

Microscopical studies to evaluate oxide copper ores in Sarcheshmeh Copper Mine, Kerman, Iran

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As a result of biological, environmental, and economic considerations, available copper in copper oxide ores that could not be recovered by pyrometallurgical methods was accumulated in so-called oxide dumps. Suitable material is treated with dilute sulfuric acid in a heap-leaching process, whereupon the copper content of the rock slowly dissolves in the acidic solution. The performed investigations show that one needs to consider the action of the acid on the copper oxide-containing rocks at the microscopic level (Fig. 1).



Figure 1: Photomicrograph of the malachite has been completely preserved in acid and texture of the rock (PPL. 5 \times).

Polished sections, thin sections, and powdered samples were subjected to chemical analysis as well as petrographic and mineralogical considerations. Microscopic studies have indicated that chemical analyses do not provide a complete picture of the effects of acid on the rock. Thus, microscopic studies on sections are shown to be a necessary requirement, neglecting of which can have negative economic and environmental effects [1].

[1] Shayestehfar M. R., Kariminasab, S. & Mohamadalizadeh, H. (2007) *Journal of Hazardous Material*, doi, 10.1016/j.jhazmat.2007.10.100.

XPS at mineral-water interface: New perspectives

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A recently developed fast-freezing procedure of wet mineral pastes centrifuged from aqueous suspensions [1, 2] as a sample preparation technique for conventional X-Ray Photoelectron Spectroscopy (XPS) experiments is presented. This technique makes it possible to approach a real mineral-aqueous solution interface in ultra high vacuum conditions. XPS data obtained for silica, gibbsite, goethite, manganite and hematite suspensions equilibrated in NaCl solutions of different pH and ionic strength are presented.

The data allow estimation of the surface density of electrolyte ions, surface point of zero charge and direct observation of interface chemical reactions such as ion pair formation, specific adsorption and ligand exchange. Evidence of unexpected reactivity of the neutrally charged basal plane of hematite resulting in the stabilization of a three-dimensional distribution of hydrated Na⁺ and Cl⁻ ions at the interface [3] is presented.

The use of fast-freezing preserves the immediate surroundings of ions and molecules at the interface, thus allowing to study chemical speciation of adsorbed organic ligands. A specific case of N-(Phosphonomethyl)glycine (PMG) sorption at the manganite and goethite surfaces is illustrated.

The technique is easy to apply to any suspension including colloids and gels of inorganic and organic nature, and was recently used to study bacterial surfaces [4].

[1] Shchukarev A. & Sjöberg S. (2005) *Surf. Sci.* **584**, 106-112. [2] Shchukarev A. (2006) *Adv. Colloid Interf. Sci.* **122**, 149-157. [3] Shchukarev A., Boily J.-F. & Felmy A.R. (2007) *J. Phys. Chem. C* **111**, 18307-18316. [4] Leone L. *et al.* (2006) *Surf. Interface Anal.* **38**, 202-205.