Transformation of Selenium Species in Sediment and Wetland Management Approaches for the Enhancement of Selenium Volatilization and Remediation Efficiency

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Executive Summary:
Over the last four years (May 97 to February 2001) a major study has been underway at the Tulare Lake Drainage District experimental Wetland in Corcoran to test the use of flow-through wetlands for the removal of selenium (Se) from agricultural drainage water. Our results show that (1) the TLDD wetland is capable of removing a substantial amount (up to 80% mass removal) of Se from agricultural drainage water, (2) the concentration of Se in the inflow drainage water (~15 ppb) was reduced to as low as 2-5 ppb, and that (3) vegetated wetland cells were more efficient in removing Se than the unvegetated cell. Although the wetland study has yet to be completely evaluated, the results clearly show that the wetland cells retained most of the Se (~60-70%) in the surface layers of sediments, i.e., in the fallen litter and detrital layers, and upper organic sediment layers. Preliminary data from XAS speciation analysis of surface and rhizosphere sediments and plant roots and shoots from Cell 5 clearly showed that the forms of Se differ greatly among these different compartments of the wetland cell.

Although the TLDD wetland was shut down in February 2001, our continuation on this research project is desperately needed so that a comprehensive analysis of the data obtained during the past years can be conducted and results can be written up for publication. For example, we have collected and analyzed many sam0ples from different wetland cells by XAS. However, these data still need to be converted from the raw data into a publishable format. In addition, we have 18 months of sediment and plant Se analyses to complete before we can obtain a complete data set for publication. Thus, the first goal of the proposed research is to complete the chemical analyses, speciation analysis, and data analysis, and write up this research for publication.

An exciting finding from our measurements of Se volatilization at the TLDD wetland was that up to 50% of the Se input could be removed via volatilization, suggesting that Se volatilization could potentially be a major pathway for Se removal. Because of the importance of Se volatilization as a pathway of Se removal in relatively innocuous forms, our second goal is to evaluate our method for measuring Se volatilization and determine whether Se is volatilized at greater rates from natural, open (unenclosed) sediment microcosms, compared to volatilization from an enclosed sediment surface (as in a volatilization chamber). One observation supporting the idea that Se volatilization rates measured by the enclosed chamber technique may be underestimated is that the Se concentration in evaporation pond water exhibited no increase with time over several years, even while the concentrations of salt and other trace elements continually increased over the same time period. Another observation supporting the idea the Se volatilization rates may have been underestimated is that about 20-30% of the total Se mass was missing from the mass balance calculation in vegetated wetland cells. The third goal of the proposed research is to use wetland management approaches to see if we can enhance Se removal by volatilization from the average of 5% of the total Se mass input to the 50% that we measured in June 1998 in Cell 5. Using flow-through wetland microcosms, we will apply three wetland management a0proaches to determine whether the Se removal efficiency of wetland microcosms through volatilization can be substantially enhanced through 1) alternate wetting/ drying cycles, 2) forced aeration, and 3) organic carbon addition. These three wetland management approaches are likely to increase Se volatilization rates and enhance the contribution of Se volatilization to the Se removal efficiency of constructed wetlands that are used for the treatment of Se-contaminated agricultural drainage water.