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Simulation of acid mine drainage generation around Küre VMS Deposits, Northern Turkey

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This study investigated comparative leaching characteristics of acidophilic bacterial strains under shifting environmental conditions at proposed two stages as formation stage or post acidic mine drainage (AMD) generation. At the first stage, initial reactions associated with AMD generation was simulated in shaking flasks containing massive pyritic chalcopyrite ore by using a pure strain Acidithiobacillus ferrooxidans and a mixed culture of Acidithiobacillus sp. mostly dominated by A. ferrooxidans and A. thiooxidans at 26oC. At the second stage, long term bioleaching experiments were carried out with the same strains at 26oC and 40oC to investigate the leaching characteristics of pyritic chalcopyrite ore under elevated heavy metal and temperature conditions. During the experiments, physicochemical characteristics (e.i. Eh, pH, EC) metal (Fe, Co, Cu, Zn) and sulfate concentration of the experimental solution were monitored during 180 days.

Significant acid generation and sulfate release were determined during bioleaching of the ore by mixed acidophilic cultures containing both iron and sulfur oxidizers. In the early stage of the experiments, heavy metal release from the ore was caused by generation of acid due to accelerated bacterial oxidation of the ore. Generally high concentrations of Co and Cu were released into the solution from the experiments conducted by pure cultures of Acidithiobacillus ferrooxidans whereas high Zn and Fe was released into the solution from the mixed culture experiments. In the later stage of AMD generation and post AMD, chemical oxidation is accelerated causing excessive amounts of contamination, even exceeding the amounts resulted from bacterial oxidation by mixed cultures. Acidithibacillus ferrooxidans was found to be more effective in leaching Cu, Fe and Co at higher temperatures in contrary to mixed acidophiles that are more prone to operate at optimal moderate conditions. Moreover, decreasing Fe values are noted in bioleaching experiments with mixed acidophiles at higher temperatures. Further depleted Fe(III) values coinciding with decreasing pH may point to precipitation of secondary phases (i.e. jarosite).

This study revealed that the metals (Fe, Cu, Co and Zn) released during short term leaching of the ore (34 days) are generally caused by acid produced by dissolution reactions rather than oxidation. In the long term experiments a more complex biogeochemical reactions (oxidation and dissolution) take place in conjunction.

Key words: Bioleaching, AMD, heavy metal release, environment, acidophilic bacteria, Küre copper ore deposits, volcanogenic massive sulfide deposits