

Bio-co-precipitation of Heavy Metals with Calcium Carbonate in Aqueous Solutions

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Microbially induced calcium carbonate precipitation (MICP) is a bio-geochemical process involving precipitation of calcium carbonate and possibility of co-precipitation of heavy metals [1]. The objectives of this study were to investigate the extent that a urease-positive bacterium, *Sporosarcina pasteurii*, can tolerate a range of heavy metals (cadmium, copper, and zinc), and to examine the bio-co-precipitation with calcium carbonate to remove these metallic toxicants from aqueous solutions.

The experiments, using the *Sporosarcina pasteurii*, were performed aerobically in growth media including urea and 30 mM CaCl₂. Each heavy metal such as cadmium, copper, and zinc was injected into the media at a concentration of 0.01 mM to 1 mM, respectively. To investigate the effect of the heavy metals on microbial growth, sampling was carried out at 1, 3, 7, and 14 days after the experimental set-up, and then pH, OD₆₀₀, and concentration of metal/Ca were measured by pH meter, UV-vis, and ICP-OES, respectively. XRD and SEM-EDS were used for mineralogical characterization of the precipitated calcium carbonates.

Microbial growth and urea degradation led to an increase in pH and OD₆₀₀, creating an environment favorable for the precipitation of calcium carbonate. Among the metal ions, the microorganisms showed the most sensitive response to Cd concentration, and microbial growth and calcium carbonate precipitation only occurred when the Cd concentrations were below 0.5 mM. The type and concentration of metal ions contributed to the mineralogy of precipitated calcium carbonate. In the Cd-containing medium, only calcite was formed by the microorganism, while in the Cu-containing medium, both calcite and aragonite were formed. In addition, the microorganisms in Zn-containing media induced precipitation of various calcium carbonates such as calcite, aragonite, vaterite, and monohydrocalcite. Metal ions showed high removal rate with precipitation of calcium carbonate when included in the medium at low concentration ranges from 0.01 to 0.05 mM. The removal rates were up to 100% for Cd and Cu, and up to 50% for Zn, respectively. These results indicated that bioprecipitation could be used to remove heavy metals via co-precipitation of heavy metals with calcium carbonate formation from aqueous solutions.

[1] Fujita et al. (2000) *Geomicrobiology Journal* **17**(4), 305-318.