Studies on the metabolic activity of leaching-active bacteria growing on metal sulfides using chip-calorimetry

Julia Hoffmann[1], Johannes Lerchner[1], Michael Schlömann[2], Florian Mertens[1]

[1] Technische Universität Bergakademie Freiberg, Institute of Physical Chemistry, Leipziger Straße 29, 09599 Freiberg, Germany
[2] Technische Universität Bergakademie Freiberg, Institute of Biosciences, Research Group Environmental Microbiology, Leipziger Straße 29, 09599 Freiberg, Germany

Key words: Bioleaching; Chip calorimetry; Microbial activity

The term bioleaching is generally understood to mean the mobilization of metal cations from insoluble ores due to microbial oxidation and complexation processes [1]. The global demand for heavy metals continues to increase. High-grade mineral deposits are becoming increasingly rare. With the help of bioleaching, even from low-grade and more complex mineral deposits, which cannot be mined efficiently with conventional extraction methods, metals can be extracted [2]. Accordingly, the availability of value elements can be increased. The aim of this work is to extend current knowledge of bioleaching processes of sulfidic ores, such as pyrite. Therefore leaching experiments were carried out with iron oxidizing microorganisms.

The acidophilic iron oxidizers *Acidithiobacillus ferrooxidans* and *Sulfobacillus thermosulfidooxidans* were used for the experiments. These microorganisms were grown on pyrite in iron free medium with a starting cell number of about $5 \cdot 10^7$ cells per mL in a bioreactor. In order to get information about the leaching process, different parameters were monitored. For the studying of the metabolic activity of microorganisms, a chip calorimeter equipped with a segmented flow technology [3] was used. This technique has the great advantage that a sample volume of only 14 µL is needed for a measurement. The heat production of up to six samples could be sequentially determined in one and the same measurement series. Each sample contains the milled pyrite, growth medium and the microorganisms. Metabolic heat production rates of up to 400 µW g^{-1} pyrite for *Acidithiobacillus ferrooxidans* and 180 µW g^{-1} pyrite for *Sulfobacillus thermosulfidooxidans* were found. Furthermore, over the experimental period of up to four weeks, the pH in the supernatant was determined by means of a pH electrode and the planktonic cell count by means of a counting chamber at each sampling. In addition, the concentration of ferrous and ferric ions in the supernatant was monitored photometrical using the ferrozine test.

[1] Rohwerder, T., Gehrke, T., Kinzler, K. and W. Sand, Bioleaching review part A. Progress in bioleaching: fundamentals and mechanisms of bacterial metal sulfide oxidation. Appl. Microbiol. Biotechnol., 2003. 63(3) 239-248.

[2] Gericke, M., Review of the role of microbiology in the design and operation of heap bioleaching processes. J. South. Afr. Inst. Min. Metall., 2012. 112 1005–1012.

[3] Lerchner, J., David, K. A., Unger, F. T., Lemke, K., Förster, T. and F. Mertens, Continuous monitoring of drug effects on complex biological samples by segmented flow chip calorimetry. J. Therm. Anal. Calorim., 2017. 127 1307-1317.