Iron biomineralization by metal-reducing bacteria enriched from a CO_2 repository candidate site

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Microbial metal reduction and mineral formation/dissolution not only play an important role in cycling of metals, carbon, and nitrogen, but also impacts on the speciation and the fate of a variety trace metals and nutrients in anoxic subsurface environments. The objectives of this research were to study microbial diversity of metal-reducing bacteria from groundwater and sedimentary rock collected from the deep subsurface environments and to examine iron reduction and biomineralization by the enriched cultures.

Metal-reducing enrichment cultures were established by inoculation of core sedimentary rock samples or groundwater obtained from the various depths (800 – 1,000 m) of a drilling in the Janggi Basin, a candidate site for geologic CO_2 sequestration, in Pohang, S. Korea. Metal-reducing bacteria, JG-4, was enriched from sedimentary rock and groundwater using various electron donors (acetate, glucose, hydrogen, lactate, pyruvate) and Fe(III)-citrate as an electron acceptor. NGS analysis was used to characterize microbial diversity of the enriched JG-4. The enriched JG-4 was used to examine the reduction of Fe(III)-citrate in HCO_3^- buffered medium (30 – 240 mM) under a N_2 atmosphere at 25°C. The mineralogical characteristics of the rock samples and the precipitated or transformed phases formed during metal reduction by metal-reducing bacteria were examined using PLM, XRD, and SEM-EDS analyses.

Mineralogical analyses showed the sedimentary rock consisted of quartz, feldspar, and calcite. The JG-4 was able to use the different electron donors (acetate, glucose, hydrogen, lactate, pyruvate) while reducing Fe(III)-citrate at 25°C. NGS analysis showed that JG-4 included *Shewanella* sp., and *Enterobacter*. The enriched JG-4 was able to reduce yellow brown Fe(III)-citrate into dark gray and dark brown siderite ($FeCO_3$) using glucose as an electron donor in HCO_3^- buffered medium (> 170 mM) under a N_2 atmosphere at 25°C. The bicarbonate concentrations of the incubation medium exerted profound influences on the formation of carbonate minerals

These results indicate that diverse metal-reducing bacteria enriched from a candidate site for geologic CO_2 sequestration induced precipitates of a carbonate mineral, siderite ($FeCO_3$), coupled to Fe(III) reduction.