Oxidation mechanism of chalcopyrite by *A. ferrooxidans*

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Chalcopyrite is an important ore mineral in sulfide deposits. It has been reported that *Acidothiobacillus ferrooxidans* (*A. ferrooxidans*), a widely ocurring bacterium, participate in the decomposition of chalcopyrite in various hypergene mine environments.

Four parallel experiments, with and without bacteria using ferrous-free culture medium or ferrous-bearing culture medium, were carried out in order to investigate the effects of *A. ferrooxidans* on the oxidation of chalcopyrite. In the two experiments with ferrous-bearing culture medium, the pH value decreases following a gradual increase, while it remains unchanged in the other two experiments using ferrous-free 9K medium. The Cu^{2+} concentrations of the experiments with bacteria are distinctly higher than those of the experiments without bacteria. The scanning electronic microscopic observations of the chalcopyrite residues show that there are numerous micro-pits on the chalcopyrite surface after oxidation by *A. ferrooxidans*. Raman spectrum reveals natural sulfur on the surface of the mineral in the experiments inoculated with *A. ferrooxidans*. No pits and natural sulfur appear in the experiments without bio-mediation. The results indicate that *A. ferrooxidans* can greatly accelerate the oxidation of chalcopyrite by surface erosion. *A. ferrooxidans* could promote the oxidation of Fe^{2+} into Fe^{3+}, and then Fe^{3+} could oxidize the sulfur of chalcopyrite into natural sulfur. The natural sulfur coating the chalcopyrite surface does not suppress the decomposition of minerals distinctly because *A. ferrooxidans* could oxidize it into SO_4^{2-}, which maintains the continuous oxidation. The occurrence of natural sulphur confirms the important roles of Fe^{3+} in the oxidation of chalcopyrite. It is reported that copper sulphide can be bio-oxidized by direct mechanism but at rates much lower than these due to indirect mechanism [1]. The present study also reveals that the indirect mechanism can significantly affect the oxidation of chalcopyrite.

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[1] Lilova & Karamanev (2005) *Hydrometallurgy* **80**, 147-154.

Source analyses of noxious elements in topsoil in Deyang, Sichuan, China

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The influence of atmosphere deposit, fertilizer and irrigation on noxious metal concentration in soil in Deyang region of Sichuan province is discussed in this paper. The Cd concentration in the atmosphere deposit in Deyang is 2.6~218 times as high as the third grade soil quality criterion, reaching 218 mg/kg in a few areas. The average Cd flux of the atmosphere deposit is 6.19 $g/hm^2 \cdot a$.

It is noticed that phosphorus and compound fertilizers with high heavy metal concentration are widely used in Deyang region. The annual input flux of Cd, As and Pb into soil in Deyang through fertilization are 1.15, 12.76 and 9.64 $g/hm^2 \cdot a$ respectively.

The influence of irrigation on heavy metal concentration in the soil in Deyang is also very high. The annual input flux of Pb, Cd, As and Hg into the soil are 171, 29.65, 12.98 and 1.4 $g/hm^2 \cdot a$ respectively.

As for the main input approaches into the soil in Deyang, we noticed that some differences are there for different metals. The input of As is mainly throuth fertilizer, which covers 59.61% of the total input flux. The main input approach of Cd is irrigation, which covers 50.42% of the total, with fertilizer covering 25.40%, atmosphere dry and wet deposits covering 24.54%. The main input approaches of Pb are irrigation, atmosphere deposits and fertilizer which respectively covers 39.6%, 38.67% and 21.73% of the total input flux. And the main input approach of Hg is fertilizer, which amounts 71.02% of the total with irrigation amounting 22% and atmosphere deposits amounting 6.98%.

According to the result made above, measures should be taken in Deyang region to improve the atmosphere environmental quality, to control sewage irrigation and to decrease fertilizer use.