

Cyclic voltammetry applied to the characterization of contaminated soils

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RESUMEN

Mining industry in Mexico has been one of the main productive activities of the country (after the conquest); today, the environmental impact generated by the high volumes of sulfurous residues left in the jales dams, is the problem to solve. Climatic characteristics of the sites where the residues are deposited have provoked their dispersion or mobility through an extended area urban or rural, giving place to soils contaminated by arsenic and heavy metals with high contaminating potential (PTE's: Pb, Zn and Cd). On the other hand, voltammetric techniques with carbon paste electrodes (CPE) have been considered, in the last 9 years, as powerful tools to characterize the oxidation and reduction processes of the pure sulfurous minerals [1-9] (galena, pyrite and arsenopyrite, etc.). However, the characteristics of those minerals are far away from that of the soils. The objective in this work is to validate the voltammetric methodology with CPE's to study contaminated soils with PTE's.

Figure 1 shows the main PTE's concentration of one profile of the soils to be analyzed and the picture of the soil *in situ*, which has been denominated profile 3.

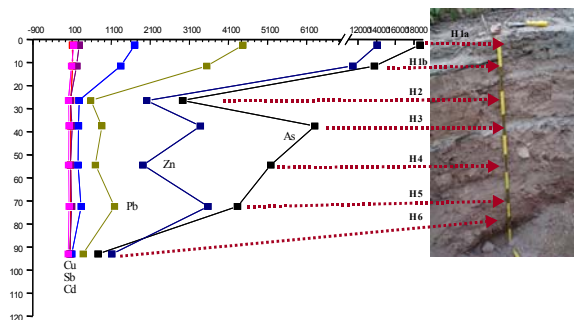


Figure 1 Chemical Analysis (fraction less than 250 µm) of the contaminated soil denominated profile 3.

Voltammetric response (showed on figure 2) of the different horizons of the contaminated profile, show that when the scan potential was initiated in the positive direction, an oxidation process is observed. In the reverse scan, at least one reduction process is observed, while toward the oxidation there are not well-defined peaks. When the scan is initiated toward the negative direction, there are not oxidation and reduction peaks, indicating that the peaks observed in the positive scan are associated to the reduction or oxidation of the products generated by the soil and the sulfurous minerals oxidation.

It is worth to mention, that the oxidation processes could be associated to the soil voltammetric response and not to the sulfurous minerals contaminating the soil. In that order, an experimental test was made by concentrating the oxidation products on the CPE surface. This was achieved by applying an oxidation

potential during 10 min and finally to obtain a voltammogram in the positive direction.

Voltammetric responses obtained when the PTE's were concentrated allowed detection of the oxidation peaks of the sulfurous minerals from the mining residues. As an example, reduction processes C1, C2, C3 and the oxidation processes A2, A3, A4, observed in the soil electrochemical response when the scan was inverted, corresponds to As, Fe Pb, Zn y Cd species present in the soil (Figure 2). This affirmation was made according to the pure sulfurous minerals responses, which were found in the same potential ranges [10].

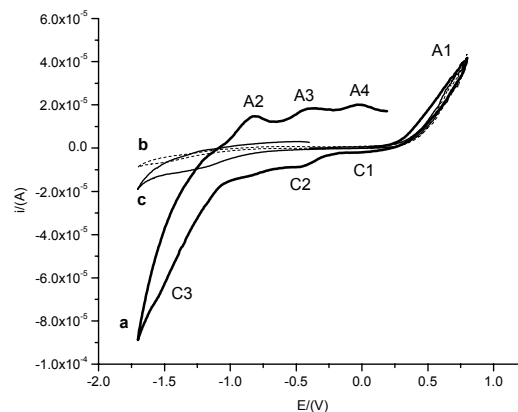


Figure 2. Voltammograms obtained on CPE-Soil 20:80%, in 0.1 M NaNO₃ with 20 mVs⁻¹ scan rate. Potential scan was initiated to positive (a y c) and negative (b) direction.

According to the literature and from this results it is possible to conclude that, being the pyrite and arsenopyrite the minerals most easily encountered in the mining residues, the acid drainages are generated by the oxidation of the ferrous minerals. On the other hand, the voltammetric methodology with CPE's to study contaminated soils with PTE's resulted adequate and it can be used in obtaining additional information of the natural oxidation mechanisms of the soils.

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