Bioleaching: Surface Phenomena Considerations

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Minerals biotechnology, called "bioleaching," employs microorganisms (e.g., *Acidithiobacillus*, *Leptospirillum*, moderately thermophilic iron- and sulfur-oxidizing bacteria, and certain *Archaea*) to extract metals from sulfide minerals. Bioleaching has been employed on a commercial scale for nearly 50 years. However, in the last decade commercial practices have become technically sophisticated and are now applied to a broad spectrum of base and precious metals, used on greater tonnages of ores and concentrates of ores, and to reprocess wastes recovering metal values and environmentally reclaiming real estate. Bioleaching is expected to play an even greater role in mineral processing in the next quarter century because of the technology's intrinsic characteristics of low cost, simplicity, robustness, flexibility, and diminished environmental impact. Despite both the current use and bright future of bioleaching, the mechanics of the technology are poorly understood. In large measure this is because bioleaching entails complex chemical, biological, and physical reactions occurring at the mineral-microorganism-solution interface. Electrochemical reactions are key, but precisely how microorganisms mediate these is unknown. Secondary minerals, whose production may be a result of microbial activity, can passivate certain mineral surfaces, terminating metal extraction. The Advanced Photon Source (APS) is anticipated to play a key role in elucidating chemical, physical, and biological phenomena occurring at microbe-mineral-solution interfaces, providing insight into microbial-mediated secondary mineral formation, and unlocking the mechanism of bioleaching. This APS contribution would be a major development because "the most important transformation in the mineral industry in the next 20 years could be the complete replacement of smelting by hydrometallurgical processing for base metals" (*Evolutionary and Revolutionary Technologies for Mining*, National Research Council, 2001), of which the bioleaching process is an important component.