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Significant Improvements in Mining with X-Ray Diffraction, Reduce Operating Costs, Greater Recovery of the Mineral and Reduction of the Volume of Mining Waste

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Abstract

In many cases during the mineral extraction, the mining engineer in each blasting, faces surprising changes in the quality of the mineral, having no precise information of the atomic changes of the minerals, X-Ray Diffraction (XRD) delivers data on where the atoms are in the minerals, reconstruct each inorganic compound known as Mineral.

Introduction

In many cases during the mineral extraction, the mining engineer in each blasting, faces surprising changes in the quality of the mineral, having no precise information of the atomic changes of the minerals, X-Ray Diffraction (XRD) delivers data on where the atoms are in the minerals, reconstruct each inorganic compound known as Mineral, see Figure 1.

I have been an eyewitness to the stoppage of some mineral work, due to the change of sphalerite, mineral with the highest content of zinc to marmite, rich in Iron and less Zinc.

The XRD [1], does not destroy the sample, is recovered after passing it through the diffract meter, measuring device, very different from other analysis techniques such as atomic absorption and ICP, which destroy the sample and use chemical reagents, this means that no the analysis of the same sample can be repeated, there is no evidence to support the data that will be used by the mining engineer.

In fact, the analyzes made by some companies and the 3D three-dimensional modeling [2] of mineralized bodies fig. [3,4], have large errors and differ from the precision needed by the operating mine engineers who are in charge of the mining personnel in each guard (work shift) are less accurate. We can improve it by up to 45% with XRD; this means that the mining engineer will have the necessary information, in advance, of the changes in the atomic structure of the minerals not only of ore (rich part) but also of the bargain (low grade material) before each blasting.

Here are 4 cases where the mining operation and the respective solution with XRD have had to be stopped

The absence of data is the cause of the stoppage of mining operations:

1. This is the case of the changes in the zinc content in the sphalerites see Figure 2 which went from having very little iron content to having very high iron percentages (Figures 1 and 2).

Solution: With XRD information, this problem is avoided because it is

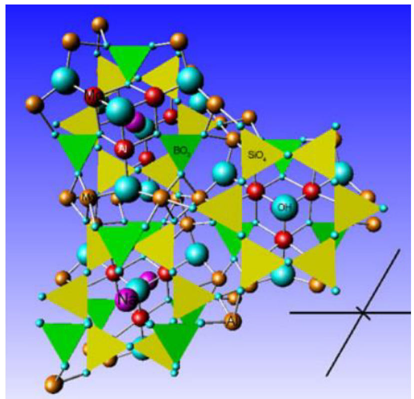

Figure 1. This is an example of three-dimensional Reconstruction, to identify the position of the atoms, which are sought to be extracted from minerals, The crystalline network of a mineral has unique properties and characteristics, which help a greater recovery of the chemical elements such as Copper, Zinc, from the stages of Prospecting, Exploration, Metallurgy and mining waste.

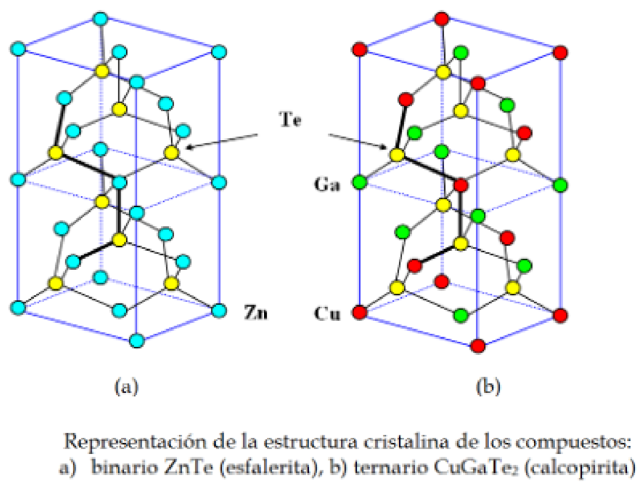

Figure 2. Zinc (zn) atoms can be replaced by Iron (fe) atoms. This complicates the process of zinc exploitation and metallurgical extraction.

possible to predict at what depth the change is going to occur and the plant is alerted that material of different crystallochemical composition will arrive, so the metallurgical treatment must have a priori information about these crystallochemical changes, so as not to throw ore at the tailings.

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2. Costs are increased by not predicting crystallochemical changes in mining: On costs due to changes in positions of the aluminum and silicon atoms, they affect the quality of the silicates that make up the rocks, where mining engineers work, for example, to make the huge shafts to extract the ore.

Solution: This is avoided with crystallochemical analyze [3] by X-Ray Diffraction "XRD".

3. When tin is found not only in the cassiterite but also in the Micas Figure 3.

The data on tin content delivered by the AA and ICP analyzes are not very accurate, because the recovery of tin will be well below the estimate and then much of the tin is lost in the queues emitted by the plant (see photo attached, which presents a slide with crystals of cassiterite and biotites that also contain tin Figure 3.

Solution: It is defined very well a priori how tin atoms are not only in the cassiterite but also in the micas and other minerals that usually contain it.

4. The atoms of calcium and magnesium, more than 1% of magnesium is enough to stop the extraction of the material from the open pit.

Cement should not use; in its manufacture; rocks with more than 1% of magnesium, then the mining engineer has to stop the extraction of the quarry parts with the presence of magnesium.

Solution: Samples from exploratory drills [4], which are made before the start of the operation, will have accurate data to select at what depth, what extent and what parts of the quarry these materials should not be extracted, due to the presence of magnesium in these rocks, the same happens with the analysis of the drills [5] of any mine, where XRD data should be included.

Summary

We present below moments of the extraction and benefit of the mineral where XRD analyze provide important data on the properties of the rocks and minerals that are being worked, the detail of how it works will be explained later in each of the moments included In the list, having XRD data reduces operating costs, greater recovery of the mineral and reduction of the volumes of mining waste, see Figures 4 and 5.

In mineral extraction, saving money and time

1. Cost reduction in the extraction of the mineral itself.

2. Lower amount of explosives and blasting in engineering works: pikes, tunnels and cuts, in sterile material.

3. Improvements and greater precision in determining and recognizing the shape of the mineralized body.

4. Greater accuracy in identifying changes in sterile and non-sterile areas [6].

Figure 3. Minerals in addition to cassiterite may contain tin, in the photograph the micas contain tin atoms.

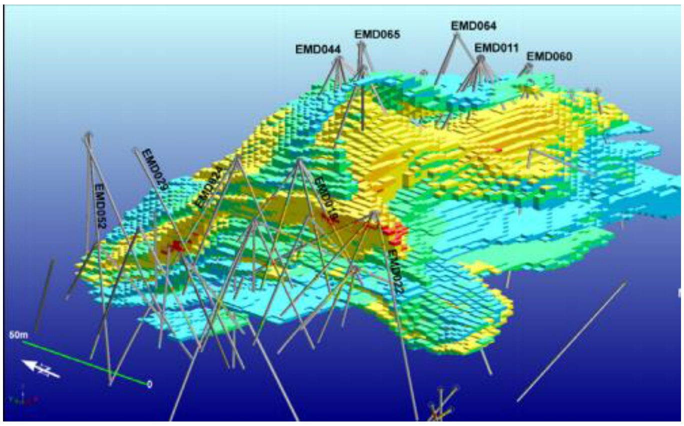


Figure 4. 3D model, ready for the exploitation design, can be improved with XRD data and avoid surprises by not including information about atom changes.

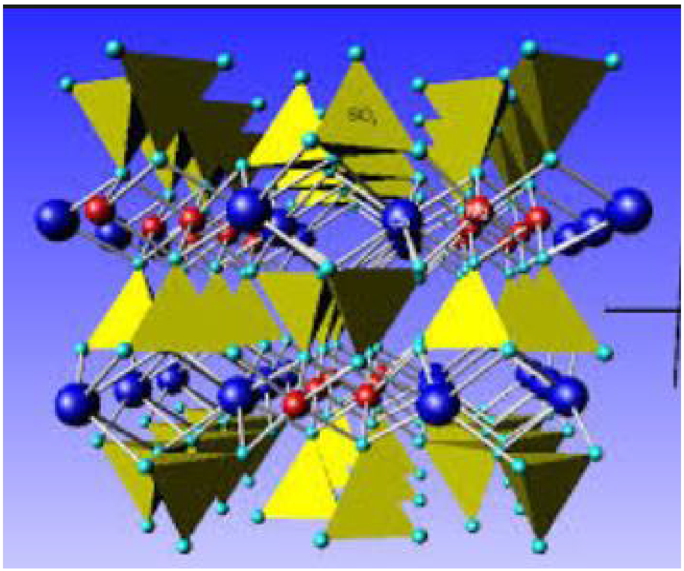


Figure 5. With these crystallo chemical data, the risks of encountering a mineralogy different from that estimated with the drills and other types of analysis are reduced, where those of X-ray Diffraction and Plasma Crystal Chemistry have not been included, among other techniques of analysis.

5. The identification of the limits between the ore and the bargain throughout the mine are much more precise.

6. Contributes help to define and choose from the rocks, which is the best to develop tunnel access to the mine.

7. Reduction of man time and time in three-dimensional modeling work.

8. The risk of having to stop the exploitation due to unscheduled and surprising changes in the type of mineral is reduced.

9. The transfer to the mining engineer [7] of all the information is much more precise.

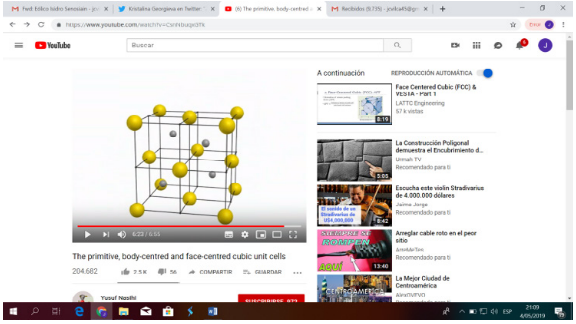
10. Value added by the presence of unidentified chemical (mineral) elements.

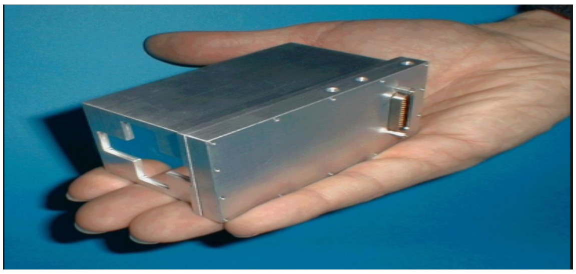
In the treatment of ore in the plant, saving money and time

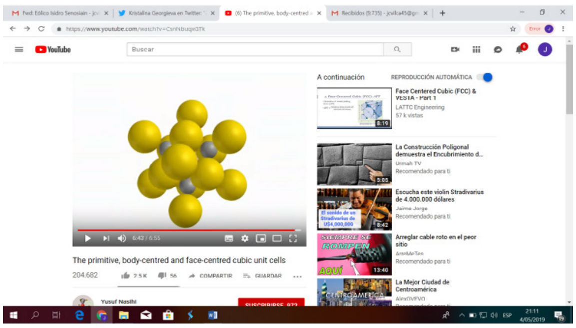
1. Improves the recovery of the mineral (Chemical Element) in the plant.

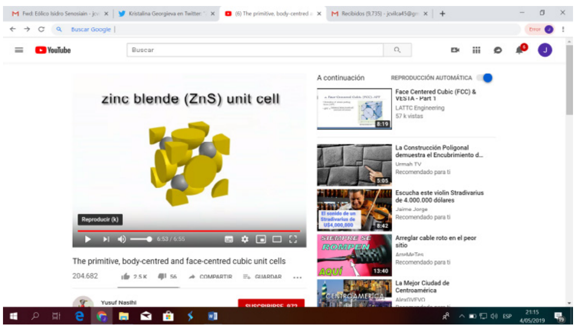
2. It is used to visualize in a three-dimensional way with which other chemical elements are united and / or associated with the one we want to recover.

3. It serves to identify the types of chemical and crystallochemical association, for example, tin with niobium and tantalum.









4. The head mineral that enters the plant is more uniform, it comes with more information.

5. Plant claims are avoided due to a change in the quality of the ore that arrives from the mine.

6. It is to predict added value by the presence of other minerals not identified with the other types of analysis.

7. It reduces the changes on the fly in plant, to adjust them to the appearance new minerals.

8. Interference is minimized.

9. Help in the recovery of a mineral determined by interference of a new one.

10. The volume of material being discarded and / or sent to the tailings is reduced.

11. Recovery rates improve.

12. The new intermediate products of the metallurgical process [8] are valued.

13. Improves the efficiency and effectiveness of plant treatment.

14. Serves to boost control.

In the tailings and waste deposits left from the mine and plant, saving money and time

1. Costs are reduced by minimizing the impact on the Environment (nature).

2. With clean Cys-Plas technologies it is possible to minimize this waste.

3. Production of electric energy [9,10] from part of this waste

In the control of inputs and components and other related and related areas

Quality control of materials and supplies, saving money and time

Conclusion

1. The new diffraction data will help the mining engineer, from the design of the extraction of the mineral to the waste produced in the mining processes.

2. The XRD data provide information to the mining engineer, so that he knows how deep the sphalerite mineral with high zinc content and very little Iron will change to the marmatite mineral with high iron concentrations, which generates serious problems in the treatment plant where it is required to recover zinc.

3. In the open pit the change of minerals with calcium to minerals with magnesium above 1% of magnesium forces to leave that part of the pit open and work only with those that have calcium.

4.New techniques such as XRD, not only provides essential data on ore ores, but works well with the minerals that make up the sterile rocks where extraction tunnels are built and the large pikes to extract the ore, is to say civil works usually.

5. Know that the contents of gold, tin, zinc, among other chemical elements and how they are and in which minerals these chemical elements are, is important in, for example, tailings and other waste from the mining industry.

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