Chromite mining waste valorization: ultrabasic rocks as neutralizing agent of acidic media

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Introduction

Chromite is mined from ophiolite complexes, which is found in the lower layers of these, between basic and ultrabasic igneous rocks. Therefore, during the mining and beneficiation processes applied for chromite, significant amounts of solid waste materials can be usually produced. These ultrabasic rocks are mainly various structures of olivine and serpentine (i.e., hydrous structures of olivine), which can also be considered as useful by-products, rather than waste. Their utilization in other processes complies with the principles of circular economy, as applied in mining activities and it has already attracted the interest of scientific community. Aim of this study was the chemical and structural characterization of an ultrabasic rock sample obtained from a chromite mining area and, subsequently, its valorization as a neutralizing agent of an acidic media.

Experimental

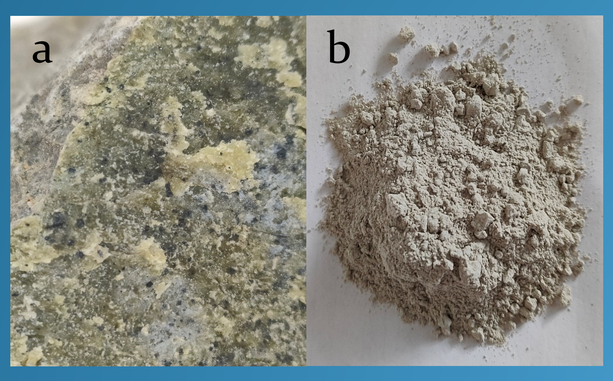

Figure 1. Samples (a) rock and (b) sieved.

- This study was carried out with samples collected from the Vourinos area in Kozani region (Western Macedonia, Greece). The sample (Fig. 1a) was grinded, homogenized and sieved <250 μm (Fig. 1b).
- Characterization by X-Ray Diffractometry (XRD) and acid digestion chemical analysis.
- For neutralization experiments, 1-6 g of the sample was placed in a conical flask and 50 mL of 0.01M H_2SO_4 was added. Then, the flask was placed on a rotary shaker for 30 min. Afterwords, the solution was filtrated, and the pH of the aquatic phase was measured.

Results and Discussion

Structural and chemical analysis:

Ultrabasic rocks are mainly various structures of olivine [$(Mg,Fe)_2SiO_4$] and serpentine [$(Mg,Fe)_3Si_2O_5(OH)_4$]. Both structures were obtained in the initial homogenized sample (Fig. 2), dominant phase of serpentine was lizardite. The serpentine group Si/(Si+Mg) ratio is in the range 0.4-0.6, while the initial sample's corresponding value was at 0.45 (Table 1). The ratio Mg/(Mg+Fe) of olivine is in the range of 0.65-0.95 and sample's corresponding value was calculated at 0.83.

Table 1. Chemical analysis of the sample.

Metal	Mg	Si	Fe	Cr	Other
% wt.	24.9	20.2	5.1	ND	<1

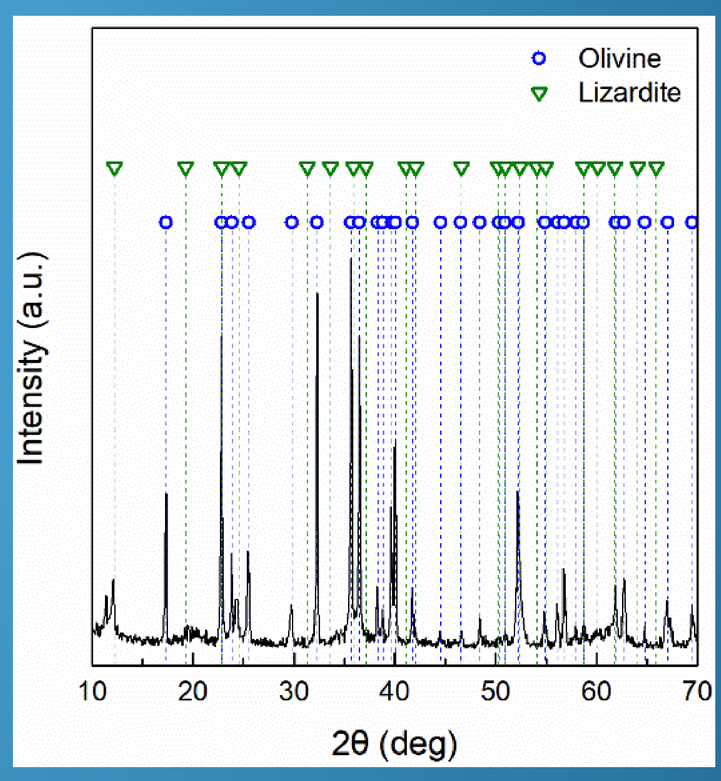

Figure 2. XRD diagram of the sample.

Neutralization experiments:

A high increase in pH value (4.56) of the acidic media (initially pH ~2) was obtain by the addition of only 1 g of the sample. The complete neutralization was achieved when 5 g of the sample was applied, following an almost linear increasing rate (Fig. 3). Regarding the dissolution of sample's metals to the aqueous phase, the concentration of Mg was in the range 160-200 mg/L for all the equilibrium pH values and Fe was <1 mg/L when the pH reached values above 3.

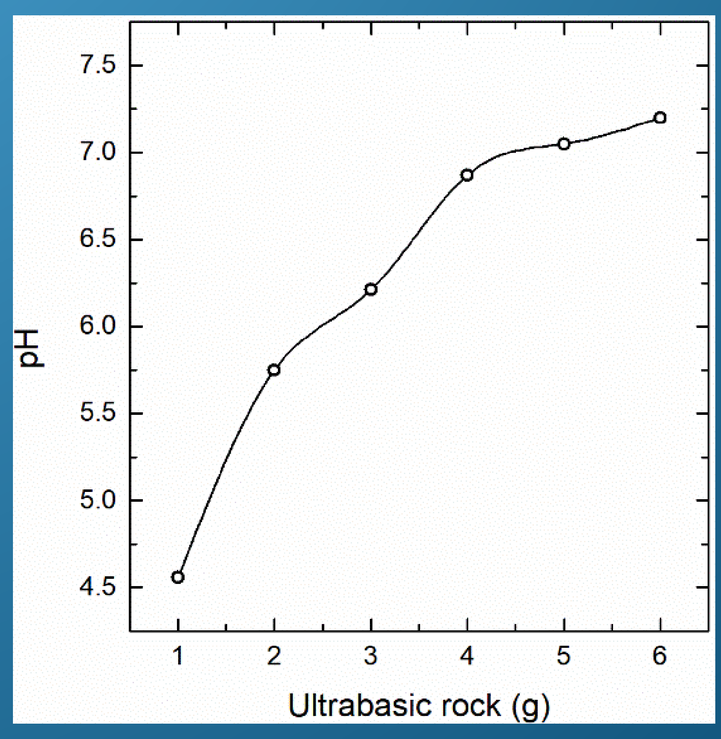

Figure 3. Neutralization of the acidic media.

Conclusions

- High serpentine content was identified in the collected ultrabasic rocks/waste.
- Ultrabasic rock waste from chromite mining was free of chromium which limits the risk of secondary contamination when using it in other applications.
- Its valorization as a neutralizing agent was achieved since the acid media reached a mildly alkaline pH value after implementation.
- This work considered to be the first step of the waste's evaluation in order to be used in real acidic waste, i.e., acid mine drainage.

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