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The determination of oxidation rates of pyrite and marcasite at low temperature for acid mine drainage and mineral waste solutions

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This thesis is an analysis of combined marcasite and pyrite oxidation rates of interest in acid mine drainage (AMD) settings. The main driving force for AMD is the interaction of bacteria, H_2O, and sulfide bearing minerals such as pyrite (FeS_2) and marcasite (FeS_2 polymorph).

Current research focuses on individual oxidation rates of pyrite and other minerals, with a gap in research around how the coexistence of pyrite and other minerals in mine tailings may affect oxidation rate speeds. Previous research (McKibben et al., 1986) supports the theory that coexistence of minerals such as pyrite and marcasite in tailings drives oxidation faster, perpetuating the AMD cycle and creating a system like a galvanic cell [1].

To close the gap in research, the following closed system experiments were done on a natural pyrite sample and pure synthetic marcasite sample to first confirm existing knowledge of oxidation leach rates and then compare the rate laws of these combined minerals. This research stimulated the reactions that occur in physical mine tailings ponds and analysis will lead to a better understanding of how mineral solutions interact. The analysis includes creating a calibration curve for the reactions using the experimental method and apparatus outlined by Mckibben et al. (2008) [2]. Using this curve, the data was analyzed along with surface area measurements of the sample particles (Brunauer-Emmett-Teller or BET multipoint method) to create oxidation rate laws. The experiment was done at the University of Toronto and BET multipoint method was carried out at McMaster University.

Determining if pyrite and marcasite interact and form a galvanic cell structure which speeds up oxidation rates may inform best practices for separation of minerals in mine tailings sites to prevent and mitigate AMD.

[1] McKibben & Barnes (1986), *Geochimica et Cosmochimica Acta* 50, 1509-1520.

[2] McKibben, Tallant, de Angel (2008), *Applied Chemistry* 23, 121-135.