Chair of Mining Engineering and Mineral Economics

Doctoral Thesis

Economic Evaluation of Trepca Resources for commercialization or re-commercialization

Alan Mencin

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Declaration of Authorship

MONTANUNIVERSITÄT LEOBEN

AFFIDAVIT

I declare on oath that I wrote this thesis independently, did not use other than the specified sources and aids, and did not otherwise use any unauthorized aids.

I declare that I have read, understood, and complied with the guidelines of the senate of the Montanuniversität Leoben for "Good Scientific Practice".

Furthermore, I declare that the electronic and printed version of the submitted thesis are identical, both, formally and with regard to content.

Date 07.07.2020

Signature Author
Alan, Mencin

Preface, Dedication, Acknowledgement

I Have been working on this thesis a long time and there are a lot of people that have helped and supported this effort. Many of my friends have continued to ask how the project has been going and when I would complete it. They always asked in a supportive fashion and always were encouraging. Without their support I would have found this to be more difficult. These include, in no particular order, Tom, Rick, Cathy, Jennifer, Pamela, Tess, Angela, Elena, Erik, and many others whose names I have forgotten to include.

I also acknowledge Montanuniversität Leoben for their assistance and support in my unorthodox path towards the completion of my degree. This includes Univ. Prof., Dipl. Ing., Dr.Mont. Nik Sifferlinger, Vizrektor Univ. Prof., Dipl. Ing., Dr.mont. Peter Moser, Univ. Prof. Mag.rer.nat. Dr.mont. Frank Melcher, and Eur Ing Dr. Corby G. Anderson QP RM CP CEng FIMMM FIChemE .

Abstract

There are many aspects to resource evaluation that need to be addressed in order to determine the feasibility of a particular project. The aspects for evaluation include many topics and tools. Very broadly, they include geological, geochemical, and geophysical analysis, statistical analysis of the resource, mine modeling, and financial analysis. The purpose of this paper is to discuss these items and to provide a coherent whole in which to work for resource and reserve evaluation particularly for the rehabilitation of older mines. The idea being that a set of simple financial tools can give some direction in deciding on which projects to pursue.

This paper will discuss resource valuation from the discovery phase through to characterization and evaluation of older or abandoned mines or other projects associated with the mine. The topics covered will include:

Geological Analysis, Resource, and Reserve Valuation
Additional issues with older mine properties
Mathematical and Financial Modeling of the resource and Global Standards
A mathematic model for evaluating possible options for commercialization.

The paper also includes a discussion of the Vardar region and specifically the Trepca Complex/ Stan Terg Mine.

Zusammenfassung

Es gibt viele Aspekte zur Ressourcenbewertung, die angesprochen werden müssen, um die Durchführbarkeit eines bestimmten Projekts zu bestimmen. Die Aspekte für die Bewertung umfassen viele Themen und Werkzeuge. Im Großen und Ganzen umfassen sie geologische, geochemische und geophysikalische Analysen, statistische Analysen der Ressource, Minenmodellierung und finanzielle Analysen. Der Zweck dieses Papiers ist es, diese Punkte zu diskutieren und ein kohärentes Ganzes zu schaffen, in dem für die Ressourcen- und Reservenbewertung gearbeitet werden kann, insbesondere für die Sanierung älterer Minen. Die Idee ist, dass eine Reihe von einfachen finanziellen Werkzeugen eine gewisse Richtung bei der Entscheidung geben kann, welche Projekte verfolgt werden sollen.

In diesem Beitrag wird die Ressourcenbewertung von der Entdeckungsphase bis hin zur Charakterisierung und Bewertung älterer oder aufgegebener Minen oder anderer mit der Mine verbundener Projekte behandelt. Die behandelten Themen umfassen:

Geologische Analyse, Ressourcen- und Reservenbewertung
Zusätzliche Probleme mit älteren Minengrundstücken
Mathematische und finanzielle Modellierung der Ressource und globale Standards
Ein mathematisches Modell zur Evaluierung möglicher Optionen für die Kommerzialisierung.

Das Papier beinhaltet auch eine Diskussion der Vardar-Region und speziell des Trepca-Komplexes/der Stan Terg Mine.

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1 Introduction

1.1 Reason/Motivation

The original intent of the project was to look at various mine sites across East and Southeast Europe that had been abandoned or had been closed to see if there was an economic reason to re-open them to produce either their original products or to extract "modern" materials whose desirability had been created with the use of newer technologies requiring those new materials. It was soon realized that considering the whole of East and Southeast Europe was too much and the focus was shifted to a single mine complex. The complex that was chosen was the Trepca complex in Kosovo. I am interested in the economics of an operating mine and the recovery of previously discarded materials as a source for economic recovery of usable materials. This is important because there are a number of old mine sites and tailings that contain substantial amounts of metals that have become economic due to changes in the processes, the price of the metals, and the costs of recovery. Examples can be found throughout the world and an example of this, to be discussed later, is in Australia.

1.2 Research Question

Trepca has been in production almost continually since 1930 with an extensive history of production. There are indications that the mine was producing as far back in time as the Roman period. However, there was a war in the region in 2000 that damaged or destroyed much of the infrastructure of the complex. In addition, there have been political changes that make it more difficult for the mine to operate at levels previously attained. The questions that I am working to answer are:

- Can the mine produce economically?
- What level of production can be considered economic?
- Are there other sources of metals such as tailings?
- Are those metals economically recoverable?
- Can this method be generally used?

There are many sources of mining and economic data available about the Trepca Mine but it is not consolidated into a single source. Another purpose of this research is to consolidate the information into a single document that provides a single source for historical information and also provides an ability to forecast into the future based on that historical information.

1.3 Method of Scientific Approach

When using the scientific method for problem solving there are a variety of items that need to be considered. The first is that you are objective. This means you base your judgements on observations and verified facts. The second one is that you realize that you and everyone else can and are biased by the individual perspective. Curiosity is a very important factor because you have to want to know the facts of the situation and not just opinions. Lastly, you have some knowledge of scientific methodology and work at applying it to the problem.

In using a scientific approach, there are 3 types of research projects. They are exploratory research, in which there is a new problem that has little about it known, testing out research, in which the limits of a previously proposed generalization are tested, and problem-solving research, in which the problem is from the "real world" (Royal Institute of Technology Stockholm, 2021).

This project is based on the problem-solving variety as there are many different issues that need to be addressed in order to solve the particular problem. These areas include the technical operation, management, economic, social, environmental, and political issues.

- Preparing the analysis of the subject
- Determining the hypotheses to be studied
- Check the partial results to verify assumptions
- Validation of the data and hypothesis

2 Valuation

2.1 Resource Valuation

According to the Canadian Institute of Mining (CIM) Council (CIM Standing Committee on Reserve Definitions, 2014), a resource is "*A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade or quality, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling.*" There are a variety of methods that can be used to determine the value of a mineral resource. Resource valuation can only be truly known when the when the resource has been fully recovered. Prior to this there are a number of assumptions to be made, and methods of evaluation to be used, to arrive at an approximate value. J.A. Bell (J A Bell, J. A., Guj, P, 2012) states there are a large number of uncertain value drivers in the evaluation of a project. This is true particularly during the evaluation of an early stage exploration project. While he addresses early stage projects, the drivers are also common in later stage projects. The value drivers include geology, various measurements, project location, maturity of the market and its psychology. Resource valuation begins early in the process with the discovery of a resource and continues through to the final stages of a producing mine. In addition, Ian Thompson (Thompson, 2000) states that exploration properties form a continuum. Thompson also provides a critique of the various methods used. Minnitt and Lilford (Lilford, E. V.,Minnitt, R.C.A, October 2002) also demonstrate the continuity of the evaluation/ mining process, in addition to showing the different types of estimating processes at different stages, in their paper. This is shown in the following figure:

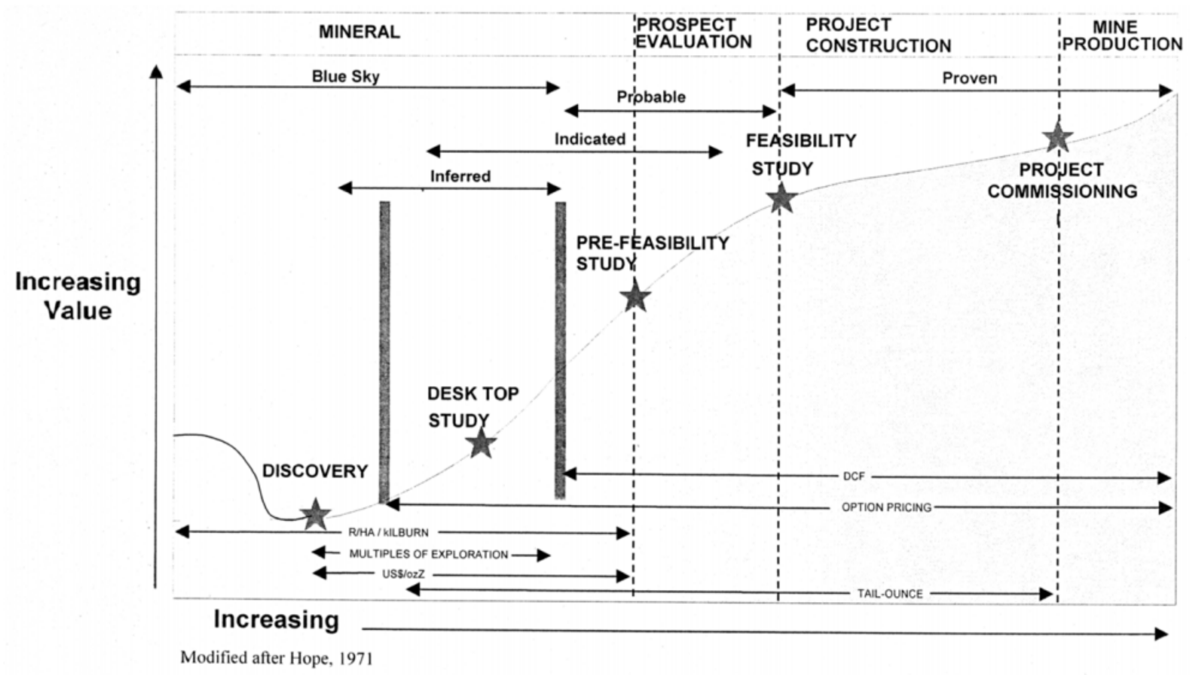


Figure 1 Continuity of Evaluation (Lilford, E. V.,Minnitt, R.C.A, October 2002)

It should be noted that the identification of various parts of the figure reflect the time of publication. The term “Desk Top Study” is now more commonly referred to as a “scoping study” or a “Preliminary Economic Assessment”. The purpose of inclusion of this figure is to show the progression of knowledge and certainty regarding the prospect.

The initial attempt to value the resource is normally based on very limited data whereas the producing mine valuation can be based on actual production and much better data about the resource. The value of a resource project can be determined in a number of different ways. E.V. Lilford states that a single method cannot be used across a range of developments. (Lilford, E.V., and Minnitt, R.C.A., January 2005) In his paper, Lilford demonstrates this by addressing five different stages of mine development. In the case of his paper, they were focused specifically South African gold mine projects. The categories that Lilford uses are:

- Greenfield exploration targets
- An identified and partially sampled mineral occurrence
- A drilled-out ore body
- A partially developed mine
- A producing mine

However, he does not address the case of a mine which has been closed or abandoned for a period of time that is being analyzed for re-opening or a change in the mineral of interest. Additionally, there is no reference to the case of evaluating tailings as these have been historically considered to be waste and have been valued as such. For the purposes of this paper I will use the above categories with one additional one that addresses an old mine that has been mostly produced and may or may not be economic.

In Lilford's analysis he divides the project using the factors of area, depth to resource, category, in situ grade and amount, proximity to other deposits, and exploration expenditure. He then proceeds to use 6 methods of evaluation. These are:

- Lilford Techno Economic Matrix Method
- Value per unit of measure
- Kilburn Method of Valuation
- Multiples of Exploration (Cost method)
- Discounted cash flow techniques (Income Approach)
- Tail margin analysis (Income method derived from cash flows)
- Option pricing

These will be discussed in detail later in the paper.

His conclusion is that the critical limitation on achieving a proper value for the project lies with the evaluator. Lilford, in his work, says that the person evaluating the project needs to have all the available information from a variety of sources, be aware of its problems, know the limitations of the methods available, then attempt to apply this knowledge to arrive at an acceptable conclusion.

2.2 Reserve Valuation

Reserve valuation is a sub category of resource valuation. According to the CIM (CIM Standing Committee on Reserve Definitions, 2014), a resource is "*the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.*

The reference point at which Mineral Reserves are defined, usually the point where the ore is delivered to the processing plant, must be stated. It is important that, in all situations where the reference point is different, such as for a saleable product, a clarifying statement is included to ensure that the reader is fully informed as to what is being reported."

2.2.1 Greenfield Stage – Discovery

A Greenfield project can begin with exploration in an area where no mining has been done and mineral deposits may, or may not, be known to exist. This happens very early in an exploration process. The discovery, or attempt at discovery, is based on the geologist's interpretation of the area geology. Normally this interpretation comes from hypothesis about the mineralization of the area based on tectonic history and possible deposition mechanisms. These are typically very difficult to value because there is little to no information on the resources, if any. Once an area has been picked for exploration, the geologist will use various tools such as airborne and satellite surveys, ground based geological and geophysical prospecting. The geologist will also plan drill target areas if it appears the other methods indicate possible resources. Methods used at this stage of exploration will typically be very inaccurate. Lilford (Lilford, E.V., and Minnitt, R.C.A., January 2005) suggests that of all the methods available for the valuation at this early stage, the ones that can be used (although effectiveness is in question) are the Kilburn method, unit of value per ounce, multiples of exploration or the Lilford TEM method. One of the items of note here is that these various methods produce estimates that can be an order of magnitude in difference.

Generally, it would be expected that if an indication of minerals is found, then a project to better define the quality and quantity of minerals would be undertaken. This would be additional geologic, geophysical, and geochemical field work and analysis. This type of work leads us into the next section which is an identified and partially sampled project.

2.2.2 Identified and Partially Sampled – Preliminary Economic Assessment

As stated above, this category is referred to by Lilford as a "Desk Top Study". For the second category, Lilford describes this type of site as one that is contiguous to other mineralized deposits and is completely drilled out, meaning the site has a well-defined set of data from a drilling program, and all necessary infrastructure to develop the property is in place.

In this particular case he adds Discounted Cash flow modeling along with Option Pricing as additional methods. With these methods there is an even wider variation. The difference from smallest to largest is a factor of more than 25 times.

2.2.3 Sampled and Characterized – Pre-Feasibility

Lilford's third model is one that has been completely defined by drilling. It is within a known metallogenic province, a full, sustainable, mining plan has been done, along with estimated recoveries of the resources. The variation from lowest to highest is a factor of about 16.

2.2.4 Mine Plan – Feasibility Study

The mine plan is an important part of the overall process. The process allows us to determine the value of the project and also allows us to determine whether the project is feasible, optimally, or sub-optimally (Hall, 2015). Mining projects are difficult to determine because of a variety of technical, metallurgical, and economic factors. These factors include the ore body size, type, and distribution along with variability of mineral prices and exchange rates. At this point, several decisions are made including the mining method, production rate, and cut-off grade. Once the plan is determined for the feasibility study, it is difficult to change. This is because at this early of a stage in the project there is not much information available and appropriate assumptions need to be made. One of the more critical ones at this stage is the determination of mining method. This has a large impact as, for example, underground mining is much more expensive than pit, or open cast. Later, when the mine is operational, the mine plan will be updated regularly due to market conditions, changes in grade and cutoff, etc.

One of the most common parts of the feasibility study is the measure of value of the project. Net Present Value (NPV) is a common measure. As Hall states, most companies have multiple goals so a variety of measures are normally used (Hall, 2015).

2.2.5 Project Commissioning

Mine commissioning is one of the critical processes for the effective and economic operation of a mine. Through the course of commissioning, the weaknesses and inefficiencies, as well as the strengths, of the mine plan are realized. At this point, once the engineering constraints are identified and remedied, the valuation of the mine can be reconsidered. Again, there are many factors to consider. Some of these are the actual production costs, the value of the mineral(s) in the market, changes to improve cash flow (mine more of a lower grade as opposed to “high grading”), etc.

2.2.6 Ongoing updates to Reserve Estimates

As the mine is in production, the process of valuation is a continual one. It is constantly being updated with information from the production in terms of quantity, grade, location, recovery cost, and market value. These inputs will affect the overall value of the mine, the cut-off value, and the overall economics of the project.

2.3 Additional issues with older mine properties

There are a variety of issues with older mine properties. These include properties reaching the end of life of a specific mineral upon which the original mine was established, changes in economic status of the mined mineral(s), the desirability of minerals not previously considered, and changes in technology.

2.3.1 Drilled out ore body – reserve valuation

Mining properties that have been in production for many years have both advantages and disadvantages when it comes to resource and reserve valuation. One of the key advantages is the ore body is relatively well defined. This is because during the process of mining the location, size, value, and quality of the resource, and the reserves, is quantified by sampling. This reduces the uncertainty to some degree. There are still situations that will not materialize. One example is where the geology and past experience indicates a body of high-grade ore should exist in a certain location but upon drilling, sampling, and possibly mining the location it is found not to exist. Also, there may be extensions to the original resource estimate that were not previously considered which will extend the life of the mine considerably.

2.3.2 Change in economics of co-products/ byproducts – resource or reserve valuation

One issue with some resources is that their value changes as different techniques and applications change. Lead was mined extensively for use in batteries and is still used today. However, lead batteries are highly recycled with 85% of the lead batteries recycled globally with nearly 100% recovery in Europe and North America (International Lead Association, 2016). Since lead is so highly recycled the price for "new" lead will be reduced since the demand is reduced by the recycling. Also, with the change in battery technology from lead-acid to Lithium-Ion and vanadium technologies the demand for lead is reduced even further. However, this also drives a new demand for lithium and other minerals which were not previously considered.

One example from the Trepca mine would be the recovery of silver, gold, copper and bismuth as co-products/ by-products. During World War II, copper and bismuth were valuable for the war effort and processing was used to recover these metals without regard to the cost of recovery. In addition, the recovery of gold and silver is dependent on the concentration of the metals in the concentrate produced. Data from the Kosovo government, as shown in the appendix, indicates that gold is occasionally recovered but, at other times, it is treated as a contaminant in the lead and zinc concentrates.

2.3.3 Changes in technology – reserve valuation

One of the things that can change is technology which will drive the evaluation in different ways. One example is a change in the method of mining a resource that is more effective and more efficient. This will allow the cut-off grade to be changed to a lower value increasing the amount of recoverable mineral material and making the mine more valuable. An example of this was the use of "hydraulic mining", which originated from Roman techniques using water, for the recovery of gold during the gold rush era in America. While the gold could be recovered by gravity separation in a pan or a sluice box, the use of pressurized jets of water to effectively erode the hillsides and recover more gold at a higher rate. Another example is the use of an aqueous solution that is pumped down one set of wells and recovered from another set of wells to dissolve the desired minerals without having to dig up large amounts of waste rock. This technology is used for the recovery of uranium in America and makes some deposits economically feasible where they otherwise might not be. According to the World Nuclear Association (World Nuclear Association, 2020), in 2016 48% of the uranium mined in the world is done with this method compared to 16% in 2000. The World Nuclear Association also says that it is seen as the best method because it is cost effective and the most environmentally acceptable method of mining uranium at this time.

Changes in technology can revise the valuation because of demands of newer minerals and metals that were not previously used. This is true when an element, previously considered as a contaminant, becomes important because of its properties. For example, technology, such as cell phones, computer screens, high power magnets, etc. has made "rare earths" important. Since the demand for these minerals and metals has gone from scientific curiosity to one of major economic importance, this change in the market has driven the re-evaluation of properties that potentially contain these elements for consideration of either changing the material recovered or possibly "mining" the waste rock.

2.3.4 Other issues

There are a number of additional items in an old mine that need to be addressed before we actually get to the cost model stage of analysis. Among them are:

- what is the state of the mine in terms of accessibility, operation, and safety?
- what capital expenditure is necessary to achieve operation?
- what is the recovery rate?
- who does the concentration and/ or refining/ smelting?
- what does the market look like?
- what are the social, economic, legal, and environmental factors?
- are there new technologies or processes that will make it workable?
- is there a reason to re-process the tailings?

2.4 Geological Analysis

2.4.1 What Constitutes a Mineral Resource?

A mineral resource is generally defined as a concentration of materials that are of an economic interest. In addition, the resource can be more broadly defined as the geologic, technical, and economic viability of a mineral body. This differs from a reserve which is broadly defined as the mineable portion of the reserve.

There are a variety of reasons for mineral resources to be an economic interest. These can range from sand, gravel, and cement that can be used to build structures to materials that have no other purpose than decoration. One method of classification is the McKelvey diagram created by V.E.

McKelvey in the early 1970's and subsequently modified by the USGS (USGS, 1980). The original diagram was simpler. Note that the diagram makes a distinction between resources and reserves.

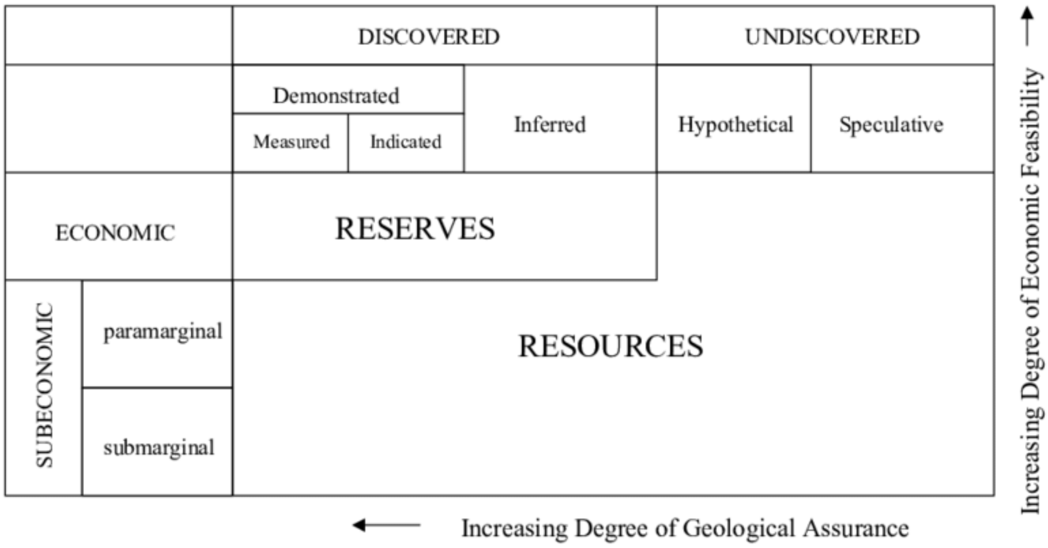


Figure 2 Early McKelvey Diagram

The revised version provides a bit more detail when attempting to describe a mineral occurrence.

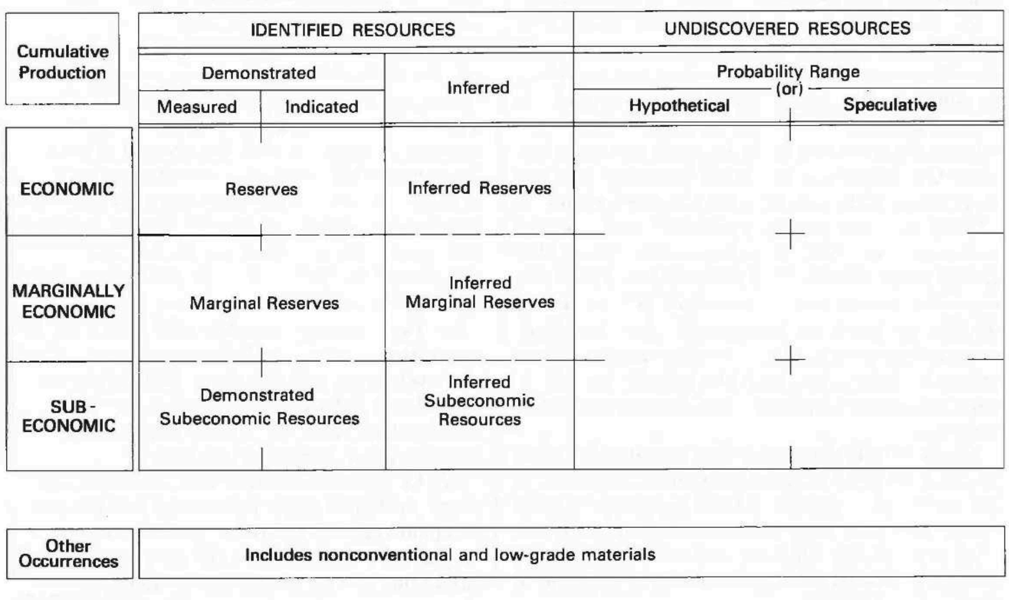


Figure 3 McKelvey Diagram (USGS, 1980)

The classification schemes are actually defined by the various entities that specify the requirements for resource/ reserve estimation. Canadian CIM classification is used in their NI 43-101. The Australasian Joint Ore Reserves Committee Code (JORC, 2019) has its own classification. SAMREC, the South African Code for the Reporting of Mineral Resources and Mineral Reserves is another classification scheme. While the purpose of these is similar, there are some differences in definition. In addition, other methods such as a classification index (Arik, 2002) are also part of the literature.

As mentioned previously, the first place to start is a geological analysis of the general area to determine if there is potential based on the geology. An example of this is the study done for the Independent Commission for Mines and Minerals in Kosovo (Beak Consultants, GmbH, 2007) (Beak Consultants GmbH, 2010). Reports like this provide the general geologic trends in an area. For example, the Vardar zone is broken into three different regions:

- The Internal Vardar subzone (IVZ)
- the Central Vardar subzone (CVZ)
- the External Vardar subzone (EVZ)

The Internal Vardar Zone (IVZ) zone is further described as:

- Neoproterozoic to Lower Palaeozoic basement of the Serbo-Macedonian Massif (SMM)
- Oligocene to Miocene-Pliocene sedimentary basins (Kamenicë basin)
- Andesitic-dacitic-latitic and pyroclastic volcanism (Volcanic complex of Braine-Carefc, Late Paleogene to Middle Miocene (Mario Zelic, 2010))

Whereas the Central Vardar Zone (CVZ) is described as:

- Low to medium grade metamorphic rocks – Paleozoic basement
- Upper Jurassic ophiolite complexes
- 800 to 1,000 m thick Cretaceous flysch
- Intensive compression tectonics
- Oligocene to Miocene-Pliocene sedimentary basins (e.g. Podujevë basin)
- Andesitic-dacitic-latitic and pyroclastic volcanism in south-eastern part of Kosovo (Volcanic complex of Nosale-Kllokot, Late Paleogene to Middle Miocene (Mario Zelic, 2010)).)

And the External Vardar Zone (EVZ) is characterized as:

- Low grade metamorphic rocks – Paleozoic basement
- Low grade metamorphic Triassic, Upper Jurassic ophiolite complexes
- Cretaceous flysch
- Oligocene to Miocene-Pliocene sedimentary basins (Kosovo basin)

- Intensive andesitic-dacitic-latitic and pyroclastic volcanism in the northern part of Kosovo (Volcanic complexes of Mitrovicë-Samadrexhë, Late Paleogene to Middle Miocene (Mario Zelic, 2010)).)

The publication continues with an extensive description of the geologic structure and the presumed geologic history.

2.4.2 Computer-based 3D Ore Body Modeling

One of the next items to perform is a modeling of the resources. This can be done at many different points with varying degrees of accuracy. In an early stage, the data may only be available from a series of drilled holes. Depending on the drill program this may or may not be adequate. There are a variety of tools that can be used to model in 3-D. In general, as long as the data is available in a format that defines location and grade, (e.g. latitude, longitude, depth, and grade) it can be modeled in 3-D.

For an older mine, such as the Artana Mine The information may be substantial, depending on the records kept and taking into account the historical production, the current state of the mine, historical drilling programs, etc. With this data the ore body can be well defined and modeled, as is shown in the following figure.

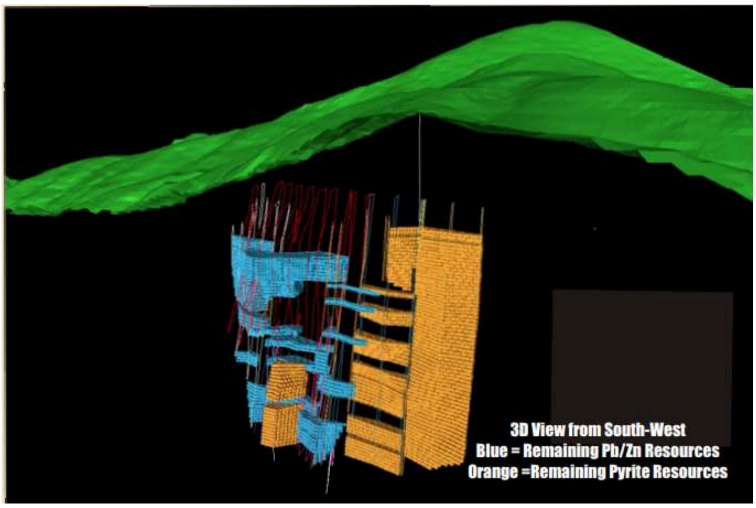


Figure 4 Computer Model of the Artana Mine (Kosovo Trust Agency Managing Privatisation in Kosovo)

It should be noted here that in the absence of a system of reporting standards, the information sheet from which this diagram was used stated the original Yugoslav figures conforming to reserve standards within the former Eastern Bloc countries.

2.4.3 Mathematical Methods of Defining the Ore Body

Geostatistics is a method of working with data that is dimensional, either 2 dimensions or 3 dimensions, or by both dimension and time. It was originally developed to predict probability distributions of ore grades for mining operations (Krige, 1952).

Variography is "The process of examining spatial dependence using a variogram; a set of procedures (as much art as science) for interpreting variograms." (ESRI, other-resources/gis-dictionary/term/variography, n.d.). A variogram graphically shows the change of the difference in value for a variable at pairs of sample points to the separation distance between those pairs.

These are part of the mathematical modeling and analysis of the resource.

2.4.3.1 Mathematical Modeling of the Resource

One of the first steps towards modeling the resource is the gathering and creating of the data. Depending on the type of resource, the data may be sparse as is the case of a preliminary prospect with few holes drilled to sample the body. There also may be a great amount of data. An example would be a producing mine with very well-defined mineralization zones and an extensive drilling program with well-defined locations and sample grading. While the actual database can take many forms, all relevant data must be in a similar format for analysis.

2.4.3.2 Creation, Standardization, and Validation of the Database

One very important step in the modeling of a resource, or reserve, is the creation of the database. This step is important because all of the analysis is based on the data, its amount, and accuracy. The database is a record of all the data available in a single standardized format. This starts with a basic form. An example of this is the following table:

Sample Identification	XXX00001
Latitude	42° 36‘ 58.125‘‘ North
Longitude	21° 25‘ 55.344‘‘ East

Depth (meters)	400
Angle (if not vertical)	Xxx
Direction (if not vertical)	Xxx
Pb grade (%)	Xxx
Zn grade (%)	Xxx
Ag grade (gm/ton)	xxx
Au grade (gm/ton)	xxx

Table 1 Database Record Format

Getting the data into a recognizable and analyzable basis is actually one of the harder things to do. Many of the field surveys have been done on the basis of a grid system that is initially not tied to a standard method of geo-location and all data needs to be tied to the local basis. Some countries have a standard for tying the mine grid to the local grid which, in Western Australia, is the Map Grid of Australia 1994 (MGA1994) (Government of Western Australia, Dept. of Mines and Petroleum). Other countries have a specific method of locating landmarks. The Gauß–Krüger system is used many areas of the world including Europe, East and Southeast Europe, and South America. The Gauß–Krüger system is similar to the universal transverse Mercator (UTM) system which ignores variations in altitude. Gauß–Krüger central meridians are only 3° apart compared to 6° for UTM. (Wikipedia, Gauß Kruger, 2020).

The other item is that the sample grades need to be in the same format. This can be oz. per ton, or some other compatible measure but, again, all have to have a similar basis for analysis.

Once the data has been normalized to a standard location scheme and content the modeling can be started.

2.4.3.3 Section Plotting and Interactive Geological Modeling

Once a database has been established and validated some initial analysis can be done by sectioning the data to see if it fits local geological models, the data is consistent, and in the case of a mined property, that it matches what has been previously mined. This can be done by a variety of computerized tools from open-source graphing and plotting algorithms to commercial software packages intended to perform the complete analysis. Some choices for open-source software are: Gnuplot, Matplotlib, R, Octave, and Scilab. Commercial packages are also available. These include SGS Genesis, Gems, Surpac, Minex, Datamine, Vulcan, Micromine, and Leapfrog (Wikipedia - Mineral Resource Estimation, 2019).

2.4.3.4 Geostatistical Analysis

Geostatistical analysis is a method by which the analyst uses sample data taken at different locations and uses various methods to interpolate the values associated with the space between known points. Geostatistics relies on both deterministic and geostatistic methods. The deterministic techniques use mathematic functions for interpolation. Geostatistics relies on statistical and mathematical methods (ESRI, Principles of Geostatistical Analysis).

2.4.3.5 Block Modeling and Block Estimation

Once the geologic modeling is done the points have polygons mathematically defined around them. This can be in 2 dimensions or 3 dimensions. There are several methods that can be used. Some of these methods are the nearest neighbor, inverse distance and Kriging (Wikipedia – Mineral Resource Estimation, 2016). These will be discussed in more detail.

2.4.3.5.1 Nearest Neighbor Method

The nearest neighbor method of grading assigns grade values based on the nearest sample points. The closest one gets a weight of one and the others get a weight of zero. Its advantages are:

- It is fast and easy to learn
- It can handle complex target functions
- It does not lose information

Disadvantages are:

- It is very slow if you need to look up a point or value
- It can be fooled by unrelated and unimportant data

According to David Sontag, for high dimension space the nearest neighbor may not be near at all (Sontag, 2016). This method can also produce biased estimates higher than would be expected using other, more robust methods.

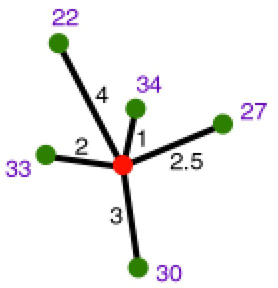
2.4.3.5.2 Inverse Distance Weighting Method

Inverse distance weighting, or as sometimes referred to as "inverse power of distance" is the simplest interpolation method. Inverse Distance Weighting is a non-linear method of interpolation that uses a weighted average to determine a value at non-sampled locations. A distance around the calculated point of interest, or neighborhood, is identified and a weighted average is taken of the observation values within this distance. The weights are inverse relative to the distance. The analyst has control over how the weighting is calculated, the size of the volume of interest (which can be expressed as a radius or a number of points), in addition to other options.

The simplest weighting function is inverse power:

$$w(d) = \frac{1}{d^p}$$

with p greater than zero. The value of p is specified by the user. The most common choice is p= 2 which makes it a function based on the "power" of the variable, e.g. 1, ¼, 1/9, etc. For p= 1, the weighting is less aggressive, e.g. 1, 1/2., 1/3, ¼, etc. As shown, the weighting is based on the distance from the non-sampled point. A more complete example is shown below:



$$Z(x) = \frac{\Sigma w_i z_i}{\Sigma w_i} = \frac{\frac{34}{1^2}+\frac{33}{2^2}+\frac{27}{2.5^2}+\frac{30}{3^2}+\frac{22}{4^2}}{\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{2.5^2}+\frac{1}{3^2}+\frac{1}{4^2}} = \mathbf{32.38}$$

Figure 5 Method of Inverse Distance Weighting

Shepard's method (Shepard, 1968), which is a variation, uses two different weighting functions and two separate neighborhoods. An inner neighborhood closer to the calculated point and an outer neighborhood further away. Normally used values for Shepard's method are an exponent of 2 for the inner neighborhood and an exponent of 4 for the outer neighborhood.

2.4.3.5.3 Kriging

Kriging is another stochastic interpolation technique to estimate the value of unknown and non-sampled points. Kriging uses a set of statistics to decide what the weights will be. Kriging assumes the variations will be based on 3 components: an overall trend, spatial correlation of points(nearer points will have similar attributes) and a random variable that is described as noise or measurement error. The method compares to a weighted moving average to determine values, or concentrations, at unsampled points based on sample data. (Krige, 1952).

There are two different methods of Kriging. They are “Kriging” and “Ordinary Kriging”. Ordinary Kriging is a statistical method of spatial estimation where the errors are minimized. These errors in variance are called the kriging variance. Kriging, assumes that local means of the samples are constant and equal to the population mean. The population mean is simple to calculate and well known.

Kriging, in general, forms weights from surrounding measured values to predict unmeasured location values and the weights come from a semivariogram that is developed by looking at the spatial nature of the data.

The semivariogram is a data plot of semivariance as a function of distance between the observations. Kriging uses a mathematical model to calculate estimates of the surface at the grid nodes. These kriging estimates are the best estimates of the surface at the specified locations. This is the best (linear and unbiased) estimate provided the surface is stationary and the semivariogram maths are correct.

The semivariance is defined as half the variance of the differences between all possible points spaced a constant distance apart.

The semivariance, or sample error, at a distance $d = 0$ will be zero. There are no differences between points that are compared to themselves. When the grid node and the observations are spaced so that all distances exceed the desired range, kriging calculates the mean.

2.4.3.6 Financial Modeling of the Resource

All of the standards speak of using various financial models for determining the value of the resource. In general terms all use the same terms of Market Value, Income, and Cost approaches. While these methods can be applied to various properties, the results can be vastly different.

2.4.3.6.1 Market Value Approach

In a market value approach for valuation, the assets are valued by applying the prevailing prices in the market to the quantity of assets or goods in stock. This method has the following advantages:

- Price, cost, and quantity data are relatively easy to obtain for established materials and markets
- Consumer preferences, or market fluctuations, can be observed and accounted for.
- It is a very standard and accepted method.

The main limitations are:

- If the good is not traded in quantity, there may be no comparable pricing to use
- Value may be affected by market imperfections or policy failures.

Lilford (Lilford, E.V., and Minnitt, R.C.A., January 2005) details several techniques for a market value approach. These are:

- Value per unit area
- Lilford Techno Economic Matrix Method (Lilford, 2004)
- US$ per unit of commodity
- Kilburn method.

The unit value per area method, as described by Lilford links value to the area of the property. It is based on inferences and assumptions of the mineral body that can vary from one region to another. The analysis is very subjective and misinterpretations of the final results are common. This means that the results should be questioned extensively. His Techno Economic Matrix attempts to improve on this by removing some of the subjectivity.

The value per unit of commodity is a straight forward method of valuation but also has limitations since it does not take into account many factors that would drive the costs of a mining operation and is also subject to problems with the geologic determination of the actual quantity of the resource.

The Kilburn Method (J A Bell, J. A., Guj, P, 2012) was developed in 1990 for mineral properties that do not contain exploitable resources.
It is a method based on four broad mineral property characteristics. These are:

- Closeness to existing geological occurrences or properties
- Estimated volume and grade
- Various geophysical and geochemical properties
- geological patterns that might indicate economic mineralization.

The problem with this method is that the analyst needs to have a strong geologic background to successfully apply the method effectively.

2.4.3.6.2 Income Approach

The income approach is a popular and commonly used valuation technique. Two of the methods are Discounted Cash Flow, and Options (sometimes referred to as Black Scholes or Real Options).

DCF has been used in many areas of investment and is well documented in valuation books and in financial textbooks. Some of its strengths are the ability to consider royalties, leases, taxation, and financing. Depreciation and amortization can also be modeled. It can also project future cash flows. However, it cannot be used effectively on less well-defined projects and is prohibited by some international codes (Lilford, E.V., and Minnitt, R.C.A., January 2005).

Options have additional benefits but are also more complex to model. Elkington (T. Elkington, T. and Gould, J., 2011) states that unlike DCF, real options valuation (ROV) reflects the ability of project operators to respond when market conditions deviate from expectation. He further states that "real options are most valuable for marginal projects, where the prospect of asymmetric upside/downside behavior is particularly prominent."

2.4.3.6.3 Cost Approach

The cost approach relies on a comparison with another property of a similar nature that can theoretically provide the same economic utility. This can also be described as comparable or replacement cost. A simple method would be a multiple regression on a variety of properties based on unit value of the resource and in situ ounces against values to determine an unknown property value.

Another method would be the Multiples of Exploration Expenditure (MEE). This method uses the amount of money expended exploring the property and then attempts to derive a multiple of that cost to determine a final value.

One of the main issues with any these methods is that they are very subjective in that there is no concrete valuation. It is based on subjective values for the comparable properties in the first instance and what the multiple should be in the second.

2.5 Global Standards

There are many standards for mineral property evaluation around the globe. Countries that have had large amounts of mining generally develop standards so that there can be consistency in the way that data is presented. The codes have many differences between them. Some of these are:

- the terms of independence requirements for the authors
- the particular manner in which documents are compiled
- the nature of the economic analysis
- the level of responsibility required from the signatories.

In addition, the project is typically subject to the reporting code for where the company is based rather than the project itself. For example, if a company is headquartered in Canada and is seeking investment capital for a project in South Africa, the Canadian Standard (NI 43-101) applies to the project. There has also been work to standardize the reports and the format.

2.5.1 Canadian Model

The Canadian model, which is commonly called “NI 43-101”, came into effect on February 1, 2001. NI 43-101 was formulated by the Canadian Securities Administrators (CSA) to inform investors about the details of mineral projects. (Canadian Institute of Mining, Metallurgy, and Petroleum, 2003), The actual title is “Standards and Guidelines for Valuation of Mineral Properties, Special Committee of the Canadian Institute of Mining, Metallurgy, and Petroleum on Valuation of Mineral Properties (CIMVAL)”.

It defines valuation tenets as:

- Materiality
- Transparency
- Independence
- Competence
- Reasonableness

In addition, it describes the qualities of the valuator and states the valuation will be based on three methods of valuation, Income, Market, or Cost, and also states that more than one should be used in the valuation of a property. It also goes further to describe what must be included in the report. The following table shows the required items:

Summary
Introduction and Terms of Reference
Scope of the Valuation

Compliance with the CIMVAL Standards
Property Location, Access and Infrastructure
Property Ownership, Status and Agreements
History of Exploration and Production
Geology and Mineralization
Exploration Results and Potential
Sampling and Assaying
Mineral Resources and Mineral Reserves
Metallurgy
Environmental Considerations
Mining and Processing Operations
Key Assumptions, Risk and Limitations
Valuation Approaches and Methods
Valuation
Valuation Conclusions
References
Certificate of Qualifications

The Canadian standard also refers to the Australian code.

In terms of the methods for valuation, the Canadian standard relies upon the "qualified person" and their judgement. It is not an objective standard as are some of the other standards.

2.5.2 American Standards

The Society for Mining, Metallurgy, and Exploration, Inc. (SME), which is an American mining organization, has also proposed its own standards for valuation. The First Edition was dated 2016. This is a new entry into the world of standards and is intended to address the United States. It does recognize and use standards from Canada, Australia, and South Africa in its development but ignores the "Russian" model of valuation. The SME version of the standard is intended to be compatible with IMVAL international standards.

The current edition (2017) has been updated, and follows the same methodology as the Canadian model in terms of its tenets. Specifically, the American version states the tenets, or principles, are:

- Competence
- Materiality
- Transparency
- Objectivity
- Independence.

(Society of Mining, and Metallurgical Engineering, 2017)

The list of requirements is slightly different than the Canadian model but there is no difference in the desired result.

Again, in terms of the methods for valuation, the American standard relies upon the "qualified person" and their judgement. It is not an objective standard.

The United States Securities Exchange Commission (SEC) Guide 7 is a requirement to provide a "final" or "bankable" feasibility study to report mineral reserves by all U.S. based mining companies. It must use the 3-year historical average price in any reserve or cash flow analysis to designate reserves, and there must be a primary environmental analysis which must be filed with the appropriate governmental authority. There are other requirements as the Guide has 3 sections but the main focus is that the SEC limits disclosure of quantities to proven (measured) and probable (indicated) reserves. In November of 2018, the SEC adopted new disclosure rules for all U.S. based mining companies. These rules are expected to take effect in 2021. While still being different than the global standards, the new rules will bring the U.S. reporting regime closer to other global reporting standards.

The major changes are that disclosure of resources must be done in a manner similar to CRIRSCO standards where they could not be previously disclosed, a "qualified person", similar to other countries, must be enlisted and they must be a member in good standing with a "recognized professional organization". This will probably be taken to mean the Society of Mining, and Metallurgical Engineering, or as it is known, the SME.

2.5.3 Australian Model

The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves of the Joint Ore Reserves Committee ('JORC Code') is a professional code of practice that sets minimum standards for Public Reporting of minerals Exploration Results, Mineral Resources and Ore Reserves.

The JORC Code is a mandatory system for the classification of minerals exploration results, mineral resources and ore reserves. It is based on levels of confidence in geological knowledge and technical and economic considerations and is included in public reports.

These public reports are prepared to inform investors and their advisors. Aside from public and company information they include exploration results, mineral resources and ore reserves estimates.

The JORC Code is one of the requirements of the Listing Rules of the Australian and New Zealand Stock Exchanges Its compliance is mandatory. (JORC, 2019).

The Australian code (VALMIN) is similar to the Canadian model but includes valuation of all minerals including oil and gas assets which the Canadian model excludes. There are other differences such as the definition of reasonableness is not in VALMIN because it is considered a part of Competence and not independent.

2.5.4 South African Model

The South African valuation codes (South African Reporting Standards, 2016) have several pieces. The "South African Code for the Reporting of Mineral Asset Valuation" (the SAMVAL Code or 'the Code') sets out minimum standards and guidelines for Reporting of Mineral Asset Valuation in South Africa.

The "South African Code for the Reporting of Exploration Results, Mineral Resources And Mineral Reserves" (the SAMREC Code, or the Code) sets out minimum standards, recommendations and guidelines for Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves in South Africa.

The "South African Code for the Reporting of Oil and Gas Resources" (SAMOG Code) is for oil and gas. It describes what is the minimum disclosure of information for public reporting of oil and gas reserves and resources.

The South Africans also have a document for precious stones. It is “SAMREC Guideline Document for the Reporting of Diamond Exploration Results, Diamond Resources and Diamond Reserves (and other Gemstones, where Relevant)”. It provides additional requirements for the valuation of diamond and gemstone reserves and resources.

2.5.5 Russian Model

The Russian and CIS model is well described by Hakan Arden (Arden). The stages are shown in the following table:

Study stage	General Task	Scope of work and deliverables
Stage I – Common geological and mineralogical work	Study of maps and field work to find locations of mineralisation	Identify sites based on geologic principles
Stage II - Prospecting and evaluation of deposits	Greenfield exploration	Technical exploration using geophysical surveys, single boreholes and workings. Estimation of resources. Technical and economic evaluations.
	Prospecting (including preliminary exploration)	More detailed survey of a prospective deposit using boreholes and workings. Estimates of configuration and size of ore bodies, and its properties. Qualitative and quantitative evaluation of resources. Technical and economic reports proposals. Technical and Economic study (TEO) of estimated cut-off parameters.
Stage III – Deposit exploration and development	Detailed exploration	Closely-spaced borehole grid for the detailed study of the ore body and the most accurate estimation of the economic potential of the deposit. Classification of A, B, C1 and C2 reserves. Determination of the final cut-off parameters and final approval of reserves.
	Mine operations	Additional work during operation for current mine planning. Development of operational cut-off parameters.

Table 2 Comparison of Russian and CIS Standards

In addition, this Novatek (Novatek, 2019) document describes the “Russian” system which is very different both in principle and detail. The international systems place the ultimate responsibility for the report on a competent, or qualified, person. On the other hand, the Russian system, as originally designed, tries to achieve total objectivity by removing “professional judgement”. Also, the website “https://www.intercontinentalmining.com/russian-reserves-resources-reporting-system/” and the paper ”Classification of Solid Mineral Resources and Reserves in Vietnam” (United Nations, 2012) give good descriptions of the Russian system. This Classifications paper’s discussion is as follows:

“The system was based on two documents: the Technico-Economicheskiye Obosnovaniye (TEO) and Technico-Economicheskiye Raschoti (TER). These translate to “techno-economic justification” and “techno- economic calculation”, or “technical-economic calculations” respectively. The TEO functions similarly to the western pre-feasibility study, but has a defined set of procedures. It includes technical options, commercial aspects, and environmental implications of a planned project.
The former Soviet system for classification was developed in 1960 and revised in 1981. It is still in use in Russia and a variety of other countries. Depending on the level of exploration, it divides mineral concentrations into categories (7), and three major groups. These are:

- fully explored reserves or resources (A, B, C1)
- evaluated reserves or resources (C2)
- prognostic resources (P1, P2, P3).

Reserves and resources that are similar to international categories are designated by the symbols A, B, C1, C2 and P1. Capital letters are used for economic categories. Sometimes, the same group of letters are written in lower case when the mineralization is considered sub-economic.
More commonly, the categories A,B,C1,C2 are referred to as “balansovye” (balance) which means they are commercially exploitable reserves and unclassified deposits are referred to as “zabalansovye” (out-of-balance) which means they are uneconomic.
In Russian, the synonyms of “balansovye” and “zabalansovye” which are “konditsionniye” (conditioned) and “nekonditsionniye” (unconditioned) respectively are also used.
The resource/reserve categories are:

- Category A The reserves have been highly defined. The boundaries are known and well defined. The quality and properties of the ore are known in detail to ensure the reliability of the projected exploitation.
- Category B The reserves in place have been explored but are not known in as much detail as category A. There is enough information to ensure the basic reliability of the project exploitation.
- Category C1 There is less detail in this category of reserves. This category can include reserves adjoining the boundaries of A and B reserves. It can also be used for very complex deposits in which the distribution cannot be determined even by a very dense grid. The quality and properties of the deposit are known by basic analyses or by analogy with known

deposits. The general conditions for exploitation are known. The geologic conditions are estimated and an allowance for barren blocks may be made statistically.

- Category C2 reserves are based on extremely loose exploration and with little data. The limits of the orebody are defined mainly by extrapolation within the known geological structure and by comparison with other similar deposits. The grade and mineral properties of the orebody are determined from samples and comparison with other mineral deposits nearby. Resources are forecast and estimated for mineralization outside the limits of the above explored areas and are often based on data from trenches and from geochemical and geophysical surveys.
- Category P1 which is a forecast category resources can extend outside the actual limits of the ore reserves defined in the C2 category. The limits are extrapolated from similar known mineral deposits in the area. P1 resources can be upgraded to C2 reserves with some additional work.
- Category P2 resources define possible mineral structures in known mineral deposits or ore-bearing regions. They are estimated based on geophysical and geochemical data. Properties are estimated by analogy with similar mineralized geologic structures nearby.
- Category P3is any potential ore-bearing deposit. These resources rely on the theoretical definition of a "favourable geological environment". Resources are calculated by comparison from figures of similar deposits in the region.

Estimates of forecast resources (P1, P2, and P3) are dependent on assumptions and projections regarding the size and grade of the deposit that are subject to confirmation by more detailed investigations. In this system the categories that are normally taken into account are A, B, C1, and C2. These are comparable to categories used in western systems.

Deposits are defined by complexity, size, and shape. The categorization systems do overlap. Complexity classes are:

- not structurally complex, they have uniform thickness and homogeneous grades
- structurally more complex with non-uniform thickness and grade variability
- even more complex structure with significant variations in dimensions and grade distribution
- exceedingly complex with extreme variations in thickness and in grade distribution

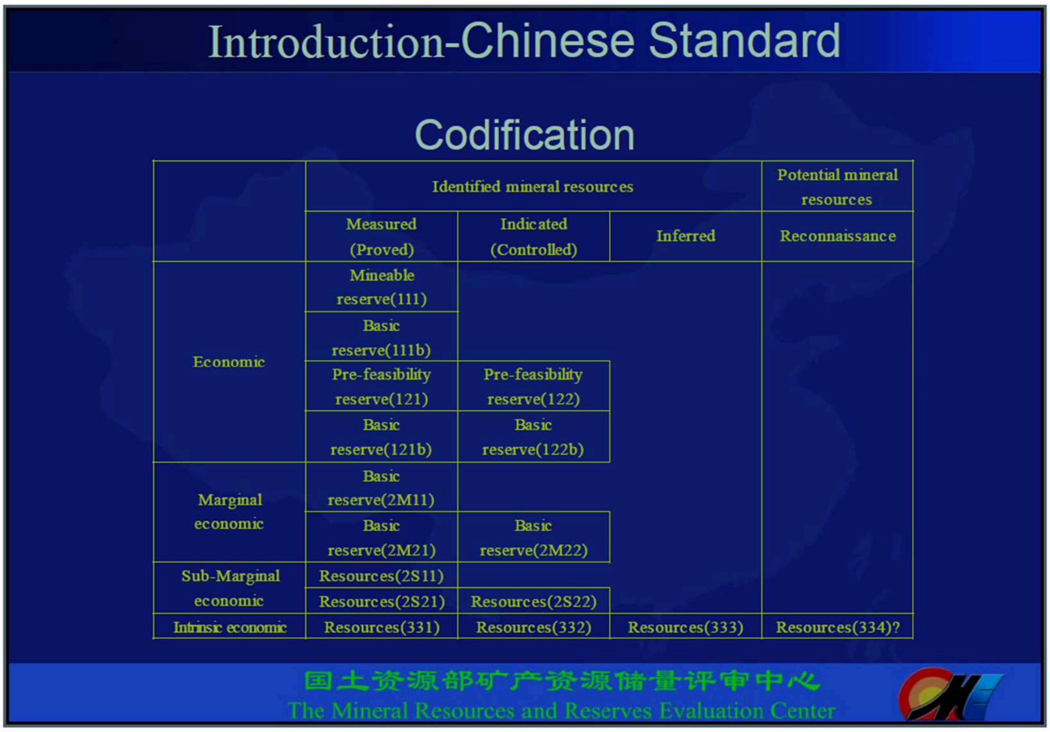
Size/shape groups are:

- Group 1 deposits - Large deposits that are simple and uniform distributions of minerals. Examples are coal, iron, disseminated copper deposits. They are easy to define.

- Group 2 deposits - Large deposits with sometimes complicated and uneven distribution of minerals. Examples are iron and sedimentary copper deposits. B category reserves can be defined by normal drilling. Additional underground work may be necessary to define the reserves. Category A reserves require close spaced drilling and underground workings.
- Group 3 deposits are smaller sized deposits with uneven distributions. Some examples are venous deposits, skarns, dykes, and pegmatites. Due to the complexity, C1 reserves need drilling and B reserves need additional underground work.
- Group 4 deposits are smaller sized deposits similar to Group 3 deposits that have more complex shapes. Drilling and underground workings are necessary to establish category B reserves.
- Group 5 deposits are small pocket deposits. Category A and B reserves cannot be established. Only category C reserves can be established.

2.5.6 Chinese System

The current Chinese State Mineral Resource and Reserve System is based on the UNFC classification. There is not a complete overlap between CRIRSCO categories and the UNFC categories, but the G1, G2 and G3 categories are almost equivalent respectively to Measured, Indicated and Inferred categories. The following chart shows the Chinese standard.



	Identified mineral resources			Potential mineral resources
	Measured (Proved)	Indicated (Controlled)	Inferred	Reconnaissance
Economic	Mineable reserve(111)			
	Basic reserve(111b)			
	Pre-feasibility reserve(121)	Pre-feasibility reserve(122)		
	Basic reserve(121b)	Basic reserve(122b)		
Marginal economic	Basic reserve(2M11)			
	Basic reserve(2M21)	Basic reserve(2M22)		
Sub-Marginal economic	Resources(2S11)			
	Resources(2S21)	Resources(2S22)		
Intrinsic economic	Resources(331)	Resources(332)	Resources(333)	Resources(334)?

Figure 6 Chinese Method of Mineral Evaluation Source: (Micon, 2019)

2.5.7 Yugoslav System

Of more significance to the purpose of this paper, the Trepca reserves and resources are reported in the Yugoslavian system. The Soviet Classification was taken as a model for the Yugoslavian Classification System which was then inherited by Serbia and Kosovo. The Classifications and Regulations) are similar. For example, in the Yugoslavian system the "Reserves" are classified into A, B, C1, C2, D1 and D2 Categories and in the Soviet system into A, B, C1, C2, P1, P2 and P3 Categories with the D categories being forecast as the Soviet P Categories are.

Russian "Balance Reserves", with consideration of all MODIFYING FACTORS, **and after any adjustments for MINING LOSSES and DILUTION**

Complexity Group	CRIRSCO category of Mineral Reserves			
	C2	C1	B	A
1	PROBABLE	PROVED	PROVED	PROVED
2	PROBABLE	PROVED	PROVED	no
3	PROBABLE	PROVED	no	no
4	PROBABLE	PROBABLE	no	no

Based on level of geological knowledge. Includes Russian "off-balance" material provided there are reasonable prospects for eventual economic extraction

Complexity Group	CRIRSCO category of Mineral Resources			
	C2	C1	B	A
1	INDICATED	MEASURED	MEASURED	MEASURED
2	INDICATED	MEASURED	MEASURED	no
3	INDICATED	MEASURED	no	no
4	INDICATED	INDICATED	no	no

Figure 7 Comparison between Russian and CRIRSCO System (Micon, 2019)

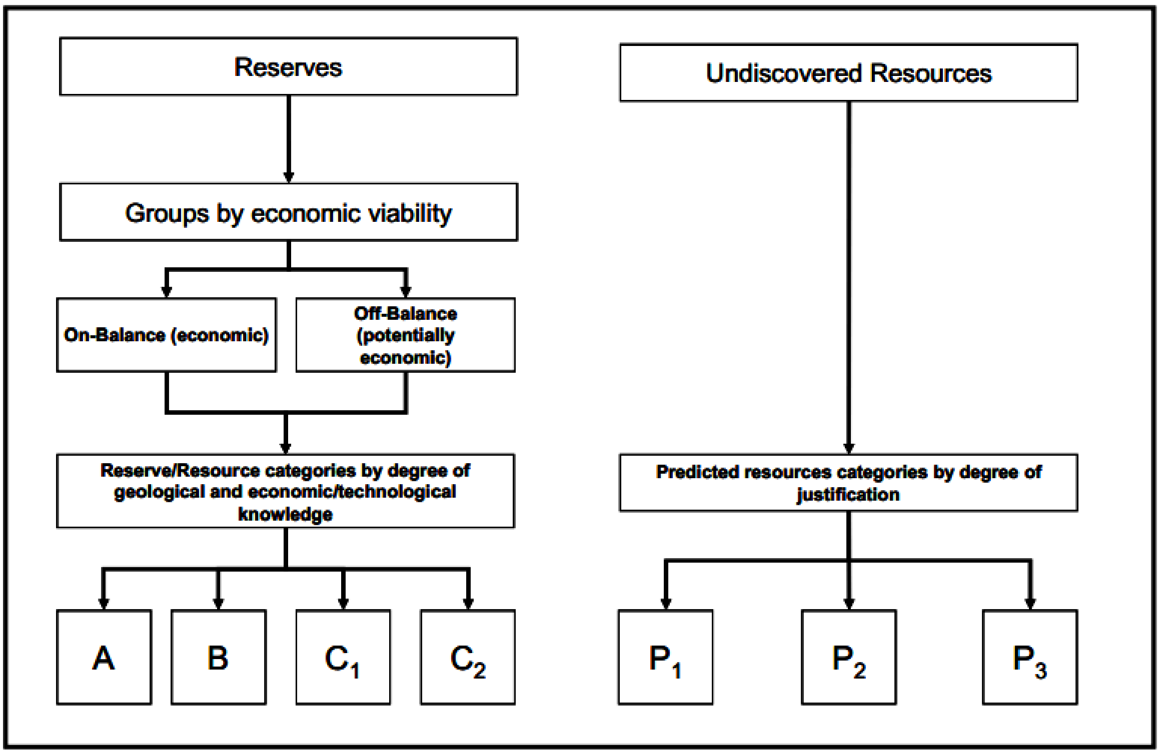


Figure 8 Process of Russian and Yugoslav Evaluation Methods (Farmer, 2014)

A chart showing the differences and similarities between all of the various systems is below:

CRIRSCO (JORC/CIM/ PERC/ NAEN)	Resource			Measured	Indicated			Inferred		Exploration Potential or Exploration Target
	Reserve			Proven	Probable					
Russian State Classification	Reserve			A, B and C1	B, C1 and C2			C2 and P1		P2 and P3
UNFC-2009 (Chinese and Indian Classification)	"E"	Economic Evaluation (100)	Designed Mining with loss	Recoverable Reserve (111)	Probable Recoverable Reserve (121)		Probable Recoverable Reserve (122)			
			Designed Mining without loss							
		Marginal Economic (2M00)		Basic Reserve (2M11)	Basic Reserve (2M21)		Basic Reserve (122b)			
		Sub-Economic (2S00)		Resource (2S11)	Resource (2S11)		Resource (2S22)			
		Intrinsically Economic (300)				Resource (331)		Resource (332)	Resource (333)	Resource (334)
	"F"	Feasibility Evaluation		Feasibility (101)	Pre-Feasibility (020)	Scoping (030)	Pre-Feasibility (020)	Scoping (030)	Scoping (030)	Scoping (030)
	"G"	Geological Evaluation		Measured (001)			Indicated (002)		Inferred (003)	Predicted (004)

Figure 9 Comparison Chart of Economic Evaluation Systems (Micon, 2019)

2.5.8 PERC Code

Additionally, there is another standard called “Pan-European Standard for Reporting of Exploration Results, Mineral Resources and Reserves”, or PERC (AlicjaKrzemień, PedroRiesgo Fernández, AnaSuárez Sánchez, IsidroDiego Álvarez, 2016). This is discussed as an additional standard for representation on European Stock Exchanges in a similar manner to the other standards. It was developed in 2006. Its main purpose is to develop a European standard for public reports about exploration results, mineral resources and mineral reserves. The Pan European Reporting Standard has its roots in the work in the UK by the Council of the Institute of Mining and Metallurgy (IMM) in 1991. They developed definitions for resources based on the listing rules for the London Stock Exchange (LSE).

The PERC standard could be used for the reporting of the reserves and resources of the Trepca. It is designed for the reporting of European commodities listed on the LSE. However, as stated above, the current format for the information is the Yugoslav/ Russian format.

2.5.9 Proposed International Models

There has been much work done to harmonize reporting standards for mineral reserves. In 1994, The Committee for Mineral Reserves International Reporting Standards (CRIRSCO) was created. Its purpose was the alignment of national minerals reporting codes. CRIRSCO published a template in 2006 which was updated in May 2013. The template aligns national reporting codes by harmonizing the definitions, classification, and estimation processes and the public reporting of exploration results, mineral resources and mineral reserves (Njowa,G., Clay, A.N., Musingwini, C. , 2014). The definitions were agreed in principle at the CRIRSCO meetings on 22 and 23 October 2012 in London. CRIRSCO Standard Definitions were published in October 2012. They have been incorporated in the International Reporting Template of CRIRSCO which was issued in November 2013. The definitions have also been included in the Codes and Standards of most of the CRIRSCO Members in their own updates.

Current CRIRSCO (CRIRSCO, 2020) members along with the relevant codes are:

- Australia and Australasia – JORC Code (2012)
- Brazil – CBRR Guide
- Canada – CIM
- Chile and Peru- Commission Minera de Chile (2004) Certification Code for Exploration Prospects, Mineral Resources and Ore Reserves
- Europe and United Kingdom – PERC Code
- India – NACRI Code
- Indonesia – KCMI Code
- Kazakhstan – KAZRC – Kazakhstan Reporting Code
- Mongolia – MPIGM Code (2014)
- Russia – OERN Code
- South Africa – SAMREC (2016)
- Turkey – UMREC Code
- United States – SME Guide for Reporting Exploration Results, Mineral Resources, and Mineral Reserves

IMVAL released a draft “Template” in May 2015 and revised it in 2017 (IMVAL, 2017). The draft provides a set of standards and guidelines to evaluate mineral assets, or mineral properties). The intent was to be recognized internationally as a reference for national code or national standards development. It had also (as of July 2016) released a second edition of the same document which also includes Petroleum as part of the standards.

The IMVAL Template contains a consensus of current best practices which they recommend as a basis for national codes or standards. It is expected to be updated from time to time. The IMVAL

Template does not stand-alone as an international reporting code, but is intended to influence and complement national codes or standards. However, it still only addresses the 3 main codes and does not address any others and appears to be independent of CRIRSCO.

2.5.10 UNFC Classification

The United Nations Economic Commission for Europe (UNECE) worked on developing their own reporting system starting in 1997. It is called the United Nations Framework Classification for Fossil Energy and Mineral Resources (UNFC). The new system was approved and the most recent update was in 2009.

The UNFC classification is a generic, principle-based system. It uses three criteria. They are Socio-economic viability (the E gradient), Project Feasibility (the F gradient), and Geological Knowledge (the G gradient) Combinations of these criteria create a three-dimensional system This is shown in the following figure.

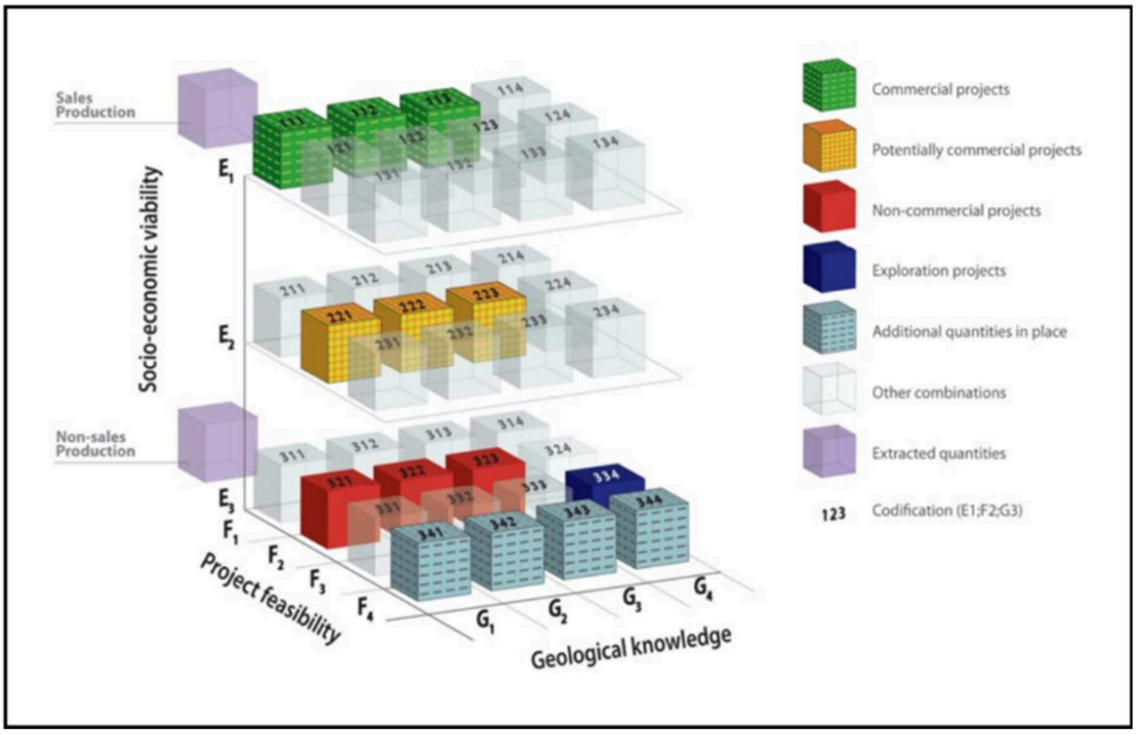


Figure 10 UNFC System (UNECE, 2019)

While all of the systems include an economic viability component, the UNFC system is the only one, at this time, to include a social viability component, it must be remembered that the UNFC system is not a reporting system as the others are. The UNFC system is not a reporting tool. There is no method to certify the analysis and it also includes undiscovered and uneconomic materials. It is intended to be a generic classification framework for solid minerals, oil, and gas in addition to being an important tool for global and governmental communication (Bankes, 2013).

3 Trepca

3.1 Kosovo Tectonic Structure

Kosovo has a varied and complex geology. The ages range from the Neo-Proterozoic to the Holocene. The geology is complicated by many large structural features on a regional scale. Some of these include normal faulting and thrusting. A simplification of the sequence, from youngest to oldest, is as follows.

- Holocene: scree from weathering of mountains and alluvium deposits.
- Pliocene: andesitic chert.
- Upper Miocene-Pliocene: formation of lignite in sedimentary basins.
- Oligo-Miocene: conglomerates, clays and limestones, including acidic to intermediate magmatism.
- Late Cretaceous: shallow-water carbonates and clastic deposits.
- Upper Cretaceous: marly limestones, sandstones and conglomerates.
- Early Cretaceous: conglomerates, sandstones and silts.
- Late Jurassic: massive limestones.
- Triassic-Jurassic: basic and acidic magmatism, along with ophiolitic crustal rifts and obduction of ultrabasic rocks.
- Triassic: clastic flows with volcanic structures ceding to carbonate platforms, then converting to dolomites and marbles.
- Perm-Triassic: carbonates, clastic, phyllite, schists and quartzite with invasive acidic magmatism (quartz porphyries).
- Late Paleozoic: schists.

Neo-Proterozoic-Paleozoic: basement of schists, gneisses and amphibolite with invasive granitic plutons. (Kosovo Commission for Mines and Minerals, 2019).

3.2 Geophysical Interpretation of the Vardar Region

Kosovo divides into two geologic halves. These are the Vardar Zone to the east and the Drenica (Drina – Ivanjica)/Korabi – Pelagonian Zone to the west. The dividing line runs NNW-SSE between the Dardania massif (Serbo-Macedonian) in Kosovo and the Dinaric Geological Belt of Albania. There is a Mesozoic fault zone called the Shkoder-Peje lineament, that divides the Drina and the Korabi into two separate zones. The Vardar Zone is economically important as it hosts the Trepca lead-zinc-silver deposits which is the topic of this paper. These deposits vary from carbonate-hosted skarns and karst fillings to vein deposits (Kosovo Commission for Mines and Minerals, 2019).

The Mesozoic limestone is faulted in many different directions. The limestones have precipitated metals out in favorable areas from mineral rich brines that have percolated through the rock. The origin of the Vardar Zone is unclear. It may have originated either as part of the Paleo-Tethys that separated Gondwanaland from Eurasia or in the Triassic Period similar to the present-day Red Sea oceanic basin (Kosovo Commission for Mines and Minerals, 2019).

The geologic closure of the Vardar Ocean is unknown. It may have occurred in either the Cretaceous or Early Tertiary periods. The formation of the ophiolites due to ocean closure and thrusting is significant for the creation of deposits of chromite. The serpentine rocks break down under weathering o produce accumulations of bauxite and lateritic nickel. Bauxite deposits in Kosovo are hosted in karst limestone (Kosovo Commission for Mines and Minerals, 2019).

The Vardar zone was defined by Kossmat (Kossmat, 1924) as a wide zone (Vardar-Tethyan mega-suture) that not only comprises remnants of oceanic lithosphere (obducted ophiolites), but also parts of ancient Gondwana. He restricted its occurrence, however, to southern Serbia, Macedonia, and Northern Greece. The Ophiolites are stratified igneous rock complexes composed of upper basalt member, middle gabbro member and lower peridotite member. Some large complexes measure more than 10 km thick, 100 km wide and 500 km long. The ophiolitic chemistry of Kosovo more closely resemble the lavas of island arcs than that of mid-ocean ridge rocks. Dating studies have found that many ophiolites were pushed onto the continent only a few million years after they formed.

The geophysical development of the Vardar region is considered to be complex with many interpretations, some of which are competing theories. Robertson and Karamata, (Robertson, A.H.F., Karamata, S., Sari, 2009) who have written extensively on the region, consider the Balkan ophiolite belts evolving from different oceanic realms. They are commonly known as the Dinaric, West Vardar and East Vardar. They also assume that the Paleozoic formations in between the ophiolite belts (Drina, Ivanjica, Jadar, and Kopaonik) are from ancient microcontinents. Schmid (Schmid, 2008) strongly argues that most Balkan ophiolites were formed by uniform subduction over the passive margin of Adria. They believe that there was a single ocean, the Neotethys, which presumably originated from mid-Triassic intracontinental rifting. Both Robertson/ Karamata and Schmidt agree that the East Vardar Zone, attached to the western-side of the Serbo-Macedonian Massif (SMM), displays singularly identifiable and distinguishing characteristics of tectonic and mineralization processes. These ophiolites are universally known as the East Vardar Zone (EVZ).

A different group of geoscientists, Petrovic, et al (Petrovic, Dragana , Vesna Cvetkov, Ivana Vasiljevic, ´ Vladica Cvetkovic, 2015), try to clear this up with additional information. In their paper, they argue that the creation of the EVZ ophiolites was related to accretion/underthrusting and it was a very different process than the emplacement of the other Balkan Ophiolites. They support this by mantle xenolith studies and studies of lamproitic lavas, which they say the studies indicate that at least parts of the mantle underneath the Tethyan Mesozoic suture are compositionally more similar to oceanic supra-subduction mantle. They also propose two possibilities that could explain their assumed eastward dipping of the EVZ. In the first case, it is possible that the location of the EVZ was related to eastward obduction, followed by re-thrusting of ophiolites under the Serbo Macedonian Massive. Int the second case, the EVZ is the easternmost parts of the Tethyan oceanic crust. This crust was then uniformly obducted onto the Adria passive margin, collided and was partly overridden by the European continent.

The Dinarides, the Vardar Zone, the Serbo-Macedonian Massif, and the Carpatho-Balkanides and the Pannonian Basin are all incorporated into the Tethyan-Eurasian Metallogenic Belt. Kosovo is somewhat seismically active because of the Alpine- Himalaya Orogenic Belt. Records show that the region experiences a lot of earthquakes. During the period from 1970 to 1990, 25 have been of 5 or greater on the Richter scale (United Nations, 2009). This is significant as the Richter scale is logarithmic.

3.3 Geology of the Vardar Region

The geology of the Vardar region is very complex. Vladica Cvetkovic (Cvetlovic, 2016) that the South Eastern European region geology comes from from the what he describes as the Vardar Tethys ocean. This is different than the Neo-Tethys above. He agrees that the geological development of the Vardar Tethys is still debated. He also states that many authors think that the Vardar Tethys Ocean was still open in the Late Cretaceous. A minority still believes that the closure was earlier in Upper Jurassic/Early Cretaceous times.

The Vardar Zone is between the Serbo-Macedonian Massif (SMM) and the Dinarides. In the east, the SMM is
superposed over the Vardar Zone. The west side of the Vardar Zone is thrust over the Pelagonian Massif/the Dinarides. The Vardar Zone is made up of a number of different formations such as small blocks of crystalline schists, Carboniferous Veles Beds, Jurassic ultramafics, Triassic sediments,

diabase-chert formations, Jurassic granitoids, Lower and Upper Cretaceous flysch and Tertiary calc-alkaline volcano-intrusive complexes (Jelenković, August 2008).

A more comprehensive geologic map of the region is shown below. It is a tectonic sketch-map of the Dinaric-Hellenic Belt.

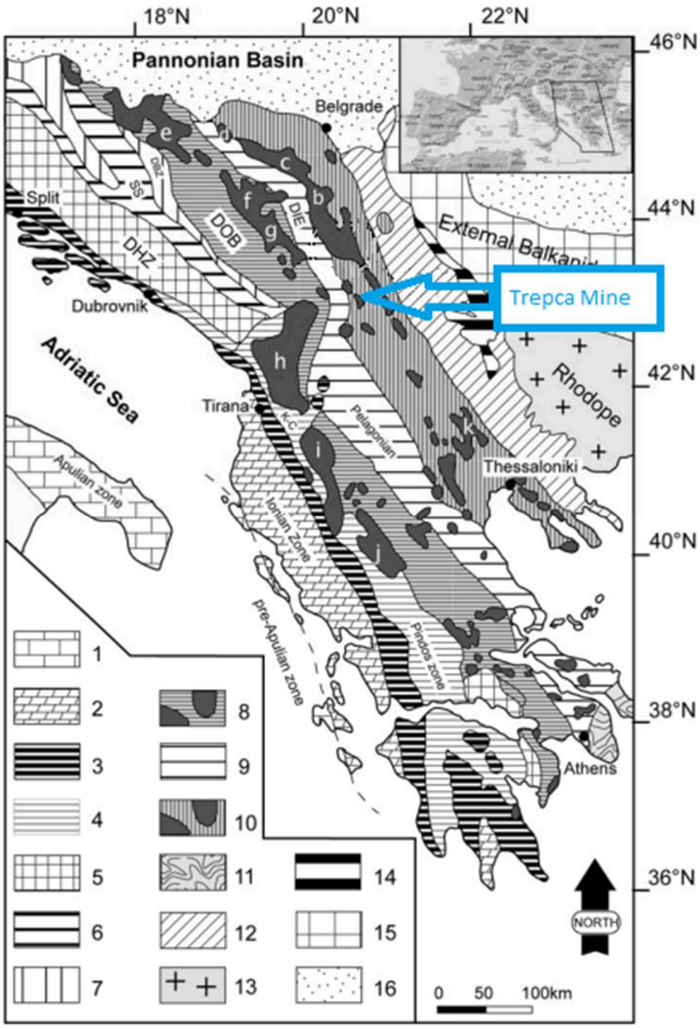


Figure 11 Tectonic Map of the Dinaric-Hellenic Belt

Legend and abbreviations:

1. Apulian and Pre-Apulian Units
2. Ionian Units
3. South Adriatic Units: Kruja, Gavrovo and Tripolitsa
4. Budva, Krasta-Cukali (K-C) and Pindos Units
5. Dalmatian-Herzegovian (DHZ) Units
6. Sarajevo-Sigmoid (SS) Unit
7. East Bosnian-Durmitor Unit (DBZ)
8. Dinaric Ophiolite Belt (DOB, dark grey: ophiolites)
9. Drinalvanjica and Pelagonian Units (DIE)
10. Vardar Units (VZ, dark grey: ophiolites)
11. Lavrion Blueschist Unit
12. Internal Dinarides and Hellenides
13. Rhodope Massif
14. Internal Balkanides
15. Intermediate and External Balkanides
16. Pannonian and Tertiary European Foreland basins.

Ophiolites

a. Ibar
b. Troglav
c. Maljen
d. Zvornik
e. KrivajaKonjuh
f. Zlatibor
g. Bistrica
h. North Mirdita
i. South Mirdita
j. Pindos
k. Guevgueli.

3.4 Trepca Geology

The Trepca complex, including processing facilities, is located in the Vardar Zone in Kosovo and Serbia. The following map shows the approximate location of Belgrade, Pristina, and Mitrovica as references (green marks), Stantërg, Crnac, and Belo Brdo (Red marks) along with other mines and facilities in the region.

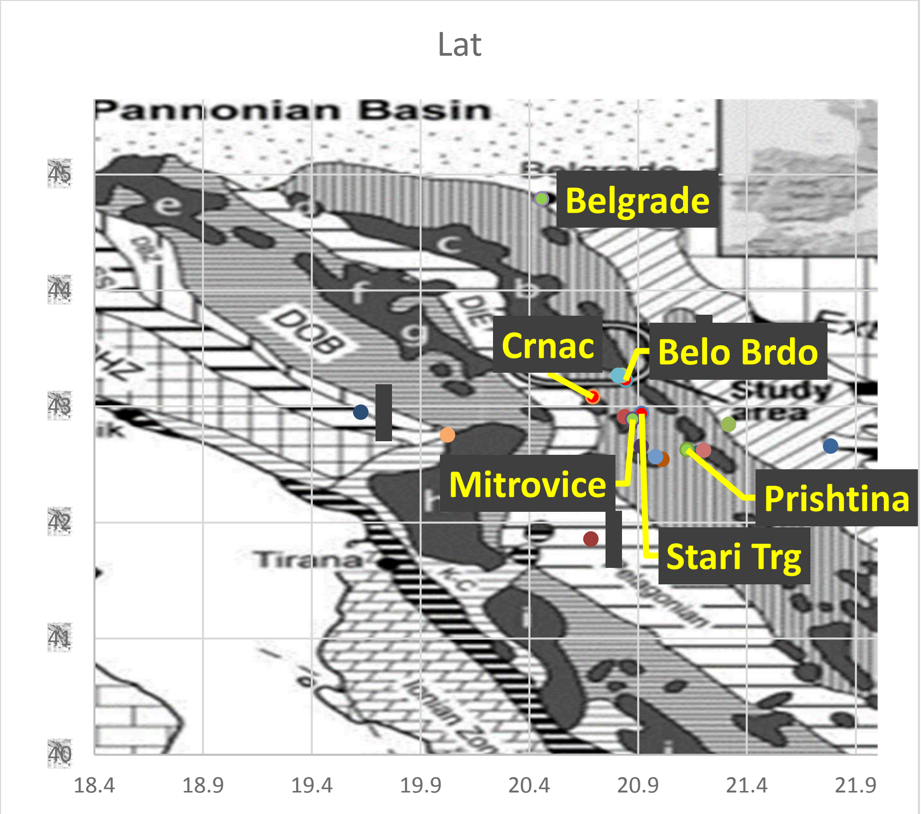


Figure 12 Map of Mines and Facilities

The Trepca mines within the Vardar are of a carbonate-replacement and vein-type lead-zinc mineralization. The mineralization is related to the Neogene andesite-latite volcanics and intrusives in the region (Mining Journal, 2005). As discussed earlier, the structure of the geology, and the Trepca Belt, are dominated by NNW-SSE trending structures. Some SE overthrusts are post-Oligo-Miocene in age while others are older (Trepca Kosovo Under UNMIK Administration, 2005). The key mines, and a simplified geologic structure are shown on the following map:

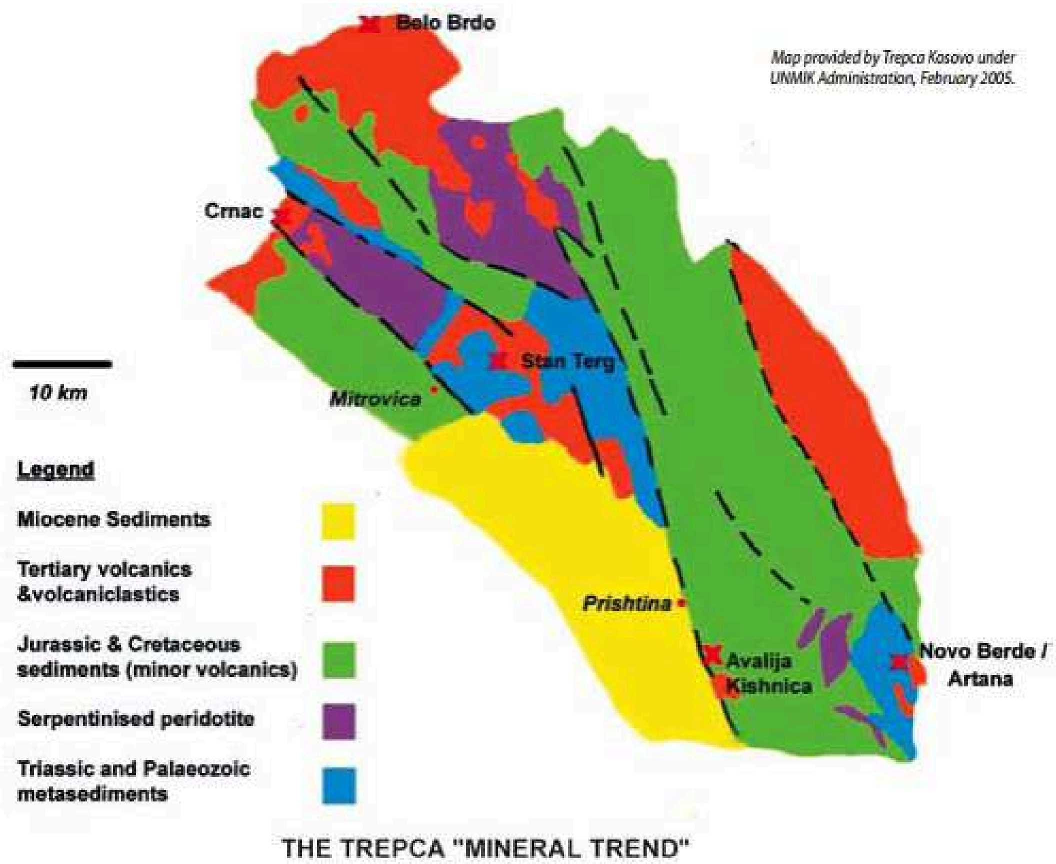


Figure 13 Source: Mining Journal (Mining Journal, 2005)

The Stantërg mine is, as mentioned above, a carbonate replacement deposit type. It is located at the south edge of Kopaonic massif. The Stantërg mine is is composed of Paleozoic and Triassic metamorphic rocks and ophiolites. The mineralization is mostly Upper Triassic limestones covered by schists. The ore bodies were formed within the carbonates or at the contact between carbonates with schists and a volcanic pipe, and have a lenticularly-elongated, columnar-like shape. Skarn minerals such as hedenbergite (a rare iron rich pyroxene) and ilvaite (a iron/ calcium sorosilicate) are present in some of the ore bodies that aer near the volcanic pipe. The principal minerals that are recovered are galena, sphalerite, pyrite, pyrrhotite, arsenopyrite, boulangerite, and chalcopyrite (Kołodziejczyk, 2016).

The Stantërg mine, which is one of the important and productive mines in the region, has a steep dip from the east to the west of about 40 degrees as is shown in the following figure.

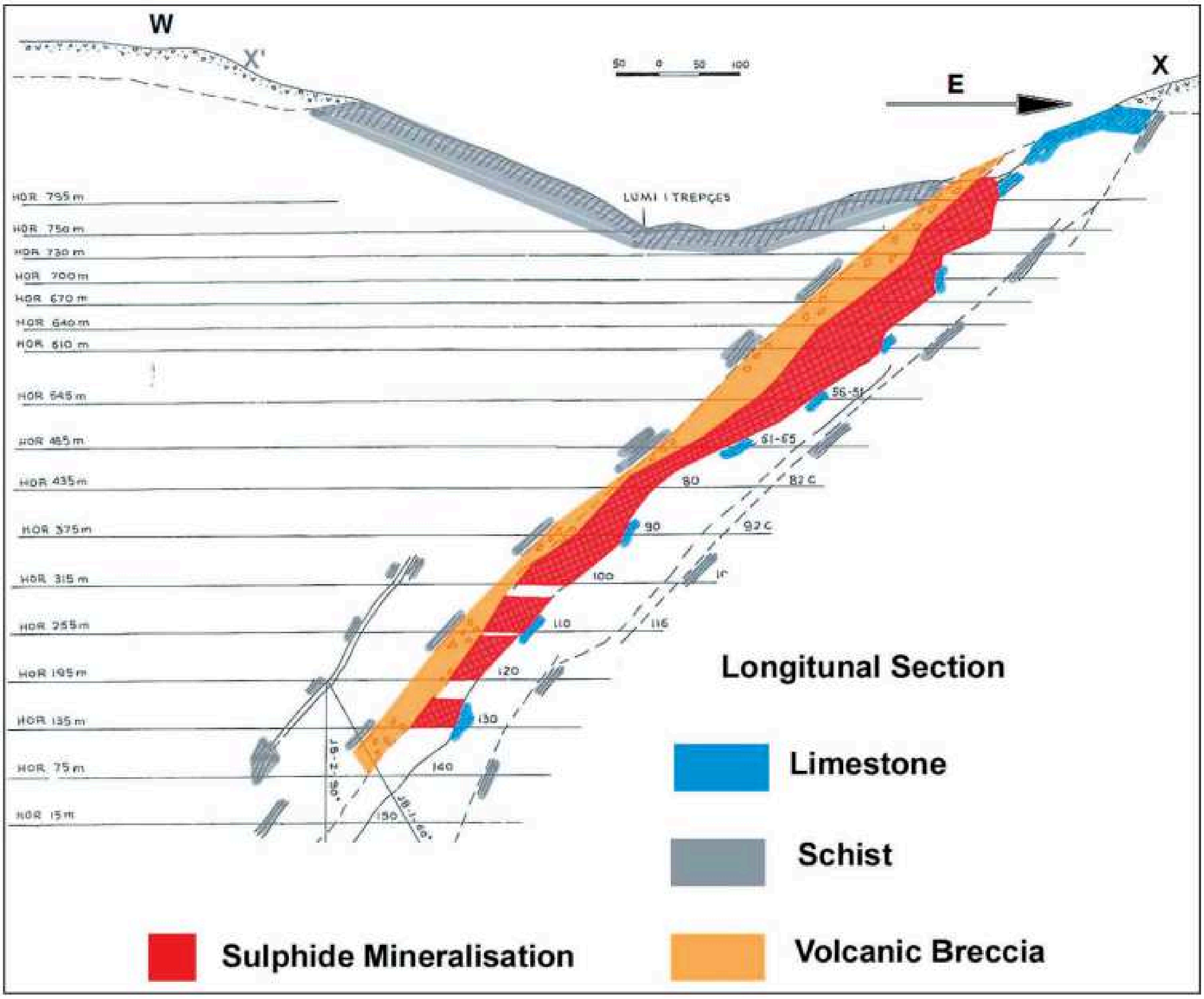


Figure 14 Mine Cross Section (Feraud, 2009)

The Trepca is a convex upward formation. The cross section above shows the mineralization, the contact with the volcanic intrusion, and the contact with the limestone. The mapping of the formation and mine was started by Titcomb and Forgan in 1936. It was completed by the geologist of the mine, Til Maliqi, in 2001 (Feraud, 2009)

A more recent report (2009) indicates that there may be more than just the traditional Pb-Zn-Ag minerals that are of interest. Selected results from the report are shown in the following table. The run of mine values for 2007 appear to be higher than the actual historical production numbers for lead and zinc but this could be explained by selective sampling as the production records for the previous years do not support such a high value. The metals that have a potential and economic interest in recovery are highlighted. Arsenic concentrations are not considered.

Element	Unit	Run of Mine 1948	Run of Mine 2007	Zn Concentrate 1999	Zn Concentrate 2006	Zn Concentrate 2007	Pb Concentrate 2006	Tailings
S	%	28.93	23.8	32.8	31.6	32.6	17.7	12.1
Pb	%	7.12	3.55	3.71	2.88	1.16	74.3	0.374
Zn	%	5.5	3.65	46.79	46.8	46.2	1.17	1.29
Ag	g/ T	85.8	70		66	37	1260	10
As	g/ T	5100	5430	400	2970	760	2850	5020
Au	g/ T	<0.2	0.195		0.14	0.066	0.349	0.21
Bi	g/ T	87	80	100	184	92	1300	60
Cd	g/ T	200	168	2300	2090	2220	72	52
Cu	g/ T	800	1172	2700	6420	5000	4740	468
In	g/ T		6.8	<20	45	70	1.4	3.3
Te	g/ T		<1	<20	4.5	<1	19	<1
Ti	g/ T		<1	<20	0.8		4.9	
Mo	g/ T		12		60	48	120	8
Sn	g/ T		36	50	84	200	120	20
W	g/ T		104		72	<10	<10	64

Table 3: Mine and Tailings Concentrations (Feraud, 2009)

Mineralization in the Artana deposit, shown in Figure 12, is hosted in Paleozoic and Cretaceous crystalline limestone sediments at the contact with gneisses, amphibolites, and Tertiary volcanic rocks. The mineralization is dominated by galena, sphalerite, and pyrite.

The Kizhnica deposit, shown in Figure 12, contains mostly Neogene andesites, Paleozoic and Mesozoic magmatic, metamorphic, sedimentary rocks and Pliocene sediments. The mineralization occurs at the contact zone between a serpentinite complex and a Lower Cretaceous flysch close to the volcanic rocks. The ore bodies have irregular shapes: veins, lenses, or impregnations. The hydrothermal mineralization is sulfides, including three generations of galena and sphalerite, sulfosalts, carbonates, and quartz.

The Drazhnje deposit, located in north-east Kosovo, close to the Batlava Lake, is in the western margin of the Lece massif and is composed of Mesozoic-Early Tertiary age andesite-dacite volcanics and pyroclastics. The mineralization is mostly hydrothermal-metasomatic. The main ore minerals are sphalerite, boulangerite, galena, pyrite (iron sulfide with a cubic crystal structure), and marcasite (iron sulfide with a orthorhombic chrystal structure). About 4 million tonnes of Pb-Zn ore with Pb + Zn content above 6% has been documented (Kołodziejczyk, 2016).

Some more recent studies have indicated there are other elements in the mines and surrounding areas. Bedri Durmishaj shows that there are, in addition to the known metals of lead, zinc, and silver, and gold, there are also indications of iron, bismuth, and antimony at the Hajvalija and Artana mines although these are in solid solution and not economically recoverable at this time. He does not indicate if these are economic quantities. He does state that the Galena of the Hajvalija mine contains more silver (> 100g/t Ag) than the other mines sampled (Durmishaj, 2016).

Also, as the ore is processed, the metals go to different concentrates. The indium and cadmium go to the zinc concentrate and the silver, gold, arsenic, molybdenum, and tin go to the lead concentrate. If there is not enough metal to justify recovery the mine is charged for contaminants. Indium has been traditionally difficult to recover from the zinc. If there is not enough metal to justify recovery the mine is charged for as contaminants.

According to the Mining Strategy of Kosovo, the active mines are Stantërg (Stari Trg), Hajvalia, Badofci, Kizhnica, Artana, Bellobërda (Belo Brdo) and Cërnaci(Cernac).

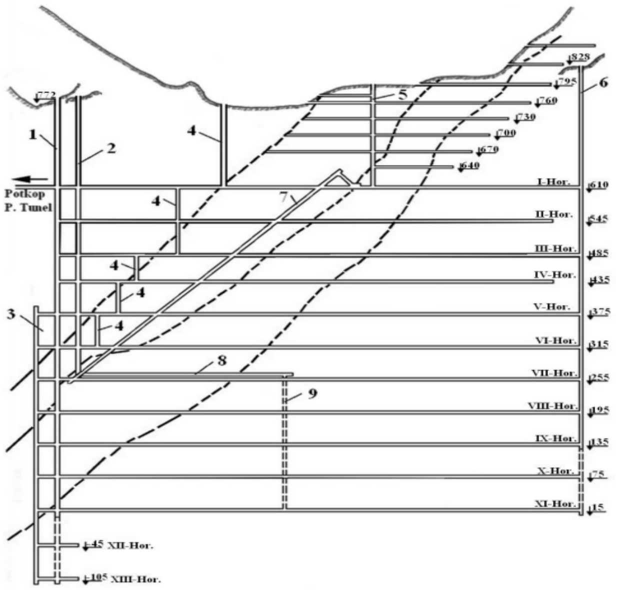
In addition, the Mining Strategy also lists a number of "presences and resources"It is important to note that not all of the listed sites are economic. These are shown in the following table:

Area	Presence or Resource Name
Stantërg	Melenica, Zjaqa, Magjera, Gjidoma, Tërstena, Rashani, Vidishiqi, Mazhiqi, Gumnishta
Southeast of Podujevës	Quka e Batllavës
Artana	Kaltërina e Përroi I Ngjyrosur
Northern Kosovo	Kallugjerica, Gomile
Southwest of Mitrovica	Cërpulë

Table 4: Presences and Resources (Ministry of Economic Development, 2012).

3.5 Trepca Mining and Processing

The Trepca mine is an underground lead-zinc mine. The vertical section of the mine is shown in the following figure.



Legend:

1- Main Extraction Shaft:

2- New Ventilation Shaft:

3- Blind Shaft:

4- Old Ventilation Shaft:

5- Old Extraction Shaft:

6- Service Shaft:

7- Downcasts No.1, 2, 3 and 4:

8- Ventilation Corridor: - Newly Designed Ventilation Shaft,

Figure 15 Vertical Section (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA – SEVER CONGLOMERATE (PART II), 2017)

According to Nicolić, here are 2 different mining methods used at the mine. They are:

- Horizontal square set stoping with stowage and safety pillars (level I through IV)
- Horizontal roof stoping with stowage and safety pillars (level V and below)

Additionally, Nicolić states that all mining below level VII is done without a safety slab.

According to information released by the Kosovo Trust Agency, the method of mining is stated as “cut and fill”. This is the type of mining that is used in the economic model.

The processing of the ore was divided into different labor units (Basic Organization of Associated Labour or Osnovna Organizacija Udruženog Rada in Serbian, abbreviated OOUR). They were:

- Mine and Flotation Trepca – Stantërg
- Mine and Flotation Kišnica and Novo Brdo – Priština
- Mine and Flotation Kopaonik – Leposavić
- Mine and Flotation Lece – Medveđa
- Mine Rudnik – G.Milanovac
- Mine and Flotation Blagodat – Vranje

The typical process for the beneficiation of the lead-zinc ore is shown in the following diagram.

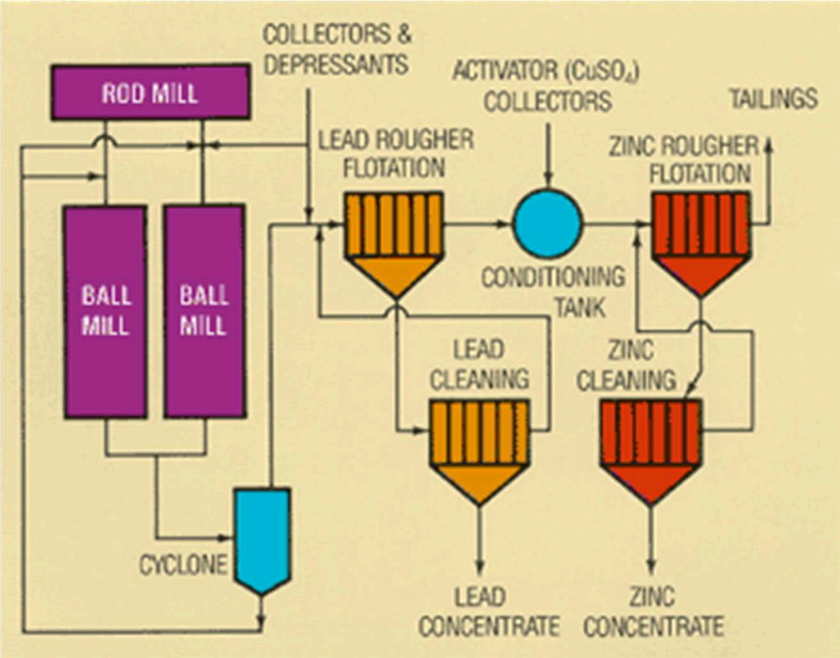


Figure 16 Generic Lead Zinc Processing (CP Chemicals, 2019)

To create a concentrate, the ore is crushed and then mixed with chemicals and put in a tank with a mixer to create a froth or foam that allows the desired mineral, either zinc or lead in the case of Trepca, to float to the top. The froth is then removed, or skimmed, to recover the mineral(s). In this process, the silver in the ore typically is recovered with the lead.

The ore from the Stantërg was originally processed in Zvečan, about 12 km away from the mine. After grinding, the flotation for lead minerals used the Sheridan-Griswold cyanide method in a basic environment at pH of between 8.5 to 8.8. The flotation process was carried out in mechanical flotation machines with 16 cells with each cell 1.08 m^3. These cells were manufactured by Denver-Fahrenwald. Flotation of zinc minerals was also carried out in the basic environment but the pulp had a pH value of 10 to 11. The flotation process was, again, in mechanical flotation machines with 16 cells also manufactured by Denver-Fahrenwald. (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA – SEVER CONGLOMERATE (PART II), 2017). The Sheridan-Griswold method, as mentioned above, uses a cyanide reagent to depress iron sulfides (Fuerstenau, Maurice C., Ed., 2007).

When the processing for the Stantërg was built in the 'First Tunnel' or Tunel I Pare, the processing in Zvečan was abandoned and the site was dismantled in 1996. During the operation of the plant at Zvecan, it had a capacity of 3,500 Tons per day of ore and also had a facility to magnetically concentrate pyrrhotite with a capacity of 1,500 tons per day (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA – SEVER CONGLOMERATE (PART II), 2017). The design capacity for processing for the ore in Tunel I Pare was 1 million tons of ore per year. Based on my visit to the processing plant, it appears that the plant is 5 separate lines of about 200,000 tons per year of capacity each.

The plant at Tuneli I Pare, which is between the mine and Zvecan, is a conventional design lead/zinc concentrator built in the 1970's. Ore is received by 10 T cars from Level 1 (610 m) and tipped directly into the primary gyratory crusher. The crushed product falls into 120t bin that is then fed to a 1,000t coarse ore bin or to 2 x 2,500-ton storage bins. An apron feeder, equipped with magnet and metal detector, feeds a 40mm vibrating screen. Screen oversize is gravity fed to a secondary cone crusher. Screen undersize and crusher product go to a 20mm vibrating screen. This screen oversize is gravity fed to a third cone crusher. This crushed product and the 20mm screen undersize go to 12 mm screens. Screen oversize is returned to the third crusher and screen undersize goes to the fine ore bin. The ore from the fine ore bin flows to two overflow ball mills. They are operating closed circuit. The ore feed rate to each ball mill is 60 – 65 t/h. Each overflow is delivered to a separate conventional lead/zinc flotation circuit. The normal particle size for flotation is 0.35 mm to 0.25 mm.

Zinc sulphate and sodium-cyanide are added to depress the zinc and lead is floated using a xanthate as a collector and alcohol as a frothing agent. The rougher concentrate goes through three stages of cleaning and cleaner tailing. The first scavenger concentrate goes to a pre-cleaner stage. The pre-cleaner concentrate goes to the first cleaners and pre-cleaner tailing returns to the lead conditioners. The scavenger concentrate is returned to the head of the scavenger circuit. Lime is added to change the pH of the tailings from lead flotation by raising it and depressing the pyrite.

Zinc is reactivated with copper sulphate then xanthate and frothing agents are added and used to float the zinc. The zinc flotation circuit is similar to the lead circuit but has more cells. Lead and zinc concentrates are thickened, vacuum disc filtered, then conveyed to a bunker. From the bunker they are loaded onto trucks.

The tailings from the zinc flotation are pumped to hydro-cyclones. The underflow goes to two banks, each containing three wet drum, low intensity, magnetic separators. The cyclone overflow goes directly to the tailing pumps.

The magnetic products are gravity fed to the pyrrhotite thickener and then to a vacuum disc filter. The non-magnetic product is pumped to a hydro-cyclone in front of the pyrite flotation circuit. The pyrite flotation circuit is similar to the lead flotation circuit. The pH is lowered, xanthate and copper sulphate are used for floatation. The pyrite is thickened, filtered on vacuum disc filters, and conveyed to a stockpile. Tailings from the pyrite circuit are pumped to the sand-fill hydro-cyclones. The overflow goes from the cyclones to the tailings pond at Zarkov Potok by pumping. The underflow goes to two storage tanks, then to the high-pressure sand-fill pump, then underground to the mine as backfill (Trepca Kosovo Under UNMIK Administration, 2005).

According to the Summary Description of Trepca, the throughput has never exceeded 750,000 tons. The plant has been refurbished somewhat and the current capacity of the plant, as refurbished, is approximately 400,000 tons of ore per year (Trepca Kosovo Under UNMIK Administration, 2005).

There are 3 older tailings locations. They are along the Ibar river and are Gornje Polje, between Topionica and Kosovska Mitrovica, and Žitkovac, which is 44pprox.. 1.5 km from the Zvečan plant site. The Gornje Polje site was active between1932 and 1962, covers approximately 20.2 hectares, and contains 12 million tons of tailings. The Žitkovac site is approximately 1.5 km from the Zvečan floatation location. It was active from 1962 to 1974, has a surface area of 10.5 hectares, approximately 8.5million tons of tailings. According to Nikolić, the tailings contain '14-25 % Fe; 8-12 % S; 18-30% SiO2; 0.3-0.4 % Pb, 44pprox.. 0.3 % Zn,etc.' (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA – SEVER CONGLOMERATE (PART II), 2017).

The current site for tailings is Žarkov Potok. This site is for the tailings from the First Tunnel. The site is located approximately 1.0 km the Gornje Polje site and 1.6 to 2 kilometers from the 'First Tunnel' floatation site. The design capacity of the tailings storage is 8.2 million cubic meters.

3.5.1 Mine Observations

3.5.1.1 Observations of the Mine

There were many observations made during the field excursion to the Trepca mines in December 2019. The workings of the mine are old and in various states of repair.

Figure 17 Picture of Mine Opening, Trepca Mine

The man lift was in poor condition visually however the function of the lift was smooth and without issues as it traveled up and down the guide rail smoothly. The safety gates did not close completely or easily. The shaft was fully lined with concrete.

Figure 18 View of the Man Lift, Trepca |Mine

The tunnels appeared to be about 2.5 meters wide and about 2.5 meters high. Many of the areas in the tunnel typically had standing water and water dripping from the ceiling. There were several areas that had quite a bit of mud on the sides of the tracks. There were no cutouts for one LDH to pass another if there were two moving ore from the face to the dump.

The ore face itself showed a large quantity mineralization as the light from the camera reflected off of the minerals (galena, sphalerite and others) and was very accessible. The ore grade could not be determined.

Figure 19 Picture of the Working Ore Face, Trepca Mine, Level 11 (700 meters)

The dewatering station I saw on level 11 had 3 pumps all of which appeared to be old but functional. I did not see how many were operating. There was a separate tank on the side of one of the tunnels for water storage if there was a problem with the lifting of the water to the surface.

Figure 20 LHD in Tunnel, Trepca Mine

The Load Haul Dumper (LHD) that was operating was a small diesel-powered vehicle. The width appeared to be about 2 meters and less than 2 meters tall with operator. It appeared to be similar to a Caterpillar 1300 series if not the exact model. This Caterpillar model has a capacity of 3.4 cubic meters and a payload capacity of 6500 kg. There was only one operating and it had to traverse approximately 700 m of tunnel each trip making the approach and return through the same tunnel.

The tunnel was only wide enough to accommodate the LHD. There were no side cuts to allow one to pass another. Again, the face from which the ore was being collected appeared to be quite rich. There was enough mineralization to see large pieces of zinc and lead minerals at the face. Based on target production for the year, the mine is probably operating single shift with only 1 LDH. This is fine for the current production level but in order to increase the production cutouts would have to be added for more than one LDH to operate and pass each other.

Production drilling was done with a jack leg drill of which there was only 1 operating. The drill appeared to be quite dated but functional. The temperature at the working face seemed to be about 30c. The air circulation was provided by a flexible pipe about 15 cm in diameter. The miners worked without shirts due to the heat in the mine.

Exploratory drilling was done with a rotary drill of unknown manufacture. It also appeared to be quite old. It appeared to be mounted on a wooden, or wood topped table. There was a considerable amount of core waste underfoot. This drilling was being done to map out a new reserve in the mine.

3.5.2 Concentrator Observations

The primary crusher appeared to be in reasonable shape although it was not running at the time. The secondary crushing line of 2 crushers was limited to only 1 operating as the second needed spare parts which were not immediately available.

Figure 21 Crushing and Separators, Tunel I pari Process Plant

While there is no mention of the spiral classifiers in the above description of the process there were two in the plant only one of which was operation capable. The other needed to be refurbished as the edges of the spiral were badly worn. The ball mills appeared to both be in working order.

Figure 22 Floatation and Spare Parts, Tunel I pari Processing

Figure 23 Additional Floatation, Tunel I pari Processing

The storage bins/ pits for the final concentrate seemed small for the original size of the mine. The ones that were viewed may have been only catch basins for the product from the concentrator and the balance was stored elsewhere. There was no baghouse operation for loading the concentrate into sacks for shipping. It appears to have been shipped bulk. The location of the smelter is unknown since it is not part of the Trepca complex.

3.5.3 Additional Metals Recovery

Additional metals that can be recovered from the process are silver, gold, copper, bismuth, and potentially tungsten. These have been recovered historically but don't seem to be reported as being recovered at this time. During the floatation process, the silver and bismuth are typically recovered with the lead.

Sintering is the first step to turn the minerals into lead. Sintering heats and then converts sulfides to oxides, volatile metals are vaporized, and most of the sulfur is converted into sulfur dioxide. The product of sintering is a firm, porous material called sinter. From there the material goes to the blast furnace where the smelting process reduces metallic oxides to metal.

The rough lead bullion, which will be bars or ingots, may have up to four distinct layers. The bottom layer is the lead bullion, which is 94 to 98 percent lead by weight., The next layer is speiss, which is a mixture of the arsenides and antimonides of copper. The third potential layer is Matte, which is primarily copper sulfide. The final layer at the top is slag, which is the metal oxides which were not reduced to the metallic state in the blast furnace. Matte and speiss are typically sold to the operators of copper smelters for metal recovery. Depending on the zinc content, the slag may be further processed or stored. The lead smelters typically operate at 1000 ºC to 1200 ºC.

Rough lead bullion is transferred to a dross kettle where it cools to less than 530ºC. The metals that were dissolved by the lead at blast furnace temperatures begin to precipitate. This precipitate contains most of the other metals (copper, silver, gold, bismuth). The precipitate is then removed.

Lead refining operations generally consist of several steps including (in sequence) softening, de-silvering, dezincing, bismuth removal, and final refining. Refiners remove silver and gold by adding zinc to the hot lead and cooling it to the melting point of zinc (~419ºC), then skimming off the zinc crust that forms. The crust contains almost all of the gold and silver. The gold/ silver is usually sold as Dore and not separated. Bismuth can be removed similarly using metals such as calcium, magnesium or potassium.

Bismuth can also be recovered from a high-bismuth alloy in a different method. The bismuth is melted in a cast iron kettle and then chlorine gas is injected. The lead, calcium, and magnesium are collected as part of the molten lead chloride slag. The bismuth metal from this process is treated with a caustic soda (sodium hydroxide) flux and niter (potassium nitrate) to remove impurities.

Following the calcining step there is a purification step in which trace impurities of other metals are removed from the zinc oxide calcine. Metallic zinc powder is added to t chemically replace copper and cadmium metals in the oxides. The copper and cadmium then precipitate out as sludge and are recovered for sale. The zinc can then be processed by pyrometallurgy or electrowinning (U.S. Department of Energy, 2013).

In the event that a high purity lead is required, the Betts process can be used. It is an electrolytic process that plates out a high purity lead while the impurities, such as silver, gold, and bismuth (more noble) are collected at the bottom of the cell as a sludge for further processing. Other impurity metals, such as zinc, copper, and magnesium, (less noble) remain in the electrolyte. This process is very expensive, however.

Zinc is processed either by electrolytic or pyrometallurgical processes. However, before either method, the zinc concentrate is roasted to remove the sulfur from the concentrate and produces an impure zinc oxide referred to as roasted concentrate or calcine.

3.6 Trepca Production

In the past, the Trepca complex was a major producer of lead, zinc, and silver. Ananias Tsirambides states that until 1985, Trepca also produced 8.7 Tons of gold (Tsiranbides, 2016). The production of ore averaged approximately 580,000 Tons per year for the period from 1932 until 1989. This includes the reduction during the war years for World War II and is shown in the following chart.

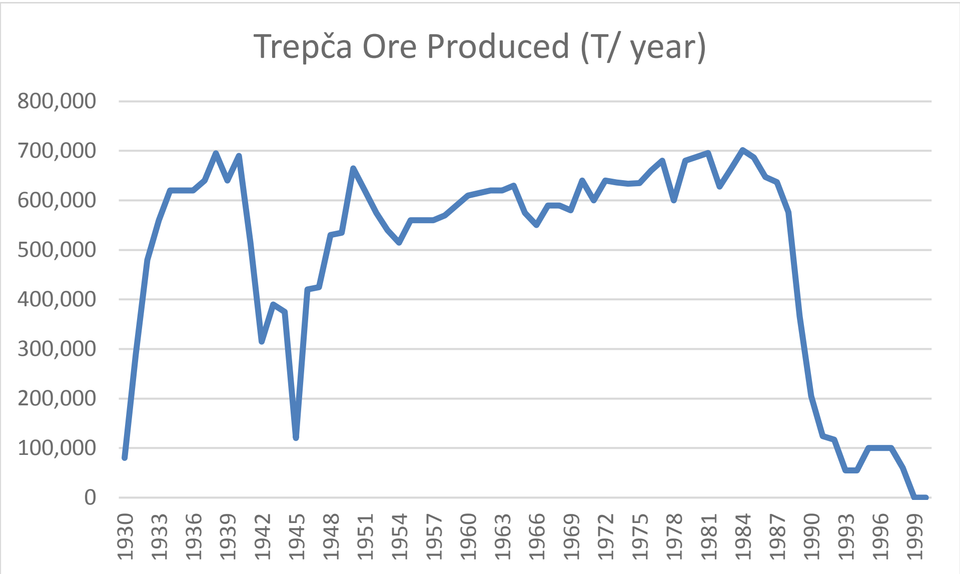


Figure 24 Ore Production 1930-1999

However, the quality and actual amount of the minerals recovered has continually declined particularly in more recent times. This is shown in the following charts.

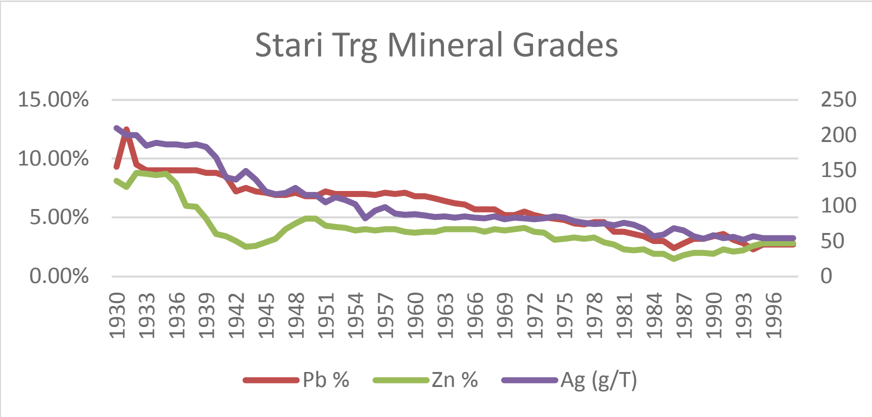


Figure 25 Ore Qualities of the Stari Trg Ore

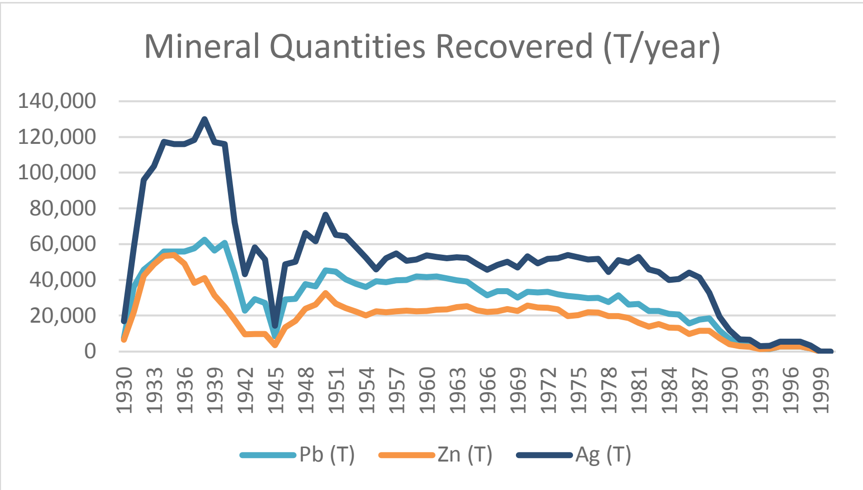


Figure 26 Tons of Metals Recovered

Trepca Ore Belt and Stan Trg mine – Geological overview and interpretation, Kosovo (SE Europe)

Additionally, there are various estimates on the amount of investment to restart the complex. They range from USD10 million (€9 Million) (International Crisis Group (ICG), 2019) to more than USD 650 million (€600 Million) (Synovitz, 2019). The larger estimate is supported by the UNMIK report that lists a large amount of physical asset work that needs to be done. However, this assumes that the existing workings are not functional. This was disproven on my visit to the mine. Additionally, some of the items are not a part of the actual mine complex but supporting infrastructure. These include (Nelles, 2003):

- rework of underground drifts, shafts, raises and stopes
- installation of new pumps and fans

- refurbishment of change houses, offices, laboratories and power distribution facilities
- repair and replacement of concentrators
- repair or replacement of loaders, drilling equipment, etc.
- construction of access roads, ore bins, explosive storages, etc.
- sampling of known mineralized structures
- underground survey(s)
- coordination and implementation of equipment/work such as installation of pumps and fans, and repair of the Shupkovac power sub-station
- rehabilitation and equipping of a new occupational health check center
- inspections of key infrastructure facilities including Non-Destructive-Testing as required.

These are just the mine costs. They do not include the environmental remediation costs.

Additionally, Sinesa Ljepojevic states in his book, “Kosovo Murky Reality” that the “whole production of everything in Trepca always was much below the published official figures” (Ljepojevic, 2008).

3.7 Mine Complex History

The Trepca mine complex has been considered one of the greatest producers of zinc in Europe. Trepca, even today, is a conglomerate in structure which includes the Stantërg mine, the Zvecan smelter, and the Mitrovicë/a industrial complex. It comprises a total of 41 installations, both inside and outside Kosovo. Trepca includes additional mines and all the process necessary for extraction, flotation, smelting, and downstream processing, as well as production and marketing (ICG Balkans, 26 November 1999).

With closures of different parts of the complex before 2000, the Trepca mining complex now is seven mines, three concentrators, one smelter, and one zinc plant. The mines and facilities are divided into 3 groups. The Northern chain, which includes the Belo Brdo, Crnac, and Žuta Prlina mines, the Middle chain, which includes the Stantërg mine, and the Southern Chain which contains the Hajvalia, Novo Brdo, and Kišnica mines (Nelles, 2003). However, there are other sources that indicate there are even fewer active mines and during our visit to the area we found that the smelter and zinc plant are now closed.

There are others, however, that divide the mines differently. They include the Artana- Novo Brdo in Zone 1, Belo Brdo, Stantërg in Zone 2 and Crnac in Zone 3. These zones are along geologic structure lines. Zone 1 is marked by the boundary of the Serb-Kosavaro-Macedonian Massif. Zone 2 follows the major fault on the eastern edge of the Miocene Prishtina basin, and Zone 3 is on the western side where the Vardar contacts the Dinaride-Drina-Ivanjica structural block (Hyseni, 2010). This appears to be a more accepted differentiation as it is used in other publications on geology (Kołodziejczyk, 2016). The map is shown in the figure below.

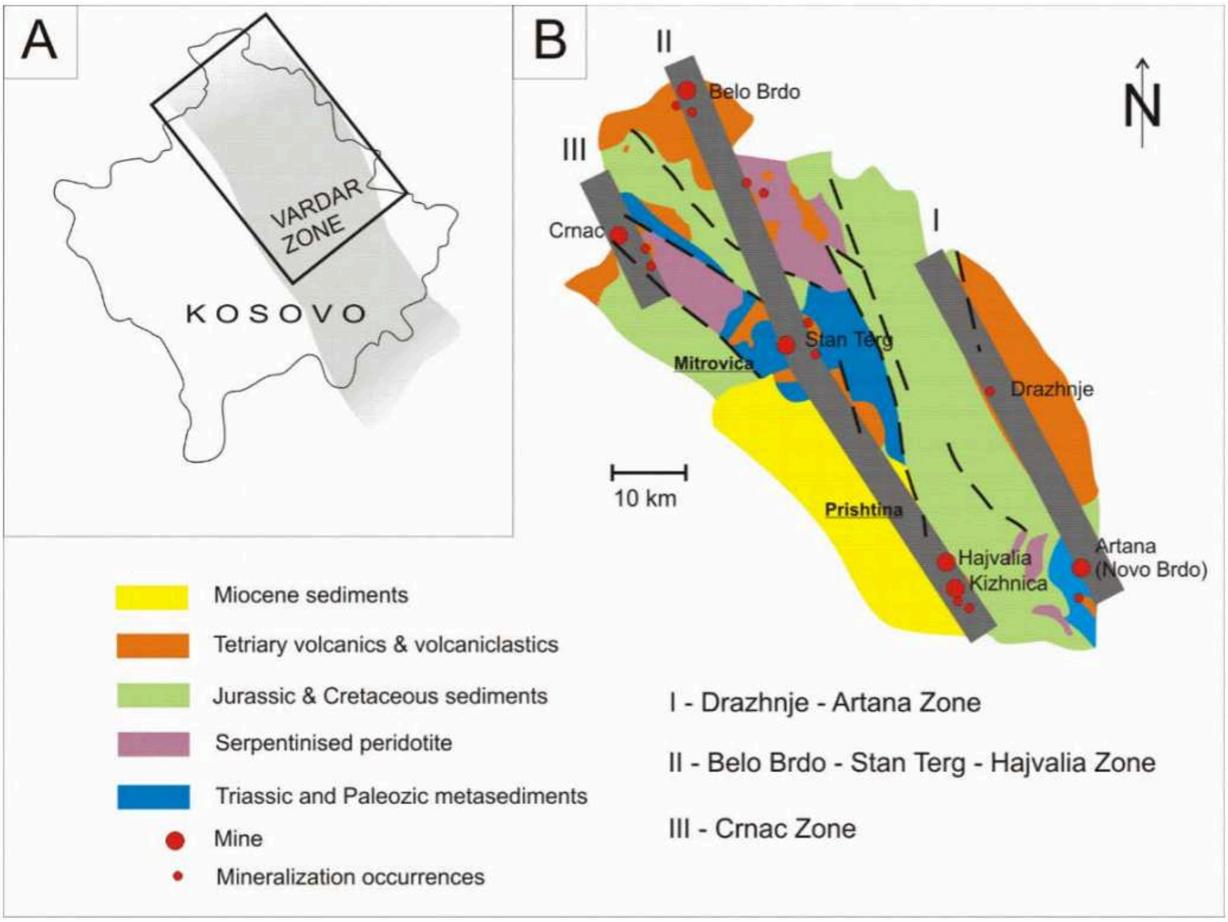


Figure 27 Map of Kosovo and Trepca Showing Zones I, II, and III

The Trepca has been producing minerals since early times. There are indications that the mine produced during Roman times and even before by a group of early people in the region called the Illyrians (Trepča_Mines, 2019). The Illyrians lived in the western part of the Balkan Peninsula. Their tribes lived in most of the countries. The countries that define their geographic spread include Croatia, Bosnia and Herzegovina, Slovenia, Montenegro, Kosovo, part of Serbia and most of central and northern Albania (Illyrians, 2019).

Roman Emperor Trajan, who ruled from 98 AD to 117 AD, took advantage of the Illyrians expertise and used them to mine and produce the metals. The main mine for this was the Stantërg, which appears to mean "old place" or "old market". When the Roman Empire collapsed in the late 300s to the late 400s, and then combined with Slavic migrations, mining activity in the region, and particularly at the Trepca, decreased leading to closure until the late Medieval Era (1000–1492).

King Uroš, who reigned from 1243 to 1276, invited Saxon miners to Serbia to develop the state's mines. The Saxons (also known as Sasi by the Serbs) were granted with keeping their identity. They were also allowed to built communities around the mines. The Trepca mine appears to have been re-opened in the second half of the 13th century. One of the early documents that mentions the mines is a charter of Pope Boniface VIII around 1303. King Milutin, who ruled from 1282 to 1321, built a coin mint in the region. Emperor Dušan, who ruled from 1331 to 1355, appointed a special knez, which is a Slavic prince or duke, to administer Trepca. The mine reached its peak during the reign of Dušan's successor, Emperor Uroš, who ruled in one form or another from 1346 to 1371. In 1363, Emperor Uroš gave Vuk Branković the title of "ruler of Drenica, Kosovo and Trepca". Branković governed Trepca until he was captured by the Ottomans in 1396. Trepca was known as a major trading town. It had good connections with other cities, like Split and Kotor on the Adriatic, and the city of Dubrovnik. As with the others mines in the Medieval Serbia a town developed around Trepca (Radoš Ljušić, 2008).

In 1389, the Battle of Kosovo occurred. Shortly after that battle, Serbia became an Ottoman vassal, but the mine continued to function normally. In 1455 the Ottomans, under the Sultan Mehmed the Conqueror, captured Trepca. During the Ottoman rule, Trepca, and all the Ottoman controlled other mines (like Novo Brdo) began to lose population and physically deteriorate. In 1685, during the Austro-Turkish War, which was fought from 1683 to 1699, the town of Trepca and its mine were destroyed. At that time, the mining stopped completely (Šentija & et al., 1981).

After the end of World War I, Nikola Pašić became Prime Minister and the Controller of the Stantërg ore deposits. He hired P.Tućan to explore the mine area and he reported extensive ore reserves (Bjelić, 2018).

In 1925, Selection Trust, a British company, assessed the mine and acquired the concession in 1926. In 1927 the Selection Trust Company established two separate companies: Trepca Mines Limited and Kopaonik Mines Limited. Exploitation of the Stantërg ore began in 1930. In 1935, the company reported a profit of 200,000 Pound Sterling (€224,000) (Palairet). Mining of the Belo Brdo deposit was begun in 1937 (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA-SEVER CONGLOMERATE (PART I), DEVEDESET GODINA RUDARSTVA I METALURGIJE U KOMBINATU ,,TREPČA – SEVER'' (I-DEO), 2017). In 1938, the Kopaonik mining concession was merged with Trepca mining concession. This brought the Vojetin mine in Kopaonik within the management of Trepca Mines Limited (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA-SEVER CONGLOMERATE (PART I), DEVEDESET GODINA RUDARSTVA I METALURGIJE U KOMBINATU ,,TREPČA – SEVER'' (I-DEO), 2017).

Due to the desire to improve production a lead smelter was built in Zvečan in 1940 (Vujić, 2014). The Germans occupied Yugoslavia in World War II. During this time, the Stantërg mine supplied 40 percent of lead used in the Nazi war industry and the Trepca complex manufactured batteries for the U-boats (Stuart, 2002). The production of batteries and other commodities continued after the war.

The complex had many modifications over the years. On 9 December 1967 a new lead smelter was opened along with a new zinc plant and battery plant. Additional floatation capacity was added at Zvečan in 1985. Production from the Crnac mine commenced in 1967 (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA-SEVER CONGLOMERATE (PART I), DEVEDESET GODINA RUDARSTVA I METALURGIJE U KOMBINATU ,,TREPČA – SEVER'' (I-DEO), 2017).

In 1985, Trepca was producing lead, zinc, bismuth, cadmium, and gold. It also produced batteries, sulfuric acid, sulfur phosphate, and fertilizers. It produced over 80% of refined lead and over 50% of refined zinc for Yugoslavia. At its peak, Trepca, as a business complex, owned a variety of assets. These included manufacturing plants in Prizren, Serbica, Peja, Vushtrri, and Gjilan. It also owned hotels, office buildings, and even farms in Vojvodina. Even though the company was successful, it "lost money" during the Socialist years under the Yugoslav system. As such it funded most of the programs of the State and investment in the mine itself was subsidized (Palairet).

In the late 1980s Serbia was working to abolish the autonomous region of Kosovo within its borders and in 1989 the workers at the Trepca mine organized a hunger strike. The strike was supported by the countries of Slovenia and Croatia and its intent was to show support for autonomy of Kosovo. The strike lasted for eight days and 180 miners were hospitalized. This was followed by the resignation of pro-Milošević leaders in Serbia. In the end, the strike did very little.

The mine and the overall complex have had numerous problems with neglect, lack of maintenance, upgrade issues, and other non-specified problems. These issues came about because of the lack of management, social, and political issues. There have been many parties and factions that have been unable to agree on what needs to be done to bring the complex back into production. When Belgrade reduced Kosovo's autonomy in 1990 and exerted control over the region additional problems were created.

The labor pool of the mine was badly out of balance. During the mines "Golden Years", there were as many as 23,000 people employed at the mines, the mills, and the manufacturing plants. However, during these years the production per worker (efficiency) was continually declining in addition to the quality of the ore. This situation appears to me to be similar to other countries where there is a 'cash cow' that is used to provide employment for the local people by hiring as many as the operation can afford but not necessarily need. In 1990 there were 1,500 employees who were office and support staff. Of the 700 mine workers left only 10 of them were actual miners. Additional attempts to hire new miners (presumably Albanians) caused strikes by the Serbian workers (Palairet).

In May of 1993, the manager of the complex, Krsta Jovanovic, stated there were no raw materials stock or spare parts and that the mine would have to be shut down. The mine only produced for 3 months in 1994 (Palairet).

The arrival of KFOR (Kosovo FORce, A NATO peace keeping force) in June 1999 caused further problems for the mining complex. The mines were split North and South with possession by the Serbs and Albanians respectively. When KFOR and UNMIK (United Nations Mission In Kosovo) arrived in 1999 there were additional problems and confusion, partly being who had control over what. Properties were looted and destroyed. UNMIK was authorized to take over all the state-owned companies. Trepca wasn't organized as a state-owned property and, as such, UNMIK chief Bernard Kouchner was not authorized to take it over. On 14 August 2000, a force of US and French soldiers stormed the premises and shut down operations (Palairet). Soldiers arrested the CEO, Novak Bjelić, who was returned to Serbia on the orders of Kouchner who then ordered the shutdown of Trepca.

In the beginning of the following year, Serbian deputy prime minister Nebojša Čović signed a document which transformed it back to a state-owned company. This, retroactively, made Kouchner's orders and decision legal.

3.8 Trepca Political Environment

The current political environment is a difficult one. It began in 1989 with the Republic of Serbia removing the autonomy of the Kosovo region, then part of the country of Serbia. Immediately after that,. Then, in 1999, North Atlantic Treaty Organization (NATO) peacekeeping forces established the Kosovo Forces (KFOR) to protect Kosovo. On February 17, 2008, the Kosovo Assembly unanimously declared its independence from Serbia as a separate country. Serbia has stated, and maintains the position, that the independence of Kosovo was illegal. Russia supported Serbia in that decision. China also supports the Russian position and, as members of the UN, both Russia and China will block any attempt to allow Kosovo to enter into the organization.

Four days of Kosovo’s declaration of independence as a separate country, fifteen countries recognized the independence of Kosovo. These countries included the United States, United Kingdom, France, Germany, Italy, and Australia. By mid-2009, 63 countries around the world, including 22 of the 27 members of the European Union had recognized Kosovo as independent (Rosenberg, 2019). Even today, the number of countries officially recognizing Kosovo as a separate country is changing.

Since 2009 the assets of Trepca have been claimed by both the Kosovars and the Serbs. The ownership is disputed to this day (International Crisis Group (ICG), 2019). This is also shown by the response from the Prime Minister of Kosovo, Ramush Harahinaj when the EU spokesman Maja Kocijancic proposed that all open issues between Serbia and Kosovo be resolved with EU mediated dialog. The Prime Minister stated that “Trepca is not an open issue between Kosovo and Serbia…” implying that Trepca is completely controlled by the Kosovars. The law securing the ownership of Trepca by the Kosovars was deemed to be unconstitutional by the Kosovo Supreme Court in 2016 (Prishtina Insight, 2019 (2)). The Constitutional Court, however, originally found the law constitutional both in content and in terms of the procedure of its ratification (Isufi, 2016).

Currently, because of the disputes, there is a 100% tariff on any articles imported from Serbia (Prishtina Insight, 2019). In addition, while the article states the 100% tax is on Serbian imports the tax also applies to imports to Kosovo from Bosnia and Herzegovina (Prishtina Insight, 2019 (2)).

The following shows the facilities on a political map.

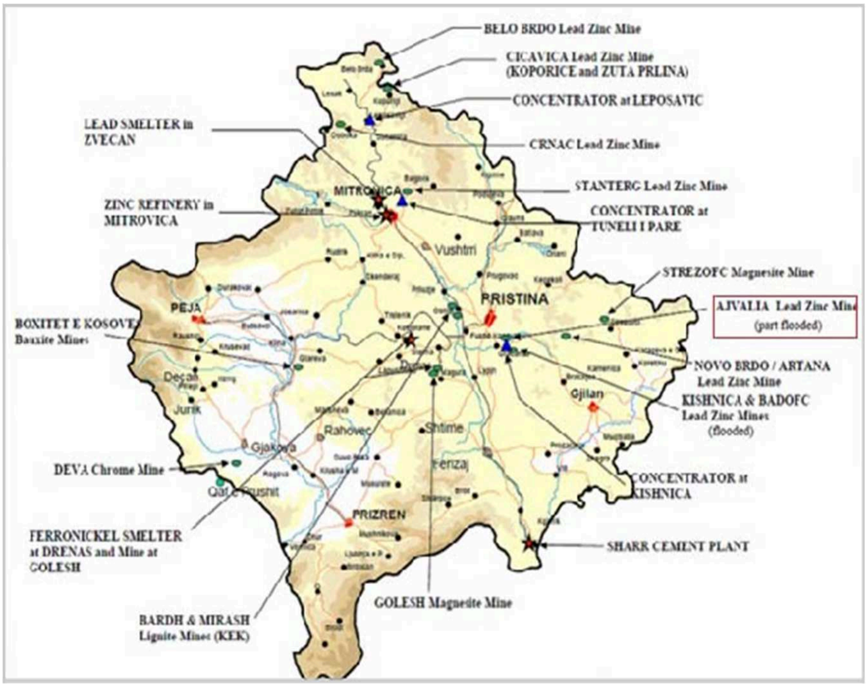


Figure 28 Map of Kosovo by CDM Int’l May 2000

According to the Economist, the current Kosovo President, Albin Kurti, who was elected in October of 2019, is continuing to take a hard position against any form of negotiation. He has stated that he will drop the tariff if Serbia will reciprocate. As the article states, that is not likely as anything Serbia would do as a response would effectively amount to recognition of Kosovo as a country. Serbia has been successful in keeping Kosovo out of Interpol and has also persuaded 12 countries to rescind their recognition of Kosovo as a country. In addition, Serbia still believes that Kosovo is a part of Serbia that was wrongly separated (The Economist, 2020).

3.9 Trepca Social Environment

The country, now known as the Republic of Kosovo, has a population of 1.8 million people. Based on a 2011 estimate, the population is comprised of Albanians (92.9%), Bosniaks (1.6%), Serbs (1.5%), Turk (1.1%), Ashkali (0.9%), Egyptian (0.7%), Gorani (0.6%), Romani (0.5%), and other/unspecified ethnicities of 0.2% (United States, 2016))

These estimates are based on the 2011 Kosovo national census, which excluded northern Kosovo. Because of this, the current census may not reflect the Serb Minority in the north and other ethnicities. The census was also boycotted by Serb and Romani communities in southern Kosovo. The official languages are Albanian and Serbian.

The main religions are:

- Muslim (95.6%)
- Roman Catholic (2.2%)
- Orthodox (1.5%) (United States, 2016).

This is consistent with the population demographics.

The country is very poor and considered to be among the poorest nations in Europe. Currently, Moldova is the only country considered to be poorer. The region is divided ethnically with the Serbs in the North and the Albanians in the south. This is shown in the following map.

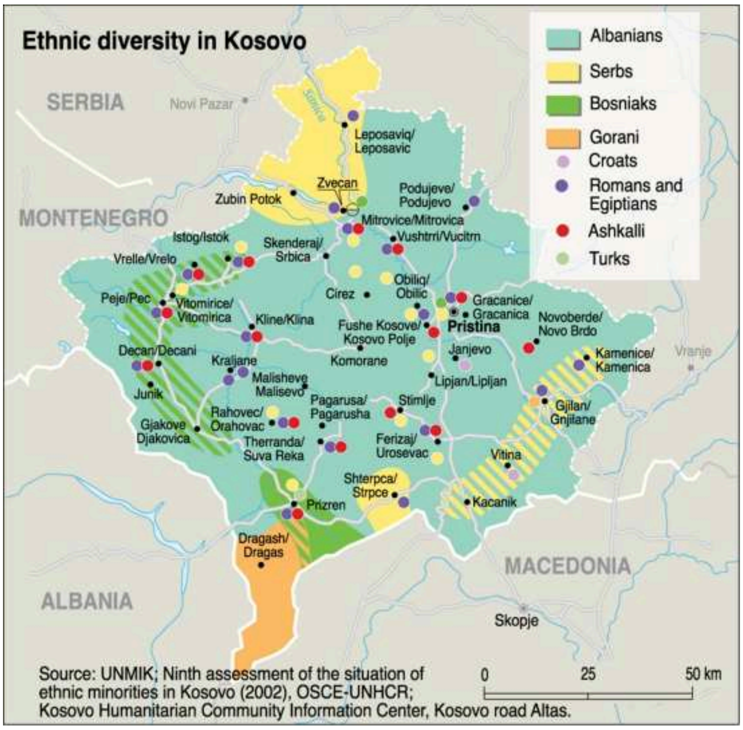


Figure 29 Ethnic Map (UNMIK 2002)

Note that the main mines of Trepca, Crnac, Belo Brdo, and Cicavica, along with the processing facilities lie along the edge, and in the area, inhabited by the Serbs. The Kishnica, Badofc, and Novo Brdo/ Artana mines are in an area that is heavily Albanian. This, in part, causes high tensions within the country.

Many of the reports indicate that the operation of the mine was split along ethnic lines with the Serbs being the management and engineering and the Kosovars/ Albanians being the mine workers. This has created additional tensions as it also drove income for the different groups.

Additionally, there is currently discussions going on between Belgrade and Kosovo to redraw the borders in the North essentially giving the Serb dominated area back to Serbia. This was originally proposed in 2018 and is still under discussion. The European Stability Initiative, a think tank, suggests that this should be dismissed (Rudic, 2019).
The conflict between the Serbs and the Kosovars/ Albanians has been going on for centuries. An early war was in 1363 when Đurađ I Balšić declared war against the Thopias of Northern Albania over territories. Karl Thopia, a 14th century King of Albania, was defeated by the ruler Balša II. Then in 1385, the defeated Thopia appealed to Ottoman Sultan Murat I for help. The Ottoman army defeated the Balšićs in the Battle of Savra in 1385 and made the Albanians vassals.

In 1595, Sinan Pasha, an Albanian-Ottoman military commander ordered the relics of Saint Sava, the founder of the Serbian Orthodox Church, burned at the Vračar hill in Belgrade.

When the Ottomans were defeated in the Russo-Turkish War, from 1877 to 1878, the Slavic Christian nations of the Balkan gained power and territory. In that war Serbia displaced about 80,000 Muslim Albanians during that winter of 1877/1878. Those refugees, known as the Muhaxir, mostly settled in what is known today as Kosovo. This large influx of refugees worsened the existing tensions between Muslims and Christians in this part of the Ottoman Empire. The report states this act of ethnic cleansing could be seen as the actual starting point of the Serbian-Albanian conflict and displayed a Serbian national consciousness.

In 1910, there was an Albanian uprising which opposed the Young Turk's policies of consolidation of the Ottoman Empire. The First Balkan War began in 1912. Serbia, Greece and Bulgaria declared war and sought to increase their territories. In 1912 Albania declared its independence. It was under foreign occupation at the time but with the aid of Austria-Hungary, drew its present borders. These borders left more than half of the Albanian population outside of the country.

In September 1913, Albanians in the Macedonian Vardar region and Pro-Bulgarian Internal Macedonian Revolutionary Organization rebelled against Serbian Chetniks. This was called the Ohrid-Debar Uprising.

In 1914, Serbia was invaded by Austria-Hungary. The Kingdom of Yugoslavia was established following the war. The Albanians of Yugoslavia were not seen as an important part of the new state but just an ethnic minority. They were Officially discriminated against and measures were taken to try to dilute the numbers of the Albanian population. This led to the formation of anti-Serbian groups called the Kacak.

In the Second World War, Kosovo Albanians rebelled against Serbia, who was occupied by the Axis powers (Germany and its allies) at the time, and tried to reunite with Albania. Kosovo, along with historical Albanian territories in Macedonia were made part of Albania. There were others who joined the Partisans of Josip Broz Tito as they disliked axis rule. They hoped to be able to fight for independence from the Axis powers. During the war years, 1941 to 1945, the mine was operated by Mansfeld A.G. from Eisleben, Germany. Rebels soon shut the mine down by disabling equipment and destroyed the power station (Nikolić, NINETY YEARS OF MINING AND METALLURGY IN TREPČA-SEVER CONGLOMERATE (PART I), DEVEDESET GODINA RUDARSTVA I METALURGIJE U KOMBINATU ,,TREPČA – SEVER'' (I-DEO), 2017).

At the conclusion of World War II, the Yugoslavia was established and the Albanians that were part of this new country split between two new entities. These were the Autonomous Province of Kosovo and the Socialist Republic of Macedonia. They were still considered to be minorities and not nations.

Protests in 1974 by Albanian students helped the autonomous province of Kosovo achieve greater autonomy. This autonomy was under the rule of the local Albanian-dominated Communist Party. Because the local rule was Albanian, this led to discrimination against local Serbs. As mentioned previously, this is a very poor region. Many of the Serbs left the region for opportunities elsewhere and the province became even more Albanian.

Through the 1980s and into 1989 Slobodan Milošević worked at reducing the autonomy of Kosovo. He ultimately gained control over the region and imposed a repressive regime. There was nothing happening in the early years of the Yugoslav Warsfrom 1991 to 1995. However, by 1996 Albanian radicals had established the Kosovo Liberation Army (KLA). The goal of the radicals was an independent Kosovo. By 1998 the province was in a state of widespread low-level war. In 1999, NATO forces combined with the KLA and removed Serbian and Yugoslav security forces from Kosovo. (Serbian~Albanian conflict, 2019) (Lee, 2019).

3.10 Trepca Environmental Issues

There are a number of reports that detail the environmental problems that are a part of the Trepca complex. A 2011 report states that “The heart of Trepca’s former operations in northern and eastern Kosovo bears a heavy legacy of toxic waste threatening tens of thousands of men, women and children.” (UNDP, 2011) According to the report, in the 1980’s the complex released 1,215 Tons per year of lead, 60 Tons per year of zinc, 2 Tons per year of cadmium, and 6 Tons per year of mercury into the environment. The annual releases of minerals and metals into the water were estimated as follows:

- 150 Tons of lead
- 300-900 Tons of zinc
- 900 Tons of fluoride

along with many other minerals and metals. Of the many environmental sites that are hazardous, 28 have been classified as very hazardous sites for environment degradation and human health reason.

The sources of these hazards are described as:

- groundwater and surface water contaiminaton from tailings,
- air pollution from tailings dust,

- contamination of agricultural soil from tailings depositions
- contamination of residential yards, public streets & squares from tailings depositions

Although not mentioned specifically, acidic mine drainage from the mines themselves can also be a major problem. This can arise from mines being abandoned and flooded.

Mrs. Dorothy Sanders, in the same report, presented a study of the Mitrovicë/Mitrovica region in which they found out of 110 samples, 108 of them exceeded natural geochemical levels. 42% of the samples were heavily contaminated with lead exceeding maximum tolerable limits.

The report also states the UNDP, in its 2007-2010 program to identify hot spots, specifically targets the Trepca/Artana and Stantërg/Stantërg mines.

More specifically, the report states that the most urgent actions are:

- Tailings in Mitrovicë/Mitrovica, Kishnicë, Graçanicë, Zveçan, Tunel I Parë, Leposaviq
- Acid mine water from the Artana mine
- Restructuring of the Kosovo mining industry, with Trepca Mine being the top priority
- Full implementation of Mining Law
- Implementation of the Mining Strategy through 2025
- New comprehensive environmental laws for the mining industry (implementation of EU Directive 2006/21/EU)

The estimated cost of the necessary immediate remediation is approximately 23 million Euro. Note that this is just for remediation not for upgrades to the processing plants which have very outdated technology.

Another report states that there are areas in Mitrovica that has an extremely high level of lead pollution. The exposure values reach 5560.8 mg/m2/day. This exceeds WHO recommended values by a factor of 20 times. (Shala, 2010)

A later report by the World Bank details the annual cost of the environmental issue remediation between 123.3 and 327.5 million Euro with a median of 222.3 million Euro. The effect of lead and heavy metals from the mines is estimated to be about one third of the cost, or about 70.7 million Euro annually. (World_Bank, 2013)

The environmental problem of lead is not just a current problem. It has the ability to impact future generations. The toxicity of lead correlates with lead concentration in blood. Intelligence impacts occur at low levels of exposure of about 1 µg/dL. It starts creating abnormalities, such as learning disabilities, deficits in motor skills, attention-deficit disorders, and behavioral disturbances, at about 10 µg/dL. Higher concentrations can lead to additional problems including coma and death. (Shabani D. e., 2019) The children had concentrations of between 12.4 and 23.6 µg/dL with the highest group being the 3 to 4-year-old children.

3.11 Trepca Ownership

The ownership of the mine complex has changed over the years from a private company to ownership by various governments. The most important view of the ownership is the current situation and the current ownership of the mine and the resources, are not clear. Each of the countries involved (Serbia and Kosovo) state that the property of Trepca is owned by them. The Serbs claim 100% ownership while the Kosovo states it is owned 80% by the state and 20% by the workers (New Delhi Times, 2019).

In 2008, Sinesa Ljepojevic made an interesting statement in his book, “Kosovo Murky Reality” saying that in the case of denationalization, the mine should be returned to its original owner (Ljepojevic, 2008), although he does not specify who that is. This could be a problem as the mine, and its resources, originally belonged to Yugoslavia which no longer exists.

In 2015, Kosovo passed a law transferring the ownership to the government. That law was struck down by the Kosovo Supreme Court in early 2016. On 7 October 2016, the country again declared its ownership of 80% of the Trepca complex with the remaining 20% owned by the workers.

According to the UN Mission in Kosovo (UNMIK), Trepca ownership is as follows:

- Serbia Development Fund – 66%
- The society in general - 27%
- Jugobanka – 2.5%
- Progress and Beobanka – 2.5%
- Serbian Electric Power – 2%.

As a result, they conclude Trepca is publicly held and under UNMIK’s authority in accordance with its mandate. But there do exist private-sector claims (International Crisis Group (ICG), 2019).

Mr Jean-Pierre Rozan claims 2.8% ownership of Trepca on behalf of the Paris-based SCMM of which he was a director. Mytilineos Holding SA (a Greek company) have also claimed that Trepca is theirs. President Rugova (elected by Albanians who had boycotted official elections) warned foreign companies in May 1997 that these agreements were considered 'null and void' however the ownership is still being contested (International Crisis Group (ICG), 2019).

There are other issues as to the "ownership" of Trepca. One of the major ones, in my opinion, is who owns what. By this I mean the enterprise can be divided into two separate parts. One of the parts consisting of the physical assets of the enterprise. These would include the buildings, the transport, the processing, and other materials necessary for the mine to operate. The other is the mineral resource itself. This becomes important because there are a variety of legal distinctions that come about because of this. The major one that is facing anyone who wishes to operate the property is a liability issue over the environmental damage done so far which appears to be extensive.

When the mine was first opened, it was a concession to mine and process the ore. The ownership of the resource, at that time, was the government. Selection Trust would have only owned the materials and equipment that they brought to the sites for the purpose of extracting the minerals.

3.12 Trepca Legal Issues

There are a large number of lawsuits of various types against Trepca, and the various groups around it. One example is a 2008 lawsuit filed with the UN Human Rights Advisory Panel by American lawyer Diane Post that the UN had, in fact, failed to protect the IDP victims and was responsible. There was a decision that they had indeed failed to protect the IDP victims. However, the issue remains unresolved to date (toxicleaks.com, 2019).

In 2006, the consulting company EiCKS stated there were over 90 companies that claim to have a part of Trepca and had filed lawsuits to make their intentions a reality. According to the Supreme Court Special Chamber, there were some 41 claims, which amount to a total of €75m (ECiKS, 2019).

Ownership of the mines and the processing also becomes a major legal issue for the future. As mentioned above, there will be a question of liability for whoever the ultimate owner of the mines and/ or the equipment. This is similar to other countries in which there are substantial minerals. For the most part based on the current statement of ownership by the Kosovo government, it is the country, or sovereign nation that owns the resource and others are given a concession, or the right, to recover, process, and sell the products, hopefully for a profit after paying concession fees.

A recent example of these problems is the attempt to IPO the Saudi Arabian oil company Saudi Aramco. If one assumes the oil is part of the IPO then the value of the operation is very high and so is the valuation. However, if the IPO is only the extraction and processing of the oil, then the valuation is much lower. Additionally, one of the reasons given for not doing the IPO in America is because of potential legal liabilities. Energy Minister Khalid al-Falih stated that he thought litigation and liability were a big concern in the US and Saudi Aramco was too big and too important to to subject the company to that kind of risk. (Financial Times, 2019) The IPO document, which contains 650 pages of information and legalese, was released in 2019 at the time of the placement on the Saudi Arabian stock exchange which is called Tawadul in Arabic (Saudi Aramco, 2019).

4 Evaluation of Products, Co-Products, and By-Products

4.1 Market Conditions for Metals

The mines of the Trepca complex have produced many different metals and products over the years. The main ones, however, have been lead, zinc, and silver. These metals are considered to be industrial metals. The industries around these are somewhat competitive as measured by the Herfindahl-Hirschman Index (HHI). This is a measure of the concentration of the industry. Generally, an HHI score of 1,500 or less indicates a relatively robust competitive market and between 1,500 to 2,500 indicates a moderately concentrated marketplace. The higher the score, up to a maximum of 10,000 indicates a less competitive and more monopolistic market. Lead has an HHI of approximately 2,331, zinc's index is 1,178, and silver has an HHI of 482. These values are based on calculations of data in World Mining Data 2019 (World Mining Data, 2019).

Information on current outlooks, resources, and substitutes for these three metals are detailed below.

4.1.1.1 Lead

There are currently identified globally more than 2 billion tons of resources. In addition, lead is one of the most recycled materials globally. Significant lead resources have been found in a variety of countries. These include Australia, China, Ireland, Mexico, Peru, Portugal, Russia, and the United States. Plastics has been found to be a substitute for lead and has reduced lead in cable covering and cans. Tin, and other low melting metals, have replaced lead in solder and electronics. The electronics industry has also moved toward flat-panel displays that do not require lead shielding. Wheel weights for balancing are now made from steel and zinc.

For most of 2018 the average LME cash price for lead was $1.04 per pound. The price was much the same in 2017. However, in 2017, prices reached a 6-year high because of low supplies of concentrate and increased demand for refined lead. During the first 10 months of 2018, prices decreased by 23%due to an increased supply of concentrate to the market. Global stocks of lead in LME-approved warehouses were 25% less in December of 2018 than those at year end 2017 (USGS, 2019).

4.1.1.2 Zinc

Zinc is a major industrial metal with many uses. Identified zinc resources of the world are about 1.9 billion tons. While zinc is an important metal, aluminum and plastics substitute for sheet products, aluminum alloys, cadmium, paint, and plastic coatings replace zinc coatings, Aluminum and magnesium-base alloys are major competitors for zinc-base die-casting alloys. Many elements are substitutes for zinc in chemical, electronic, and pigment uses.

In 2018, the zinc metal market continued the deficit observed in 2017, with consumption exceeding production. The USGS estimates that global refined zinc production in 2018 was 322,000 tons less than the estimated consumption of 13.74 million tons (USGS, 2019).

4.1.1.3 Silver

There was a large historical demand for silver, not only for jewelry, but for imaging, particularly black and white photography, x-rays, etc. Digital imaging, film with reduced silver content, silver-less black and white film, and xerography are all substitutes for silver. Surgical pins and plates are now made with stainless steel, tantalum, and titanium. Stainless steel substitutes for silver flatware. Non-silver (lithium and others) batteries may replace silver batteries in some applications. Aluminum and rhodium can be used in mirrors and other reflecting surfaces. Global silver reserves are approximately 560,000 Tons. Resources are estimated at 1,740,000 Tons.

The average silver price in 2018 was $15.30 per troy ounce. The average price in 2017 was about $16.80 per troy ounce. (USGS, 2019).

Silver reports mostly to the lead concentrate when the ore is processed. It can then be recovered by the smelter if the concentration is high enough. Otherwise it is considered a contaminant and will reduce the overall income from the concentrate.

4.1.1.4 Gold

Gold is a minor constituent in the Trepca mine stream. However, it is one of the metals that can be recovered from the stream. Aside from jewelry and monetary uses, gold has many uses in a variety of industries. A few of the uses are electronics (connectors), treating patients with arthritis, fillings and crowns for teeth, and protective coatings for aerospace. Gold and gold alloys are widely used in electrical and electronic products. Gold cladding over other metals, including silver, is used in jewelry to economize on gold. Palladium, platinum, and silver can substitute for gold except where gold's specific properties are required. According to the USGS, there are approximately 54,000 tons of gold reserves globally (USGS, 2019).

Gold has risen in price from July 2018 to its current level or USD 1,488 per ounce. Over the past several years it has traded at about USD 1,200 per ounce varying up and down from there. Its high price was USD 1,838 on 25 July 2011.

Gold reports mostly to the lead concentrate when the ore is processed. It can then be recovered by the smelter if the concentration is high enough. Otherwise it is considered a contaminant and will reduce the overall income from the concentrate.

4.1.1.5 Copper

Copper has a long history. It was originally mined to produce tools and later alloyed to create bronze, for which one of the historical eras is named the bronze age. Copper and copper alloy products are used in building construction, transportation equipment, electrical and electronic products, consumer and general products, and industrial machinery and equipment. Global reserves are approximately 830,000 Tons (USGS, 2019).

The copper market has been very volatile with prices ranging from a high of USD 10,106.50 per ton in February 2011 to a low of USD 4,332per ton in January 2016. The current price is about USD 4,782 per ton (October 2019).

Copper reports to both the zinc and lead concentrates when the ore is processed. It can then be recovered by the smelter if the concentration is high enough. Otherwise it is considered a contaminant and will reduce the overall income from the concentrate.

4.1.1.6 Bismuth

Bismuth has a variety of applications. It is used in cosmetics, industrial, laboratory, and pharmaceutical applications. Bismuth use in pharmaceuticals included bismuth salicylate (for treatment of upset stomach) to treat burns, intestinal disorders, and stomach ulcers. Bismuth is also used in glazes and pigments. Bismuth can also be used as a nontoxic replacement for lead in brass, free-machining steels and alloys, and solders. It can also be used for lubricating greases. Its low melting point makes it ideal for a triggering mechanism for fire sprinklers and for holding devices to grind optical lenses. Bismuth-tellurium-oxide alloy film paste is used to manufacture of semiconductors.

Substitutes for bismuth can be alumina, antibiotics, calcium carbonate, and magnesia. Other substitutes, depending on the application, are titanium dioxide-coated mica flakes, fish-scale extracts, cadmium, indium, lead, tin, and resins.

World bismuth reserves are estimated at 320,000 tons. China has 240,000 tons of bismuth reserves, which accounts for 75% of the world total. Bolivia and Mexico each have 10,000 tons, while the US and Canada both possess 5,000 tons. The remaining countries have 50,000 tons of reserves. Bismuth is normally not a direct product but a byproduct of processing lead ores (USGS, 2019).

Bismuth reports mostly to the lead concentrate when the ore is processed. It can then be recovered by the smelter if the concentration is high enough. Otherwise it is considered a contaminant and will reduce the overall income from the concentrate.

4.1.1.7 Indium

Indium is an important metal in today's electronics industry. Indium-Tin-Oxide, (ITO), as a thin-film coating, improves electrical conductivity in flat-panel displays, particularly liquid crystal displays (LCDs). Indium has a variety of uses in alloys and solders, electrical components and semiconductors, and research.

Indium is recovered from sphalerite. The indium concentrations are normally less than 100 parts per million. As a substitute, hafnium can replace indium in nuclear reactor control rod alloys (USGS, 2019).

There are no reliable estimates of global indium resources. 95% of Indium is recovered as a byproduct of zinc smelting. The average indium content of zinc deposits, as stated above, ranges from less than 1 to 100 ppm. An additional small percentage comes from the smelting and processing of copper and tin ores as a byproduct. In 2019, the USGS estimated the global zinc reserves were around 230 million tons (USGS, 2019). Using the updated USGS estimate for zinc, and the information from Polinares, by assuming an average indium content of only 50 g indium per ton of zinc content in the ore, the calculated indium reserves in these zinc deposits are approximately 11,500 tons (Polinares, 2012).

Indium reports mostly to the zinc concentrate when the ore is processed. It can then be recovered by the smelter if the concentration is high enough, however, it is difficult to recover. Otherwise it is considered a contaminant and will reduce the overall income from the concentrate.

4.2 Critical Raw Materials

Critical raw materials have become an important consideration in deciding what can, and should, be produced from mines. This applies not only to mines globally but also to mines within the European Union, and East and Southeast Europe.

In 2017 the European Union released a list of critical raw materials based on a variety of factors. Some of the purposes of this list were to:

- identify investment needs to help reduce Europe's reliance on imports of raw materials;
- provide support to innovation on raw materials supply in the EU's Horizon 2020 research and innovation program;
- show the importance of critical raw materials in transitioning to a low carbon, resource-efficient, more circular economy.

The EU is not the only group concerned with critical raw materials. The United States also has its own evaluation of critical raw materials. The following table shows the critical raw materials as determined by the EU and the United States. The EU list contains 27 critical raw materials (European Commission, 2017), not all of which are mined materials. The US list contains 35 critical materials (U.S. Dept of Interior, 2020), all of which are mined. There are 20 items that are common to both economies.

Critical Material	Use	Critical to EU	Import Reliance Rate (EU)	Critical to US
Aluminum (bauxite)	most sectors of the economy	No		Yes

Antimony	batteries and flame retardants	Yes	100%	Yes
Arsenic	lumber preservatives	No		Yes
Barite	cement and petroleum industries	Yes	80%	Yes
Beryllium	aerospace and defense industries	Yes	N/A	Yes
Bismuth	medical and atomic research	Yes	100%	Yes
Borate		Yes	100%	No
Cesium	research and development	No		Yes
Chromium	stainless steel and other alloys	No		Yes
Cobalt	rechargeable batteries and superalloys	Yes	32%	Yes
Coking Coal	steel manufacture	Yes	63%	No
Fluorspar	manufacture of aluminum and fluorine compounds	Yes	70%	Yes
Gallium	integrated circuits, optical devices like LEDs, semiconductors	Yes	34%	Yes
Germanium	fiber optics, night vision applications, semiconductors	Yes	64%	Yes
Graphite (natural)	lubricants, batteries, and fuel cells	Yes	99%	Yes
Hafnium	nuclear control rods, alloys, and high Temperature Ceramics	Yes	9%	Yes
Helium	MRIs, lifting agent, and research	Yes	96%	Yes
Indium	LCD screens	Yes	0%	Yes
Lithium	batteries	No		Yes
Magnesium	furnace linings for manufacturing steel and ceramics	Yes	100%	Yes
Manganese	steelmaking	No		Yes
Natural Rubber		Yes	100%	No
Niobium	steel alloys	Yes	100%	Yes
Phosphate Rock		Yes	88%	No
Phosphorus		Yes	100%	No
Platinum group metals	catalytic agents	Yes	99.60%	Yes
Potash	fertilizer	No		Yes

Rare earth elements group	batteries and electronics	Yes	100%	Yes
Rhenium	lead-free gasoline and superalloys	No		Yes
Rubidium	research and development in electronics	No		Yes
Scandium	alloys and fuel cells	Yes	100%	Yes
Strontium	pyrotechnics and ceramic magnets	No		Yes
Silicon Metal		Yes	64%	No
Tantalum	electronic components, mostly capacitors	Yes	100%	Yes
Tellurium	steelmaking and solar cells	No		Yes
Tin	protective coatings and alloys for steel	No		Yes
Titanium	white pigment or metal alloys	No		Yes
Tungsten	wear-resistant metals	Yes	44%	Yes
Uranium	nuclear fuel	No		Yes
Vanadium	mostly in titanium alloys	Yes	84%	Yes
Zirconium	high-temperature ceramics industries	No		Yes

Table 4: Critical Raw Materials for the EU and United States

It is interesting to note that while lithium-based batteries are used in a wide-ranging number of products, the EU determined that lithium was not one of its critical materials. It is also interesting to note that while the EU has no, or low, dependence on external sources, for example hafnium at 9%, they are still considered as a critical raw material. The report also contains a chart showing the relative importance and risk of the various materials.

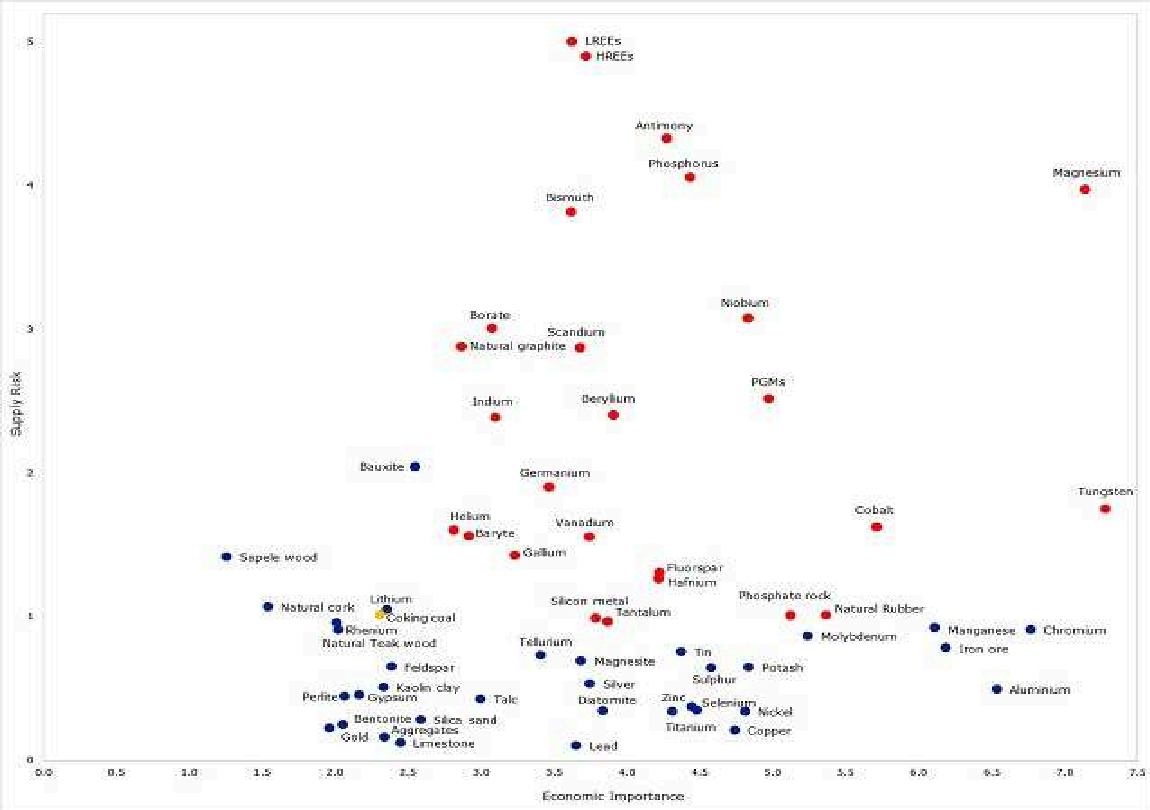


Figure 30 Chart Showing the Relative Economic Importance and Supply Risk

It is also important to note where the majority of the critical raw materials for the EU originate. The following map shows the locations and percentages.

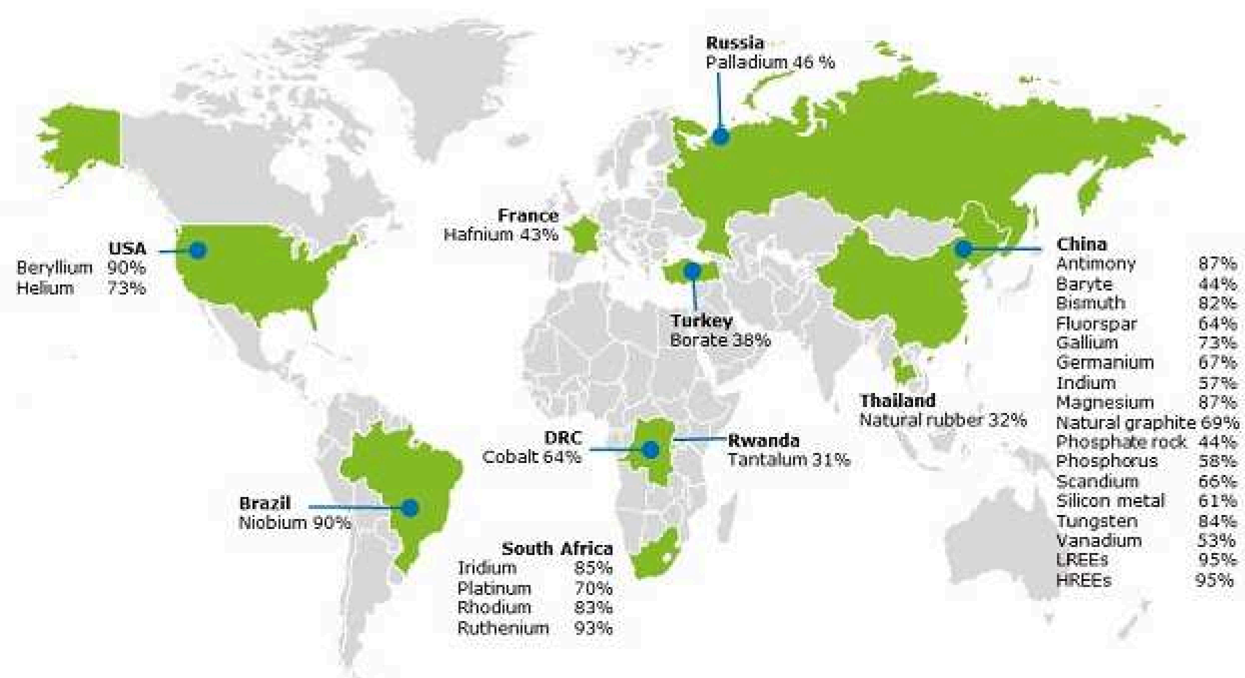


Figure 31 Map Showing Location of Sources of Critical EU Raw Materials

Also significant is the locations of various raw materials in the EU. The following map shows the locations of some of the critical materials near, and in, Kosovo. It is important to note that while the region contains the critical materials of cobalt, borates, and antimony, none of these materials are associated with the Trepca complex.

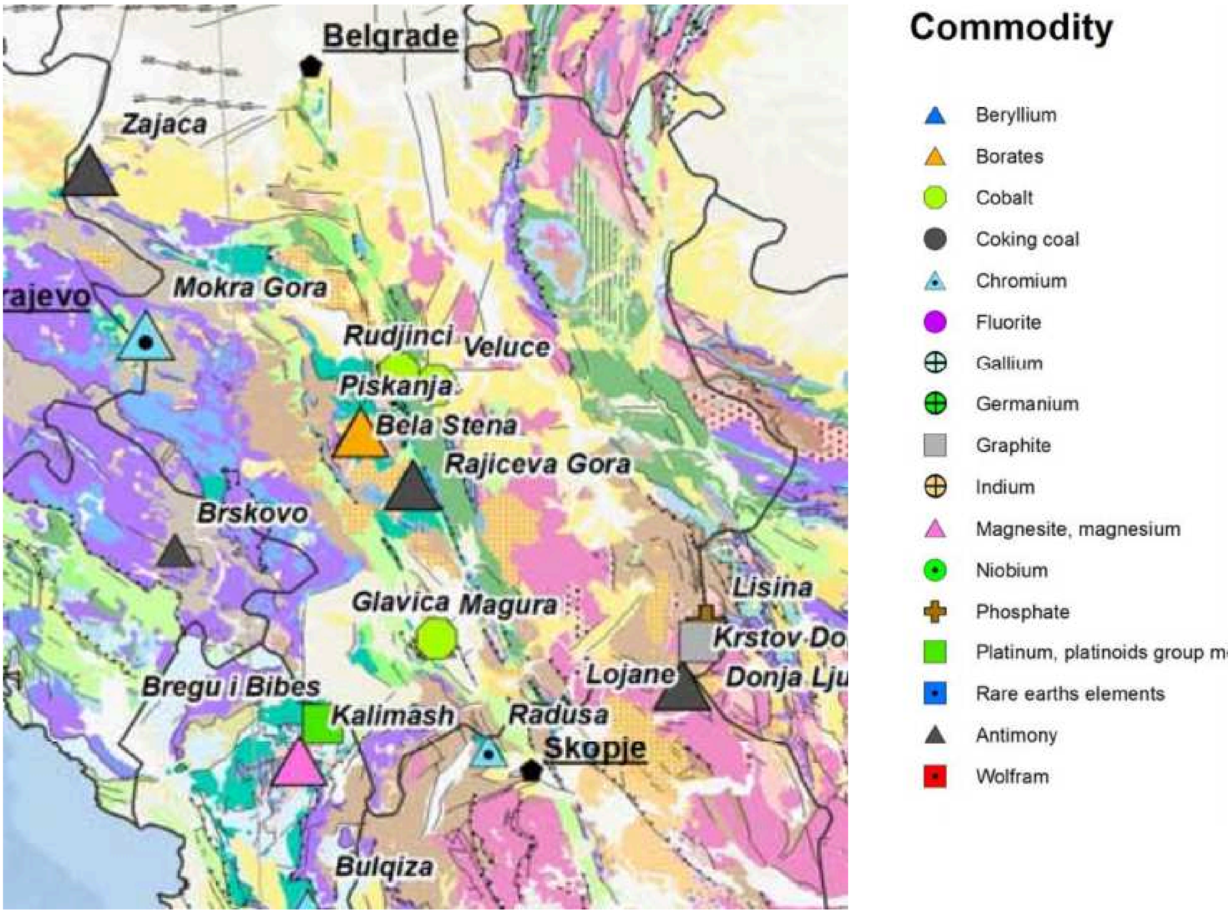


Figure 32 Map Showing Locations of EU Critical Materials (European Geosciences Union, 2015)

4.3 Mine Analysis

The various mines of the Trepca complex have been evaluated and reserve/ resource estimates have been made. For the Stantërg mine, the following values were published in a research paper (Hyseni, 2010). The reported values do not meet any mining standards for reporting but do give some estimate of the value of the mine. It is important to note that while gold is known to exist in the deposits, and has been produced, it is not mentioned or recorded in any of the explorations or production records. It is only shown in the production reports. The prices used to calculate the value of the various categories were retrieved from the London Metal Exchange (LME) on 7 September 2019 in Euro.

Stantërg	Tons	% Pb	% Zn	g/t Ag	Market Value (€)
Proven reserves:	120,340	5.14	5.13	88.0	32,648,172.18

Probable reserves:	311,660	5.10	3.17	80.5	68,702,502.41
Total mineable reserves:	432,000	5.10	3.17	80.5	95,230,318.43
Total resources:	12,488,000	3.21	2.21	56.4	1,840,614,147.87

Table 5: Stan Terg Reserves (Hyseni, 2010)

These values, while reasonable, are suspect because in the same report, Sylejman Hyseni gives different values in another section. He states that the five key mines total 7,068,000 tonnes of 5.46 wt% lead, 5.64 wt% zinc and 116 g/tonne silver (Hyseni, 2010). While the Hyseni values for the lead and zinc, and silver are all higher than the reported production values of the Stantërg, the total resources for all 5 mines are 56.6% of the total resources reported for the single mine, the Stantërg. The total resource value is similar at this level at roughly €2 Billion, although, again, the values reflect one mine versus the entire complex. The USGS estimates that Trepca has 150 million Tons of ore containing 6% zinc, 4% lead, 0.16% copper, 110 grams per ton silver, and 0.27 grams per ton of gold. However, this appears to be resources and not reserves (USGS, 2020). A report by IBP, Kosovo's estimated lead and zinc reserves to be about 48 million Tons (International Business Publications, 2016). However, there are no grade figures, or a list of mines, associated with this estimate. Another presentation places the reserves at 60 million Tons, again with no grade information or mine list (Shabani M. , 2016). A report by A. Tsiranbides, states that Trepca has >150Mt of probable/ indicated reserves containing an average of 6% lead and 4% zinc. He also states there is a significant content of silver and gold in the current product of lead/ zinc concentrate but gives no value and does not specify if this is for the Stantërg mine or the whole complex (Tsiranbides, 2016).

Additionally, the Republic of Kosovo produced a Mining Strategy and also provides values and grades for several of the mines and complexes. These values are in the following table.

Mine-Locality	Ore Quantity	Pb (%)	Zn (%)	Ag (g/T)	Pb (T)	Zn (T)	Ag (kg)
Stantërg	20,754,000	4.02	4.02	76	834,311	674,505	1,577,304
Melenica	2,552,000	5.8	5.8	85	148,016	107,184	216,920
Magjera	600,000	3.8	3.8	72	22,800	18,000	43,200
Mazhiq-Maja Madhe	1,500,000	3.3	3.3	60	49,500	42,000	90,000
Gjidomë-Mazhiq	2,000,000	3.3	3.3	60	66,000	56,000	120,000
Rashan-Tërstenë	2,500,000	3.3	3.3	60	82,500	70,000	150,000
Zjaqë	5,175,000	2.83	2.83	16	146,453	112,815	82,800
TOTAL	35,081,000	3.85	3.85	65	1,349,580	1,080,504	2,280,224

Table 6: Mine Ore Quantities (Energy, 2002)

Including other mines, the Mining Strategy lists additional values for other areas and a summary of the Stantërg area.

Location	Ore (T)	Pb (%)	Zn (%)	Ag (g/T)	Pb (T)	Zn (T)	Ag(kg)
Stanterg	35,081,000	3.85	3.85	65	1,349,579	1,080,504	2,280,224
Cernac/BB/Gom	7,544,227	6.85	5.07	96.13	516,645	382,373	725,256
Artane/NB	16,037,227	4.67	6.52	89.91	749,354	1,045,444	1,441,879
TOTAL	58,662,569	4.46	4.28	75.81	2,615,578	2,508,321	4,447,359

Table 7: Trepca Reserves (Ministry of Economic Development, 2012)

A report issued by the Republic of Serbia Ministry of Mining and Energy states that Stantërg has reserves of at least 5.6 million tons (Energy, 2002). This is based on the Yugoslavian standards which are similar to the Russian Standard.

The current estimate of reserves by the Kosovo government (Independent Commission for Mines and Minerals) is shown in the following table.

Mines	**Category**	**Ton**	**Pb%**	**Zn%**	**Ag g/t**
Stantërg	A+B+C1	12,319,303.00	3.96	2.61	65.44
Artana (Përroi I ngjyrosur +Kaltrina)	A+B+C1	7,914,014.00	2.62	3.14	106.23
Hajvalia, Badovc, Kishnica	A+B+C1	4,675,000.00	5.49	4.17	79.9
Bello Berdo	A+B+C1	1,995,979.00	7.5	5.87	87
Crnac	A+B+C1	2,377,548.00	5.1	3.18	66
Total	A+B+C1	**28,481,844.00**	**4.08**	**3.2**	**80.1**

Table 8: Reserves (Kosovo Commission for Mines and Minerals, 2019)

While these values are from the Ministry of Economic Development, like the previous tables, they are slightly different and refer to reserves. This leads me to understand the previous tables as resources. The values in the above table are consistent with JORC measured and proven categories. The value of the mined ore is discussed further below.

Based on my research and the actual production figures, as available from the report, “The future of the property status of Trepca and its development (revitalization) perspective” (Group for Legal and Political Studies, 2015), show that the grade of ore has been continually decreasing over the years as expected. It also shows that the estimates are very high compared to actual recent production. Based on the information available and its provenance, it would appear that 3.96% Pb, 2.61% Zn and 65.44 gram per ton of silver for the Stantërg mine would be reasonable values for run-of-mine based on the report provided by the Kosovar government.

There are additional products that could be recovered. The report by Feraud indicates there are minerals of interest in the mines, concentrates, and the tailings that might be worth further research. The table below highlights the more interesting ones. While the characterization of the ore and the tailings appears to be comprehensive because of the completeness of the metals reported the actual values are somewhat suspect and need further evaluation since there was only one sample of each site of about 2 Kg examined.

The elements that seem to have the most interest, aside from the known and produced metals, are cadmium (168 g/ton), tin(36 g/ton), germanium(9.1 g/ton), gallium (5.3 g/ton), tellurium (elevated levels in the concentrates), and indium(6.8 g/ton). Tungsten is a metal of interest and appears to be high enough (104 g/ton) to warrant further consideration through additional sampling and testing. One reason stated for the interest in indium is that its concentration appears to increase as one proceeds downdip in the mine. While all these are discussed as possibilities, more work would need to be done to define the reserve and actual mine concentrations (Feraud, 2009).

TREPCA STARI TRG / STAN TERG

Sample Number	A.th.	Unit	1	2	3	4	5	6	7
Nature/Year			Run of mine ore 1948	Run of mine ore 2007	Zn concentrate 1999	Zn concentrate 2006	Zn concentrate 2007	Pb concentrate 2006	Tailings
Laboratory			Trepca/Zvecan	BRGM	S.G.S.	BRGM	BRGM	BRGM	BRGM
SiO2	1	%	12.10	7.2	0.39	1.2	<1	<1	16
Al2O3	1	%	2.51	<1	0.04	<1	<1	<1	<1
K2O	0.5	%		<0.5	0.005	<0.5	<0.5	<0.5	<0.5
CaO	1	%	3.40	14.4	0.56	1.6	1.6	<1	22.4
Fe2O3 t (total Fe expressed as Fe2O3)	1	%	11.02	42	4.65	22	19.2	8.8	23.2
TiO2	0.01	%		<0.01	0.02	<0.01	<0.01	<0.01	0.04
MgO	1	%	0.45	<1	0.030	<1	<1	<1	<1
MnO	0.01	%	2.33	1.88	0.56	0.68	0.72	0.04	**4.08**
P2O5	100	g/t		820		980	980	3340	770
S	0,1	%	28.93	23.8	32.8	31.6	32.6	17.7	12.1
Pb	0.1	%	**7.12**	**3.55**	**3.71**	**2.88**	**1.16**	**74.3**	0.374
Zn	0.1	%	**5.50**	**3.65**	**46.79**	**46.8**	**46.2**	**1.17**	**1.29**
Ag	0.2	g/t	85.8	70		66	37	**1260**	10
As	20	g/t	**5100**	**5430**	**400**	2970	760	2850	**5020**
Au	0.005	g/t	<0.2	0.195		0.140	0.066	0.349	0.210
Bi	10	g/t	87	80	100	184	92	**1300**	60
Cd	2	g/t	200	168	2300	**2090**	**2220**	72	52
Cu	5	g/t	800	1172	2700	**6420**	**5000**	**4740**	468
Ga	0.1	g/t		5.3		17	25	0.5	6.1
Ge	0.1	g/t		9.1		4.6	2.4	3.5	7.2
Hg	0.1	g/t				1.42		0.34	
In	0.1	g/t		6.8	<20	**45**	**70**	1.4	3.3
Sb	10	g/t	traces	268		124	136	**1380**	100
Se	1	g/t		<1	<20	<1	<1	2.3	<1
Te	1	g/t		<1	<20	4.5	<1	**19**	<1
Tl	0.1	g/t			<20	0.8		**4.9**	
B	10	g/t		12		<10	<10	<10	24
Ba	10	g/t		<10		28	16	<10	44
Sr	5	g/t		56		32	28	28	76
Be	2	g/t		<2		<2	<2	<2	<2
Li	10	g/t		<10		<10	<10	<10	<10
Ce	10	g/t		24		12	28	12	24
La	20	g/t		<20		<20	<20	<20	<20
Y	20	g/t		<20		<20	<20	<20	<20
Nb	20	g/t		20		<20	<20	<20	24
Zr	20	g/t		<20		<20	<20	<20	<20
Co	5	g/t		8	<20	8	8	12	8
Cr	10	g/t		<10		24	<10	20	24
Ni	10	g/t		44	<20	44	48	16	60
V	10	g/t		<10		<10	20	<10	<10
Mo	5	g/t		12		**60**	48	**120**	8
Sn	10	g/t		36	50	84	**200**	**120**	20
W	10	g/t		**104**		**72**	<10	<10	**64**

Table 9:Metal Concentrations of the Various Sources (Feraud, 2009)

Germanium is also mentioned in the report by the Ministry of Economic Development although there is no prospective quantity given by the ministry (Ministry of Economic Development, 2012).

Income calculations on the other minerals that are in the mine show there might be some additional interest in them provided the recovery cost does not exceed the value of the metal itself. The following table shows the value of some of the other metals identified in addition to the main ones of lead, zinc, silver, and sometimes gold, bismuth and copper. Again, the metals that have a potential and economic interest in recovery are highlighted and Arsenic is not considered.

Element	Unit	Run of Mine 2007	Price/gm (2019)	€ equivalent per ton of ore (2019 values) (Historical products)	€ equivalent per ton of ore (2019 values)
S	%	23.8			
As	g/ t	5430			
Pb	%	3.55	0.002	71.00	71.00
Zn	%	3.65	0.002	73.00	73.00
Ag	g/ t	70	0.513	35.91	35.91
Au	g/ t	0.195	43.256	8.43	8.43
Bi	g/ t	80	0.005	0.40	0.40
Cu	g/ t	1172	0.005	5.86	5.86
Cd	g/ t	168	0.001		0.17
Sn	g/ t	36	0.016		0.58
Ge	g/ t	9.1	2.352		11.83
Ga	g/ t	5.3	0.336		1.78
In	g/ t	6.8	0.336		2.28
				194.60	211.24

Table 10:Value of Mine Metals (Feraud, 2009)

The above chart shows that if germanium, gallium, and indium are recovered at the smelter in addition to the normally recovered products, an increase in income of about 5% could be realized. Recovery of copper, if feasible also increases the income.

Bismuth, as mentioned previously, is most often a byproduct of processing lead ores (Asian Metals, 2019). If one uses a rough rule of thumb of €25 to €50 per ton of ore processed (Mining.com, 2019), there is justified reason to consider evaluation of the mine for recovery of minerals other than lead, zinc, and silver although the main value for the mine is in these three metals. Gold has been produced from the mine as have most of the other metals. However, the ones that do not appear to have been recovered historically are Indium, germanium, and tin. These should be reviewed economically and considered as part of the potential of the mine, however, there might not be enough tin to be worth considering. It depends on the marginal cost of production which includes the cost of smelting and refining.

The tailings have a similar profile. There are elements that might have an interest but assuming that tailings processing is similar to open-pit processing and the tailings can be processed for €10-€20 per Ton making the potential recovery of several of the additional metals significant. (Mining.com, 2019). The metals that have a potential and economic interest in recovery are highlighted and Arsenic is not considered. Again, the tungsten could be a contaminant from the testing process.

Element	Units	Assay	Price/gm	€ equivalent per ton (2019)
Pb	%	0.374	0.002	7.14
Zn	%	1.29	0.002	26.66
Ag	g/ t	10	0.513	5.13
As	g/ t	5020	0.001	3.32
Au	g/ t	0.21	43.256	9.08
Bi	g/ t	60	0.005	0.32
Cu	g/ t	468	0.005	2.43
In	g/ t	3.3	0.336	1.11
Sn	g/ t	20	0.016	0.32
W	g/ t	64	0.039	2.50
Gross Income per ton if all are recovered				58.01

Table 11:Tailings Metals (Feraud, 2009)

Given this profile, there are certain elements that are probably not worth reviewing. As an example, the average workable concentration for tungsten is between 0.1% and 1.0% while the concentration in the tailings is 64 gm/t (0.0064%). Again, it is possibly a contaminant. However, since there is so much zinc in the tailings, the original processing methods for zinc recovery should be reviewed for improvements that will provide a higher yield in the original processing.

Generally, however, the concentrations in the tailings are of such a poor quality that there is no reason to reprocess them. The exception to this would be if recovery methods have improved to the point of making low concentration residues economic.

That being said, other tailings have potential, according to the UNMIK report. They have done some analysis of the existing sites and put together a table. However, the same problem exists with the concentrations as above. The metals that have a potential and economic interest in recovery are highlighted and Arsenic is not considered.

Type	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings Old	Tailings New	Granulated Slag	Zn Residue EMCO	Zn Residue Jarosite
Location	Gracanica	Badovac	Artana	Gornje Polje	Zitkovac	Stantërg	Leposavic	Leposavic	Zvecan	MIP	MIP
Status	closed	active	closed	closed	closed	Active	closed	active	closed	closed	closed
Quantity	11.5M.t	8M.t	1M.t	12M.t	9M.t	9M.t	2.7M.t	3.7M.t	2.6M.t	0.5M.t	0.13M.t
Al_2O_3 %	4.40%	5.10%	1.60%			0.57%	2.80%		0.02%	1.10%	
Bi mg/Kg	17	18		17		49	<10		25		
Cd mg/ Kg	47	34		<10		<10	18			2,000	
Cu%	0.03%	0.03%		0.01%		0.02%	0.01%			0.50%	
Fe_2O_3%	24.00%	28.00%		32%		30%	24		29%	24%	
MgO%	3	4		<1	No Available Information	<1	3.9	No Available Information		0.7	No Available Information
Ni%	0.03%	0.06%		0.02%		0.00%	0.08%				
Pb%	0.71%	0.60%	1.00%	0.21%		0.22%	0.33%		2.00%	4.50%	
Zn%	0.69%	0.56%	0.50%	0.14%		0.12%	0.26%		12%	21%	
ZnO	7-12%										
Au g/T			1.3								
Ag g/T	17	12	20	12					256	50	

Table 12:Tailings Summary (Feraud, 2009)

These potential areas are significant in their quantities and, in some cases, the potential for remediating an environmental problem. These fall into 3 categories. They are:

- Mining/ Development waste
- Concentrator Tailings
- Processing By-products

The mining development waste is not likely to contain anything of interest as it is normally barren/ low grade. The older tailings might contain useful products as the old recovery processes were not as efficient as present methods (poor recovery rates) so there may have been minerals left in the material that can be effectively recovered by modern processes. The metallurgical by-products fall into the same category (Trepca Kosovo Under UNMIK Administration, 2005).

4.4 Economics of Kosovo and Trepca

The economics of the Trepca are tied directly to the economics of the country. As has been previously mentioned, the country is very poor, and as such has no real industry. Kosovo imports a very large number of items. The main imports are mineral products, machinery, appliances and electric materials, prepared food, beverages and tobacco, metals and chemical products. Kosovo's imports most of its materials from several partners. The main partners are Macedonia, Germany, Serbia, Italy, China and Turkey. At the same time, Kosovo's main exports are metals (47 %) and mineral products (30 %), or 77% of the total exports. Kosovo also exports a variety of items. Chief among these are prepared food, plastics and rubber, machinery, appliances and electric materials and textiles. Kosovo mainly exports to Italy, Albania, Macedonia, Switzerland, Montenegro and Germany.

The balance of trade is shown in the following graph. It continues to worsen with imports greater than exports. This is true even though the economy is growing at a slow pace. It is also important to note that Foreign Direct Investment (FDI) has been continually decreasing.

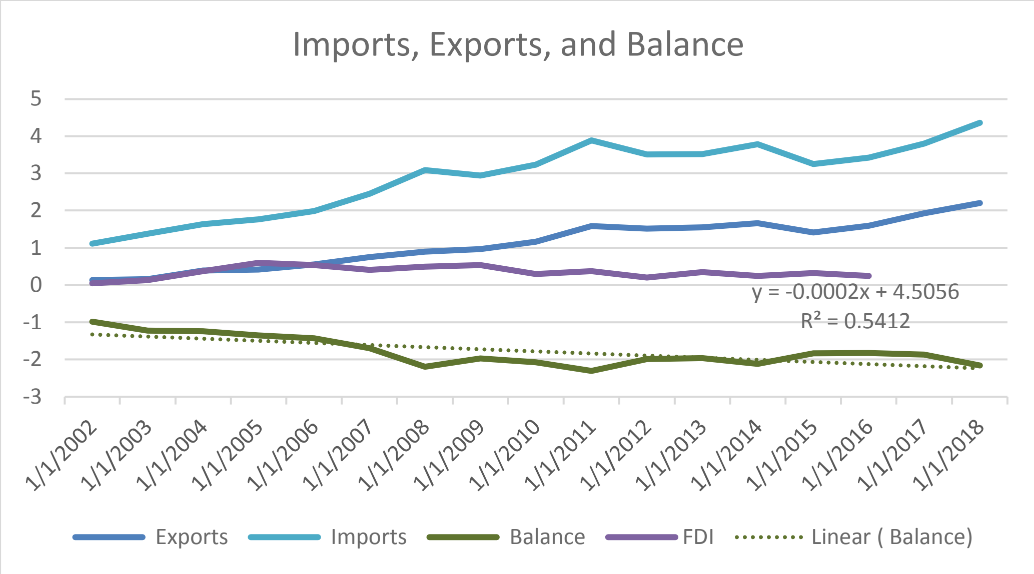


Figure 33 Kosovo Imports, Exports, and Balance

Kosovo export data shows that the export of lead and zinc concentrate to be about 9% of the total exports with a value of about €32.2 million in 2017. Production information for the Stantërg mine gives its contribution of about €26.6 Million in 2017. Given that these values are consistent, and there are other mines that contribute to the total exports, the overall values appear to be reasonable. The Kosovo Agency of Statistics (KAS) reported a reduction in metals of exports of 15.3% while my calculated value, based on production, is 14.5% so those values are also comparable.

5 Economic Models of the Mine

5.1 Economic Model

There are a variety of sources for data and models of mines. One of these is the “O Hara” model which was originally published in 1980. It was based on data gathered from a variety of countries. The author updated the model in 1988 and the model was published in the Society of Mining, Metallurgy, and Exploration’s “SME Mining Engineering Handbook” in 1992 (Akbari, 2005).

The majority of the equations in the O Hara model are for capital and fixed costs. As such, I felt that the majority of the information was not applicable in this case. Based on interviews with the management and staff of the mine, it is my opinion that the costs for the mine and concentrator are skewed and need to be addressed differently.

In general, it appears the impact of fixed costs and capital investment is stepwise in terms of increases in capacity while variable and direct costs are more nuanced. In this particular case, the mine is running at a very low utilization. The overall capacity of the mine and plants is considerably higher than current operating levels. As an example, the flotation plant runs about once per week for about a day even though it is staffed full time so the costs are skewed due to startup and shutdown costs in addition to higher maintenance costs.

The capital, operating, and milling (flotation) costs are independently accounted for and modeled as such along with being calibrated to match the costs given me by the mine management.

Another source of data is CostMine from Infomine. This is a commercial source of cost models and cost data for individual pieces of equipment. The CostMine data includes models for various sizes of processing plants and the associated equipment sizes and labor associated with the different processing rates. Cost mine also has a variety of models for different types of mines (surface, underground, placer) and hydrometallurgical models for one, two, or three product recovery circuits (Infomine, 2019).

For the purpose of this paper, I will use the models developed by the United States Bureau of Mines (now the United States Geological Survey) in 1991. This series of models were developed by the Bureau to make quick estimates for capital and operating costs using existing mines and performing regressions on the data. The equations take the form of:

$Cost_i = (Cost\ Factor_i) \times (Short\ Ton\ Production/\ day)^{(Regression_i\ Factor)}$.

The equations cover both capital and operating costs, are simple, but appear to be accurate enough, when updated, to be suitable for inclusion in a spreadsheet model. The Bureau of Mines report allows for the creation of both a capital model and an operational model. The report contains several models. These are for both open pit (2) and underground (6) mines. There are 11 mill models. Cost equations are included for access roads, power lines, and tailings ponds. The paper also contains adjustment factors for haul distances in open pit mines and mine depth for underground mines. The costs are updateable using standard cost indices. While they are simplified models there is enough of a breakdown to allow analysis of the various cost areas of the mine (Camm, 1991). The financial analysis of the Trepca mine is based on a model created specifically for the purpose from this information. This model is included in appendix 7 of the paper. Several of the sheets are truncated as many of the cells to the right of the displayed pages are continuations of the data shown in various rows.

The project cost model is one that can be used not only for the Trepca, but for other mines as well. The model and can also handle multiple input variations. In addition, the intent is to also have a model that can be used with a variety of spreadsheet programs and systems. To test that goal, the model was successfully run on a Linux system with kernel 4.19.0-6 and LibreOffice version 6.1.5.2.

Using this model, the different inputs, such as variation in grade, production, recovery, and content of metals in the concentrate and their combined effect on the profitability of the mine. The model used for this paper has been converted to € per ton and costs updated to 2019. It also includes a breakdown of the costs associated with the operation of the mine. The ore grade is based on the values reported to the Kosovo government. The reported grades are also the basis of the calculation for the government royalty. These values are 3.43% wt. of lead, 3.11% wt. of zinc and 33.8 gm/Ton for the silver. There are no given amounts for any of the other possible metals so they are currently treated as contaminants. This includes any gold that may be present. The cost summary for a production level of 110 000 tons per year, which is the current stated capacity of the mine by management, is shown below.

The costs in the model were directly calibrated using cost data from the mine itself. I am confident in their accuracy relative to the stated costs. However, I do not have confidence in the overall accuracy as I have no secondary source of information on the operational costs of the mine and other expenses. Based on these two factors, I would estimate the Operational Expenses accuracy (OPEX) to be +/- 20% and the Capital Expenditure accuracy (CAPEX) to be +/-50%.

First Year Total Costs	Euros	Percent
Labor	3,544,525	36.71%
Electricity	1,802,728	18.67%
Equipment	1,322,352	13.70%
Construction material	863,658	8.95%
Steel	828,673	8.58%
Lumber	447,765	4.64%
Explosives	408,694	4.23%
Lube	215,498	2.23%
Reagents	122,688	1.27%
Fuel	98,345	1.02%
Tires	44,264	0.46%
Total Cost	9,654,926	100.00%

Table 13: Estimated Mining Costs

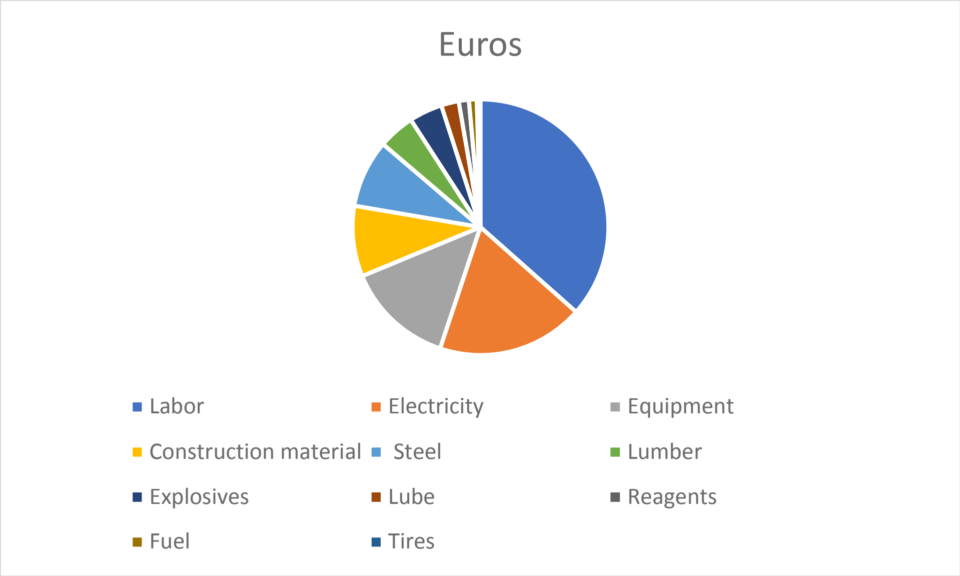


Figure 34 Breakdown of Costs

This cost is calibrated against the cost information provided by the mine management and included in the appendices. The calibration takes into account the international prices for the various materials the mine needs and adjusted labor rates based on the current Kosovo economy.

The initial analysis of the mine based on the model indicates the mine is operating at a loss at this time. That loss is about 18% per year. The management stated that they believe the break-even to be approximately 60 000 tons per year. The model shows this to be a loss of more than 33% per year. The split between the income from metals recovery can be seen in the following chart.

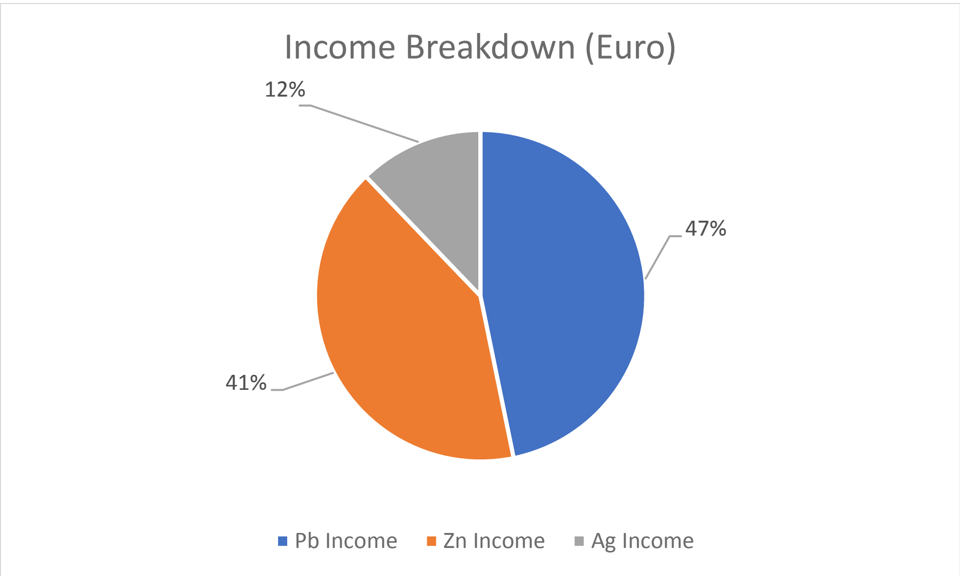


Figure 35 Breakdown of Income

A basic production capacity analysis using the above concentrations shows the following trend and break even.

Processing Rate (Tons/ Yr)	Income	Mining	Processing	Treatment Charge	Total Expenses
50	4,920,141	3,960,313	2,308,005	1,583,148	7,851,466
100	9,840,282	6,025,303	3,150,008	3,166,296	12,341,607
150	14,760,423	7,841,220	3,838,466	4,749,444	16,429,131
250	24,600,705	11,109,214	5,017,017	7,915,740	24,041,972
350	34,440,987	14,101,371	6,058,522	11,082,036	31,241,929
450	44,281,269	16,922,767	7,021,614	14,248,332	38,192,713

Table 14:Total Expenses by Processing Rate

The difference in the income versus the total expenses is that the mine costs as shown do not include the royalties that are due the Kosovar government and are not a direct mine cost. They royalties are included in the break-even analysis. The break-even capacity, based on the current model is about 229,900 Tons per year.

These values are shown in the following table.

First Year Total Costs	Euros	Percent
Labor	4,891,280	32.18%
Electricity	3,151,955	20.74%
Equipment	1,905,804	12.54%
Construction material	1,541,513	10.14%
Steel	1,347,545	8.87%
Lumber	910,715	5.99%
Explosives	772,738	5.08%
Lube	289,005	1.90%
Reagents	256,438	1.69%
Fuel	131,687	0.87%
Tires	75,876	0.50%
Total Cost	15,198,680	100.00%

Table 15:Total Expenses for the Break-Even Production

The following chart shows the break-even analysis in a chart format.

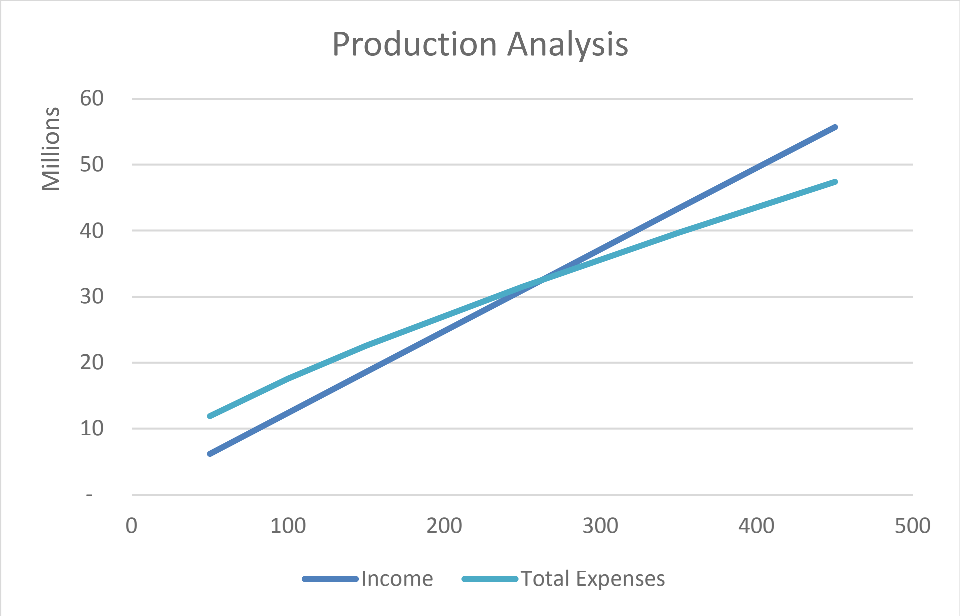


Figure 36 Break Even Chart

If only lead and zinc are considered, then the mine has to produce ~417,800 tons of ore per year to break even. The first year costs, on this basis, are shown in the following table and chart.

First Year Total Costs	Euros	Percent
Labor	6,482,632	28.65%
Electricity	5,067,738	22.39%
Equipment	2,615,604	11.56%
Construction material	2,503,942	11.06%
Steel	2,036,937	9.00%
Lumber	1,618,847	7.15%
Explosives	1,294,711	5.72%
Lube	377,613	1.67%
Reagents	466,019	2.06%
Fuel	166,831	0.74%
Tires	117,420	0.52%
Total Cost	22,630,873	100.00%

Table 16:Total Expenses for the Break-even Without Silver

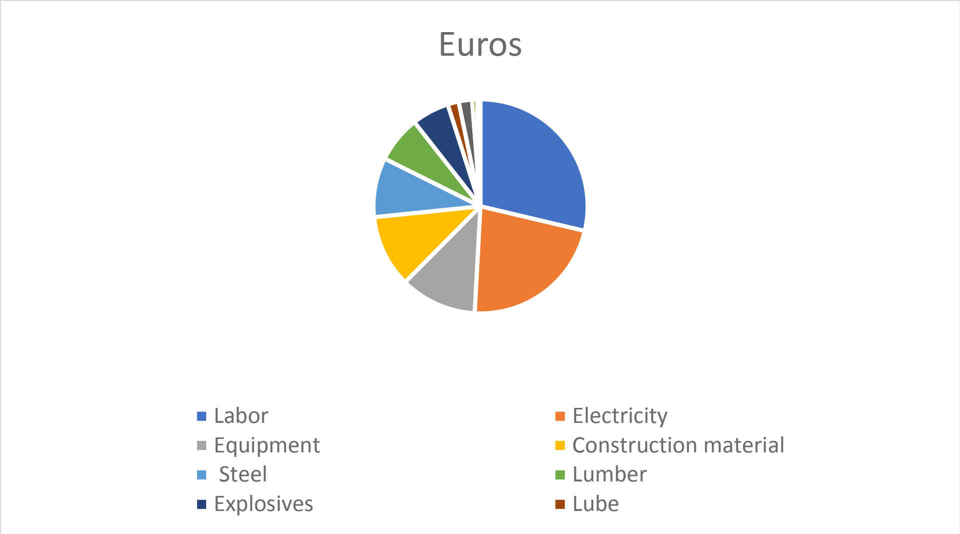


Figure 37 Lead Zinc Production Expense Chart

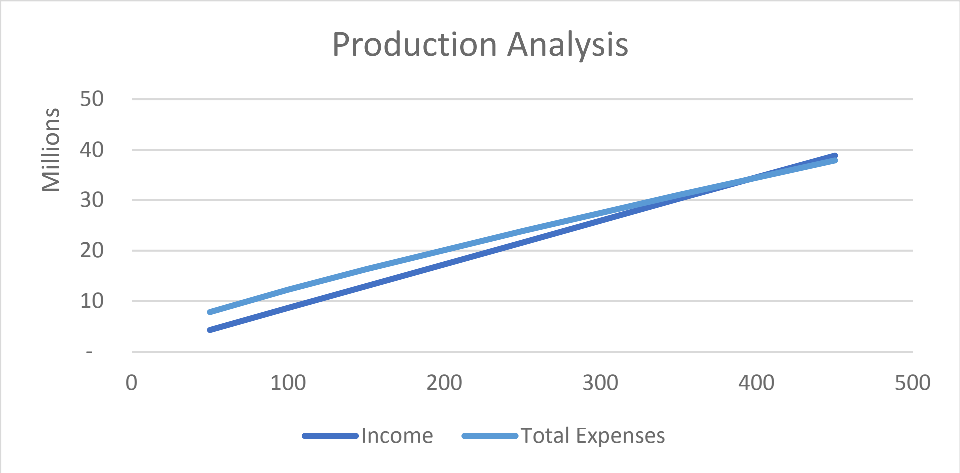


Figure 38 Lead Zinc Production Break-even

Gold recovery does have an impact on the return of the mine. Based on a concentration of 0.195 grams per ton in the ore and a recovery of 73% of the gold, it can add up to 6% to the total return of the mine. Based on discussions with management, and the information provided by the Kosovar government, it is currently not accounted for nor does it provide an income. The potential effect on income is shown in the following table and chart.

First Year Income	Euro	
Pb Income	10,587,101	44.13%
Zn Income	9,280,614	38.69%
Ag Income	2,756,784	11.49%
Au Income	1,364,580	5.69%
Total Income	23,989,078	100.00%

Table 17: Potential Income Including Gold

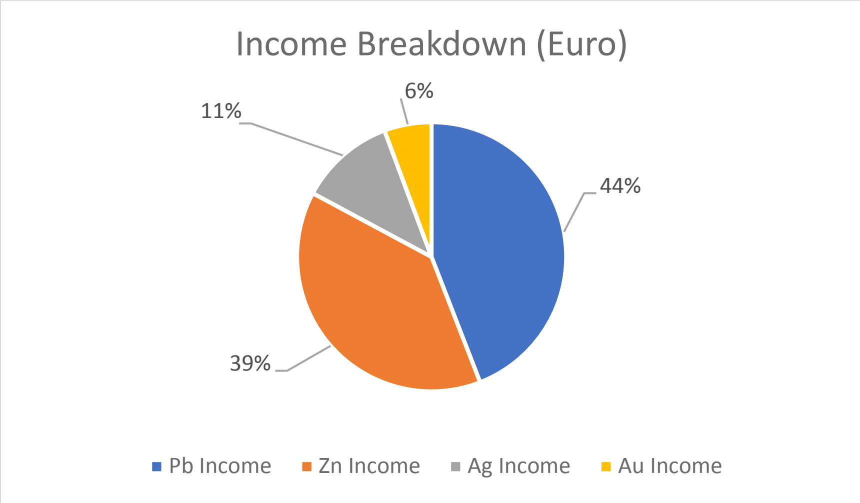


Figure 39 Income Including Gold

A sensitivity analysis was conducted in five areas. This was done with the break-even model. These were the ore grade, processing recovery, mining labor, processing labor, and tonnage. The results show that the most critical variable, given that grade is uncontrollable, is the recovery of the minerals. The tonnage, mining labor, and processing labor, while having a similar trend to the grade and recovery, do not impact the economics as much. The sensitivity analysis results are shown in the following table. The values shown are the first-year rate of return with the base case being that of breakeven so that the initial rate of return is zero.

Sensitivity Analysis	-10%	Base Case	10%
Grade	-10.09%	0.00%	9.15%
Recovery	-7.01%	0.00%	6.57%
Tonnage	-2.54%	0.00%	2.28%
Labor	-4.34%	0.00%	4.28%
Operating	-4.39%	0.00%	4.81%

Table 18: Sensitivity Analysis

These sensitivity results for changes in recovery, tonnage, labor, and operating costs are shown in the following graph.

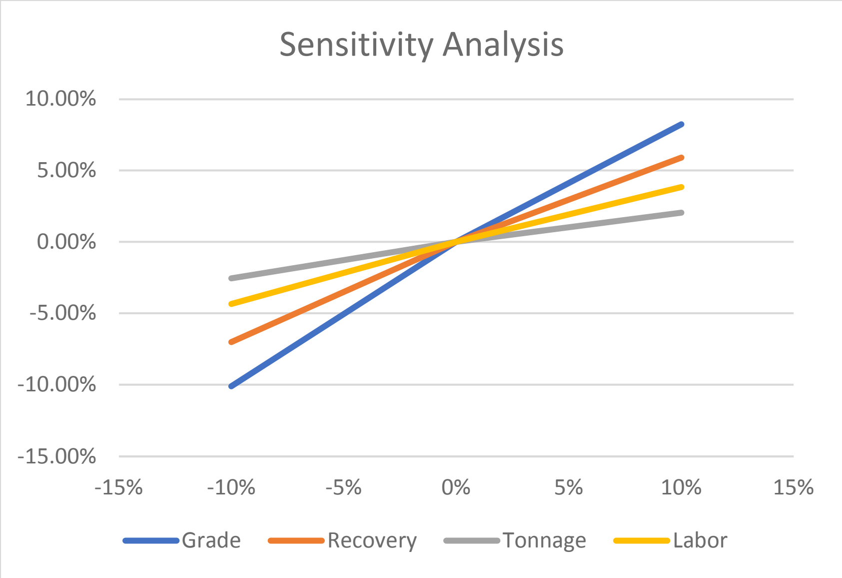


Figure 40 Sensitivity Analysis

Based on the analysis, the critical factors for the operation are the grade of ore and the recovery, or the amount of metal recovered from the ore. The grade cannot be changed much as it is a function of the mine but there is some control over by searching for higher grade faces in the mine and producing them in a process called high-grading. However, this practice is not sustainable.

Additionally, if there are improvements in recovery, processing labor and mining labor of 10%, then the amount of ore required for "break even" drops to ~122,000 tons. Alternatively, if the production rate is kept at the break-even quantity of about 230,000 tons the model yields a rate of return of 14.74%. The breakeven quantity costs are shown in the following table.

Annual Cost	Mining	Processing	Treatment Charge	Total Expenses
First Year	9,218,749	4,088,137	8,007,848	21,314,733

Table 19: Break even Expenses, Needed Cost Reduction

Based on the operation of the mine and the calculated break-even of about 230,000 tons per year, the fixed cost of increasing the production would require the purchase of a LHD so that there can be 2 machines moving ore from the deposit to the lift. The lift has the required capacity to get the ore from the depthof the mine. The downstream processes, specifically the concentrator, has the capacity to handle the increase in feed. There would also be an increase in the cost of labor because more people are required to mine, load, and process the ore.

5.2 Concentrator Process Analysis

There are a variety of tools that can be used to analyze processes to determine quality control problems. These have a variety of names. They are commonly in a category called Statistical Process Control (SPC). Originally developed as a control method by Walter Shewhart (Walter A. Shewhart, 2019) at Bell Laboratories in the early 1920s and further developed by W. Edwards Deming (W. Edwards Deming, 2019) throughout WWII and after. The area of SPC became important to Japan as they developed their industries and began to compete on a global basis. The basic process also goes by other names and variations such as Total Quality Management, Quality Assurance, 6 sigma, Reliability Engineering, and ISO 9000 as examples. The use of SPC can show systematic variations of a process so that a cause can be determined and "repaired".

With the data provided by the Independent Commission for Mines and Minerals (ICMM) of Kosovo an analysis of the recovery of lead and zinc can be made at a high level. As the data shows in the following charts, the overall recovery process is good as it stays within the upper and lower control limits but both show there is a non-random element in the recovery that is causing a lower overall recovery for both lead and zinc than there should be.

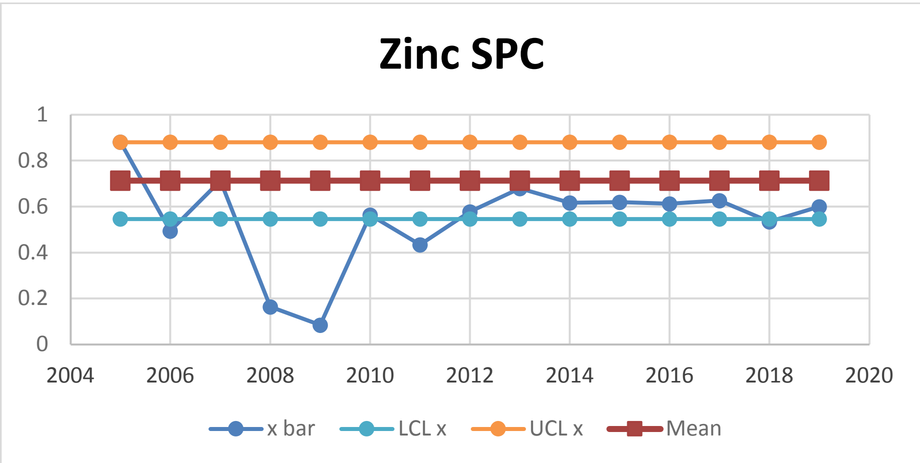


Figure 41 Zinc SPC Chart

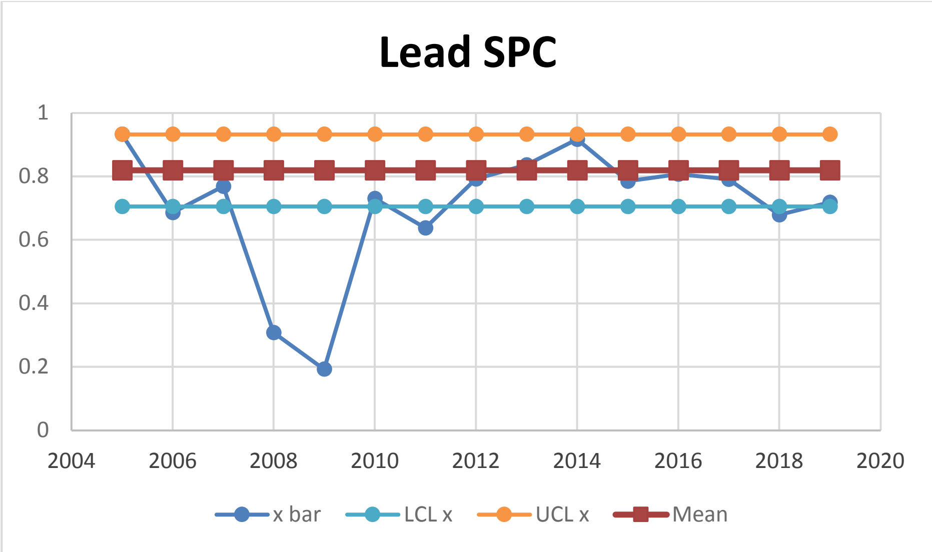


Figure 42 Lead SPC Chart

This variation is -3.6 percent for lead and -11 percent for zinc using data from 2014 to the present. Recovering these amounts of metal would conservatively increase the income to Trepca by approximately €500,197 per year or about 2.26% rate of return above break-even.

More detailed data is needed for a thorough analysis as this needs to be done at a plant and process line level.

In researching literature, one potential solution is to perform an analysis similar to the work done by Xianping Luo on the importance of pulp concentration for the flotation of galena. He demonstrated that the increase of solid-in-pulp concentration had a significant impact on the recovery and selective separation of lead (Xianping Luo, 2016). This would help by determining the optimal balance with regards to the grinding and flotation of the Trepca ores. However independent work would need to be done because the ore that was tested appears to have no arsenic which could affect the overall recovery.

Additional independent analysis should be done on the tailings to determine if there are problems with the liberation either in the grinding circuit or the flotation process directly. This type of study quantizes the particle size, the type of minerals, and the amount remaining. When this is compared with the feed a determination of the actual recovery can be made along with recommendations on the process improvements.

Part of the study around the flotation would be to determine what the theoretical recovery is for the mine. This, along with actual recovery, is based on many factors such as agitation, chemistry, air flow, minerology, and particle size to name a few. The effects of this can be shown on a grade/

recovery curve. The grade/ recovery curve shows the percent metal recovery against the final concentrate grade. These factors drive a material balance around the flotation, the recovery, and subsequently the location of the operating point on a grade/ recovery curve. A grade/ recovery curve is a visual representation of the flotation process and can contain theoretical limits to the actual recovery. For example, if the feed is only the mineral of interest, then the recovery of the mineral will be 100% because there is no other material in the process and the grade will be 100% as there is no other material in the concentrate. The actual amount of material in the concentrate and the tailings would still vary based on the effectiveness of the process. As the feed changes, the theoretical recovery shifts down and to the left on the chart and there are reductions in both the grade and the recovery. In general, since there is not a pure feed, the effectiveness of the separation is reduced. As you move away from the theoretical limits the chart will show increased waste material in the concentrate (dilution) and a greater transfer of the mineral of interest to the tailings (losses). Changes in the process to improve the operation will shift the operating point to the right and up. A theoretical grade/ recovery chart is shown in the figure below. The curve shown is the hypothetical curve for the mine operation. The hypothetical operating point is also shown on the figure. The values for the hypothetical operating point are used in the economic model for the mine.

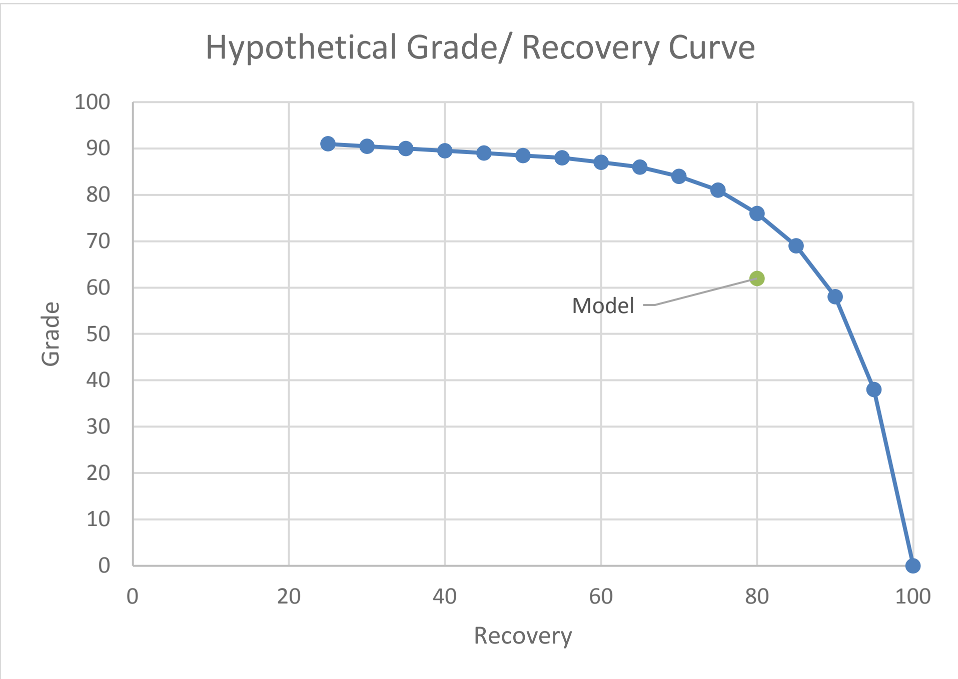


Figure 43 Hypothetical Grade Recovery Chart

5.3 Re-Processing Opportunities

There are additional opportunities available in the re-processing of tailings or scrap piles around the various locations. As previously mentioned, there was some metallurgical work done on the run-of-mine and the tailings. Analysis showed there were some possibilities to re-process the waste piles and tailings to produce saleable products, improve the environment, and also provide a net positive income for the mine owners. The analysis done is shown in the following table. The metals with a concentration of higher than 100 PPM (100 gram per Ton) are highlighted and Arsenic is not considered. Again, the tungsten value is suspect.

Element	Unit	Run of Mine 1948	Run of Mine 2007	Zn Concentrate 1999	Zn Concentrate 2006	Zn Concentrate 2007	Pb Concentrate 2006	Tailings
S	%	28.93	23.8	32.8	31.6	32.6	17.7	12.1
Pb	%	7.12	3.55	3.71	2.88	1.16	74.3	0.374
Zn	%	5.5	3.65	46.79	46.8	46.2	1.17	1.29
Ag	g/ T	85.8	70		66	37	1260	10
As	g/ T	5100	5430	400	2970	760	2850	5020
Au	g/ T	<0.2	0.195		0.14	0.066	0.349	0.21
Bi	g/ T	87	80	100	184	92	1300	60
Cd	g/ T	200	168	2300	2090	2220	72	52
Cu	g/ T	800	1172	2700	6420	5000	4740	468
In	g/ T		6.8	<20	45	70	1.4	3.3
Te	g/ T		<1	<20	4.5	<1	19	<1
Ti	g/ T		<1	<20	0.8		4.9	
Mo	g/ T		12		60	48	120	8
Sn	g/ T		36	50	84	200	120	20
W	g/ T		104		72	<10	<10	64

Table 20:Concentration of Various Process Streams (Feraud, 2009)

The analysis of this table shows that there are a variety of metals that are present in trace concentration and are low enough that recovery would be uneconomic. However, there are several that have been recovered in the past that are still significant. These being Bismuth, Cadmium, and Copper. What is more significant is the tailings. There are a variety of metals and minerals present that would possibly be worth recovering. These are shown in the next table.

The report goes on further to state another focus of the study was the Novo Brdo (Artana) ore deposit. They state the mine has a high concentration of indium in its zinc concentrate of around 200gm/ Ton while the ore itself has a concentration of 6.8 gm/ ton. They go on further to state the old tailings of the Artana could contain up to 2.5 g/ Ton of gold with a potential of 21 million tons of "ore". The report goes further to state the recovery would be hampered by the lack of free gold and the iron being in sulfide compounds (Feraud, 2009).

Another report done at the same time does not have the same quantities of tailings. However, it does provide a list of tailings and a metallurgical analysis of the individual tailings. They agree that there is a substantial amount of gold and silver in the Artana tailings.

Type	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings Old	Tailings New	Granulated Slag	Zn Residue EMCO	Zn Residue Jarosite
Location	Gracanica	Badovac	Artana	Gornje Polje	Zitkovac	Stantërg	Leposavic	Leposavic	Zvecan	MIP	MIP
Status	closed	active	closed	closed	closed	active	closed	active	closed	closed	closed
Quantity	11.5M.t	8M.t	1M.t	12M.t	9M.t	9M.t	2.7M.t	3.7M.t	2.6M.t	0.5M.t	0.13M.t
Al_2O_3 %	4.40%	5.10%	1.60%			0.57%	2.80%		0.02%	1.10%	
Bi mg/Kg	17	18		17		49	<10		25		
Cd mg/ Kg	47	34		<10		<10	18			2,000	
Cu%	0.03%	0.03%		0.01%		0.02%	0.01%			0.50%	
Fe_2O_3%	24.00%	28.00%		32%		30%	24		29%	24%	
MgO%	3	4		<1	No Available Information	<1	3.9	No Available Information		0.7	No Available Information
Ni%	0.03%	0.06%		0.02%		0.00%	0.08%				
Pb%	0.71%	0.60%	1.00%	0.21%		0.22%	0.33%		2.00%	4.50%	
Zn%	0.69%	0.56%	0.50%	0.14%		0.12%	0.26%			21%	
ZnO	7-12%										
Au g/T			1.3								
Ag g/T	17	12	20	12					256	50	

Table 21: Tailings Summary (Feraud, 2009).

6 Alternative Process Recovery

Minerals can generally be classified by a concentration factor. This factor is the amount by which an element needs to be concentrated above the earth's crustal value to be economic. In this table, the higher concentration values are the economic averages of existing mines. The lower values are the approximate lower limits for economic feasibility. This lower limit will vary with both the market and newer technologies.

	Crust Concentration (%)	Concentration for Economic Mining (%)	Approximate Concentration Factor
Pb	0.0012-0.0016	3.0-5.0	2,500-4,200
Zn	0.0013-0.007	1.0-7.1	800-5,000
Cu	0.0055-0.007	0.3-1.0	55-180
Ni	0.0075-0.008	0.2-1.22	27-163
Ag	0.0000063-0.000007	0.021-0.05	3,500-8,000

Au	0.0000004	0.0001-0.0005	250-1,250
Fe	5.0-6.3	30-62	6-12
Cr	0.02	30	1,500
Ni	0.0075-0.008	1.5	180-200
Al	8.13	30-47	4-6
Mo	0.000016	0.21	13,000
Mn	0.10	35	350
U	0.0002	0.1	500
Co	0.0025	0.05	20-60
V	0.01-0.019	0.6	32-60
Ti	0.44-0.66	3-12	7-27
W	0.00011-0.000125	0.1-1.0	900-9,100

Table 22: Total Expenses by Processing Rate

Source: https://universalium.academic.ru/294684/Concentration_factors_for_ore_bodies_of_common_metals, also https://www.911metallurgist.com/blog/geological-theory-of-plate-tectonics-mineralizing-process, also https://www.slideshare.net/hzharraz/topic-1concepts-of-an-ore-deposit, also USGS

While there is a large quantity of iron, it is not recoverable. The report states this as the mineral hematite (Fe_2O_3). It is about one quarter of the total tailings or about 13 million tons of Fe_2O_3 equivalent. However, the iron in this type of ore body is usually a sulfide (pyrite or phyrotite) and not easily, or economically, recoverable.

Another possibility is the granulated slag at Zvecan. According to the work done by the French Cooperative (Feraud, 2009), it contains approximately 2.6 million tons of material with a substantial amount of zinc (12%) along with lead (2.0%) and silver (256 gm/T) in recoverable quantities.

An analysis of the material done at Montanuniversität Leoben is shown in the following table.

Compound	Wt. [%]	Mole Wt	Moles Oxygen	Mass Oxygen %	Moles of Metal	Metal Mole Wt	Mass % Metal	Metal (Gm/ Ton)	Mass Metal (Tons)
MgO	1.17%	40.30	1	0.465%	1	24.31	0.706%	7,062	17,654
Al2O3	1.94%	101.96	3	0.912%	2	26.98	1.026%	10,257	25,642
SiO2	19.56%	60.08	2	10.419%	1	28.09	9.144%	91,444	228,611
P2O5	0.05%	141.94	5	0.028%	2	30.97	0.021%	214	535
SO3	3.03%	80.06	3	1.815%	1	32.07	1.213%	12,127	30,318
Cl	0.01%	35.45	0	0.000%	1	35.45	0.013%	130	325
K2O	0.34%	94.20	1	0.058%	2	39.10	0.284%	2,839	7,098
CaO	19.89%	56.08	1	5.674%	1	40.08	14.213%	142,131	355,326
TiO2	0.15%	79.87	2	0.061%	1	47.87	0.091%	911	2,278
Cr2O3	0.05%	151.99	3	0.015%	2	52.00	0.034%	335	838
MnO	0.72%	70.94	1	0.162%	1	54.94	0.557%	5,568	13,921
Fe2O3	37.18%	159.69	3	11.175%	2	55.85	26.005%	260,046	650,116
NiO	0.02%	74.69	1	0.005%	1	58.69	0.018%	181	452
CuO	0.68%	79.55	1	0.137%	1	63.55	0.544%	5,440	13,601
ZnO	11.15%	81.38	1	2.193%	1	65.38	8.961%		224,027
As2O3	0.11%	197.84	3	0.027%	2	74.92	0.085%	848	2,121
SrO	0.02%	103.62	1	0.003%	1	87.62	0.016%	161	402
MoO3	0.06%	143.94	3	0.019%	1	95.94	0.038%	380	950
Ag2O	0.01%	231.74	1	0.001%	2	107.87	0.009%	93	233
SnO2	0.02%	150.71	2	0.003%	1	118.71	0.012%	118	295
Sb2O3	0.08%	291.52	3	0.013%	2	121.76	0.063%	635	1,587
BaO	0.03%	153.33	1	0.003%	1	137.33	0.022%	224	560
PbO	3.74%	223.20	1	0.268%	1	207.20	3.470%		86,751
Total	100.00%			33.46%			66.55%		

Table 23: Metallurgical Analysis of Slag Done at Montanuniversität Leoben

The analysis shows the slag to 8.96% zinc, 3.47% lead, and 93 gm per ton in addition to 13,600 tons of copper.

Additional analysis of the slag was done by Afrim Osmani and Musa Rijaz (Osami, 2009). While their study shows that there are a "quantity of rare metal" the paper does not detail these metals. They do detail the amount of lead, zinc, and other metals in a similar manner to the above. This gives us a second source of analysis that we can use as a comparison. Because of the way the metals and compounds are reported there is not a direct correlation and the numbers may not total 100%.

Compound	[%]	Mole wt	Moles O	Mass Oxygen %	Moles of Metal	Metal Mole Wt	Mass % Metal	Metal (Gm/ Ton)	Mass Metal (Tons)
MgO	3.15%	40.30	1	1.250%	1	24.31	1.900%	18,996	47,489
Al2O3	7.77%	101.96	3	3.658%	2	26.98	4.112%	41,123	102,807
SiO2	22.96%	60.08	2	12.228%	1	28.09	10.732%	107,323	268,308
S	1.54%	80.06	0	0.000%	1	32.07	0.617%	6,168	15,419
CaO	16.48%	56.08	1	4.702%	1	40.08	11.778%	117,781	294,453
FeO	35.31%	159.69	1	3.538%	2	55.85	24.697%	246,967	617,418
Cu	0.68%	79.55	0	0.000%	1	63.55	0.544%	5,440	13,601
ZnO	10.30%	81.38	1	2.025%	1	65.38	8.275%	82,750	206,875
Pb	1.82%	207.20	0	0.000%	1	207.20	1.820%	18,200	45,500
Total	100.01%			27.42%			64.51%		

Table 24: Metallurgical Analysis of Slag Done in Kosovo

Normally, the zinc slags are economic at a concentration of 9% to 10% and a quantity of 1 million tons. An economic analysis of the processing of this residue shows that it has a very high potential to generate an income that would allow a variety of other activities to be undertaken, including significant environmental remediation. The zinc slags are traditionally treated by a fuming process, however, the main reason for looking at other processes, particularly a hydrometallurgical process is that there is existing equipment that might be utilized to recover the metals with improved chemistry.

One possible process for the recovery of zinc was developed by Mintek called the Enviroplas process. The process heats the feed to a temperature of between 1400ºC and 1500ºC. This vaporizes the lead and the zinc. The vapors are then sent to a lead splash condenser. The zinc and lead are condensed out of the vapor. The condenser is operated at about 550ºC. The resulting solution is cooled down to about 450oC to separate the solidifying zinc (420ºC M.P.) from the liquid lead (327ºC M.P.). The zinc recovered is 99.8% pure. Materials not vaporized in the initial heating are recovered as a disposable slag.. Depending on the operation, this process can recover 65% to 85% of the zinc, however, it makes no mention of the recovery of the lead or of the cost of the process. It does state that the slag from the process is safe for disposal (Abdel-latif, 2002).

Another process which might be used is a hydrometallurgical process. The residue is mixed with H_2SO_4, then roasted. The mix is then subject to a water leaching. This is followed by a NaCl leach to recover the lead. Approximately 80% to 85% of the Zn can be recovered. Depending on the process conditions, greater than 90% of the lead can be recovered (Turan, 2004).

Based on the above chemical analysis, and the zinc, lead and sliver are recovered at the 90% level, the income from the recovery can be good. The investment in the process is determined by information provided by the Proceedings of the International Symposium on Primary and Secondary Lead Processing, Halifax, Nova Scotia, August 20-24, 1989 and updated to current cost values. The calculations are then done by summing the income and expenses, including the royalties and excluding taxes (none) and interest on the investment. The calculations also assume a 90% recovery of metals and ignores the copper (International Symposium on Primary and Secondary Lead Processing, 1989) (pp. 49-52). The appropriate values are shown in the following table:

Capital Cost (Capex)		$30,772,000.00
NPV at	0%	$83,637,954.09
NPV at	10%	$15,782,935.33
NPV at	20%	($13,496,844.17)
NPV at	30%	($27,016,744.47)
NPV at	40%	($33,411,692.38)
IRR	14.41%	
Payback Period	5.169	Years

Table 25: NPV, IRR, and Payback for Zinc Waste

The caution is that this is a very preliminary analysis and the cost model would have to be evaluated and validated further.

The modeling for this paper was done on the basis of a small open pit mine and a hydrometallurgical process since the tailings are stored as a mound that is easily handled with normal earth moving equipment and additional equipment for the processing of the material since there in no equipment of the type necessary to handle the waste.

The cost structure results, based on the above model, and a processing rate of 250,000 metric tons per year, and a pyrometallurgic processing plant with the costs updated to 2019 are shown in the following table and graph (International Symposium on Primary and Secondary Lead Processing, 1989).

First Year Total Costs	Euros	Percent
Labor	7,476,483	21.72%
Electricity	3,889,162	11.30%
Equipment	4,785,261	13.90%
Construction material	102,671	0.30%
Steel	18,195	0.05%
Lumber	-	0.00%
Explosives	77,328	0.22%
Lube	156,412	0.45%
Reagents	7,914,785	22.99%
Fuel	10,007,200	29.07%
Tires	45,487	0.13%
Total Cost	34,427,498	100.00%

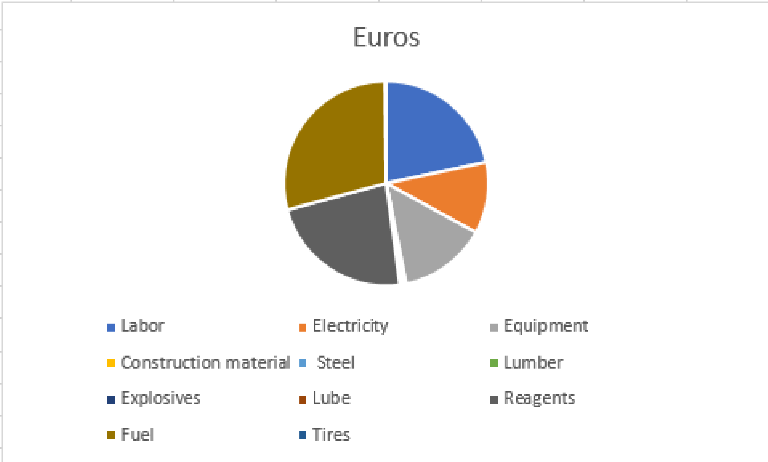


Table 26: Total Expenses at 250,000 Tons Per Year

The results are shown in the following table.

Processing Rate (Tons/ Yr)	Income	Mining	Processing	Treatment Charge	Total Expenses	Profit Per ton ore
50,000	12,607,134	1,375,600	6,282,821	2,856,115	10,514,537	41.85
100,000	25,214,269	1,817,736	12,548,759	5,712,231	20,078,727	51.36
150,000	37,821,403	2,259,873	18,810,757	8,568,346	29,638,976	54.55
250,000	63,035,672	3,144,145	31,328,840	14,280,577	48,753,563	57.13
350,000	88,249,941	4,028,418	43,842,364	19,992,808	67,863,590	58.25

Table 27: Total Expenses by Processing Rate

A sensitivity analysis was done around the project and the results are similar to the previous model. The greatest change is from the grade and recovery values.

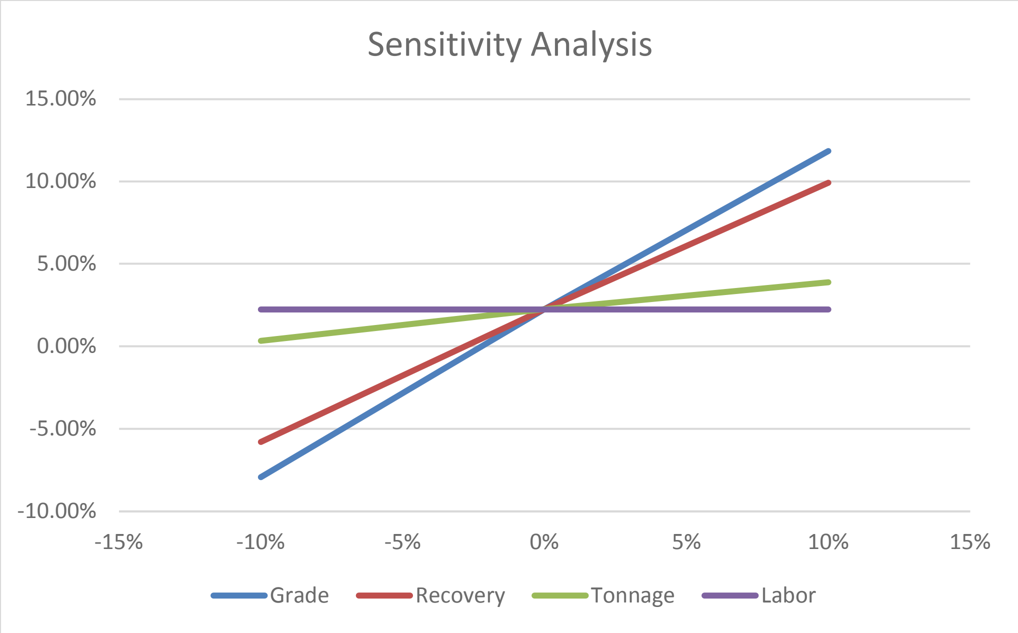


Figure 44 Alternative Process Sensitivity Analysis

7 Discussion

7.1 Standards

In general, the National, and International, Standards are intended to be a reference for new mine projects as there is normally a long time between the prospecting for a metal, or mineral, and the development of a mine. As demonstrated, there are a series of steps that further define the quantity and quality of the ore and the potential profitability of the mine prospect is developed. While the definition and analysis of an existing mine, waste or tailings can be done in a similar manner they typically are not subject to the regulations because the tailings are not normally considered to be a resource. For most mining operations they are a waste product with no value. Yet it can be demonstrated in many instances that processing improvements, changes in chemistry and processing have made many waste or tailings valuable resources. An example of this would be the KalTails project undertaken by the Newmont Corporation. The KalTails project, which ran from 1989 to 1999, processed 60 million tons of tailings by hydraulically mining and reprocessed. The processing used Carbon-in-Circuit (CIC) and Carbon-in-Pulp (CIP) leach and absorption circuits. The remaining tailings were moved 10km south east of Kalgoorlie. 695,000 ounces of gold were recovered (Tailings.info, 2019).

What is significant about this kind of project is that by applying modern methods to the tailings, there can be a significant improvement in the economics of what was previously considered as waste and also a method for remediating a tailings issue in an economic way it is, if not profitable, at least economically neutral.

Additionally, even though the standards, such as NI 43-101, do not directly address the tailings recovery, the methods stated in the document are applicable. As an example, NI 43-101 requires the following sections in the report:

- Sampling and Assaying
- Metallurgy
- Environmental Considerations
- Mining and Processing Operations
- Key Assumptions, Risk and Limitations
- Valuation Approaches and Methods
- Valuation
- Valuation Conclusions

These sections, with appropriate modifications to the sampling, metallurgy, and environmental sections can be used for the evaluation of a non-standard "deposit" such as a tailings pond. However, these types of projects are normally going to be internal and not subject to the reporting standards. As an example of the use of a standard, in particular, the NI 43-101, is the Parral project in Chihuahua, Mexico (Dodd, 2013). This report was done in 2013 for Absolute Gold Holdings Inc. and GoGold Resources Inc. and was done as an independent project, not as part of an existing mine. The project was comprised of dry land tailings deposited from the historical Mina la Prieta mine over a period of 50 years. The content of the tailings was estimated to be 21.3 Mt grading 0.31 g/t Au and 38.5 g/t Ag. One of the differences in using the standard for this type of project is that since the material is a very specific quantity there are no reserves, only the resource of the tailings.

7.2 Political and Social Environment

The political and social factors are an important issue. This is demonstrated by the fact that since the country declared independence in 2008, it has received 115 diplomatic recognitions as an independent state including the United States and Canada. Some of those recognitions have since been withdrawn. However, there are also a number of states and nations still do not recognize Kosovo as an independent state. Most significantly are China, Russia, Mexico, and Serbia, the latter which believes that Kosovo is the southern part of their country. Serbia did begin to normalize relations with the government of Kosovo in 2013 but has since suspended talks with the imposition of a 100% tax on importing Serbian goods (International Recognition of Kosovo, 2019).

This has significance in the ongoing operation of the mine complex and is demonstrated by the fact that when data is requested on the mines in the northern part of the country, which is mostly Serb, the management of the mine is unable to provide such information but can readily provide data for the StanTerg mine and the other mines in the south which is mostly Albanian.

The status of Kosovo continues to be an international debate and a conflict region as is demonstrated by the current status of recognition versus non-recognition and the visible presence of United Nations peace keeping forces that were visible during my visit to the region.

The social environment is very complex with historical and cultural differences throughout the region.

One of the reasons for this is that it is driven, in part, by the religious influence of each group. Another piece of the political factor is driven by the interaction with various organizations on a more global basis. Based on discussions with the management of the mine they indicated they believed the social and political issues were not a problem, however, it also appeared that there was some tension because the management could not provide reliable information on the “northern” mines which were located in the “Serbian” part of the country.

The region has been populated for centuries by both the Orthodox Serbs and the Muslim Albanians. Over the centuries there have been purges and attacks on both the people and the institutions that each holds to be very important. I include the religions in this group because they are inextricably part of the fabric of each of the groups and the region and the society.

Generally, the assumption is that Kosovo will become a separate country and that it will have autonomy from Serbia. If that is the case, then there is less of an issue regarding the political and legal issues surrounding the complex. I believe the social issues will still continue to be a problem.

7.3 Environmental Issues

As stated above, there are a number of environmental issues associated with the past 80 years of mine operation. These include heavy metals, tailings, contaminated cities, and acid mine drainage to mention a few. Depending on the funding available, there may, or may not, be sufficient money to actually solve some of these problems. Given the political and economic uncertainty, I do not think this will be addressed in the near future.

7.4 Trepca (Stan Terg) Mine

The actual analysis of the mine is the most direct. There are a number of factors and items that need to be addressed and individually discussed. One is the actual employment of the mine. Based on standard methods of determining the number of workers needed, there should be around 40 workers at the mine given the amount of ore produced. The concentrator should have about 20 workers. The total employment, based on the management information provided, is about 700. Management has also stated the average age of the employees is 55. They have also stated that they cannot attract younger workers to become miners. This leads me to believe the "workers" ages are actually higher then stated and that there are very few who actually work at the mine or concentrator.

The metallurgy of the mine is one of the easier factors. The mine does seem to be in a good position in terms of the actual ore. Observation showed that the face of the deposit was quite rich as galena and zinc minerals could be readily identified in quantity. Past production history has indicated that most of the other metals available in the mine have been exploited at one time or another. The list includes copper, gold, cadmium, and bismuth, in addition to the main ones of lead, zinc, and silver. Of particular interest from the metallurgical work done are indium and tin in addition to the historical and known ones. As discussed above, reprocessing the tailings for various metals, including zinc and others with updated processing is possible. The metallurgy is one of the positive factors for the future development of the complex.

However, the metallurgy of the concentrator is a problem. The statistical analysis shows the lead and zinc recovery to be good, in general, but there also appears to be a problem with the recovery of the metals. A liberation study, or metallurgical audit, would help to determine where the problem is. The specific areas that could be affecting recovery are:

- Less than optimal grinding (either too small or too large)
- Improper chemical usage in the pulp
- Improper aeration in the mixer
- Improper mixing

Given the physical visit and opinion of the operation I would expect the issue to be in the grinding circuit as the equipment is very worn and in need of refurbishment or repair.

There are a variety of impacts of the environmental issues, at the local and the regional level, that impact both the people of the region, the government, and the Trepca operation. As has been stated, there is a large amount of pollution from the metals released from the mine and the processing facilities that makes living in the region extremely hazardous to the people living there. This also effects the economic and legal status of the complex. The amount of money required to clean up the current environment and to mitigate any additional sources of pollutants is very high. Legally, it has a huge impact on who owns what and what parties are liable for these expenses. This is perceived as a negative for the future of the complex.

There is still exploration activity in the area. A company named Tethyan has been granted a 3-year exploration permit 5 km Southwest of Belo Brdo to search for hosted copper-gold porphyries (Mining Weekly, 2019).

The legal issues, those including ownership, financial liabilities, environmental liabilities, and others continue to be a barrier to returning the complex to its historical production levels. These are also perceived to be a negative for the future of the complex.

Additionally, the Kosovo Ministry of Economic development prepared, in 2012, a document called "Mining Strategy of the Republic of Kosovo 2012-2025". The paper includes 4 pillars upon which the future of mining in Kosovo will be based. They are:

- Favorable conditions for the economic assessment of mining resources and attraction of investments.
- Enhancement of human and institutional capacities in the mining sector
- Social considerations and community benefits
- Environmental care

This document also outlines the vision, mission, legal and institutional framework, for all of the mineral resources (Ministry of Economic Development, 2012).

There are also other mines that are part of the Trepca that might be more economic to re-open/ restart/ increase production because of high concentrations such as the Artana/ Novo Brdo mine that, according to old Yugoslav estimates, 16,037,227 tons of ore with concentrations of 4.67% lead, 6.52% zinc and 89.91 grams per ton of ore although one website states the mine currently has 2,700,000 tons of ore with 4.43%Pb, 5.42% Zn and 140.6 g/t Ag (mineralienatlas.de, 2019). The main problem with this mine appears to be that it is currently operating at a minimal level.

7.5 Economics and Model

Market demand is also an important factor. The demand for lead is increasing due in part to the use of sealed lead acid batteries for e-bikes, scooters, and cars. However, there are newer battery technologies that will replace some of the demand for lead based batteries, those being lithium, vanadium, and other higher energy density battery chemistries. The demand for zinc is also predicted to increase with the current supply of zinc being less than the demand. Forecasts expect this to be the case through 2021 (Mining Technology, 2019). Silver demand is expected to increase in the short term and the market is expected to be able to absorb all of the production. In addition, the production of silver from mining is expected to decrease about 2% in the coming year (The Silver Institute, 2019).

Overall, the demands of the market are a positive factor for the Trepca complex as all of the metals produced are in market demand due to demand exceeding supply for the near future.

The model is flexible in its application. The model can handle changes in the ore quantity and quality over time. The model is built to allow inflation, royalties, taxes, changes in the refining charges, along with a number of different scenarios for the number of recoverable metals. This model accommodates the metals that have been historically recovered from the Stan Terg mine. These include, other than the lead, zinc, and silver, gold, bismuth, and copper. It can be modified to handle any other combination of metals that are necessary to analyze.

It is also simple enough that it does not rely on any specific function that is exclusive to Excel and as such, is capable of working in a variety of different spreadsheet programs such as LibreOffice which is a cross-platform office suite.

7.6 Mine and Mine Operation

Based on the operation of the mine and the calculated break-even of about 230,000 tons per year, the fixed cost of increasing the production would require the purchase of an LHD so that there can be 2 machines moving ore from the deposit to the lift. The ore lift has the required capacity and the downstream processes, particularly the concentrators, have the capacity to handle the increase in feed. There would also be an increase in the cost of labor because there would also be more people necessary to mine, load, and process the ore.

Current values from CostMine for the LHD of an appropriate design are about €570,000.

The actual operating structure of the mine should also be inspected and its safety and stability determined. This would have an estimated cost of about €100,000.

Given that the mine appears to be in a negative cash flow position, these purchases and costs may not be possible and the inspection of the mine and its structure might uncover additional items that need refurbishment or repair.

7.7 Concentrator Operation

The concentrator is a standard process and, as stated above, does not appear to be in good operation even though it was supposed to be refurbished a few years ago for processing up to 400,000 tons per year, or about 1,500 tons per day. Currently the concentrator is not run on a continuous basis as the mine cannot produce enough ore for it to run in any more than a batch operation. The current process is to wait until the 10,000-ton intermediate storage is filled, then run the process to empty the bins. At the current production rate of 110,000 tons per year from the mine, it takes about 1 month to fill the bins so the concentrator is run about 1 time per month. Assuming the limitation is the mill, which has a capacity of about 60 tons per hour, or about 1,500 tons per day, of which there is only one operational at this time, this takes about 1 week.

It is estimated that the necessary costs for the repairs to the grinding circuit are about €500,000 and the possible changes in the chemistry of the process would be about €14,000 plus testing fees to determine if the problem is with the grinding or the chemistry. As mentioned above, there is some modern research that indicates there might be some improvements to the chemistry that will allow higher recoveries than were possible in the past.

7.8 Alternative Recovery

The alternative recovery is one of the more interesting options but, at present, it is also one of the least thought of ones by management. Given the amount of zinc in the waste and the possibilities of recovering it for a substantial profit it would be a great help as it is also a short-term project. It would also help to pay for some of the other needed upgrades to the facilities and also help to pay for environmental remediation.

While the current model makes the assumption that it would be expensive to set up a “open pit” mine, the existing infrastructure of the mine is already in existence. There would probably be some purchases of specific equipment but the cost should be considerably less than the shown cost. In addition, the assumption that it would cost twice as much as a “normal” two product hydrometallurgical plant, the returns are substantial enough that it could cost even more and still be profitable. Also, since there is excess capacity at the Tunel I Pari plant there is a possibility that it could be processed there using existing equipment and produce an even higher return.

8 Conclusions

The conclusions of this research are as follows:

The national and international standards are a good staring point for the summary of opportunities including the reprocessing of waste and tailings although that was not the original intent. The use of the standard will still be driven by the location of the project and, most importantly, the location of the company and which standard is applied to a particular exchange. If there is no external investment being used for a project, then the national standards are not necessary but they still provide a stable framework under which the project resources can be evaluated.

The political and social environment will also continue to have an impact on the future of the mine and other projects. It would appear that while there is a division as to the sovereignty of the country of Kosovo there are other issues that will make it difficult to operate and maintain the mine complex. These are more driven by the lack of younger workers and miners and the desire of younger Kosovars are finding better economic opportunities elsewhere. They prefer to go elsewhere in the world for better jobs and not work in the mines as their fathers and grandfathers did. It still remains that want to help their country and are willing to remit earnings back to Kosovo and are searching for opportunities within Kosovo.

The environmental issues will continue to have a very large impact both in the near tern and further out into the future. It does not affect just the Trepca complex and the Stan Terg mine but the entire

country. This is from a health and economy standpoint. Obviously, the health will be impacted as the negative effects of the heavy metals and other forms of pollution impact the living conditions but there will also be a large economic impact as the country wrestles with the cost of cleaning up the tailings, acid drainage and the pollution from the heavy metals and sulfur for years to come.
The economics of the recoverable metals and the market in general are favorable for the mine. There will be increased demand for all of the metals produced, and capable of being produced, at the Trepca complex. The economics of the country, however, do not allow for much of an expansion at this time without external funding from individual investors, the World Bank, EBRD, or some similar organization. As is shown above, over the past few years eternal investment in the country has been in decline. I think this is in part due to the perception that it is still a conflict zone.

The model, as developed for this project, is robust and flexible enough that it can quickly be configured to allow decisions to be made quickly on the merits of a project. This includes changes in the mine operation, processing changes in concentrators, etc., and other projects such as tailings re-processing and waste processing. It also enables the user to evaluate the differences in treatment charges and refining charges, and their impact on the profitability of the mine operation.

There are several issues with the mine and its management in addition to the previously stated problems with the ownership which also creates management problems of its own. First, I believe I can demonstrate the management of the mine does not comprehend what some of the problems are. The management has chosen to focus on the simple items, the metallurgy around the concentrator as an example. In doing so, they have endangered the rest of the operation. It also appears that they are not taking full advantage of the metals recovery that can help with the income of the mine. The most significant of these is the recovery of gold and copper. While they do not add much to the income of the mine, any additional improvements can help.

Additionally, the mine management needs to focus on improving the quantity of the ore being produced by the mine. This is consistent with a comment from a mine expert that “it is the tons” that make a mine or concentrator profitable.

The main focus of the management is to improve the recovery of the concentrator. This is a good plan but there needs to be an analysis of the tailings (a liberation study) to determine exactly where the problem lies. As stated above, this alone should add at least €1 million to the income of the mine.

Reprocessing of the zinc waste appears to be a very good option for a short term project that has a very good upside potential. This is shown by the analysis of the model around the existing zinc waste. Other projects, such as reprocessing the tailings, could also be a positive short term project that could generate incomes for Trepca.

One management problem with the ownership is in this situation the management is quite often politically appointed and does not have any experience operating a mine complex. As such, many of the decisions are based on individual and political expectations and not on actual fact.

The future of the Trepca complex will be driven by many, and in some cases, competing factors. I believe that it is the non-technical issues that are the most difficult and will make progress in the rehabilitation of the mine a difficult, if not impossible one at this time.

9 Bibliography

Njowa,G., Clay, A.N., Musingwini, C. . (2014). A perspective on global harmonisation of major national mineral asset valuation codes. *Resources Policy*, 1-14.

Abdel-latif, M. A. (2002). FUNDAMENTALS OF ZINC RECOVERY FROM METALLURGICAL WASTES IN THE ENVIROPLAS PROCESS. *Minerals Engineering, Volume 15, Issue 11, Supplement 1, November 2002*, 945-952.

Akbari, A. D. (2005). An updated and modified O'Hara cost estimating model based on World and Iran economic conditions. *Application of Computers and Operations Research in the Mineral Industry.* Tucson, AZ, U.S.A.: CRC Press, Taylor & Francis Group.

AlicjaKrzemień, PedroRiesgo Fernández, AnaSuárez Sánchez, IsidroDiego Álvarez. (2016). Beyond the pan-european standard for reporting of exploration results,mineral resources and reserves. *Resources Policy 49*, 81-91.

Arik, A. (2002). 30th APCOM Symposium Proceedings, Phoenix, Arizona, 2002. *Comparison of Resource Classifi cation Methodologies With a New Approach*.

Asian Metals. (2019, September 12). *Bismuth resources, reserves and production*. Retrieved from asianmetal.com: http://metalpedia.asianmetal.com/metal/bismuth/resources&production.shtml

Bankes, P. (2013, 4 23). CRIRSCO – UNFC Bridging Document. *CRIRSCO – UNFC Bridging Document.pdf*. International Council on Mining and Metals.

Beak Consultants GmbH. (2010). Geology and Minerals of Kosovo. Freiberg, Germany.

Beak Consultants, GmbH. (2007). *The Compilaton of Geo-Scientific Maps of Kosovo, General Map of Minerals 1:200.000.* Prishtinë: Beak Consultants, GmbH.

Bjelić, N. (2018, March 29). *"Казивања о "Трепчи": 1303–2018 – Први помен рудника" [Tales of "Trepča": 1303–2018 – First mention of the mine].*

Camm, T. W. (1991). *Simplified Cost Model for Pre-Feasibility Minerals Evaluations.* Spokane, WA: United States Geological Survey.

Canadian Institute of Mining, Metallurgy, and Petroleum. (2003). *STANDARDS AND GUIDELINES FOR VALUATION OF MINERAL PROPERTIES SPECIAL COMMITTEE OF THE CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM ON VALUATION OF MINERAL PROPERTIES (CIMVAL).*

CIM Standing Committee on Reserve Definitions. (2014, May 10). CIM DEFINITION STANDARDS - For Mineral Resources and Mineral Reserves. *CIM Standards*. Canadian Institute for Mining, Metallurgy and Petroleum.

CP Chemicals. (2019, 11 17). *Introduction to Mineral Processing*. Retrieved from Chevron Phillips: http://www.cpchem.com/bl/specchem/en-us/Pages/IntroductiontoMineralProcessing.aspx

CRIRSCO. (2020, 2 2). *Committee for Mineral Reserves International Reporting Standards*. Retrieved from CRIRSCO.COM: http://www.crirsco.com/members.asp

Cvetlovic, V. e. (2016). *Geology of South-Eastern Europe.* Belgrade.

Dodd, D. S. (2013). *INDEPENDENT TECHNICAL REPORT ON THE PARRAL TAILINGS PROJECT CHIHUAHUA, MEXICO.* Port Lewis, Mauritius: MDM Enterprises.

Durmishaj, B. (. (2016, July). Some Differences On Py-Sph-Ga Mineral Phases In Hajvali - Badovc - Kizhnica, And Artana Mine (Electronic Microprobe Analyses). Trepca Ore Belt, Kosovo. *INTERNATIONAL JOURNAL OF TECHNOLOGY ENHANCEMENTS AND EMERGING ENGINEERING RESEARCH, VOL 4, ISSUE 1*, pp. 12-16.

ECiKS. (2019, September 15). *kosovo-three-enterprises-held-hostage*. Retrieved from eciks.com: https://eciks.com/kosovo-three-enterprises-held-hostage/

Energy, R. o. (2002). *Mineral Deposits of Serbia Ore Deposit Database.* Belgrade: Republic of Serbia.

European Commission. (2017). *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the 2017 list of Critical Raw Materials for the EU, COM (2017) 490 final.* Brussels: European Commission.

European Geosciences Union. (2015). Critical Raw Materials Deposits of Europe. Munich, Germany, Europe.

Farmer, K. (2014). International standardisation for the reporting of Mineral Resources and Ore Reserves. Vienna. Retrieved from IAEA – Vienna. 23 - 27 June, 2014 p.1.

Feraud, J. D. (2009). *French scientific cooperation 2007-2008 on the Trepca lead-zinc-silver mine and the gold potential for Novo Brdo/Artana tailings (Kosovo) Final Report BRGM Report No. RP-57204-FR.* Orleans: BRGM.

Financial Times. (2019, September 16). *Saudi Aramco IPO delayed until 2019, UK officials told*. Retrieved from The Financial Times: https://www.ft.com/content/62fa88b0-21f4-11e8-9a70-08f715791301

Fuerstenau, Maurice C., Ed. (2007). *Froth Flotation: A Century of Innovation.* Littleton, Colorado: Society for Mining, Metallurgy, and Exploration, Inc.

Government of Western Australia, Dept. of Mines and Petroleum. (n.d.). Code of Practice Mines Survey, Second Edition. Western Australia, Australia: Government of Western Australia, Dept. of Mines and Petroleum.

Group for Legal and Political Studies. (2015). *The future of the property status of Trepca and its development (revitalization) perspective.* Kosovo: British Embassy in Kosovo.

Hall, A. (2015, August). *The Role of Mine Planning in high Performance.* Retrieved 10 1, 2016, from www.ausimmbulletin.com: https://www.ausimmbulletin.com/feature/the-role-of-mine-planning-in-high-performance/

Hyseni, S. e. (2010). Trepça Ore Belt and Stan Terg mine – Geological overview and interpretation,. *Geologija*.

ICG Balkans. (26 November 1999). *TREPCA: Making Sense of the Labyrinth.* Washington – Prishtinë/Priština: ICG Balkans Report N° 82.

Illyrians. (2019, September 1). Retrieved from Illyrians: https://en.wikipedia.org/wiki/Illyrians

IMVAL. (2017). *INTERNATIONAL MINERAL PROPERTY VALUATION STANDARDS TEMPLATE ("IMVAL Template").* IMVAL.

Infomine. (2019, 12 2). *miningintelligence - Industry Standard for Mining Cost Estimating*. Retrieved from costs.infomine.com: https://costs.infomine.com/

International Business Publications. (2016). *Kosovo Country Study Guide, Volume 1, Strategic Information and Developments.* Washington, DC: IBC, Inc.

International Crisis Group (ICG). (2019, September 1). *Trepca: Making Sense of the Labyrinth*. Retrieved from www.refworld.org: https://www.refworld.org/docid/3ae6a6de8.html

International Lead Association. (2016). *lead recycling.* Retrieved 10 1, 2016, from ila-lead.org: http://www.ila-lead.org/lead-facts/lead-recycling

International Recognition of Kosovo. (2019, 12 26). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/International_recognition_of_Kosovo

International Symposium on Primary and Secondary Lead Processing. (1989). Proceedings of the International Symposium on Primary and Secondary Lead Processing. In I. S. Processing, *Primary and Secondary Lead Processing: Proceedings of the International Symposium on*

Primary and Secondary Lead Processing (pp. 49-52). Halifax, Nova Scotia: International Symposium on Primary and Secondary Lead Processing.

Isufi, P. (2016, 10 31). Constitutional Court refuses Srpska Lista request against Trepca. *Prishtina Insight*. Prishtina, Kosovo: Prishtina Insight.

J A Bell, J. A., Guj, P. (2012, May 24-25). Exploration Value Drivers and Methodologies. *Project Evaluation Conference*, (pp. 17-27). Melbourne, Vic.

Jelenković, R. (August 2008). Mineral resources of Serbia. *Gelolgica Carpathia*, 345—361.

JORC, A. J. (2019, 10 24). *What is the JORC Code?* Retrieved from http://www.jorc.org: http://www.jorc.org/index.asp

Kołodziejczyk, J. e. (2016, May 6). Sn-Bearing Minerals and Associated Sphalerite from Lead-Zinc Deposits, Kosovo: An Electron Microprobe and LA-ICP-MS Study. *Minerals*.

Kosovo Commission for Mines and Minerals. (2019, November 12). *Mineral Resources/ Geology*. Retrieved from www.kosovo-mining.org: https://www.kosovo-mining.org/mineral-resources/geology/?lang=en

Kosovo Trust Agency Managing Privatisation in Kosovo, w.-k. (n.d.). Artana Mine. Prishtina, Kosovo.

Kossmat, F. (1924). Geologie der zentralen Balkanhalbinsel, mit einer Ubersicht des dinarischen Gebirgsbaus. *Die Kriegsschauplatze*, 198.

Krige, D. G. (1952). A statistical approach to some basic mine valuation problems on the Witwatersrand. *J. of the Chem., Metal. and Mining Soc. of South Africa*, 119–139.

Lee, R. A. (2019, Sept 11). *kosovar_serb_warfare*. Retrieved from www.historyguy.com: https://www.historyguy.com/kosovar_serb_warfare.html

Lilford, E. (2004). Advanced Considerations, Applications and Methodologies in the Valuation of Mineral Properties. *Doctoral thesis submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg*.

Lilford, E. V.,Minnitt, R.C.A. (October 2002). Methodologies in the valuation of Mineral Rights. *The Journal of The South African Institute of Mining and Metallurgy*, 369-384.

Lilford, E.V., and Minnitt, R.C.A. (January 2005). A comparitive study of valuation methodologies for mineral developments. *The Journal of the South African Institute of Mining and Metallurgy*, 29-42.

Ljepojevic, S. (2008). *Kosovo Murky Reality.* Bloomington, Indiana: AuthorHouse.

Mario Zelic, S. A. (2010). GEOLOGICAL AND GEOCHEMICAL FEATURES OF THE KOPAONIK INTRUSIVE COMPLEX (VARDAR ZONE, SERBIA). *Ofioliti, 35 (1)*, 33-47.

Melcher, F. e. (2017). *Economic Geology of the Eastern and South-eastern European (ESEE) Region.* Leoben: Berg- und Hüttenmännische Monatshefte.

Micon. (2019, 10 25). *micon-international*. Retrieved from Micon International: https://www.micon-international.com/mineral-resource-reporting-differences-between-cim-jorc-and-others/

mineralienatlas.de. (2019, November 11). *Artana (Novo Brdo) Mine*. Retrieved from Mineralienatlas - Fossilienatlas: https://www.mineralienatlas.de/lexikon/index.php/Kosovo/Prishtina%2C%20Distrikt/Novo%20Brdo/Artana%20%28Novo%20Brdo%29%20Mine

Mining Journal. (2005). Kosovo: Land of Opportunity for Mining and energy. *Mining Journal, Special Publication*, 1-20.

Mining Technology. (2019, September 15). *Global zinc market to grow at 3.8% in 2022*. Retrieved from Mining Technology: https://www.mining-technology.com/comment/zinc-outlook-2019/

Mining Weekly. (2019, September 18). *Tethyan granted new exploration permit in Kosovo*. Retrieved from Mining Weekly: https://www.miningweekly.com/article/tethyan-granted-new-exploration-permit-in-kosovo-2018-06-12

Mining.com. (2019, September 12). *Mining.com*. Retrieved from Making the Grade: Understanding Exploration Results: www.mining.com/web/making-the-grade-understanding-exploration-results/

Ministry of Economic Development. (2012). *Mining Strategy of the Republic of Kosovo 2012-2015.* Prishtina: Ministry of Economic Development.

Nelles, P. T. (2003). *Trepca Kosovo under UNMIK Supervision: The Trepca Goal.* UNMIK.

New Delhi Times. (2019, September 15). *Serbia and Kosovo spar over Trepca Complex*. Retrieved from New Dehli Times: https://www.newdelhitimes.com/serbia-and-kosovo-spar-over-trepca-mining-complex/

Nikolić, B. (2017). *NINETY YEARS OF MINING AND METALLURGY IN TREPČA – SEVER CONGLOMERATE (PART II).* Belgrade: UNIVERSITY OF BELGRADE - FACULTY OF MINING AND GEOLOGY.

Nikolić, B. (2017). *NINETY YEARS OF MINING AND METALLURGY IN TREPČA-SEVER CONGLOMERATE (PART I), DEVEDESET GODINA RUDARSTVA I METALURGIJE U KOMBINATU ,,TREPČA – SEVER" (I-DEO).* Belgrade: UNIVERSITY OF BELGRADE - FACULTY OF MINING AND GEOLOGY.

Novatek. (2019). *Russian Classification of Reserves.* Retrieved from www.novatek.ru: https://www.novatek.ru/eng/news_center/clas/

Osami, a. e. (2009). Slag Valorisation of Reductive Smelting Process by Shaft Furnace in the Lead Metallurgy of “Trepça” Complex with Economical and Environmental Effects. *J. Int. Environmental Application & Science, Vol. 4 (2):*, 198-206.

Palairet, M. (n.d.). *Trepca, 1965-2000.* Edinburgh: UNMIK.

Petrovic, Dragana , Vesna Cvetkov, Ivana Vasiljevic, ´ Vladica Cvetkovic. (2015). A new geophysical model of the Serbian part of the East Vardar ophiolite: Implications for its geodynamic evolution. *Journal of Geodynamics*.

Polinares. (2012). *Polinares working Paper no. 39, Fact Sheet Indium.* Brussels: Polinares, EU Policy on Natural Resources.

Prishtina Insight. (2019 (2), 2 5). Kosovo Politicians and EU clash over the future of Trepca. *Prishtina Insight*. Prishtina, Kosovo: Prishtina Insight.

Prishtina Insight. (2019, September 15). *Kosovo Politicians and EU Clash Over theh Future of Trepca*. Retrieved from Prishtina Insight: https://prishtinainsight.com/kosovo-politicians-and-eu-clash-over-the-future-of-trepca/

Radoš Ljušić, e. (2008). *Енциклопедија српског народа [Encyclopedia of the Serbian people].* Belgrade: Zavod za udžbenike (Institute for Textbooks).

Robertson, A.H.F., Karamata, S., Sari. (2009). Overview of ophiolites and related units in the Late Palaeozoic–Early Cenozoic magmatic and tectonic development of Tethys in the northern part of the Balkan region. *Lithos*, 1-36.

Rosenberg, M. (2019, September 1). *ThoughtCo.* Retrieved from Kosovo Independence: https://www.thoughtco.com/kosovo-independence-overview-1435550

Royal Institute of Technology Stockholm. (2021, 06 13). *Scientific Approach PDF*. Retrieved from www.hth.se: https://www.kth.se/social/files/58222b03f276547ecf843c67/F5_16_komp.pdf

Rudic, F. (2019, September 16). *EU Should Reject Serbia-Kosovo Border Changes: Report*. Retrieved from Balkan Insight: https://balkaninsight.com/2019/04/26/eu-should-reject-serbia-kosovo-border-changes-report/

Saudi Aramco. (2019). Saudi Aramco Prospectus. Dammam, Saudi Arabia: Saudi Aramco.

Schmid, M. B. (2008). The Alps-Carpathians-Dinarides-connection: a correlation of tectonic units. *Swiss Journal of Geoscience*.

Šentija, J., & et al., e. (1981). *Opća enciklopedija Jugoslavenskog leksikografskog zavoda, članak Srbi – historija [General Encyclopedia of the Yugoslav Lexicographical Institute, article on Serba – history].* Zagreb: Miroslav Krleža Institute of Lexicography.

Serbian~Albanian conflict. (2019, Sept 11). Retrieved from iliria-iliria.blogspot.com: https://iliria-iliria.blogspot.com/2010/11/serbianalbanian-conflict.html

Shabani, D. e. (2019). *Blood Lead Level of Children and its Trend in Mitrovica, Kosova.* Stuttgart: Thieme Open Access.

Shabani, M. (2016). Kosovo Land of Mining Opportunities. *PDAC Conference.* Toronto.

Shala, F. e. (2010). Air pollution in the area around the Mining Complex Trepça in Kosovo. *Recent Advances in Energy & Environment* (pp. 310-314). Cambridge, UK: WSEAS.

Shepard, D. (1968). A two-dimensional interpolation function for irregularly-spaced data. *23rd National Conference ACM* (pp. 517-524). ACM.

Society of Mining, and Metallurgical Engineering. (2017). *SME STANDARDS AND GUIDELINES FOR VALUATION OF MINERAL PROPERTIES (Including Petroleum).* Denver, CO: Society of Mining, and Metallurgical Engineering.

Sontag, D. (2016). *Lecture 11.* Retrieved 9 4, 2016, from Course Lecture: http://cs.nyu.edu/~dsontag/courses/ml13/slides/lecture11.pdf

South African Reporting Standards. (2016). Retrieved 10 1, 2016, from SAMCODE: http://www.samcode.co.za/

Stuart, P. (2002, June 28). *World Socialist Web Site.* Retrieved from The Trepca mining complex: How Kosovo's spoils were distributed: https://www.wsws.org/en/articles/2002/06/trep-j28.html

Synovitz, R. (2019, September 1). *Radio Free Europe/ Radio Liverty*. Retrieved from Kosovo's Economy Still Struggling Five Years After Independence: https://www.rferl.org/a/kosovo-economy-struggling/24901946.html

T. Elkington, T. and Gould, J. (2011). Optimisation with options. *Mining Technology*, 233-240.

Tailings.info. (2019, 12 20). *kaltails*. Retrieved from www.tailings.info: http://www.tailings.info/casestudies/kaltails.htm

The Economist. (2020, 2 13). New face, old grudges, Albin Kurti's new start in Kosovo. *The Economist*.

The Silver Institute. (2019, September 15). *Silver Market Trends – 2019*. Retrieved from The Silver Institute: https://www.silverinstitute.org/silver-market-trends-2019/

Tory, A. (2019). Selective Separation of Hematite by a synthesized Depressant in Various Scales of Anionic Reverse Floatation. *Minerals*, Minerals 2019, 9, 124; doi:10.3390/min9020124, also www.mdpi.com/journal/minerals.

toxicleaks.com. (2019, September 15). *Twenty_years_later,_the_Trep%C4%8Da_mines_of_Kosovo*. Retrieved from toxicleaks.com: https://toxicleaks.com/wiki/Twenty_years_later,_the_Trep%C4%8Da_mines_of_Kosovo

Trepca Kosovo Under UNMIK Administration. (2005). *SUMMARY DESCRIPTION OF THE LEAD ZINC SILVER RESOURCES AND THE TREPCA MINES IN KOSOVO.* New York: UN Mission in Kosovo (UNMIK).

Trepča_Mines. (2019, September 12). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Trep%C4%8Da_Mines#cite_ref-10

Tsiranbides, A. (2016). Gold Metallogeny of the Serbo-Macedonian-Rhodpe Metallogenic Belt. *Bulletin of theGeological Society of Greece*, pp. 2037-2046.

Turan, M. D. (2004). Recovery of zinc and lead from zinc plant residue. *Hydrometallurgy 75* , 169-176.

U.S. Department of Energy. (2013). *Energy and Environmental Profile of the U.S. Mining Industry, Chapter 6, Lead and Zinc.* Washington: U.S. Department of Energy.

U.S. Dept of Interior. (2020). *List of 35 critical minerals.* Washington, DC: Department of Interior.

UNDP. (2011). *TAKING ACTION TOGETHER: INDUSTRIAL WASTE MANAGEMENT FOR TREPCA ENTERPRISE.* Mitrovica: UNDP.

UNECE. (2019). *United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).* Retrieved from www.unece.org: https://www.unece.org/energy/se/unfc_2009.html

United Nations. (2009). *Mining and Environment in the Western Balkans.* Vienna: United Nations Environmental Programme.

United Nations. (2012). *www.unece.org.* Retrieved from fileadmin/DAM/energy/se/pp/unfc/IntWs_UNFC_Bangkok_Feb2012/CCOP/9b_Vietnam_SMRC.pdf: https://www.unece.org/fileadmin/DAM/energy/se/pp/unfc/IntWs_UNFC_Bangkok_Feb2012/CCOP/9b_Vietnam_SMRC.pdf

United States. (2016). *CIA World Factbook.* Washington, DC: Central Intelligence Agency.

USGS. (1980). Principles of a Resource/ Reserve Classification for Minerals. *USGS Circular*. United States: United States Bureau of Mines.

USGS. (2019). *Mineral Commodity Summaries 2019.* Reston, VA: Department of the Interior, United States Geological Survey.

USGS. (2020). *Deosit in Kosovo, Serbia.* Denver: United States Geological Survey.

Vujić, S. (2014). THE HISTORY OF SERBIAN MINING. In Roots, *Serbian Mining and Geology in the Second Half of XX Century* (pp. 1-38). Belgrade: Academy of Engineering Sciences of Serbia, Matica srpska and Mining Institute of Belgrade.

W. Edwards Deming. (2019, 12 26). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/W._Edwards_Deming

Walter A. Shewhart. (2019, 12 26). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Walter_A._Shewhart

Wikipedia - Mineral Resource Estimation. (2019). Retrieved 9 3, 2016, from Mineral Resource Estimation: https://en.wikipedia.org/wiki/Mineral_resource_estimation

Wikipedia, Gauß Kruger. (2020, 2 2). *https://en.wikipedia.org/wiki/Gauss%E2%80%93Kr%C3%BCger_coordinate_system*. Retrieved from Gauß-Kruger coordinate system: https://en.wikipedia.org/wiki/Gauss%E2%80%93Kr%C3%BCger_coordinate_system

(2019). *World Mining Data.* Vienna: Federal Ministry for Sustainability and Tourism.

World Nuclear Association. (2020, 1 31). *In Situ Leach Mining of Uranium (Updated October 2017)*. Retrieved from World-Nuclear.org: https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/in-situ-leach-mining-of-uranium.aspx

World_Bank. (2013). *Kosovo Country Environmental Analysis 2013.* World Bank.

Xianping Luo, e. a. (2016). The critical importance of pulp concentration on the flotation of galena from a low grade lead–zinc ore. *Journal of Materials Researcch and Technology*, 131-135.

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11 List of Tables

12 List of Abbreviations

NI 43-101	Canadian Standard
CSA	Canadian Securities Administrators
CIMVAL	Canadian Institute of Mining, Metallurgy, and Petroleum on Valuation of Mineral Properties
SME	Society for Mining, Metallurgy, and Exploration, Inc.
IMVAL	International Mineral Valuation Committee
JORC	Joint Ore Resource Committee
TEO	Technico-Economicheskiye Obosnovaniye
TER	Technico-Economicheskiye Raschoti
JORC	Joint Ore Reserves Committee
SAMOG	South African Code for the Reporting of Oil And Gas Resources
SAMREC	South African Code for The Reporting Of Exploration Results, Mineral Resources And Mineral Reserves
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
KAZRC	Kazakhstan Reporting Code
MRC	Mongolia Reporting Code
NAEN	Russia Mineral Resource Code
IMM	Institute of Mining and Metallurgy
LSE	London Stock Exchange
UNECE	United Nations Economic Commission for Europe
UNFC	United Nations Framework Classification for Fossil Energy and Mineral Resources
KFOR	Kosovo FORce
FDI	Foreign Direct Investment
KAS	Kosovo Agency of Statistics
LHD	Load Haul Dumper
SPC	Statistical Process Control
OOUR	Basic Organization of Associated Labour

MGA1994	Map Grid of Australia 1994

Annex Table of Contents

1 Trepca information from the mine

Q: What is the content of lead, zinc and silver (%Pb, %Zn, g/T Ag) sent to processing from:

Stari Terg Mine

Artana Mine

Belo Brdo + Crnac

A: The content of metals (lead, zinc and silver) on the ore extracted from the Stan Terg Mine is as follows

- Pb content % 3.43
- Zn content % 3.11
- Ag content gr. <100

While content in te Kishnica/Artana Mine is as follows

- Pb content % 3.80
- Zn content % 4.08
- Ag content gr. 250

Unfortunately, we do not have reliable records for the Belo Berdo and Cernac Mines on the Northern Part of Trepca.

Q: The total annual costs for:

Stari Terg Mine

Artana Mine

Belo Brdo + Crnac mines

A: I am afraid that in this question we can't provide reliable data based on the actual figures since they are not available, but based on previous experienced cost per ton of extracted ore is as below:

- Stan terg Mine $186.00
- Artana Mine $195.00

While for Belo Berdo and Cernac Mines we do not have figures.

The total number of employees at:

Stari Terg Mine ……………………………………… 504 workers

Artana Mine …………………………………………..186 workers

Belo Brdo + Crnac ………………………………… unknown

Tunel I Pari concentrator ………………………. 140 workers

Kishnice concentrator ………………………………57 workers

Leposavic concentrator…………………………… unknown

The total annual costs for:

Stari Terg Mine……………………………………….6,166,332.00€

Artana Mine……………………………………………2,642,713.00€

Belo Brdo + Crnac……………………………………..Unknown

Tunel I Pari concentrator…………………………….3,320,332.00€

Kishnice concentrator…………………………………1,423,000.00€

Leposavic concentrator……………………………….unknown

The number of circuits and condition of equipment at:

Kishnice concentrator………………………………..????????

Leposavic concentrator………………………………????????

The quantity of concentrate sold and grade (%Pb, %Zn, g/T Ag) from:

Tunel I Pari concentrator ……………..Pb%68.94; Zn%48.80; Ag% -

Kishnice concentrator…………………..unknown

Leposavic concentrator…………………Pb%65.57; Zn%45.20; g/Ag 2150 gr/t

2 Government Production Data – All Mines

Statistics for Filtered Records

Country ***Kosova***

Company ***"Trepça - Ndermarrje në Administrim te AKP"***

Commodity: Lead-Zinc

Unit: t

Current Date: 11/25/2019

Year	Exploited Reserves (Company Report)																				1.Q+2.Q+3.Q+4.Q	Average Content			
	1. Quarter	silver g/t	gold g/t	lead %	zinc %	2. Quarter	silver g/t	gold g/t	lead %	zinc %	3. Quarter	silver g/t	gold g/t	lead %	zinc %	4. Quarter	silver g/t	gold g/t	lead %	zinc %		silver g/t	gold g/t	lead %	zinc %
2005											782.00	0.00	0.00	4.42	3.46	25,362.90	30.79	0.00	3.27	3.31	26,144.90	29.86	0.00	3.30	3.31
2006	511.00	0.00	0.00	4.39	3.97	519.00	0.00	0.00	4.39	3.97	671.00	0.00	0.00	4.39	3.97	86,900.00	31.58	0.00	4.02	3.09	88,601.00	30.97	0.00	4.03	3.11
2007	11,631.20	0.00	0.00	4.68	3.07	10,245.00	0.00	0.00	5.58	2.96	12,805.00	0.00	0.00	5.44	2.83	74,187.00	57.76	0.00	3.79	3.68	108,868.20	39.36	0.00	4.24	3.44
2008	35,343.40	16.69	0.00	3.53	3.15	29,852.00	15.13	0.00	3.54	3.19	37,125.40	19.84	0.00	3.53	3.19	39,448.40	20.83	0.00	3.53	3.26	141,769.20	18.34	0.00	3.53	3.20
2009	34,472.00	0.00	0.00	4.15	3.32	35,120.20	0.00	0.00	4.09	3.34	40,519.00	0.00	0.00	4.01	3.16	48,026.00	0.00	0.00	4.04	3.17	158,137.20	0.00	0.00	4.07	3.24
2010	35,698.83	33.97	0.00	3.96	3.24	43,844.47	37.23	0.00	3.99	3.11	55,669.00	29.10	0.00	3.82	3.44	50,629.27	25.37	0.00	3.75	2.79	185,841.57	30.94	0.00	3.87	3.14
2011	53,416.41	66.89	0.00	3.52	2.85	64,083.00	41.86	0.00	3.00	2.68	57,688.50	41.67	0.00	2.65	2.42	57,927.50	12.91	0.00	3.05	3.39	233,115.41	40.36	0.00	3.05	2.83
2012	48,250.70	48.51	0.00	3.62	3.72	67,321.00	43.14	0.00	3.52	3.19	60,844.36	42.30	0.00	2.58	2.93	49,073.80	51.05	0.00	2.04	1.80	225,489.86	45.79	0.00	2.96	2.93
2013	50,112.57	64.19	0.00	2.68	2.71	61,071.70	51.57	0.00	3.08	2.44	65,044.00	47.24	0.00	3.55	3.03	76,540.00	32.44	0.00	2.73	3.28	252,768.27	47.16	0.00	3.02	2.90
2014	69,244.60	49.09	0.00	3.05	2.51	82,491.20	41.54	0.00	2.23	2.75	84,193.00	40.70	0.00	2.72	2.82	81,325.00	31.79	0.00	2.62	3.15	317,253.80	40.47	0.00	2.64	2.82
2015	64,463.00	55.62	0.00	2.68	2.52	64,005.00	28.11	0.00	2.42	2.17	61,467.00	26.84	0.00	2.53	2.78	61,513.00	43.70	0.00	3.62	2.79	251,448.00	38.67	0.00	2.81	2.56
2016	68,546.00	49.48	0.00	3.63	3.43	62,301.00	48.81	0.00	3.13	3.13	57,514.00	35.33	0.00	3.17	3.13	63,044.00	39.29	0.00	2.91	2.78	251,405.00	43.52	0.00	3.22	3.13
2017	56,789.00	46.64	0.00	3.08	3.13	59,864.00	32.66	0.00	2.67	3.32	58,782.50	31.32	0.00	2.78	3.10	47,937.00	34.86	0.00	3.17	3.20	223,372.50	36.34	0.00	2.91	3.18
2018	47,155.00	38.73	0.00	3.07	2.85	57,523.00	34.41	0.00	3.22	2.96	53,187.00	38.12	0.00	2.91	3.20	80,711.00	27.16	0.00	2.56	2.51	238,576.00	33.64	0.00	2.90	2.84
2019	44,436.00	37.56	0.00	2.62	2.58	54,066.00	28.18	0.00	2.61	2.41	51,740.00	31.11	0.00	2.68	2.63						150,242.00	31.96	0.00	2.63	2.53

3 Government Concentrate Data – All Mines

Country ***Kosova***

Company ***"Trepça - Ndermarrje në Administrim te AKP"***

Commodity: Lead-Zinc

Unit: t

Current Date: 11/25/2019

Year	Produced concentrate and content of useful components in concentrate (Q1)								Produced concentrate and content of useful components in concentrate (Q2)							
	silver		gold		lead		zinc		silver		gold		lead		zinc	
	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content
	kg	g/t			%	%	%	%	kg	g/t			%	%	%	%
2005																
2006																
2007					497.76	69.50	308.00	48.50					549.00	69.50	282.00	48.50
2008																
2009																
2010					1,797.00	66.41	1,931.00	43.43					1,497.00	65.76	1,574.00	43.37
2011					1,894.63	71.28	1,567.05	47.10					2,011.31	69.70	2,250.54	46.33
2012					1,792.50	73.64	1,962.40	49.90					2,412.00	63.46	2,748.80	38.45
2013					2,071.38	72.52	2,163.56	48.65					2,383.30	70.28	2,594.20	48.06
2014					2,734.07	69.70	2,425.23	46.10					3,116.89	69.80	3,375.22	48.01
2015					1,894.00	71.01	1,917.00	47.72					1,779.00	70.20	2,220.00	46.17
2016					3,038.00	71.50	2,489.00	48.21					2,238.00	69.57	2,884.00	46.89
2017	61.92	1,045.00			1,876.00	71.71	2,030.00	46.61	44.48	985.00			1,759.65	69.78	2,999.71	46.81
2018					1,671.40	69.99	1,778.75	47.84					2,052.83	69.25	2,230.03	46.98
2019					1,070.39	69.42	1,318.87	46.07					1,618.84	68.12	1,729.08	46.85

Year	Produced concentrate and content of useful components in concentrate (Q3)								Produced concentrate and content of useful components in concentrate (Q4)							
	silver		gold		lead		zinc		silver		gold		lead		zinc	
	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content	Quantity	Metal Content
	kg	g/t			%	%	%	%	kg	g/t			%	%	%	%
2005													1,184.15	68.05	1,604.33	47.57
2006													3,728.36	65.67	2,887.96	47.06
2007					648.00	69.50	319.00	48.50					3,262.30	72.80	4,587.44	48.69
2008													5,824.11	26.47	7,891.83	9.43
2009													6,223.75	19.88	7,466.08	5.83
2010					2,606.00	61.65	2,851.00	41.82					2,332.00	62.84	1,513.00	38.27
2011					1,675.10	67.79	1,608.58	47.35					1,890.34	33.88	1,982.40	16.62
2012					2,077.11	63.90	2,582.46	37.27					2,016.00	55.29	2,401.57	34.11
2013					2,329.00	71.30	2,366.00	47.12					2,241.50	68.73	3,293.04	47.64
2014					2,685.87	70.62	3,059.86	46.75					2,508.00	67.72	2,836.00	47.43
2015					1,631.00	69.60	2,077.00	46.93					2,487.00	72.84	2,516.00	42.59
2016					1,946.00	70.92	2,630.00	46.92					2,017.00	70.47	2,204.00	46.62
2017					1,831.15	69.37	2,351.73	47.41					1,851.81	70.13	2,089.54	47.31
2018					1,629.96	70.16	2,027.36	46.58					1,367.22	70.12	1,645.66	47.17
2019					1,497.45	66.59	1,845.60	46.92								

Year	Produced concentrate (Q1+Q2+Q3+Q4)				Average content of useful components in concentrate			
	silver	gold	lead	zinc	silver	gold	lead	zinc
	Quantity	Quantity	Quantity	Quantity	Metal Content	Metal Content	Metal Content	Metal Content
	kg		%	%	g/t		%	%
2005			1,184.15	1,604.33			68.05	47.57
2006			3,728.36	2,887.96			65.67	47.06
2007			4,957.06	5,496.44			71.67	48.66
2008			5,824.11	7,891.83			26.47	9.43
2009			6,223.75	7,466.08			19.88	5.83
2010			8,232.00	7,869.00			63.77	41.84
2011			7,471.38	7,408.57			60.61	38.76
2012			8,297.61	9,695.23			63.79	39.38
2013			9,025.18	10,416.80			70.67	47.84
2014			11,044.83	11,696.31			69.50	47.14
2015			7,791.00	8,730.00			71.12	45.66
2016			9,239.00	10,207.00			70.68	47.16
2017	106.40		7,318.61	9,470.98	1,019.92		70.26	47.03
2018			6,721.41	7,681.80			69.83	47.11
2019			4,186.68	4,893.55			67.91	46.67

4 Royalty Statement and translation

Original

Ne pajtim me liglin 2008/03-L081, per themelimin e komisionit te pavarur per minera dhe minerale ne mbledjen e mbajtur me 9/7/2010, merr kete:

VENDIM

Miratohet lista e tantiemave per mineralet metalike metodologjia....dhe percaktenzbritjet e lejueshme se me poshte:
1. Lista d tantiemes eshte e bashkangjitur.

2. Motodologjia e llogaritjes

Totali i sasise se shfrytezuar nga miniera * perqindja e mineralis ne zehe * cimimi shites ne tregun boteror * perqindja e caktuar ne listen e tantiemave * zbritja e lejueshme = tantiema e pagueshme.

3. Cmimi shites per kalkulimin e tantiemes percaktohet ne baze te informatave nga tregu boteror LME (London Metal Exchange).

4. Kalkulimi i tantiemes eshte i vecante dhe nuk ka te beje me taksa tjera asnje shpenzim nuk merret parasysh me rastin e caktimit te tantiemes.

5. Zbritjet e lejueshme 10% per kompanite te cilat e perpunojne mineralin ne koncentrat, ndersa 20% per mineralet te cilat bejne shkrirjen e mineraleve ne kosove.

Translation

In accordance with Law 2008/03-L081, on the Establishment of an Independent Commission for Mines and Minerals, held on 9/7/2010, the following:

DECISION

Approved list of metal minerals methodology ... and permissible deductions below:
1. The list is attached.

2. Calculation methodology

Total quantity used by the mine * Percentage of ore mined * Selling price on the world market * Percentage set in the royalties list * Allowable deduction = royalties payable.

3. The selling price for the royalty calculation is determined on the basis of information from the LME (London Metal Exchange) world market.

4. The royalties calculation is separate and has nothing to do with other taxes.

5. 10% allowable deductions for companies that process mineral concentrate, and 20% for minerals that merge minerals in Kosovo.

Lista e Tantiemes per mineralet metalike - Royalty list for metalic minerals									
Nr.	Grupi i lëndës minerale/Commodity group	Nëngrupi i lëndës minerale/Commodity subgroup	Lënda minerale/Commodity Shqip	English	Njësia/Unit (t,m³)	Tantiema/Royalty %	(€)	Formula	Vërejtje/Coments
	1	2	3	4	5	6	7	8 9	10
2	Mineralet metalore	Metalet e çmuara	Argjendi (Ag)	Silver		5,00%		Totali i sasisë së shitjes/nxjerrjes nga miniera * përqindja e mineralit në xehe * çmimi i shitjes në tregun botëror * përqindja e caktuar në listën e tantiemave * zbritja e lejueshme = tantiema e paguesheme.	1. Çmimi i shitjes për kalkulimin e tantiemës përcaktohet në bazë të informatave nga tregu botëror LME (London Metal Exchange). 2. Kalkulimi i tantiemës duhet të bëhet [illegible] tantiemës. 3. Zbritjet e lejueshme 10 % për kompanitë të cilat e përpunojnë mineralin në koncentrat, ndërsa 20 % për mineralet të cilat bëjnë shkrirjen e mineraleve në Kosovë.
			Ari (Au)	Gold		5,00%			
			Mineralet e platinës (Pt)	Platinoid minerals		5,00%			
			Platina (Pt)	Platinum		5,00%			
		Mineralet hekur bartëse	Hekuri (Fe)	Iron	t	4,50%			
			Xehe hekuri	Iron ore	t	4,50%			
			Xehe hekuri kokrriza	Oolitic iron ore	t	4,50%			
			Kromi	Chromium	t	4,50%			
			Xehe kromi	Chromite ore	t	4,50%			
			Magnetiti	Magnetite	t	4,50%			
			Mangan-Mn	Manganese	t	4,50%			
			Xehe mangani	Manganese ore	t	4,50%			
			Piriti	Pyrite	t	4,50%			
		Metale me ngjyra	Alumini (Al)	Aluminum-Al	t				
			Xehe Boksiti	Bauxite ore	t	4,50%			
			Bakri (Cu)	Copper	t				
			Xehe bakri	Copper ore	t	4,50%			
			Xehe Bizmuti (Bi)	Bismuth ore	t	4,50%			
			Galiumi (Ga)	Gallium-Ga	t				
			Kadmiumi (Cd)	Cadmium	t	4,50%			
			Kobalti (Co)	Cobalt	t	4,50%			
			Nikeli (Ni)	Nickel	t	4,50%			
			Xehe Ni-Co	Nickel-Cobalt ore	t	4,50%			
			Plumbi (Pb)	Lead	t	4,50%			
			Zinku (Zn)	Zinc	t	4,50%			
			Xehe (Pb-Zn-Ag)	(Lead, zinc, silver) ore	t	4,50%			
		Metale të rralla	Antimoni (Sb)	Antimony	t				
			Xehe Sb	Antimony ore	t	4,50%			
			Arseni (As)	Arsenic	t	4,50%			
			Xehe Kallai	Tin ore	t	4,50%			
			Zhiva-Hg	Mercury		4,50%			
			Xehe Hg	Mercury ore		4,50%			
			Xehe molibdeni	Molybdenite		4,50%			
			Xehe tungsteni	Tungsten ore					

5 Production Data 1930 – 2018

Year	Ore Produced (T/ year)	Pb %	Zn %	Ag (g/T)	Bi %	Pb (T)	Zn (T)	Ag (T)	Bi (T)	Cu Conc. (T)
1930	80,000	9.30%	8.10%	210		7,440	6,480	17		
1931	290,000	12.50%	7.60%	200		36,250	22,040	58		
1932	480,000	9.50%	8.80%	200		45,600	42,240	96		
1933	560,000	9.00%	8.70%	185		50,400	48,720	104		
1934	620,000	9.00%	8.60%	189		55,800	53,320	117		
1935	620,000	9.00%	8.70%	187		55,800	53,940	116		
1936	620,000	9.00%	7.90%	187	0.00%	55,800	48,980	116	27	
1937	640,000	9.00%	6.00%	185	0.01%	57,600	38,400	118	47	
1938	695,000	9.00%	5.90%	187	0.01%	62,550	41,005	130	58	1,863
1939	640,000	8.80%	4.90%	183	0.01%	56,320	31,360	117	75	2,101
1940	690,000	8.80%	3.60%	168	0.02%	60,720	24,840	116	114	2,508
1941	515,000	8.50%	3.40%	140	0.02%	43,775	17,510	72	78	542
1942	315,000	7.20%	3.00%	137	0.02%	22,680	9,450	43	54	907
1943	390,000	7.50%	2.50%	149	0.02%	29,250	9,750	58	63	1,376
1944	375,000	7.20%	2.60%	137		27,000	9,750	51		868
1945	120,000	7.10%	2.90%	120		8,520	3,480	14		
1946	420,000	6.90%	3.20%	116		28,980	13,440	49		
1947	425,000	6.90%	4.00%	118		29,325	17,000	50		
1948	530,000	7.10%	4.50%	125		37,630	23,850	66		
1949	535,000	6.80%	4.90%	115		36,380	26,215	62		
1950	665,000	6.80%	4.90%	115		45,220	32,585	76		
1951	620,000	7.20%	4.30%	105		44,640	26,660	65		
1952	575,000	7.00%	4.20%	112		40,250	24,150	64		
1953	540,000	7.00%	4.10%	108		37,800	22,140	58		

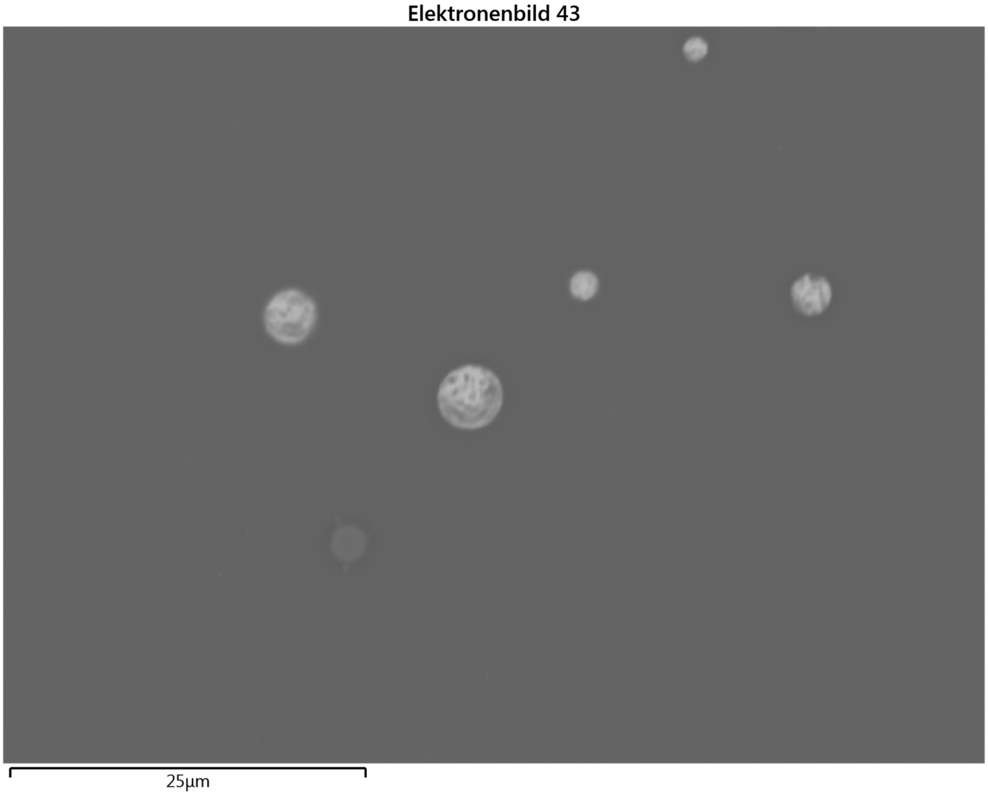
1954	515,000	7.00%	3.90%	102	36,050	20,085	53
1955	560,000	7.00%	4.00%	82	39,200	22,400	46
1956	560,000	6.90%	3.90%	93	38,640	21,840	52
1957	560,000	7.10%	4.00%	98	39,760	22,400	55
1958	570,000	7.00%	4.00%	89	39,900	22,800	51
1959	590,000	7.10%	3.80%	87	41,890	22,420	51
1960	610,000	6.80%	3.70%	88	41,480	22,570	54
1961	615,000	6.80%	3.80%	86	41,820	23,370	53
1962	620,000	6.60%	3.80%	84	40,920	23,560	52
1963	620,000	6.40%	4.00%	85	39,680	24,800	53
1964	630,000	6.20%	4.00%	83	39,060	25,200	52
1965	575,000	6.10%	4.00%	85	35,075	23,000	49
1966	550,000	5.70%	4.00%	83	31,350	22,000	46
1967	590,000	5.70%	3.80%	82	33,630	22,420	48
1968	590,000	5.70%	4.00%	85	33,630	23,600	50
1969	580,000	5.20%	3.90%	81	30,160	22,620	47
1970	640,000	5.20%	4.00%	83	33,280	25,600	53
1971	600,000	5.50%	4.10%	82	33,000	24,600	49
1972	640,000	5.20%	3.80%	81	33,280	24,320	52
1973	636,000	5.00%	3.70%	82	31,800	23,532	52
1974	634,000	4.90%	3.10%	85	31,066	19,654	54
1975	635,000	4.80%	3.20%	83	30,480	20,320	53
1976	660,000	4.50%	3.30%	78	29,700	21,780	51
1977	680,000	4.40%	3.20%	76	29,920	21,760	52
1978	600,000	4.60%	3.30%	74	27,600	19,800	44
1979	680,000	4.60%	2.90%	75	31,280	19,720	51
1980	688,000	3.80%	2.70%	72	26,144	18,576	50
1981	696,000	3.80%	2.30%	76	26,448	16,008	53
1982	628,000	3.60%	2.20%	73	22,608	13,816	46
1983	664,000	3.40%	2.30%	67	22,576	15,272	44
1984	702,000	3.00%	1.90%	57	21,060	13,338	40

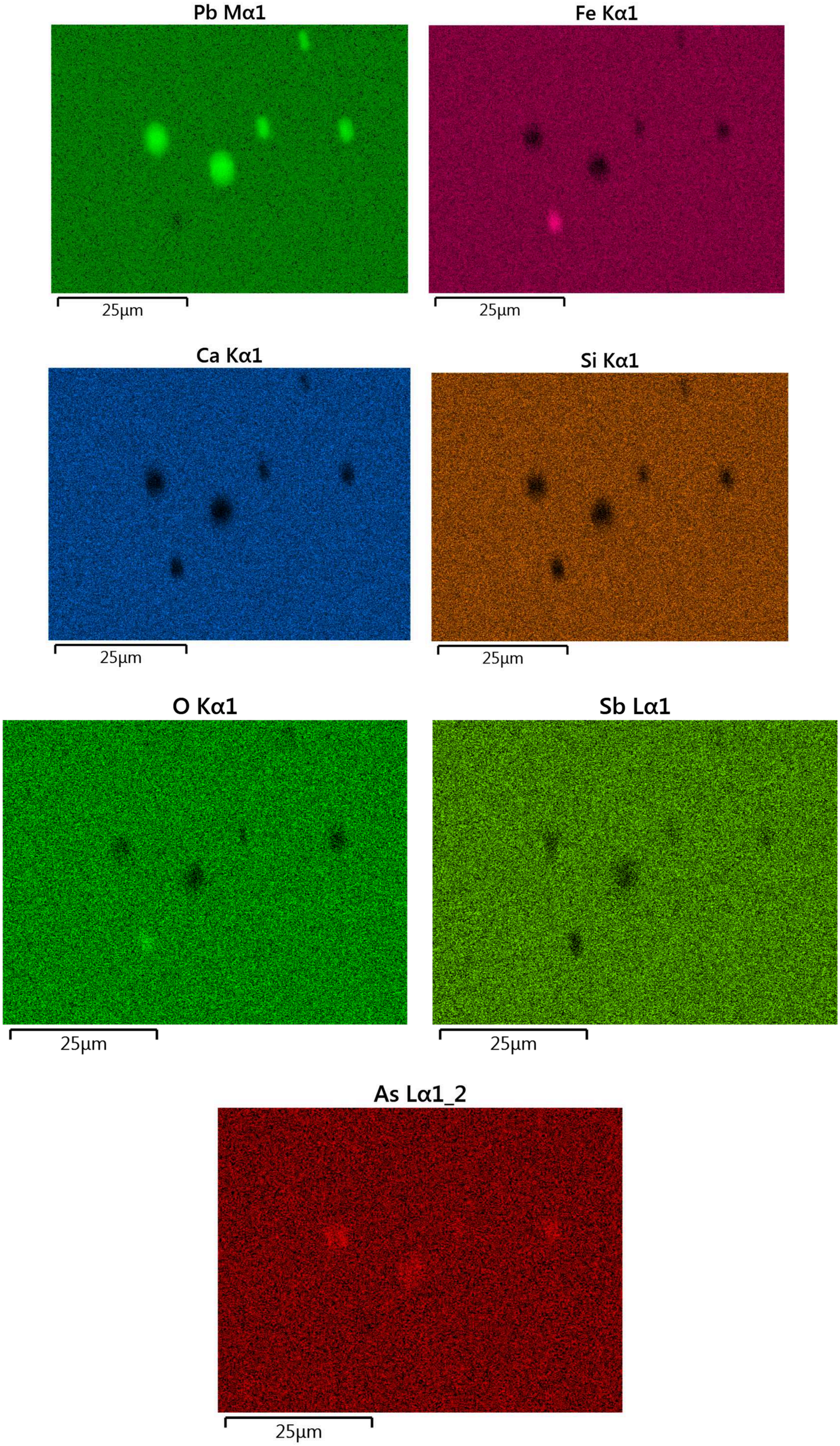
1985	687,000	3.00%	1.90%	59	20,610	13,053	41		
1986	647,000	2.40%	1.50%	68	15,528	9,705	44		
1987	637,000	2.80%	1.80%	65	17,836	11,466	41		
1988	576,000	3.20%	2.00%	57	18,432	11,520	33		
1989	366,000	3.20%	2.00%	53	11,712	7,320	19		
1990	205,000	3.40%	1.90%	58	6,970	3,895	12		
1991	124,000	3.60%	2.30%	54	4,464	2,852	7		
1992	117,000	3.10%	2.10%	56	3,627	2,457	7		
1993	55,000	2.80%	2.20%	52	1,540	1,210	3		
1994	55,000	2.30%	2.60%	57	1,265	1,430	3	Assumed amounts	
1995	100,000	2.70%	2.80%	54	2,700	2,800	5	2.70%	2.80%
1996	100,000	2.70%	2.80%	54	2,700	2,800	5		
1997	100,000	2.70%	2.80%	54	2,700	2,800	5		
1998	60,000	2.70%	2.80%	54	1,620	1,680	3		
1999	0	3.85%	2.13%	55.504	0	0	0		
2000	0	3.82%	2.10%	54.8301	0	0	0		
2001	0	3.79%	2.08%	54.1656	0	0	0		
2002	0	3.76%	2.06%	53.5103	0	0	0		
2003	0	3.73%	2.03%	52.8639	0	0	0		
2004	0	3.70%	2.01%	52.2261	0	0	0		
2005	12,200	3.67%	1.99%	51.5969	448	243	1		
2006	41,830	3.64%	1.97%	50.9758	1,524	822	2		
2007	52,350	3.62%	1.94%	50.3628	1,893	1,017	3		
2008	69,854	3.59%	1.92%	49.7575	2,506	1,343	3		
2009	89,225	3.56%	1.90%	49.1599	3,176	1,696	4		
2010	96,123	3.53%	1.88%	48.5697	3,395	1,807	5		
2011	112,915	3.51%	1.86%	47.9868	3,958	2,099	5		
2012	125,945	3.48%	1.84%	47.4109	4,381	2,315	6		
2013	139,459	3.45%	1.82%	46.8419	4,814	2,535	7		
2014	67,859	3.43%	1.80%	46.2796	2,325	1,220	3		
2015		3.40%	1.78%	45.724	0	0	0		

2016		3.38%	1.76%	45.1747	0	0	0
2017	154,884	3.35%	1.74%	44.6317	5,188	2,693	7
2018	132,496	3.32%	1.72%	44.0949	4,405	2,278	6

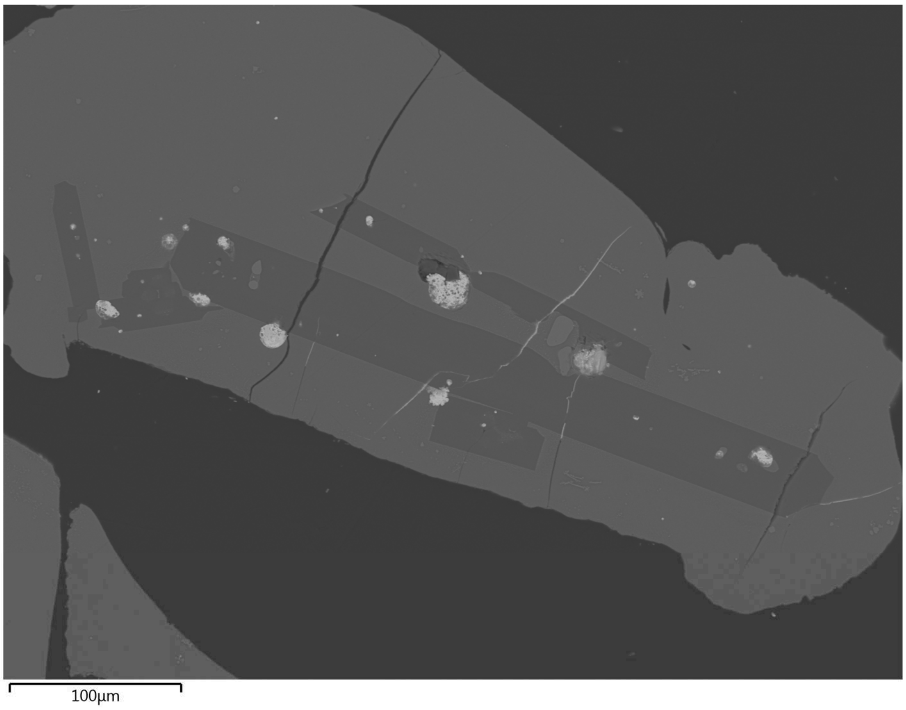
Indicates interpolated values

6 Scanning Electron Microscope Mapping

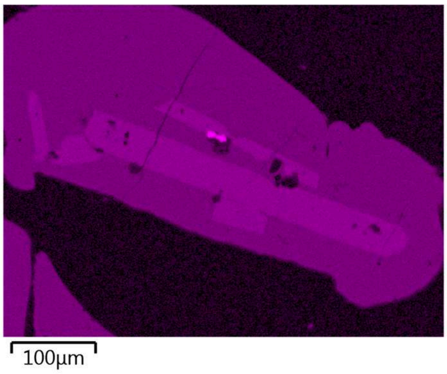



Pb Mα1
25µm
Fe Kα1
25µm
Ca Kα1
25µm
Si Kα1
25µm
O Kα1
25µm
Sb Lα1
25µm
As Lα1_2
25µm

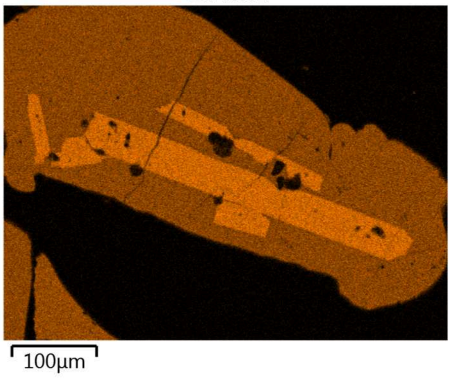
Elektronenbild 52

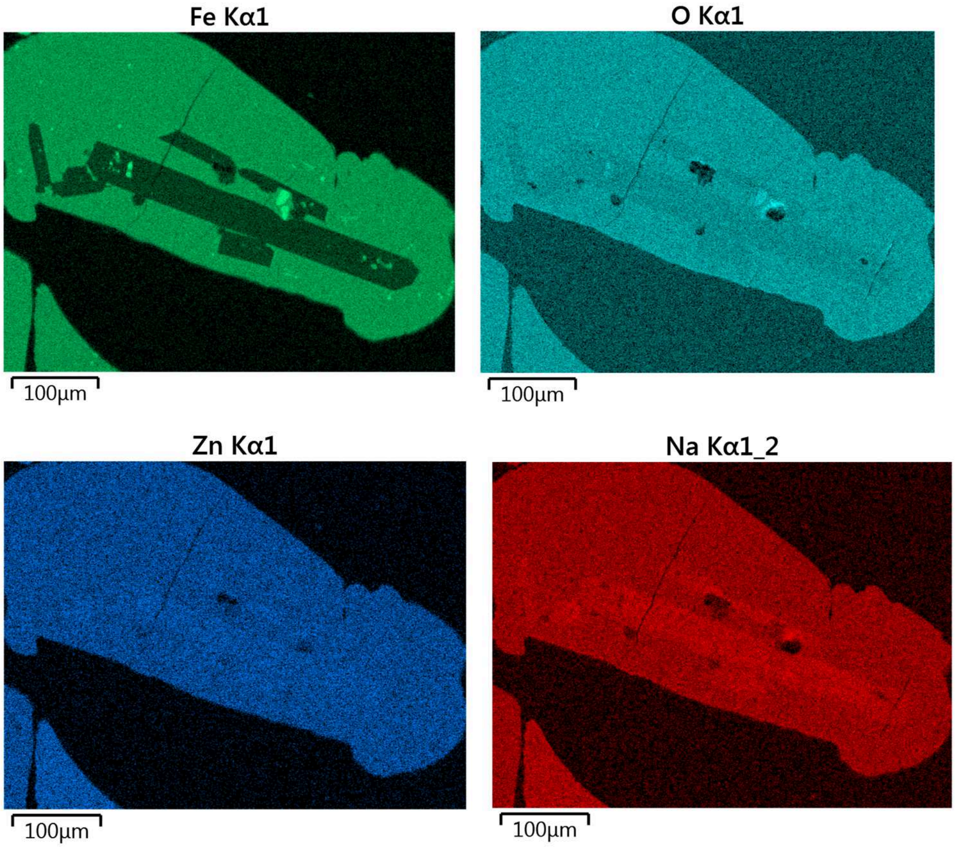


Si Kα1



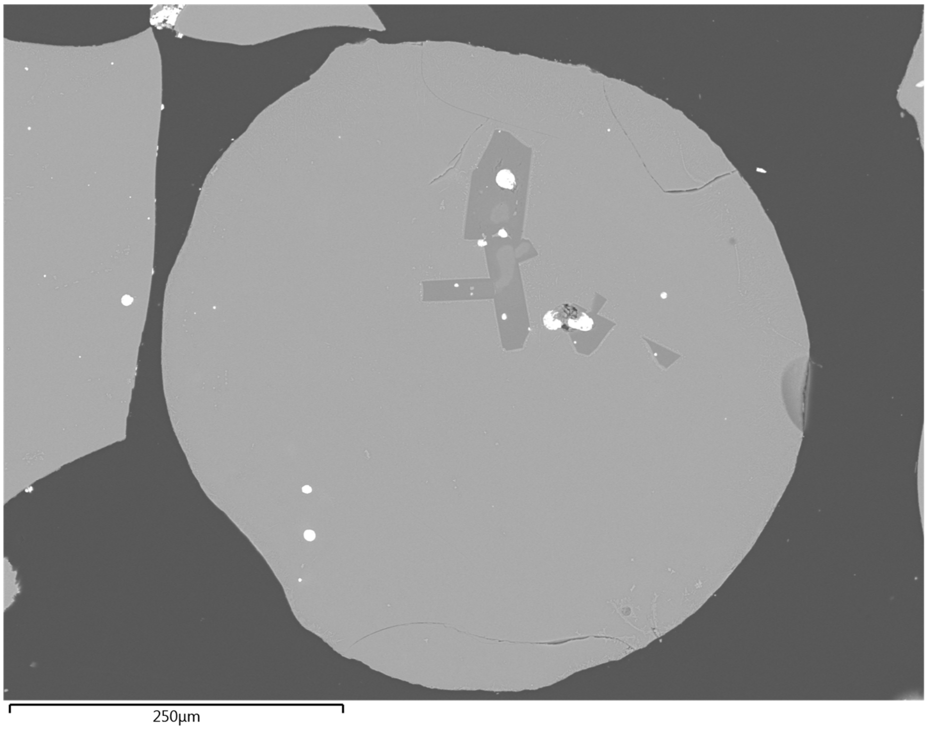
Ca Kα1



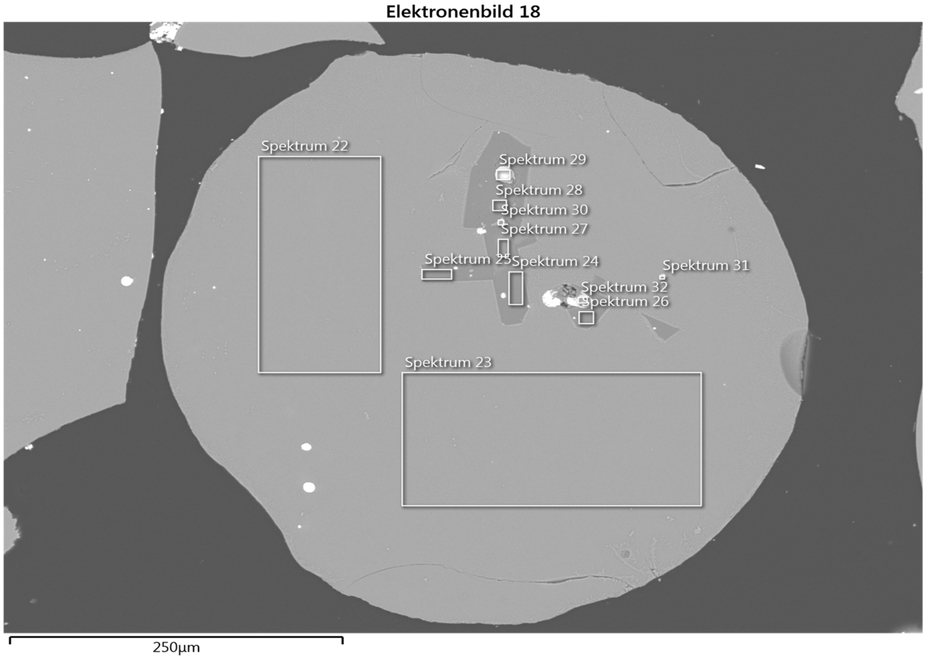

Fe Kα1
100µm
O Kα1
100µm
Zn Kα1
100µm
Na Kα1_2
100µm

7 Scanning Electron Microscope Pictures

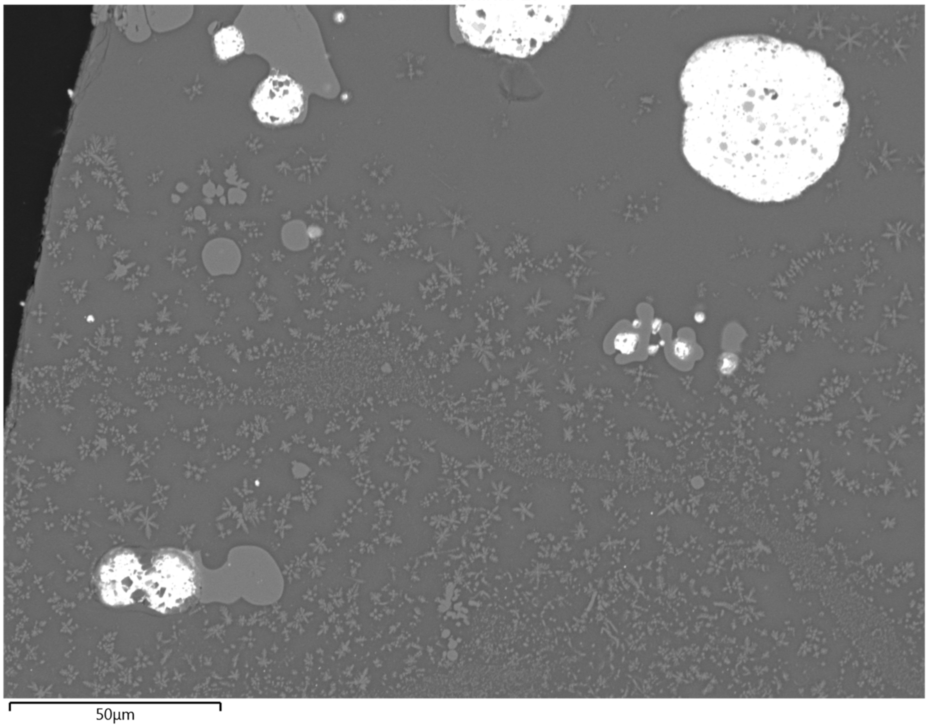
Elektronenbild 17



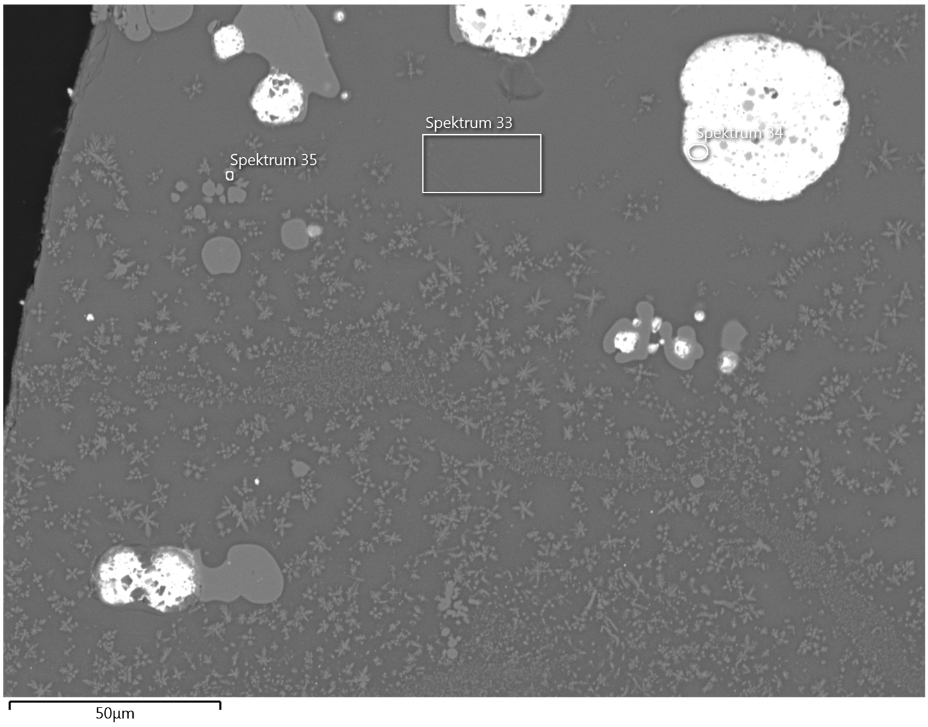
Elektronenbild 18



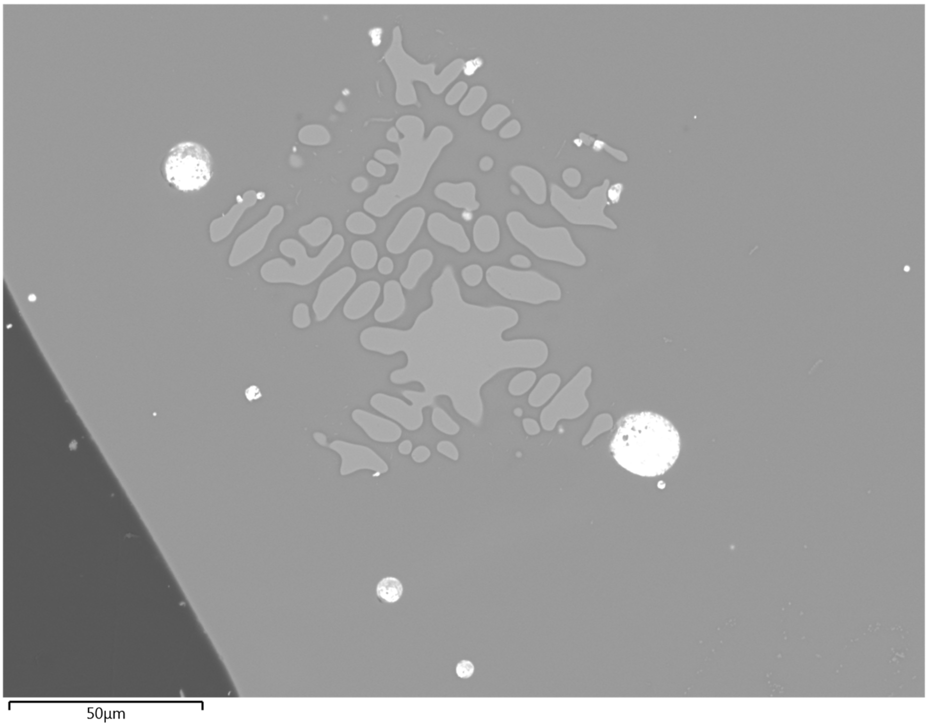
Elektronenbild 19



Elektronenbild 20



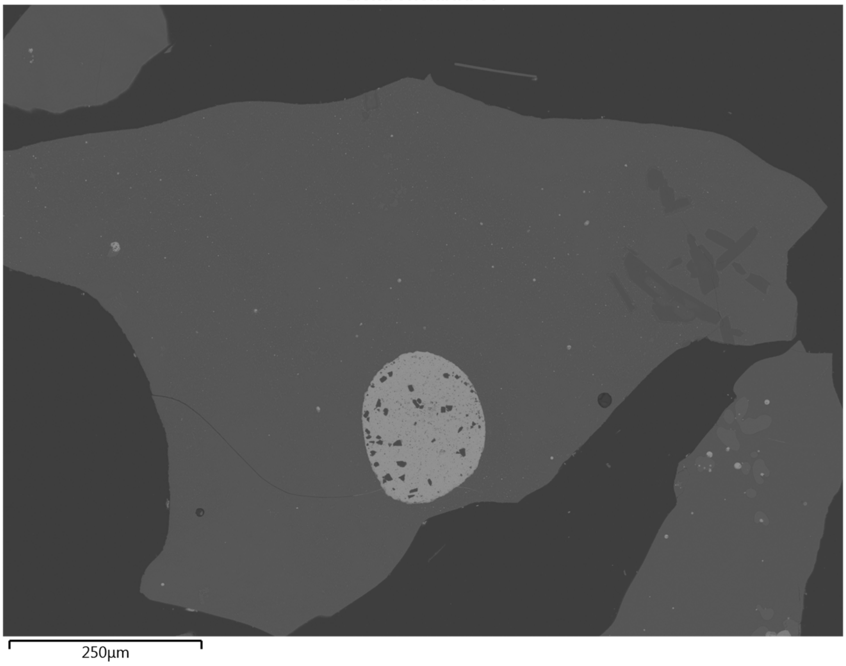
Elektronenbild 21



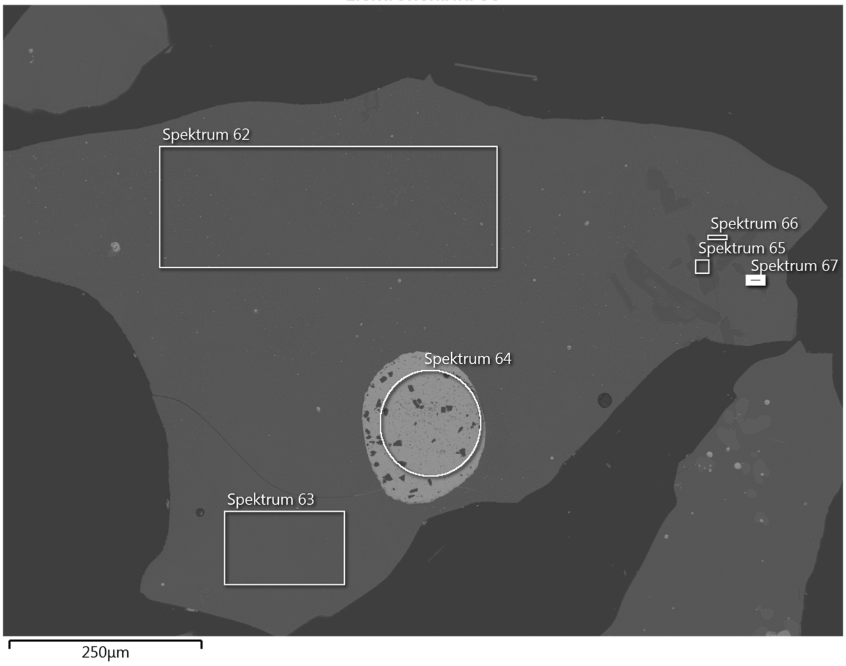
Elektronenbild 22

There are no pictures from Elektronenbild 23 - 36

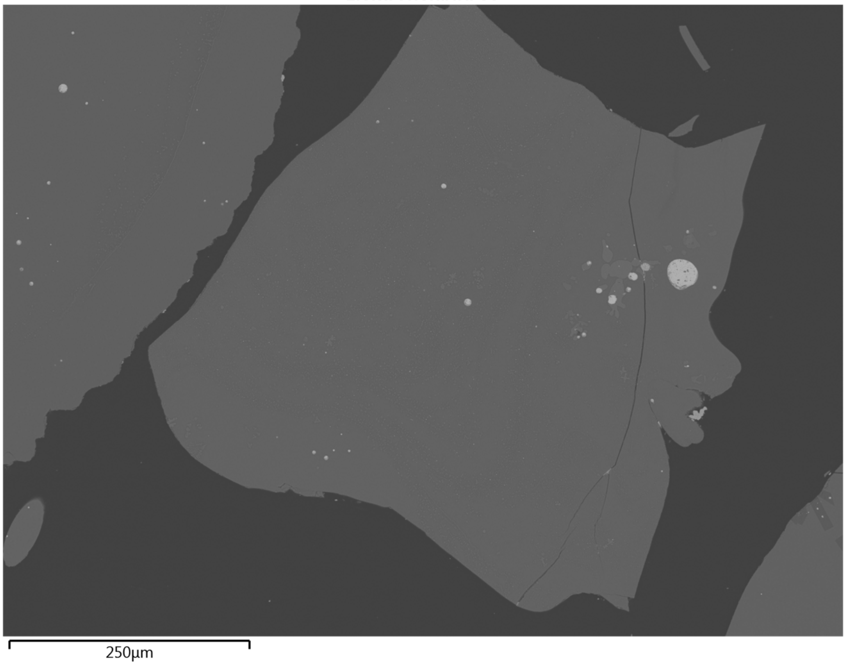
Elektronenbild 37



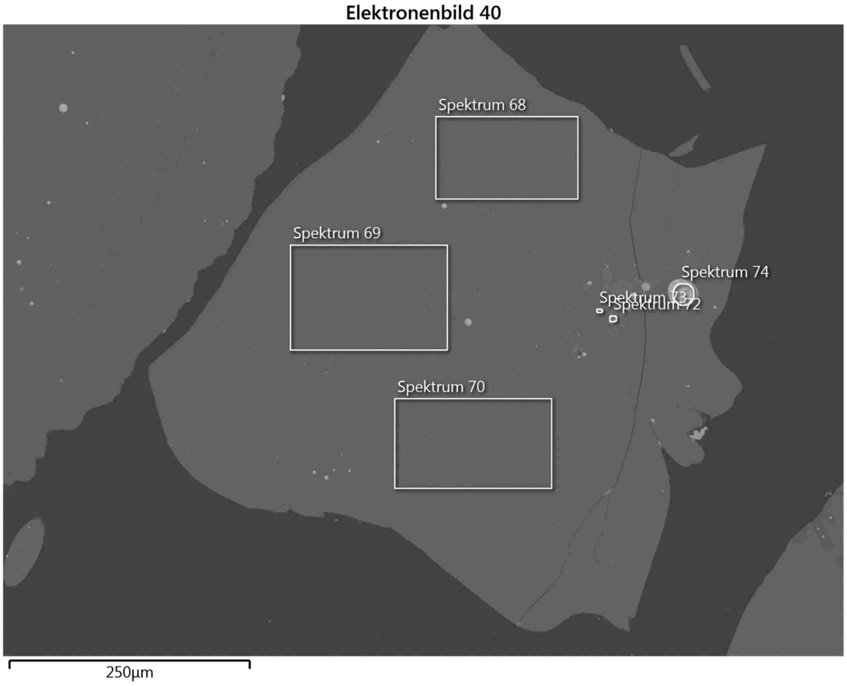
Elektronenbild 38



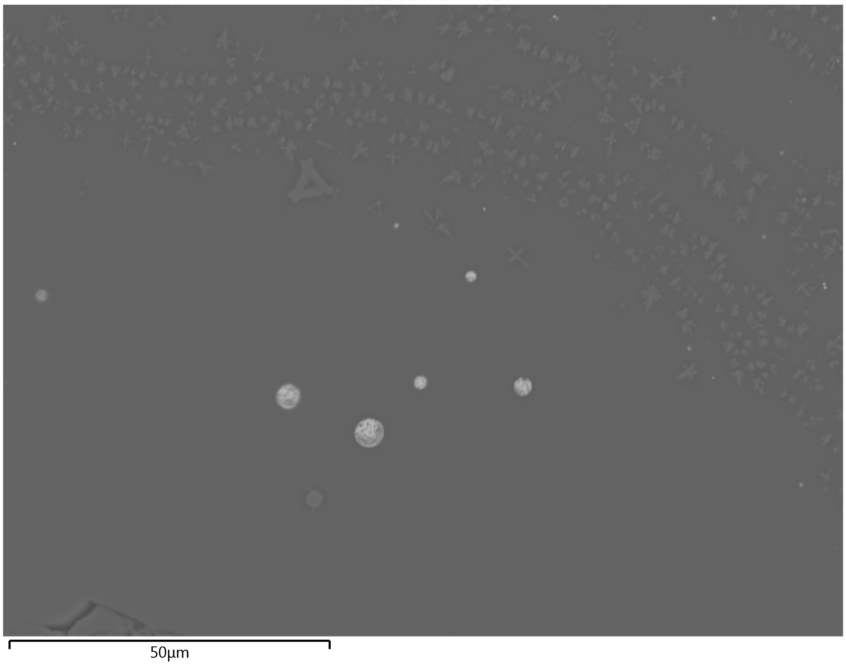
Elektronenbild 39



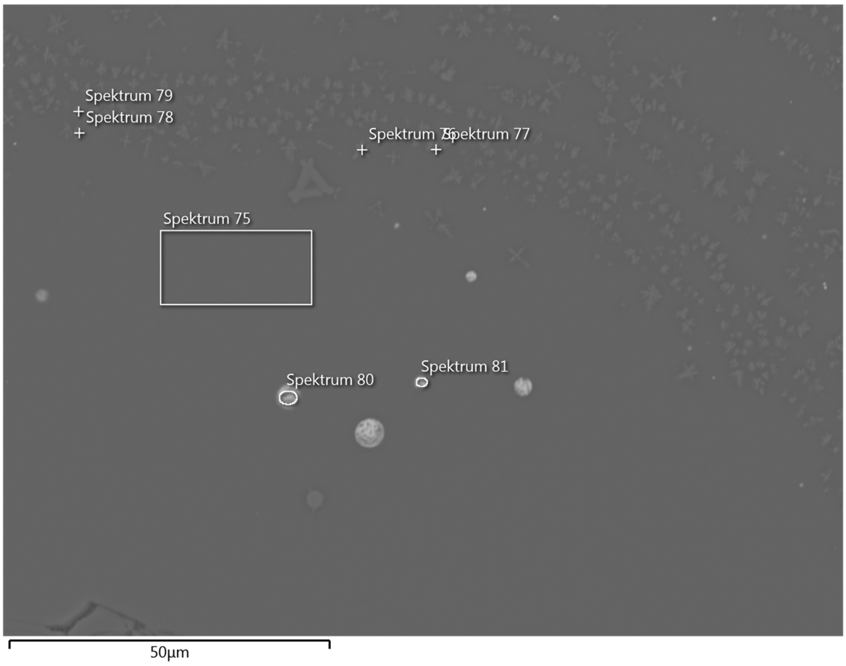
Elektronenbild 40



Elektronenbild 41

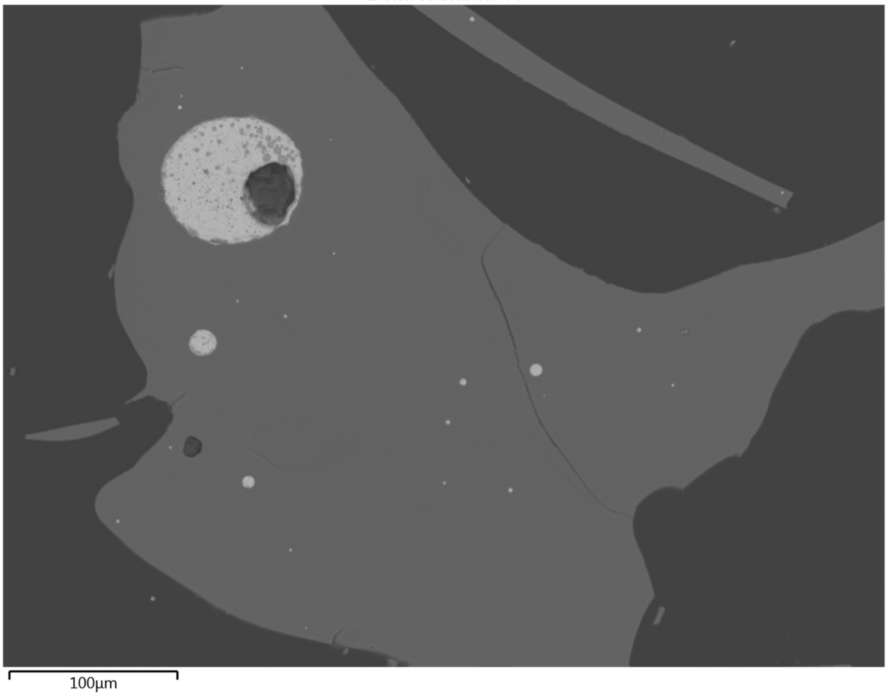


Elektronenbild 42

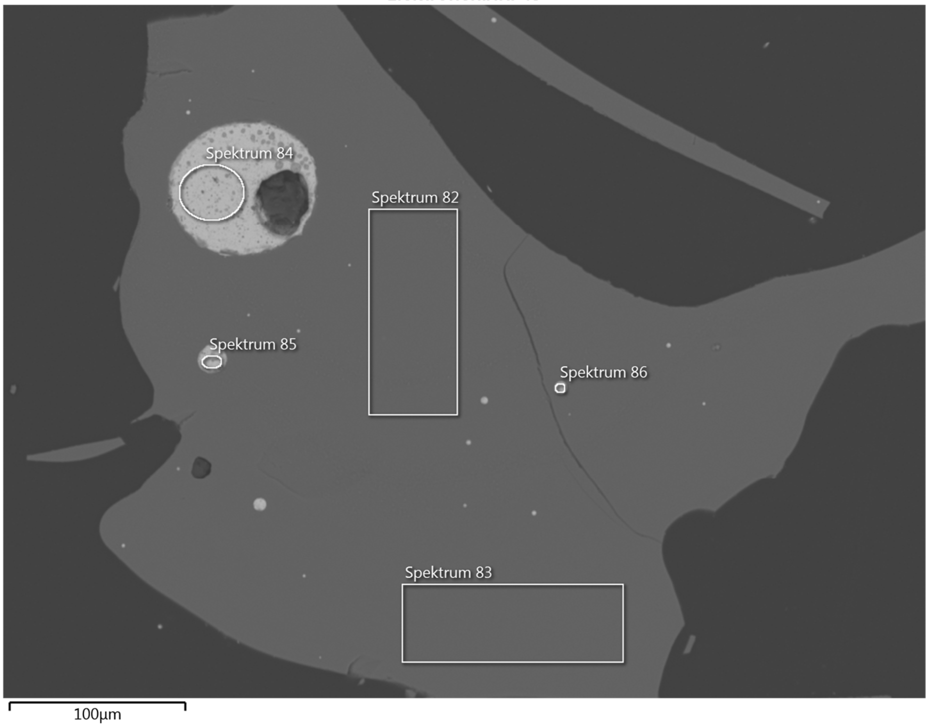


There is no picture for Elektronenbild 43

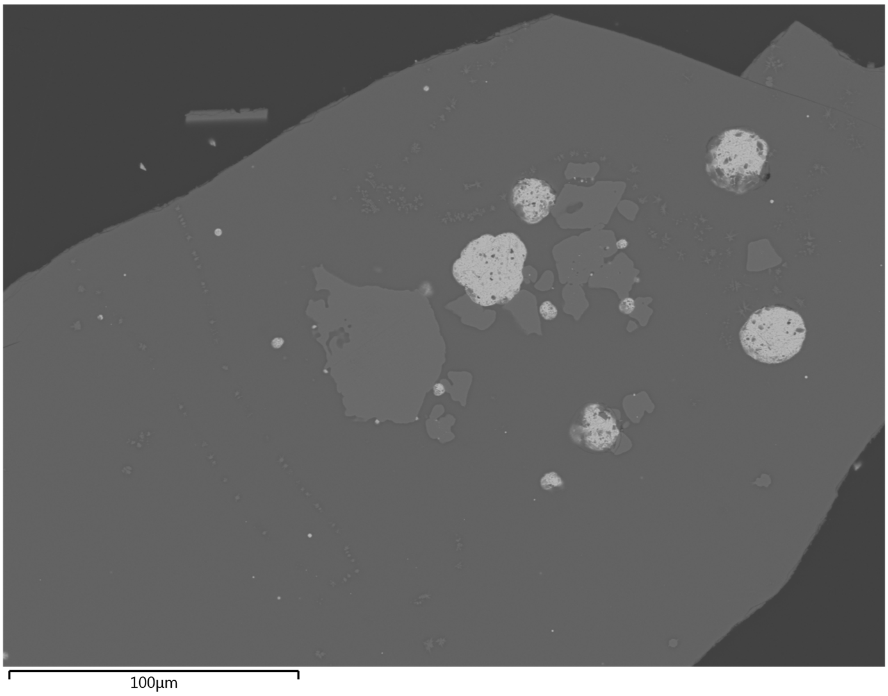
Elektronenbild 44



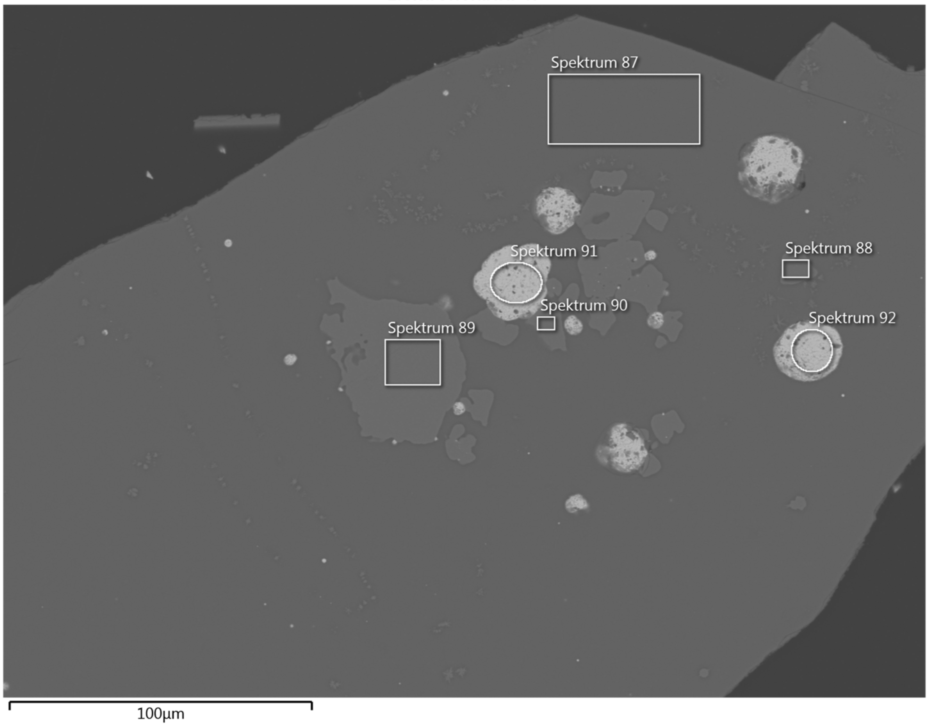
Elektronenbild 45



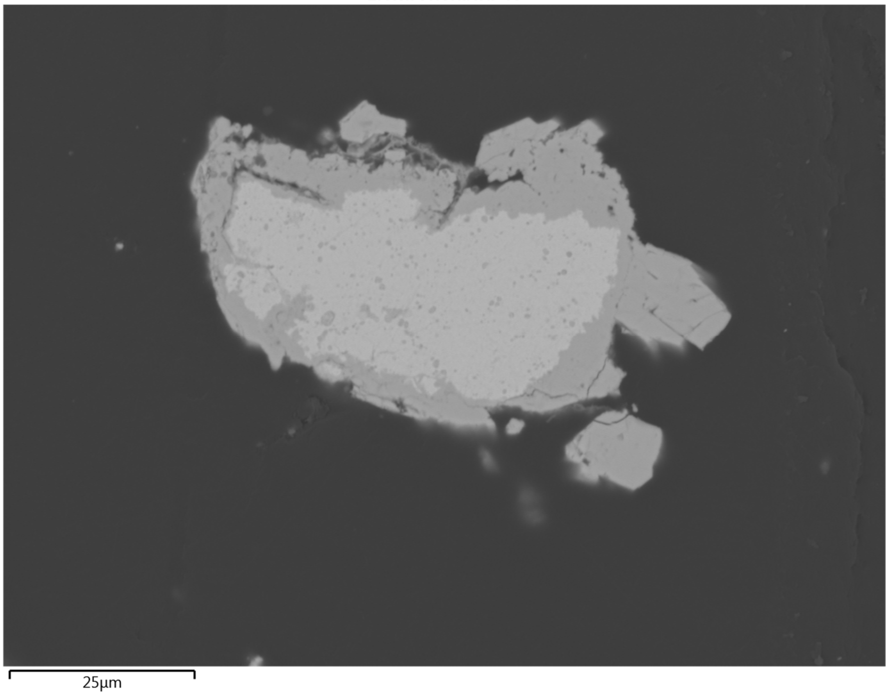
Elektronenbild 46



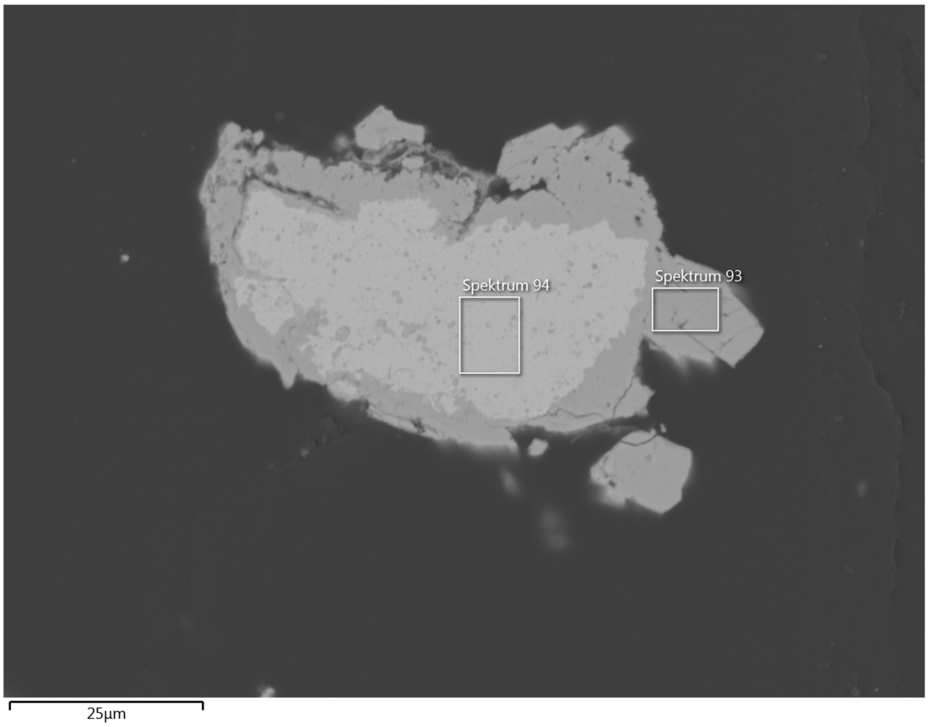
Elektronenbild 47



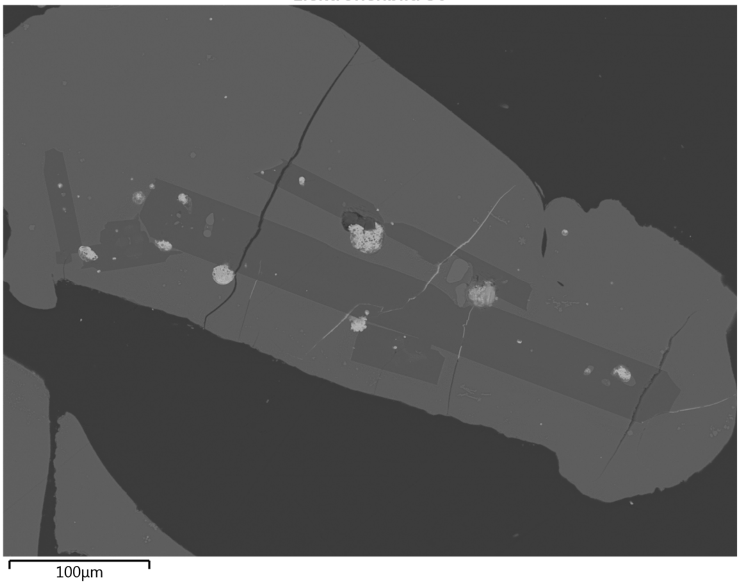
Elektronenbild 48



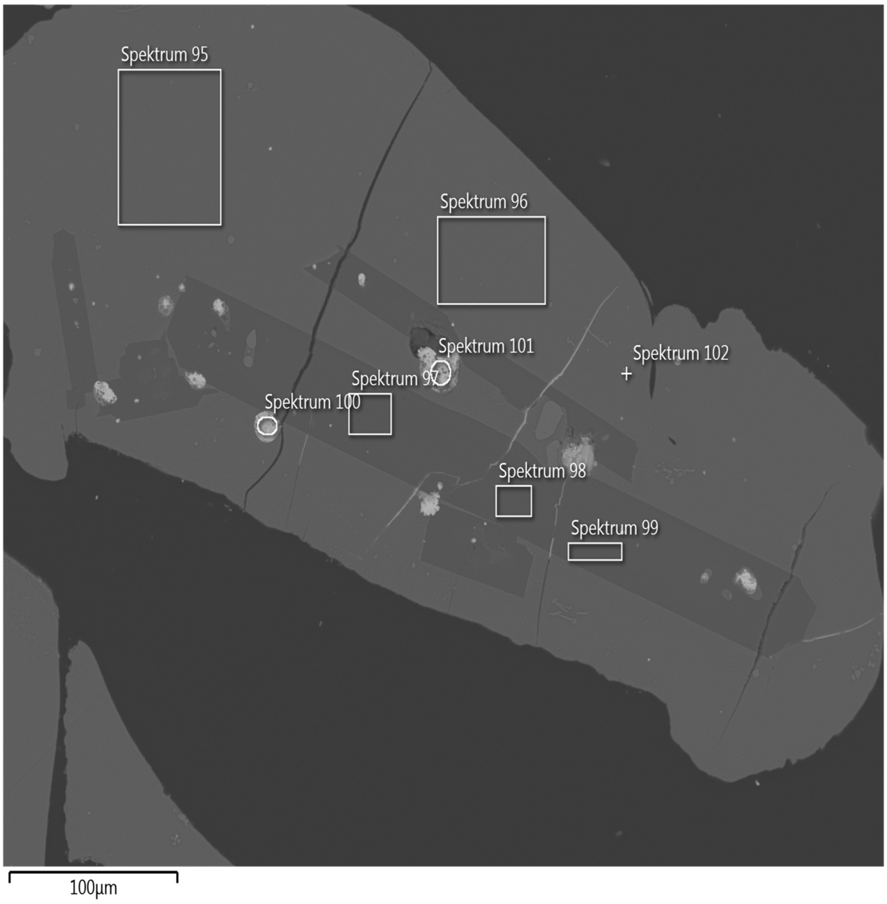
Elektronenbild 49



Elektronenbild 50



Elektronenbild 51



8 Financial Model Printouts (Excel Model and Slag Model)

Note All inputs are marked by green cells

Total Reserves (Tons)	12,319,303					Dilution	Recovery
Production (T/ Year)	229,917.14	See Sensitivity			Open pit	0.05	0.9
Production (T/ Day) Calc'd	884.30			1	Block caving	0.15	0.95
Mine Type	2	Cut and Fill (200-8,000 TPD	Mine type per Kosovo Trust Agency Report	2	Cut-and-fill	0.05	0.85
Days / Week (5 or 7)	5	Mine Life Chk		3	Room-and-pillar	0.05	1.85
Mine Life (Calc'd)	47.82	53.6		4	Shrinkage	0.1	0.9
Mine Depth (Meters)	610			5	Sublevel longhole	0.15	0.85
Process Plant	2	Floatation Mill (2 Product)		6	Vertical crater retreat	0.1	0.9
Capital Investment	-	0=no, 1=yes					

Ore Adjustment

	Mine Production Values	Amount in Concentrate	Amount in Tailings	100% Adjusted Values	Weight % in ore	Normal price Units	Prices per Unit Value
Lead Wt %	3.43%	62.00%	0.72%	3.43%	3.43%	€ per kg	1.98
Zinc Wt %	3.11%	40.00%	1.23%	3.11%	3.11%	€ per kg	2.19
Silver gm/ Ton (lead)	33.800	1,260.000	10.000	33.800	0.0034%	USD Per Troy Oz	18.00
Silver gm/ Ton (zinc)	-	-	-	-	0.0000%	USD Per Troy Oz	18.00
Gold gm/ Ton (lead)	-	-	-	-	0.000000%	USD Per Troy Oz	1500.00
Gold gm/ Ton (zinc)	-	-	-	-	0.0000%	USD Per Troy Oz	1500.00
Copper gm/ Ton	-	-	-	-	0.0000%	€ per kg	5.32
Bismuth gm/ Ton	-	-	-	-	0.0000%	€ per kg	0.76
Cadmium gm/ Ton	-	-	-	-	0.0000%	€ per kg	2.64

Assumptions:
Treatment Charges are based on a flat rate given by trepca on the current contract.
lead and zinc concentrates are sold as above including treatment charges
silver and gold content is considered

If silver and gold are to be considered and the model needs to be more accurate, use the following
Gold: Deduct 0.03 to 0.07 troy ounce per dry tonne and pay for 95% of the remaining gold at market value.
Silver: Deduct 0.5 to 2.0 troy ounce per dry tonne and pay for 95% of the remaining silver at market value.
https://costs.infomine.com/costdatacenter/smeltingcosts.aspx

Recovery based on actual Trepca production

	Annual Incr. / Decr.	1	2	3	4	5	6
Monthly Prod. of ore	0%	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76
Lead Wt %	0%	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%
Zinc Wt %	0%	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%
Silver Wt%	0%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%
Gold Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Copper Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Bismuth Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Cadmium Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Price Projection

Lead Price	0%	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
Zinc Price	0%	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
Silver Price	0%	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
Gold Price	0%	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64
Copper Price	0%	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18
Bismuth Price	0%	760.96	760.96	760.96	760.96	760.96	760.96
Cadmium Price	0%	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36

Senior Debt	10,000,000
Interest Rate	8%
Term (Years)	5
Payment (Monthly)	$202,763.94

Subordinate Debt	
Interest Rate	12%
Term	5

Payment	$0.00
Inflation Rate	0%
Taxes	0%
Royalty percentage lead	4.50%
Royalty percentage zinc	4.50%
Royalty percentage silver	4.50%
Allowable deduction lead	10.00%
Allowable deduction zinc	10.00%
Allowable deduction silver	10.00%

			0.85	181.8181818	285	0	
			0.95	181.8181818	380	0	
			0.95	0	0	0.818181818	
			0.95	0	0	0	

	Processing Adjustment 100%			Per DMT			
Prices Oct 2019 Euro/ Ton	Processing Recovery	Metal in Concentrate	Percentage Paid	Treatment Charge €/ T	Treatment Charge €/ T	Refining Charge €/ oz	Refining Charge €/ T
1975.00	80.0%	62.0%	85%	182	285	-	-
2191.00	62.4%	40.0%	95%	182	380	-	-
526102.36	71.0%	0.1%	95%	-	-	0.82	26,306
526102.36	0.0%	0.0%	0%	-	-	-	-
43841863.64	0.0%	0.0%	0%	-	-	-	-
43841863.64	0.0%	0.0%	0%	-	-	-	-
5318.18	0.0%	0.0%	0%	-	-	-	-
760.96	0.0%	0.0%	0%	-	-	-	-
2636.36	0.0%	0.0%	0%	-	-	-	-

7	8	9	10	11	12	13	14
19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76
3.43%	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%
3.11%	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%
0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64
5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18
760.96	760.96	760.96	760.96	760.96	760.96	760.96	760.96
2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36

This Page has no information.

Period	1	2	3	4	5	6	7	8
Senior Debt	10,000,000.00	9,863,902.72	9,726,898.13	9,588,980.18	9,450,142.77	9,310,379.78	9,169,685.03	9,028,052.32
Interest	66,666.67	65,759.35	64,845.99	63,926.53	63,000.95	62,069.20	61,131.23	60,187.02
Payment	202,763.94	202,763.94	202,763.94	202,763.94	202,763.94	202,763.94	202,763.94	202,763.94
Balance	9,863,902.72	9,726,898.13	9,588,980.18	9,450,142.77	9,310,379.78	9,169,685.03	9,028,052.32	8,885,475.40
Subordinate Debt	-	-	-	-	-	-	-	-
Interest	-	-	-	-	-	-	-	-
Payment	-	-	-	-	-	-	-	-
Balance	-	-	-	-	-	-	-	-
Total Balance	9,863,902.72	9,726,898.13	9,588,980.18	9,450,142.77	9,310,379.78	9,169,685.03	9,028,052.32	8,885,475.40

Monthly amounts	1	2	3	4	5	6	7	8
Labor	197,645	197,645	197,645	197,645	197,645	197,645	197,645	197,645
Equipment	72,886	72,886	72,886	72,886	72,886	72,886	72,886	72,886
Steel	86,428	86,428	86,428	86,428	86,428	86,428	86,428	86,428
Lumber	75,893	75,893	75,893	75,893	75,893	75,893	75,893	75,893
Fuel	10,974	10,974	10,974	10,974	10,974	10,974	10,974	10,974
Lube	14,274	14,274	14,274	14,274	14,274	14,274	14,274	14,274
Explosives	64,395	64,395	64,395	64,395	64,395	64,395	64,395	64,395
Tires	6,323	6,323	6,323	6,323	6,323	6,323	6,323	6,323
Construction material	128,459	128,459	128,459	128,459	128,459	128,459	128,459	128,459
Electricity	216,074	216,074	216,074	216,074	216,074	216,074	216,074	216,074
Reagents	-	-	-	-	-	-	-	-
	873,352	873,352	873,352	873,352	873,352	873,352	873,352	873,352

Monthly amounts	1	2	3	4	5	6	7	8
Labor	209,961	209,961	209,961	209,961	209,961	209,961	209,961	209,961
Equipment	85,931	85,931	85,931	85,931	85,931	85,931	85,931	85,931
Steel	25,867	25,867	25,867	25,867	25,867	25,867	25,867	25,867
Lumber	-	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-	-
Lube	9,810	9,810	9,810	9,810	9,810	9,810	9,810	9,810
Explosives	-	-	-	-	-	-	-	-
Tires	-	-	-	-	-	-	-	-
Construction material	-	-	-	-	-	-	-	-
Electricity	46,589	46,589	46,589	46,589	46,589	46,589	46,589	46,589
Reagents	21,370	21,370	21,370	21,370	21,370	21,370	21,370	21,370
	399,527	399,527	399,527	399,527	399,527	399,527	399,527	399,527
Tons of Ore	19,160	19,160	19,160	19,160	19,160	19,160	19,160	19,160
Recovered Lead	526	526	526	526	526	526	526	526
Recovered Zinc	372	372	372	372	372	372	372	372
Recovered Silver	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460
Recovered Gold	-	-	-	-	-	-	-	-
Recovered Copper	-	-	-	-	-	-	-	-
Recovered Bismuth	-	-	-	-	-	-	-	-
Recovered Cadmium	-	-	-	-	-	-	-	-
Tons Conc. Lead	848	848	848	848	848	848	848	848
Tons Conc. Zinc	929	929	929	929	929	929	929	929
Tons Silver	0.45965	0.45965	0.45965	0.45965	0.45965	0.45965	0.45965	0.45965
Tons Gold	-	-	-	-	-	-	-	-
Tons Copper	-	-	-	-	-	-	-	-
Tons Bismuth	-	-	-	-	-	-	-	-

Tons Cadmium	-	-	-	-	-	-	-	-
Treatment Charge Pb	241,581	241,581	241,581	241,581	241,581	241,581	241,581	241,581
Treatment Charge Zn	352,982	352,982	352,982	352,982	352,982	352,982	352,982	352,982
Refining Charge Ag $ Au	12,091	12,091	12,091	12,091	12,091	12,091	12,091	12,091
	606,655	606,655	606,655	606,655	606,655	606,655	606,655	606,655

Monthly amounts	1	2	3	4	5	6	7	8
	-	-	-	-	-	-	-	-

Monthly amounts	1	2	3	4	5	6	7	8
	-	-	-	-	-	-	-	-

Monthly amounts	1	2	3	4	5	6	7	8
Annual environmental								
	-	-	-	-	-	-	-	-

Monthly amounts	1	2	3	4	5	6	7	8
	-	-	-	-	-	-	-	-

Month	1	2	3	4	5	6	7	8
Pb Income	882,258	882,258	882,258	882,258	882,258	882,258	882,258	882,258
Zn Income	773,384	773,384	773,384	773,384	773,384	773,384	773,384	773,384
Ag Income (lead)	229,732	229,732	229,732	229,732	229,732	229,732	229,732	229,732
Au Income (lead)	-	-	-	-	-	-	-	-
Cu Income	-	-	-	-	-	-	-	-
Bi Income	-	-	-	-	-	-	-	-
Cd Income	-	-	-	-	-	-	-	-
Other Income	-	-	-	-	-	-	-	-
Total Income	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375
Mining								
Labor	197,645	197,645	197,645	197,645	197,645	197,645	197,645	197,645
Equipment	72,886	72,886	72,886	72,886	72,886	72,886	72,886	72,886
Steel	86,428	86,428	86,428	86,428	86,428	86,428	86,428	86,428
Lumber	75,893	75,893	75,893	75,893	75,893	75,893	75,893	75,893
Fuel	10,974	10,974	10,974	10,974	10,974	10,974	10,974	10,974
Lube	14,274	14,274	14,274	14,274	14,274	14,274	14,274	14,274
Explosives	64,395	64,395	64,395	64,395	64,395	64,395	64,395	64,395
Tires	6,323	6,323	6,323	6,323	6,323	6,323	6,323	6,323
Construction material	128,459	128,459	128,459	128,459	128,459	128,459	128,459	128,459
Electricity	216,074	216,074	216,074	216,074	216,074	216,074	216,074	216,074
Reagents	-	-	-	-	-	-	-	-
	873,352	873,352	873,352	873,352	873,352	873,352	873,352	873,352
Processing								
Labor	209,961	209,961	209,961	209,961	209,961	209,961	209,961	209,961
Equipment	85,931	85,931	85,931	85,931	85,931	85,931	85,931	85,931
Steel	25,867	25,867	25,867	25,867	25,867	25,867	25,867	25,867
Lumber	-	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-	-
Lube	9,810	9,810	9,810	9,810	9,810	9,810	9,810	9,810
Explosives	-	-	-	-	-	-	-	-

Tires	-	-	-	-	-	-	-	-
Construction material	-	-	-	-	-	-	-	-
Electricity	46,589	46,589	46,589	46,589	46,589	46,589	46,589	46,589
Reagents	21,370	21,370	21,370	21,370	21,370	21,370	21,370	21,370
Total Processing	399,527	399,527	399,527	399,527	399,527	399,527	399,527	399,527
Refining Expense	-	-	-	-	-	-	-	-
Treatment Charge	606,655	606,655	606,655	606,655	606,655	606,655	606,655	606,655
Total Refining	606,655	606,655	606,655	606,655	606,655	606,655	606,655	606,655
Royalty Expense	5,840.69	5,840.69	5,840.69	5,840.69	5,840.69	5,840.69	5,840.69	5,840.69
Environmental Expense	-	-	-	-	-	-	-	-
Other Expenses	-	-	-	-	-	-	-	-
Total Other Expenses	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841
Total Expenses	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375	1,885,375
Income less Expenses	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Taxes	-	-	-	-	-	-	-	-
Finance Expense	-	-	-	-	-	-	-	-
Net Income	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

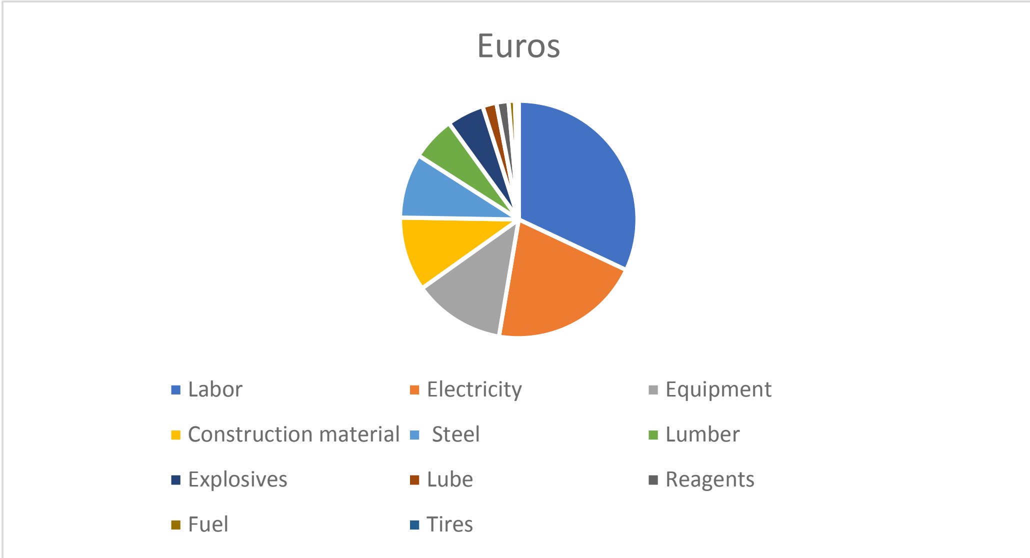
Year	0	1	2	3	4	5	6	7	8
Pb Income	-	10,587,099	10,587,099	10,587,099	10,587,099	10,587,099	10,587,099	10,587,099	10,587,099
Zn Income	-	9,280,612	9,280,612	9,280,612	9,280,612	9,280,612	9,280,612	9,280,612	9,280,612
Ag Income (lead)	-	2,756,784	2,756,784	2,756,784	2,756,784	2,756,784	2,756,784	2,756,784	2,756,784
Au Income (lead)	-	-	-	-	-	-	-	-	-
Cu Income	-	-	-	-	-	-	-	-	-
Bi Income	-	-	-	-	-	-	-	-	-
Cd Income	-	-	-	-	-	-	-	-	-
Other Income	-	-	-	-	-	-	-	-	-
Total Income	-	22,624,495	22,624,495	22,624,495	22,624,495	22,624,495	22,624,495	22,624,495	22,624,495
Mining		21							
Labor	-	2,371,744	2,371,744	2,371,744	2,371,744	2,371,744	2,371,744	2,371,744	2,371,744
Equipment	-	874,629	874,629	874,629	874,629	874,629	874,629	874,629	874,629
Steel	-	1,037,141	1,037,141	1,037,141	1,037,141	1,037,141	1,037,141	1,037,141	1,037,141
Lumber	-	910,715	910,715	910,715	910,715	910,715	910,715	910,715	910,715
Fuel	-	131,687	131,687	131,687	131,687	131,687	131,687	131,687	131,687
Lube	-	171,290	171,290	171,290	171,290	171,290	171,290	171,290	171,290
Explosives	-	772,738	772,738	772,738	772,738	772,738	772,738	772,738	772,738
Tires	-	75,876	75,876	75,876	75,876	75,876	75,876	75,876	75,876
Construction material	-	1,541,512	1,541,512	1,541,512	1,541,512	1,541,512	1,541,512	1,541,512	1,541,512
Electricity	-	2,592,891	2,592,891	2,592,891	2,592,891	2,592,891	2,592,891	2,592,891	2,592,891
Reagents	-	-	-	-	-	-	-	-	-
Total Mining	-	10,480,224	10,480,224	10,480,224	10,480,224	10,480,224	10,480,224	10,480,224	10,480,224
Processing		22							
Labor	-	2,519,535	2,519,535	2,519,535	2,519,535	2,519,535	2,519,535	2,519,535	2,519,535
Equipment	-	1,031,174	1,031,174	1,031,174	1,031,174	1,031,174	1,031,174	1,031,174	1,031,174
Steel	-	310,402	310,402	310,402	310,402	310,402	310,402	310,402	310,402
Lumber	-	-	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-	-	-
Lube	-	117,715	117,715	117,715	117,715	117,715	117,715	117,715	117,715
Explosives	-	-	-	-	-	-	-	-	-

Tires	-	-	-	-	-	-	-	-	-
Construction material	-	-	-	-	-	-	-	-	-
Electricity	-	559,062	559,062	559,062	559,062	559,062	559,062	559,062	559,062
Reagents	-	256,438	256,438	256,438	256,438	256,438	256,438	256,438	256,438
Total Processing	-	4,794,326	4,794,326	4,794,326	4,794,326	4,794,326	4,794,326	4,794,326	4,794,326
Refining Expense		-	-	-	-	-	-	-	-
Treatment Charge		7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857
Total Refining		7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857	7,279,857
Royalty Expense		70,088	70,088	70,088	70,088	70,088	70,088	70,088	70,088
Environmental Expense		-	-	-	-	-	-	-	-
Other Expenses		-	-	-	-	-	-	-	-
Total Other Expenses		70,088	70,088	70,088	70,088	70,088	70,088	70,088	70,088
Total Expenses	-	22,624,496	22,624,496	22,624,496	22,624,496	22,624,496	22,624,496	22,624,496	22,624,496
Income less Expenses		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Taxes		-	-	-	-	-	-	-	-
Finance Expense		-	-	-	-	-	-	-	-
Net Income	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Annual Returns		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cash Flows	-	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
		(1)	(1)	(2)	(2)	(3)	(4)	(4)	(5)
Payback									

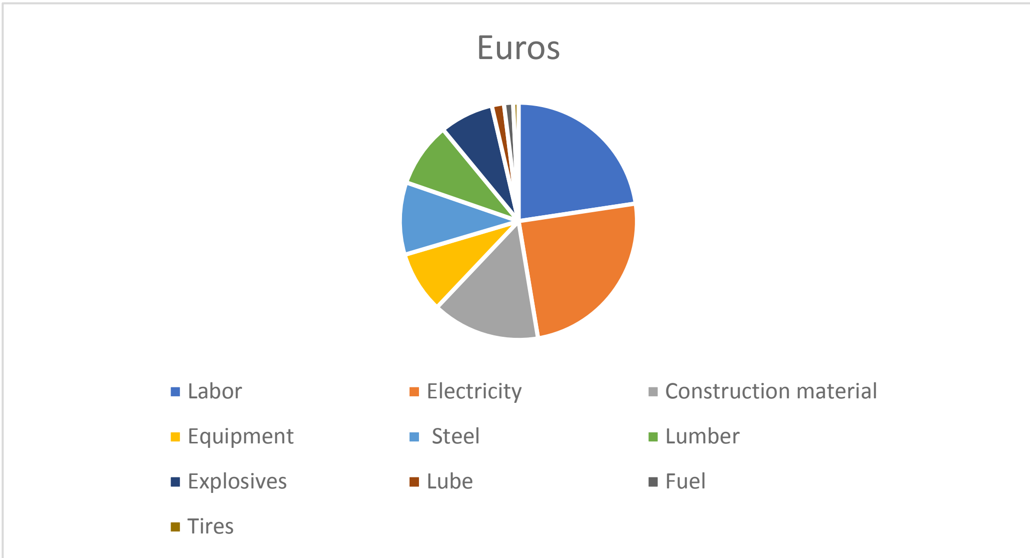
Net Present Value Rate	0%			
Net Present Value	($6.08)		NPV Rate	
Internal Rate of Return	N/A		0%	($6.08)
Payback	-	Years	10%	($3.40)
			20%	($2.13)

30%	($1.45)
40%	($1.05)

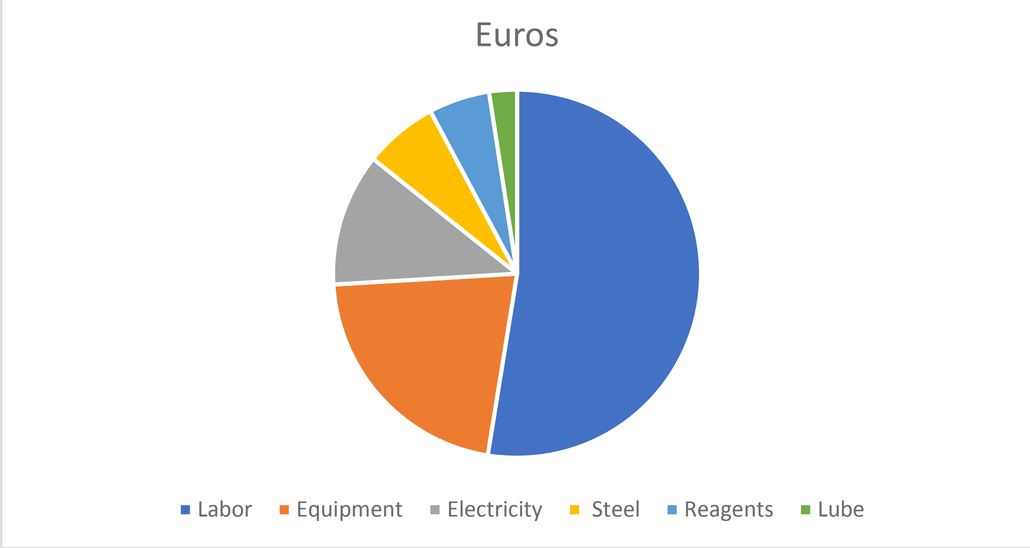
First Year Total Costs	Euros	Percent
Labor	4,891,279	32.18%
Electricity	3,151,953	20.74%
Equipment	1,905,803	12.54%
Construction material	1,541,512	10.14%
Steel	1,347,544	8.87%
Lumber	910,715	5.99%
Explosives	772,738	5.08%
Lube	289,005	1.90%
Reagents	256,438	1.69%
Fuel	131,687	0.87%
Tires	75,876	0.50%
Total Cost	15,198,674	100.00%



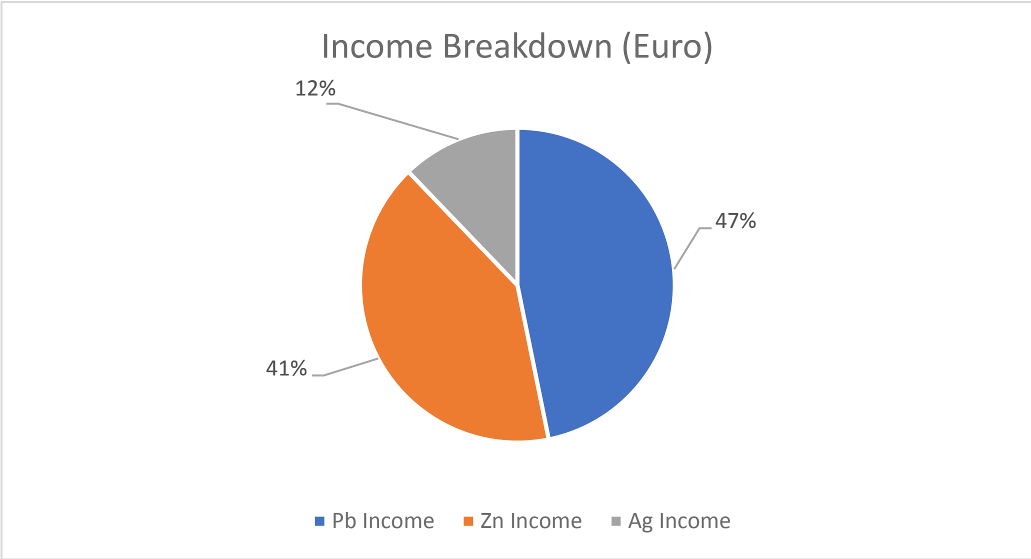
First Year Mining	Euros	Percent
Labor	2,371,744	22.63%
Electricity	2,592,891	24.74%
Construction material	1,541,512	14.71%
Equipment	874,629	8.35%
Steel	1,037,141	9.90%
Lumber	910,715	8.69%
Explosives	772,738	7.37%
Lube	171,290	1.63%
Fuel	131,687	1.26%
Tires	75,876	0.72%
Reagents	-	0.00%
	10,480,224	100.00%



First Year Processing	Euros	Percent
Labor	2,519,535	52.55%
Equipment	1,031,174	21.51%
Electricity	559,062	11.66%
Steel	310,402	6.47%
Reagents	256,438	5.35%
Lumber	-	0.00%
Fuel	-	0.00%
Lube	117,715	2.46%
Explosives	-	0.00%
Tires	-	0.00%
Construction material	-	0.00%
	4,794,326	100.00%

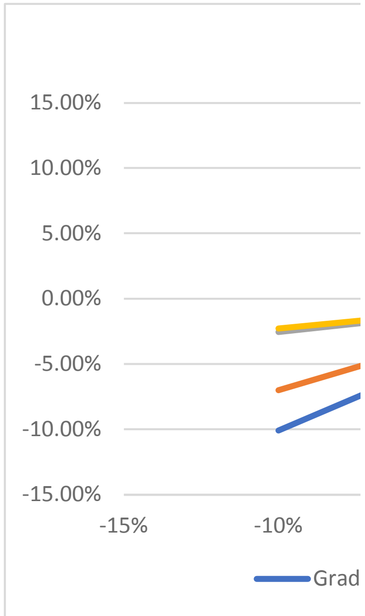


First Year Income	Euro	
Pb Income	10,587,099	46.79%
Zn Income	9,280,612	41.02%
Ag Income	2,756,784	12.18%
Au Income	-	0.00%
Cu Income	-	0.00%
Bi Income	-	0.00%
Cd Income	-	0.00%
	22,624,495	100.00%



Rate of Return

Sensitivity Analysis	-10%	0%	10%
Grade	-10.09%	0.00%	9.15%
Recovery	-7.01%	0.00%	6.57%
Tonnage	-2.54%	0.00%	2.28%
Labor	-2.29%	0.00%	2.16%
Operating	-4.39%	0.00%	4.81%
		0.00%	



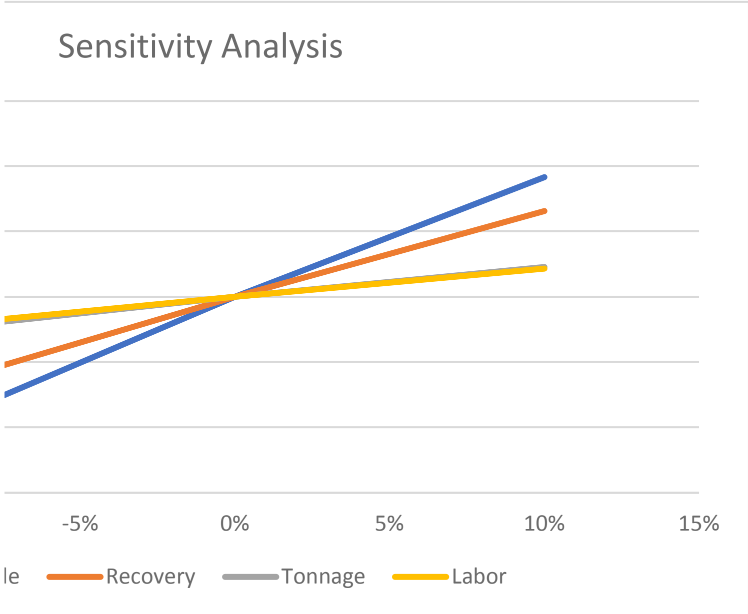
Grade	Recovery	Tonnage	Labor	Operating
100%	100%	100%	100%	100%

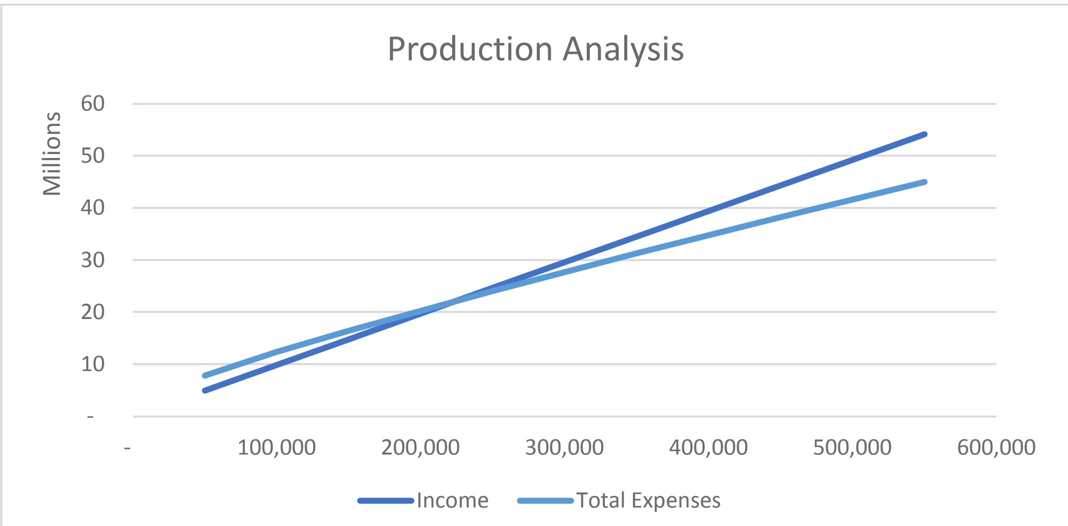
mining labor	Process Labor	Operating Cost	Milling Cost
50%	90%	100%	100%

229,917

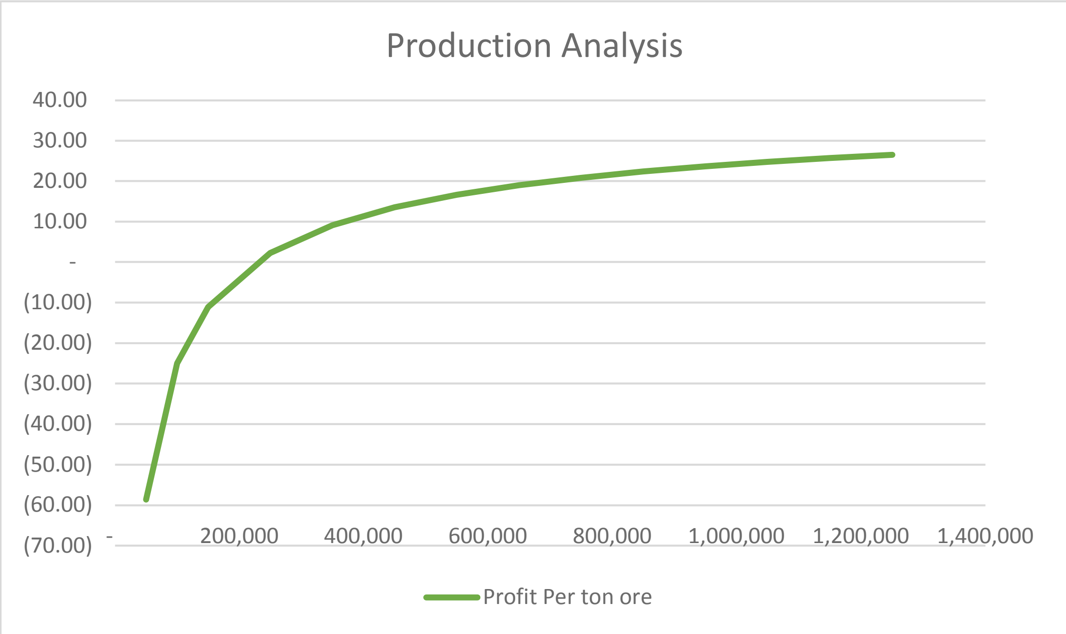
	Processing Rate (Tons/ Yr)	Income	Mining	Processing	Treatment Charge	Total Expenses	Profit Per ton ore	Rate of change	Cost per Ton
	229,917	22,624,495	10,480,224	4,794,326	7,279,857	22,554,407	0.30		98.10
lead zinc and silver	50,000	4,920,141	3,960,313	2,308,005	1,583,148	7,851,466	(58.63)		157.03
	100,000	9,840,282	6,025,303	3,150,008	3,166,296	12,341,607	(25.01)	33.61	123.42
	150,000	14,760,423	7,841,220	3,838,466	4,749,444	16,429,131	(11.12)	13.89	109.53
	250,000	24,600,705	11,109,214	5,017,017	7,915,740	24,041,972	2.23	13.36	96.17
	350,000	34,440,987	14,101,371	6,058,522	11,082,036	31,241,929	9.14	6.91	89.26
	450,000	44,281,269	16,922,767	7,021,614	14,248,332	38,192,713	13.53	4.39	84.87
	550,000	54,121,551	19,623,632	7,932,316	17,414,628	44,970,576	16.64	3.11	81.76
	650,000	63,961,833	22,232,890	8,804,845	20,580,924	51,618,659	18.99	2.35	79.41
	750,000	73,802,116	24,769,115	9,647,960	23,747,221	58,164,295	20.85	1.86	77.55

850,000	83,642,398	27,245,127	10,467,507	26,913,517	64,626,150	22.37	1.52	76.03
950,000	93,482,680	29,670,243	11,267,615	30,079,813	71,017,671	23.65	1.28	74.76
1,050,000	103,322,962	32,051,506	12,051,330	33,246,109	77,348,944	24.74	1.09	73.67
1,150,000	113,163,244	34,394,400	12,820,971	36,412,405	83,627,776	25.68	0.95	72.72
1,250,000	123,003,526	36,703,307	13,578,356	39,578,701	89,860,363	26.51	0.83	71.89


Sensitivity Analysis
-5%
0%
5%
10%
15%
le
Recovery
Tonnage
Labor


Production Analysis
Millions
60
50
40
30
20
10
-
-
100,000
200,000
300,000
400,000
500,000
600,000
Income
Total Expenses

L


Production Analysis
40.00
30.00
20.00
10.00
-
(10.00)
(20.00)
(30.00)
(40.00)
(50.00)
(60.00)
(70.00)
-
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
Profit Per ton ore

		UoM	
Commodity and commercial terms / assumptions			
	Metal Prices		
*	Zinc	USD/t	1,975
*	Lead	USD/t	2,191
*	Copper	USD/t	0
*	Gold	USD/troy oz	1,500
*	Silver	USD/troy oz	18.00
	Average Payable Metal (after minimum deductions)		
	Zinc	%	95%
	Lead	%	85%
	Copper	%	0%
	Gold	%	0%
	Silver	%	95%
	Treatment Charge (TC) / Refining Charge (RC)		
*	Zinc	% of zinc price	10%
	Lead	% of lead price	10%
	Copper	% of copper price	
	Gold	USD / t oz	
	Silver	USD / t oz	1.00
Production assumptions			
	Production		
	Ore Throughput	tonnes per day	884
	Operational days p.a.	days	250
*	Ore Milled	t	221,074

KEY

Input field

Calculated field

* Data which is reported in Interim Management Statements and/or Half Year

t = tonnes

g / t = grammes per tonne

t oz = troy ounce

grammes to troy ounces: 31.103

dmt = dry metric tonne

	Mill Head Grades		
*	Zinc	%	3.11%
*	Lead	%	3.43%
*	Copper	%	
*	Gold	g/t	0.00
*	Silver	g/t	33.80
	Recoveries		
*	Zinc	%	62.4%
*	Lead	%	80.0%
*	Copper	%	
*	Gold	%	0.0%
*	Silver	%	71.0%
	Metal produced		
*	Zinc contained in concentrate	t	4,287
*	Lead contained in concentrate	t	6,064
*	Copper contained in concentrate	t	-
*	Gold	t oz	-
*	Silver	t oz	170,519
	Concentrate grade		
	Zinc	%	40%
	Lead	%	62%
	Copper	%	
	Concentrate tonnes		
*	Zinc concentrate	dmt	10,718
*	Lead concentrate	dmt	9,781
*	Copper concentrate	dmt	-

Cost assumptions

Operating Cost				
Operating Cost/t ore milled	USD/dmt	120.00	Based on SRK Consulting presentatioı	
Freight Cost/t total concentrate	USD/dmt	100.00		

C1 Cash Cost calculation

					In Euros
	C1 Cash Costs (/t payable Zn)				In Euros
	Operating Cost	USD/t payable	6,514		25,386,508
	TC (zinc only)	USD/t payable	520		2,025,667
	Freight (all concentrates)	USD/t payable	503		1,961,598
*	Gross	USD/t payable	7,537		29,373,773
	Zinc	USD/t payable			
	Lead	USD/t payable	(2,247)		
	Copper	USD/t payable	-		
	Gold	USD/t payable	-		
	Silver	USD/t payable	(674)		
	By-Product Credits	USD/t payable	(2,921)		
*	**Net**	**USD/t payable**	**4,616**		

	1		1	2	3
	Depth Factors	2	Block Caving (4,000 - 40,000 TPD	Cut and Fill (200-8,000 TPD	Room and Pillar (500-40,000 TPD)
	Capital	3	Capital	Capital	Capital
Labor	2,367,204	4	2,403,817	1,733,407	889,922
Equipment	2,580,158	5	6,931,745	24,367,779	5,443,222
Steel	659,513	6	497,247	585,959	442,051
Lumber	-	7	75,061	25,587	5,574
Fuel	-	8	5,159	34,202	61,357
Lube	127,810	9	2,210	5,628	16,969
Explosives	147,294	10	167,861	527,272	601,168
Tires	-	11	1,276	77,841	35,609
Construction material	663,594	12	1,833,528	882,004	372,533
Electricity	39,350	13	8,776	8,484	6,621
Reagents		14			
Cost in 1989 USD	6,584,922	15	11,926,680	28,248,165	7,875,026
Cost in 2018 USD	11,767,256	16	21,312,977	50,479,470	14,072,671
Cost in Euro	10,697,505	17	19,375,433	45,890,427	12,793,337

costs are expressed in dollars per short ton ($/st).
Costs based in 1989
To update, multiply by 1.787
original values for production are in short tons
D is in feet to the ore body

Depth (Meter)	610.00
T/ Day (Metric)	884.30
Depth (D in feet)	2013
T/ Day (X in Short Ton)	990.4122925

Information Source: USGS Mine cost model. Thomas W. Camm
Source: https://pubs.usgs.gov/usbmic/ic-9298/html/camm5sfo.htm

4	5	6			2
Shrinkage Stope (100-6,000 TPD)	Longhole (400-10,000 TPD)	Vertical Crater Retreat (400-9,000 TPD)	Capital Cost Mine Cut and Fill (200-8,000 TPD	2	Floatation Mill (2 Product)
Capital	Capital	Capital	Capital	3	Capital
2,877,823	1,027,964	1,917,973	6,661,629	4	1,455,492
6,964,607	2,493,317	4,114,096	43,778,149	5	3,572,584
132,120	383,522	92,887	2,023,325	6	764,661
92,600	73,230	24,111	41,567	7	
7,380	24,755	4,548	55,563	8	
1,201	10,602	1,974	216,776	9	-
234,953	231,762	210,341	1,095,864	10	
12,917	32,492	7,566	126,456	11	
1,973,305	649,639	1,107,109	2,510,894	12	4,162,413
13,819	21,561	6,145	77,708	13	-
			-	14	-
12,310,727	4,948,844	7,486,749	56,587,933	15	9,955,150
21,999,269	8,843,584	13,378,820	62,246,726	16	17,789,854
19,999,335	8,039,622	12,162,564	56,587,933	17	16,172,594
			Euros		

3 Floatation Mill (3 Product)	Capital Cost Mill Floatation Mill (2 Product)	Total Capital Cost
Capital	Capital	
1,544,869	2,364,513	9,026,142
3,791,259	5,803,825	49,581,974
748,654	1,242,227	3,265,552
	-	41,567
	-	55,563
-	-	216,776
	-	1,095,864
	-	126,456
4,427,748	6,762,030	9,272,924
-	-	77,708
-	-	-
10,512,529	16,172,594	72,760,527
18,785,889	17,789,854	80,036,580
17,078,081	16,172,594	72,760,527
	Euros	Euros

Model			1	2	3	4
	Depth Factors	2	Block Caving (4,000 - 40,000 TPD	Cut and Fill (200- 8,000 TPD	Room and Pillar (500-40,000 TPD)	Shrinkage Stope (100-6,000 TPD)
	Operating per T	3	Operating	Operating	Operating	Operating
Labor	2.03	4	7.32	20.65	5.84	13.05
Equipment	0.66	5	0.90	1.43	0.66	0.64
Steel	0.28	6	0.22	2.20	0.98	2.71
Lumber	-	7	0.31	2.18	-	1.59
Fuel	-	8	0.17	0.31	0.47	0.19
Lube	0.18	9	0.10	0.23	0.16	0.13
Explosives	-	10	0.18	1.85	2.02	2.00
Tires	-	11	0.15	0.18	0.08	0.18
Construction material	0.20	12	0.81	3.48	0.02	1.73
Electricity	2.82	13	0.90	3.38	0.44	2.04
Reagents		14				
Cost in 1989 USD	6.17	15	11.05	35.89	10.67	24.25
Cost in 2018 USD	11.03	16	19.74	64.13	19.06	43.34
Cost in Euro	10.03	17	17.95	58.30	17.33	39.40
		18				
Capital Cost		19				
Operating Cost (Euro/ Metric Ton	11.24	20	20.10	65.29	19.41	44.13
Total Operating Cost	9,935	21	17,774	57,740	17,165	39,024
Days Per Year	260	22	260	260	260	260
Monthly Cost	215,263	23	385,105	1,251,025	371,904	845,510
Annual Cost	2,583,157	24	4,621,264	15,012,298	4,462,847	10,146,116

costs are expressed in dollars per short ton ($/st).

Costs based in 1989

To update, multiply by 1.787
original values for production are in short tons
D is in feet to the ore body

Mining Type	2.00		Cut and Fill (200-8,000 TPD
Depth (Meter)	610.00		
T/ Day (Metric)	884.30	Calculated	
Depth (D in feet)	2013		
T/ Day (X in Short Ton)	990.4122925		
Process Plant	2.00		Floatation Mill (2 Product)

Information Source: USGS Mine cost model. Thomas W. Camm
Source: https://pubs.usgs.gov/usbmic/ic-9298/html/camm5sfo.htm

5	6		
Longhole (400-10,000 TPD) Operating	Vertical Crater Retreat (400-9,000 TPD) Operating	Cut and Fill (200-8,000 TPD Operating	Adjustment factor
7.37	6.66	20.63	50%
0.62	0.45	3.80	100%
0.96	0.48	4.51	100%
0.18	0.15	3.96	100%
0.22	0.23	0.57	100%
0.10	0.10	0.75	100%
0.68	1.71	3.36	100%
0.23	0.18	0.33	100%
1.03	1.07	6.70	100%
0.36	1.02	11.28	100%
		-	100%
11.75	12.06		
20.99	21.55		
19.08	19.59	55.90	
21.37	21.94	55.90	
18,899	19,399	49,430.65	
260	260	260.00	
409,474	420,305	1,070,997.33	
4,913,689	5,043,656	12,851,967.93	
		Model Values in this column are Euro per Ton all corrections applied.	

		2	3		
	2 3	Floatation Mill (2 Product) Operating	Floatation Mill (3 Product) Operating	Floatation Mill (2 Product)	Adjustment Factor
Labor	4	7	8	12.18	90%
Equipment	5	2	3	4.48	100%
Steel	6	1	1	1.35	100%
Lumber	7			-	100%
Fuel	8			-	100%
Lube	9	0	0	0.51	100%
Explosives	10			-	100%
Tires	11			-	100%
Construction material	12	-	-	-	100%
Electricity	13	1	1	2.43	100%
Reagents	14	1	1	1.12	100%
Cost in 1989 USD		13	15		
Cost in 2018 USD		23	26		
Cost in Euro		21	24	22.07	
		23.42	26.55	22.07	
		20,713	23,482	19,516.44	
		260	260	260.00	
		448,777	508,775	422,856.20	
		5,385,328	6,105,297	5,074,274.36	
				Model Values in this column are Euro per Ton all corrections applied.	

Month	1	2	3	4	5	6	7	8
Ore Produced	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76	19,159.76
Concentration of lead	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%	3.43%
Concentration of zinc	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%	3.11%
Concentration of sliver	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%	0.0034%
Price lead	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
Price zinc	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
Price silver	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
Royalty percentage lead	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Royalty percentage zinc	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Royalty percentage silver	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Allowable deduction lead	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Allowable deduction zinc	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Allowable deduction silver	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Royalty lead	5,841	5,841	5,841	5,841	5,841	5,841	5,841	5,841
Royalty zinc	5,875	5,875	5,875	5,875	5,875	5,875	5,875	5,875
Royalty silver	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533
	13,249	13,249	13,249	13,249	13,249	13,249	13,249	13,249

Note All inputs are marked by green cells

Total Reserves (Tons)	2,500,000					Dilution	Recovery
Production (T/ Year)	250,000.00	See Sensitivity			Open pit	0.05	0.9
Production (T/ Day) Calc'd	961.54			1	Block caving	0.15	0.95
Mine Type	2	Small Open Pit	Mine type per Kosovo Trust Agency Report	2	Cut-and-fill	0.05	0.85
Days / Week (5 or 7)	5	Mine Life Chk		3	Room-and-pillar	0.05	1.85
Mine Life (Calc'd)	8.93	10.0		4	Shrinkage	0.1	0.9
Mine Depth (Meters)	-			5	Sublevel longhole	0.15	0.85
Process Plant	2	Slag Pyro Process		6	Vertical crater retreat	0.1	0.9
Capital Investment	1	0=no, 1=yes					
				Ore Adjustment			
				100%			

	Mine Production Values	Amount in Concentrate	Amount in Tailings	Adjusted Values	Weight % in ore	Normal price Units	Prices per Unit Value
Lead Wt %	3.47%	74.30%	0.37%	3.47%	3.47%	€ per kg	1.98
Zinc Wt %	8.96%	75.00%	1.00%	8.96%	8.96%	€ per kg	2.19
Silver gm/ Ton (lead)	93.000	1,260.000	10.000	93.000	0.0093%	USD Per Troy Oz	18.00
Silver gm/ Ton (zinc)	-	-	-	-	0.0000%	USD Per Troy Oz	18.00
Gold gm/ Ton (lead)	-	-	-	-	0.000000%	USD Per Troy Oz	1500.00
Gold gm/ Ton (zinc)	-	-	-	-	0.0000%	USD Per Troy Oz	1500.00
Copper gm/ Ton	-	-	-	-	0.0000%	€ per kg	5.32
Bismuth gm/ Ton	-	-	-	-	0.0000%	€ per kg	0.76
Cadmium gm/ Ton	-	-	-	-	0.0000%	€ per kg	2.64

Assumptions:
Treatment Charges are based on a flat rate given by trepca on the current contract.
lead and zinc concentrates are sold as above including treatment charges
silver and gold content is considered

If silver and gold are to be considered and the model needs to be more accurate, use the following
Gold: Deduct 0.03 to 0.07 troy ounce per dry tonne and pay for 95% of the remaining gold at market value.
Silver: Deduct 0.5 to 2.0 troy ounce per dry tonne and pay for 95% of the remaining silver at market value.
https://costs.infomine.com/costdatacenter/smeltingcosts.aspx

Recovery based on actual Trepca production

	Annual Incr. / Decr.	1	2	3	4	5	6
Monthly Prod. of ore	0%	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33
Lead Wt %	0%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%
Zinc Wt %	0%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%
Silver Wt%	0%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%
Gold Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Copper Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Bismuth Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Cadmium Wt%	0%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Price Projection							
Lead Price	0%	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
Zinc Price	0%	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
Silver Price	0%	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
Gold Price	0%	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64
Copper Price	0%	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18
Bismuth Price	0%	760.96	760.96	760.96	760.96	760.96	760.96
Cadmium Price	0%	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36

Senior Debt	88,266,802
Interest Rate	8%
Term (Years)	10
Payment (Monthly)	$1,070,919.88
Subordinate Debt	
Interest Rate	12%
Term	5

Payment	$0.00
Inflation Rate	0%
Taxes	0%
Royalty percentage lead	4.50%
Royalty percentage zinc	4.50%
Royalty percentage silver	4.50%
Allowable deduction lead	10.00%
Allowable deduction zinc	10.00%
Allowable deduction silver	10.00%

0.85	181.8181818	285	0
0.95	181.8181818	380	0
0.95	0	0	0.818181818
0.95	0	0	0

Prices Oct 2019 Euro/ Ton	Processing Adjustment 100% Processing Recovery	Metal in Concentrate	Percentage Paid	Per DMT Treatment Charge €/ T	Treatment Charge €/ T	Refining Charge €/ oz	Refining Charge €/ T
1975.00	89.7%	74.3%	85%	182	285	-	-
2191.00	90.0%	75.0%	95%	182	380	-	-
526102.36	90.0%	0.1%	95%	-	-	0.82	26,306
526102.36	0.0%	0.0%	0%	-	-	-	-
43841863.64	0.0%	0.0%	0%	-	-	-	-
43841863.64	0.0%	0.0%	0%	-	-	-	-
5318.18	0.0%	0.0%	0%	-	-	-	-
760.96	0.0%	0.0%	0%	-	-	-	-
2636.36	0.0%	0.0%	0%	-	-	-	-

7	8	9	10	11	12	13	14	15
20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33
3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%
8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%
0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64	43,841,863.64
5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18	5,318.18
760.96	760.96	760.96	760.96	760.96	760.96	760.96	760.96	760.96
2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36	2,636.36

This page contains no data.

Period	1	2	3	4	5	6	7
Senior Debt	88,266,802.24	87,784,327.71	87,298,636.68	86,809,707.71	86,317,519.22	85,822,049.47	85,323,276.59
Interest	588,445.35	585,228.85	581,990.91	578,731.38	575,450.13	572,147.00	568,821.84
Payment	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88
Balance	87,784,327.71	87,298,636.68	86,809,707.71	86,317,519.22	85,822,049.47	85,323,276.59	84,821,178.56
Subordinate Debt	-	-	-	-	-	-	-
Interest	-	-	-	-	-	-	-
Payment	-	-	-	-	-	-	-
Balance	-	-	-	-	-	-	-
Total Balance	87,784,327.71	87,298,636.68	86,809,707.71	86,317,519.22	85,822,049.47	85,323,276.59	84,821,178.56

16	17	18	19	20	21	22	23
80,681,997.39	80,148,957.49	79,612,364.00	79,072,193.21	78,528,421.29	77,981,024.22	77,429,977.84	76,875,257.81
537,879.98	534,326.38	530,749.09	527,147.95	523,522.81	519,873.49	516,199.85	512,501.72
1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88
80,148,957.49	79,612,364.00	79,072,193.21	78,528,421.29	77,981,024.22	77,429,977.84	76,875,257.81	76,316,839.66
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
80,148,957.49	79,612,364.00	79,072,193.21	78,528,421.29	77,981,024.22	77,429,977.84	76,875,257.81	76,316,839.66

8	9	10	11	12	13	14	15
84,821,178.56	84,315,733.20	83,806,918.21	83,294,711.12	82,779,089.32	82,260,030.04	81,737,510.36	81,211,507.22
565,474.52	562,104.89	558,712.79	555,298.07	551,860.60	548,400.20	544,916.74	541,410.05
1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88	1,070,919.88
84,315,733.20	83,806,918.21	83,294,711.12	82,779,089.32	82,260,030.04	81,737,510.36	81,211,507.22	80,681,997.39
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
84,315,733.20	83,806,918.21	83,294,711.12	82,779,089.32	82,260,030.04	81,737,510.36	81,211,507.22	80,681,997.39

24
76,316,839.66
508,778.93
1,070,919.88
75,754,698.71
-
-
-
-
75,754,698.71

Monthly amounts	1	2	3	4	5	6	7	8	9	10
Labor	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445
Equipment	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130
Steel	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
Lumber	-	-	-	-	-	-	-	-	-	-
Fuel	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477
Lube	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653
Explosives	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444
Tires	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791
Construction material	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556
Electricity	-	-	-	-	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-	-	-	-
	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012

11	12	13	14	15	16	17	18	19	20	21	22
217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445
12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130
1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
-	-	-	-	-	-	-	-	-	-	-	-
9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477
2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653
6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444
3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791
8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012

23	24
217,445	217,445
12,130	12,130
1,516	1,516
-	-
9,477	9,477
2,653	2,653
6,444	6,444
3,791	3,791
8,556	8,556
-	-
-	-
262,012	262,012

Monthly amounts	1	2	3	4	5	6	7	8	9	10
Labor	-	-	-	-	-	-	-	-	-	-
Equipment	-	-	-	-	-	-	-	-	-	-
Steel	-	-	-	-	-	-	-	-	-	-
Lumber	-	-	-	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-	-	-	-
Lube	-	-	-	-	-	-	-	-	-	-
Explosives	-	-	-	-	-	-	-	-	-	-
Tires	-	-	-	-	-	-	-	-	-	-
Construction material	-	-	-	-	-	-	-	-	-	-
Electricity	-	-	-	-	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Tons of Ore	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833
Recovered Lead	648	648	648	648	648	648	648	648	648	648
Recovered Zinc	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681
Recovered Silver	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743
Recovered Gold	-	-	-	-	-	-	-	-	-	-
Recovered Copper	-	-	-	-	-	-	-	-	-	-
Recovered Bismuth	-	-	-	-	-	-	-	-	-	-
Recovered Cadmium	-	-	-	-	-	-	-	-	-	-
Tons Conc. Lead	872	872	872	872	872	872	872	872	872	872
Tons Conc. Zinc	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241
Tons Silver	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300
Tons Gold	-	-	-	-	-	-	-	-	-	-
Tons Copper	-	-	-	-	-	-	-	-	-	-
Tons Bismuth	-	-	-	-	-	-	-	-	-	-

Tons Cadmium	-	-	-	-	-	-	-	-	-	-
Treatment Charge Pb	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661
Treatment Charge Zn	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577
Refining Charge Ag $ Au	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851
	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088

11	12	13	14	15	16	17	18	19	20	21	22
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833	20,833
648	648	648	648	648	648	648	648	648	648	648	648
1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681
1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743	1.743
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
872	872	872	872	872	872	872	872	872	872	872	872
2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241	2,241
1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300	1.74300
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

-	-	-	-	-	-	-	-	-	-	-	-
248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661	248,661
851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577	851,577
45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851	45,851
1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088

23	24
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
20,833	20,833
648	648
1,681	1,681
1.743	1.743
-	-
-	-
-	-
-	-
872	872
2,241	2,241
1.74300	1.74300
-	-
-	-
-	-

-	-
248,661	248,661
851,577	851,577
45,851	45,851
1,146,088	1,146,088

Monthly amounts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

23	24
-	-

Monthly amounts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

23 24

- -

Monthly amounts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Annual environmental																				
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

21	22	23	24
-	-	-	-

Monthly amounts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

23	24
-	-

Month	1	2	3	4	5	6	7	8	9
Pb Income	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272
Zn Income	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383
Ag Income (lead)	871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147
Au Income (lead)	-	-	-	-	-	-	-	-	-
Cu Income	-	-	-	-	-	-	-	-	-
Bi Income	-	-	-	-	-	-	-	-	-
Cd Income	-	-	-	-	-	-	-	-	-
Other Income	-	-	-	-	-	-	-	-	-
Total Income	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801
Mining									
Labor	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445
Equipment	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130
Steel	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
Lumber	-	-	-	-	-	-	-	-	-
Fuel	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477
Lube	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653
Explosives	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444
Tires	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791
Construction material	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556
Electricity	-	-	-	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-	-	-
	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012
Processing									
Labor	-	-	-	-	-	-	-	-	-
Equipment	-	-	-	-	-	-	-	-	-
Steel	-	-	-	-	-	-	-	-	-
Lumber	-	-	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-	-	-
Lube	-	-	-	-	-	-	-	-	-
Explosives	-	-	-	-	-	-	-	-	-

Tires	-	-	-	-	-	-	-	-	-
Construction material	-	-	-	-	-	-	-	-	-
Electricity	-	-	-	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-	-	-
Total Processing	-	-	-	-	-	-	-	-	-
Refining Expense	-	-	-	-	-	-	-	-	-
Treatment Charge	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088
Total Refining	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088
Royalty Expense	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92
Environmental Expense	-	-	-	-	-	-	-	-	-
Other Expenses	-	-	-	-	-	-	-	-	-
Total Other Expenses	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425
Total Expenses	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525
Income less Expenses	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276
Taxes	-	-	-	-	-	-	-	-	-
Finance Expense	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920
Net Income	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356
Net Income	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356
	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%

10	11	12	13	14	15	16	17	18	19	20
1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272	1,088,272
3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383	3,498,383
871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147	871,147
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801	5,457,801
217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445	217,445
12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130	12,130
1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516	1,516
-	-	-	-	-	-	-	-	-	-	-
9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477	9,477
2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653	2,653
6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444	6,444
3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791	3,791
8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556	8,556
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012	262,012
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088
1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088	1,146,088
6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92	6,424.92
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425
1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525	1,414,525
4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276	4,043,276
-	-	-	-	-	-	-	-	-	-	-
1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920	1,070,920
2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356
2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356	2,972,356
210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%	210.13%

21	22	23	24
1,088,272	1,088,272	1,088,272	1,088,272
3,498,383	3,498,383	3,498,383	3,498,383
871,147	871,147	871,147	871,147
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
5,457,801	5,457,801	5,457,801	5,457,801
217,445	217,445	217,445	217,445
12,130	12,130	12,130	12,130
1,516	1,516	1,516	1,516
-	-	-	-
9,477	9,477	9,477	9,477
2,653	2,653	2,653	2,653
6,444	6,444	6,444	6,444
3,791	3,791	3,791	3,791
8,556	8,556	8,556	8,556
-	-	-	-
-	-	-	-
262,012	262,012	262,012	262,012
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
1,146,088	1,146,088	1,146,088	1,146,088
1,146,088	1,146,088	1,146,088	1,146,088
6,424.92	6,424.92	6,424.92	6,424.92
-	-	-	-
-	-	-	-
6,425	6,425	6,425	6,425
1,414,525	1,414,525	1,414,525	1,414,525
4,043,276	4,043,276	4,043,276	4,043,276
-	-	-	-
1,070,920	1,070,920	1,070,920	1,070,920
2,972,356	2,972,356	2,972,356	2,972,356
2,972,356	2,972,356	2,972,356	2,972,356
210.13%	210.13%	210.13%	210.13%

Month	0	1	2	3	4	5	6
Pb Income	-	13,059,261	13,059,261	13,059,261	13,059,261	13,059,261	13,059,261
Zn Income	-	41,980,596	41,980,596	41,980,596	41,980,596	41,980,596	41,980,596
Ag Income (lead)	-	10,453,759	10,453,759	10,453,759	10,453,759	10,453,759	10,453,759
Au Income (lead)	-	-	-	-	-	-	-
Cu Income	-	-	-	-	-	-	-
Bi Income	-	-	-	-	-	-	-
Cd Income	-	-	-	-	-	-	-
Other Income	-	-	-	-	-	-	-
Total Income	-	65,493,616	65,493,616	65,493,616	65,493,616	65,493,616	65,493,616
Mining		23					
Labor	2,979,262	2,609,345	2,609,345	2,609,345	2,609,345	2,609,345	2,609,345
Equipment	41,013,966	145,559	145,559	145,559	145,559	145,559	145,559
Steel	1,016,255	18,195	18,195	18,195	18,195	18,195	18,195
Lumber	43,461	-	-	-	-	-	-
Fuel	59,373	113,718	113,718	113,718	113,718	113,718	113,718
Lube	9,760	31,841	31,841	31,841	31,841	31,841	31,841
Explosives	915,392	77,328	77,328	77,328	77,328	77,328	77,328
Tires	135,603	45,487	45,487	45,487	45,487	45,487	45,487
Construction material	1,501,776	102,671	102,671	102,671	102,671	102,671	102,671
Electricity	14,791	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-
Total Mining	47,689,640	3,144,145	3,144,145	3,144,145	3,144,145	3,144,145	3,144,145
Processing		-					
Labor	7,586,621	-	-	-	-	-	-
Equipment	-	-	-	-	-	-	-
Steel	-	-	-	-	-	-	-
Lumber	-	-	-	-	-	-	-
Fuel	-	-	-	-	-	-	-
Lube	-	-	-	-	-	-	-
Explosives	-	-	-	-	-	-	-

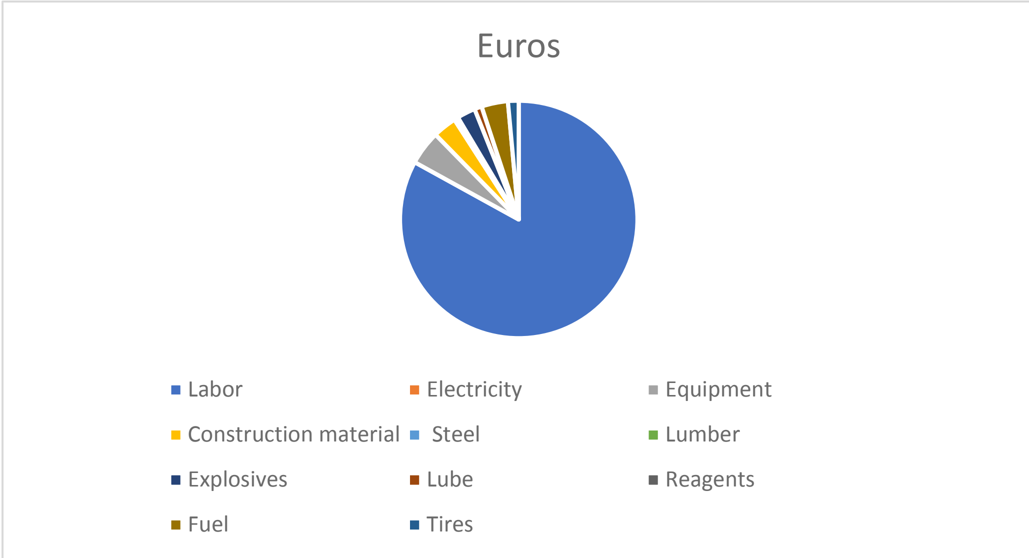
Tires	-	-	-	-	-	-	-
Construction material	32,990,541	-	-	-	-	-	-
Electricity	-	-	-	-	-	-	-
Reagents	-	-	-	-	-	-	-
Total Processing	40,577,162	-	-	-	-	-	-
Refining Expense		-	-	-	-	-	-
Treatment Charge		13,753,056	13,753,056	13,753,056	13,753,056	13,753,056	13,753,056
Total Refining		13,753,056	13,753,056	13,753,056	13,753,056	13,753,056	13,753,056
Royalty Expense		77,099	77,099	77,099	77,099	77,099	77,099
Environmental Expense		-	-	-	-	-	-
Other Expenses		-	-	-	-	-	-
Total Other Expenses		77,099	77,099	77,099	77,099	77,099	77,099
Total Expenses	88,266,802	16,974,300	16,974,300	16,974,300	16,974,300	16,974,300	16,974,300
Income less Expenses		48,519,316	48,519,316	48,519,316	48,519,316	48,519,316	48,519,316
Taxes		-	-	-	-	-	-
Finance Expense		12,851,039	12,851,039	12,851,039	12,851,039	12,851,039	12,851,039
Net Income	(88,266,802)	35,668,277	35,668,277	35,668,277	35,668,277	35,668,277	35,668,277
Annual Profit		210.13%	210.13%	210.13%	210.13%	210.13%	210.13%
Cash Flows	(88,266,802.24)	48,519,316	48,519,316	48,519,316	48,519,316	48,519,316	48,519,316
		48,519,316	97,038,632	145,557,948	194,077,264	242,596,580	291,115,896
Payback			1.099	2.649	4.199	5.748	7.298

Net Present Value Rate	10.000%	NPV Rate	0%	$83,637,954.09
Net Present Value	$190,784,900.60		10%	$15,782,935.33
Internal Rate of Return	54.25%		20%	($13,496,844.17)
Payback	1.099		30%	($27,016,744.47)
			40%	($33,411,692.38)

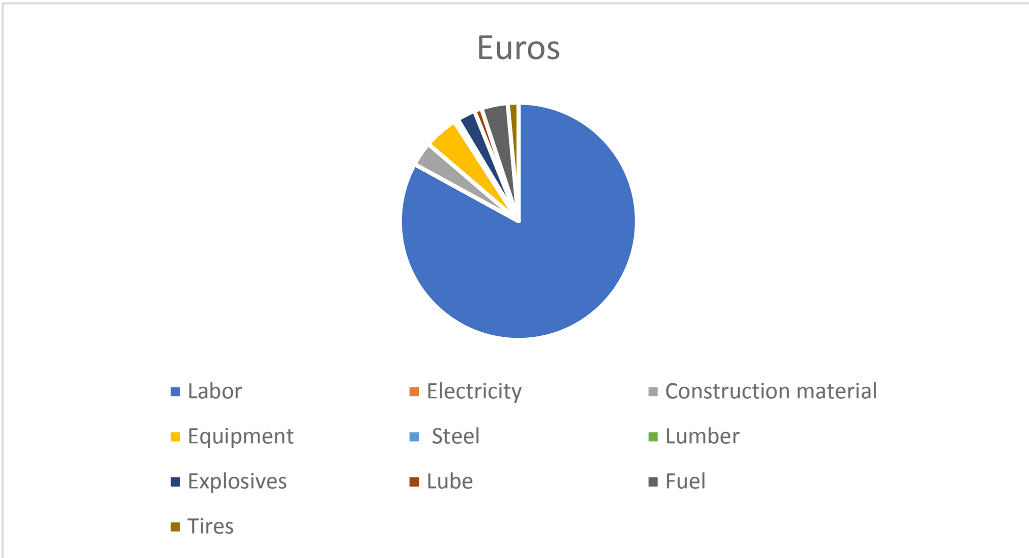
7	8	9	10
13,059,261	13,059,261	13,059,261	13,059,261
41,980,596	41,980,596	41,980,596	41,980,596
10,453,759	10,453,759	10,453,759	10,453,759
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
65,493,616	65,493,616	65,493,616	65,493,616
2,609,345	2,609,345	2,609,345	2,609,345
145,559	145,559	145,559	145,559
18,195	18,195	18,195	18,195
-	-	-	-
113,718	113,718	113,718	113,718
31,841	31,841	31,841	31,841
77,328	77,328	77,328	77,328
45,487	45,487	45,487	45,487
102,671	102,671	102,671	102,671
-	-	-	-
-	-	-	-
3,144,145	3,144,145	3,144,145	3,144,145
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
13,753,056	13,753,056	13,753,056	13,753,056
13,753,056	13,753,056	13,753,056	13,753,056
77,099	77,099	77,099	77,099
-	-	-	-
-	-	-	-
77,099	77,099	77,099	77,099
16,974,300	16,974,300	16,974,300	16,974,300
48,519,316	48,519,316	48,519,316	48,519,316
-	-	-	-
12,851,039	12,851,039	12,851,039	12,851,039
35,668,277	35,668,277	35,668,277	35,668,277
210.13%	210.13%	210.13%	210.13%
48,519,316	48,519,316	48,519,316	48,519,316
339,635,212	388,154,528	436,673,844	485,193,160
8.848	10.398	11.947	13.497

First Year Total Costs	Euros	Percent
Labor	2,609,345	84.21%
Electricity	-	0.00%
Equipment	145,559	4.70%
Construction material	102,671	3.31%
Steel	18,195	0.59%
Lumber	-	0.00%
Explosives	77,328	2.50%
Lube	31,841	1.03%
Reagents	-	0.00%
Fuel	113,718	3.67%
Tires	45,487	1.47%
Total Cost	3,098,658	100.00%

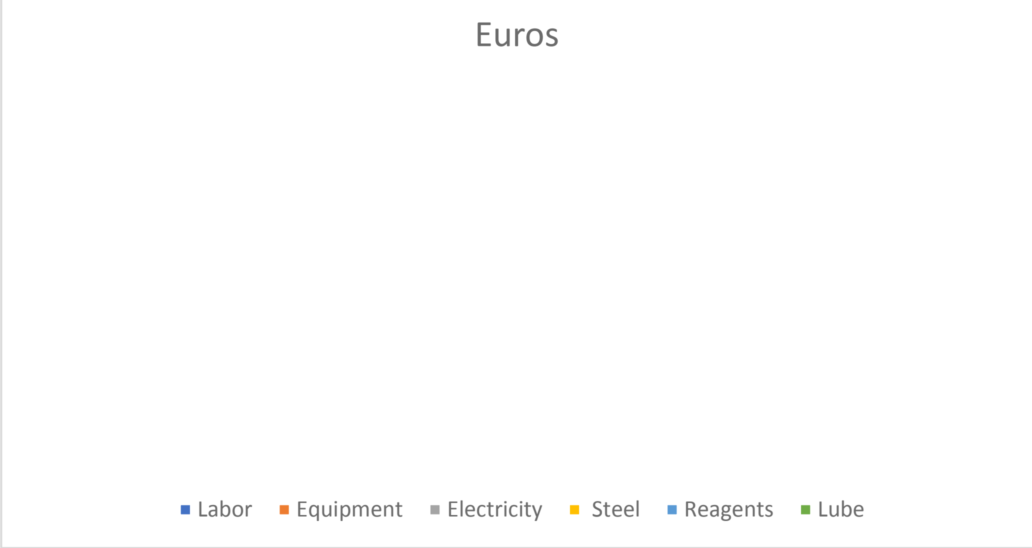


First Year Mining	Euros	Percent
Labor	2,609,345	82.99%
Electricity	-	0.00%
Construction material	102,671	3.27%
Equipment	145,559	4.63%
Steel	18,195	0.58%
Lumber	-	0.00%
Explosives	77,328	2.46%
Lube	31,841	1.01%
Fuel	113,718	3.62%
Tires	45,487	1.45%
Reagents	-	0.00%
	3,144,145	100.00%

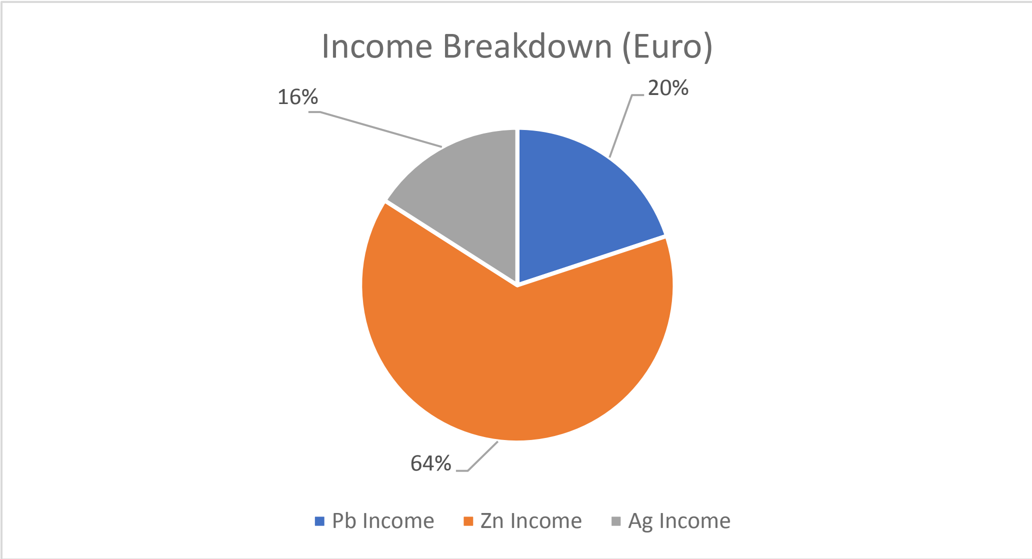


CV

First Year Processing	Euros	Percent
Labor	-	#DIV/0!
Equipment	-	#DIV/0!
Electricity	-	#DIV/0!
Steel	-	#DIV/0!
Reagents	-	#DIV/0!
Lumber	-	#DIV/0!
Fuel	-	#DIV/0!
Lube	-	#DIV/0!
Explosives	-	#DIV/0!
Tires	-	#DIV/0!
Construction material	-	#DIV/0!
	-	#DIV/0!



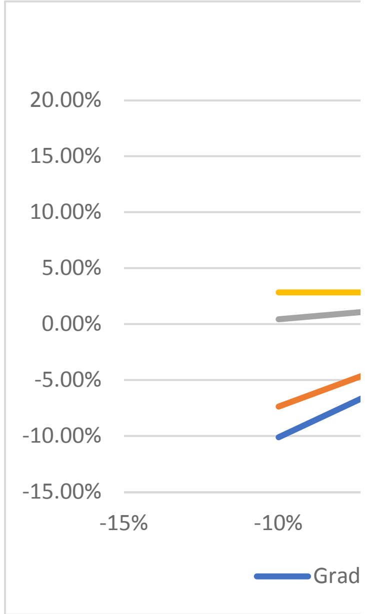
First Year Income	Euro	
Pb Income	13,059,261	19.94%
Zn Income	41,980,596	64.10%
Ag Income	10,453,759	15.96%
Au Income	-	0.00%
Cu Income	-	0.00%
Bi Income	-	0.00%
Cd Income	-	0.00%
	65,493,616	100.00%



First Year Total Costs	Euros	Percent
Labor	-	0.00%
Electricity	-	0.00%
Equipment	-	0.00%
Construction material	-	0.00%
Steel	-	0.00%

Rate of Return

Sensitivity Analysis	-10%	0%	10%
Grade	-10.09%	2.84%	14.86%
Recovery	-7.37%	2.84%	12.47%
Tonnage	0.44%	2.84%	4.85%
Labor	2.84%	2.84%	2.84%
Operating	-2.55%	2.84%	8.86%

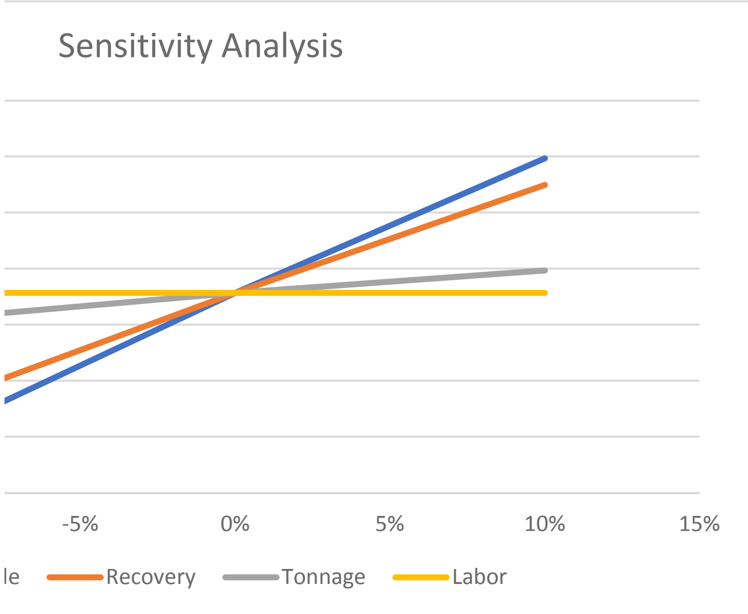


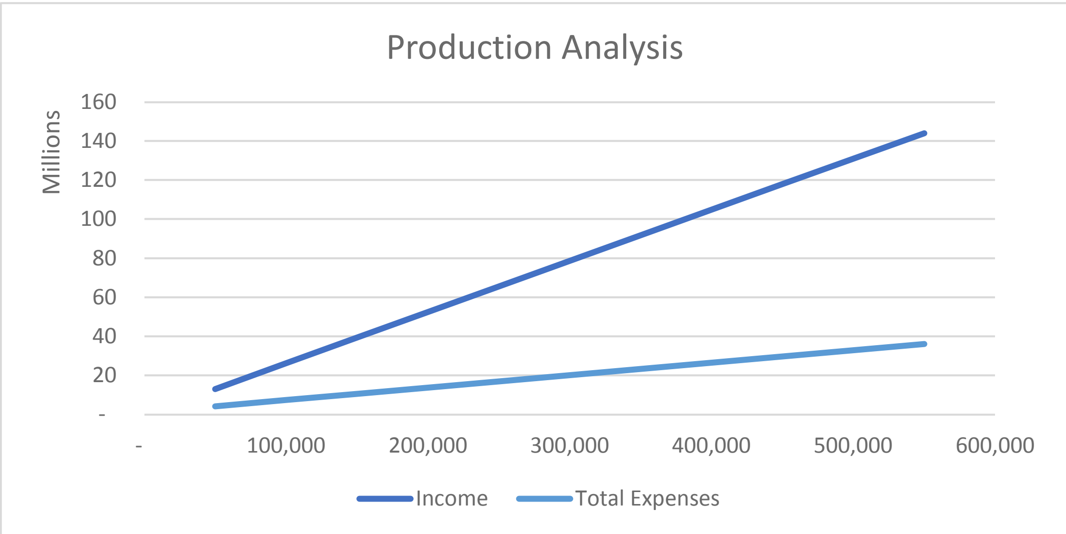
Grade	Recovery	Tonnage	Labor	Operating
			210.13%	
100%	100%	100%	100%	100%

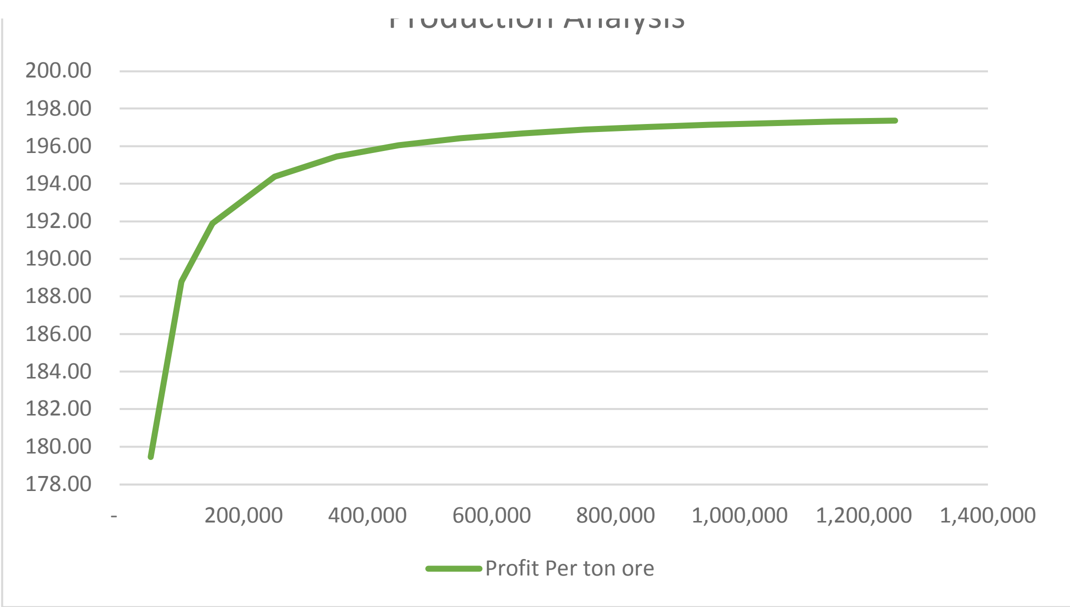
mining labor	Process Labor	Operating Cost	Milling Cost
100%	100%	100%	100%

	Processing Rate (Tons/ Yr)	Income	Mining	Processing	Treatment Charge	Total Expenses	Profit Per ton ore	Rate of change	Cost per Ton
	250,000								
	250,000	65,493,616	3,144,145	-	13,753,056	16,897,201	194.39		67.59
lead zinc and silver	50,000	13,098,723	1,375,600	-	2,750,611	4,126,211	179.45		82.52
	100,000	26,197,446	1,817,736	-	5,501,222	7,318,959	188.78	9.33	73.19
	150,000	39,296,170	2,259,873	-	8,251,834	10,511,706	191.90	3.11	70.08
	250,000	65,493,616	3,144,145	-	13,753,056	16,897,201	194.39	2.49	67.59
	350,000	91,691,063	4,028,418	-	19,254,278	23,282,696	195.45	1.07	66.52
	450,000	117,888,509	4,912,690	-	24,755,501	29,668,191	196.05	0.59	65.93
	550,000	144,085,956	5,796,963	-	30,256,723	36,053,686	196.42	0.38	65.55
	650,000	170,283,402	6,681,236	-	35,757,945	42,439,181	196.68	0.26	65.29
	750,000	196,480,849	7,565,508	-	41,259,168	48,824,676	196.87	0.19	65.10
	850,000	222,678,295	8,449,781	-	46,760,390	55,210,171	197.02	0.15	64.95
	950,000	248,875,741	9,334,053	-	52,261,612	61,595,666	197.14	0.12	64.84
	1,050,000	275,073,188	10,218,326	-	57,762,835	67,981,161	197.23	0.09	64.74

1,150,000	301,270,634	11,102,599	-	63,264,057	74,366,656	197.31	0.08	64.67
1,250,000	327,468,081	11,986,871	-	68,765,279	80,752,150	197.37	0.06	64.60


Sensitivity Analysis
-5%
0%
5%
10%
15%
le
Recovery
Tonnage
Labor


Production Analysis
Millions
160
140
120
100
80
60
40
20
-
-
100,000
200,000
300,000
400,000
500,000
600,000
Income
Total Expenses


200.00
198.00
196.00
194.00
192.00
190.00
188.00
186.00
184.00
182.00
180.00
178.00
-
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
Profit Per ton ore

	1		1	2	3
	Depth Factors	2	Block Caving (4,000 - 40,000 TPD	Small Open Pit	Room and Pillar (500-40,000 TPD)
	Capital	3	Capital	Capital	Capital
Labor	-	4	628,891	1,833,905	936,092
Equipment	-	5	4,187,899	25,246,425	5,754,463
Steel	-	6	107,876	625,563	463,237
Lumber	-	7	-	26,753	5,895
Fuel	-	8	37,070	36,548	64,308
Lube	-	9	9,488	6,008	17,785
Explosives	-	10	17,898	563,476	630,295
Tires	-	11	8,205	83,472	37,319
Construction material	-	12	207,175	924,429	393,472
Electricity	-	13	-	9,104	6,958
Reagents		14			
Cost in 1989 USD	-	15	5,204,502	29,355,682	8,309,825
Cost in 2018 USD	-	16	9,300,445	52,458,604	14,849,657
Cost in Euro	-	17	8,454,950	47,689,640	13,499,688

costs are expressed in dollars per short ton ($/st).
Costs based in 1989
To update, multiply by 1.787
original values for production are in short tons
D is in feet to the ore body

Depth (Meter)	-
T/ Day (Metric)	961.54
Depth (D in feet)	0
T/ Day (X in Short Ton)	1076.923077

Information Source: USGS Mine cost model. Thomas W. Camm
Source: https://pubs.usgs.gov/usbmic/ic-9298/html/camm5sfo.htm

4	5	6	Capital Cost Mine		2
Shrinkage Stope (100-6,000 TPD)	Longhole (400-10,000 TPD)	Vertical Crater Retreat (400-9,000 TPD)	Small Open Pit	2	Floatation Mill (2 Product)
Capital	Capital	Capital	Capital	3	Capital
3,037,030	1,080,843	2,039,221	2,979,262	4	4,669,996
7,325,939	2,617,845	4,388,117	41,013,966	5	
141,168	396,487	99,681	1,016,255	6	
99,498	75,453	25,994	43,461	7	
7,852	25,988	4,862	59,373	8	
1,278	11,129	2,111	9,760	9	-
250,497	240,079	225,821	915,392	10	
13,779	34,100	8,081	135,603	11	
2,075,683	677,928	1,169,042	1,501,776	12	20,307,552
14,844	22,798	6,611	14,791	13	-
			-	14	-
12,967,568	5,182,650	7,969,542	47,689,640	15	24,977,548
23,173,043	9,261,395	14,241,571	52,458,604	16	44,634,879
21,066,403	8,419,450	12,946,882	47,689,640	17	40,577,162
			Euros		

	Processing Original Cost	Ton conversion	Inflation Conversion	Euro Conversion
Installed Equipment	10,693,000.00	1.12	1	1
Engineering/ Const./ Fee	2,459,000.00	1.12	1	1
Contingency	1,315,000.00	1.12	1	1
Total	14,467,000.00			

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Floatation Mill (3 Product)	3 Capital Cost Mill Floatation Mill (2 Product)	Total Capital Cost
Capital	Capital	
1,637,587	7,586,621	10,565,883
4,018,123	-	41,013,966
793,452	-	1,016,255
	-	43,461
	-	59,373
-	-	9,760
	-	915,392
	-	135,603
4,704,897	32,990,541	34,492,318
-	-	14,791
-	-	-
11,154,059	40,577,162	88,266,802
19,932,304	44,634,879	97,093,482
18,120,276	40,577,162	88,266,802
	Euros	Euros

Scale Factor

1.899144482	22,744,458.18
1.899144482	5,230,395.84
1.899144482	2,797,059.99
	30,771,914.01

-24, 1989

Model	Depth Factors		1	2	3	4
		2	Block Caving (4,000 - 40,000 TPD	Small Open Pit	Room and Pillar (500-40,000 TPD)	Shrinkage Stope (100-6,000 TPD)
	Operating per T	3	Operating	Operating	Operating	Operating
Labor	1.87	4	7.13	3.87	5.73	12.87
Equipment	-	5	0.88	0.32	0.66	0.63
Steel	-	6	0.22	0.04	0.97	2.70
Lumber	-	7	0.31	-	-	1.57
Fuel	-	8	0.17	0.25	0.46	0.18
Lube	-	9	0.09	0.07	0.16	0.12
Explosives	-	10	0.18	0.17	2.00	1.98
Tires	-	11	0.14	0.10	0.07	0.18
Construction material	0.19	12	0.79	0.04	0.02	1.69
Electricity	-	13	0.89	-	0.42	2.02
Reagents		14				
Cost in 1989 USD	2.05	15	10.82	4.86	10.51	23.93
Cost in 2018 USD	3.67	16	19.34	8.68	18.78	42.77
Cost in Euro	3.33	17	17.58	7.90	17.07	38.88
		18				
Capital Cost		19				
Operating Cost (Euro/ Metric Ton	3.73	20	19.69	8.84	19.12	43.55
Total Operating Cost	3,590	21	18,932	8,503	18,382	41,873
Days Per Year	260	22	260	260	260	260
Monthly Cost	77,789	23	410,189	184,223	398,286	907,239
Annual Cost	933,464	24	4,922,274	2,210,681	4,779,429	10,886,874

costs are expressed in dollars per short ton ($/st).

Costs based in 1989

To update, multiply by 1.787
original values for production are in short tons
D is in feet to the ore body

Mining Type	2.00		Small Open Pit
Depth (Meter)	-		
T/ Day (Metric)	961.54	Calculated	
Depth (D in feet)	0		
T/ Day (X in Short Ton)	1076.923077		
Process Plant	2.00		Slag Pyro Process

Information Source: USGS Mine cost model. Thomas W. Camm
Source: https://pubs.usgs.gov/usbmic/ic-9298/html/camm5sfo.htm

5	6		
Longhole (400-10,000 TPD) Operating	Vertical Crater Retreat (400-9,000 TPD) Operating	Small Open Pit Operating	Adjustment factor
7.22	6.49	10.44	100%
0.61	0.44	0.58	100%
0.96	0.48	0.07	100%
0.18	0.15	-	100%
0.22	0.22	0.45	100%
0.09	0.10	0.13	100%
0.68	1.71	0.31	100%
0.23	0.17	0.18	100%
1.02	1.05	0.41	100%
0.35	1.02	-	100%
		-	100%
11.56	11.84		
20.66	21.16		
18.78	19.24	12.58	
21.04	21.55	12.58	
20,230	20,717	12,092.87	
260	260	260.00	
438,312	448,868	262,012.11	
5,259,749	5,386,420	3,144,145.27	
		Model Values in this column are Euro per Ton all corrections applied.	

This page contains no data.

		2	3	
	2	Slag Pyro Process	Floatation Mill (3 Product)	Slag Pyro Process
	3	Operating	Operating	
Labor	4	11	8	-
Equipment	5	10	3	-
Steel	6	-	1	-
Lumber	7			-
Fuel	8	22		-
Lube	9	0	0	-
Explosives	10			-
Tires	11			-
Construction material	12	-	-	-
Electricity	13	9	1	-
Reagents	14	17	1	-
Cost in 1989 USD		69	14	
Cost in 2018 USD		123	25	
Cost in Euro		112	23	-
		125.32	25.52	-
		120,496	24,537	-
		260	260	260.00
		2,610,737	531,643	-
		31,328,840	6,379,721	-
				Model Values in this column are Euro per Ton all corrections applied.

Month	1	2	3	4	5	6	7	8	9
Ore Produced	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33
Concentration of lead	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%
Concentration of zinc	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%
Concentration of sliver	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%
Price lead	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
Price zinc	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
Price silver	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
Royalty percentage lead	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Royalty percentage zinc	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Royalty percentage silver	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
Allowable deduction lead	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Allowable deduction zinc	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Allowable deduction silver	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Royalty lead	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425
Royalty zinc	18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404
Royalty silver	4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587
	29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416

10	11	12	13	14	15	16	17	18	19	20
20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33	20,833.33
3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%	3.47%
8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%	8.96%
0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%	0.0093%
1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00	1,975.00
2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00	2,191.00
526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36	526,102.36
4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%	4.50%
10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425	6,425
18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404	18,404
4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587	4,587
29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416	29,416

21	22	23	24
20,833.33	20,833.33	20,833.33	20,833.33
3.47%	3.47%	3.47%	3.47%
8.96%	8.96%	8.96%	8.96%
0.0093%	0.0093%	0.0093%	0.0093%
1,975.00	1,975.00	1,975.00	1,975.00
2,191.00	2,191.00	2,191.00	2,191.00
526,102.36	526,102.36	526,102.36	526,102.36
4.50%	4.50%	4.50%	4.50%
4.50%	4.50%	4.50%	4.50%
4.50%	4.50%	4.50%	4.50%
10.00%	10.00%	10.00%	10.00%
10.00%	10.00%	10.00%	10.00%
10.00%	10.00%	10.00%	10.00%
6,425	6,425	6,425	6,425
18,404	18,404	18,404	18,404
4,587	4,587	4,587	4,587
29,416	29,416	29,416	29,416