Influences of light on microbial oxidation of sphalerite

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Metal sulfides are common in a varity of rocks while they are unstable as being exposed to air. Microbial oxidation of sulfides left in tailings generates acid mine drainage (AMD) and damages local environmental quality. Sphalerite, the dominant zinc mineral, is an important semiconductor mineral because of its large negative conduction band potential, which makes complicate sphalerite - microoranism interactions mediated by sunlight. This study investigates the influence of light on microbial oxidation of sphalerite based on comparative experiments.

In this study, a strain of *Acidithiobacillus ferrooxidans (A. ferrooxidans)* was isolated from AMD in a Cu-Au mine. And low Fe^{2+} 9K medium were employed. Xenon lamp coupled with an optical filter of 420 nm, provided constant monochromatic light. A series of batch experiments were performed for 26 days, including dark-abiotic, dark-biotic, light-abiotic, and light-biotic. In biotic groups, a cell concentration of ~10^7 cells/mL were inoculated.

For abiotic groups, the light hardly affects the release of Zn^{2+} in the first 10 days. However, more Zn^{2+} ions were measured in the following days. Neither secondary mineral nor difference in surface morphological changes of sphalerite was observed in light and dark conditions. For biotic groups, the influences of light can be determined. With illumination, Zn^{2+} concentration in solution was relatively low while biofilm developed remarkably. Although bacterial erosion of sphalerite surface was much greater in both conditions, group with light was slightly weaker than that in the dark. In both conditions, secondary precipitates of schwertmannite, iron phosphate, and jarosite were observed whithout clear difference. The differences due to light were observed, but the underlying mechanism is not clear yet. In one aspect, electrons as well as holes with high oxidizability can be generated by photoexcitation of sphalerite. If photogenic holes are captured by environmental organics, photogenic electrons could reduce transition metal ions (e.g., Fe^{3+} to Fe^{2+}) and/or directly facilitates the growth of microorganism, which protects sulfides from microbial oxidation. In another aspect, light can enhance the EPS secretion, which favors biofilm development and surface erosion. The contribution of both aspects to microbial oxidation may vary with time and microbe-mineral systems.