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BASE METALS PRODUCTION IN THE SOUTH-WEST EUROPE

PROIZVODNJA BAZNIH METALA U JUGOZAPADNOJ EUROPI

Abstract

Base metals like lead and zinc are ranked in the fourth respectively in the fifth place in the world being debated about their use. In the last two years, the relation supply/demand of these metals is obviously disordered in favor of raising demand, and this has caused an enormous variety of prices for base metals in the market. From the other side, the region of Balkan is relatively rich with ore deposits of these metals. Changes and transitions which happened through 90-ties destroyed the mining production which still is not erected. The European Union after year 2000 approved some regulations with which are prescribed the framework of sustainable development of the mining sector. Besides, in the past, there were built metallurgy capacities for Pb and Zn, which today but also in a certain future will not easily face with European frameworks, but will also not have sufficient concentrates for their own processing capacities. In this paper, there has been analyzed the actual situation in primary ore and concentrate production and is estimated the expected perspective of ore and metal production, always seen from the point of view of European requirements for sustainable development. The need for a closer cooperation in between ore-processing and metallurgy units in the region, with the purpose of full rationalization, to effectively solve the environmental problems and better financial circulation, appears as one of the potential and acceptable options.

***Keywords**: Lead, Zinc, Concentrate, Smelters, European standards, investments.*

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1. INTRODUCTION

Lead and zinc ores in the western Balkans region are extracted and are smelted since ancient roman time. These ores, except base metals may contain also other metals (Cu, Ba, Ni, Bi, Cd), precious metals (Ag, Au) and the rare ones (In, Se, Te Ge, Ga, Ta, W, Va, etc.). Presence of metals Cu, Ba, Ni, Bi, Cd, Hg in ores, causes difficulty in further technological processing, but, on the other hand some of these metals (Bi, Cd, Cu, Ni, Ag, Au), if extracted, increase the economic value of the ore.

Generally, geological structure of the Balkan Peninsula has given the possibility of formation of many metalogenic fields, rich with base metals, with a precious metal and rare metals. Starting from the ridges of Carpates, and continuing with Rodopes, and in their contacts with tectonic zone of Vardar and with Dinarides, there can be identified some locations in which the mineralization and ore deposits of lead – zinc, are important and with eligible economic potential.

At the regional level, there can be distinguished some ore deposit localities with local and wider importance, which are opened mines and flotations, for processing the lead– zinc ores. Also the region has "inherited" from the past some metallurgic plants for treatment of concentrates and producing pure metals: in Bulgaria (KCM.S.A – Plovdiv, Pb-Zn Complex Ltd. Kerdjali), in Rumania (Sometra Mytelineos S.A), in Macedonia (smelter "Zletovo" – Veles), in Kosovo (lead smelter - Zveçan and zinc Electrolyze – Mitrovica) and in Serbia (zink Electrolyze – Zorka/Binani – Shabac).

Ore production and production of selective concentrates of Pb and Zn, is not in concordance with installed metallurgical capacities, and unavoidably will result in a high cost of treatment charges (T/C). Changes and transformations which are happening in the global mining level and also in regional level, are not appropriate for mines and metallurgies in the region. Such a huge concentration of mines and flotation's, and in particular metallurgical processing capacities, hardly can resist the competition, if there have not opened processes of professional and business cooperation in between all these factors. Intensive cooperation in this field is seen as a chance for increasing the economic effects, increase of profit and expected impact on the region in the overall European production of Pb, Zn and other metals.

2. PRODUCTION STAGES FOR PB AND Zn

In most cases, minerals of lead and zinc are found jointly in nature and usually followed with Ag. Also the main production of antimony (Sb), cadmium (Cd) and bismuth (Bi) in the world comes as a byproduct during treatment of Pb and Zn ores.

Pb grade of ore in a consolidated ore deposit, may have values from the lowest economic limit ("Cut-off-grade") until to 15 %, whereas zinc may take values up to 20 %. In most common cases, existing ore deposits in the world, balance their reserves with average Pb + Zn = 8 % - 14 %. Changes in market metal prices and changes in ore and

concentrate production cost, effect on changing this calculated grade and on balancing the total reserves in the deposit.

Commonly, the lead concentrate contains 50–78% Pb and in cases when produced by sulfide ores, it contains 15–20% S. Zinc concentrate contains 40–60% Zn, and usually 26–34% S. The collective concentrate contains Pb from 5% - 35%, Zn from 5% - 38%. Generally, the process from mine to pure metals, are long, complex and sequential (fig. 1).

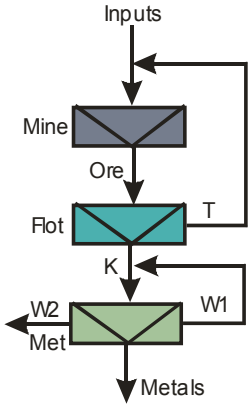

Fig.1: *Sequentional production process*

In any case, the extractive technology of Pb and Zn has these characteristics:

- Pb-Zn mines usually are underground mines, whereas surface mines are rare for these two metals. Ores in most cases are found in sulfide form, and their processing in separate concentrates (selective) of Pb and Zn are the usual step to be followed. In some cases, the mineralogy of the ore determines to derive only collectively concentrate with high content of Pb and Zn. Metallurgical treatment of these two types of concentrates is different.
- The material balance of processing is distinguished with the low quantity of the ore which will be separated in concentrate (about 10% – 12 %). The other mass of ore material treated as waste. The historic waste or produced from an actual process, according to the EU directives, must be treated according to the regulations of IPPC (Integrated Pollution Prevention Control). That means, recycling and/or returning it in the mine as backfilling material. In each case, the mineral waste must cover, and precipitated water must isolate and be clean.
- Smelting of selective Pb/K, in 10 last years have advanced a lot, so that today it is attempted to use integrated technologies, without prior roasting of the concentrate. This new technological way of lead extracting, makes possible obvious reduction of sulfide gas emission and at the same time metallurgical recycling of slag, those remained from the past, and also those which come out of the process. Recycling of slag and recycling of dust makes possible economic extraction of rare metals which usually are found in ore in trace forms, whereas their concentration is found in by

products during metallurgical treatment. In this direction, all smelters in the region have many problems which collide with European regulations for sustainable development;

- Hydro-metallurgical processes with which are treated nowadays the zinc concentrates are quite modern and those require only additional engineering training in order to avoid accidents, and to minimize impact to environment.
- In principle, the high amount of sulfur acid from the Pb and Zn processes, and its limited use, become an obstacle for metallurgical treatment of sulfide ores.
- The metallurgical process of Pb and Zn, is characterized with a high number of closed cycles (hydro-filling, recycling of dusts, water recycling, treatment of slag with fuming, hematite process, jarosite process or pyrite calcinations process, etc.).

Raw metals derived from metallurgical processes, undergo also a final purification process (refining), benefiting metals with required commercial purity, but at the same time are derive the precious metals (Au, Ag);

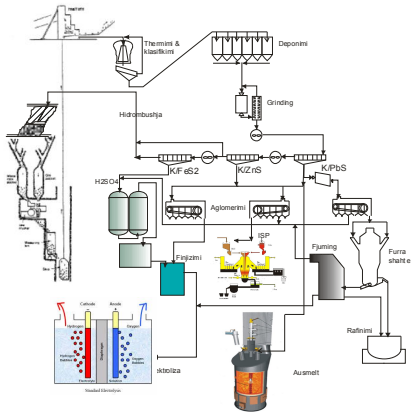

***Fig. 2**: Pb & Zn production stages*

3. PRICES, PRODUCTION AND CONSUMPTION

Prices of lead and zinc historically have shown a periodic oscillation, marking the average period 10 to 12 years. Viewing the situation in the last decade, since the beginning of 2005, lead and zinc prices marked rising trend, making a change of lead value from 750 $/t to 3800 $/t and zinc from 870 $/t to 4200 $/t. Increasing trend of price (with short oscillations) has lasted till the end of the year 2007, whereas in 2013 is noticed the tendency of price stabilization for Pb about 2200 $/t and Zn about 1850 $/t. This situation with the price has influenced that many lead-zinc mines, to review their position. Besides, positive change of prices has influenced on increasing the interest of private capital to invest in industry of extraction and production of these metals.

Forecasting of price trends for 10 coming years is impossible. Increase of demand, decrease of metal stock and propulsive development of the metal processing

industry in China and Southeastern Asia, are indicators which increase the reliability of the prognosis for stabilization of Pb prices in level of 2200 $/t and for Zn in level of 2000 $/t, in the future period of 10 years. This prognosis is hopeful for reactivation of existing mines in the region, for opening new mines in explored ore deposits, and for increasing of geological and mining exploration, with the purpose of determining the resources and reserves, in full compliance with accepted standards (CIMM, JORK).

Price of metals in the market, also in the past has been a strong regulator of ore and metal production in mines of countries which are "new" in the market economy. This should not be neglected problem which may result from widespread trend of "economic neoliberalism" and phenomenon "resource curse", which can include the Western Balkan countries.

Presently, the biggest Pb producer in the world is Australia (23 % of the total world production). Other big producers are China, USA, Peru, Canada and Mexico. Total production of Pb from ores in the world actually is at level of 3,31 x 10^6 t Pb metal in concentrate, that is approximately 67 x 10^6 t of ore with average Pb 5.5 %. It is estimated that world reserves of Pb are 64 x 10^6 t Pb in concentrate, or the equivalent (with 5.5 % Pb), total world reserves are 1.16 x 10^9 t of ore [6]. With the mining production level of year 2005, the total world reserves of Pb ore will be finished in 17 coming years if not invested in exploration and discovering new ore deposits.

The biggest metal producers based on zinc concentrate are China, Australia, Canada, Peru and USA. World production of Zn for year 2007, reaches the quantity of 4.88 x 10^6 t of zinc concentrates. The total world reserves of Zn are estimated to be 190 x 10^6 t metal in concentrate}.

4. PB AND ZN PRODUCTION IN THE REGION

The Balkans region since 1989 faces different difficulties. All transformations which have happened or are still happening in the region, have left huge consequences in the mining production sector and in the production of base metals.

Almost all mines of Pb and Zn in the region have had a long period of crisis in production and particularly in development, what has influenced that the greatest number of these mines remains behind with the dynamic of developing mining and remain behind on modern trends of technological development in the world. The situation and the possibility for production of Pb-Zn ore in the region are:

Kosovo, before the year 1989, with annual production of 90 to 100 thousand tons Pb, with 50 thousand tons Zn, with 200 t Bi, with the 120 t Cd, with 120 t Ag and with about 300 Kg gold, was the biggest producer in the region. The known events during the last 20 years practically have destroyed the big producing system "Trepça".

Trepça mines formally are under Kosova Privatization Agency. [*There are 9 mines which can produce ore: Mine "Trepça" – Stantërg with flotation in Tuneli, mines "Cernac", Belo Berdo" and "Zhuta Perla" with flotation in Leposaviq, mines "Kizhnica",*

"Hajvalia", "Badovc" and "Artana" with flotation in Kizhnica. On the other hand, in the mineral belt from Leposaviq to Gjilan, there are given at least four explored ore deposits and ready sites for opening and exploitation].

Estimations carried till now, show that in the existing mines would have to be invested on worker training, on preparatory works and on new mining equipment. Each of the mines requires an investment of 20 to 40 Mil €, in order to achieve the full capacity. Also, the two existing flotation plants require investment for modernization.
Particular issues are the Pb smelter in Zveçan and Zn Electrolytic plant in Mitrovica. The smelter has stopped operating because of enormous pollution of the environment (August 2000). Estimations are that a new smelter (Ausmelt) with production capacity of 65.000 t/year of refined Pb, would have full technical and economic justification. On the other hand, based on merit estimations [5], reparation and elimination of damages in the Zinc Electrolyze, would influence positively in business indicators of the mines around.

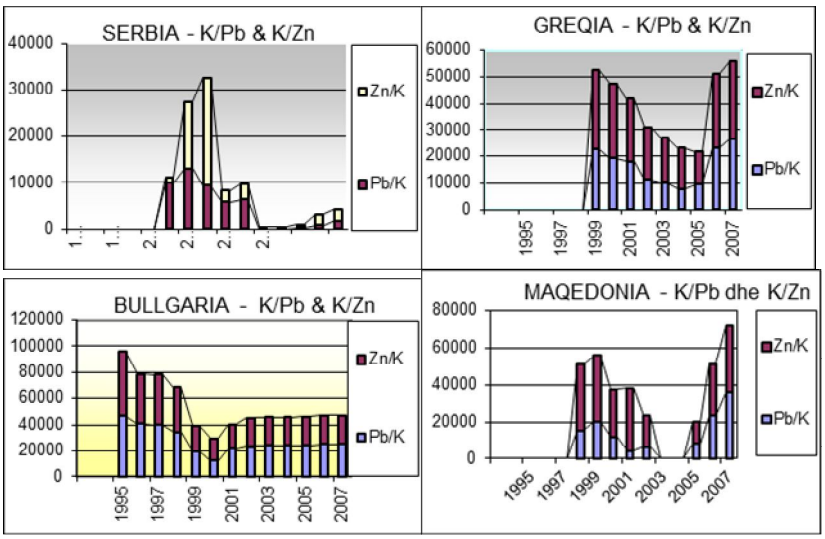

Fig. 3: *Pb and Zn concentrate production in the region countries*

Bulgaria is taken as a stable producer of ores and metals of Pb and Zn. Bulgarian mineral belts of Pb – Zn is mainly found in Rodope Mountains, in central-southern part, near the Greek-Bulgarian border. In this part are the large mines Gorubso - Rudozem, Madan - Rudozem, Laki, Dimov Dol, Kerdjali, Magjarovo, Erna Reka, Mir, Gueshevo, Rudmetal A.D, etc. Mines have their own flotation's with a total ore processing capacity of 5.1 Million t/y. All these mines, have suffered from political changes in the country and region.

Though internal stability was not good during 1990, the Bulgarian Government made liberalization and licensing of exploration and exploitation of the mines, has relatively quickly arrived to stabilize this sector. This Government, in 1998 approved the National Program for Sustainable Development of the Mines, a thing which motivates

local and foreign private capital investment, by emphasizing that underground mineral resources are state owned property, but gives the opportunity to local and international companies to take the right for development and exploitation of the mines and deposits for 35 years, with possibility for extension for 15 years more.

Local managements, first became owners (80%) of two smelters – in Plovdiv (KTZM2000) and in Kerdjali (Pb-Zn Complex PLC – Kardjali), whereas later privatized mining complexes Gorubso – Rodozem, Rudmetal A.D, etc.

The smelter in Plovdiv, except that has fulfilled the European criteria minimizing the emissions and harmful discharges in the environment, has also installed the Fuming technology for slag treatment, and in this case produces metal oxides (Zn, In, Ge, Te Se, etc).

Some of the big world corporations also have obtained the right for exploration and exploitation (Navan Resources - Ireland, Hereward Ventures - UK).

Metallurgies in Plovdiv and in Kerdjali, today face lack of concentrates for filling their production capacities.

Greece has some ore deposits of Pb –Zn. Important ones can be considered Olympias, Stratoni (with mines Madem Lakos and Mavras Petras), Polykastron and Molaoi (Peloponnese).

Multinational company European Goldfields Ltd as owner of (65%) of the mining complex Olympias /Stratoni and flotation in Stratoni, had proclaimed that Stratoni will start ore production in 2006 (170.000 t/y), by increasing it in 2010 up to 400.000 t/y, whereas for the mine Olympias, the company is working to gain the license for exploitation, as it has problems with the position of ore deposits against to the city.

Since 1999, Stratoni mines have produced ore which has been processed in flotation Stratoni.

Geological reserves in this deposit are considerable (16 Mt, Pb = 4.4%; Zn =5.84% and Ag=136 g/t).

Ore deposit Polykastron-Skra is not in exploitation and there is no plan currently for opening it. Estimated reserves are 2.5 Mt with Pb = 3.03%, Zn = 3.85% and Ag = 15 g/t.

Identified mineralization Molaoi (Peloponnese) is not yet explored completely, so that the expected reserves are 3.8 x 106 t, Pb = 1.76%, Zn= 8.27%, and Ag = 55 gr/t. However, the companies engaged at geological exploration in Greece, yet are not sure that will be equipped with exploitation license. Particularly, the environmental problems can be present for ore deposits of Olympias, from the point of view of endangering the archeological values. This fact makes more costly the Greek production in the region and in a way that keeps it even out of the competition.

Macedonia in the past has been one of the stable producers for base metals. Pb-Zn deposits are laid mainly in the north-eastern part of Macedonia, in the province of Kratova – Zletova. Within these ore holding fields, there have been opened three underground mines: Mine of Zletovo with selective flotation in Probishtip, mine Sase

(Kamenica) with collective/selective flotation, and mine Toranica with collective/selective flotation in Kriva Palanka.

In 2003, the Macedonian Government and interested parties proposed to study development and modernization of the mines so that they produce quantities of concentrate with which there will be fulfilled the requirements up to about 78% of the Lead-Zinc smelter in Veles (ISP technology). This means that mines must produce about 38000 t/year Pb metal and about 30000 t/year Zn metal from selective or collective concentrate. Smelter in Veles, with the ISP technology, has the capacity of 44000 t/year Pb, about 32000 t/year Zn and a quantity of other metals like (Cd, Au, Ag, Sb, As, Mn and Ni).

Except from financial difficulties, the mines and the smelter in Veles, until in the end of the year 2005 faces also with other problems mainly related to environmental protection, lack of necessary supplies, miners strikes and other problems, so that the Macedonian Government decided to temporarily close the smelter in Veles, and chemical industry nearby, whereas the mines (Zletovo, Sase and Toranica), are put in the list of national privatization program.

Currently, only the mine Sase is privatized. The new owner of this mine became the Russian-Caribbean company "Romtrade" for the purchase price of 3.020.000 €., and with obligation to employ 920 employees and to invest (26 Million $) on improvement of the mining technology and the flotation so that it reaches production of 600.000 t of ore or 35.000 t C/Pb and 45.000 t/year C/Zn. Modernization of the flotation to produce selective concentrate, with extraordinary success achieved the company Metco Minerals and this has raised the aspirates of the new owner to increase the mine production up to 800000 t/year and necessary extension of the flotation. The daily produced concentrate is loaded in special trucks and transported to the smelter of Plovdiv. The mine and flotation Sase are a success story in this field for the whole region, and represents an encouragement for other mines.

Mine Zletovo with flotation in Probishtip is before the privatization process, but is currently facing miners strikes and low ore reserves.

Mine Toranica with flotation in Kriva Pallanka is not yet privatized as there is believed that there is low chance that this mine achieves the required production level.

The important issue remaining unsolved is privatization of the Pb and Zn smelter in Veles. Historical pollution and non safety at production or even buying the quantity of concentrates which would ensure production and profit for the smelter, these are the main obstacles for what this process is not yet finalized.

Serbia has several Pb and Zn deposits. Mines which are active or which could quickly start production are Rudnik G.M (already privatized), Blagodat (before privatization process), Lece (privatized already), Bobija /Tisovik and Suva Ruda. These mines, at 1999 have been a part of the "Trepca" complex or have sent concentrate for smelting in Trepca. However, mines in Serbia have undergone one huge crise from which they are not yet recovered.

All mines to be returned in production have the primary interest that their concentrates of Pb to be processed in Trepça, whereas the Zn concentrates may be in Zorka/Shabac (for what Zorka has the capacity and fulfills environmental requirements). Zorka since 2005 was borrowed to the company MDIL Binani Group London with a production capacity of Zn of 32,000 t/y, what requires quantity from cca 80.000 t C/Zn. Serbian governments after two years operation of the company Binani has obtained the right of privatization and currently Zorka is under limited operation.

Rumania is distinguished with low grade ore deposits of Pb and Zn (Pb = 0.4%-1% and Zn = 0.6% - 1.2% and Cu = 0.35%, with traces of Sb, Bi, Cd, AU, Ag). Main mines are Baia Mare, Borsa, Certej, and province Rodna. Recovery of metals from concentrate is reported to be low (between 50% and 75% for Pb and Zn). Smelting and refining of Pb and Zn from local concentrates and from the imported ones was done in ISP smelter Sometra S.A (since 1999, property of Mytelanois), with a capacity of 42,000 t/year Pb and 66,000 t/year Zn.

Rumanian mines do not seem to have perspective, though the European company Goldfields Ltd is investing on exploration works in the Certej mine.

5. **EXPECTED PRODUCTION**

The smelters built in the region, seems that have huge capacities and it is difficult for them to be supplied with the needed quantities of concentrate from their own countries, but also balancing in the level of the whole region shows an evident lack of concentrates. Taking into consideration current situation and real possibilities of the mines in the region, is given a production prognosis with the reliability of about 65% to be achievable (fig.4), in order to calculate the level of filling the metallurgical capacities, but also to come to the proper conclusions. Metallurgical capacities are shown in the Tab.1.

Table 1: *Metallurgical capacities*

Company	Location	Pb (t/a)	Zn (t/a)	Ag (t/a)
Trepça	Mitrovica/ Kosovo	83000	50000	105
KCM S.A.	Plovdiv/ Bulgaria	44000	60000	60
Pb- Zn Complex Ltd	Kardjali/ Bulgaria	33000	27200	45
Veles	Macedonia	50000	60000	65
Sometra (Mytelineos S.A)	Romania	30000	60000	45

Zorka	Serbia	0	32000	
TOTAL		240000	289200	320
Needed concentrate (t)		380952	680471	

It is a fact that Pb smelters in the region **have a capacity** of 240000 t/year refined Pb, and 289200 t/year pure Zn. This means that mines in the region needed to produce 381.000 t/year Pb concentrates and 680.000 t/year Zn concentrates. Current production capacity in the mines of the region is 163.000 t C/Pb and 216.000 t C/Zn. Noticed the lack of concentrates which soon will face the metallurgical capacities. This is one of the main reasons for setting closer and amicable contacts in between the producers (mines and metallurgies) in the region, with the purpose of short term and long term harmonization of supply and demand of the concentrates and services of smelters and electrolysis.

The real possibility of producing Pb concentrate is quite limited. An optimistic estimation would determine the maximal Pb/K in the region of 195.000 t/year (Trepça - 65.000, Gorubso – 30.000, Others BG – 12.000, Sase – 30.000, Toranica – 20.000, Stratoni – 18.000, Rumania – 20.000). For filling the smelter capacities, the region must import 186.000 t C/Pb.

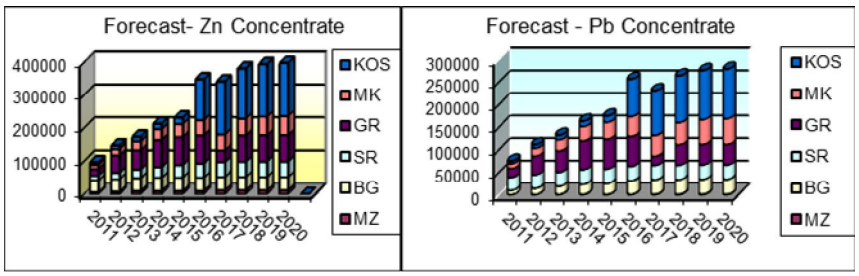

Fig. 4: *Expected concentrate production at next 10 years*

Also needs for Zn concentrate in the region reach the quantity of 680.500 t (Tab.1), whereas the region will have the possibility to produce (optimistic prognosis), 233.000 t Zn/K, so that the region would have to import about 448.000 t Zn/K (Fig.4). Concentrate deficit given in current market prices, reach the amount of 700 Million $. This high value is a sufficient reason for a closer cooperation between interested parties in order to minimize expenses for raw material and for transportation.

CONCLUSSION

The South-Western Balkans region is rich with resources of Pb and Zn ore. In the past there have been opened mines, there had been built flotations and smelters of Pb and Zn, attempting to keep the “autonomy” of producers and states.

With the essential changes which still happening in the region, there are being created conditions of globalization of this sector, by increasing the impact of multinational companies on profit exploration from quick exploitation of resources and by leaving aside the needs for investment on exploration and opening of new ore deposits.

Taking into account the geographical short distance of Pb-Zn mines in the region, locations and metallurgic capacities, railway and road infrastructure, labor force and other advantages, is proposed as a main advantage the need for a more intensive cooperation in the region.

Cooperation would be concentrated at the beginning in the following crucial issues:

- ✓ The research of most optimal solutions, with which would be rationalized the production cost and would be increased efficiency at work.
- ✓ Minimization of environmental impact; in this way establishing a suitable climate for economic development.
- ✓ Cooperation on increasing attention for a safe and healthy work of the miners;
- ✓ To discuss the balance of concentrate production capacities and metallurgical processing capacities, in order to increase the efficiency and bilateral or multilateral economic aspect.
- ✓ Close cooperation with NESMI and full application of RTD strategies, with the purpose of protecting the trade companies with mineral resources and supporting the engagement of world known companies for real investment in the mining sector, by maximizing economic effects for the country in which are exploited the mineral resources.

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