COUPLING OF BIOTIC AND ABIOTIC ARSENITE OXIDATION IN SOIL

by

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ABSTRACT

Arsenic (As) is a redox-active metalloid whose toxicity and environmental mobility depend on oxidation state. Recent instances of human As poisoning from drinking water motivated this investigation of the biogeochemical processes governing As mobility in soil. Arsenite [As(III)], the more toxic and mobile form of As, can be oxidized to arsenate [As(V)] by both minerals and microbes in soils. Previous studies showed that manganese (Mn) oxide minerals can oxidize As(III) and sorb As(V). Additionally, numerous soil bacteria have been shown to oxidize As(III) as a detoxification process. These and other types of mineral and microbial oxidants coexist in soils and their activity is intricately linked due to the biogeochemical heterogeneity of soils. In this study, it was found that the rate of As(III) oxidation was enhanced when heterotrophic As(III)-oxidizing soil bacteria isolates and a model Mn oxide mineral were mixed in microbe-mineral batch experiments. Soil column experiments, testing the rates of biotic versus abiotic As(III) oxidation, showed that biological activity was required for As(III) oxidation to proceed. The As(III) oxidation kinetics presented here, from multiple levels of biogeochemical complexity and a range of time scales, contribute to understanding coupled microbe-mineral processes necessary for environmental remediation of this toxic element.