Acid Leaching and Dissolution of Major Sulfide Ore Minerals: Processes and Galvanic Effects in Complex Systems

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The mechanisms of dissolution of the major base metal sulfide minerals pyrite, chalcopyrite, galena and sphalerite in acidic (chloride) media have been investigated. Experiments were conducted with mineral powders (45-150 micrometre size fractions) prepared by grinding in air. During the dissolution experiments, the pH was maintained at 2.5 using an auto-titration instrument; solutions were equilibrated with air and experiments conducted at 25C. Dissolution mechanisms were investigated using both solution analysis (by ICP-AES and HPLC) and through the analysis of the surface chemistry of residual sulfides using XPS.

The results, which provide additional insights into mechanisms involved, suggest that the initial dissolution of pyrite is congruent and leads to a S-rich surface layer. In line with our previous work [1], chalcopyrite dissolution (as illustrated in Figs 1 & 2) is clearly incongruent with the development of a Cu, S-rich (near) surface layer; this is accompanied by the consumption of protons (unlike pyrite dissolution which results in acidification). Apparently incongruent dissolution of galena and sphalerite may reflect the formation of elemental S at the surface, although this was not directly observed under the experimental conditions used in our analyses.

The rates of dissolution of chalcopyrite, galena and sphalerite in the presence of pyrite are determined, respectively, as 19, 31 and 1.5 times more rapid than in single mineral experiments (Fig. 3). These data are consistent with the electrochemical process of galvanically-promoted mineral oxidation of the other sulfides in the presence of pyrite [2]. In the case of galena, the experimental data suggest extensive release of lead ions and development of a sulfur-rich surface during galvanically-promoted dissolution.

These studies, combining a range of well-established methods, add to our understanding of acid leaching of metal sulfides under oxygenated conditions and the likely role of electrochemical processes in these phenomena.

REFERENCES

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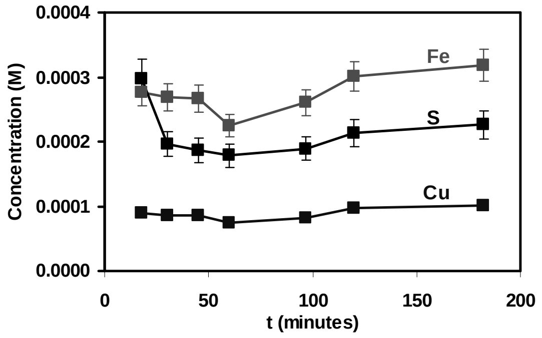

Fig 1. Variation in leach solution concentrations with time for chalcopyrite dissolution

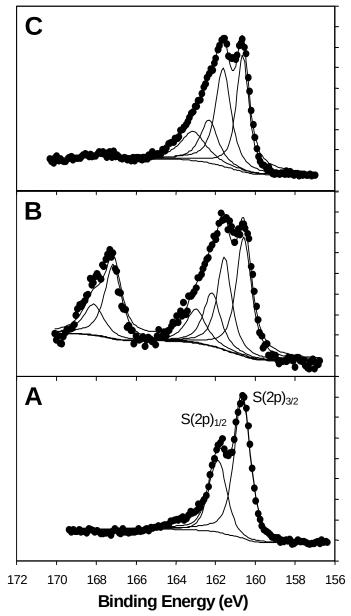

Fig. 2. S2p XPS data for freshly cleaved (A), ground (B) and leached (C) chalcopyrite

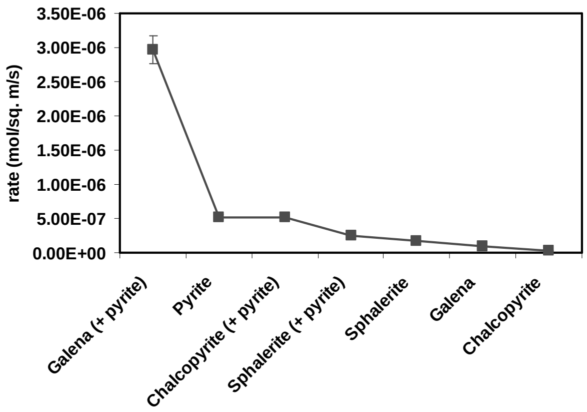

Fig. 3. Varying leach rates for single or two-phase sulfides