NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

"UNDERGROUND MINING DESIGN AND PLANNING: "CORANI" MINE PROJECT"

COURSE: MINING PLANNING

STUDENTS:

BARZOLA BENITO, KEF

HUAYNATE MEZA, JHONATAN

POMA VILA, ANDERSON

SANCHEZ GARCIA, DANIEL

ZORRILLA ALIAGA, POL

PROFESSOR: ENG. HENRY BRAÑES GALLARDO

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CHAPTER 1: ABSTRACT

This evaluation is carried out with the application of the knowledge acquired in the five years of studies. The study includes the development of the block model, resource estimation, mine planning and economic evaluation. The Corani Project contains mineralization of silver, lead and zinc, it contains in three zones: Corani Main, Corani Minas and Corani Este. The Corani project is located in the Southeast of Peru within the district of Puno. It is located approximately between the cities of Cusco and Puno. It is located between 4800 and 5200 meters above sea level in the Andes Mountains. The vegetation within the area consists of small herbs and moss mounds. The mountains in the areas adjacent to the project have permanent snow, but snow is occasionally received in the project area but is not permanent. This work was based on the JORC code, Guidelines of Technical Economic Evaluation of Mineral Industries Projects – AUSMM, DS 023-2017 Occupational Health and Safety Regulations and the code of ethics of the College of Engineers of Peru. The regional geology in the Corani Project area is characterized by volcanic flows. The base of the deposit is shales, covered by a layer of tuff that were mineralized, finally, tuffs from the last post-mineralization volcanic flow is evident. The statistics result of different standard deviation of length composite shows the best composities is 3 meters and the statistics shows that the ore body has economic mineralization of silver, lead and zinc. The mineral resources were estimated by Kriging. The mineral resources are reported at a cut-off grade of 110.1 g / ton of silver-equivalent. The cut-off grade was estimated based on a price of US $ 18.1 per ounce of silver, US $ 0.9 per pound of lead and US $ 1.1 per pound of zinc. The silver-

equivalent grade assumes 69.6% recovery for silver, 61% recovery for lead and 67% recovery for zinc. Three mining methods were defined by the UBC criterion, such as:

- Sub level stoping
- Sub level caving
- Block caving

The conceptual economic evaluation based on Profitability Index suggest to apply Sub Level Caving.

CHAPTER 2: INTRODUCTION

The Corani project is located in the Southeast of Peru within the district of Puno. It is located approximately between the cities of Cusco and Puno.

INTRODUCTION

Bear Creek Mining Corporation (Bear Creek) owns the Corani Project in Peru. Corani project deposits contain mineralization of silver, lead and zinc in potentially economic concentrations.

The Corani project is located between the cities of Cusco and Puno, in the department of Puno, in southeastern Peru. The three deposits addressed in this report are:

- Main Corani
- Corani Mines
- East Corani

There are additional exploration objectives in the area that are not included in this resource. They will be explained later in the discussion about the geological environment and adjacent properties.

Assumptions

The present work presented multiple limitations due to the little information available about the project. Not having enough information, certain information was assumed in order to develop the conceptual study of the Corani project. Among this supposed information are:

Geomechanical Model

RMR box rock, mineral, compressive strength and other geomechanical conditions were assumed in order to determine the method of exploitation and sizing the cuts.

Geometallurgical Model

The average metallurgical recovery values for each type of mineralization were assumed in the present conceptual study, as well as the method of processing to be used in the project.

Metal prices

The price of silver, lead and zinc were estimated based on their historical prices, creating a price estimating function and being used in the report.

Equipment price

The prices of the equipment were assumed, based on the information published in CostMine. These prices were adjusted by applying a factor based on the Peruvian market.

Mining Recovery and Dilution.

Once the cut-off was defined, the mining recovery and dilution values were estimated using the MSO software.

Objectives as a limitation

The present work was done on an academic basis which limits the extensions of the work in a certain way. On the other hand, the present work presents the bases of a conceptual study, going through all the stages concerning this study.

Participation of guide teachers

This project was carried out with the help of teachers Henry Brañes Gallardo and Javier Perales Orellana, responsible for the course, as well as the theoretical part and the practical part respectively. It is a great help in carrying out the conceptual study of the Corani project.

This led to an educational and professional development of the team responsible for preparing the conceptual study of the Corani project.

Mining Industry Standards and Guides

This document has been produced using guides and codes of the mining industry such as:

- International Organization for Standardization. ISO 14001- "Environmental Management System" is an internationally accepted standard that indicates how to put an effective environmental management system in place. It is designed to help organizations stay commercially successful without ignoring their environmental responsibilities. The ISO 14001 standard is applied in the environmental risk assessment nuance.
- National Instrument 43-101, is the national instrument for the Mining Project Disclosure Standards, which are owned or explored by companies that report these results in Canadian stock markets. This includes foreign-owned mining entities that are listed on stock exchanges supervised by the Canadian Securities Administrators, even if they only operate in over-the-counter derivatives or other instrumented securities.
- SME 2017, In December 2015, the Society for Mining, Metallurgical and Exploration (SME) adopted the first edition of the Standards and Guidelines for the valuation of mineral properties, which were published in the 2016 edition. This edition provides updated instructions for the assessment of mineral properties. The updates maintain alignment with the template of international standards for the valuation of mineral properties and the international valuation standards IVS.
- Mining Project Evaluation. The proposed mining projects vary according to the type of metal or material that will be extracted from the ground, most of the proposed projects involve the extraction of deposits of minerals such as copper, nickel, cobalt, gold, silver, zinc, lead, molybdenum and platinum. The large-scale environmental impacts of mining projects imply that these metals are the subject of this guide.
- Valuation Guidelines for Mineral Properties. The Mining Association of Canada. Since 1935, the Canadian Mining Association (MAC) has been the national voice of the Canadian

mining industry. MAC promotes the industry nationally and internationally, works with governments on policies that affect the sector and educates the public about the value that mining brings to the economy and daily life of Canadians. The members of this association represent the majority of Canadian production of basic and precious metals, uranium, diamonds, metallurgical coal, extracted oil sands and industrial minerals, and actively participate in mineral exploration, mining, smelting, refining and semi-manufacturing.

- Code of Ethics – Peruvian College of Engineers
- DS 023 - 2017 Occupational Health and Safety Regulation in Mining, Peru

CHAPTER 3: TRUST OF OTHER SPECIALISTS

Academic and technical support for the present evaluation was provided by the professors of the mining planning course, Henry Brañes and Javier Perales.

CHAPTER 4: PROPERTY DESCRIPTION AND LOCATION

The Corani project is located in the Southeast of Peru within the district of Puno. It is located approximately between the cities of Cusco and Puno.

Location

The Corani project is located in southeast of Peru within the department of Puno. It is approximately located between the cities of Cusco and Puno. Figure 1 illustrates the general location on the map of Peru.

The project is located at a height between 4800 and 5200 meters above sea level in the Vilcanota Andean mountain range. The vegetation within the area consists of small herbs and moss mounds. The mountains in the areas adjacent to the project have permanent snow. However, the project area itself occasionally receives snow, but is not permanent.

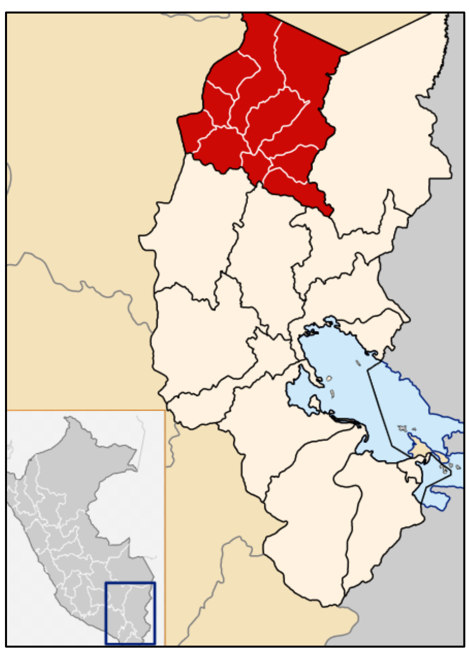


FIGURE 1. LOCATION OF THE CORANI PROJECT

Project area

The mining concession application (also called denouncement) in Peru is submitted to the Geological, Mining and Metallurgical Institute (INGEMMET) that is part of the Ministry of Energy and Mines of Peru. Complaints may vary in size from 100 to 1000 hectares. They are rectangular geometries parallel to the UTM grid system (WGS 84) used in the district.

It is not necessary to demarcate the concession limits on the ground, since the main documentation exists with the coordinate limits presented in the INGEMMET.

The maintenance of the concessions requires:

- Payment of the license cost.
- Minimum production required.
- A penalty if there is no project production.

The range of costs ranges from $ 3 / hectare to $ 60 / hectare for penalties if there is no production.

The Corani Project consists of 12 mining concessions that constitute a total of 5700 hectares. In particular, the three mineralized zones are contained in the concessions: Corani I, Corani III, Minzapata 4 and Corani 5. The concession table and a general location map is provided in Table 1 and Figure 2.

Table 1. CORANI 100 concession of the project according to GEOCADMIN

Nombre: CORANI 100	
Nombre	CORANI 100
Titular	BEAR CREEK MINING S.A.C.
Fecha Formulación	Agosto 8, 2005
Estado	D.M. Titulado D.L. 708
Ubigeo	210305
Has.	200,00
Estado	TITULADO
CODIGOU	10251005
RESOL_TIT	04733-2005-INACC/J

FECHA_RESOL_TIT	Noviembre 13, 2005
DESIC_RESOL_TIT	CONCESION MINERA
DEPA	PUNO
PROVI	CARABAYA
DISTRI	CORANI
DIRECCION	AV. LOS CONQUISTADORES N°1144 PISO SEIS SAN ISIDRO LIMA 27
HASDATUM	200,00

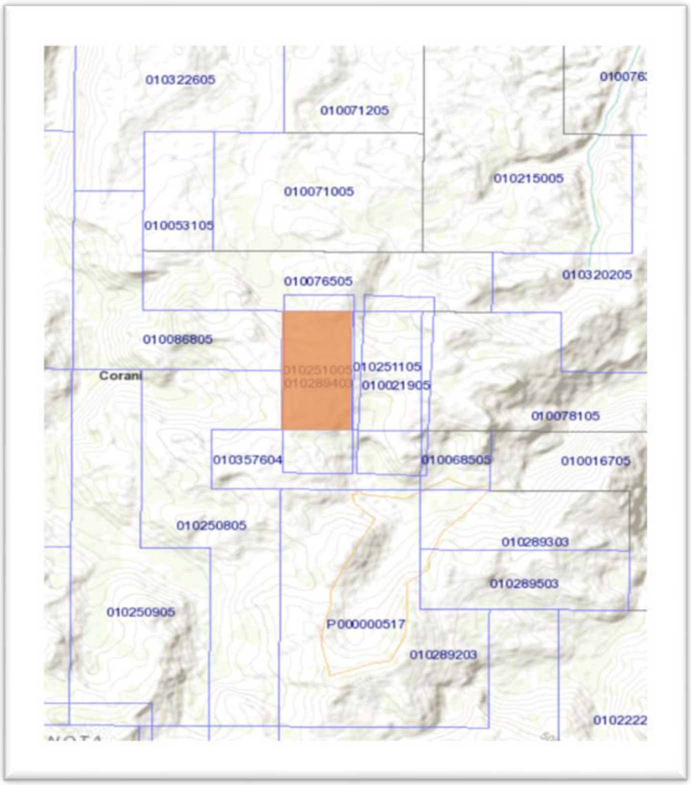


FIGURE 2. MAP OF THE MINING REQUEST OF THE CORANI PROJECT

Agreement and Levies

Three necessary permits or approvals are needed in Peru for exploration:

- Primary permit or (Affidavit)
- Surface use permit, and
- Water use permit.

The Affidavit is issued by the Ministry of Energy and Mines and may be a Category B allows for less than 20 perforations, or a Category C for more than 20 perforations. Bear Creek Corani received his Category C permit on March 1, 2006.

Surface permits are obtained from local indigenous populations since surface areas are divided into small local villages for grazing or agriculture. The closest towns of Quelcaya and Chacaconiza have granted surface permits to Bear Creek based on the signatures of most of the villagers within each town. A rental agreement for exploration rights and the exploration camp have been established with the villages.

Water rights for exploration are obtained from the local Technical Administration Office of the Irrigation District. Bear Creek has obtained authorization for water use in September 2006. This has changed, now is the ALA and ANA.

CHAPTER 5: ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

Property Access

There is road access to the Corani Project from Cusco, Puno and Juliaca, all the main cities in southeastern Peru. The paved road from Cusco to Puno passes through Santa Rosa. From Santa Rosa, there are approximately 152 km of dirt roads to reach the project. The last 97km of dirt roads are not improved and cross high mountain passes.

There is also an access road from Macusani to the east of the project. Future plans contemplate access to the project from Macusani, approximately 25 km east of the Corani Project. There is a paved road from Juliaca to Macusani.

Weather

The climate in Corani is dry and cold. Low temperatures during the winter months of June and July are approximately –8 degrees Celsius. In summer you have high temperatures, in December and January they are around 18 degrees Celsius. Snowfalls of 10 to 20 centimeters occur in the winter months. There is a rainy season from November to February when the roads can be muddy.

Bear Creek has been actively exploring in Corani since May 2005 and has not encountered a significant obstacle to access to the project during that time.

Geography and vegetation

The Corani project is located at altitudes of 4,800 to 5,200 meters in the southeast of the Andes of Peru. The terrain is mountainous and exhibits the properties of the glacial terrain. The mountains near more than 5,500 meters high have permanent snowfield coverage.

The vegetation in Corani consists of low grass and moss. Local people graze llamas and alpacas on the valley floors in the area.

Local resources and infrastructure

Currently, the closest city that uses the current access road is Ñunoa. Bear Creek considers improving the road to Macusani as part of the project. This would shorten the amount of dirt or gravel roads that would have to be traveled during the development of the project.

The nearest power line is in Macusani. Currently, generators provide energy for the exploration camp. Fuel and supplies are brought by road from Cusco, which is generally a 6-hour trip.

There is rail access in Santa Rosa that connects to the cities of Cusco, Juliaca and Arequipa (www.ferrocarriltransandino.com), then goes down to the coast and connects to the port terminal of Matarani (www.tisur.com.pe), being Currently the main port in southern Peru.

The Corani exploration camp consists of a series of temporary wooden structures that include a small dining room, bedrooms, central warehouses and core registration and sample preparation facilities. The camp is located approximately 4.5 km in a straight line southeast of the exploration activity center. The camp is about 4,660 m high, where a high hill separates the exploration area from the camp.

CHAPTER 6: HISTORY

Exploration history

Small-scale exploitation in the area is of unknown age and can be traced back to the Spanish colonial era. To the south and east of the current Corani project there is evidence of exploitation of Antimony, they were supposedly active in the early 1900s (World War I), when the price of antimony was relatively high.

During the First World War it was used for weaponry purposes and later used throughout the development of the automobile industry, although not to the levels reached during the First World War.

Before the early 1950s, mineral exploration consisted of shallow prospecting wells in the northern part of the current Corani Project.

Historical estimate of mineral resources

The first modern evaluation of silver and lead mineralization began with the location of the mineral and concessions in 1951 by Augusto León.

Corani Mining Company was formed in 1956 to develop the previously prospective silver and lead mineralization. The mines were developed and operated from 1956 to at least 1967.

Initially they produced 80 tons per day. In 1967, Corani Mining Company was owned by two thirds of Palca Mining Company and one third by M. Hochschild (now Hochschild Mining PLC, www.hochschildmining.com).

Historical production

Total historical production is uncertain but estimated at 100,000 tons of silver-lead-zinc ore. In early 1967, estimated mining production was reported at around 3,400 short tons per month, with grades of 7.0-9.0 percent lead, 2.3 percent zinc, and 8.0 to 11.0 ounces per ton of silver.

In 1965, Korani Mining Company was seeking financing to increase production from 80 tons per day to 300 tons per day.

Historical maps of the underground works show developed on four levels (levels 4820, 4843, 4860 and 4870 m for 50 meters vertically) that extend over an area of approximately 500 meters in a general north-south direction (parallel to the strike). 150 meters east-west. It is not known when the operations of Korani Mining Company ceased, but presumably they ceased in the late 1960s or early 1970s.

The following exploration activity was carried out by the Minsur company. This exploration included 40 shallow drill holes at various locations, including several shallow holes in the gold zone south of the current resource area. Despite the fact that Minsur is an active mining company in Peru; Bear Creek Mining Corporation's attempts to copy Minsur's exploration data have been unsuccessful.

None of the information from Minsur's exploration (www.minsur.com) is available or verifiable; although gold mineralization was allegedly found in some of the Minsur drilling.

In late 2003 and early 2004, Rio Tinto Mining and Exploration began a copper porphyry mineralization exploration. During 2004, Rio Tinto conducted surface mapping, sampling and magnetic studies, and access roads developed in the area. This initial Rio Tinto work defined anomalous silver and lead mineralization at the deposit south of the Corani mines, and also defined an anomalous zone of gold mineralization in rock and soils.

CHAPTER 7: GEOLOGICAL ENVIRONMENT AND MINERALIZATION

Regional geological environment

The Corani Project area is located within the Eastern Mountain range of the Central Andes. The Project area is supported by tertiary volcanic rocks from the Quenamari Formation, specifically a thick series of lithic crystalline tuffs and andesite flows that cover varied deformations of the Lower Paleozoic to the Ambo and Tarma Groups. The main host for mineralization is the Chacaconiza member of the Quenamari Formation. The Chacaconiza is the youngest member of the Quenamari and is made up of a sequence of crystal-lytic and crystal-vitric-lithic tuffs. The tuffs are extensively hydrothermally altered and are generally argilized to low-temperature clays, and have variable faults, fractures and gaps. Mineralization at the Corani Project occurs in three distinct and separate zones: Corani Main, Corani Mines and East Corani, each of which differs slightly in terms of alteration and mineral assembly. In general, outcropping mineralization throughout the Corani Project is associated with iron and manganese, barite and silica oxides. The silicification is penetrating and structurally controlled along the veins. In the drill core, mineralization occurs in typical low to intermediate silver-lead-zinc sulfide (Ag-Pb-Zn) mineral assemblies. The most abundant silver-containing mineral is Argentine fine-grained tetrahedrite or freibergite.

Structurally, the Corani deposit is located within a stacked sequence of normal listric faults that strike predominantly north to north-northwest with moderate to shallow western falls (50 ° to <10 °). The hanging walls of the listric faults are extensively fractured and breached, providing structural preparation for subsequent or syngenetic mineralization. Stacked listric faults are most prominent in the main areas of Corani Mines and Corani. The Corani East area contains a single known lastric fault with a widely fractured and breached hanging wall. Contact with the underlying Paleozoic sediments locally corresponds to lastric faults that submerge slightly to the west.

Geology of the property

Within the Corani resource area, the sediments are generally red shales. There has been folding and failure of this meta-sedimentary sequence. However, the regional fault is northwest with falls to the southwest of 11 to 50 degrees.

A sequence of volcanic tuffs uncomfortably overlaps the sediments. These tuffs are of tertiary age and are generally classified as crystal-lithic and crystal-vitreous-lithic with quartz eyes ranging up to 5mm in diameter. These rocks range from well-established to massive, with the development of columnar joints in the most massive areas.

The tuffs have been divided into pre-mineralization tuffs and post-mineralization tuffs.

The entire resource within the Corani district is housed in pre-mineralized tuffs. The post mineralized tuffs are effectively sterile and uncomfortable overlapping the pre-mineralized unit below.

Mineralization

There is structural preparation for the soil mass at Corani, and there is a general north-northwest orientation to structurally controlled vein mineralization within the main pipeline and Mines areas.

Figure 3 is a summary of the geological map of the Corani resource area. Sediments emerge in the valley soils and pre-mineralized and post-mineralized tuffs.

Figure 4 is an east-west cross section through the Corani resource area looking north, the local sequence of post-mineralized tuff covering the pre-mineralized tuff, covering the sediments is indicated in the section.

The geology shown in Figures 3 and 4 cover the Corani drilling area and not extrapolated to a great distance beyond the drilling data, hence the colorless areas in Figure 3.

There is a gold zone located south of the Corani resource area about 3 km. To the southeast of the gold zone another 1.5 km is an area known as the antimony zone. The gold zone appears to be a structurally controlled NS vein that has potentially interesting gold in grades that have been sampled with trenches.

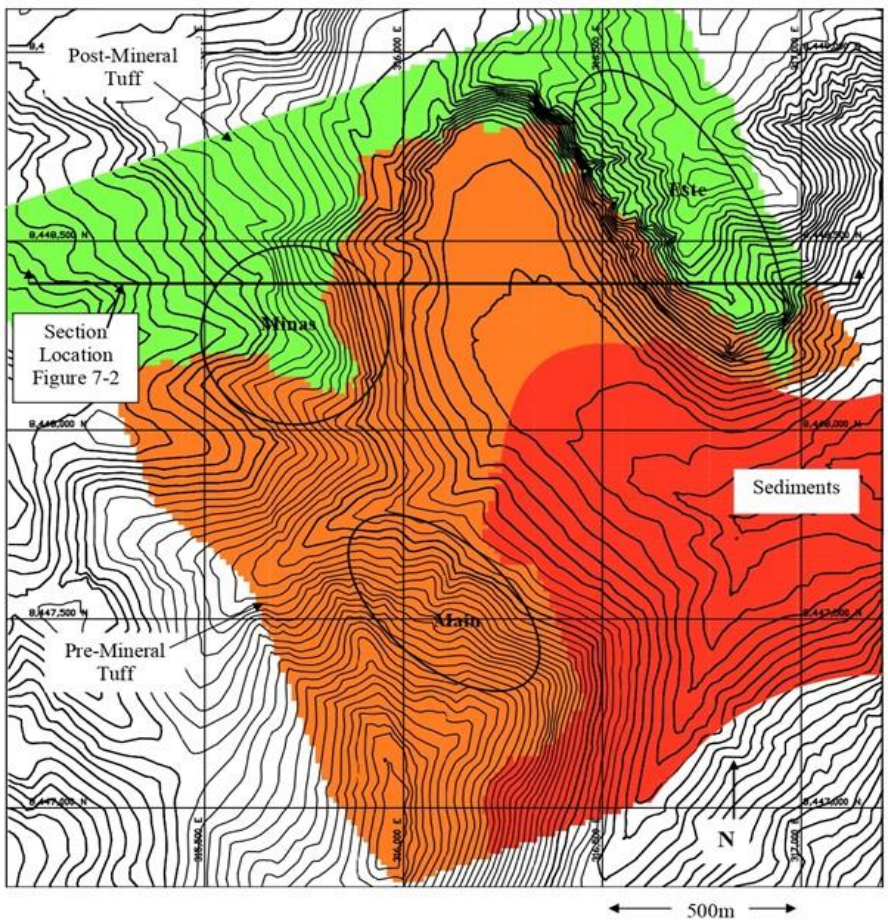


FIGURE 3. GEOLOGICAL MAP OF MINERAL RESOURCES IN CORANI

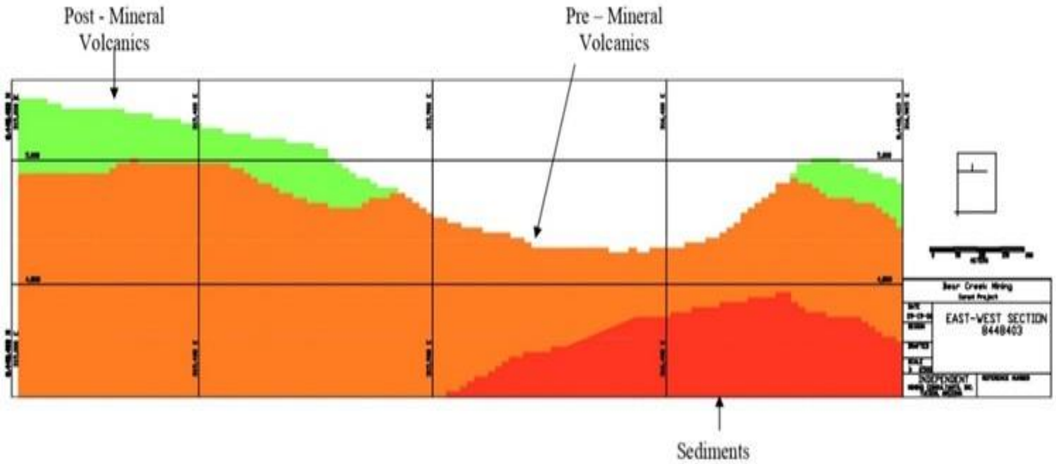


FIGURE 4. GEOLOGICAL SECTION OF EAST-WEST

CHAPTER 8: TYPES OF DEPOSITS

Mineral deposits are mineral occurrences of sufficient size and grade, formed by geological processes, where mineral substances with economic interest accumulate to be exploited with the available technical means.

The profitability of a mineral deposit depends on its intrinsic characteristics (such as tonnage and grade) and extrinsic characteristics (such as tax rates, metal prices)

Classification by training environment

The advantages of this classification are that the geological environments, where the deposit was formed define the group, the disadvantages of this classification is that first there is a large number of deposits formed in various stages with different factors and the second is that generally a mineralization It is formed by a set of factors, which does not necessarily depend on the environment. (ex: The veinform deposit depends essentially on the box rock).

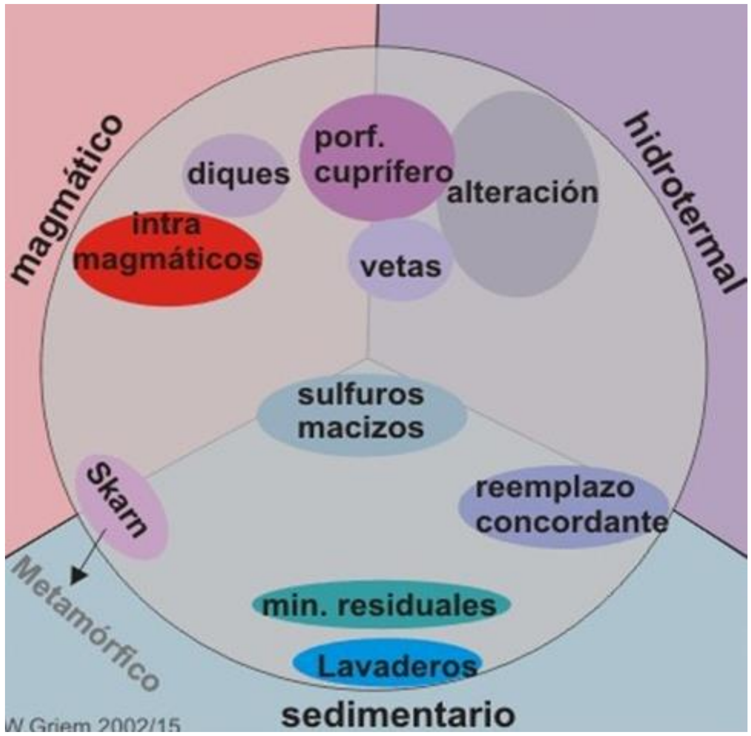


FIGURE 5. CLASSIFICATION BY ENVIRONMENT

Classification by shape or symmetry of the deposit

It is known that the symmetry or shape of a deposit gives us a well-defined group of different deposits and the exploitation methods also depend on them. The advantages are that this classification is a fairly logical grouping, and the disadvantages are that the symmetries are not totally clear, for example due to "semi-irregular", "almost concordant"; also, that this classification lacks scientific and as we know the shape of a mineral deposit is secondary and does not have an intrinsic relationship with its mineralization.

Table 2. Classification of mineral deposits.

Clasificación de los depósitos minerales según su simetría y forma					
1	discordantes - regulares		tabulares-vetiformes	vetas	
				zona de falla	
			tubulares	diatremas	
				chimeneas	
2	discordantes - irregulares		Impregnaciones	Pórfidos cupríferos	
				Alteraciones	
			Reemplazo	Flats	
				Skarn	
3	concordantes	estrato - ligados	mentarios simples, autóctonos (del lugar mis	Sulfuros (Cu) en caja sedimentaria	
				Banded Iron Formation	
				Hierro oolítico	
				Sal, Evaporitas	
				Fosfatos	
				Calizas	
				Energéticos: Carbón, Hulla, Turba	
			Sedimentarios alóctonos(transportadas)	Lavaderos	fluviales
					eólicos
					coluviales
					litorales: Fe-brechas
				acumulaciones clásticas	Arenas, Areniscas
					Gravas
					Arcillas
			reemplazo cocordante		
			depósitos residuales	Bauxitas	
				Lateritas	
			caja vólcanica - (sedimentaria)	Sulfuros macizos	Tipo Besshi
					Tipo Cipre
					Tipo Kurorko
					Tipo primitivo
			roca/ caja metamórfica		
			Caja ígnea	magmáticos primarios	
			Impacto		

Classification by chemical content

The Corani deposit is best described as a low to intermediate epithermal sulphidation deposit with silver, lead and zinc mineralization hosted in factories, veins and breccia. Mineralization is mainly located in a set of listric faults with a general blow from north to northwest and submerges to the west, with expansion segments related to subvertical structures and gaps in the hanging wall, and veins that form factories in the wall of the foot. Structural control of mineralization is a product of extensional tectonics that developed the series of north-northwest trending fractures and faults and whose movements provided structural preparation for the entry of mineralizing hydrothermal fluids. Mineralization at Corani is likely to be laterally and vertically distal to an intrusive liquid source. Mineral textures are classified from coarse crystalline quartz-pyrite-chalcopyrite in the southern part of the Project area, to fine-grained sulfide minerals, dominated by pyrite in the north, suggesting a flow of hydrothermal fluid from south to north. This spatial zoning suggests a rapidly chilled mineral fluid, typical of a distal environment surrounding a buried intrusion. The multiphase nature of mineralization and zoning at Corani may be related to multiple fluid dissolution events of an evolving porphyry-type system that possibly underlies the southern part of the area. Alternatively, mineralizing solutions may be related to the siting of shallow subvolcanic domes.

CHAPTER 9: EXPLORATION

Bear Creek has been conducting exploration at Corani since early 2005. Bear Creek's work has included detailed mapping, manual trenching with canal sampling, and core drilling. There is a total of 25 completed trenches within the Corani resource area with 1,295 analyzed intervals totaling 2,924 meters of trench data. There are four additional trenches in the gold zone to the south.

CHAPTER 10: DRILLING

Drilling of the Corani project started in June 2005 and has been under the control of Bear Creek Mining Corporation. All drilling to date has been performed using a 6.36 cm diameter (2.5 inch) HQ core diamond drill.

The perforation pattern is generally within the series of sections spaced 50 m apart. Angle drills are used to try to cross perpendicular to the overall structural orientation of the reservoir. Often multiple holes are drilled from the same platform to reduce surface impact and obtain the necessary drilling coverage at depth.

Some areas have been filled at distances of 25m and other parts of the reservoirs are still in 100m spaces. The intentions are to fill the widest areas up to the space of 50 m. A brief review of the grade and thickness maps in Section 9.0 indicates that each of the three deposits is still open as they have not been closed by drilling in all directions.

Figure 10-1 presents a drill hole location map of the Corani data available as of mid-July 2006. This is the information used in the development of this resource estimate.

The diamond drill holes in the Corani database as of July 2006 were as follows:

- Number of drillings = 236
- Number of sample intervals = 6,695
- Total drilling meters = 38,855.9 meters
- Number of silver trials = 16,227
- Number of lead tests = 16,276
- Number of zinc tests = 16,277
- Number of copper tests = 16,277

Currently, the Bear Creek Mining company reports a greater number of exploration drills, data not available for this study.

In addition to the diamond drill data, the following ditch data at Corani was used in the model.

- Number of trenches = 25
- Number of sample intervals = 1,297
- Total meters of trench data = 2,923.8 meters
- Number of silver tests = 1,295
- Number of lead tests = 1,295
- Number of zinc tests = Not analyzed
- Number of copper tests = Not analyzed

The drill collars were lifted with manual GPS that have a reported accuracy of + -3.0 meters.

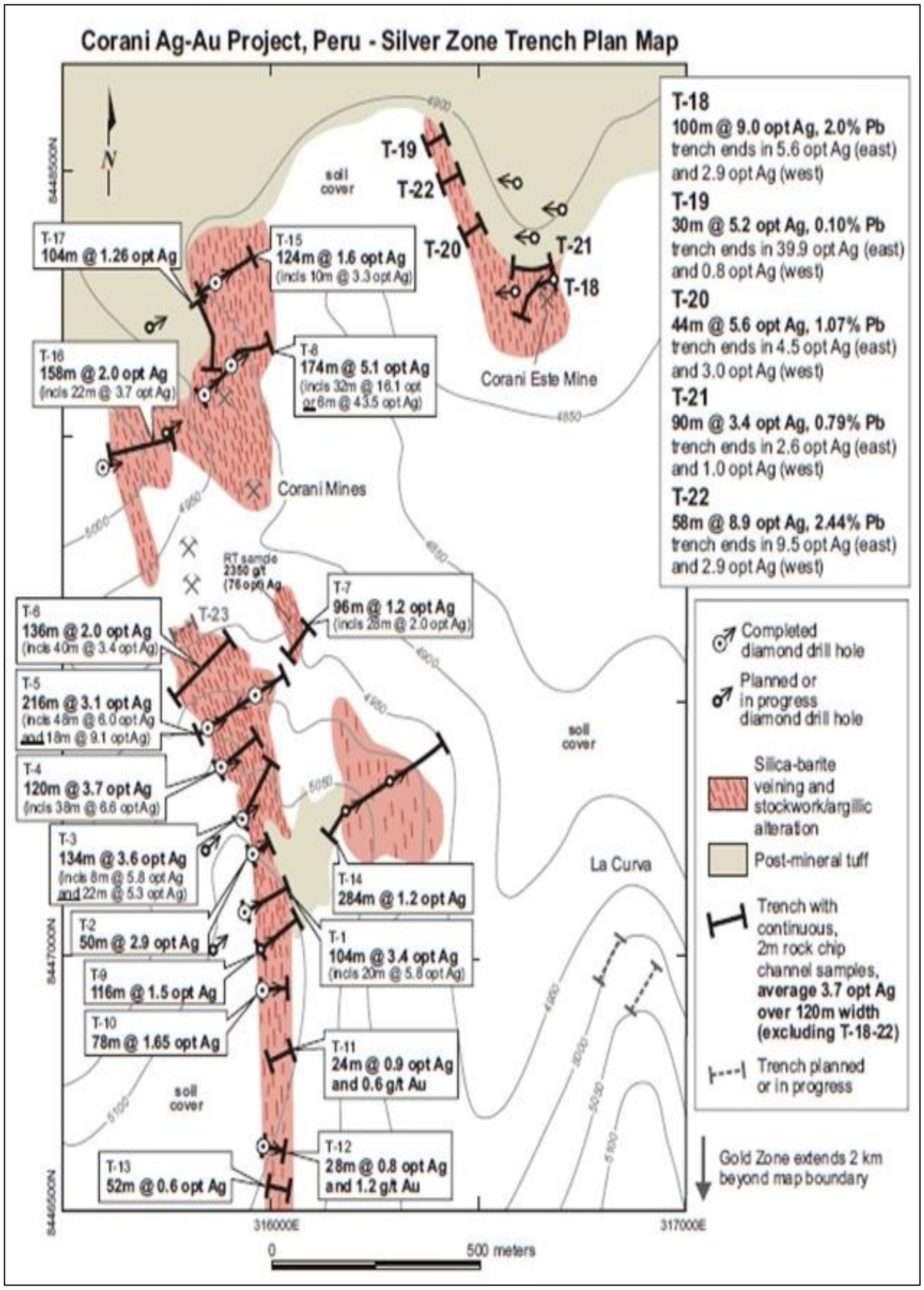


FIGURE 6. MAP OF EXPLORATIONS

CHAPTER 11: PREPARATION OF SAMPLES, ANALYSIS AND SECURITY

Samples of the diamond drill core are recorded in a system for preparation and analysis. Each core drill sample is approximately 5 to 8 kg. The prepared sample is sent to certified laboratories in Lima.

Sample preparation procedures are as follows:

- The sample is dried at 110 - 120 degrees C.
- The entire sample is crushed with a jaw crusher and roller at 70% passing 2 mm (approximately 10 meshes).
- 250 mg are divided by the rifle divider. Coarse rejects are returned to Bear Creek.
- The division is sprayed using a ring and a disc sprayer at 85% passing 75 microns.

The silver testing procedure for the Corani project is as follows:

- A pulp sample is digested with 3 acids: hydrofluoric, nitric and perchloric. This results in a cake.
- The remaining cake is leached with hydrochloric acid.
- The hydrochloric acid solution is subjected to AA to determine the concentration of dissolved silver.

The size of the aliquot used in the analysis is not recorded in the methods as published online. The procedure is reported to be robust in the reported range of 1 to 1,000 mg / tonne of silver. Samples are also analyzed for lead, zinc and copper by digestion with three acids, followed by an Atomic Absorption analysis. Some gold trials have been completed, but were not used in the resource calculation.

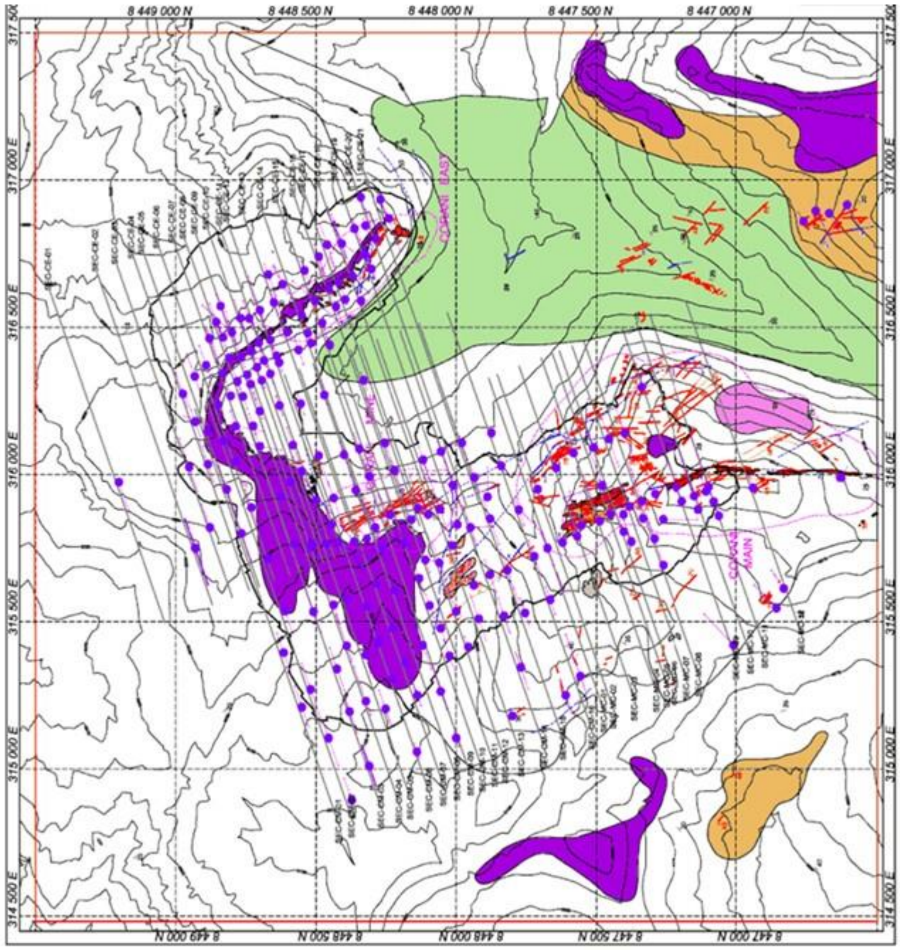


FIGURE 7. TOPOGRAPHY OF THE PROJECT AREA

Bear Creek handles samples from the chain of custody and security, as drilling, sample preparation, splitting, and transportation to a private carrier in Cusco are under the control of Bear Creek staff.

CHAPTER 12: DATA VERIFICATION

Bear Creek handles samples from the chain of custody and security, as drilling, sample preparation, splitting, and transportation to a private carrier in Cusco are under the control of Bear Creek staff.

Database inspection

The following procedures were carried out to verify the initial data of the present study:

i. Review of Necklaces and Essays

ii. Review of the Import Format to Minesight or Datamine

iii. Topography map.

QPs pre-inspection

Rock lithologies, types of alteration, and significant structural features are consistent with the descriptions provided in existing project reports, and the author saw no evidence in the field that could significantly alter or refute the current interpretation of the local geological environment. (as described in chapter 7 of this report).

A total of 96 collar locations (approximately 20% of the total used to develop the block model) were previously verified in the field using a portable GPS unit. The mean variance between the field collar coordinates and the collar coordinates contained in the project database is approximately 18m, well within the expected margin of error taking into account the difference between survey methods.

CHAPTER 13: MINERAL PROCESSING AND METALLURGICAL TESTING

Metallurgical tests

Rock lithologies, types of alteration, and significant structural features are consistent with the descriptions provided in existing project reports, and the author saw no evidence in the field that could significantly alter or refute the current interpretation of the local geological environment.

Project information is currently in the early stages of a process metallurgical testing program. Conclusions on the best approach to metallurgical recovery have yet to be developed as the testing program continues.

Preliminary tests of the process were performed by Plenge Labs and Dawson Metallurgical Labs who addressed direct cyanidation with six bottle roller tests. The cyanide susceptibility of the bottle balancing tests ranged from 40.5 to 79.1% silver after 96 hours. Six additional whole rock cyanide leaching tests have been completed and the average silver recovery for all whole rock tests is 51.7%.

Metallurgical samples were recovered from two twin diamond drill holes (DDH-C8-A in Corani Mines and DDH-C23-C in East Corani). Initial floatation work on samples from these holes indicated good recovery performance harder. The buoyancy separation of lead was clean and that of zinc was less than desired. The results of the metallurgical tests to date are listed below:

- A combination of selective flotation to recover silver rich lead concentrates followed by cyanidation of flotation tailings to recover additional silver is currently indicated as the process flow sheet for the project. When the grade of zinc warrants it, a separate zinc concentrate is considered.

- Marketable lead-silver concentrates with grades of up to 60% lead and more than 160 Oz / t silver have been produced.
- Zinc concentrates with grades of 45% to 50% have been produced.
- The arsenic and antimony contents are below the casting penalty levels.
- The best lead flotation results were obtained in a composite material with a grade of 4.46% Pb, producing a lead recovery of 70% and a silver recovery of 49%. Cyanide leaching from the flotation tails in this case recovered an additional 24% of the total silver contained, giving an overall silver recovery of 73%.
- Zinc recovery by flotation is favorable in zinc grades greater than 1%. The best zinc flotation results were obtained in a higher grade zinc compound (4.4% Zn) that produces a zinc concentrate that analyzes 46% zinc with a recovery of 65%.
- Cyanidation of low sulfide whole mineral compounds produced silver extractions in the range of up to 79%. Cyanide consumption was relatively high (greater than 2.8 kg / t) at the high concentrations used in the tests. Additional evidence indicates that lower concentrations of cyanide leach solution are effective with significantly less cyanide consumption. More testing is needed to optimize the leaching process; however, direct cyanide leaching seems appropriate for low sulfide portions of the resource.

Hazen Research, Inc. completed the mineralogical testing of Corani samples in August 2006 and two studies by G&T Metallurgical Services in August and September 2006. Determination of minerals from that work has provided guidance for the continuous effort of the float test.

Zinc can be processed slightly differently than lead and silver. This is because zinc is produced in discrete sheaths that are sometimes separated from silver and lead mineralization. For example, if a 1% zinc cutoff grade is applied to the model, 72% of the zinc metal reports 19% of tons of resources (measured and indicated). This result indicates that a component of more than 1% of zinc tonnage is out of the current resource.

As metallurgical testing continues, external zinc zones will be evaluated for addition to the resource.

Only part of the deposit is likely to go through a zinc recovery loop. Floatation recoveries for higher grade zinc material have indicated that an overall zinc recovery could be in the mid range of 60%.

For the purposes of establishing the resource, metal recoveries of 85% for silver and 65% for both lead and zinc were applied. These values are based on the initial process recoveries observed in the test job and other similar properties of silver, lead, and zinc. Additional test work in progress, you may change these numbers in the future.

Additional tests were carried out in 2018 and 2019 on 12 samples from 9 wells (6 of which were new) drilled in the Este, Minas and Main wells to improve the knowledge of the material against metallurgical processes. This new information improved the result of the metallurgical recovery percentages. Total silver recoveries ranged from approximately 63% to 84%.

CHAPTER 14: ESTIMATION OF MINERAL RESOURCES

The Mineral Resource estimate is often a team effort (for example, it may involve one person or team collecting the data and another person or team preparing the Mineral Resource estimation). Within this team, geologists generally play the pivotal role. Ore Reserve estimation almost always involves a team effort involving a number of technical disciplines, and within that team, mining engineers generally occupy the central role. Documentation for an estimate of Mineral Resources or Ore Reserves may be compiled by, or under the supervision of, a Competent Person or Persons, whether a geologist, mining engineer, or member of another discipline. However, it is recommended that in cases where there is a clear division of responsibilities within a team, each Competent Person should accept responsibility for their particular contribution. For example, one Competent Person could accept responsibility for collecting Mineral Resource data, one for the Mineral Resource estimation process, one for the extraction study, and the project leader could accept responsibility for the document as a whole. It is important that the Competent Person who accepts global responsibilities for an estimate of Mineral Resources or Mineral Reserves and supporting documentation, which has been prepared in whole or in part by others, is satisfied that the work of the other taxpayers is acceptable.

Table 3. Mineable Resources - Cutoff = 94.7 gpt Ag

CLASSIFICATION	TONNAGE	AGEQ	AG	PB	ZN
1	38´460,429	162.86	85.95	1.44	0.93
2	26´833,662	142.35	73.18	1.39	0.76
3	6´936,777	141.92	73.12	1.41	0.74

Methodology for estimating mineral resources

The estimation of the mineral resources of the Corani project will follow the following procedures:

- Verification and preparation of the database
- Construction of the geological model
- Determine the resource domains
- Data composites, to perform statistical and geostatistical analysis
- Calculation of the block model, interpolation of laws.
- Classification of resources and validation
- Determine the estimated cutoff grade and the form of extraction
- Determination of reserves

Table 4. Statistics of drillings without composer.

	Valid	Total Weight	Sum	Minimum	Maximum	Mean	Std. Devn.	Variance	Co. of Variation
AG	28,416	0.0000	927,341.8000	0.0000	5,840.0000	32.6345	75.3138	5,672.1680	2.3078
AU	3,891	0.0000	2,697.9600	0.0000	1,000.0000	0.6934	22.6965	515.1301	32.7329
CU	28,326	0.0000	815.7500	0.0000	2.0400	0.0288	0.0571	0.0033	1.9824
PB	28,366	0.0000	15,717.0800	0.0000	16.6500	0.5541	0.8945	0.8000	1.6143
ZN	28,422	0.0000	10,300.6900	0.0000	17.1500	0.3624	0.8016	0.6425	2.2118

Data Preparation

"For statistical and variographic analysis, only fully sampled ore intercepts are selected from high-confidence drills. This procedure ensures the inclusion of the test population without bias, although it reduces the number of selected samples and, therefore, the data density." (Mineral Resource and Ore Estimation - The AusIMM Guide to Good Practice - 23 Monograph, 2001, p. 208).

Statistical analysis of the Assays file

Analysis was performed for the 4 important elements (Ag, Cu, Pb, Zn) present in the collected samples. The maximum and minimum values of the elements of the file "rpt201.la" were obtained in order to assign a representative interval width and to be able to visualize in the best way the histograms obtained based on the collected samples.

Values such as average grade, standard deviation and coefficient of variation were obtained. The obtained results are showed next.

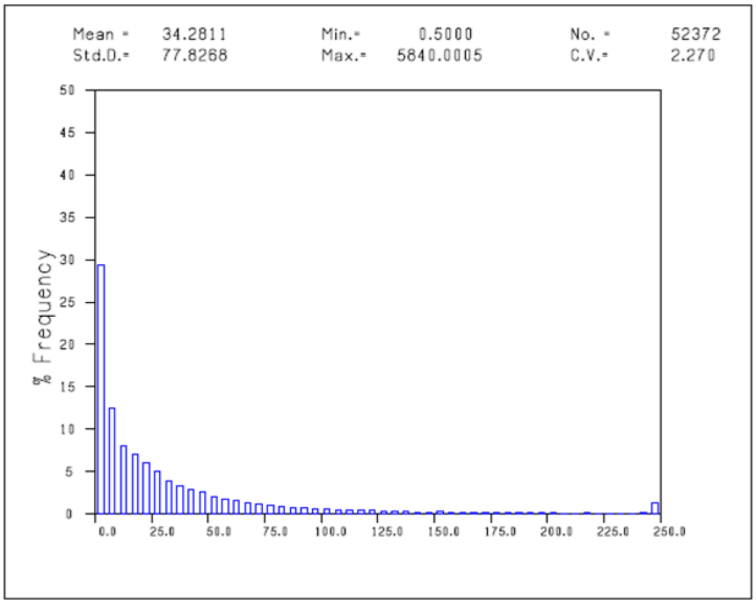


FIGURE 8. FREQUENCY HISTOGRAM OBTAINED FOR AG

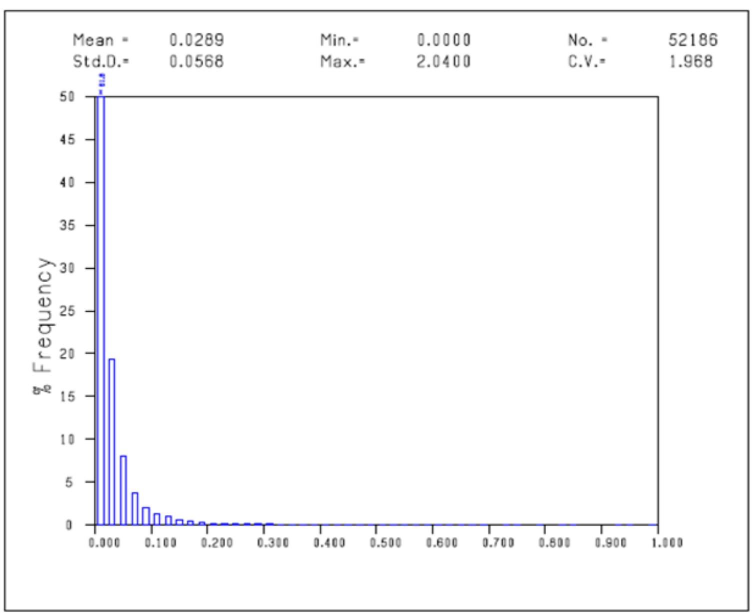


FIGURE 9. FREQUENCY HISTOGRAM OBTAINED FOR CU

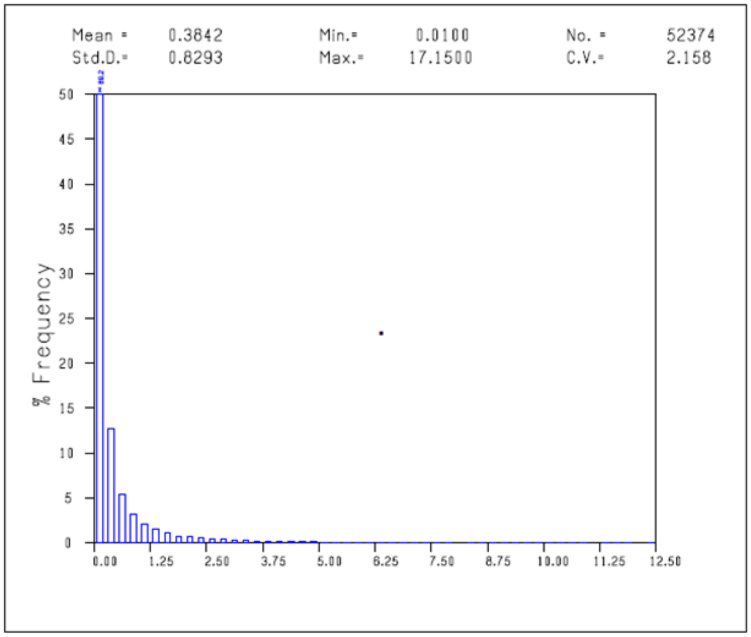


FIGURE 10. FREQUENCY HISTOGRAM OBTAINED FOR PB

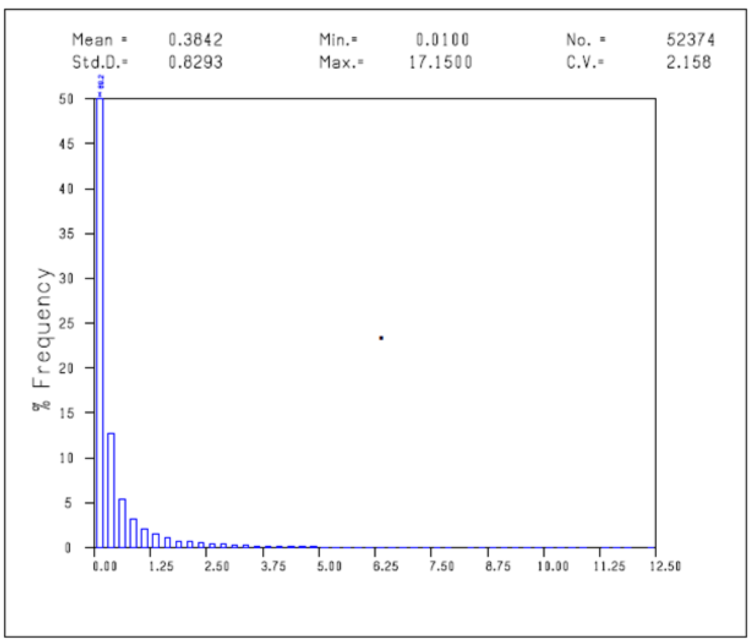


FIGURE 11. FREQUENCY HISTOGRAM OBTAINED FOR ZN

Table 5. Summary of the statistics obtained

	Mean	Min.	Max.	Std.D.	C.V.
Ag	34.2811	0.5	5840.0005	77.8268	2.27
Cu	0.0289	0	2.04	0.0568	1.968
Pb	0.5809	0	16.65	0.9148	1.575
Zn	0.3842	0.01	17.15	0.8293	2.158

The histogram provides an overview of the concentration ranges of a population. The histogram should always be done to determine, according to the form, the type of treatment that will be done to the set.

The shape of the histograms is asymmetric, with a skewed distribution of the data, with a high peak on the left side of the graph which means the presence of many samples with low values followed by a queue of high values.

The coefficient of variation (C.V.) is a useful measure of skewness for a positively skewed distribution.

< 1 : Probable local estimation OK

1 – 2 : Difficulty with external values

>2 : The external values will cause a problem

So we note that in Ag and Zn extreme values will cause a problem.

Drill Composite

The purpose of the composite is to make the sampling length have equal (regular) lengths. Therefore, the drilling compound was made for different lengths, from 2 to 10 m, to observe its behavior and the following was obtained.

Table 6. Summary at different composite lengths.

#	Lenght	Mean	STD	CV	Min	Max	ΔMean	ΔSTD	ΔAssay	Δ%CV
26448	2	34.3	77.8	2.3	0.5	5840	0%	0%	0%	0%
17935	3	34.3	65.2	1.9	0.5	2740	0%	-16%	-32%	-16%
13533	4	34.3	66.4	1.9	0.5	3515	0%	-15%	-49%	-15%
10891	5	34.3	61.7	1.8	0.5	2630.4	0%	-21%	-59%	-21%
9107	6	34.3	59.9	1.7	0.5	2390.3	0%	-23%	-66%	-23%
7858	7	34.3	56.3	1.6	0.6	1770.6	0%	-28%	-70%	-28%
6912	8	34.3	55.3	1.6	0.5	1802	0%	-29%	-74%	-29%
6174	9	34.3	52.3	1.5	0.6	967.8	0%	-33%	-77%	-33%
5593	10	34.3	53.8	1.6	0.5	1469.8	0%	-31%	-79%	-31%

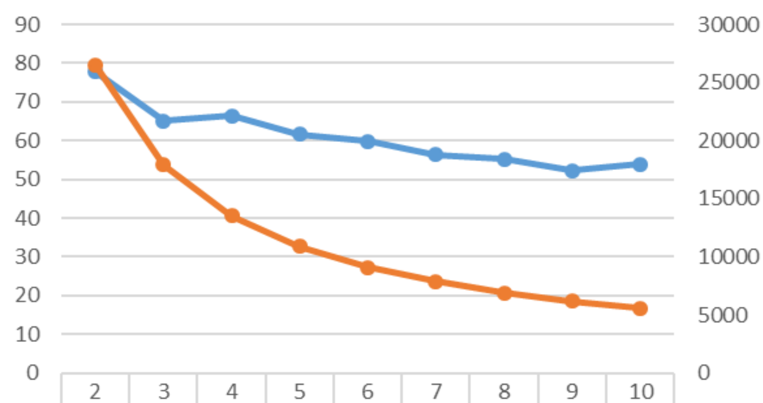


FIGURE 12. STD GRAPH (BLUE) VS ASSAYS (RED)

The standard deviation results in a numerical value, which represents the average difference between the data and the mean. Then, the analysis is performed between the different composite lengths and the variation of the standard deviation with respect to the value obtained in the first composite length (2m). The following was obtained.

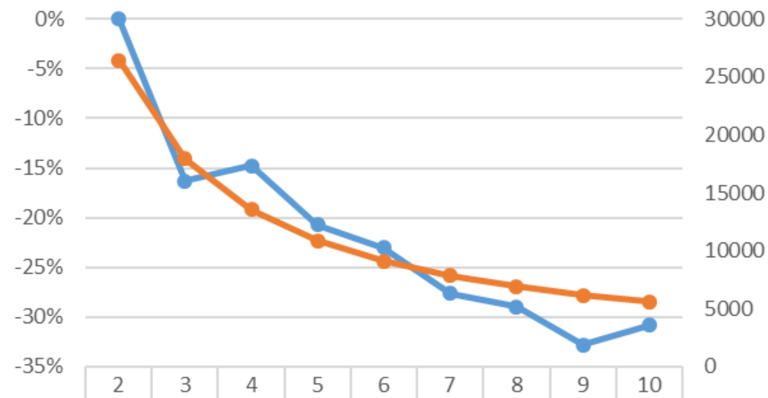


FIGURE 13. GRAPH Δ% STD (BLUE) VS ASSAYS (RED)

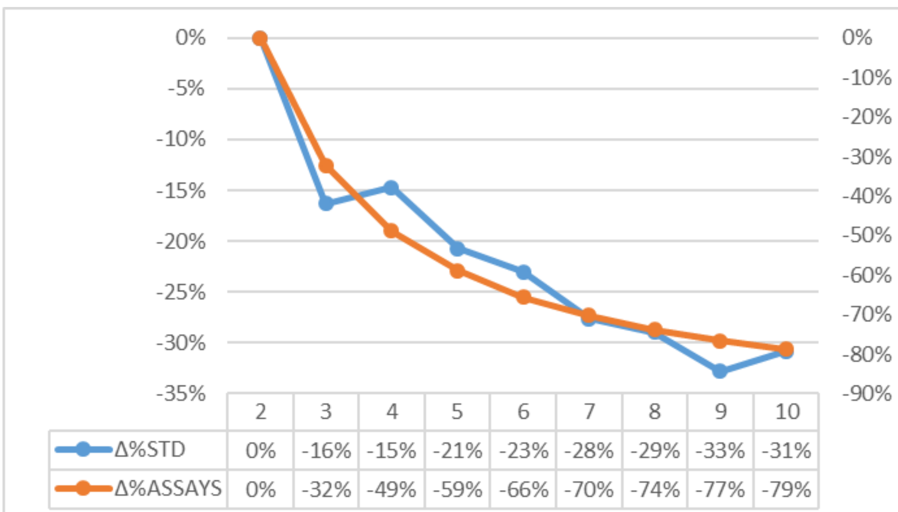


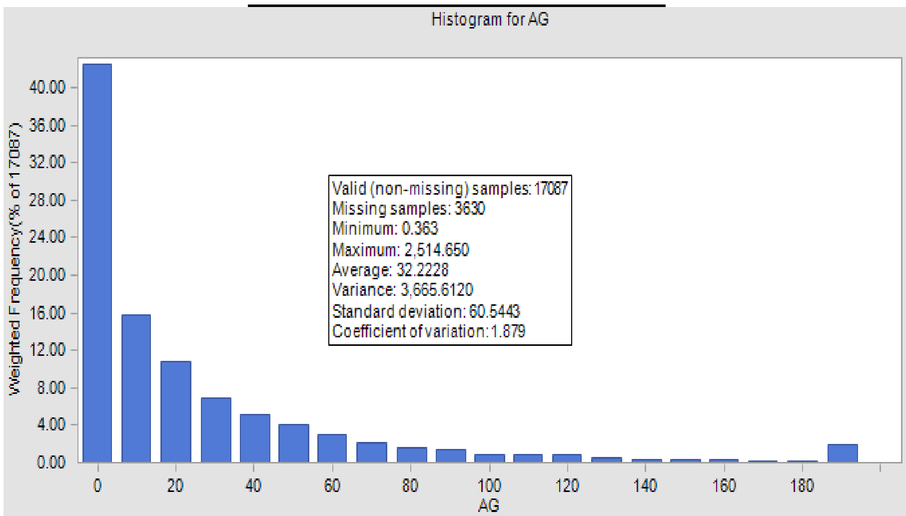
FIGURE 14. GRAPH Δ% STD VS Δ% ASSAYS

Capping

The presence of samples with high grade values can negatively influence the calculation of resources. These outlier values can lead to an overestimation of Corani's resources. After reviewing and studying the probabilistic graphs and histograms, the capping was performed giving the following values.

Table 7. Summary of Cap Sample Values

METAL	CAP SAMPLE
Ag	800 g/t
Au	12.5 g/t
Cu	1.00%
Pb	10.00%
Zn	10.00%



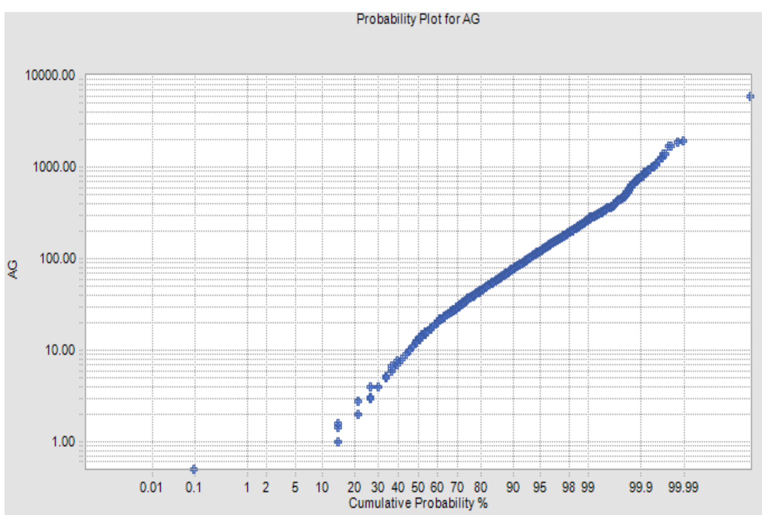
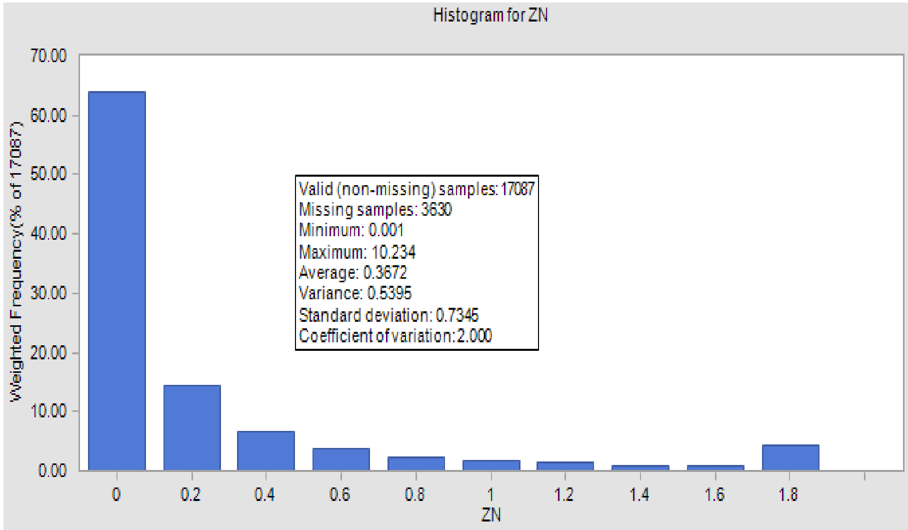


FIGURE 15. PROBABILITY PLOT AND HISTOGRAM FOR SILVER SAMPLES



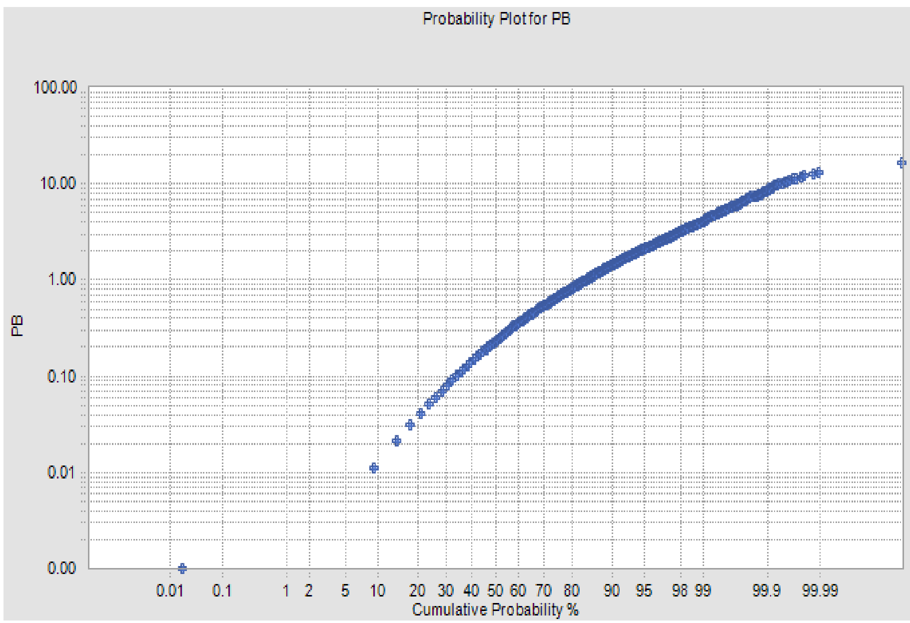


FIGURE 16. PROBABILITY PLOT AND HISTOGRAM FOR GOLD SAMPLES

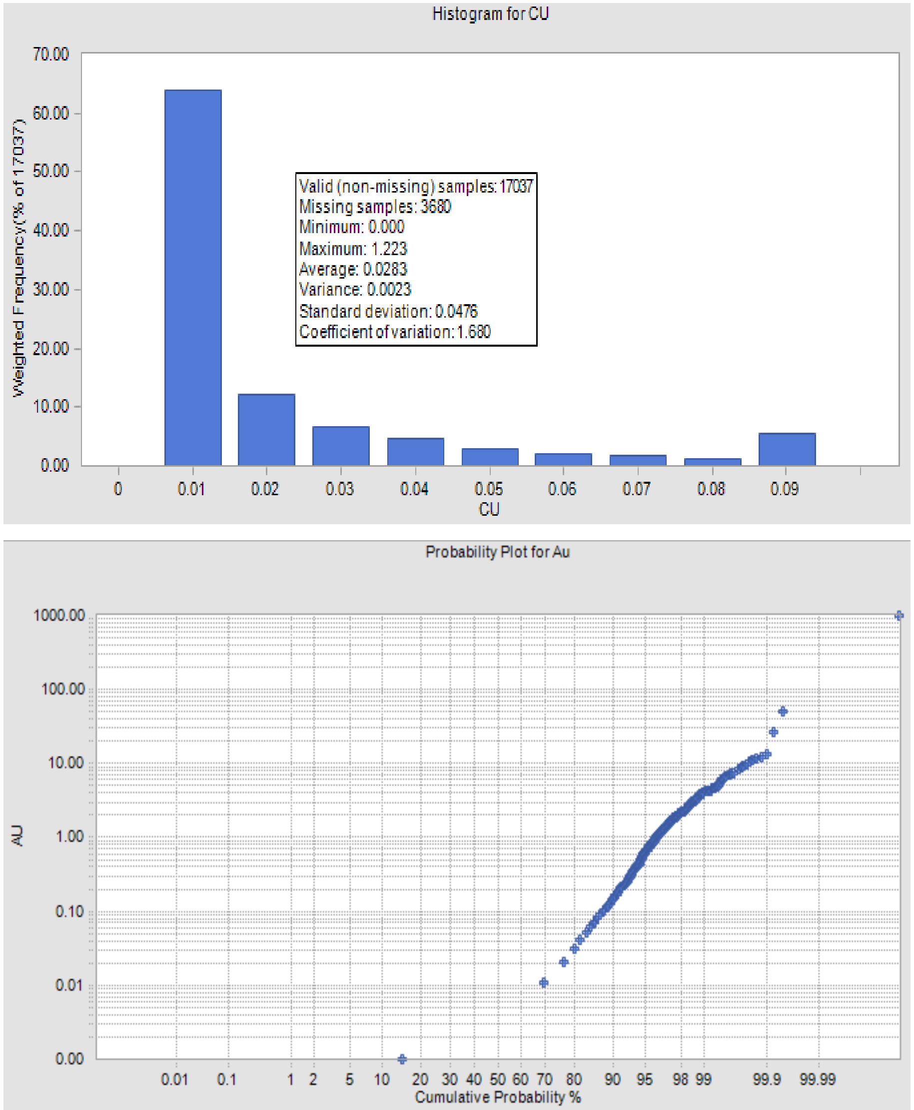
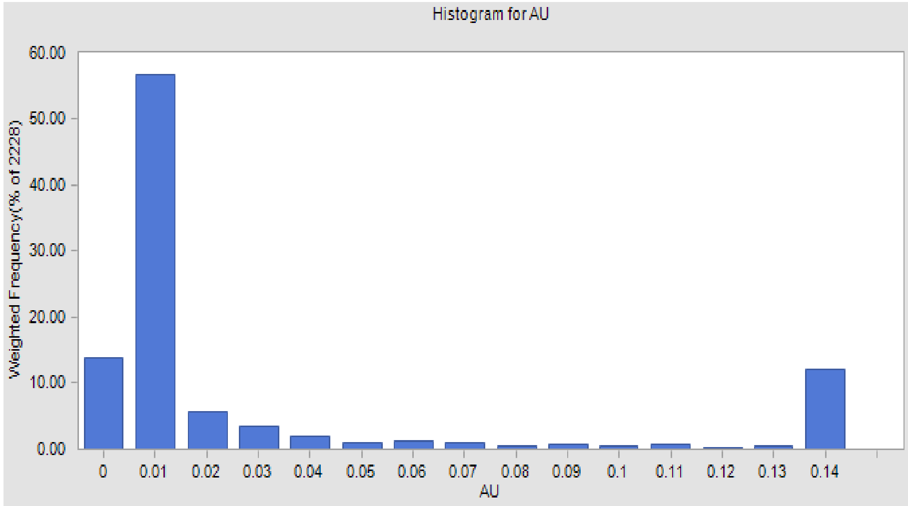


FIGURE 17. PROBABILITY PLOT AND HISTOGRAM FOR COPPER SAMPLES



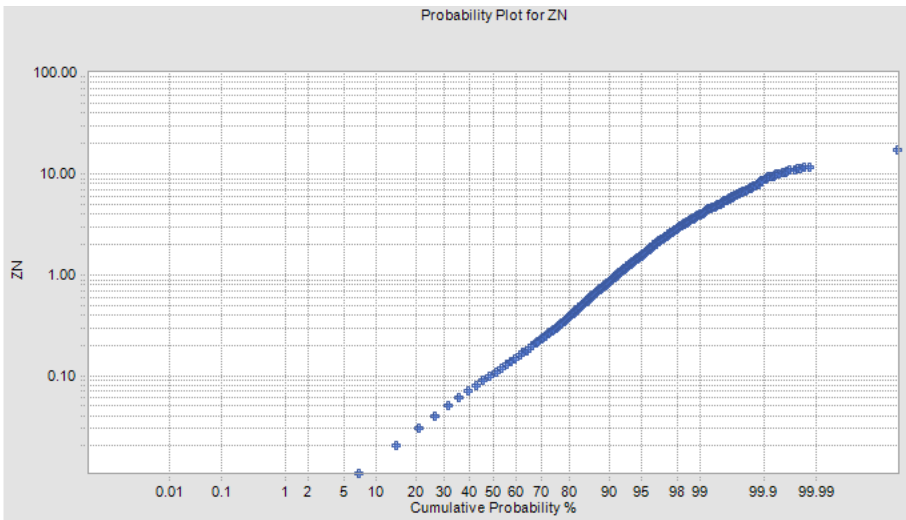
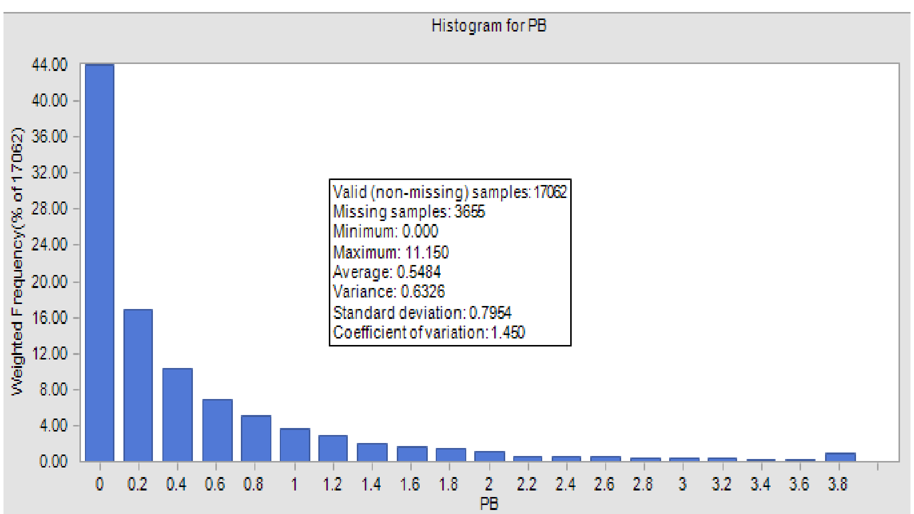


FIGURE 18. PROBABILITY PLOT AND HISTOGRAM FOR ZINC SAMPLES



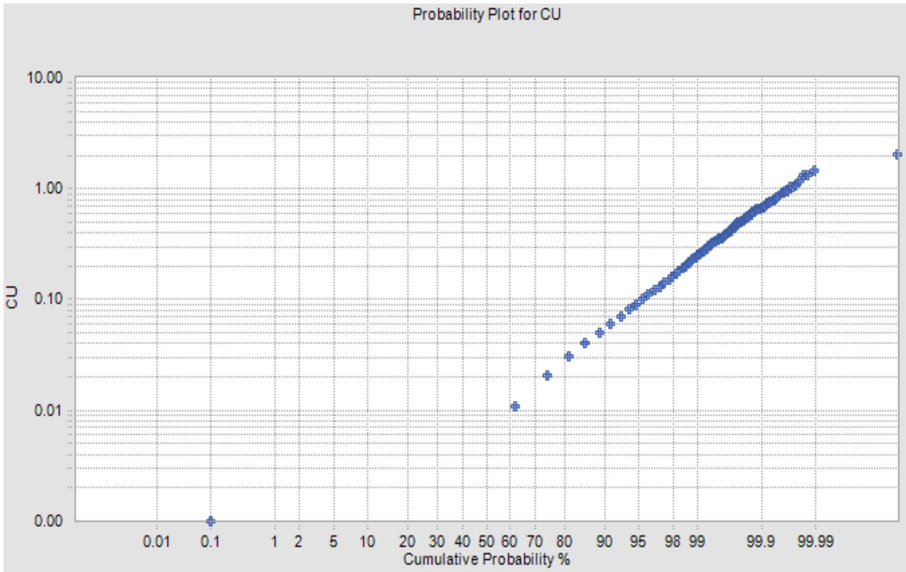


FIGURE 19. PROBABILITY PLOT AND HISTOGRAM FOR LEAD SAMPLES

Variograms

Once the Capping and the composites had been carried out, a variogram study was carried out in order to determine the maximum range and define the dimensions of the ellipsoid of influence.

When analyzing variograms in different directions and dips, it was determined that the following variograms have the greatest range for each element under study.

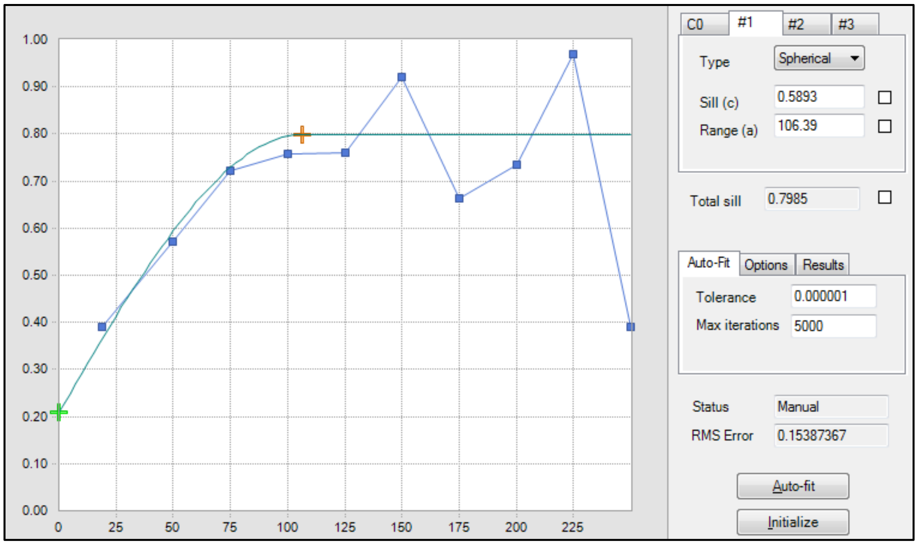


FIGURE 20. VARIOGRAM PB (120 ° / 60 °)

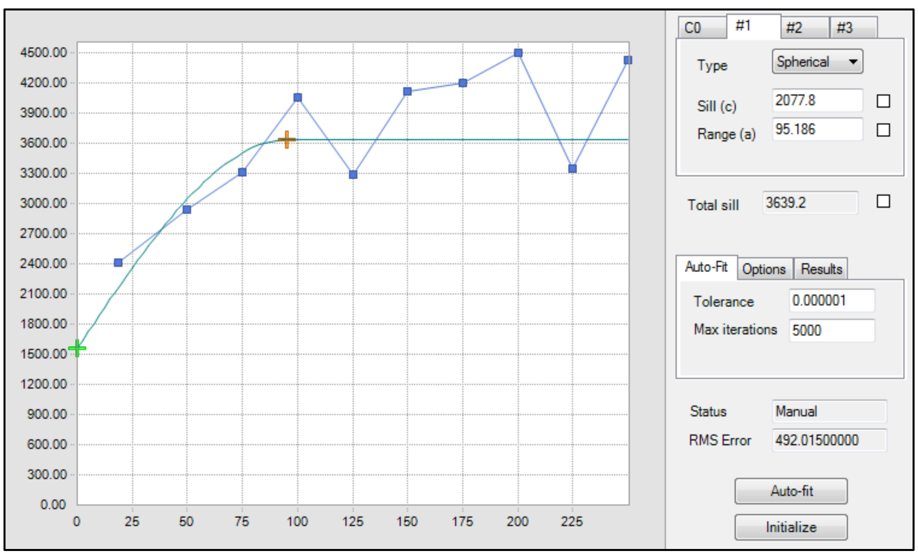


FIGURE 21. VARIOGRAM AG (120 ° / 30 °)

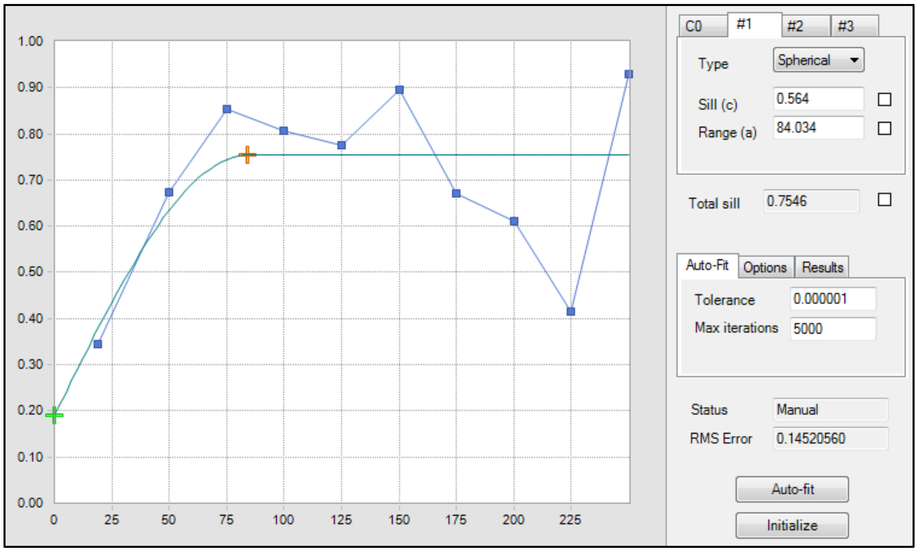


FIGURE 22. VARIOGRAM ZN (120 ° / 30 °)

Table 8. Summary of scopes and variograms for each element

Element	Direction	Scope
AG	120°/30°	105
PB	120°/60°	95
ZN	120°/60°	85

Block Model

From the geological model the block model of the Corani project was created, the size of the blocks is 10x10x10 meters. The block model is not rotated. The initial coordinates, block size, and number of blocks in each direction are shown in the following table.

Table 9. Definition of block size

Zone	Axis	Lenght	Origin	#
Corani	X	10	314800	240
	Y	10	446800	260
	Z	10	4000	150

Degree of Estimation and Validation

Silver, lead and zinc grades were estimated using Kriging. For all the elements the estimation was made using 2 fields: the number of compounds and the distance of the inference ellipsoid.

Table 10. Composites and influence radius used in the estimation.

Classification	# Composites		Influence Radius (m)
	Min	Max	
1	4	15	0 - 25
2	2	15	25 - 50
3	1	15	50 - 150

Classification of Mineral Resources

The amount of resources and laws of the Corani project were estimated according to the Australian Code to Report on Mineral Resources and Ore Reserves (The JORC Code).

The classification of mineral resources was made according to:

- Measured: Estimated blocks with a minimum of 4 composites, which are within an influence radius of 0 to 25 meters.
- Indicated: Estimated blocks with a minimum of 2 composites, which are within a radius of influence of 25 to 50 meters.
- Inferred: Estimated blocks with a minimum of 1 composites, which are within a radius of influence of 50 to 150 meters.

Mineral Resources Report

The Australian Code for Reporting on Mineral Resources and Ore Reserves (The JORC Code) defines a mineral resource as:

A “Mineral Resource” is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in the form and quantity in which there are reasonable probabilities of eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are subdivided, in order of ascending geological confidence, into categories of Inferred D21 Indicated D22 and Measured D23.

The term “that there are reasonable probabilities of eventual economic extraction” requires that the estimated quantity and grade have a certain economic factor and that the mineral resources be reported with an appropriate cut-off grade considering possible scenarios of extraction and metallurgical recoveries. To comply with this requirement, it was considered that the exploitation method to be used is underground. The Mineral Resources Report is shown below.

Table 11. Mineral resources for the Corani deposit, Puno, Peru, November 20,2019

Category	TONNE (‘000)	Ag Eq (g/t)	Ag (g/t)	Pb (%)	Zn (%)
MEASURED	30,494	162.86	93.93	1.54	1.06
INDICATED	19,128	142.34	81.4	1.52	0.88
M+I	**49,623**	**174.89**	**89.1**	**1.53**	**0.99**
INFERRED	4,682	165.1	83.75	1.54	0.87

Mineral resources are reported at a cutoff grade of 110.1 g / ton of silver-equivalent. The cutoff grade is estimated based on a price of $ 18.1 per ounce of silver, $ 0.9 per pound of lead and $ 1.1 per pound of zinc. The silver-equivalent calculation assumes 69.6 percent recovery for silver, 61 percent recovery for lead, and 67 percent recovery for zinc.

Sensitivity analysis of laws

The mineral resources of the Corani project are subject to a selection of the court law. In order to reflect this relationship, the Tonnage-Law model is shown below.

Table 12. Tonnage and grades, for different cut laws of the Corani project

Cut Law (g/t)	Measured + Indicated		Inferred	
	TONNE (000't)	AgEq (g/t)	TONNE (000't)	Law AgEq (g/t)
0	371,070	60.56	70,863	44.73
10	355,844	62.84	65,237	48.12
20	301,084	71.84	50,615	57.7
30	239,856	83.38	36,936	69.78
40	193,640	94.99	27,343	82.11
50	158,178	106.27	20,515	94.54
60	130,992	116.97	16,174	105.24
70	109,395	127.26	12,810	115.91
80	90,569	138.14	10,100	126.97
90	74,620	149.55	7,980	138.08
100	60,549	162.24	6,286	149.66
110	49,715	174.77	4,696	164.94
110.1	**49,623**	**174.89**	**4,682**	**165.1**
120	41,501	186.66	3,682	178.71
130	35,140	197.85	2,993	191.11
140	29,854	209.02	2,399	204.93
150	25,246	220.75	2,026	216.08
160	21,573	231.97	1,663	229.32
170	18,374	243.68	1,413	240.81
180	15,698	255.4	1,245	249.68
190	13,555	266.56	991	266.688
200	11,743	277.65	863	276.7

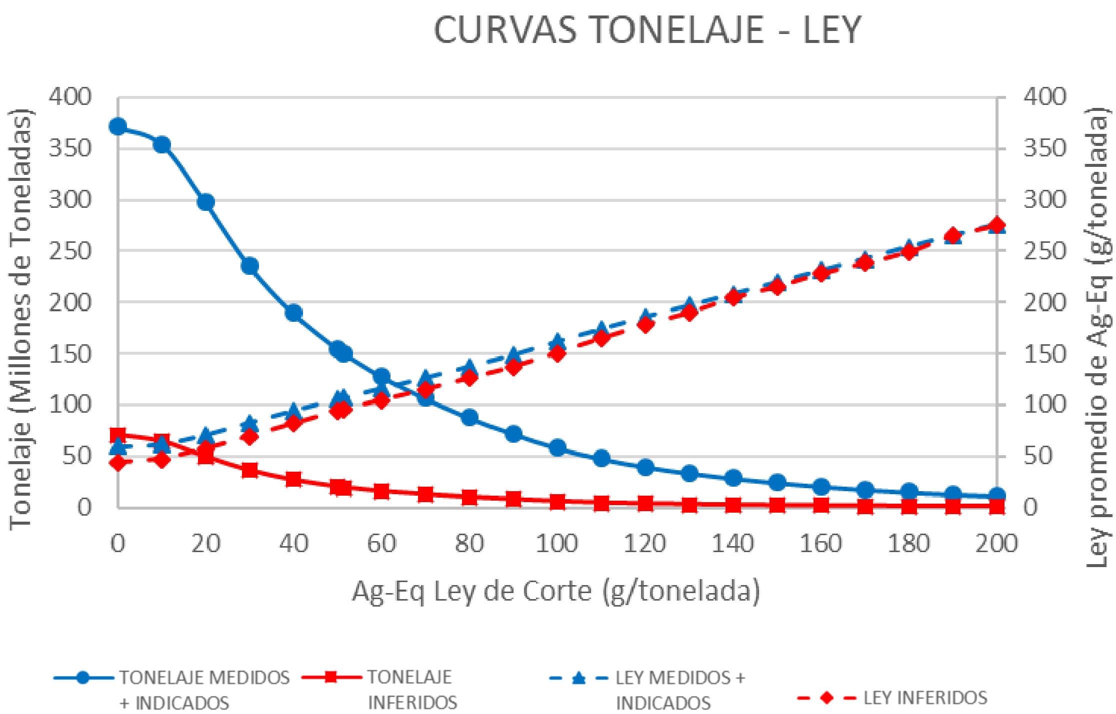


FIGURE 23. TONNAGE CURVE - LAW FOR THE CORANI PROJECT

CHAPTER 15: MINING METHOD AND MINING PLANNING

This section contains the conceptual design of the Corani project mining and extraction plan through underground mining.

Selecting the mining method

The selection of the UBC mining method is a modification of Nicholas's (1981) approach. According to Nicolas, each mining method is classified according to the suitability of its distribution of geometry / grade and mineral area, geomechanical characteristics of the mineral and box rocks.

Based on the Nicholas and UBC method, it is determined that the methods that best suit the deposit.

Table 13. Characteristics of the mineral body

Rock	Rock Substance Strength	Description
Mineral	10 - 15	Moderate
Roof Box	5 - 10	Weak
Floor Box	10 - 15	Moderate

Table 14. Mechanical properties of the rock.

Rock	Rock Mass Rating (RMR)	Description
Mineral	40 - 60	Moderate
Roof Box	20 - 40	Weak
Floor Box	40 - 60	Moderate

Table 15. Mining Methods.

Final Results		
1	Sublevel Caving	35
2	Sublevel Stoping	33
3	Cut and Fill	33
4	Open Pit	30
5	Block Caving	30
6	Top Slicing	12
7	Square Set	12
8	Shrinkage Stoping	-23
9	Longwall	-72
10	Room and Pillar	-81

We select the 3 best methods to carry out the trade-off analysis to determine which is the ideal mining method for the project. Finally, he decided on the following methods:

- Sublevel Caving
- Sublevel Stoping.
- Block Caving.

Sublevel Caving

Sublevel Caving is a mining method by sinking where the superimposed sterile material collapses and fills the vacuum that leaves the extraction of the mineralized body. This process must propagate to the surface, thereby creating a subsidence cavity or crater. Although this method is preferably applied in large vertical tabular deposits, there is a variant for the exploitation of narrow veins called Longitudinal Sublevel Caving.

In the first instance, the Sublevel Caving method will be described in general, to then describe its longitudinal variant, applied in deposits with the shape of narrow veins.

To carry out the extraction, the mineralized body is divided into vertically spaced sublevels between 10 to 20 m. At each sublevel, a network of parallel galleries is developed that cross the body transversely, at distances between 10 to 15 m. Then, the extraction of the mineral is carried out from these sublevels in a descending sequence.

The design of the Sublevel Caving method considers the following parameters and characteristics:

- Grade distribution: The deposit should have a reasonably uniform grade distribution, ideally with a low law zone around the mineralized body to minimize the impact of dilution generated by the incorporation of sterile material.
- Shape: The shape of the mineralized body should preferably be tabular and regular.
- Dip: The dip of the mineralized body must be greater than the angle of repose of the broken mineral, to facilitate gravitational runoff.
- Geotechnics: The mineralized rock must present sufficient conditions of competition so that the works placed on it remain stable with a minimum of fortification elements. Instead, the surrounding rock should be poorly competent to facilitate the sinking process once extraction of mineralized rock has begun.
- Selectivity: The mineralized body is extracted in its entirety by means of conventional drilling and blasting. Therefore, this exploitation method has a lower selectivity.

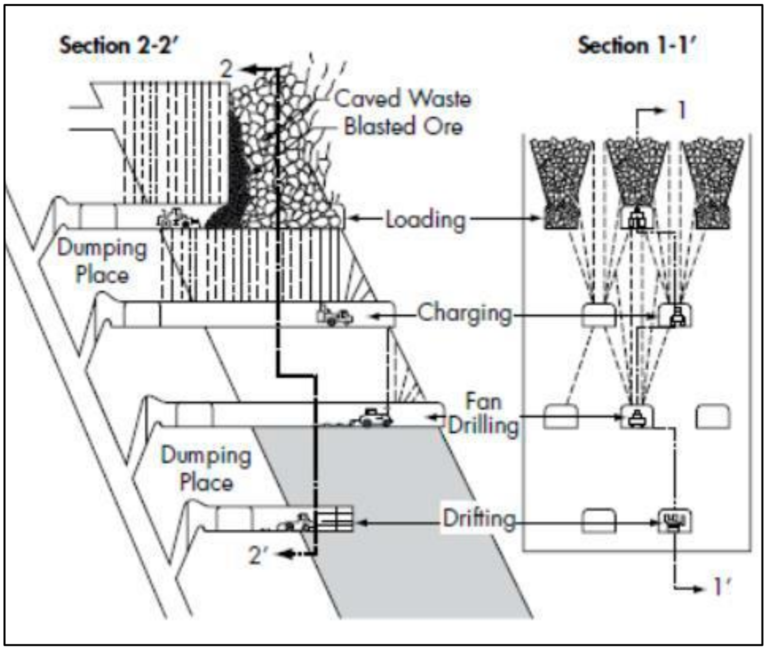


FIGURE 24. SUBLEVEL CAVING CONVENTIONAL VERSION (KVAPIL, 1992)

Sublevel Stoping

Sublevel Stoping is a mining method in which the mineral is excavated through vertical fans, generating an excavation of larger dimensions called a large house. The uprooted ore is collected and mined in “funnels” or trenches located at the base of the mining unit.

This method is preferably applied in vertical or subvertical tabular deposits with power greater than 10 m, where the edges or contacts of the mineralized body must be regular.

The design of the Sublevel Stoping method considers the following parameters and characteristics:

- Size: Preferably the power of the mineralized body should be greater than 10 m, however, there are cases where the minimum power of the exploitation unit is 3 m.
- Shape: The shape of the mineralized body where the exploitation units will be located should preferably be tabular and regular.

- Dip: The dip of the house must be greater than the angle of repose of the broken material, that is, greater than 50 °.
- Geotechnics: The resistance of the mineralized rock must be moderate to competent, while the box rock (HW-FW) must be competent to avoid increasing external dilution. The characteristics of the mineral will determine the size of the pillars and blocks, which affect the productivity of the exploitation unit (Pakalnis 2002).
- Pillar Size: The purpose of the pillars is to support and divide the large houses, within the mineralized body. The size of the pillars is dependent on the induced stresses, structures, quality of the rock mass and operational conditions.
- House Light: The light is designed to control external dilution and prevent collapse of the houses or “air blast”. The length of the light is mainly governed by the quality of the hanging wall (HW).
- Selectivity: The selectivity of the method is limited by areas with sterile material, which can be incorporated as abutments. Changes that occur in the geometry of the mineralized body can be addressed by modifying the drilling pattern at each sublevel.

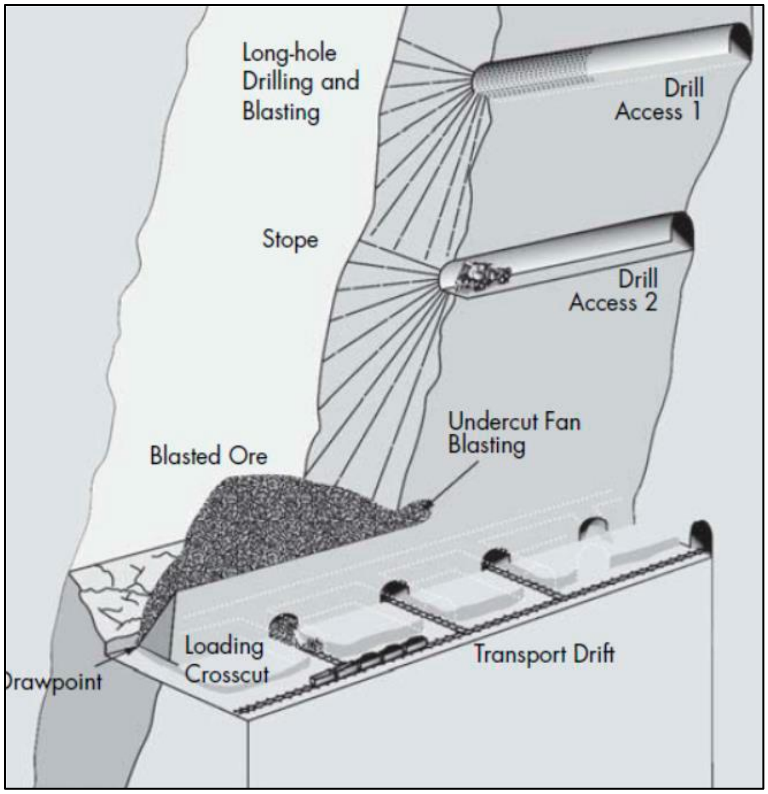


FIGURE 25. SUBLEVEL STOPING CONVENTIONAL VERSION (HAMRIN, 2001)

Block Caving

In this method the mineral is fractured by itself, as a result of internal forces and efforts; minimal drilling and blasting is required in production. The mine plan is divided into large sections or blocks, generally with a horizontal square section of more than 1,000 square meters (11,000 square feet); each block is completely cut by a horizontal cut that is dug at the bottom of the block.

Gravitational forces are on the order of millions of tons acting on the rock mass, thus causing fracturing of the rock.

Application conditions.

The block caving is used in large and massive bodies and with the following characteristics:

- The body must have a high dip, it must be vertical and of great extension.
- After cutting the rock must be able to break into suitable fragments.
- Surface conditions must allow subsidence of the excavated area.
- The mineral must be homogeneous and scattered.

These conditions limit the application of the method; Looking at global practices, we see the block sinking used in low-grade copper, iron ore, and molybdenum and diamond mineralization.

Justification and background

- This method is applicable due to its low production cost compared to other methods.
- Unit drilling and blasting are reduced.
- The method is applied to stratiform or massive reservoirs with pronounced dip and low grade.
- This system offers high production in each start cycle, it also has great fragmentation due to the action of gravity.

Development

The preparatory work for the sinking of blocks consists of:

- Freight or transport galleries regularly arranged under the block.
- A grill level is developed to control fragmentation and when secondary blasting is necessary.
- The “ore pass” are located at the level of the chute
- The “raise fingers” are developed in the form of cones at the cutting level.

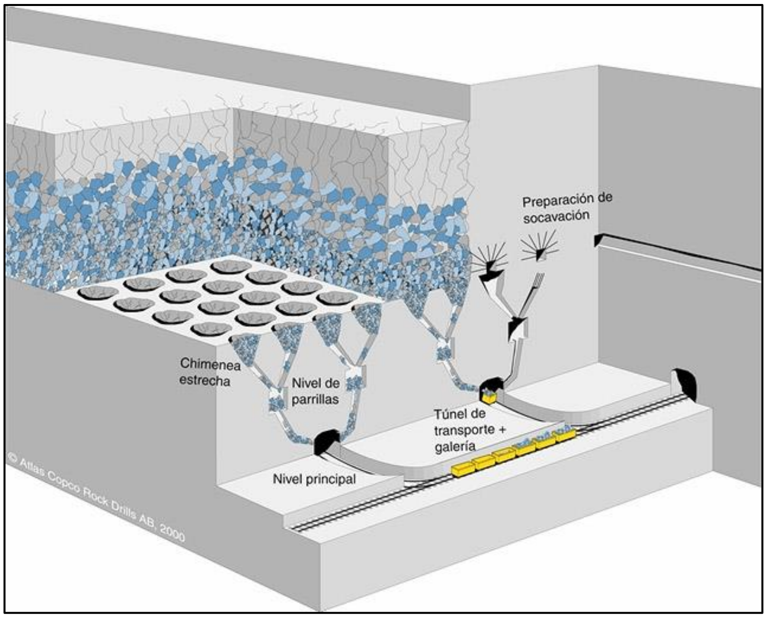


FIGURE 26. BLOCK CAVING SCHEME

Trade-off mining methods

For the selection of the mining method, an economic analysis was performed with the available resources. According to the costs of each method of exploitation, a cutoff grade was obtained, which when analyzed on the tonnage-grade curve indicated the amount of resource for each method of exploitation.

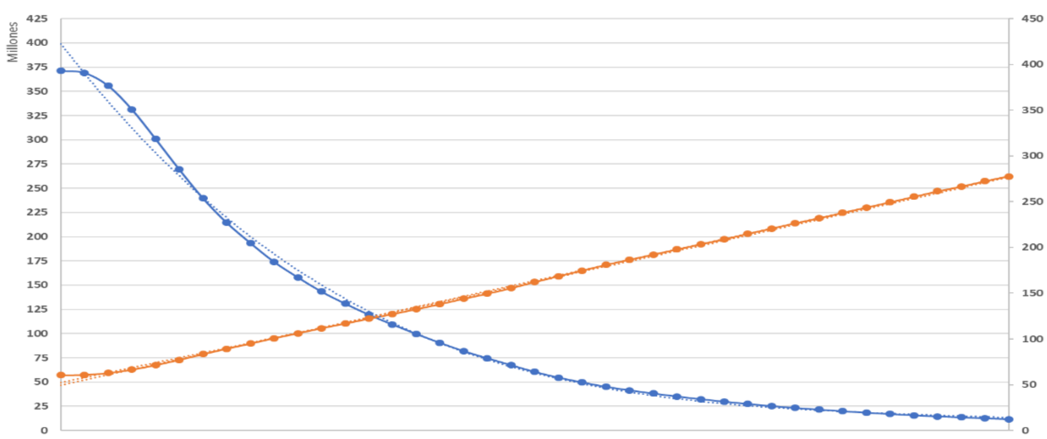


FIGURE 27. TONELAGE CURVE (BLUE) - LAW (RED) FOR MEASURED AND INDICATED RESOURCES OF THE CORANI PROJECT

To determine the life of the mine, the Taylor rule formulas were applied to determine optimal mine life and optimal plant size. This was applied for each of the methods since each method has a different cut-off grade and therefore a different amount of resources. After this, an economic analysis was performed where an investment was estimated for each of the methods.

Table 16. Trade-off analysis of underground mining methods

SELECTION OF THE MINING METHOD						
INPUTS						
Price Ag:	18.100	US$ / Oz				
Cost F&R:	1.500	US$ / Oz				
Mine Life in Years				11	15	16
Description			Units	SLS	SLC	BK
COSTS (Input)						
Mining Cost			$/TM	29.4	20.3	16.9
Plant/Process Cost			$/TM	13.1	10.3	9.7
G&A Cost			$/TM	4.5	4.5	4.5
Others (10%)			$/TM	4.7	3.5	3.1
STOCKPILES						
Cut Law			gr Ag	147.1	110.1	97.5
Tonnage			TM	18,412,298	53,779,426	71,173,980
Ag Law			gr	215.06	173.34	159.31
Plant Capacity			tpd	4,650	9,959	12,357
CAPITAL						
Mine Investment (P&D)			M US$	24	52	65
Plant Investment			M US$	58	124	154
Total Investment			M US$	83	177	220
RESULTS (ordered from lowest to highest NPV)						
NPV			M US$	183.8	415.2	505.6
IRR			%	49%	44%	43%
NPVI				2.22	2.35	2.30

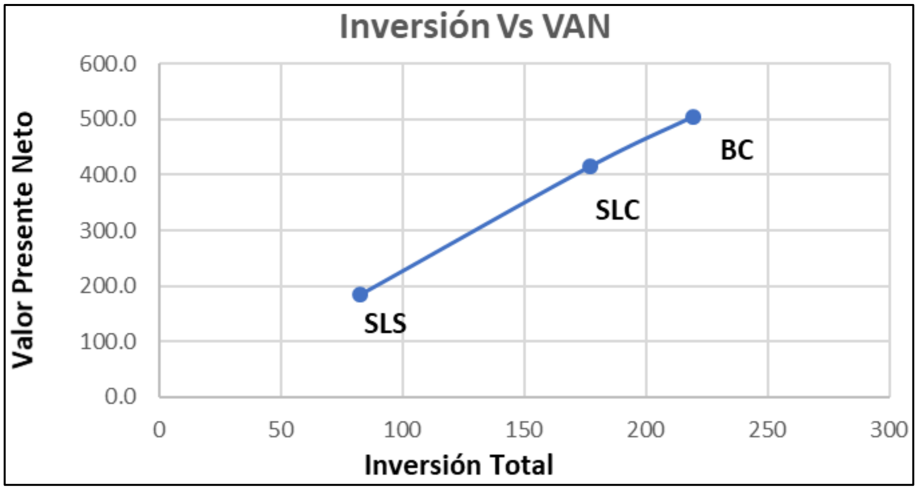


FIGURE 28. INVESTMENT VS NPV FOR EACH EXPLOITATION METHOD

Trade-Off result

After our analysis, we determined that the method to be applied is Sublevel Caving, because although it is not the one that generates the highest NPV, but it has a higher IRR with respect to the method that generates the greatest utility. In addition, massive methods such as Block Caving are not yet widely applied in Peru, so there may be difficulties when applying them.

Optimal Plant Capacity Analysis

Plant capacity has been defined after an analysis of higher return on investment. The following values have been considered for our calculation:

Table 17. Assumed Values for Plant Capacity Analysis

Investment		
Fixed investment	118'000'000	$
Variable investment	79.4	$/t
Variable costs	31.2	$/t
Fixed costs	1280000	$
Mineral Value	55.6	$/t
Discount rate	10	%
Days x year	360	días

Table 18. Values obtained - Plant Capacity Sensitivity

Plant Capacity	4000	5000	6000	7000	8000
Lifetime	25.214269	20.17141556	16.809513	14.408154	12.607135
Annual Income	80064000	100080000	120096000	140112000	160128000
Annual Costs	46208000	57440000	68672000	79904000	91136000
Operating margin	33856000	42640000	51424000	60208000	68992000
Present value	307943938	364045451	410636369	449582747	482449871
Investment	232336000	260920000	289504000	318088000	346672000
NVP	75607938	103125451	121132369	131494747	135777871

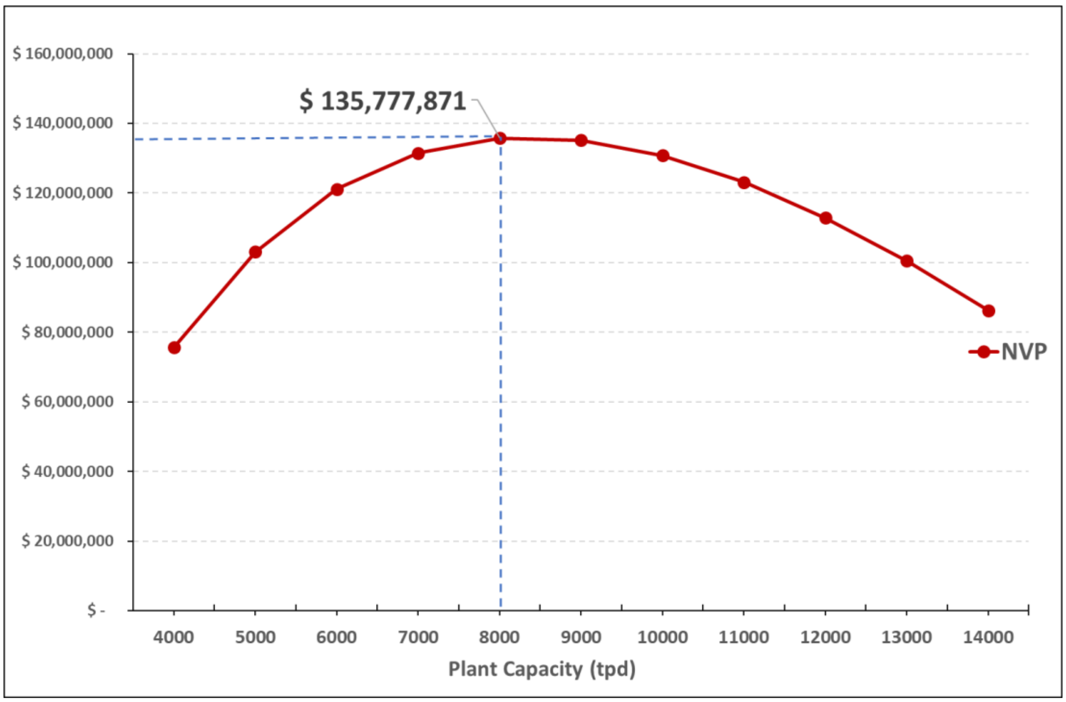


FIGURE 29. PLANT CAPACITY FULL ANALYSIS

Requirement of mining equipment

With the input parameters and the technical data of the mining equipment, the number of equipment to be used within the mining operation will be estimated.

15.4.1. Production LHD

First, we have to obtain the density of loose material, which is calculated as follows:

Loose material density = $\frac{Rock\ In\ Situ\ density}{1+Fluffing\ Factor} = \frac{2.01}{1+18\%}$ *t/m3 = 1.70 t/*m^3

Second, the total time the equipment takes to load and carry is calculated, for this we consider the KPIs of the factory equipment, which gives us the loading time = 1.5 min and the maneuvering time = 0.5 min.

We proceed to calculate the total time:

Total time = charging time + maneuvering time + travel time of loaded equipment + travel time of empty equipment

Total Time = = 1.5 min + 0.5 min + [$\frac{Loaded\ Distance}{Loadeed\ Speed}$ */ Units conversion (km/h to m/ min)] + [* $\frac{Empty\ Distance}{Empty\ Equipment\ Speed}$ */ Units conversion (km/h to m/ min)]*

Total Time = = 1.5 min + 0.5 min + [$\frac{60\ m}{24\ km/hr} / \frac{1000\ m}{60\ min}$ *] + [* $\frac{60\ m}{30\ km/hr} / \frac{1000\ m}{60\ min}$ *] = 2.27 min/cycle*

Number of Cycles= $\frac{60\ min/hr}{Total\ Time} = \frac{60\ min/hr}{2.27\ min/ciclo}$ *= 26.4 cycles/hr*

We proceed to calculate the load per cycle, as follows:

Load per cycle = Bucket capacity * Bucket fill factor * Loose material density

Load per cycle = 3.7 m^3 * 0.88 * 1.7 t/m^3 = 5.5 t / cycle

Then, we calculate the hourly performance as follows

Hourly performance = Number of cycles * Load per cycle = 26.4 cycles / hour * 5.5 t / cycle = 147 t / cycle

We proceed to calculate the operational performance:

Operating performance = Hourly performance * Utilization * Operational factor * Hours of work per shift * Number of shifts

Operating Performance = 147 t / hr * 0.9 * 0.8 * 12 hr * 2 = 2533 TPD

And finally, we calculate the number of production LHDs:

Number of Equipment = Daily Productivity / Operating Yield = 8000 TPD / 2533 TPD = 3.2

Equal to 4 Production LHD

Table 19. Analysis of Production LHD requirements

SANDVIK LH307 Cargo Equipment		
Annual productivity	2,880,000	Tpa
Daily productivity	8,000	Tpd
Hours of work per shift	12	Hr
Number of shifts	2	
Bucket capacity	4.84	yd3
Bucket capacity	3.70	m3
Bucket Fill Factor	0.88	
In Situ Rock Density	2.01	t/m3
Fluffing factor	18.0%	
Loose material density	1.70	
Total time	2.27	min/cycle
Loading time	1.5	Min
Maneuvering time (unloading, turning)	0.5	Min
Team travel time	0.2	Min
Loaded distance	60	M
Loaded speed	24	km/hr
Return time	0.1	Min
Empty distance	60	M
Empty equipment speed	30	km/hr
Operational delay	0	Min
Number of cycles	26.4	cycles/hour
Load per cycle	5.5	t/cycle
Hourly performance	147	Tonnage/hour
Utilization	0.9	
Operational factor	0.8	
Operational performance	2533	Tpd
Number of teams	3.2	
Number of teams	4	

15.4.2 Advance LHD

First, we have to obtain the daily production and the loose material density, which is calculated as follows:

Daily production = Daily advance * Section area = 120 m * 25 m^2 = 3000 m^3

Loose material density = $\frac{Rock\ In\ Situ\ density}{1+Fluffing\ Factor} = \frac{2.75}{1+18\%}$ *t/m3 = 2.33* t/m^3

Second, the total time the equipment takes to load and carry is calculated, for this we consider the KPIs of the factory equipment, which gives us the load time = 2 min, the maneuver time = 1.5 min and the operational delay = 1 min.

We proceed to calculate the total time:

Total time = charging time + maneuvering time + travel time of loaded equipment + travel time of empty equipment + operational delay

Total Time = = 2 min + 1.5 min + [$\frac{Loaded\ Distance}{Loadeed\ Speed}$ */ Units conversion (km/h to m/ min)] + [* $\frac{Empty\ Distance}{Empty\ Equipment\ Speed}$ */ Units conversion (km/h to m/ min)] + 1 min*

Total Time = = 1.5 min + 0.5 min + [$\frac{80\ m}{26\ km/hr} / \frac{1000\ m}{60\ min}$ *] + [* $\frac{80\ m}{30\ km/hr} / \frac{1000\ m}{60\ min}$ *] + 1 min = 4.8 min/cycle*

Now the number of cycles is calculated, as follows:

Number of Cycles = $\frac{60\ min/hr}{Total\ Time} = \frac{60\ min/hr}{4.8\ min/cycle}$ *= 12.4 cycles/hr*

We proceed to calculate the load per cycle, as follows:

Load per cycle = Bucket capacity * Bucket fill factor * Loose material density

Load per cycle = 10.7 m^3 * 0.9 * 2.33 t/m^3 = 22.4 t / cycle

Then, we calculate the hourly performance as follows

Hourly performance = Number of cycles * Load per cycle = 12.4 cycles / hour * 22.4 t / cycle = 278 t / cycle

We proceed to calculate the operational performance:

Operating performance = Hourly performance * Utilization * Operational factor * Hours of work per shift * Number of shifts

Operating Performance = 278 t / hr * 0.9 * 0.8 * 12 hr * 2 = 4805 TPD

And finally, we calculate the number of advance LHDs:

Number of Equipment = Daily Productivity * Loose Material Density / Operating Yield = 3000 m ^ 3 * 2.33 t / m ^ 3/4805 TPD = 1.5

Equal to 2 Advance LHD

Table 20. Analysis of Advance LHD Requirements

SANDVIK LH621i Carguio Kit		
Dairy produce	3,000	m3
Section area	25	m2
Base	5	M
Height	4.5	M
Hours of work per shift	12	Hr
Number of shifts	2.00	
Bucket capacity	14	yd3
Bucket capacity	10.7	m3
Bucket Fill Factor	90%	
In Situ Rock Density	2.75	t/m3
Fluffing factor	0.18	
Loose material density	2.33	
Total time	4.84	min/ciclo
Loading time	2.0	Min
Maneuvering time (unloading, turning)	1.5	Min
Team travel time	0.2	Min
Loaded distance	80.0	M
Loaded speed	26	km/hr
Return time	0.16	Min
Empty distance	80	M
Empty equipment speed	30.0	km/hr
Operational delay	1.0	Min
Number of cycles	12	ciclos/hora
Load per cycle	22.4	t/ciclo
Hourly performance	278	Tonelada/hora
Utilization	1	
Operational factor	0.8	
Operational performance	4805	Tpd

Number of teams	2

15.4.3 Production JUMBO

We consider technical data such as drilling speed and drilling ratio of mining equipment in the equations.

We proceed to calculate the operational performance:

Operating Performance = Drilling Speed * Utilization * Operational Factor * Hours of work per shift * Number of shifts

Operating Performance = 35 m / hr * 0.9 * 0.8 * 12 hr * 2 = 605 m / day

We proceed to calculate the need for drilling, as follows:

Drilling need = Daily productivity / Drilling ratio = $\frac{8000\ TPD}{8\ T/m} = 1000\ m/day$

And finally, we calculate the number of production Jumbos:

Number of Equipment = Need for Drilling / Operating Performance = $\frac{1000 m/día}{605 m/día}$= *1.7*

Equal to 2 production Jumbos.

Table 21. Analysis of Production JUMBO requirements

Equipo de Perforación SANDVIK DU412i		
Annual productivity	2,880,000	tpa
Daily productivity	8,000	tpd
Hours of work per shift	12	hr
Number of shifts	2	
Drilling speed	35.00	m/hr
Utilization	0.9	

Operational factor	0.8	
Operational performance	60480%	m/day
Drilling ratio	8.00	ton/m
Need for drilling	1000	m/day
Number of teams	1.65	
Number of teams	2.00	

15.4.2 Advance JUMBO

We consider technical data such as drilling speed and drilling ratio of mining equipment in the equations.

We proceed to calculate the operational performance:

Operating Performance = Drilling Speed * Utilization * Operational Factor * Hours of work per shift * Number of shifts * 30

Operating Performance = 25 m / hr * 0.9 * 0.8 * 12 hr * 2 * 30 = 12960 m / month

We proceed to calculate the need for drilling, as follows:

Drilling need = Daily productivity / Drilling ratio= $\frac{240\ m}{0.0150\ m} = 16000\ m$

And finally we calculate the number of advance Jumbos:

Number of Equipment = Need for Drilling / Operating Performance = 16000 / (12960m / month) = 1.2

Equal to 2 advance JUMBO

Table 22. Analysis of Production JUMBO requirements

Drilling equipment SANDVIK DD422Ie		
Annual advance	2,880	M
Monthly advance	240	Drilled m
Hours of work per shift	12	Hr
Number of shifts	2	
Drilling speed	25.00	m/hr
Utilization	0.9	

Operational factor	0.8	
Operational performance	1296000%	m/month
Drilling ratio	0.02	Drilled m / Advance m
Need for drilling	16000	M
Number of teams	1.23	
Number of teams	2.00	

15.4.4 Production DUMPER

First, the total time that the equipment takes to carry is calculated, for this we consider in the equations the technical data of the factory equipment that gives us the loading time = 12 min, the unloading time = 3 min and the waiting time = 2 min.

We proceed to calculate the total time:

Total time = charge time + discharge time + equipment travel time + return time + waiting time.

Total time = = 12 min + 3 min + [$\frac{Loaded\ Distance}{Loadeed\ Speed}$ / Units conversion (km/h to m/ min)] + [$\frac{Empty\ Distance}{Empty\ Equipment\ Speed}$ / Units conversion (km/h to m/ min)] + 2 min

Total Time= = 12 min + 3 min + [$\frac{3000\ m}{30\ km/hr} / \frac{1000\ m}{60\ min}$] + [$\frac{3000\ m}{35\ km/hr} / \frac{1000\ m}{60\ min}$] *+ 2 min = 28.1 min/cycle*

Now the number of cycles is calculated, as follows:

Number of Cycles = $\frac{60\ min/hr}{Total\ Time} = \frac{60\ min/hr}{28.1\ min/cycle}$ *= 2.1 cycles/hr*

We proceed to calculate the load per cycle, as follows:

Load per cycle = Hopper capacity = 60 t / cycle

Then, we calculate the hourly performance as follows

Hourly performance = Number of cycles * Load per cycle = 2.1 cycles / hour * 60 t / cycle = 128 t / hr

We proceed to calculate the operational performance:

Operating performance = Hourly performance * Utilization * Operational factor * Hours of work per shift * Number of shifts

Operating Performance = 128 t / hr * 0.9 * 0.85 * 12 hr * 2 = 2349 TPD

And finally, we calculate the number of production trucks:

Number of Equipment = Daily Productivity / Operating Performance = 2349 TPD / 4805 TPD = 3.4

Equal to 4 production trucks.

Table 23. Analysis of Production TRUCK requirements

Equipo de Acarreo SANDVIK TH663i		
Annual productivity	2,880,000	tpa
Daily productivity	8,000	tpd
Hours of work per shift	12	hr
Number of shifts	2	
Hopper capacity		
Total time	28	min/cycle
Charging time	12	min
Download time	3	min
Team travel time	6	min
Loaded distance	3000.00	m
Loaded speed	30	km/hr
Return time	5.1	min
Empty distance	300000%	m
Empty equipment speed	35.00	km/hr
Wait time	2	min
Number of cycles	2.13	cycles/hour
Load per cycle	60.00	t/ciclo
Hourly performance	127.9	Tonnage /hour
Utilization	0.9	
Operational factor	0.9	
Operational performance	2348.6	tpd
Number of teams	3.4	
Number of teams	4	

15.4.4 Advance DUMPER

First, we have to obtain the daily production and the loose material density, which is calculated as follows:

Daily production = Daily advance * Section area = 120 m * 25 m^2 = 3000 m^3

Second, the total time that the equipment takes to carry is calculated, for this we consider the KPIs of the factory equipment that gives us the loading time = 12 min, the unloading time = 3 min and the waiting time = 2 min.

We proceed to calculate the total time:

Total time = charge time + discharge time + equipment travel time + return time + waiting time.

Total time = = 12 min + 3 min *+ [* $\frac{Loaded\ Distance}{Loadeed\ Speed}$ */ Units conversion (km/h to m/ min)] + [* $\frac{Empty\ Distance}{Empty\ Equipment\ Speed}$ */ Units conversion (km/h to m/ min)] + 2 min*

Total Time= = 12 min + 3 min + [$\frac{3000\ m}{30\ km/hr}$ / $\frac{1000\ m}{60\ min}$ *] + [* $\frac{3000\ m}{35\ km/hr}$ / $\frac{1000\ m}{60\ min}$ *] + 2 min = 28.1 min/cycle*

Now the number of cycles is calculated, as follows:

Number of Cycles = $\frac{60\ min/hr}{Total\ Time}$ = $\frac{60\ min/hr}{28.1\ min/cycle}$ *= 2.1 cycles/hr*

We proceed to calculate the load per cycle, as follows:

Load per cycle = Hopper capacity = 60 t / cycle

Then, we calculate the hourly performance as follows

Hourly performance = Number of cycles * Load per cycle = 2.1 cycles / hour * 60 t / cycle = 128 t / hr

We proceed to calculate the operational performance:

Operating performance = Hourly performance * Utilization * Operational factor * Hours of work per shift * Number of shifts

Operating Performance = 128 t / hr * 0.9 * 0.85 * 12 hr * 2 = 2349 TPD

And finally, we calculate the number of production trucks:

Number of Equipment = Daily Productivity / Operating Performance = 2349 TPD / 3000 TPD = 1.3

Equal to 2 production trucks.

Table 24. Analysis of Advance TRUCK requirements

Equipo de Acarreo SANDVIK TH663i		
Daily advance	120	m
Dairy produce	3,000	m3
Section area	25	m2
Base	5.00	m
Height	4.5	m
Hours of work per shift	12.0	hr
Number of shifts	200%	
Hopper capacity	60	Ton
Total time	28.14	min/cycle
Charging time	12.00	min
Download time	3.0	min
Team travel time	6	min
Loaded distance	3000.0	m
Loaded speed	30.0	km/hr
Return time	5.14285714	min
Empty distance	3000	m
Empty equipment speed	35	km/hr
Wait time	2.0	min
Number of cycles	2.1	cycles/hour
Load per cycle	60	t/ciclo
Hourly performance	127.9	Tonnage/hour
Utilization	1	
Operational factor	1	
Operational performance	2348.6	tpd
Number of teams	3	
Number of teams	3	

15.4.4 Injector, Expellent, and Auxiliary Fans

Table 25. Analysis of fan requirements

Equipment	Equipment(US$)	Units	Useful life	(US$/ton)
Injector fan	1000000	4	10	0.06
Extractor fan	600000	4	10	0.04
Auxiliary Fan	40000	8	10	0.00
Total				0.10

Summary requirement of mining equipment

A large presence of the fleet of loading, hauling and drilling equipment manufactured by the SANDVICK brand and the presence of ventilation equipment manufactured by the AIR-TEC company can be observed.

Table 26. (A) Summary of mining equipment to be used

Preparation	Capacity	Units
LHD	4.84 yd3	2
JUMBO	43'	2
TRUCK	60 ton	3
AUXILIARY FAN	20 kW	8
BOLTERS	24'	5
SCALERS	37'	5
SHOTCRETE MIX	20 m3/ h	2
	Total	27

Table 27. (B) Summary of mining equipment to be used

Production	Capacity	Units
LHD	14 yd3	2
JUMBO	43'	2
TRUCK	60 ton	3
INJECTOR FAN	122.18 kW	8
EXTRACTOR FAN	47.13 Kw	4
	Total	19

CHAPTER 16: METHODS OF METALLURGICAL PROCESSING AND RECOVERY

16.1 PROCESSING METHOD

The project site is located on high-altitude terrain with a steep slope that has limited flat space. These considerations require special attention to develop acceptable spaces for facilities. The development of the site layout considered maximizing ease of operation and minimizing both capital and operating costs.

The Corani project's processing facility is based on a two-phase sequential flotation concentrator, generating two products: a silver-enriched lead concentrate and a zinc concentrate with a slight presence of silver.

The plant design incorporates the following process areas:

- Primary crushing and thick stock pile.
- SAG grinding, followed by ball grinding.
- Selective lead-zinc flotation.
- Thickening and filtering of concentrates (Pb-Zn).
- Thickening and filtering of tailings.
- Tailings dry storage system.
- Preparation of reagents and auxiliary facilities.

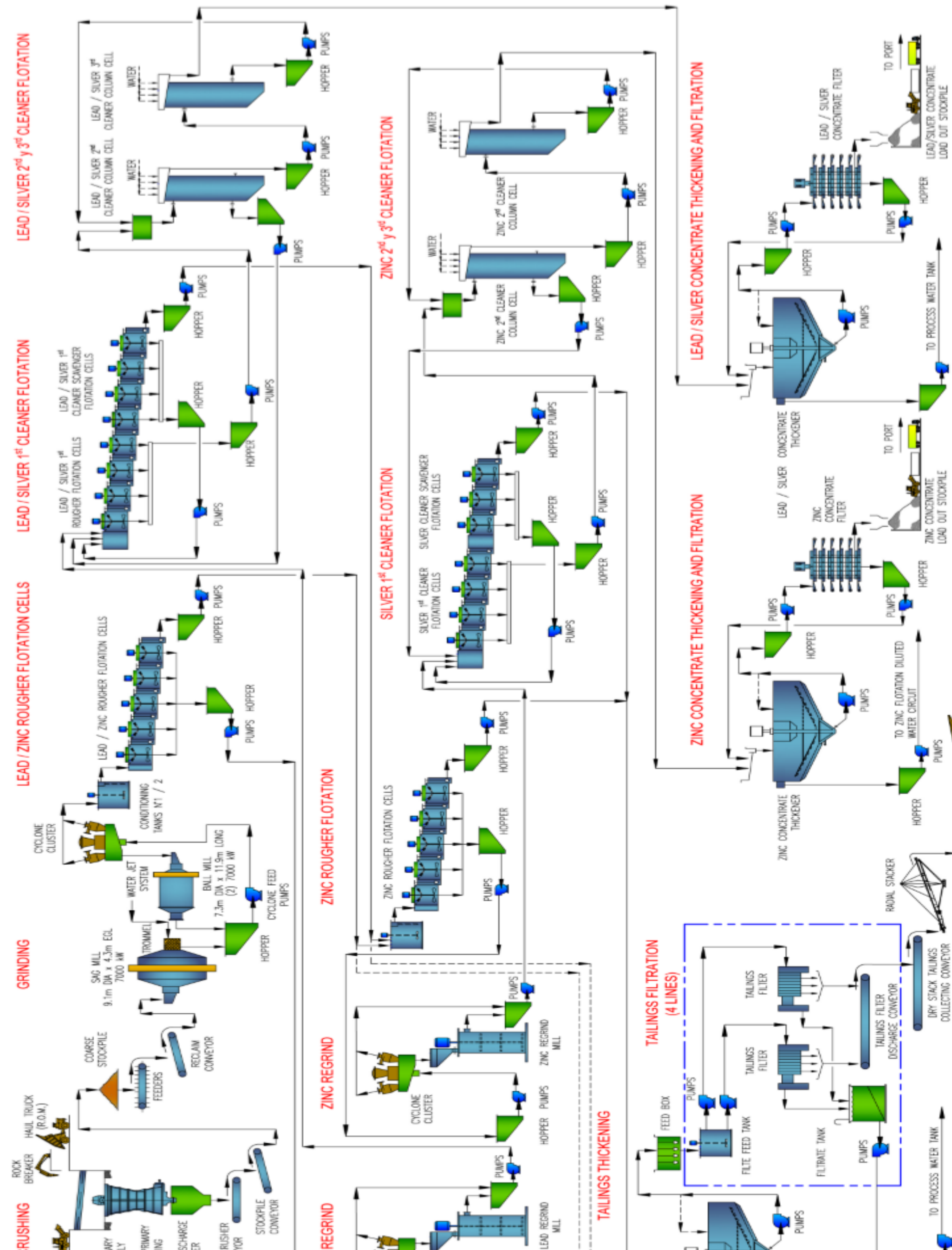


FIGURE 30. PROCESS FLOW DIAGRAM FOR THE CORANI PROJECT

Processing Design Criterion

The metallurgical testing campaigns carried out from 2006 to 2015 have produced variable recoveries of the metals of interest to the project (Ag, Pb and Zn).

Parameters that influence recovery are:

For lead recovery:

- Lead in the Head Act.
- Elevation of the mine.
- Percentage of galena present vs. Lead phosphates.
- Amount of oxides present (Fe, MnO).

For Zinc recovery

- Zinc grade on the head.
- Elevation of the mine.
- Pyrite law on the head.

The following tables present the main criteria used for the design of the processing.

Table 28. Design criteria for primary crushing and transport.

	Value	Unit
Production rate	22,500	tpd
Availability	70	%
Ore Crushing rate, Design	1,339	tph
Crushing Feed F100	1,000	mm
Crushing Feed F80	460	mm
Crushing Product P80	150	mm
Mine Truck	135	t
Downloading Point	2	not simultaneous
Moisture	3	%

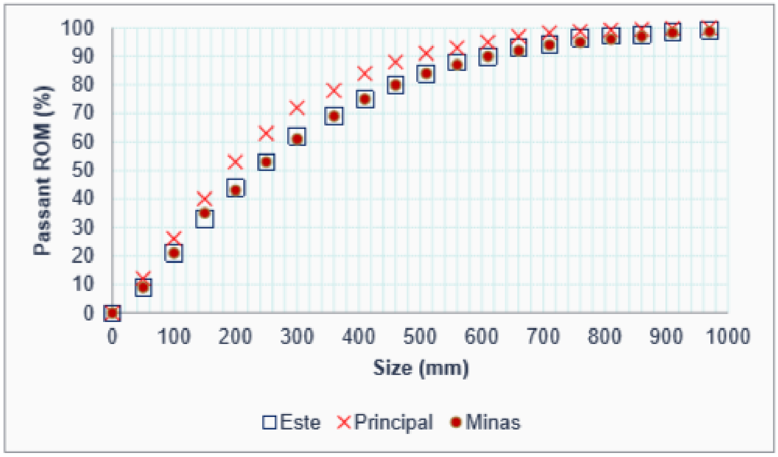


FIGURE 31. SIZE DISTRIBUTION OF ROM PARTICLES

Table 29. Design criteria for the thick pile stock.

	Value	Unit
Total Capacity	44,530	t
Live Capacity	11,250	t
Feeders	3	units
Moisture	4	%

Table 30. Design criteria for SAG grinding.

	Value	Unit
Production rate	22,500	t/d
Availability	92	%
Feed F80	150	mm
Product T80	1,180	µm
SAG Mill feed rate	1,019	t/h
Critical Speed	75	%
Circuit, type	open	---
Density	75	%
Pebble Generation, max	25	%
Pebble recycling system	Water Jet	---

Tabla 31. Criterio de diseño de la molienda de bolas.

	Value	Unit
Circuit Type	Closed	
Critical Speed	78	%
Availability	92	%
Fresh Feed	1,019	t/h
Feed F80	2,700	µm
Product P80	90	µm
Slurry Density	70	% w/w
Ball Load	37	%

Table 32. Design criteria for hydrocyclones.

	Value	Unit
Number (operating/stand-by)	8 / 2	Units
Circulating Load	350	%
Overflow	32	%
Cyclones O/F P80	90	µm

Table 33. Design criteria for lead flotation.

	Laboratory	Factor	Holding up
Rougher	12 min	2.5	15%
First Cleaner	5 min	2.5	10%
Cleaner-Scavenger	6 min	2.5	10%

Table 34. Design criteria for zinc flotation.

	Laboratory	Factor	Holding up
Rougher	12 min	2.2	15%
First Cleaning	6 min	2.0	10%
Scavenger	5 min	2.0	10%

Table 35. Design criteria for column cells.

	Lead Flotation	Zinc Flotation	Unit
Slurry Speed	10 – 48	10 - 48	m/h
Froth Carry	2 – 4	2 - 4	$g/min/m^2$
Lifting Capacity	2	2	$t_{conc}/h/m^2$
Number of Cells	1	1	
pH	6 - 7	11,5	

Table 36. Design criteria for thickening of concentrates.

	Lead	Zinc	Unit
Quantity	1	1	
Type	High Rate	High Rate	
Specific Capacity	1.1 (7)	0,7 (7)	$m^3/m^2/h$
pH	6 – 7	11	
Slurry Density (U/F)	65	65	% w/w

Table 37. Design criteria for tailings thickening

	Value	Unit
Quantity	1	
Type	High Rate	
Specific Capacity	0.5	$t/h/m^2$
pH	11	
Pulp Density (U/F)	55 - 60	% w/w

Table 38. Design criteria for filtering concentrates.

	Lead	Zinc	Unit
Head Tank	1	1	Units
Residence Time	8.5	9.8	H
Filters Quantity	1	1	Units
Type	Vertical High Pressure	Vertical High Pressure	
Specific Capacity	0.566 (8)	0.456 (8)	$t/h/m^2$
pH	6	12	
Pulp Density	65	65	% w/w
Final Moisture	8	8	% w/w

Table 39. Design criteria for tailings filtering.

Tailings Filtration	Value	Unit
Head Tank	4	units
Residence Time	1.5	h
Filters Quantity	8	Units
Type	Horizontal High Pressure	
Specific Capacity	0.145 (9)	$t/h/m^2$
pH	11	
Pulp Density	55	% w/w
Moisture	17	% w/w
Tailings filtrate tank	1	units
Residence Time	18	min

Table 40. Consumption of reagents.

Reagents	Value	Unit
Sodium Isopropyl Xanthate (SIPX)	40	g/t
A404	15	g/t
Zinc Sulfate	620	g/t
Sodium Cyanide	210	g/t
Copper Sulfate	290	g/t
Methyl Isobutyl Carbinol (MIBC)	50	g/t
Sodium Sulfite	505	g/t
Sodium Hydroxide	10	g/t
Flocculant	20	g/t
Antiscalant	5	g/t

Table 41. Other consumables.

Consumables	Value	Unit
Primary Crusher Liners	8	g/t
SAG Mill Liners	50	g/t
SAG Mill Balls (5”)	500	g/t
Ball Mill Liners	30	g/t
Ball Mill Balls (2” – 3”)	500	g/t
Regrind Balls	20	g/t
Regrind Mill Liners	10	g/t

16.2 Metallurgical recovery

The processing design assumes the following global recoveries for lead, zinc and silver by concentrates (lead and zinc concentrates).

Table 42. Global recoveries by type of concentrate.

Concentrate	Lead, %	Zinc, %	Silver, %
Lead Concentrate	61.15	---	50.42
Zinc Concentrate	---	66.97	20.33
Total	61.15	66.97	70.75

These recoveries were used only to generate the mass balance and not for the calculation of metallic recoveries in the financial model, according to the 2015 study.

CHAPTER 17: PROJECT INFRASTRUCTURE

17.1 Access route

The access road for the construction of the Corani project will be the existing access that will be improved. This will be a 42 km access that connects to the interoceanic highway that connects to the Port of Matarani with 632 km. The Interoceanic Highway is paved and has two lanes.

17.2 Shipping Port

The Matarani port has facilities for the shipment of concentrates, this port is used by the Antapacay Mine, Las Bambas, and Cerro Verde.

17.3 Power supply

The project requires a 138 kV power transmission line. The new substation will connect with the San Gabán II - Azángaro power transmission line.

The power will be distributed in 13.8kV from the Corani main substation. The electrical lines will be aerial, and underground for the plant and administration area.

For the camp, a 13 km line of 13.8 kV transmission line is needed.

CHAPTER 18: MARKET STUDY AND CONTRACTS

18.1 International Quotes for Silver, Copper, Lead and Zinc

To consider a long-term sale value (LOM), the cycles of the metals: Silver, Copper, Lead and Zinc have been analyzed. Defining for one of these metals a conservative value, as well as the behavior (probability distribution function).

Let's see in the following figures, the behavior of these metals and their international prices, within the information that is available.

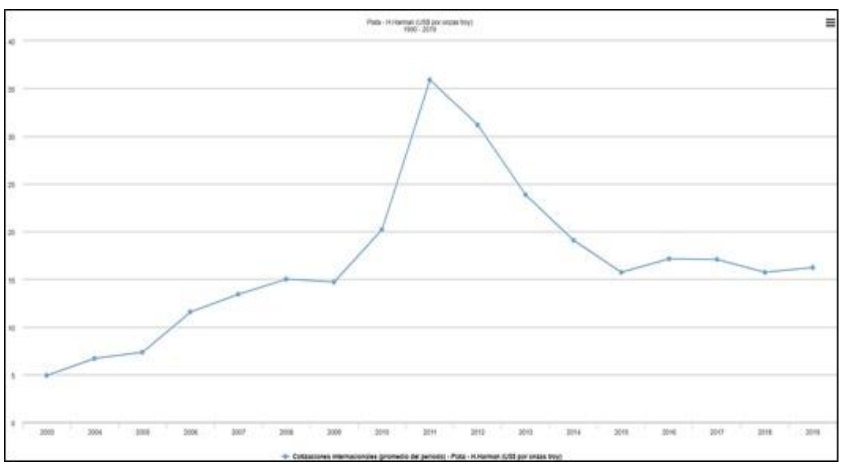


FIGURE 32. SILVER QUOTATION IN AMERICAN DOLLARS BY ONZA TROY

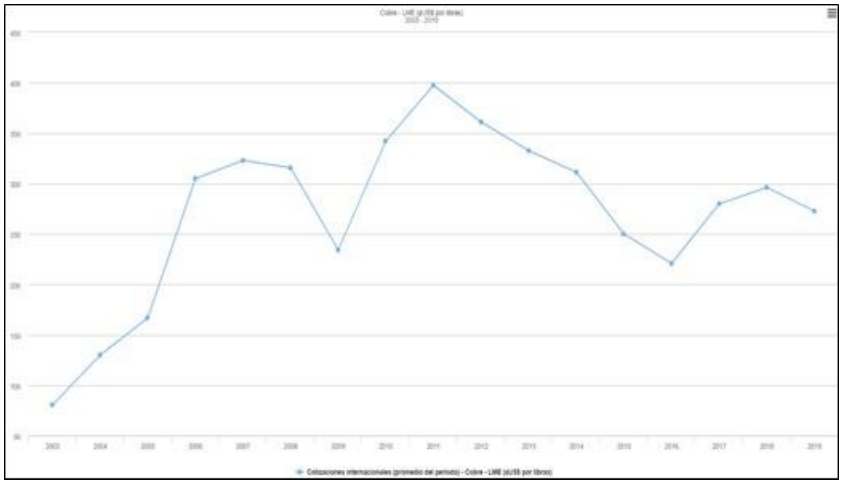


FIGURE 33. COPPER QUOTATION IN CENTRALS OF AMERICAN DOLLAR BY POUND

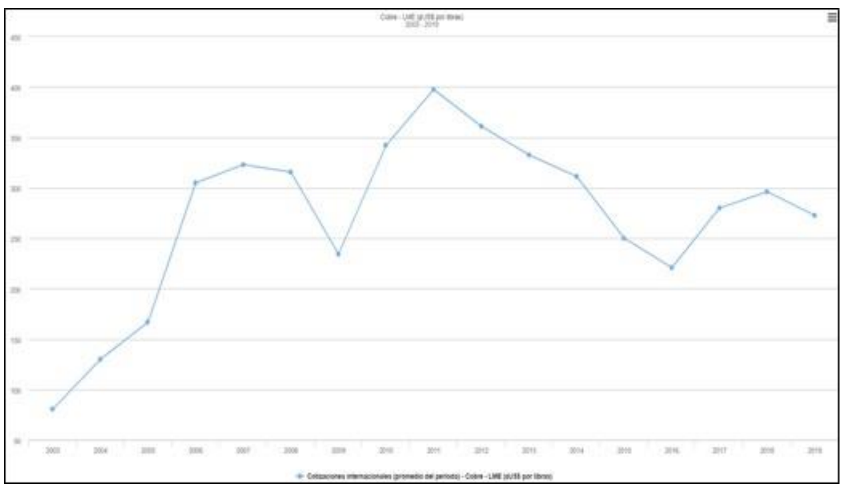


FIGURE 34. ZINC QUOTATION IN CENTRALS OF AMERICAN DOLLAR BY POUND

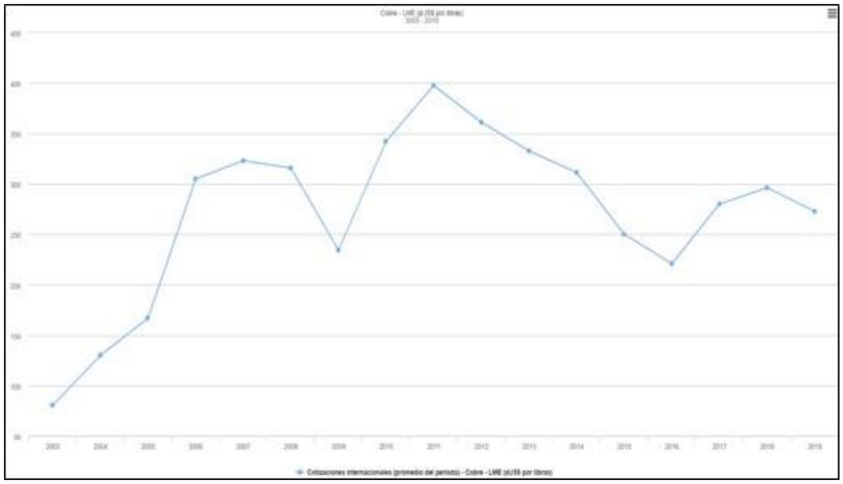


FIGURE 35. LEAD QUOTATION IN **CENTRALS OF AMERICAN DOLLAR BY POUND**

CHAPTER 19: ENVIRONMENTAL STUDIES, PERMITS AND SOCIAL IMPACT

19.1 Environmental studies

The Peruvian Ministry of Energy and Mines (MEM) approved the Environmental Impact Study (EIA) for the Corani Project by means of directorial resolution No. 355-2013-MEMIAAM. The approved EIA is for the operation of an open pit of 20,000 tpd, the company must submit a Modification of the EIA to request underground mining.

19.2 Permission management

For this management the following regulations are shown

a) Mining Property

- Supreme Decree No. 014-92 EM - Approving the Single Ordered Text of the General Mining Law.
- Supreme Decree No. 018-92 EM - Mining Procedures Regulation.
- Law No. 26615 - National Mining Cadastre Law.

b) Surface Property

- Law N ° 27015 - Special Law that Regulates the Granting of Mining Concessions in Urban Areas and Urban Expansion.

c) Mining Exploration

- Supreme Decree No. 018-92 EM - Mining Procedures Regulation.

d) Mining

- Supreme Decree No. 040-2014-EM - Regulation of Environmental Protection and Management for Exploitation, Benefit, General Labor, Transport and Mining Storage Activities.

e) Water Permits

- Supreme Decree No. 006-2010-AG - Approves the Organization and Functions Regulations of the ANA National Authority.
- Supreme Decree No. 001-2010-AG - Approves the Regulation of Law No. 29338, the Law on Water Resources.

f) Pre-Operation Permits

- Supreme Decree No. 024-2016 - Approval of Occupational Safety and Health Regulations in Mining.
- Legislative Decree No. 662
- Legislative Decree No. 757
- Supreme Decree No. 024-93-EM - Approve Regulation of Title Ninth of the General Mining Law, referring to Guarantees and Investment Promotion Measures in mining activity.

g) Operating Permits

- Law No. 30299 - SUCAMEC
- Supreme Decree No. 023-2017 - MINAM
- Law No. 28090: Law regulating the closure of mines
- Supreme Decree No. 014-92-EM - Approving the Single Ordered Text of the General Mining Law

h) Mining Inspection

- Law No. 27474 - Law on the Supervision of Mining Activities
- Supreme Decree No. 082-2002-EF

i) Administrative Management System

- ISO 14001 - Environmental Management System. Although this certification is not a legal requirement, the certification helps to reduce the perception of contamination and impact with rural communities.

The following figure shows the management of permission to develop.

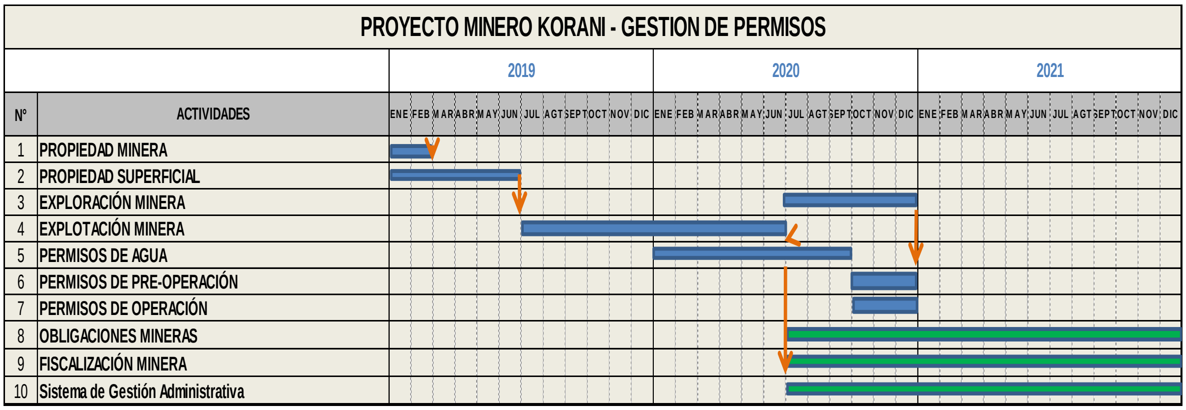


FIGURE 36. PERMIT MANAGEMENT

19.3 Social impact

The social impact of the Corani Project has positive and negative impacts, these are:

Positive impacts:

Indicate benefits (royalties, social investment)

- Satisfactory macroeconomic contribution, currency flow and tax.
- Contribution of Mining Royalties
- Employment generation.
- Local and regional economic development.

Negative impact:

- Environmental liabilities left by mining operations, the deposits of mining residues constitute a health risk.
- Water contamination by mining effluents.

- Many of the abandoned mines where the surface has not been rehabilitated, show a negative image of the business management of old mining.

CHAPTER 20: CAPITAL AND OPERATING COSTS

20.1 CAPITAL COSTS

The capital and operation costs of the Corani Project were based on the mine plan and the design of the process plant. Capital costs were based on estimates for the equipment, materials, labor, and services needed to implement the design. Operating costs were based on estimates of labor, materials, energy, supplies, fuel, and estimates from consultants and potential suppliers to operate the mine and plant as designed.

Table 43 Summary of Capital Costs of the Corani project

Cost per Area	Cost (Millions of $)
General	34.347
Mine	40.057
Infrastructure	45.231
Processing plant	87.787
WWTP	23.731
Energy	1.427
Auxiliary Installations	14.541
Engineering	7.226
Auxiliary services	9.456
Commissioning and Suppliers	8.564
Project Management and Supervision	14.988
Owner Costs	25.515
Contingency and escalation	33.277
Total	**346.152**

20.2 Operating Costs

Table 44 Summary of operating costs of the Corani project

Cost per Area	Cost (Millions of $)
Mine	375.365
Processing plant	511.886
Treatment, Refining and Shipping	315.932
G&A	79.411
Claim and Close	11.4381
Total	**1,294.403**
LOM ROM tonnage	**36,308.459**
Average operating cost	**35.64 $/t**

CHAPTER 21: ECONOMIC ANALYSIS

The financial evaluation presents the determination of the net present value (NPV), the amortization period (time in years to recover the initial capital investment) and the internal rate of return (IRR) for the project.

Annual cash flow projections were estimated over the life of the mine based on estimates of capital expenditures, production costs, and sales revenue. Revenue is based on the production of a zinc-silver concentrate and a lead-silver concentrate.

Explain the Economic model, use of the economic evaluation guide and economic model of the AUSIMM

Mine production

Mining production is reported as ore and waste from the mining operation. Annual production figures were obtained from the mining plan, as previously reported in this report. A total of 38.48 million tons of ore are mined at an average grade of 88.04 g / t silver, 1.42% lead and 0.97% zinc

Plant Production

The design base of the process plant is 9000 tons per day with 96% mill availability. Metal recoveries, which are variable by mineral characteristics, are expected to average 67.1% for zinc, 61% for lead and 69.6% for silver.

Smelter and Refinery Return Factors

The lead and zinc concentrates will be transported to a retention facility in the Matarani port and consolidated for shipment to a smelter for final processing. Charges for smelting and refining treatment will be negotiated upon the completion of the sales agreements.

Income

Revenue is the gross value of metals payable sold before treatment charges and transportation charges. The metal price assumptions used in the economic model are: Zinc $ 1.1 / lb, Lead $ 0.9 / lb and Silver $ 18.1 / oz

Cash flow

Table 45 Economic Evaluation of the Corani project

EVALUACION ECONOMICA PROYECTO CORANI DE 8 000 TPD - NOVIEMBRE 2019

	Units	2019	2020	2021	2030	2031	2032	Total
	Años Operac.		1.0	1.0	1.0	1.0	0.6	19.9
Mineral	**TM**		**2,880,000**	**2,880,000**	**2,880,000**	**2,880,000**	**1,728,000**	**36,288,000**
Ag Grade	**gpt**		**90.48**	**90.55**	**95.21**	**85.67**	**77.79**	**93.762**
Pb Grade	**%**		**1.53**	**1.37**	**1.40**	**1.43**	**1.36**	**1.50**
Zn Grade	%		**0.24**	**0.37**	**1.31**	**1.19**	**1.02**	**1.04**
Total Material	TM		2,880,000	2,880,000	2,880,000	2,880,000	1,728,000	36,288,000
Rec.Metalurgica Ag			69.63%	69.63%	69.63%	69.63%	69.63%	69.6%
Rec.Metalurgica Pb			61.00%	61.00%	61.00%	61.00%	61.00%	61.0%
Rec.Metalurgica Zn			67.07%	67.07%	67.07%	67.07%	67.07%	67.1%
Producción Ag	**ozs**		**5,834,132**	**5,838,711**	**6,138,996**	**5,523,917**	**3,009,602**	**76,177,447**
Producción Pb	**lbs**		**59,371,738**	**53,104,177**	**54,324,318**	**55,520,794**	**31,574,996**	**731,670,316**
Producción Zn	**lbs**		**10,139,096**	**15,886,709**	**55,660,424**	**50,597,302**	**26,038,076**	**555,817,975**
METALES PAGABLES								
Ag Pagable	**95%**		**5,542,426**	**5,546,775**	**5,832,047**	**5,247,721**	**2,859,122**	**72,368,575**
Pg Pagable	**95%**		**56,403,151**	**50,448,969**	**51,608,102**	**52,744,754**	**29,996,246**	**72,368,575**
Zn Pagable	**90%**		**9,125,186**	**14,298,038**	**50,094,382**	**45,537,572**	**23,434,268**	**68,559,703**

Estado de Resultados Proyectados (US$ 000)			2019	2020	2021	2030	2031	2032	Total
Ventas	Precio								
Ventas por Ag	18.1	US$ '000		100,318	100,397	105,560	94,984	51,750	1,309,871
Ventas por Pb	0.9	US$ '000		50,763	45,404	46,447	47,470	26,997	625,578
Ventas por Zn	1.1	US$ '000		10,038	15,728	55,104	50,091	25,778	550,260
Total Ventas		US$ '000		161,118	161,529	207,111	192,545	104,524	2,485,709
Costos de Operación									-
Mina	9.20	US$/TM Min		(26,496)	(26,496)	(26,496)	(26,496)	(15,898)	(333,850)
Planta	15.07	US$/TM Min		(43,413)	(43,413)	(43,413)	(43,413)	(26,048)	(547,005)
G&A	2.53	US$/TM Min		(7,274)	(7,274)	(7,274)	(7,274)	(4,364)	(91,649)
Otros (10%)	0.34	US$/TM Min		(976)	(976)	(976)	(976)	(586)	(12,301)
Ventas,transporte,refinación	9.12	US$/TM Min		(26,266)	(26,266)	(26,266)	(26,266)	(15,759)	(330,947)
Total Costo Operación	**36.2585775**			(104,425)	(104,425)	(104,425)	(104,425)	(62,655)	(1,315,751)
Utilidad Bruta				56,694	57,104	102,686	88,121	41,870	1,169,958
Regalías	2%			(1,317)	(1,326)	(2,385)	(2,047)	(973)	(27,177)
Depreciación				(36,372)	(36,372)	(3,141)	(3,141)	(3,141)	(324,165)
Utilidad Neta antes de Impuestos		**US$' 000**	**(346,152)**	19,005	19,405	97,160	82,933	37,756	818,616
Participación Laboral	8.0%			(1,520)	(1,552)	(7,773)	(6,635)	(3,020)	(65,489)
Impuesto a la Renta	29.5%			(5,158)	(5,267)	(26,369)	(22,508)	(10,247)	(222,172)
Utilidad Neta despues de Impuestos		**US$' 000**		12,326	12,586	63,018	53,790	24,489	530,954

Flujo de Caja Proyectado			0	1	2	11	12	13	Total
Utilidad Neta despues de Impuestos				12,326	12,586	63,018	53,790	24,489	40,834,611
Depreciación				36,372	36,372	3,141	3,141	3,141	6,052,700
Costo de Cierre de Mina	0.312			(899)	(899)	(899)	(899)	(539)	(2,120,898)
Capital Inicial			(346,152)						(6,052,700)
Capital Sostenimiento	1.00%			(3,462)	(3,462)	(3,462)	(3,462)	(3,462)	(8,685,625)
Flujo de Caja		**US$' 000**	(346,152)	44,339	44,598	61,799	52,571	23,629	30,028,089

Flujo de Caja Proyectado			0	1	2	11	12	13	Total
Itilidad Neta despues de Impuestos				12,326	12,586	63,018	53,790	24,489	40,834,611
Depreciación				36,372	36,372	3,141	3,141	3,141	6,052,700
Costo de Cierre de Mina	0.312			(899)	(899)	(899)	(899)	(539)	(2,120,898)
Capital Inicial			(346,152)						(6,052,700)
Capital Sostenimiento	1.00%			(3,462)	(3,462)	(3,462)	(3,462)	(3,462)	(8,685,625)
Flujo de Caja		US$' 000	(346,152)	44,339	44,598	61,799	52,571	23,629	30,028,089

VAN	$87,397,948
TIR	14%
Per_Rec_Inversion	5

Sensitivity Analysis

- For the Net Present Value:

Table 46 Sensitivity Analysis for NPV

VAN	Precio de Metal de Ag	Costo de Operación	Inversion
30%	$226,090,750.70	-$51,282,564	-$16,447,652
20%	$179,859,816.61	-$5,055,727	$18,167,548
10%	$133,628,882.52	$41,171,111	$52,782,748
0%	**$87,397,948.43**	**$87,397,949**	**$87,397,948**
-10%	$41,167,014.34	$133,624,786	$122,013,148
-20%	-$5,063,919.75	$179,851,624	$156,628,348
-30%	-$51,294,853.84	$226,078,461	$191,243,548

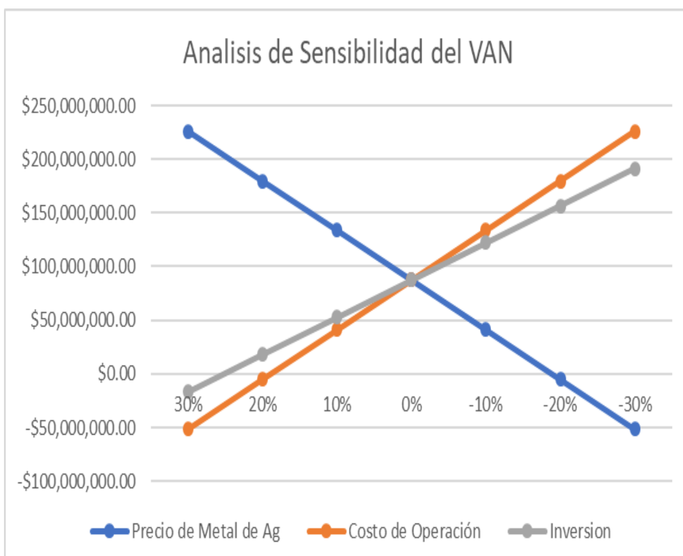


FIGURE 37. SENSITIVITY ANALYSIS FOR THE NPV

- For the Internal Rate of Return

Table 47 Sensitivity Analysis for IRR

TIR	Precio de Metal de Ag	Costo de Operación	Inversion
30%	20.9%	7.2%	9.3%
20%	18.8%	9.7%	10.8%
10%	16.6%	12.1%	12.5%
0%	**14.4%**	**14.4%**	**14.4%**
-10%	12.1%	16.6%	16.7%
-20%	9.7%	18.8%	19.3%
-30%	7.2%	20.9%	22.6%

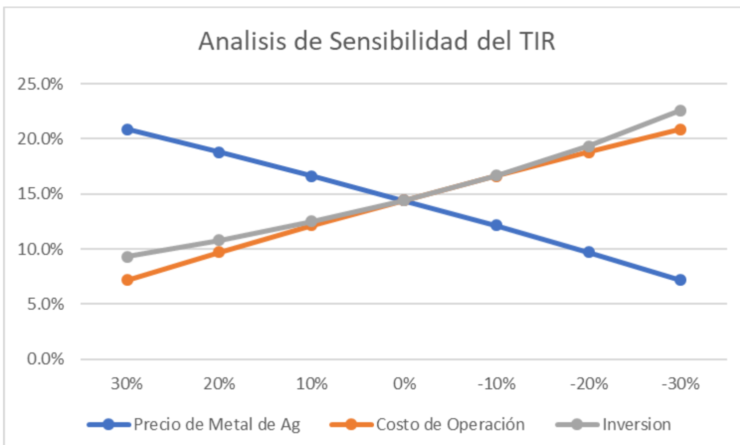


FIGURE 38. SENSITIVITY ANALYSIS FOR THE IRR

Risk associated with the mining project

a) Environmental Risk. The environmental risk that exists in the project is that the Sub Level Caving mining method; It will have greater subsidence to greater depth in the areas surrounding the mining project such as the Corani community, for which the patent risk within the closure of mines must be foreseen in order to have physical and chemical stability of the mine.

Another risk is the pollution that affects the community members, cattle and animals that generates the loading of the mineral and the treatment of the mineral inside the beneficiation plant.

For this reason, it is necessary to have an adequate EIA and in accordance with international standards that support good practices.

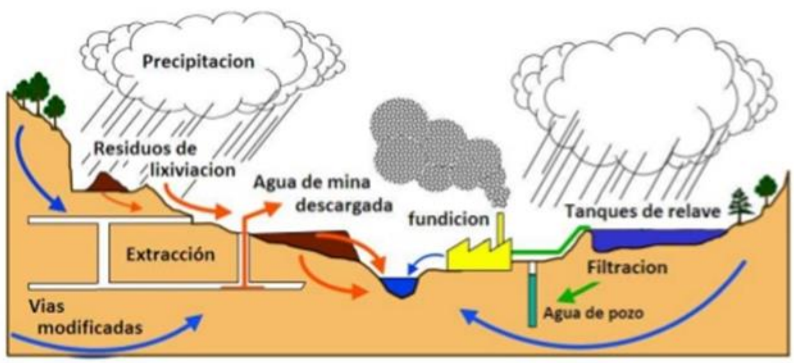


FIGURE 39. ENVIRONMENTAL IMPACTS ASSOCIATED WITH UNDERGROUND MINING

b) Social Risk. This risk can paralyze the construction of the mining project or the operation of the mine, so this social conflict must be foreseen, not seeing it as a threat but as an opportunity to change the education and health of the population through this project. mining is made, the commitments and promises of the mining company must be made during the LOM and not only be in words but in deeds to avoid this latent social risk, the constant communication of the mining company with the community to avoid these risks social. The Peruvian State must constantly participate so that there is harmony between the mining company and the community surrounding the mining operation.

FIGURE 40. SOCIAL CONFLICT ASSOCIATED WITH MINING IN GENERAL

SWOT Analysis

Table 48. SWOT of the mining project throughout the useful life of the mine

STRENGHTS	OPPORTUNITIES
- High proven and probable reserves - Use of cutting-edge technology in its mining operations - Peruvian and Canadian capitals belong to this mining company	- Largest mining project in the Puno region - Great demand for local workers for the construction of the mining project - Global consolidation of the silver industry
WEAKNESSES	**THREATS**
- Location of the mine away from a port and refinery - High dependence on world market prices - Does not present a strategic partner - Huge delays in mining project preparation	- Social conflicts in the construction of the mining project - Significant decrease in the price of metal such as silver, zinc and lead

Risk Prioritization

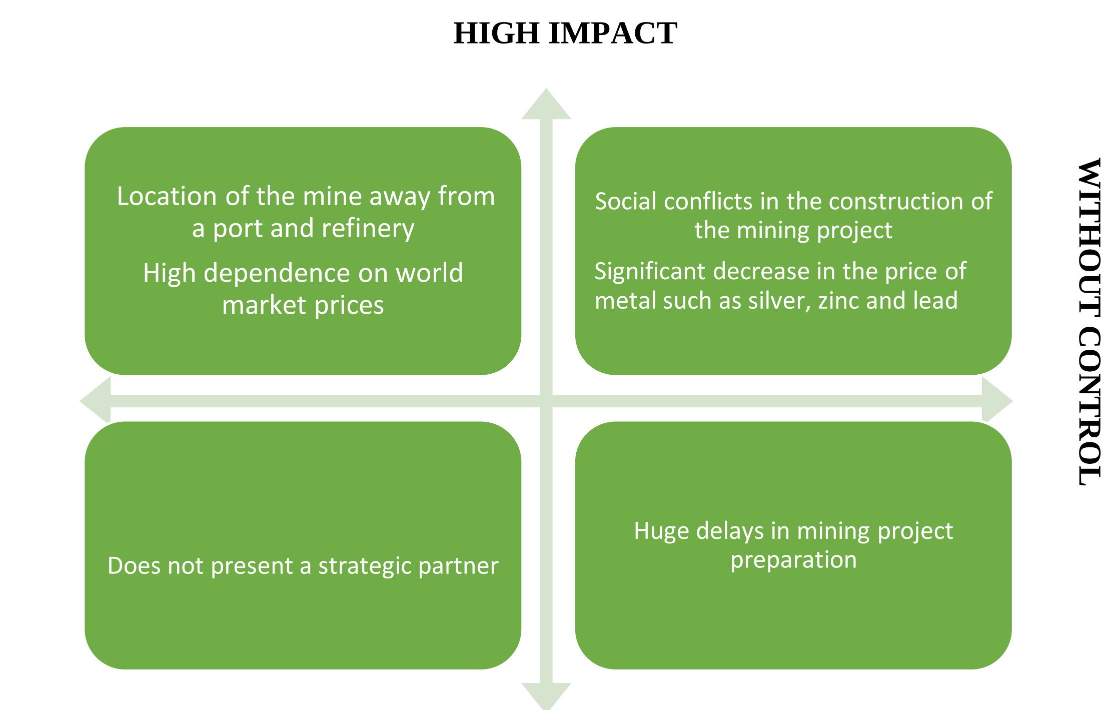


FIGURE 41. PRIORITIZATION OF RISKS

Prioritization of Opportunities

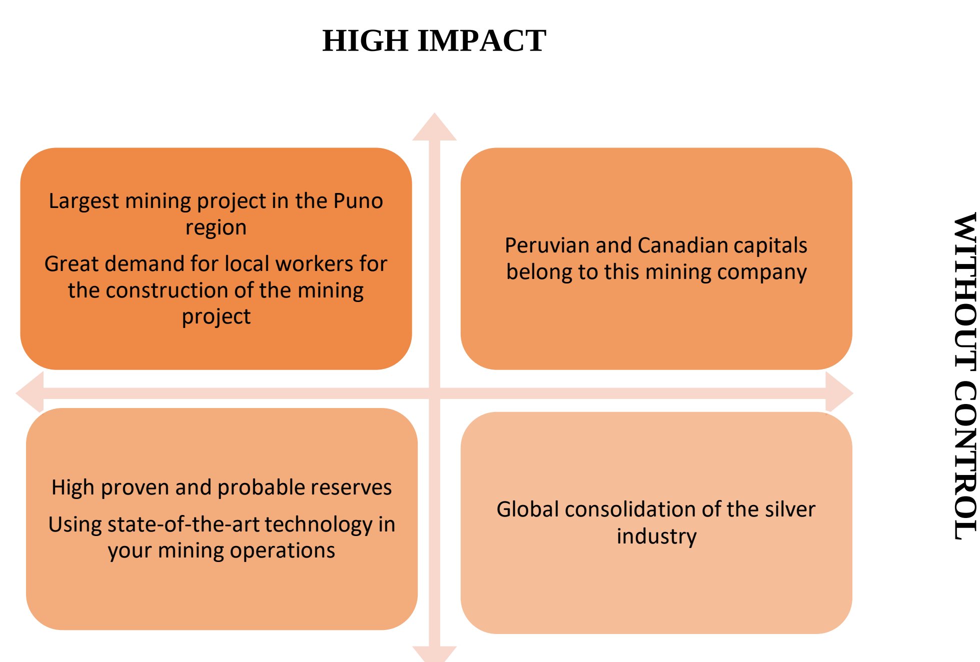


FIGURE 42. PRIORITIZATION OF OPPORTUNITIES

CHAPTER 22: ESTIMATING MINABLE RESOURCES

Mineral resources are reported at a cutoff grade of 110.1 g / tonnage of silver-equivalent. The cutoff grade is estimated based on a price of $ 18.1 per ounce of silver, $ 0.9 per pound of lead and $ 1.1 per pound of zinc. The silver-equivalent calculation assumes 69.6 percent recovery for silver, 61 percent recovery for lead, and 67 percent recovery for zinc.

Table 49. Mineral resources for the Corani deposit, Puno, Peru, November 20,2019

Descripción	Unid.	Recursos Minables
Tonelaje de Mineral	TMS	36,288,000
Ley de Plata	gpt	93.76
Ley de Plomo	%	1.50
Ley de Zinc	%	1.04
Contenido Plata	Oz	109,390,758
Contenido Plomo	TMS	544,320
Contenido Zinc	TMS	377,395

CHAPTER 23: ADJACENT PROPERTIES

The Corani project is located near the San Rafael mine of MINSUR, the Macusani Project and the Ollachea Project.

23.1 San Rafael Mine (Tin)

The San Rafael Mine is a tin mining operation, located in the Antauta district, Melgar Province, Puno Region, between 4,500 and 5,000 meters above sea level. The San Rafael Mine operates with the SLS mining method and has a 2,900 tpd concentrator plant; It is a third largest producer of tin in the world, producing 12% of tin in the world.

23.1 Macusani Project (Lithium and Uranium)

The Macusani lithium-Uranium project is located between 4,300 and 5,000 meters above sea level in the Macusani district, adjacent to Corani, in the province of Carabaya, in the Puno region.

Macusani Yellowcake is the company that owns the project, which explores and exploits radioactive minerals, a subsidiary of the Canadian Plateau Energy Metals Inc.

23.2 Ollachea Project (Gold)

The Ollachea Project is located in the Puno region, approximately 230 km north of Lake Titicaca, on the eastern slope of the Andes. Located in the northern area of the gold sedimentary strip heading northwest. The project is controlled by Minera IRL.

CHAPTER 24: OTHER DATA AND RELEVANT INFORMATION

Occupational safety and health is an activity that is regulated, mining companies are required to present their Mining Safety policy. The following Occupational Health and Safety Policy has been defined for the project.

OCCUPATIONAL HEALTH AND SAFETY POLICY

Leadership

Maintain visible leadership in the field, from the highest line of the organization.

Watch over the People

No person will be exposed to controlled and uncontrolled risks, proactive conduct is required of all personnel, companies and contractors.

Communication

Establish open communication channels so that workers have the freedom to report all risks of any kind.

Infrastructure

The company will provide an adequate infrastructure to protect the safety and health of our collaborators.

Safety culture

The company will provide an occupational health and safety system to generate a safety culture.

CHAPTER 25: INTERPRETATION AND CONCLUSIONS

- The economic analysis was performed using a discounted cash flow (DCF) which is standard industry practice.
- The capital cost estimate (CAPEX) presented in this Report is for a silver-lead-zinc concentrator mine and plant capable of producing and processing an average of 9000 tpd of ore (dry basis).
- NPV of $ 87,400,000 was obtained for a mine life of 13 years. The profitability of the IRR is 14%.
- For deposits with low grades, selective underground mining methods are very expensive, therefore, massive mining methods such as Sublevel Caving used for this work are used.

CHAPTER 26: RECOMMENDATIONS

- Estimate the missing data to carry out a conceptual study based on a comparison with other mining projects that have similar characteristics.
- Estimate metal prices based on international prices in each month from January 1998 to October 2019, US inflation in each month from January 1998 to October 2019 and the Multilateral inflation in each month from January 1998 to October 2019.
- Carry out an optimization study to see the possibility of reducing operating costs.

CHAPTER 27: REFERENCES

- NI43-101 Technical Report: Corani Project Detailed Engineering Phase 1. (2017). [ebook] Santiago: Sedgman Chile SpA. Available at: https://www.bearcreekmining.com/site/assets/files/4258/a668-d03-04010-rt-0001_rev_0_corani_ni43-101_final.pdf [Accessed 30 Nov. 2019].
- BCM Q2 2019 MDA - 19 Aug 2019 FINAL. (2019). [ebook] Lima: SMV. Available at: http://www.smv.gob.pe/ConsultasP8/temp/BCM%20Q2%202019%20MDA%20-%2019%20Aug%202019%20FINAL.pdf [Accessed 20 Aug. 2019].
- http://biblioteca.unmsm.edu.pe/redlieds/Recursos/archivos/MedioAmbienteMinero/Regla_cierre_minas.pdf
- https://www.minam.gob.pe/wp-content/uploads/2017/06/DS-003-2017-MINAM.pdf

APPENDIX A

Engineering Standards and Regulations Applied in the Project

Engineering Standards

ISO 19426-4:2018

Structures for mine shafts — Part 4: Conveyances

This standard specifies the loads, the load combinations and the design procedures for the design of the steel and aluminum alloy structural members of conveyances used for the transport of personnel, materials, equipment and rock in vertical and decline shafts. The conveyances covered by this document include personnel or material cages (or both), skips, kibbles, equipping skeleton cages, inspection cages, bridles, crossheads and counterweights. This document adopts a limit states design philosophy.

ISO 19426-5:2018

Structures for mine shafts — Part 5: Shaft system structures

This standard specifies the loads, the load combinations and the design procedures for the design of shaft system structures in both vertical and decline shafts. The shaft system structures covered by this standard include buntons, guides and rails, station structures, rock loading structures, brattice walls, conveyance and vehicle arresting structures and dropsets, services supports, rope guide anchor supports and box fronts.

This standard adopts a limit states design philosophy.

ISO 17757:2019

Earth-moving machinery and mining — Autonomous and semi-autonomous machine system safety.

The standard provides safety requirements for autonomous machines and semi-autonomous machines (ASAM) used in earth-moving and mining operations, and their autonomous or semi-autonomous machine systems (ASAMS). It specifies safety criteria both for the machines and their associated systems and infrastructure, including hardware and software, and provides guidance on safe use in their defined functional environments during the machine and system life cycle. It also defines terms and definitions related to

ASAMS. Its principles and many of its provisions can be applied to other types of ASAM used on the worksites.

ISO 18758-2:2018

Mining and earth-moving machinery — Rock drill rigs and rock reinforcement rigs — Part 2: Safety requirements

This standard specifies the safety requirements for rock drill rigs and rock reinforcement rigs designed for the following underground or surface operations:

a) blast hole drilling; b) rock reinforcement; c) drilling for secondary breaking; d) dimensional stone drilling; e) mineral prospecting, e.g. utilizing core drilling or reverse circulation; f) water and methane drainage drilling; g) raise boring.

The standard is not applicable to the following machines: drill rigs for soil and rock mixture; (geothermal drill rigs, water well drill rigs, water jet drill rigs, micro pile drill rigs; surface horizontal directional drill rigs (HDD), kelly drill rigs (and casing drivers); cable tool drill rigs; pre-armouring machines; sonic drill rigs; shaft sinking drill rigs; crane attached drill rigs; drill rigs on derricks; scaling machines.

Mine Safety and Health Administration 30 CFR Part 75 RIN 1219–AA11

Safety Standards for Underground Coal Mine Ventilation.

Section 75.310 Installation of Main Mine Fans

Main mine fans serve a vital role in providing ventilation to prevent methane accumulations and possible explosions as well as providing miners with a healthful working environment. Section 75.310 is primarily directed at protecting the main mine fans from fires and damage in the event of an underground explosion so that necessary ventilation can be maintained. Monitoring of the fans to assure that they are operating properly is an element of this protection.

ISO 23875:2021

Mining — Air quality control systems for operator enclosures — Performance requirements and test methods.

This standard specifies performance and design requirements for air quality control systems for operator enclosures and their monitoring devices. The design specifications are universal in their application and do not contemplate specific mining environments. They are intended to meet identified parameters of both pressurization and respirable particulate and carbon dioxide concentrations. This document also specifies test methods to assess such parameters and provides operational and maintenance instructions. Recommendations are made for operational integration of the air quality control system.

National Regulations on Mining and Environment

Government Supreme Decree D.S.Nº 016-93-EM
Peruvian Government Ministry of Energy and Mining.
Environmental Regulation for Mining Exploration Activities.
Program for the Adequacy and Environmental Management (PAMA) for the Mining and Metallurgical Activities in the Country.

Government Supreme Decree D.S.Nº 059-2005-EM
Regulation of Environmental Liabilities of the Mining Activity.
Identification of the environmental liabilities of the mining activity, responsibility and financing for the environmental remediation of the areas affected by the liabilities, in order to mitigate their negative impacts on the health of the population, the surrounding ecosystem and property.

Government Ministerial Resolution No. 315-96-EM / VMM
Maximum Permissible Levels of Elements and Compounds Present in Gaseous Emissions from Mining-Metallurgical Units.
Sulfur anhydride emissions, particles emissions, lead emissions, arsenic emissions, gases and particles concentration, control points. Measurements carried out in accordance with the provisions of the Protocol Monitoring of Air Quality and Emissions for the Mining Subsector, Ministry of Energy and Mining.

Government, Ministry of Energy and Mining, Ministerial Resolution No. 011-96-EM.
Maximum Permissible Levels for Liquid Effluents for Mining and Metallurgical Activities.
Effluents coming from: a) Any work, excavation or work carried out on the ground, or of any wastewater treatment plant associated with labor, excavations or work carried out within the boundaries of the Mining Unit. b) Tailings deposits or other treatment facilities that produce water residuals. c) Concentrators, roasting plants, smelters and refineries, provided that the facilities are used for washing, crushing, grinding, flotation, reduction, leaching, roasting, sintering, smelting, refining, or treatment of any mineral, concentrate, metal, or by-product.

APPENDIX B

Multiple Constraints, Restrictions and Limitations

The following constraints, restrictions and limitation have been considered in the project

Availability of Geological, Geophysical and Geochemical Data

In this project, it has not been straightforward to collect relevant geological, geophysical and geochemical data. Several information and data sources have been considered and analyzed to gather proper and significant data to complete the project. The following sources have been considered: National Society of Mining, Petroleum and Energy SNMPE, Geological, Mining and Metallurgical Peruvian Institute IGMMP, Peruvian Geological Institute, Government Ministry of Mining and Energy. All required information and data was finally found and made available.

Uncertainties and Risks

Given all the factors and issues involved, mining exploration and production are high-risk ventures. Geological concepts with respect to structure and mineral charge are uncertain. On the other hand, economic evaluations have uncertainties related to cost estimation, changing conditions in economically viable sites, changes in mining technology, fluctuations in mineral price and market conditions, political situation, community relations, etc. All these issues must be carefully analyzed in order to ensure the profitability of the project for the most conservative economic conditions and diversity of scenarios. In this project, all these issues have been considered from a conservative scenario and criteria.

Low Grade Deposits

For deposits with low grades, selective underground mining methods are very expensive, therefore, massive mining methods such as Sublevel Caving are used in this work.

Sublevel caving is a stoping method in which relatively thin blocks of ore are caused to cave by successively undermining small panels. The ore deposit is developed by a series of sublevels spaced at vertical intervals. Usually, only one or two sublevels are developed at a time, beginning at the top of the ore body. The sublevels are developed by connecting the raises with a longitudinal subdrift from which timbered slice drifts are driven right and left opposite the raises to the ore boundaries or to the limits of the block.

Safety Considerations

Mining exploration and production present diverse safety issues that must be taken into account in the development of the project. In recent years, Peruvian regulations on mining safety and environment have become stricter. It is important to comply with safety standards pointing to satisfy proper safety levels considering their impact in the project budget. Care of human life, well-being and safety is an important issue to take into account throughout the different stages of the project and its life-cycle.

Environment and Sustainability

The mining and metallurgical industry face diverse and broad environmental issues at both local and global levels which could affect the project sustainability. The project considers environmental issues such as potential effluents spills, soil, air and water pollution, habitat protection and biodiversity. The project also considers community relations with local people as an important stakeholder of the project.

Schedule

The project must be completed in one academic semester. It is estimated the project requires an average of 150 hours of teamwork with 4-5 students per team. Considering that, besides the senior design project course, students are enrolled in 3-4 additional courses in the academic semester, students have to plan ahead in order for identify all required activities, distribute the tasks among all team members and, finally, integrate all partial tasks to configure the final project.

Other Constraints

The following constraints have also been considered in the project:

- Geographical and accessibility restrictions that make difficult the transport of materials and equipment.
- Technology availability and applicability in the well(s) area.