Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25275

# Microbial iron removal process by aeration and schwertmannite formation from acid mine drainage at the Date mine, Japan

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Many acid mine drainage (AMD) contains significant iron (Fe) over 100–10000 mg/L. Ferrous ion ($Fe^{2+}$) is found as a dominant species, and it is generally precipitated as hydroxide (ferrihydrite) at pH 3–5 by oxidation to ferric ion ($Fe^{3+}$) and neutralization by reaction with alkaline reagent and/or limestone. This precipitate causes clogging in active treatment plants and coating of the limestone surfaces in passive treatment systems. Therefore, selective Fe removal from AMD is recognized as the first process to maintain effective active/passive treatments. However, the abiotic oxidation rate of $Fe^{2+}$ in acidic conditions becomes low; thus many researchers are trying to use Fe-oxidizing bacteria (FeOB) for effective Fe removal without the excess addition of a chemical reagent. Other Fe-precipitates such as schwertmannite and jarosite, thermodynamically stable in the acidic environment (pH 1–4), are sometimes found in bioactive mine sites and treatment systems, which precipitates could contribute to effective Fe removal in acidic conditions. In this study, we set an aeration system to remove $Fe^{2+}$ from anaerobic AMD (pH ~3) at the Date Mine, Japan, by in-situ growing the FeOB and examine the bio-geochemical process of Fe-precipitates in the reaction system. The aeration system (volume: 500 L, residence time: 5 h, air flow rate: 20 L/min) was set at the Date mine in July 2024, resulting in dissolved oxygen increasing from 0 to 8–11 mg/L and $Fe^{2+}$ concentration decreasing from 150 to 20 mg/L. The X−ray diffraction of the precipitate obtained from the system showed the schwertmannite formation. The drainage sample was reacted with or without the Fe precipitates (5%, v/v) for 120 min in a 300 mL PP beaker, and we found a complete $Fe^{2+}$ removal by the Fe precipitates addition. Our result explains that the FeOB is concentrated on the Fe precipitate structure and it can effectively oxidize $Fe^{2+}$ to $Fe^{3+}$.