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ECONOMIC APPLICABILITY AND VALUE OF JEWELRY MINERALS, METALLIC AND PRECIOUS RESOURCES IN KOSOVO AND METOHILJA

Abstract

This research refers to the estimates of economic usability and value of jewelry minerals, metallic and precious resources in Kosovo and Metohija. In this regard, there is a great economic interest in already proven exploitable and profitable investments in the target mines and deposits of Trepca, Goles, but also in the deposits of Crepulja, Malisevo near Prizren, Slivovo etc. To the contrary, we have insufficiently known and explored jewelry minerals-raw materials. Therefore, the common opinion and estimation of geologists and gemologists is supported that there is a significant interest of foreign investors in the mineral raw materials and that those investors in jewelry minerals - raw materials which are evidently found among the deposits in Kosovo and Metohija that have already been explored or are insufficiently explored, are to be encouraged. It is certain that there is an evident mineral and jewelry wealth that is still unused a great extent.

Keywords: *jewelry minerals, metallic resources, precious resources, investors*

1 INTRODUCTION

Evidently, the natural wealth of earth's rocks are metallic ore and jewelry minerals-raw materials from Stari Trg and other mines such as Ajvalija, Kishnica, Novo Brdo and Belo Brdo belonging to a business system of Trepca in Kosovo and Metohija. Jewelry minerals-raw materials such as pyrite, sphalerite and galena in combination with quartz are an important source of known metals such as lead and zinc. Other not so well known and insufficiently explored deposits of famous gemstones of quartz chalcedony, opal group and chryso-prase, were found in Goles near Pristina, Klobukar near Belo Brdo, Banjice near Pec, then Leposavic, Donje Jarinje and other places. Jewelry minerals are not only irrationally used, but are somehow destroyed in

some places by the unplanned explosions. The ignorance of jewelry mineral resources through the law and regulations that have not been adopted in Kosovo and Metohija only increase this negative and irrational trend towards them.

The research points on the mineral resources; zinc, silver and gold in Kosovo and Metohija, as well as points brought by the certain corporations, primarily from Canada, in this paper will only confirm the record of the Byzantine historian Hristovulov from the first half of the 15th century, whom we quote: "... gold and silver literally outburst from sources, everywhere where it is being dug there is gold and silver powder in large quantities and the best quality, even better than the one in India.

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That is why the Serbian state has been privileged from the beginning". This paper will only confirm the extraordinary properties of the earth's rocks, especially through the fact that there are andesite, dacite and other rocks in Kosovo and Metohija where exist exploitable gold deposits.

2 JEWELRY MINERAL AND THEIR ECONOMIC VALUE AND APPLICABILITY IN KOSOVO AND METOHILJA

The archaeological excavations prove that the mineral resources in Kosovo and Metohija had been exploited even before the arrival of the Romans, and during the Roman rule, the province of Southern Mesia (today's territory of Central Serbia and Kosovo and Metohija) was considered as a mining province. In the Serbian professional literature on gemstones, the first paper was a manual of the famous mineralogist and geologist Sava Urosevic "The precious minerals and gemstones" from 1925. The precious minerals in ex-Yugoslavia began to be more intensively explored in the 1970s by a mining engineer Slobodan Zegarac. For the to-pic that is being dealt with in the paper is

most interesting that back in 1981, more detailed research was carried out on the territory of Kosovo and Metohija, where the significant quantities of gemstones exist. The most interesting are deposits of opal and chrysopras of various colors in the deposite of Goles, otherwise known as the magnesite mine.

The region of Kosovo and Metohija and thus Serbia was among the first countries in Europe involved in the mining and metallurgy of precious metals, and also of precious and semi-precious stones in the Middle Ages. The name semi-precious stone in Serbian gemological terminology is now abandoned. In the past, the main center of jewelry production and forging coins was Novo Brdo, and the gemstones were taken from the nearby deposits of opal, chalcedony, chrysoprase, and other minerals. The most important European mine in the era of Nemanjic was Novo Brdo, in which lead and silver mixed with gold were obtained. At the beginning of the 15th century, one of the oldest mining laws in Europe dates back to the Mining Code of Despot Stefan Lazarevic from 1412 (Figure 1). During the time of Djuradj Brankovic, a fifth of Europe's needs for silver was satisfied from here.



Figure 1 Law on the mines of Stefan Lazarevic [1]

This region is gemstone Opal-rich with a deposit on the mountain Goleš in the mine that has the same name. The reserves of magnesite are considered to be the largest reserves in the Balkans estimated at 2.4 million cubic meters of medium to high quality magnesite of pure white colour, whose the European market value in 2005 was 800 euros and more per m³. Significant quantities of decorative Opal stone green in colour are contained in magnesite. In Kamenica municipality in Strezovci, there is a deposit of magnesite whose reserves are estimated at 4.5-5.5 million tons, while the European market value in 2005 was 400-

800 euro per m³. There is also a research and estimates taken from the research of the London magazine for the Goleš mine which is one of the largest magnesite mines in Kosovo and Metohija. The mine has reserves of 1.74 million tons with the classification of 46.23% magnesite ore and 2.66% silicon dioxide resulting in 804,400 tons of magnesite and 46,300 tons of silicon dioxide (Table 1). Both mines originally worked before 1990, where production in the Goleš mines was 110,000 tons of magnesite, 22,000 tons of synthesized magnesite and 10,000 tons of calcium mixture in the form of magnesite per year.

Table 1 Mixed reserves of magnesite of the Goleš and Strezovac basin mine [2]

Mine	Tones	MgO%	SiO ₂ %	CaO%
Goleš	1.740.000	46,23	2,66	0,95
Strezovac basin-Belo brdo	3.660.000	40,49	6,29	5,45

The name of the jewelry mineral opalis derived from the Sanskrit word "upala" which means gem, and it refers to the gemstones in general. Its color has several nuances of brown, white (especially attractive milky white), green - Prase in several shades, yellow and bluish (Figure 2). Brown opal and colorful chalcedon are present in the Klobukar region near Novo Brdo-Kosovo and Metohija. Nowadays, the price per kilo-

gram at the world market is 10-250 euros. There is also a deposit of chalcedons on the mountain Goleš, whose color is orange and whose price per kilogram is 10-250 euros. Chalcedon has been in use in the Mediterranean area already in the Bronze Age. It was as been used in the ancient Greece and central Asia for jewelry and seals. The term Chalcedon is derived from the name of the Greek city Chalkedon in Asia Minor.



Figure 2 Milky white and transparent opal, orange Chalcedon and kahapong-GO₄ from Goleš deposit [3]

A rare gemstone of chrysopras in Kosovo and Metohija can be found on the mountain Goles, 15 kilometers away from Pristina, which is at an altitude of 1.119 meters. In addition to Western Australia, chrysopras can also be found in Germany, Madagascar, Zimbabwe, Tanzania, India, Kazakhstan, South Africa, Poland, California, Arizona, USA, Brazil, Russia and Oregon. The price of this gemstone in the world is ranging from 10-300 euros per kilogram. Chrysopras had been mentioned since the first century of the new era, but it was not excavated in large quantities until the second half of the 18th century. The Helen, Romans and Egyptians used it for jewelry and decorative items.

The Prussian king Friedrich the Great decorated his palace with objects that were partly or entirely made of this stone. His favorite ring (according to the tradi-

tion he never removes it) had a large central chrysopras surrounded by fifteen diamonds, and he wore a stick with a ball of chrysopras. Otherwise, the cost of chrysopras in Kosovo and Metohija is 50.000 euros per ton for mixed quality non-commercial type and 45.000 euros for mixed quality commercial type. It is economically profitable taking into account only the cost, costs of research and exploitation of these minerals. In truth, the deposits of expensive minerals-raw materials of the first and second class have not been discovered until now in Serbia and Kosovo and Metohija, but only those cheaper III, IV and V class (including chalcedony). Nevertheless their exploitation can be profitable. The following confirms the justification of re-engineering as a strategic development option for the company [4].

Table 2 Deposits and types of jewelry minerals in Kosovo and Metohija [5]

Deposit	Chalcedony-varieties of brown, green, red, grey and white Opal-variety of brown
Klobukar near Novo Brdo-Kosovo and Metohija	Silicon mass predominantly black in color
Crni kamen near Strezovaca	Magnesite-silicachert pale yellow to pink color, silicified dolomite of brown color
Magnesite deposit near Strezovaca	Opal varieties of different colors; Chalcedony varieties of different colors; Quartz variety jasper
Leposavic-Donje Jerinje, Kremenjacki potok	Quartz variety mountain crystal, rhodochrosite, pyrite, sphalerite-variety, marmatite
Deposit Pb-Zn Stari Trg, Trepca Kosovo i Metohija	Deposits Ni Cikatovo and Baks (opal variety of green and other colors; Chalcedony-chrysoprase variety, occurrence Gladno selo (silicified wood)
A group of deposits and occurrences in Drenica	Kosovo and Metohija (opal-brown variety)
Occurrence Mirena on Goles, Kosovo and Metohija	Opal milky white variety, kaholong
Occurrence Medvece in Kosovo and Metohija	Opal-variety Chrysopal, honey opal, milky white opal, kaholong i others; chalcedony variety of Chrysoprase
Deposit Ni Glavica in Kosovo and Metohija	Deposit of marble onyx
Banjica near Pec	Chalcedony-varieties of brown, green, red, grey and white Opal-variety of brown

3 RESERVES OF METALLIC AND PRECIOUS MINERALS IN KOSOVO AND METOHILJA

The ancient Romans knew about the mineral resources of Trepca. This is also supported by an oil lamp found in the old underground mines. In addition to Trepca, the Romans also exploited the rich deposits in these areas, such as, for example, Srebrenica, Kopaonik, Gracanica, Socanica, etc. (Table 2). What is interesting about this site is the fact that the construction of a fortress in the Ibar valley was funded from silver obtained from this mine, and also the first Serbian silver Dinar (1412, despot Stefan Lazarevic) was minted from silver obtained from this mine. Known as a large deposit of lead-zinc ore, Trepca is distinguished by its diverse mineralogical composition. More than 60 different minerals have been identified. Due to the beauty of its crystals, many

minerals from Trepca are found in many museums around the world [6].

The Trepca hydrothermal deposits of lead and zinc are an important source of basic metals and minerals in southern Europe [7]. The most productive mines in this business system are Stari Trg, Crnac, Belo Brdo, Kisnica and Ajvalija with production in the past of 60 million tons with 8% lead-Pb and zinc-Zn and more than 4,500 tons of silver-Ag [8]. The content of metals such as lead-Pb, zinc-Zn and silver-Ag in the deposits of the mine Crnac-northern Kosovo and Metohija, can be upgraded into a higher category B + C1 (Table 3) after the completion of research papers with reference to the ore reserves of these metals.

Table 3 Reserves B + C1 category in "Crnac/east" [9]

Category	Content of metal		
	Pb (%)	Zn (%)	Ag (g/t)
B + C1	8,25	2,33	93,5

Under the jurisdiction of Unmik, over the past seventeen years (2000-2017), only about 20,000 tons of lead was processed in the Trepca business system, while only 1,000-1,500 tons of waste and scraps of raw lead were refined in the refinery, mostly collected from the industrial facility of Trepca [10]. According to Unmik data from 2001 to this year 29,000,000 tons of ore were extracted in the business system Trepca-mine-Stari Trg, with variations of: 3.40-3.45% for lead-Pb, 2.23-2.36% for zinc-Zn, 74-81 grams, i.e. about 999,000 tons of lead-Pb, 670,000 tons of zinc-Zn and 2,200 tons of silver-Ag. It is estimated that partial revitalization, with only some improvements in this business system, will cost

between US \$ 15 and US \$ 30 million [11]. The mine of Stari Trg at its deposits such as Meljanica, Mazic, Zijac and other surrounding deposits has reserves of around 35,081,000 million tons with significant massive deposits of sulphide ores or if expressed through the quantity of metals in the ores it is 1,349,579 tons of lead-Pb, 1,080,504 tons of zinc-Zn and 2,280,224 kg of gold-Au [12].

It is impossible to determine precisely the value of the main minerals at the Stari Trg mine because there were no more precise researches on their reserves conducted by the former Trepca business system (Table 4). The mine Stari Trg is one of the world's largest deposite of galenite (Pbs), which is

the dominant lead ore in this mine. Galenite is mineralogical and auction-interesting because galenite and sphalerite together crystallize in more than 30 nicely crystallized minerals. After all, lead absorbs radiation and is used for protection in hospitals and in the nuclear industry. Another very usable

mineral is pyrite (FeS_2), whose presence in a lesser extent was confirmed by a microsonde research in the ore at Stari Trg mine. The name of this mineral comes from the Greek word pyr, meaning fire, because it creates sparks when struck. This mineral is a raw material for the production of sulfuric acid.

Table 4 Presumed mining reserves, total mine usable reserves and resource potential of Stari Trg Trepca mine [13]

Mining reserves	Tones	Pb (%)	Zn (%)	Ag (g/t)
Proven reserves	120.340	5,14	5,13	88,0
Presumed reserves	311.660	5,10	3,17	80,5
Total mineral usable reserves	432.000	5,10	3,17	80,5
Total resources	12.488.000	3,21	2,21	56,4

From 1931 to 1998 Trepca business system produced bismuth in the amount of 4.118 tons with other related metal minerals, such as antimony, cadmium, gold and silver. The main minerals in Stari Trg are galenite, pyrite and sphalerite, which are associated with a small amount of mineral bismuth with sulfosalts gold-Au, silver-Ag and lead-Pb (Pictures 3 and 4). Mining deposits, such as Kisnica, Novo Brdo and

Draznje in the east of Kosovo and Metohija have not been studied in detail, but the composition of the ore, textural and structural characteristics of the ore is similar to those in Stari Trg as shown by a similar hydrothermal source [12]. This is confirmed by the mineral reserves in Crnac area in northern Kosovo and Metohija with a high content of lead Pb 8.25%, zinc Zn 2.33% and silver Ag 93.5% g/t [14].

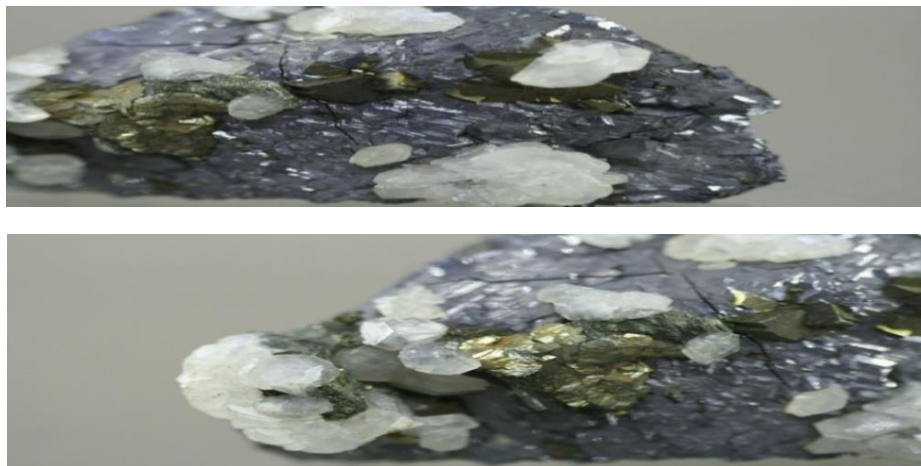


Figure 3 Galenite, arsenopyrite and pyrite from Trepca [15]



Figure 4 Vivianite-siderite pyrite from Trepca-Stari Trg [16]

The renewed research zones on zinc, lead and silver were carried out by the Canadian company "Altair Resources" from Vancouver, even in the period of the ex-Yugoslav government during the 1980s. Also, the research of the newer period from May

to June 2016 referred to the Crepulja region, 17 kilometers west of the city of Mitrovica in the northern part of northern Kosovo and Metohija. Based on this research, the following data are present (Table 5).

Table 5 Research zone "Crepulja" [17]

Trench	Trench length (m)	Sample	From	To	Length	Zn (%)	Pb (%)
8	15	14	3,1	5,2	2,1	35,8	2,77
		15	5,2	7,7	2,5	37,02	1,75
9	14	Non-mineralized terrain					
10	12,5	18	1,7	3,4	1,7	36,57	3,95
11	20,5	6	0	6,4	6,4	1,69	0,43
		5	6,4	7,3	0,9	41,39	2,27
		4	13,5	15	1,5	34,79	3,66
12	17,7	3	11	11,8	0,8	28,9	5,21
		2	13	14,6	1,6	1,09	1,53
		1	15,6	16,5	0,9	4,53	2,13
Occurrences on the surface	n/a	19	n/a	n/a	n/a	38,28	1,8

These data only show that this area is highly mineralized in certain zones, and has a high quality level of zinc lead mineralization up to 41.39% of zinc Zn and up to 5.21% of lead-Pb. Surface excavations of mineralized high quality zinc were sampled and amounts 38.28% of zinc-Zn and 1.8% of lead-Pb. The parts of trenches, explored

in 1974, were re-activated in 2016 and confirmed the high presence of zinc-Zn, up to 37.98%, and lead-Pb, up to 4.78% [16]. In the 1950s, the excavations and explorations of the Crepulja region were carried out by the Trepca business system. This was confirmed by the latest gravity research in March 2017, again by Altair Resources from

Vancouver that this area of the targeted zone, 5 km long and 200-300 meters wide, indicated a lead-mineralization zone of a high quality between 17 and 35% of zinc-Zn and lead-Pb [18].

4 RESOURCE POTENTIALS OF PRECIOUS METALS - GOLD AND SILVER IN KOSOVO AND METOHIJA

Kosovo and Metohija is another region rich in precious metals, gold and silver, above all. The potentials of economic resources in terms of lead, zinc, as well as gold, silver, and other rare and critical metals still exist today. Stari Trg in Kosovo and Metohija is one of the most important historical and mining districts in Europe for lead, zinc and silver [19]. Gold in Kosovo and Metohija is often found accompanied with the other minerals such as zinc, copper, lead and silver, although the alluvial reserves have been found along the rivers.

For many years now, gold in Kosovo and Metohija has been mostly exploited in the Novo Brdo mine that operated between 1939 and 1989. It was the mine with the highest content of gold in the whole of ex-Yugoslavia. Before closing, the mine produced about 11.9 tons of gold. In 2005, the Independent commission for mines and minerals of Kosovo and Metohija, under the jurisdiction of Unmik, estimated that the share of the Trepca mine was estimated at around 3 billion euros. The remaining ore capacity is 29 million tons, out of which 990,000 tons is lead, 670,000 tons is zinc-Zn, and 2.200 tons is gold-Au. Table 6 shows the high percentage of gold and silver in the mines of Belo Brdo and Crnac in the north of Kosovo and Metohija [20].

Today, the largest gold mine in Kosovo and Metohija is a mine located in Malisevo, the municipality of Prizren (Figure 5). It is estimated that the Malishevo mine contains gold reserves of about 120 million tons with gold contents of 1.18 g/t.

Table 6 Reserve of precious metals in Kosovo and Metohija [21] and [22]

Location	Gold (Au) g/t	Silver (Ag) g/t	Silver/kg	The price of silver per kg 2018 [23]	Financial value of silver (in dollars)	Platinum
Stari Trg	0,6	76,00	1.577.304	530,66 USD	837.012,14	There is no available research on presence of platinum group metals. Researches are planned to be carried out in mountain massif of Djakovica
Belo Brdo	0,7	96,13	725.256		384.864,35	
Crnac	1,0					
Ajvalija	0,5	89,91	1.441.879		765.147,51	
Kisnica	1,1					
Badovac	0,25					
Novo Brdo	1,6					
Crepulja	0,13	-	-		-	
Draznja	-	39,66	-		-	

This means that the reserves are estimated at about 142 tons of gold [24]. This area was explored in the 80s of the last century, but according to data a gold testing was not conducted. This project was recognized in 2007 after the Lydian program of Lydian International Ltd from

Canada, when tests were carried out on a sample from 18 meters depth, and it was found 0.86 g/t of gold, while from 13 meters depth 1.8 g/t of gold was found (in 2008, 1.25 g/t of gold was found at 51 meters depth, and 1.08 g/t of gold at 38 meters depth) [25].

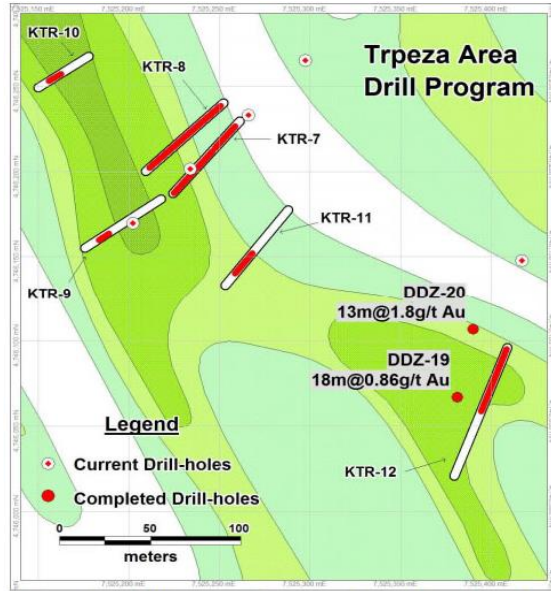


Figure 5 Explored area of Malisevo near Prizren "Drazinje project" of a potential gold mine [26]

When it comes to gold, there are several more projects underway. This includes the exploration of primarily the wider area of Pristina, Slivovo that is 15 kilometers far away. This is a joint venture between the Government of Kosovo and Metohija and Avrupa Minerals Ltd. from Canada, which together with Bymecut International Ltd. from Australia joined this research project. The research was concentrated on the Sli-

vovo region, which showed the signs of golden deposits at 126.6 meters of the rock depth. The proof is a recently completed initial resource model, and the assessment of the Slivo project "Avrupa Minerals Ltd." (Table 7). This company has two projects in Kosovo and Metohija in the length of 47 km² and in mid-2016, it showed that within 640,000,000 million tons of ore were found, 4.8 g/t of gold and 14.68 g/t of silver.

Table 7 Research project "Slivovo" [27]

Explored area	Grams/t of gold	Grams/t of silver	%copper	% lead	% zinc
Slivovo	6,2	15,0	0,092	0,16	0,45

Therefore, the marked mineral resources of the project "Slivovo" amount to 98.700 ounces of gold and 302.000 ounces of silver. The estimated cost for the full three-phase research program amounts to approximately \$ 8.3 million [28]. Cooperation with the foreign companies in the exploration and exploitation of gold and silver in Kosovo and Metohija is necessary

because the lack of investment funds is one of the main issues to be addressed [29].

CONCLUSION

It is obvious that almost all deposits of jewelry minerals in Kosovo and Metohija are not well known and have not been sufficiently explored. Many countries and

regions around the world traditionally encourage the processing of quality gemstones and, in general, the jewelry minerals - raw materials. To this day, there has been no systematic research into jewelry mineral resources in the territory of Kosovo and Metohija. It remains unknown that as per the market of Kosovo and Metohija for expensive and semiprecious stones-jewelry minerals-raw materials, there are no fairs and legal procedures for them. To begin the exploitation of these jewelry minerals, according to the expert estimates, no more than 10,000 euros is required. However, in order to begin the exploitation of jewelry mineral resources in Kosovo and Metohija, we must take a concession and pass procedures just like for the exploitation of gold and other precious ores.

Economically exploitable and primarily proven amounts of metallic resources and precious metals in Kosovo and Metohija are of particular interest for foreign companies and investors, based on the profit available in target mines and deposits. First of all, the economically profitable and exploitable reserves of magnesite mines at Goles and Strezovac basin are referred here, as well as the research project of lead, zinc and silver in the Crepulja region and gold in the Slivovo region. According to the calculations of a Turkish company for the project exploitation and from the point of view of investors in mineral resource, there should be 30,000 tons of reserves of ore (lead, zinc and silver) in comparison to about 40 million euros of investments. Hence, the answer is got to the question that mining is an area in which foreign investors have an interest to invest. Some previous experience with the research of mineral resources conducted by the foreign companies shows that through such investments the investor invested at least 10 euros per hectare in the first year, 20 euros per hectare in the second year and 30 euros per hectare in the third year of research. Such mineral raw materials research requires a total foreign investment in mineral resource research of about 150 million euros, on average in three years, separately. Based

on the previous research, the foreign companies are interested in the new mineral resource deposits, but also those located between the old deposits. Those sites that have been already known are not particularly interesting.

On the whole, Kosovo and Metohija is generally accessible, geographically and mineralogically compact area where the jewelry minerals, metallic reserves and precious metals are quite comparatively distributed. In the other words, Kosovo and Metohija has a total area of less than 10,000 square kilometers. This area is connected with 630 km of main roads and 330 km of railway infrastructure system. Although in the last five years, a lot has been done in terms of building a traffic infrastructure in the territory of Kosovo and Metohija and a wider region (Pristina-Djeneral Jankovic road with FYR of Macedonia, the highway of Kosovo and Metohija with Albania, etc.), the investments should be directed to the construction of local and regional roads to the mining sites and locations that are not quite in a prosperous state. The economic and especially unresolved political status of certain mining companies and their poor privatization, associated with the poor socio-economic situation of the domicile population, expressed primarily through a poor living standard, will not contribute to the development of the resource industrial complex of the region of Kosovo and Metohija. The lack of a concrete and targeted government policy with the unresolved political and economic status of some mining companies, for example, Trepca dealing with development of mining the precious and metallic resources and jewelry minerals-raw materials of Kosovo and Metohija, contributes only to a hyper stagnation of this sector. This is confirmed and estimated by the US Agency for International Development that the Trepca South business system is deeply in crisis because it functions with just 1/5 of its total production capacity from 2000 to 2012 [30]. In 2013, the Trepca North business system produced 11,000 tons of lead-Pb concentrate and 8,000 tons

of zinc-Zn concentrates, which is only 15% of its capacity [31].

Natural minerals, first of all zinc, lead, silver and gold, and jewelry raw materials should not only attract the attention of foreign corporate investors, but especially the cooperation of the local self-government and those ones on whose territory those raw materials are located. Hence, the mining sector should be the primary sector of a wider region of Kosovo and Metohija, Serbia and the Balkans, where these raw materials are located.

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