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# GEOLOGICAL AND ECONOMIC ASSESMENT OF THE PERSPECTIVE OF THE MINING IN LJUBIJA ORE REGION

Cvijić Ranko[1], Milošević Aleksej[2,] Čelebić Miodrag[2], Kovačević Žarko[2]

[1]*Institut of mining Prijedor, Bosnia and Herzegovina, e.mail. cvijic.ranko@gmail.com*
[2]*University of Banja Luka, Faculty of mining Prijedor, Bosnia and Herzegovina*

ABSTRACT

The iron ore of the Ljubija ore region for decades has a very great impact on the overall social reproduction in the area of the city of Prijedor, RS, BiH, which is clearly connected with the constant renewal and intensification of the production process. We have systematic geological explorations last over 135 years and exploitation with certain interruptions over 100 years. Existing resources/reserves should be optimally activated in order to achieve the commercial viability of investment funds invested in them, but also those that have yet to be invested, and a certain expected national benefit, and at the same time an intensive geological exploration of the potential space for finding new reserves in terms of iron ore base.

The paper attempts to assess the real justification of further geological exploration and exploitation in this area and the strategy for further development of iron ore mining.

Key words: *Ljubija ore region, iron ore, ore resources/reserves, geological exploration, exploitation, development*

## INTRODUCTION

The mining area of the Ljubija ore region, with an area of about 1500 km$^2$, in the western part of the Republic of Srpska, in the area between Novi Grad, Prijedor, Bronzani Majdan, Sanski Most and Budimlić Japra, has been a significant source of iron ore and stone for decades for the entire socioeconomic development of Prijedor regions, Republika Srpska and Bosnia and Herzegovina. In this mining region, iron ore is being industrially excavated since 1916, in a mine that is one of the largest iron ore suppliers in the Balkans.

Therefore, it is important that the institutions of the Republic of Srpska, the City of Prijedor and for the iron ore mines operating on the territory of the Prijedor region to analyze the existing data, assess the state of the raw material base, the economic importance of the ore reserves, assess the real justification of further geological exploration and exploitation of ore at this area, and consider the strategy of further development of mining in the region.

## MINING AND ECONOMIC STRENGTH OF THE REGION

In line with the projection of iron ore production in the Ljubija ore region and the rational use of available and potential resources/reserves with a strategy for the protection and improvement of the

living and working environment [1], the overall importance of mining can be expressed as:

- Realization of continuity in the production of iron ore for the needs of ferrous metallurgy in this region;
    - Making profits from production as a precondition for investing their own resources in development, growth of personal and general standards, etc.;
    - -Creation of profitable iron ore production creates preconditions for the development of other accompanying activities (transport, tertiary and non-industrial activities);
    - Analyzes show that one employee in the production of iron ore, in the reproducing units, infrastructure and other activities of the region and wider receives employment of 15 to 20 workers, and that each employee provides for the existence of another 3 to 4 members of the immediate family;
    - -The production of iron ore creates real conditions for further growth of living standards and human and social development. Education of an increasing part of the population at higher levels of education has a backward impact on the growth of labor productivity and the increase in the overall positive economic effects of the region and the Republika Srpska.

## MINING RESOURCES/RESERVES IN THE LJUBIJA ORE REGION

In accordance with current knowledge, the resources of the iron ore consist of [1,2]:
a. explorated deposits of iron ore areas in Omarska, Ljubija and Tomašica, Table 1,
b. discovered minerals (registered and partially researched) and
c. defined prospective areas of different degrees of potentiality.

The identified mining resources/reserves are the result of high productivity of the area. If the overall productivity of the Ljubija ore region is fully considered, then the total resources/reserves should be increased by 91,5 million tons of ore, which makes up about 180 million tons of exploitable resources/reserves [3,4,5,6]. Based on detailed geological analyzes, the conditions of the localization of ore deposits and the legality of their location, the great potential of the Ljubija ore region is estimated to find new resources/reserves of carbonate and oxide type.

Table 1. Condition of ore resources and ore reserves of Ljubija ore region (milions of tonnes)

| | Ore type | Ore resources | Ore reserves |
|---|---|---|---|
| Omarska | oxide | 80 | 16 |
| | carbonate | 15 | - |
| Ljubija | oxide | 32 | 13 |
| | carbonate | 163 | 14 |
| Tomašica | oxide | 6 | - |
| | oxide pelitoide | 47 | - |
| Total | oxide | 167 | 29 |
| | carbonate | 178 | 14 |
| | total | 345 | 43 |
| Note: In Omarska, 39,5 mill tons of oxide ores have been produced so far, in Ljubija 23,7 millons of oxide and carbonate ores, in Tomašica 24,5 million tons of oxide ores.<br>Concepts: *Ore resources* are commercially non-specific due to insufficient research;<br>*ore reserves* are sufficiently explored resources with proven technical efficiency, economic effectiveness and ecological acceptability of exploitation. | | | |

The worldwide practice of assessing the quality of iron ores is very different. The general tendency is the application of extremely rich and pure ores [1], and is conditioned by:

- strict economic standards in the production of iron, which are most important for the overall economy of ironworks;
- very high requirements for the cleanliness of iron from the point of view of harmful components, because this is a prerequisite for meeting the ever-firmer demands of consumers of quality steel products.

In the world, mainly (over 90%), ore mines of hematite and magnetite are exploited, which yield high quality concentrates from 62% to 68% Fe. The ore of the Ljubija ore region are different types of limonite, siderite and other carbonates, with lower content of iron. Limonite ore are exploited in Omarska, with a iron content of 46.5% Fe. In Ljubija, it is planned to exploit the remaining limonite ores of 40% Fe and carbonate ore with 25% Fe, whose concentrates will have lower iron content than usual on the world market [7]. The use of these concentrates should be confirmed in the conditions of individual ironworks - željezare [1].

The common characteristic of the qualitative characteristics of the explored mineral resources/reserves in the area of the Ljubija ore region are [1]:

- the quality does not reach the top world indicators, which limits the wider quality of processing based on quality
- all kinds of ores have not reached the maximum quality possibilities, and the realization should go in the direction of:
    - introduction of new technologies of mineral procesing
    - the use of various forms of selective exploitation
    - geological research for finding new deposits within the available potentials
    - a very tight connection with the processors of the ore is necessary

## TECHNOLOGY OF MINERAL PROCESING

Ores without prior preparation can no longer be used in ironworks. The basic characteristic of the mineral procesing process is the physical separation of iron ore from impurities, thus obtaining the appropriate concentrates of iron ore [4,5,6]. Combined washing, grading and magnetic separation technology was applied to limonite ore in "Omarska". Washing and grading technology was applied in the "Ljubija" mines, and in the "Tomašica" mine the drying and grading technology of limonite-branded ores.

Future works in seeking a solution must go in the following directions:

- the exploitation of known reserves of ore requires the optimization of the existing condition, which implies the maximum utilization of the qualitative depository facilities and the available mining facilities, as well as in the ironworks
- valorisation of solutions obtained from the previous technological research into the mineral procesing of the ore

An example of this is the valorization of carbonate/bazične ore from Ljubija, carried out in cooperation with the institutes in Zenica and Paris for ironworks ArcelorMittal Zenica [8,9].

## TIME DURABILITY RESERVES

Reserves of the Omarska Mine, open pit Buvač, [3,4], can be completed by the end of 2025 according to the projected production. Therefore, the priority need to include the remaining mining reserves from the Central mines of Ljubija in the production process is imposed [5]. Carbonate ores are problematic due to the low content of iron. The largest deposit of oxide ores in Ljubija - Vidrenjak (approximately 13 million of tonns reserves) is problematic due to the contents of the barite, where the technical and technological conditions for separation and enrichment of this type of ore should be addressed. Timely

involvement of the mining potential from the Central mines of Ljubija, mining production could take place according to the dynamics given in Table 2.

Table 2. Planed production per years (million of tonns) concetrate

| Mines/ore type | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | **total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Omarska** limonite | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | | | | | | | | 12,08 |
| **Ljubija** limonite | | | | | | | | | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 10,30 |
| **Ljubija** karbonate | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 0,4 | 5,6 |
| **Total** concrecate | 1,5 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,9 | 1,7 | 27,98 |
| Note: According to world standards, to start with production on a open pit deposit of 5 - 7 years is required, and a mine with mineral processing plants is 12-15 years is required; Carbonate ore can be used only in the mix with limonite ores from Omarska and Ljubija, up to 30%. | | | | | | | | | | | | | | | | |

## GEOLOGICAL RESEARCHES

The iron ore in the Ljubija ore region is being exploited for a continuous period of more than 100 years. At that time over 90 million tons of ore were extracted. Now there is a serious issue of further perspective. Is everything what nature has created discovered and excavated, or has still hidden iron ores bodies [10]. This question is attempted to respond with the help of metalogenic research, metalogenic analysis and the accompanying assessment of the potentialities of the regions. The carried out metalogenenic and other analyzes within the framework of the Ljubija ore region undoubtedly point to the significant possibilities of extending the existing mineral and raw material base in both quantitative and qualitative terms [7,10,11,12,13].

On the basis of all the studied materials and field tests, it is reliably established that the area of the Ljubijaore ore region and its frame had a complex evolution in the carbons, permus and triads. The geological pillar of the Ljubija ore region consists of: carbon javoric flysch, permo-triassic clastite, triassic tergene-carbonate, vulcanogeno-clastic terigens and carbonate formations, and neogen-quaternary lake crevices, Figure 1.

Exploration on field, before development of a metalogenetic study,was found that the primary iron ore is bound to an olistostromic member of the carbonaceous javorik flych formation, for carbonate olistolitic blocks that are "fall into" in the alevrolitic-sandstone matrix. In order to solve the issue of the genesis of primary deposits of iron, it was important to determine the origin - the source of the material for their formation. The carbonate blocks are transformed into the ore hydrothermaly, metasomaticaly and represent the primary siderite-ankerite ore bodies or their parts, what was proven by detailed geochemical tests [16,17,18,19,20].

Experimental geophysical and other exploratory works were performed according to the program of geological explorations [12,13]. All the research carried out in the past five goidins were done in the organization and under the supervision of the ArcelorMittal Prijedor mine.

In addition with that, further geological explorations are planned, Figure 2, as follows:

- detailed geological research to move resources into reserves
- basic geological explorations for indicating and discovering new ore bodies (until 2019) [10],
- detailed geological explorations of the indicated ore bodies and mineralization based on basic geological expolaration (roughly until 2024).

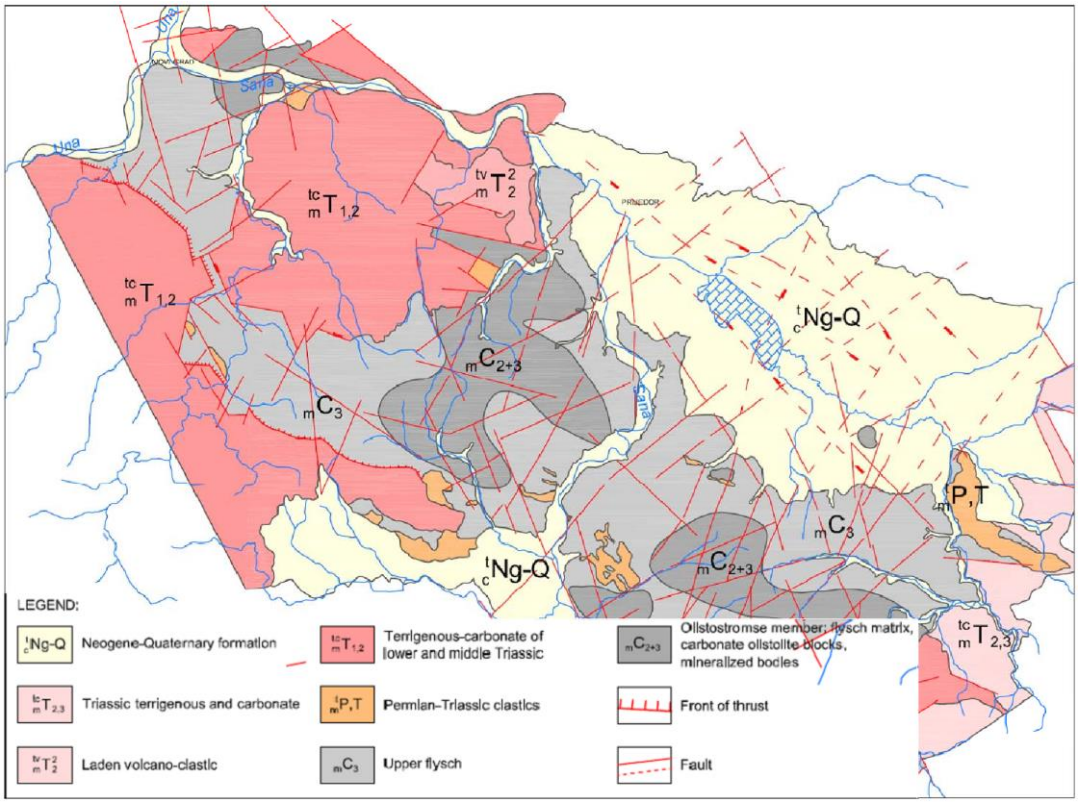


Figure 1. Schematic representation of the geological base for metallogenic map of Ljubija area

There is neccesary for permanent geological research, for the purpose of deeper knowledge of the geological characteristics of the region, better knowledge of the iron ore, due to the ever-firmer demands of the market, and the emergence of new deposits.

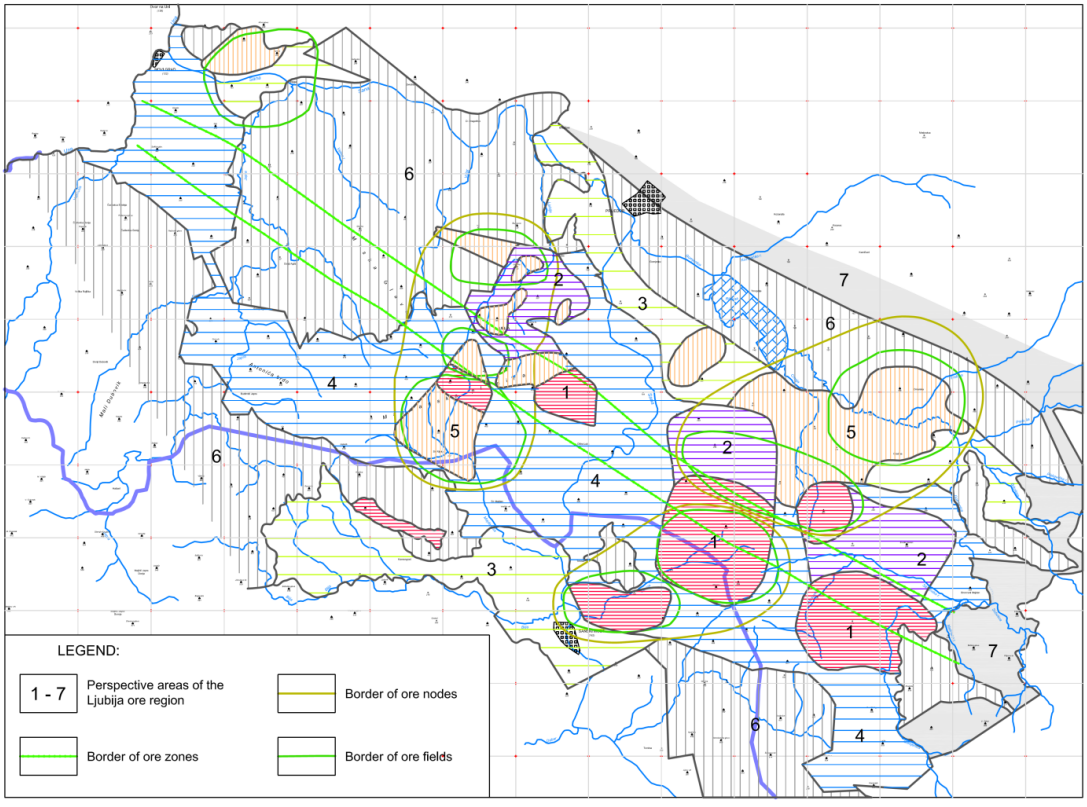


Figure 2. Prognosis map for iron ores of Ljubija ore region

## STRATEGIC PLANS

In the strategy of valorizing the available ores of iron from the Ljubija ore region, it is necessary:

- Creating a favorable socio - economic environment at the level of the Republic of Srpska (legal frameworks, mineral strategies and policies, and necessary measures).
- Maximum professional engagement in order to provide conditions for achieving optimal quality parameters, which satisfy iron ore consumers [8] .

## POSSIBLE RISKS

In the system of exploration and exploitation of the iron ore there is a greater number of risks [1]. In mining, in general, geological (natural), mining and exploitation, ecological and market/economic risks are of the highest importance. However, from the point of view of investments in the exploration and exploitation of iron ore of the Ljubija ore region, the present conditions are especially current political risks, which also stand in a certain correlation with the profesional risk. Political risks relate to certain specificities of the social, economic and political factors of the environment.

The size of the political risk is determined by: state stability, relations between political parties and the character of the party in power, state (constitutional) regulation, quality of governance, foreign policy, foreign policy characteristics, possible crisis of government, instability and unprincipled tax policy, concession policy, level of corruption, etc.

## CONCLUSION

Iron ore deposits with a relatively large mineral resource exploration base and the potential to be expanded remain the focus of attention on the territory of the city of Prijedor, the region and Republika Srpska, but on the basis of the concept of sustainable balanced development and portfolio effects. The contemporary social and economic logical need to treat available iron ore resources in accordance with long-term and strategically set goals, and on the principles of modern management as a specific form of the most widely-defined management of resources, people and capital, was imminent.

The social problems posed by this and the existing concrete resources of the iron ore of the Ljubija ore region represent one of the most important comparative advantages of the city of Prijedor, the region and Republika Srpska.

Here, the comparative advantage is particularly reflected in cooperation with the world leader in the development and production aspect of the iron and steel ore, Arcelor Mittal, which is the strategic partner of the Government of the Republic of Srpska.

Therefore, these resources should be optimally activated in order to achieve the commercial viability of invested investment funds in them, but also those that have yet to be invested, and a certain expected national benefit. This requires the realization of the listed geological and other accompanying research, which should not be a limiting factor, because without it there is no reproduction of mineral ores, iron ore, continuity of production and development.

This is understood, that the precise elaboration of the strategy and the establishment of a lasting stable policy within the Republic of Srpska as a whole in relation to the resources of the iron ore of the Ljubija ore region are assumed, in other words, a clear position of the emphasized national respect and respect for those resources is needed.

From the presented material, the following can be concluded:

- exploitation of iron ore in Omarska mine ends in 2025,

- by timely inclusion of the remaining reserves of ore from the Central Mines Ljubija, the mining activity can be extended until 2032,
- the requirement for the achievement of the previous objective is to start production in the Central Mines in 2018,
- in order to be realized beforehand, an urgent agreement is needed between the subjects of RŽR Ljubija a.d. Prijedor, the Republika Srpska Government and the City of Prijedor,
- that the mining production will continue after 2032, it is necessary to conduct intensive geological research in order to find new deposits

If the previous activities are not realized, it can be expected that by the year 2025 the production of iron ore in the Ljubjevski Rudni region will cease.

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