Fate of Uranium in Wetlands: Impact of Drought followed by Re-flooding

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Uranium contamination in groundwater can be mitigated in anoxic zones by iron-reducing bacteria that reduce soluble U(VI) to insoluble U(IV) and by uranium immobilization through complexation and sorption. Wetlands often link ground and surface-waters, making them strategic systems for potentially limiting migration of uranium contamination of water resources. Little is known about how drought periods that result in the drying of wetland soils, and consequent redox changes, affect uranium fate and transport in wetlands. In order to better understand the fate and stability of immobilized uranium in wetland soils, and how dry periods affect the uranium stability, we dosed saturated wetland mesocosms planted with *Scirpus acutus* with low levels of uranyl-acetate for 5 months before imposing a 9-day drying period followed by a 13-day rewetting period. Concentrations of uranium in mesocosm effluent increased after rewetting, but the cumulative amount of uranium released in the 13 days following the drying constituted less than 1% of the uranium immobilized in the soil during the 5 months prior to the drought. This low level of remobilization suggests that the uranium immobilized in these soils was not primarily bioreduced U(IV), which could have been oxidized to soluble U(VI) during the drought and released in the effluent during the subsequent flood. XANES analyses confirm that most of the uranium immobilized in the mesocosms was U(VI). Compared to mesocosms that did not experience drying or rewetting, mesocosms that were sacrificed immediately after drying and after 13 days of rewetting had less uranium in soil near roots and more uranium on root surfaces. Mapping of uranium and iron on root samples before and after drying has been performed to understand whether this migration of uranium is attributable to coprecipitation or sorption of dislodged uranium on roots' iron oxide coatings. Results show that short periods of drought conditions in a wetland may impact uranium distribution, but these conditions may not cause large losses of immobilized uranium from the wetland. Further experiments investigated the possibility of links between uranium immobilization and nitrogen cycling in wetlands. A recently identified *Acidimicrobiaceae* bacterium (A6) derives energy from ammonium oxidation coupled with iron reduction. This bacterium has been found in uranium-contaminated wetland sediments at the Savannah River Site. Lab experiments have demonstrated that A6 can use U(VI) as an electron acceptor in the presence of ammonium, suggesting that natural sites of active ammonium oxidation by A6 could be hotspots of uranium immobilization.