Utilization of Biomineralization Processes for Carbon Sequestration

Yul Roh[1], April McMillan[2], Robert Lauf[2], Tommy Phelps[1]

[1] Environmental Sciences Division, Oak Ridge National Laboratory*, Oak Ridge, TN 37831
[2] Metal and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831

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Biological conversion of CO_2 into sparingly soluble carbonate minerals such as calcite($CaCO_3$) and siderite ($FeCO_3$) has been studied using iron-reducing bacteria in conjunction with metal containing fly ash and lime. Psychrotolerant (PV-1; W3-7-1), mesophlic (BrY), and thermophilic (TOR-39, C1) iron-reducing bacteria were used to examine biogeochemical processes such as dissolution and mineralization using fly ash in the presence of N_2, N_2/CO_2, and H_2/CO_2 headspace gases as well as in HCO_3^- buffered media (30 - 210 mM). Chemical analysis of culture media after incubation revealed that the leaching of Ca and Fe from fly ash was significantly reduced in the presence of a H_2/CO_2 atmosphere and in HCO_3^- buffered media (> 140 mM). This effect was a consequence of microbial metal reduction and the precipitation of siderite in the presence of appropriate electron donors such as lactate and glucose. Iron-reducing bacteria applied to fly ash plus lime also precipitated calcium carbonate onto fly ash particulates in HCO_3^- buffered media (> 140 mM). The precipitation is likely facilitated by the organisms altering local Eh, pH, and nucleation conditions. Biological carbonate mineral formation using fly ash and lime materials indicated that bacteria may complement the capture of carbon dioxide from fossil fuel plants while potentially stabilizing fly ash wastes.

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