

## Changes of microbial diversity and mineralogical composition during anoxic bioreduction of acid mine drainage

YURI LEE AND YUL ROH\*

Dept. of Earth and Environmental Sciences, Chonnam National University, YongBong-dong, Buk-gu, Gwangju, Rep. of Korea (\*correspondence: rohy@jnu.ac.kr)

Microorganisms can aid or accelerate metal oxidation reactions and cause precipitation of metal hydroxide and/or iron-oxyhydroxysulfate mineral at acid mine drainage (AMD) [1]. The objective of this study was to examine changes of microbial diversity and mineralogical composition during anoxic bioreduction of AMD.

AMD including precipitates were sampled at Jeonju II mine, Wanju-gun, S. Korea. Glucose (10 mM) was inoculated into AMD to stimulate anoxic bioreduction of AMD using 2-L serum bottles closed with rubber stoppers. Changes of microbial diversity, geochemical and mineralogical characteristics were monitored by 16S rRNA, XRD, SEM-EDX, TEM-EDX, ICP-AES, and IC analyses.

Major elements of AMD and precipitates are Fe, Al, Mn, Na, and S (SO<sub>4</sub>). Mineralogical composition of precipitates at AMD are schwertmannite [Fe<sub>8</sub>O<sub>8</sub>(OH)<sub>8.2x</sub>(SO<sub>4</sub>)<sub>x</sub>·nH<sub>2</sub>O] and akaganeite (β-FeOOH). 16S rRNA analysis showed that iron-oxidizing bacteria (e.g. *Gallionella* sp.) are dominant under oxic conditions, but iron-reducing bacteria (e.g. *Geobacter* sp.) are dominant under anoxic environments. Geochemical and mineralogical analyses showed that schwertmannite and akaganeite transformed into iron sulfide (FeS) and siderite (FeCO<sub>3</sub>) within 3~4 days of the microbial growth stimulation under anoxic environments. Iron-reducing bacteria such as *Geobacter* sp. reduced Fe (III)-containing minerals such as schwertmannite and akaganeite into siderite under anoxic environments in AMD.

These results suggest that microorganisms can aid or accelerate precipitation of Fe (III)-containing minerals such as iron hydroxide and iron-oxyhydroxysulfate under oxic conditions and of Fe (II)-containing minerals such as FeS and siderite under anoxic environments at acid mine drainage (AMD).

[1] Johnson & Hallberg (2003) *Research in Microbiology* **154**, 466–473.

## CO<sub>2</sub> clathrate formation and dissociation rates below 273K

J.R. LEEMAN<sup>1</sup> AND M.E. ELWOOD MADDEN<sup>2</sup>

<sup>1</sup>School of Geology and Geophysics, University of Oklahoma, Norman OK 73019, USA (jleeman@ou.edu)

<sup>2</sup>School of Geology and Geophysics, University of Oklahoma, Norman OK 73019, USA (melwood@ou.edu)

CO<sub>2</sub> clathrate hydrate is likely an important volatile phase within permafrost and polar ice on Mars as well as icy moons and comets. In addition, CO<sub>2</sub> hydrate may be useful on Earth as a solid phase for CO<sub>2</sub> separation and sequestration in cold climates. However, we know very little about hydrate formation rates at temperatures below the freezing point of water ice, where hydrate forms from solid ice reacting with gas or liquid CO<sub>2</sub>. A device has been constructed to measure the rate of CO<sub>2</sub> and CH<sub>4</sub> clathrate formation and dissociation at temperatures below 273 K. A known surface area of ultrapure water ice is exposed to gas at temperatures and pressures within the hydrate stability field. Formation rates are determined by measuring the gas pressure decay within the headspace of the vessel, while dissociation rates are measured by monitoring the pressure increase as gas evolves. In both cases, the gas flux in/out of the hydrate is calculated by applying the Van der Waal's equation to high resolution temperature and pressure measurements. Initial formation rates averaged 1.57x10<sup>-4</sup> molm<sup>-2</sup>s<sup>-1</sup> at an average pressure of 7.45x10<sup>-1</sup> MPa. Initial dissociation rates varied from 3.7 x10<sup>-4</sup> molm<sup>-2</sup>s<sup>-1</sup> to 3.5x10<sup>-4</sup> molm<sup>-2</sup>s<sup>-1</sup> at 4.46x10<sup>-1</sup> MPa and 1.01x10<sup>-1</sup> MPa respectively. These experiments took place at 250K. Following the initial reaction of the surface layer of ice (formation) or hydrate (dissociation), a thin layer forms and the process becomes diffusion limited. Determining the diffusion coefficient is non-trivial, as this is a moving boundary problem (similar to the Stefan problem) and several methods of solution are currently being investigated. These data have implications for modelling fluxes in both terrestrial and extra-terrestrial clathrate reservoir systems.