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Research Paper

Recovery of Rare Earth Elements from the Tailings Dam of Chador Melo Iron Ore Processing Plant

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Abstract: The tailings dam of the Chadormelo iron ore processing plant has rare earth elements and its identification operation was carried out in the first step. The results showed that the tailings dam is composed of major minerals such as hematite, quartz, fluorapatite, calcite, goethite, and dolomite so that about 84.75% by weight of this sample is iron oxides with 41.52% by weight, calcium and magnesium oxides with 17.74% by weight, quartz with 20.2% by weight, and aluminum oxides with 5.29% by weight respectively. The total grade of rare elements in the sample is 1068.57 ppm, of which 84.61% by weight are light rare elements and 15.39% by weight are heavy rare elements. The d80 of the sample is 46.35 microns. SEM studies showed that the minerals monazite, xenotim, and apatite in this sample contain rare elements and the monazite mineral is dispersed in the amount of iron and apatite in a few microns. The wet magnetic separation method was used as a pre-concentration method for iron removal and pre-concentration of rare elements, which due to the high grade of rare elements in the magnetic product (802 ppm) as a pre-concentration method for rare elements before the leaching operation Not used.

Keywords: Iron Ore tailings dam, Chadormelo, Rare element recovery, Monazite, Apatite.

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INTRODUCTION

The diverse optical, magnetic, electrical, catalytic, chemical, metallurgical, and nucleus properties of rare elements have led to new technologies such as LCDs, permanent magnets, home batteries, and mobile rechargeable batteries have application. [1-3]. There are about 200 minerals of rare elements, among which, monazite (Ce, La) PO4, xenotim (YPO4) are economic minerals [3,4]. There are a variety of processing methods for preconcentration rare elements. After extraction and crushing, the ore is preconcentrated by methods such as flotation, magnetic separation, or gravity to obtain concentrates of rare elements. Then, to recover the compounds of rare elements, the obtained concentrate is subjected to leaching with hydrochloric, nitric, or sulfuric acid [5,6]. The choice of each of the sulfuric, nitric, and hydrochloric acids as a leaching agent depends on the selected properties in the separation of rare elements, the type of gange minerals in the ore and the type of organic solvents used in the extraction step. [7,8]. After leaching, by methods such as extraction with organic solvent [9], ion exchange [10] and precipitation [11], the operations of enrichment and purification of rare elements are performed, and finally, after purification, rare elements in solution are recovered as carbonate, sulfide and hydroxide deposits [12]. Iran is one of the importers of rare elements. For this reason, sampling was done from the waste dam of Chadormelo iron ore ores factory, which contains rare elements, and to determine the appropriate method of ores, pre-processing and extraction of its rare elements, identification was performed in the first step.

IDENTIFICATION STUDIES

Sampling

From the tailings dam of Chadormelo iron ore processing factory with dimensions of approximately 200 meters by 300 meters, ten separate points with a distance of approximately 50 meters from each other, using a mechanical excavator, a well with a depth of approximately 5 meters and a diameter of approximately 2 meters was dug at each point. And from different parts of the excavated materials, 5 sub-samples and a total of 50 sub-samples with a total weight of 1327 kg were sampled at each point. After drying and passing the samples at each point through a 500 micron sieve, homogenization and sample division were performed.

Materials and methods

ASTM model sieves have been used for more sieve analysis. Aligent 7900 ICP-MS was used to analyze the rare elements. Magix pro (Pw 2440) XRF device was used to identify the oxide composition of the constituent elements of the materials in the tailings dam.

ICP-Mass analysis

The results of analyzes performed on ten samples separately and combined samples showed that the difference in the grade of rare elements in the samples taken from different parts of the tailings dam with the combined sample is very small, so instead of interpreting on separate samples, experiments and interpretations have been performed on composite samples prepared from a mixture of 10 separate samples. Figures 1 and 2 show the average grade of light and heavy rare elements in terms of ppm in the composite sample, respectively.

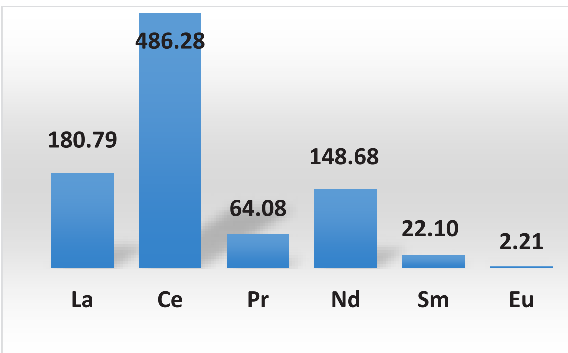

Figure 1. Average grade of rare light elements in terms of ppm in the composite sample

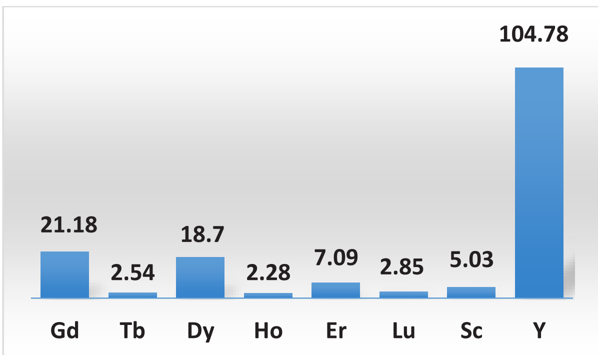

Figure 2. Average grade of rare heavy elements in terms of ppm in the composite sample

XRF analysis

XRF results showed that about 84.75% by weight of the total sample were iron oxide minerals (hematite and goethite minerals) with 41.52 wt%, calcium and magnesium oxides (calcite and dolomite minerals) with 17.74 wt% and quartz with 20.2% by weight, and aluminum oxides with 5.29% by weight.

Sieve analysis

Sieves of 106, 90, 75, 63, 53, 45 and 38 microns were used for sieve analysis. d80 The representative sample is 46.35 microns.

XRD analysis

The results of XRD analysis on the sample show that the tailings dam is composed of major minerals such as hematite, quartz, fluorapatite, calcite, goethite, and dolomite, respectively

SEM study

The results showed that the monazite and apatite minerals in the sample contained rare elements. Monazite mineral is a few microns more scattered in apatite mineral. The involvement of monazite with iron oxides is also observed in many parts of the samples. In some areas, monazite is also found to be involved with carbonate minerals such as calcite and dolomite. Xenotime (yttrium-bearing mineral) is also seen to a lesser extent in the sample, which is involved with monazite and apatite.

INVESTIGATION OF UPGRADING OF RARE ELEMENTS BY WET MAGNETIC SEPARATION METHOD (HIGH INTENSITY)

A high-intensity magnetic separation operation (17,000 gausses) was performed on the feed. A magnetic separation operation was performed on the magnetic product with an intensity of 12,000 gausses to separate the ferromagnetic material from the diamagnet. It carries the weight of rare elements and this part in terms of weight constitutes 35.48% of the total weight of the input load with 802 ppm. Lack of sufficient degree of freedom and the involvement of minerals containing rare elements such as monazite, apatite, and xenotim with iron oxide minerals, the results of SEM studies in Figure 3 also confirm the involvement of these minerals with iron oxides.

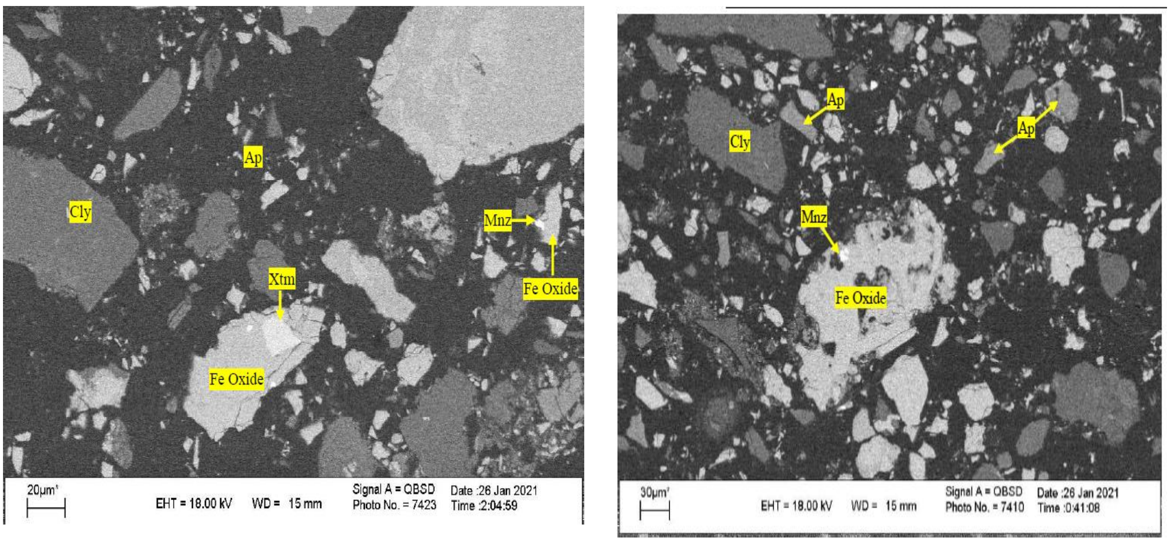

Figure 3. Involvement of monazite, apatite, and xenotim with iron oxides in the magnetic separation product

CONCLUSION

The sample taken from the tailings dam of the Chadormelo iron ore processing plant contains rare elements and to preconcentration and select a suitable method for recovering the rare element, it is necessary to identify the studied sample. The results of these studies are summarized as follows:

Hematite, quartz, fluorapatite, calcite, goethite, and dolomite are the main constituent minerals, respectively, and about 84.75% by weight of the total sample are iron oxides (hematite and goethite minerals) with 41.52 wt%, respectively. Calcium and magnesium oxides (calcite and dolomite minerals) with 17.74 wt%, quartz with 20.2 wt%, and aluminum oxides with 5.29 wt%. The average grade of iron in the sample is about 28.51% and the grade of iron increases from 19.24 to 30.31% by decreasing the grain size from 110 microns to less than 45 microns, respectively. The results of SEM studies have shown that the minerals monazite, xenotim, and apatite in this sample contain rare elements. Monazite mineral is observed in a few microns more scattered in apatite mineral. However, monazite interactions with iron oxides can also be seen in many parts of the sample. In some areas, monazite is also found to be involved with carbonate minerals such as calcite and dolomite. 53.5, 19.99, and 16.44 percent of the total weight of rare light elements. Of the heavy elements, the elements yttrium, gadolinium and dysprosium have the highest grade and make up about 63.71, 12.88, and 11.37% by weight of all rare heavy elements, respectively. The total average grade of light and heavy rare elements is about 904.12 and 164.45 ppm, respectively, and the total average grade of all rare elements in this sample is about 1068.57 ppm, of which 84.61 its weight percentage consists of rare light elements and 15.39% of its weight consists of rare heavy elements. The results of sieve analysis also show that the d_{80} of the studied sample without crushing with only the initial preparation is equal to 46.35 microns. Due to the high percentage of iron in the test sample, high-intensity magnetic separation method was performed to remove iron and preconcentration rare elements. Due to the interaction of rare element minerals with iron oxides, the isolated magnetic product contained 802 ppm of rare elements. It shows that the magnetic separation method has not performed well in the field of preconcentration and the direct acid leaching method with nitric and hydrochloric acids is recommended to recover rare elements.

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