GEOCHEMICAL STUDY OF WASTE DIKE FROM KHERZET YOUCEF AND CHAABET EL HAMRA MINES

[1]MALEK OULD HAMOU, [2]AMIRA MERCHICHI

[1,2]Laboratory of mining engineering, National Polytechnic School, El Harrach, Algiers, Algeria.
E-mail: ouldhamoumalek@yahoo.fr, amira.merchichi@g.enp.edu.dz

Abstract - Today, the mining industry raises very acute environmental problems. The major difficulty with the approach of the environmental problems in the mining industry is the extreme diversity of situations, which implies particularly varied solutions. This work contributes on one hand:
- A better understanding of the geochemical behavior of mineral processing tailings from Kherzet Youcef and Chaabet El Hamra mines. This requires a granulo-chemical and mineralogical characterization.
- In the other hand, to beneficiate these residues by flotation as to a get ride of the heavy metals wich are harmefull to the environment.

Index Terms - Environment, Geochemistry, Flotation, Leaching, Mine Tailings.

I. INTRODUCTION

Exploitation and beneficiation of minerals generate economic profiles and even large quantities of solid and liquid wastes. Since the last century, it was the case of Youcef Kherzet mining complex, located in the Ain Azel region (wilaya of Setif), dealing with ore flotation operated two fields: lead - zinc deposit of Kherzet Youcef and zinc deposit of Chaabet El Hamra. As mater of fact, this complex has produced a large quantity of waste which isstored on the surface. In recent years, research studies were conducted in order to control the Environmental problems caused by residues [1] [2], and limit their impacts by the application of methods controlling the contamination from these residues.

This work presents the results of a study of the geochemistry, and the re-processing of tailings coming from the site of Kherzet Youcef complex (W. Setif) using the flotation method.

The tailings are subject to some chemical instability which is the likely source of pollution of the surrounding environment (alluvium soils, groundwater…) [3]. Following the mobility and dispersion of ETM (trace metals) such as arsenic, cadmium, copper, lead, zinc ... This is confirmed by the analyzes of leachate column.

To reduce this environmental problem caused by this waste, we proposed the flotation solution. Hence, the metals contained in the tailings was reduced and the Lead and Zinc is economicaly recovered. The experiment started with collective flotation, followed by a selective flotation while optimizing the amount of flotation reagents used for this purpose.

The area concerned by this study is located in the east of Algeria, city of Ain Azel (Fig.1). This complex includes two lead-zinc mines: the mine of Kherzet Youcef, 5 km northwest of the city of Ain Azel and the mine of Chaabet El Hamra, 4.5 km from Ain Azel and 12 km to the southeast of the mine of Kherzet Youcef, respectively. The tailings dam occupies an area of 7Ha [4] [5].

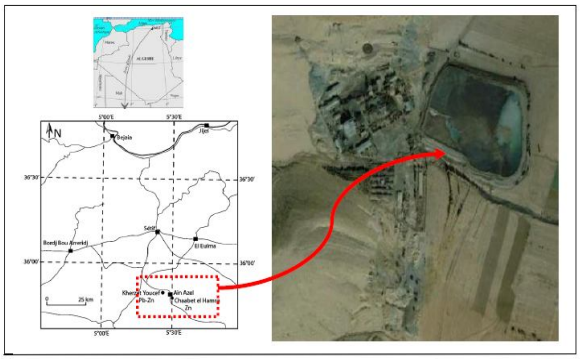


Fig. 1 Location of the study area

II. METHODOLOGY

In the laboratory, we have prepared six samples for characterization and for leaching tests (in columns and mini cells) and flotation (Fig.2).

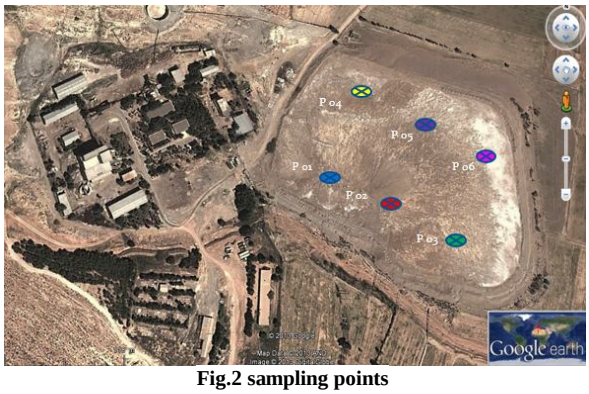


Fig.2 sampling points

The first step is the characterization, in which we determine the chemical analysis of the grains, and the

physical properties (density, humidity, carbonate content).
The second step is the granulo-chemical study of 03 samples, allowing us to determine that the zinc-lead mineralization is in the fine fraction (between 63 µm and 200 µm). In addition, the size of the residue is spread.
The analytical methods used are mainly XRD (X Ray Diffraction) and AAS (Atomic Absorption Spectroscopy).
The results of the diffraction analysis confirm the alteration of the residues by the presence of sulfate minerals due to their contact with air and water; Moreover, it allowed us to know their mineralogical composition: sulphides of zinc, lead, and iron. Carbonate minerals especially dolomites are also present.

A. Column tests

The column tests were carried out in order to study the geochemical behavior occurring in the dam tailings and evaluate their potential for generation of acid mine drainage or contaminated neutral drainage. In this study, the leachate waters with zinc and other metallic elements is evaluated. Six columns (C1 to C6) have been installed, each containing one of the sampled residue.
The kinetic column tests are performed in columns made of PVC (Polyvinyl chloride) with a height of 01 m and a diameter of 10 cm. A geotextile placed at the bottom to prevent migration of the particles and allow the circulation of water, as shown in Figure 3.
The column tests are carried out in the laboratory for one month. The wetting (or leaching) corresponds to a filling of the column with distilled water until the surface of the waste rock [6]. The water stays in contact with the residue for one month. Then the column is emptied by the bottom valve on a duration of 3 days and chemical analysis are carried out.

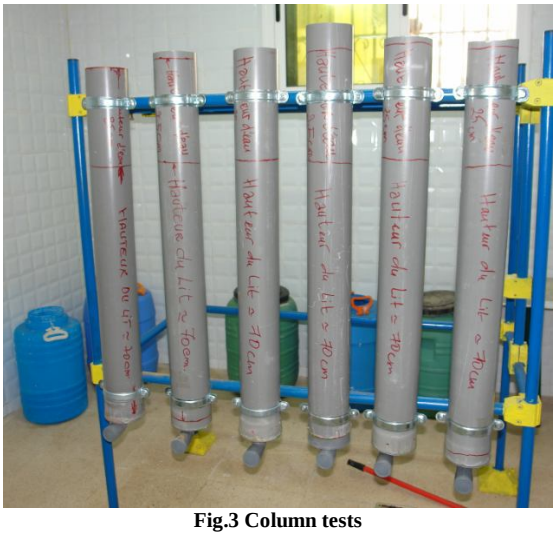


Fig.3 Column tests

B. Mini cells tests

Kinetic tests were carried out on a smaller scale in order to evaluate the geochemical behavior of releases from the Chaabet El Hamra and Kherzet Youcef mines. the mini-cells were the most appropriate tool, because the tests are easier to implement and can amplify the reactions [7].

Sample preparation

The residues contained in the mini-cells are of different composition:
Mini cell 01: sample ground to 80µm.
Mini cell 02: sample without grinding.
Mini cell 03: sample composed of 80% of residue without treatment (grinding) and 20% of Carbonates.

The mini-cell tests are based on a methodology developed by Cruz (2001), modified by Villeneuve (2004). They are also kinetic tests with wetting-drying cycles and the results of this method are often similar to those of the wet cell tests (ASTM D5744-96 standard), but are obtained on a smaller quantity of sample [8] [9].

Seventy grams of each type of residue are introduced into Buchner funnels with a diameter of 9 cm on a 0.45 µm pore filter paper. The Büchner is placed on a support under which is placed a vacuum flask of 250 ml to recover the leaching water, as shown in Figure 4 below.

Two leachings per week are performed (every 3 and 6 days alternately) [10]. During these, 70 ml of distilled water are introduced into the mini-cell and remain in contact with the waste rock. The water is then removed under vacuum from the cell to be recovered in the Erlenmeyer flask. Parameters analyzed are pH and potential Redox.



Fig.4 Mini cells tests

C. Flotation tests

Flotation tests were performed by using two flotation cells (Denver). The conditioning time of each reagent is set for all flotation tests, and so is the flotation time. We recover the foam formed on the surface, during 5 minutes for Pb and Zn, corresponding to a main flotation and / or control.

For each test, a quantity of 250 g or 375 g of residue (according to the flotation cell) and a volume of water respecting the liquid/solid ratio. The reagents were then added according to the type of flotation [11].



Fig.5 Flotation cell

III. RESULTS

The leaching tests in PVC columns, allowed us to confirm that the residue impact on the environment by the release of trace metals such as arsenic, cadmium, copper, lead, zinc…

This conclusion is proved by the analysis of leachate columns Cd (38.36 µg/l) Cr (< 5 µg/l) , Cu (83.93µg / l) and Ni (43.46µg / l). The tests in mini cells, allowed us to note that the dam has a neutral medium (pH = 6-7). Then we can note that residues do not generate acid mine drainage, but a contaminated mine drainage.

To reduce this environmental impact of residues, we used flotation. The flotation treatment method begins with a selective flotation in order to develop, lead and zinc. These results are conclusive for Zn concentrate, however unfavorable for lead recovery.

In addition, the results of flotation tests on three different classe sizes showed that the optimum recovery of both concentrates is in the fraction of 100/200 microns. Therefore, an advanced mechanical preparation will increase efficiency. In the end, we also studied the collector as a main parameter and by achieving a best recovery, with a consumption of 200g per tonne of ore processed.

In conclusion we have proposed a flowsheet using a flotation process, in the one hand and the re-processing of the tailings as to reduce the heavy metals in the final residues.

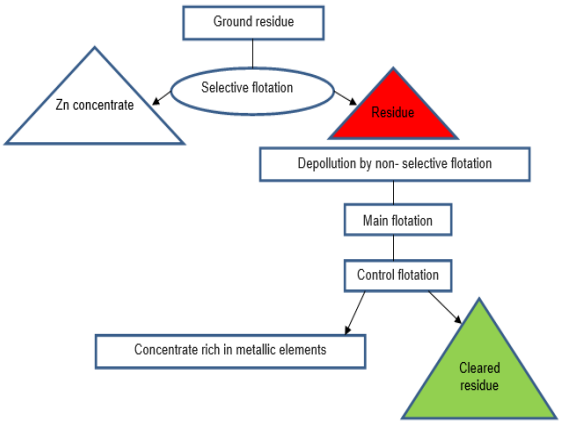


Fig.6 Proposed flow sheet valorisation and re-treatment of Kherzet Youcef tailings

CONCLUSION

Research studies have been conducted to control the environmental problems generated by residues, to limit their impacts, by the application of methods controlling contamination from these residues. In addition, geochemical studies were conducted to control the mechanisms governing geochemistry of metals under different conditions.

In view of the results obtained in this work, we propose to guide the further work as follows:

- Optimization of the proposed flotation scheme and its application at industrial scale;
- Characterization of residues in depth.

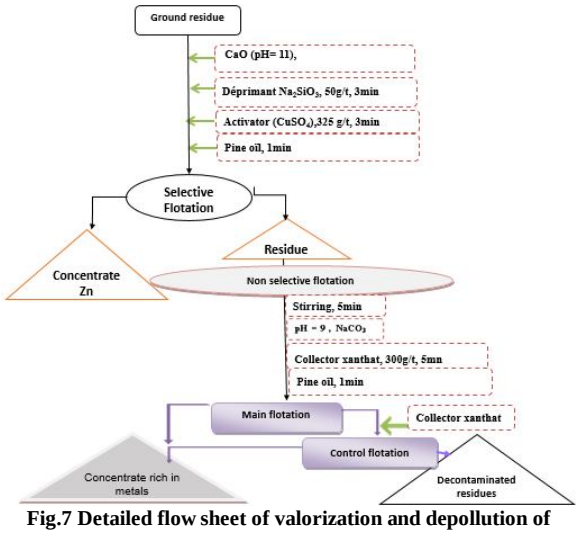


Fig.7 Detailed flow sheet of valorization and depollution of Kherzet Youcef tailings

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