A Novel Approach for Nuclear Waste Curation: A Manganese and Uranium Coupled Biogeochemical Cycle

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Nuclear waste disposal is a global concern. The problem of nuclear waste disposal is growing and threatens the environment, people, and future generations as well. As we continue to release radioactivity to the environment and even after more than 40 years, we still not have a successful plan for nuclear waste disposal. Nuclear fuel typically contain uranium dioxide (UO2), in which the uranium is in the +4 oxidation state. After its use, spent uranium dioxide may be stored in container but one worry is that UO2 will oxidize into mixed oxides since it is not stable. These uranium oxide reactions can lead to environmental contamination. Mn oxides are widespread in the environment and their surface reactivity has higher potential to modify the geochemical behavior of Uranium. I have investigated the effect of different concentrations of Mn on the coupled biogeochemical oxidation reduction reactions of U and Mn. Experiments conducted with synthetic MnO2, Biogenic MnO2 and the third one is in the presence of Mn(II) oxidizing spores Bacillus SG-1 and 5% headspace oxygen show that the Mn oxides produced by these spores can rapidly oxidize UO2. All the three experiments shown oxidation of UO2 and because of this oxidation Mn Oxides are reduced. The rate of UO2 oxidation is equal to the rate of MnO2 oxidation. Biogenic Mn oxides oxidized UO2 5 times faster than synthetic UO2. These results emphasize the need to consider the impact of Mn(II) oxidizing bacteria when predicting the potential of UO2 oxidation in the subsurface.

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