Management Effects on Selenium Fractionation, Speciation and Bioavailability in Sediments from Evaporation Basins

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Executive Summary:
The proposed research will provide a critical understanding of selenium fractionation, speciation and bioavailability within the Joint Research Project "Mitigating Selenium Ecotoxic Risk by Combining Foodchain Breakage with Natural Remediation." The joint research project involves a te3am of multidisciplinary investigators and cooperators joining forces to reduce the selenium ecotoxicity associated with disposal of agricultural drainage waters in evaporation basins within the San Joaquin Valley. Details of the joint project, including background, goals, and specific research efforts, are described in the proposal by Higashi and Flocchini. Evaporation basins are a proven economic means for disposing of agricultural drainage waters, but there is much concern with potential Se toxicity to migratory waterfowl. Recent research by Fan and Higashi demonstrated a high potential for minimizing environmental hazards associated with using evaporation basins for removal of Se from agricultural drainage waters. The method involves breaking the food chain by harvesting invertebrates and volatilization of selenium by aquatic microorganisms. Additional scientific data are required to validate the effectiveness of such a management system in reducing Se ecotoxicity.

This research component will provide critical information concerning the relationship between the chemical forms of selenium in sediments and Se bioavailability from three evaporation basins. W will use Tulare Lake Drainage District (TLDD) evaporation basins with and without invertebrate harvesting (Hacienda Evaporation Basin [HEB], no harvesting and Southern Evaporation Basin [SEB], with harvesting) and yet to be established new systems with and without harvesting at Lost Hills Water District (LHWD). The specific objectives of this research are to:

1. Determine spatial patterns of selenium speciation in the water column and fractionation of solid-phase selenium in sediments from evaporation basins under contrasting management practices, and
2. Evaluate the bioavailability of Se in sediments using Se speciation, bioavailability indicators and microphyte bioavailability tests.

Intact sediment cores and associated water column samples will be taken at several locations throughout each basin. Aqueous selenium will be speciated into inorganic (selenate, selenite) and organic forms. Sequential selective-extractions of sediments will be used to identify soluble, ligand-exchangeable,, carbonate-associated, organic matter-associated, insoluble elemental Se and residual resistant forms of Se. The soluble and exchangeable fractions are considered readily bioavailable. Selenium speciation as inorganic Se[VI], Se[IV] and organic Se in the readily bioavailable fractions will be determined, as well as bioavailable indicators such as proteinaceous Se and selenomethionine (Se-Met) (coordinating with Higashi). Further, bioavailability of fractions will be tested with bioassays using microphytes (coordinating with Fan).

Information obtained in this research will be integrated with results from associated studies examining management effects, Se bioavailability in the newly-formed sediment phase (suspended or most-recently settled sediment) (Higashi), morphological community structure analyses with in situ chamber experiments (Rejmankove), and the assessment of lower foodchain Se biogeochemistry (Fan). The experimental design is highly complementary to the project proposed by Frankenberger/Zhang for studying Se speciation on a large scale (27 evaporation ponds). This joint research will provide a critical scientific understanding of Se biogeochemistry and assist in managing evaporation basins to reduce Se ecotoxicity risk in the San Joaquin Valley.