Phytoremediation of Selenium-Contaminated Drainage Sediments and Chemical Characterization of Potentially Ecotoxic Se Forms

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Principal Investigator: Norman Terry
Department of Plant and Microbial Biology
UC Berkeley
(510) 642-3510
nterry@nature.berkeley.edu

Executive Summary:

Extensive accumulation of Se in drainage sediments represents a potential ecotoxic threat. For example, the drainage sediments of the Broadview Water District of the San Luis Drain contain ~50 to60 mg Se kg^{-1}. Such high levels of Se pose a substantial ecotoxic risk to local wildlife. EPA has expressed serious concerns regarding the future treatment of drainage sediment in the San Luis Drain (Federal Register: March 23,2001, V. 66, No. 57). The goals of this proposal are twofold: firstly, to evaluate different types of phytoremediation as a means of attenuating/ remediating Se contamination of drainage and other wetland sediments, and secondly, to chemically characterize inorganic, and especially organic, forms of Se in sediments and plant tissues in order to better evaluate their ecotoxic risk. The specific objectives are to 1) determine the extent to which different plant genotypes (i.e., *Salicornia*, wildtype and genetically engineered Indian mustard) can enhance phytoremediation of Se-contaminated drainage sediments through phytoextraction and phytovolatilization; and 20 identify and determine changes in potentially ecotoxic chemical forms of Se in the sediment-plant phytoremediation treatment system, with particular focus on specific Se compounds within the organic Se fractions.

The experimental approach will be to test 1) Indian mustard plants that have been genetically modified in terms of a superior ability to absorb and tolerate high levels of selenate Se, 2) wildtype Indian mustard, and 3) *Salicornia*, a plant species with an exceptionally high capacity for phytovolatilization, for their efficiency in removing Se from Se-contaminated drainage sediments. The experiments will be conducted using microcosms in a controlled-environment greenhouse. Measurements will be made of total Se in sediments and in plant tissues, and of total Se volatilized, in order to determine the ability of the different plant genotypes for Se phytoextraction and phytovolatilization. X-ray absorption spectroscopy (XAS) and HPLC-ICP-MS techniques will be combined to more precisely define the chemical forms of Se in drainage sediments and in plant tissues. XAS speciation analysis will be used to distinguish several groups of organic Se compounds from elemental Se, selenate, and selenite, while HPLC-ICP-MS will quantify the composition of the organic Se compounds in sediment and plants. Thus, this research will evaluate the potential of phytoremediation (by testing different plant genotypes) to attenuate the risk of high Se concentrations in sediment; it will also identify the changes in the chemical forms of Se present in sediment and plant tissue within each phytoremediating plant system. We are especially interested in learning if phytoremediation changes the composition of organic pools of Se, which are potentially more toxic than inorganic forms such as selenate or selenite.