UNIVERSITY OF CALIFORNIA, SAN DIEGO

Microbial Oxidation of Cobalt:

Characterization and Its Significance in Marine Environments

A dissertation submitted in partial satisfaction of the

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in Marine Biology

by

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ABSTRACT OF THE DISSERTATION

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Cobalt (Co) is an important trace metal with biological, environmental, and economic significance. In the environment, Co has two oxidation states, Co(II) and Co(III). In aerobic environments, the geochemical cycling of cobalt (Co) has often been considered to be controlled by the scavenging and oxidation of Co(II) on the surface of manganese (Mn(III,IV)) oxides or manganates. I have investigated the ability of Mn(II)-oxidizing bacteria to bind and oxidize Co(II) in the absence of oxidized Mn to determine whether some of these bacteria also oxidize Co(II) independent of Mn oxidation.

The ability of marine Mn(II)-oxidizing bacteria to bind and oxidize Co(II) was studied in the laboratory using Mn(II)-oxidizing spores of the marine bacterium

Bacillus sp. strain SG-1. A method was developed to measure Co(II) oxidation using radioactive ^{57}Co as a tracer and treatments with non-radioactive (cold) Co(II) and ascorbate to distinguish bound from oxidized Co. SG-1 spores were found to oxidize Co(II) over a wide range of pH, temperature, and Co(II) concentration. Co(II) oxidation occurred optimally around pH 8 and between 55°C - 65°C.

Using the ^{57}Co radiotracer technique, the oxidation and precipitation of Co was determined in the water column of the seasonally anoxic fjord, Saanich Inlet, British Columbia, Canada, and from coastal water and sediments collected off Mission Bay and San Diego Bay, San Diego, CA. Light was shown to enhance Co(II) oxidation in both *in situ* and on deck incubations. Dichlorophenyl dimethyl urea (DCMU), an inhibitor of oxygenic photosynthesis, however, did not inhibit Co(II) oxidation. From these results and those from size fractionation and poisoning experiments, Co(II) oxidation in marine environments including sediments, is mediated mainly by bacterial activities and not by any other particles including photosynthetic organisms. In the water column above the O_2/H_2S interface in Saanich Inlet, bacterial catalysis is one of the major factors causing Co precipitation; chemical precipitation (mainly, metal sulfide formation) seems to be an important factor of Co precipitation in anaerobic and sulfidic environments.

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