Technification of Open Pit Explotation through Topography and Implementation of Mining Plans in Minas Belencito - Monjas - San Antonio

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Key words: Plan implementation, Geology and Mining, Photogrammetry, Women in mining topography (Gender diversity)

SUMMARY

Open pit mining is a fundamental base of the economic and industrial development of various countries, so it is necessary the technology and implementation of good practices that affect the safe, sustainable and efficient extraction.

Mining planning is a key factor in the success of a project, it is therefore necessary to have clear objectives and goals in the short, medium and long term, however unlike any other project the foundation of mining is the duration of the resource , the sequential exploitation of an open pit mine must allow the deposit to be extracted safely, economically, sustainably and sustainably. Obtaining optimal designs is a fundamental part of the extraction of resources, the other is the implementation and field monitoring of these geometries, a work that is a surveyor's burden, led in this case by a woman.

Through this summary we can show how the constant and disciplined work, combined with the use of specialized technologies and software that have allowed a safe, optimal and sustainable operation in the San Antonio - Belencito and Monjas Mines.

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Palabras clave: implementación del plan, geología y minería, fotogrametría, mujeres en la topografía minera (diversidad de género)

RESUMEN

La Mineria a cielo abierto es una base fundamental del desarrollo económico e industrial de diversos países, se hace necesario por tanto la tecnificación e implementación de buenas prácticas que permitan la extracción segura, sostenible y eficiente.

La planificación Minera es un factor clave en el éxito de un proyecto, es necesario por tanto tener claros los objetivos y metas a corto, mediano y largo plazo, sin embargo a diferencia de cualquier otro proyecto el fundamento de la minería es la duración del recurso, la explotación secuencial de una Mina a cielo abierto debe permitir extraer el depósito de manera segura, económica, sostenible y sustentable. La obtención de diseños óptimos es una parte fundamental de la extracción de los recursos, la otra es la implementación y seguimiento en terreno de estas geometrías, labor que se encuentra a cargo del topógrafo, liderado en este caso por una mujer.

A través de este resumen podremos evidenciar como el trabajo constante y disciplinado, combinado con el uso de tecnologías y software especializados han permitido garantizar una p operación segura, optima y sostenible en las Minas San Antonio – Belencito y Monjas.

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1. Introduction

The success of any type of Project is divided into two fundamental parts: Planning and execution, according to different authors; a project is the search for an intelligent solution to a problem to be solved, so a sequence of unique, complex and related activities that must be completed within a specific time and fulfilling a set budget.
In the case of mining, planning is essential to make decisions, determine the sequence of ore extraction, establish production programs and generate the required supply.
In Argos, Long, medium and short term planning is generated that allow to have a clear navigation chart, with this guideline is done the modeling and calculation of the quantities to be extracted; the project by the Directorate of Canteras, who follow the guidelines that are marked in the field by the survey commissions, is the help of the project.
Through this document it will be shown that the constant accompaniment of topography and teamwork between those who plan and those who execute have allowed to optimize resources and therefore generate savings; It is wrong to think that a long-term mining operation can be maintained without pre-established and approved planning.
Argos is planned through the use of specialized software, ideal professionals and teamwork, seeking to generate efficient, profitable and sustainable farms.
If it is true that the planning of a mine is similar to the planning of any other project, there is something that differentiates it and is that the value of the business is limited to the mineral resource, this is exhaustible and therefore objective planning of the extraction must be carried out.
The knowledge of the site to be exploited and the correct topographic description will allow us to economically evaluate the project and carry out a more objective planning, adapting the design to obtain the best possible geometry. The objective of strategic mining planning is to establish a geometry and operating sequence that allows the deposit to be extracted in the best way taking into account all the technical, economic, operational, economic, environmental, social and characteristics guidelines of the topography and the deposit, while ensuring compliance with environmental standards. This document will show the evolution of the extraction of the San Antonio Mine, Mina Monjas and Mina Belencito through the implementation of optimal Mining Planning and marking and monitoring in the field with topography, currently allowing to have safe, profitable and sustainable operations.

2. THEORETICAL MARK

Mining design and planning seeks to optimize mining resources and reserves by ensuring proper exploitation; using technical standards for the approval of mining processes in Argos and complying with the company's sustainability policies.

It focuses on making designs and modeling in 3D according to the Geology of the Site, quality and the costs of extraction, transport and other topics typical of the operation.

Operationally, The Mining Planning should be guided in:

- Compliance with production estimates to meet plant requirements.
- Detect critical areas in a timely manner, to give immediate solution.
- Cost reduction.
- Increase extraction, according to production needs.
- Increase development work, resulting in increased reserves to CP.
- Effective coordination between the staff of the productive area, by exchanging daily experience in problem solving and meeting goals, which encourage real teamwork.
- Participate in defining the scope and premises of Resource Development projects to ensure the availability of mining resources and reserves.
- Interact with the areas of geology and resource development to geotechnically validate mining designs and the possibility of taking advantage of new raw material alternatives respectively.

A short-term mining plan is developed based on long- and medium-term planning guidelines and contains:

- Requirements of raw materials in quality and quantity.
- Volume of mineral and sterile to be removed.
- Plans with operating sectors and quantity of material to be extracted in each area.
- For cement, simulation in specialized software to establish the mixture with the expected quality.
- Indication in site plans and storage form of the extracted sterile.
- Mining infrastructure works to be developed (roads, water conduction works in the mine, etc.).
- Extraction sequence over time in quality and quantity.
- Areas available for environmental recovery.

2.1.SPATIAL LOCATION OF THE PROJECT

The farms in mention represent a small percentage of the one belonging to the organization, these mines are located in the Department of Boyacá in Colombia as shown in Image No. 1.

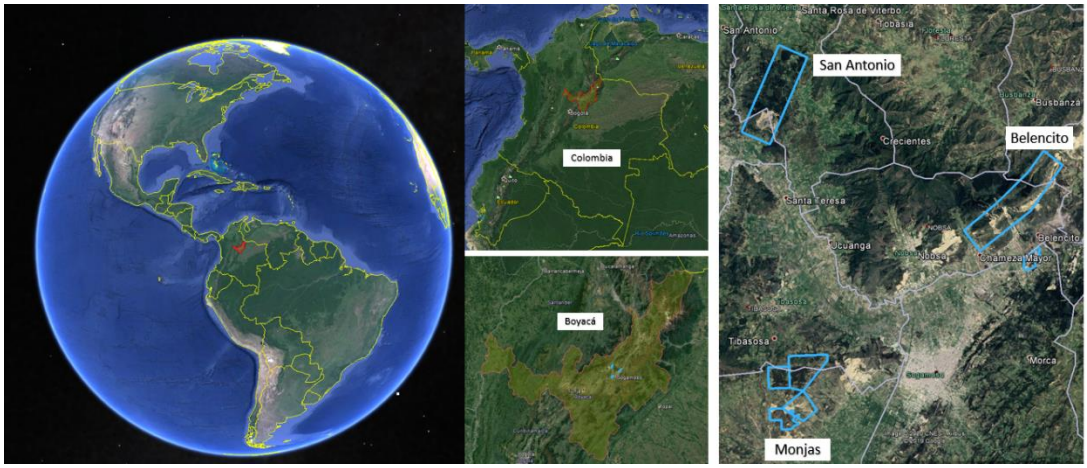
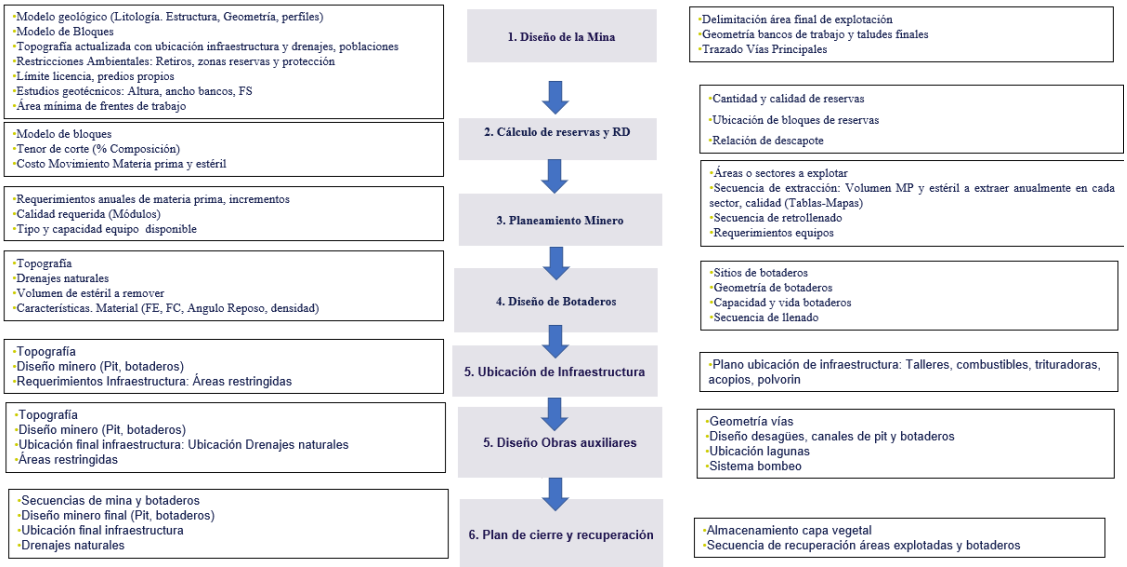


Image1: Location of the Study Quarries. Source: Own Google Earth.

2.2. MINING PLANNING PROCESS

2.2.1. CONCEPTUAL MAP



Concept Map Source: Generation Own Argos Guidelines

2.2.2. INPUT INFORMATION

2.2.2.1. Geology

It has the deposit modeled in 3D solids, allowing to visualize the spatial distribution of resources, the quality and quantity of the mineral of interest and sterile materials, as well as the characteristics of each formation, the bearing and blighting, the depth and form, and the chemical composition.
The Geological field is very wide, but we can determine 4 basic steps to obtain the model:

2.1.1.1.1 Prospecting

It is the stage in which activities and operations are carried out that allow to determine the nature and characteristics of the deposit in a given area. Image No. 2 shows geological paths on a visual of potential high ground and visual inspection of an existing operating front.

Image No. 2 unit distribution and geomorphology, Argos mining titles. Source: Argos

2.1.1.1.2 Exploration

It allows to have a more detailed knowledge of the deposit, evaluate its economic viability, characterize the ore, determine in general the physical and chemical characteristics of a deposit generating as a product generate solids very approximate to reality.

Image No. 3 drill drilling with core recovery, next to the cores arranged in the box with their corresponding interval ready for the Logueo. Source: Argos

2.1.1.1.3 Sampling and Analysis

Samples obtained from drilling are used, tested in certified laboratories that issue reliable results; subsequently a geostatistical work is determined the best way to establish each is the quality sectorized in a model called qualities or blocks, where each block contains its own physical and chemical characteristics which is a powerful tool of description of the deposit.

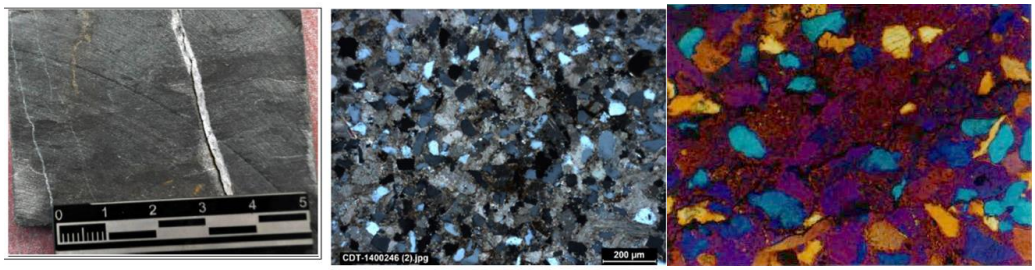


Image No. 4 petrographic analysis. Source: Argos

2.1.1.1.4 Modeling

With georeferenced drilling mesh, chemical sampling, geostatistics is carried out the modeling of the solids of each lithological unit of the site, allowing a complete description of the Geology.

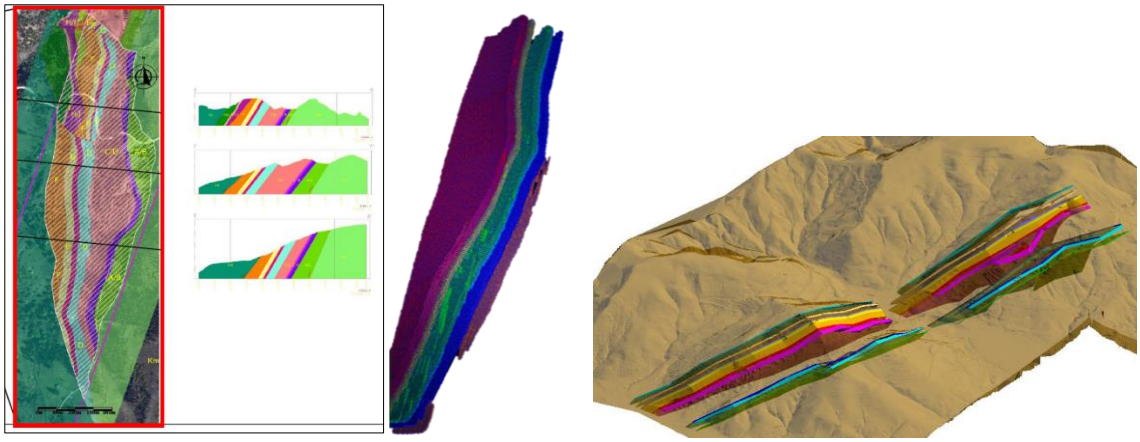


Image No. 5 Geological Cartography, Solids of the Deposit and Model of Qualities . Source: Argos

2.2.2.2. Topography

It is essential to have as much detailed description as possible of the topography where the Project will be developed, it should include all the infrastructure, location of roads, populations, drains, ambienta, social and legal restriction polygons in order to establish the actual area to intervene.

Image No. 5 photoplane and topographical contours Mining front Mina Belencito. Source: Argos

2.2.2.3. Geotechnics

A comprehensive study is necessary to determine the conditions of stability of the terrain according to the characterization of the materials present in the Project, in order to determine the safety factor and geometric parameters such as: the angles of each slope, the height of the benches, the berm widths and the global angle of the slopes

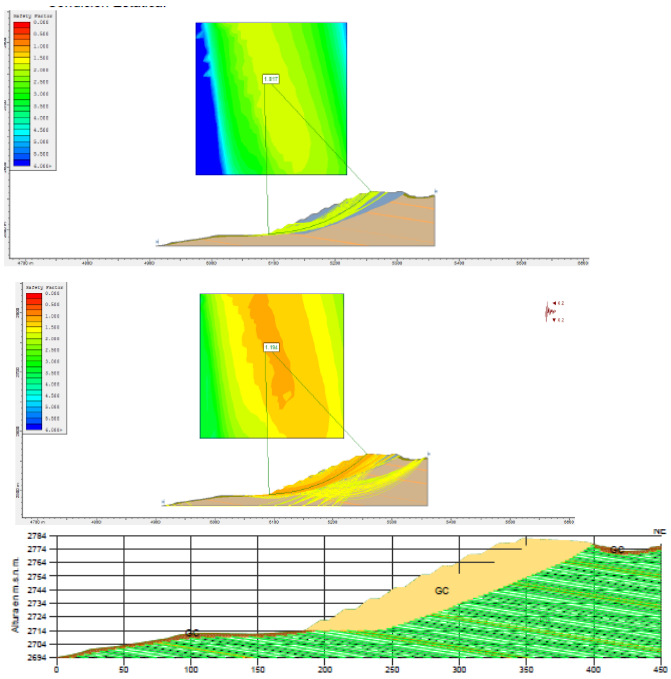


Image No.6 Geotechnical and stability analysis of a profile. Source: Argos

2.2.3. OUTPUT INFORMATION

2.2.3.1. DESIGNS AND GEOMETRIES

According to the analysis that is carried out, the optimal mine design is sought through the specialized software, geometries are obtained in 3 dimensions and planes, this includes the designs of Sterile Layout Areas, pathways and all the necessary infrastructure.

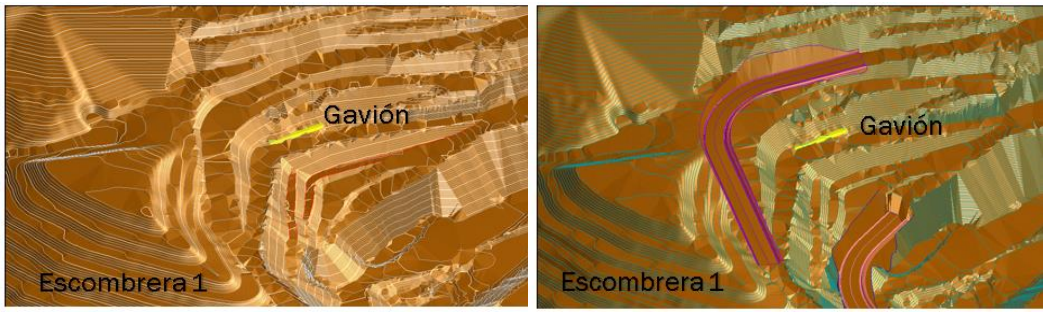


Image No.7 Design of a track. Source: Argos

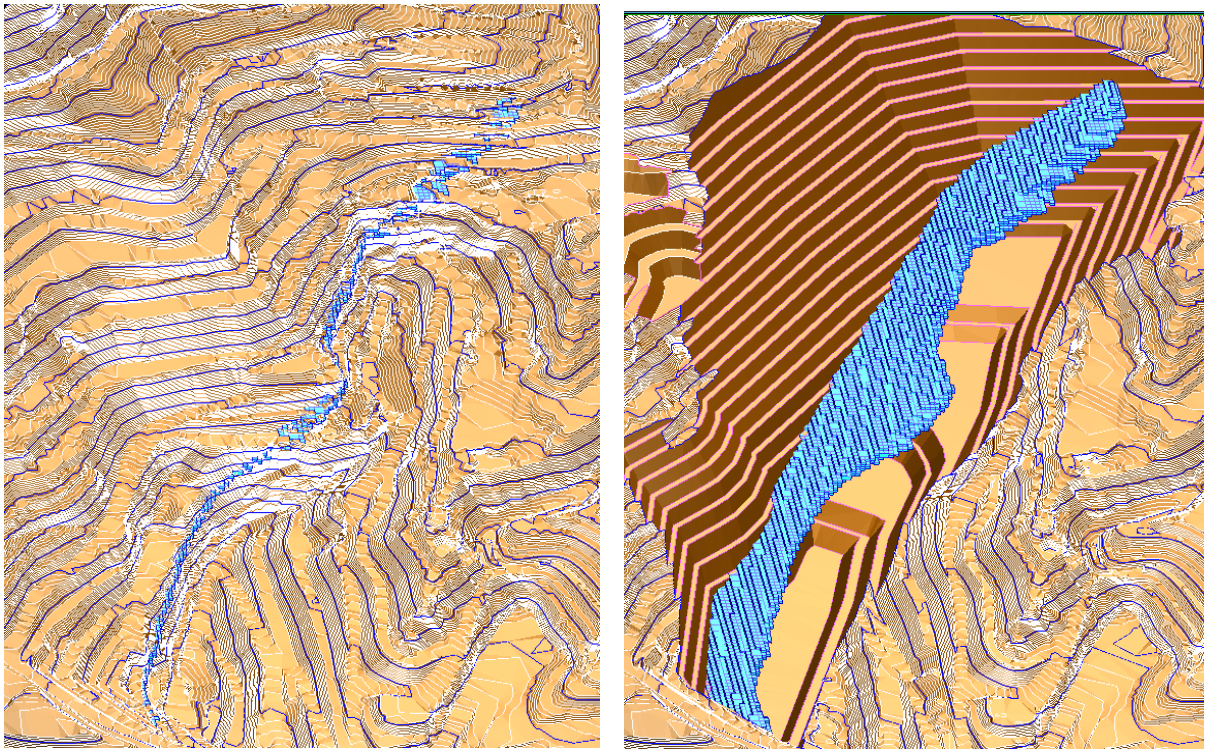


Image No.8 Geometric design of a Mine with the mineral to be extracted (In blue). Source: Argos

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2.1.1.1. TOPOGRAPHICAL REPLANTING IN THE FIELD

2.1.1.1.1. MARKING OF CHAMFERS ACCORDING TO DESIGN

Image No.9 Marking chamfers and cutting lines. Source: Argos

2.1.1.1.2. MARKING OF VOLADURA PLACES WITH LEVELS IN msnm


Image No.10 Marking a blast plate and subsequent drilling. Source: Argos

2.1.1.1.3. MARKING NEW WAYS


Marking alignments and one-way levels, Source: Argos

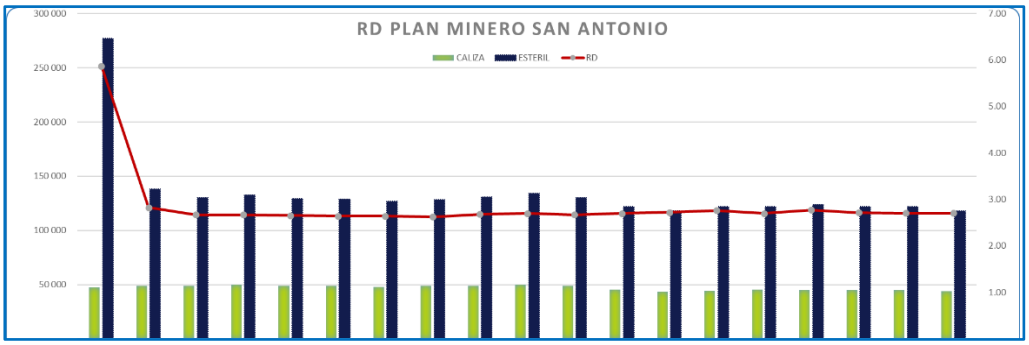
2.1.1.1.4. MARKING OF STERILE DISPOSITION AREAS

Marking of Levels and Alignments. Source: Argos

2.1.1.2. VOLUMETRIC CALCULATION

The volumetric calculation of the movement of sterile and minerals gives us the indicator of stripping ratio: it is the ratio between the number of tons of sterile to be removed to obtain a ton of ore in an open pit farm.

$$RD = \frac{Toneladas\ de\ esteril}{Toneladas\ de\ mineral}$$



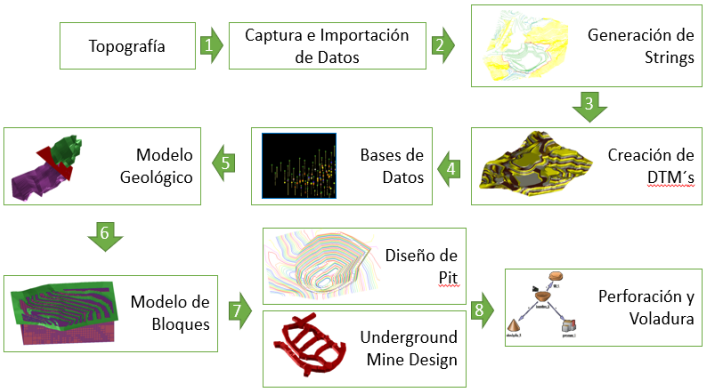
Graph of behavior over a period of 19 bimonthly of the Ratio of Convertible ne a Mining sequence.. Source: Argos

3. SOFTWARE APPLICATIONS

Currently in the organization, three-dimensional software specialized in planning, design, extraction and geology is used to store extensive databases and generate complete graphic outputs.

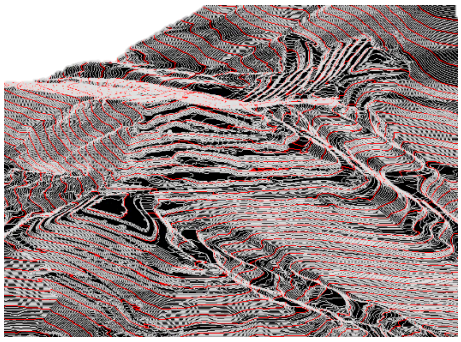
3.1.MINERA PLANNING

A step-by-step of the process already described is performed, some of the input information is processed and the results are obtained, the main object of the software is to optimize the times and generate more reliable information. Mining Design Stages in Software:

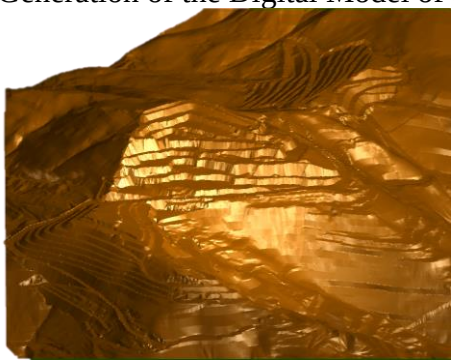


3.2.TOPOGRAPHY AND PHOTOGRAMETRIA

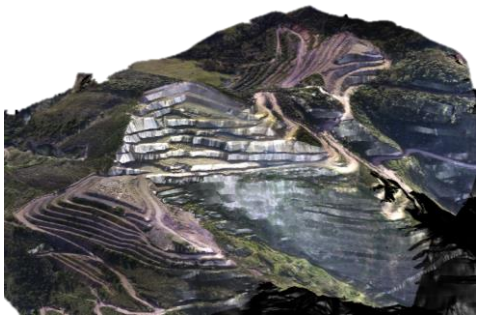
Toposurface generation: Terrain contours



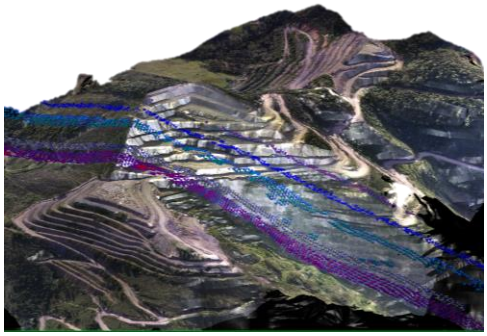
Generation of the Digital Model of the Field



Load the photoplanes generated with PIX4d into the digital terrain model:

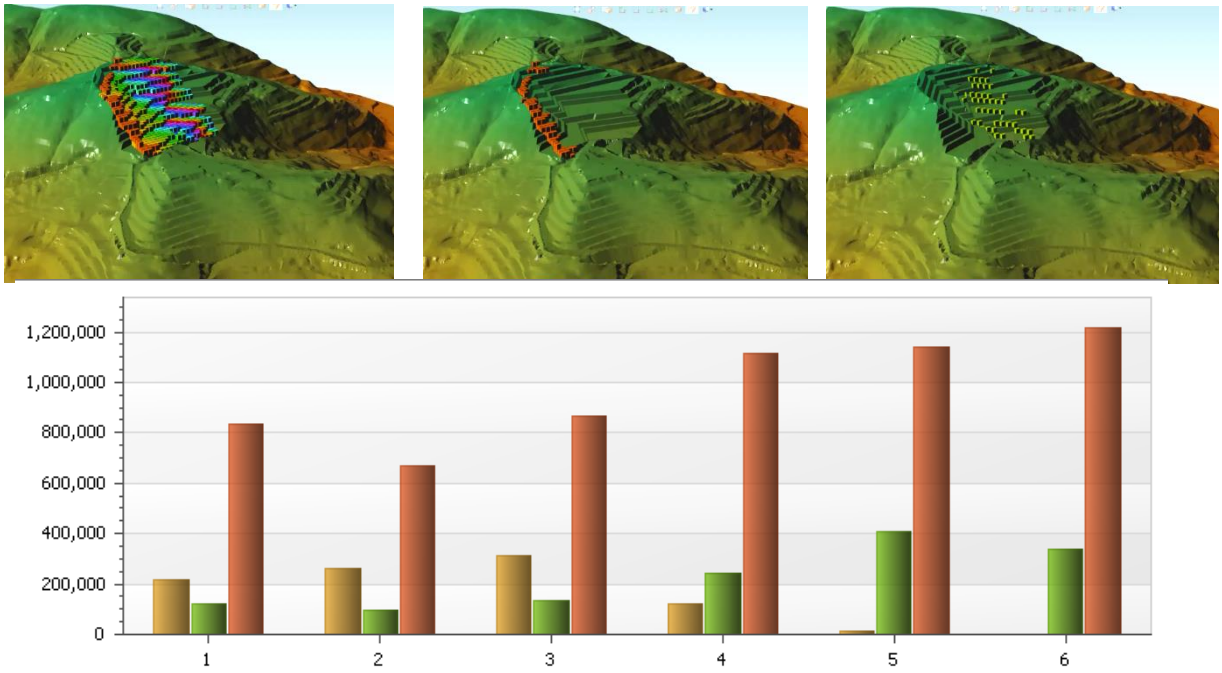


Load the blocks model of the geological mantle:



4. MINING SEQUENCE

Through the specialized software you get the sequence of extraction of the amount of the required ore, with the desired quality and in a certain time.

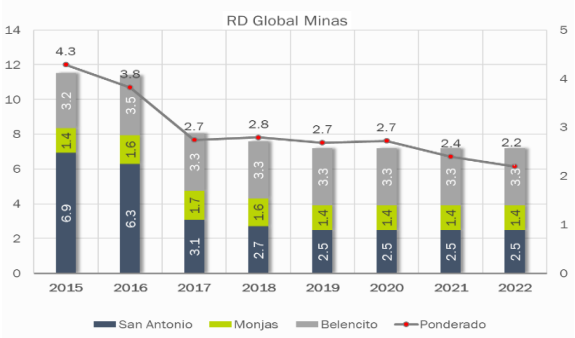


Software-generated extraction sequence graphics.

5. Results

5.1 REDUCING THE LIST OF DESPORTS WHILE MAINTAINING MINE DEVELOPMENT

During the last years (Approximately 12) it has been managed to form a team made up of professionals in Topography, Mines and Geology who worked hand in hand have implemented the model of Technical Mining Planning, being at the forefront of new technologies and the innovation of processes.
It has been podiumd that the optimization of the designs and the ideal topographic control allows to reduce the ratio of convertible of the three mines as shown below:



5.2 TECHNOLOGY OF THE MINE'S GEOMETRIA

When marking on the ground, the mining operator has a guide to follow and makes the cuts and fills according to the chamfers installed in the field.
It is possible to see slopes with heights and angles established in geotechnical studies; Flat berms with the right widths, roads with optimal designs, safe operation, topography with well-defined geometric sides and compliance with international standards. The following photographic records show the process of cutting and filling technology in theMines and the final result.

Steril courts for San Antonio Mine development.

Terraces of development Mina San Antonio.

Profile of slopes Mina San Antonio.

Geometria Area of stennile dispocision No. 1 Mina San Antonio

Geometria Area of stenci dispocision Cuista No. 2 Mina San Belencito

Geometria Area of stenci dispocision Cuista No. 2 Mina San Belencito

Geometria Area of stennile dispocision No. 2 Mina San San Antonio

Geometria Front exploitation Mina Belencito

Geometria Area of stennile dispocision No. 2 Monjas MIne

Geometria Area of stennile dispocision No. 1 Monjas MIne

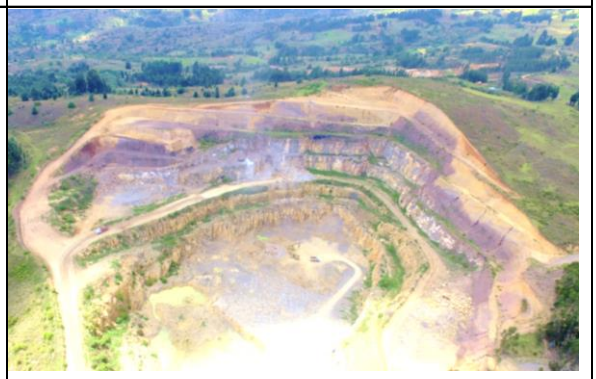
5.3 SAN ANTONIO MINE

ANTES	DESPUES
	
	
	

5.4 BELENCITO MINE

ANTES	DESPUES
	
	
	
	

5.5 MONJAS MINE

ANTES	DESPUES
	
	
	
	

6. Conclusions

- It is possible to demonstrate the technology in a mine through topographic control, well-defined berms and slopes and developed ore cloaks

- Topography has become a very dynamic profession, it must incorporate more knowledge into daily applications in addition to the essence of the surveyor is required to have a broader field of action.

- The technology of mining operations is necessary to be able to guarantee the extraction of minerals, it must be at the forefront of technology.

- Between different Teamworks with people with different capacities allows to achieve success in any project, this with a clear guideline established in a previous planning.

- Topography is an indispensable tool in the implementation of a mining planning, since it allows to make precise cuts and fills, rethink established alignments and comply with the monitoring and production indicators.

- An unsentweight mine cannot guarantee its long- or medium-term existence.

- Untracked topographical mining becomes a mine with unsafe operations.

- A No Topography mine will generate arbitrary geometries, even though a Mining planning has been established, it will not be able to reach the objectives set with the design data.