Cu** (%)	**Cd** (%)	**As** (%)	**Sb** (%)
Average	4.36	5.45	126.07	1.29	0.01	0.18	0.05	0.54	0.21
Median	4.56	4.8	140.00	1.00	0.01	0.08	0.03	0.41	0.21
Standard deviation	2.58	4.10	66.91	0.96	0.01	0.47	0.04	0.41	0.13
Minimum	0.8	1.06	15.00	0.40	0.00	0.00	0.00	0.08	0.00
Maximum	13.25	17.85	254.00	4.20	0.03	2.60	0.21	1.75	0.55
No. of samples	29	29	29	29	29	29	29	29	29

Table-2. Correlation matrix for the mineral deposit of përroi i ngjyrosur (Artana). The correlation coefficients are significant for $p < 0.05$, when have a value greater than 0.43. No. of samples = 29.

Elements	**Pb**	**Pb ox**	**Zn**	**Zn ox**	**Ag**	**Au**	**Bi**	**Cu**	**Cd**	**As**	**Sb**
Pb %	**1.00**	0.47	**0.53**	0.04	**0.66**	**0.47**	0.09	0.64	0.33	0.51	-0.26
Pb ox %	0.47	1.00	0.09	0.19	0.18	0.64	-0.27	0.52	-0.08	0.23	0.06
Zn %	**0.53**	0.09	**1.00**	0.49	**0.55**	0.13	0.15	0.17	0.21	0.43	-0.17
Zn ox %	0.04	0.19	0.49	1.00	0.24	-0.10	0.20	-0.14	-0.01	-0.09	0.02
Ag gr/t	**0.66**	0.18	**0.55**	0.24	**1.00**	0.09	0.52	0.22	0.33	0.19	-0.09
Au gr/t	**0.47**	0.64	0.13	-0.10	0.09	**1.00**	-0.50	0.59	0.29	0.54	-0.04
Bi %	0.09	-0.27	0.15	0.20	**0.52**	-0.50	1.00	-0.25	0.12	-0.47	-0.11
Cu %	**0.64**	0.52	0.17	-0.14	0.22	**0.59**	-0.25	1.00	-0.05	0.33	0.11
Cd %	0.33	-0.08	0.21	-0.01	0.33	0.29	0.12	-0.05	1.00	0.26	-0.44
As %	**0.51**	0.23	**0.43**	-0.09	0.19	**0.54**	-0.47	0.33	0.26	1.00	-0.29
Sb %	-0.26	0.06	-0.17	0.02	-0.09	-0.04	-0.11	0.11	-0.44	-0.29	1.00

Table-3. The weights of the factors (Vary max normalized). The method of main components. Bold values are about the 0.7 and biggest that so.

Elements	Factors			
	F1	F2	F3	F4
Pb %	**0.680**	**0.563**	-0.316	0.137
Pb ox %	0.806	-0.039	0.150	0.123
Zn %	0.259	0.340	-0.248	0.772
Zn ox %	-0.138	0.046	0.108	0.905
Ag gr/t	0.202	**0.832**	-0.205	0.274
Au gr/t	**0.833**	-0.200	-0.270	-0.073
Bi %	-0.513	**0.800**	0.005	0.041
Cu %	**0.861**	0.237	0.173	-0.116
Cd %	0.044	0.225	**-0.786**	-0.022
As %	**0.605**	-0.187	**-0.537**	0.208
Sb %	0.077	-0.044	**0.798**	-0.030

From the above table, result these geochemical associations are:

1. Pb-Au-Cu-As;
2. Pb-Ag-Bi and
3. Sb on antagonism to Cd and As.

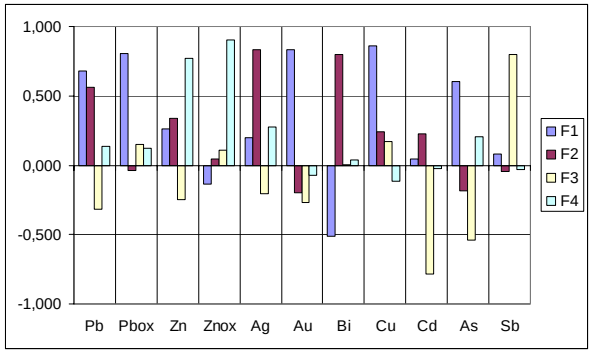

Figure-4. The weight of factors, mineral deposit of the Përroi i ngjyrosur (Artana ore field).

CONCLUSIONS

According to the factorial analysis, the result of these geochemical associations are as follows: Pb-Au-Cu-As-(Zn-Ag-Sb); Pb-Ag-Bi-(Zn-Cu-Cd). These geochemical associations show a strong link to gold (Au) with copper (Cu) and lead (Pb), and its weak links with zinc (Zn) and silver (Ag). On the contrary, silver (Ag) shows the strong links with lead (Pb) and bismuth (Bi). Antimony (Sb) is mainly collected together with copper (Cu), bismuth (Bi) and lead (Pb) but in antagonism with the first associations of gold (Au).

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