Shifts in microbial composition and S chemistry in a wet-dry-wet cycle on methylmercury production in sulfurized biochar-amended floodplain soil

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Introduction

Hg is a global contaminant, and transformation of Hg to methylmercury (MeHg), a more toxic neurotoxin, is mainly driven by microbial processes. Periodic flooding and drying in floodplains alters microbial and geochemical conditions controlling Hg bioavailability. Previous studies on sulfurized biochar (MOAK) suggest >99% Hg removal, while MeHg production in MOAK-amended systems under representative flooding and drying conditions has not yet been evaluated.

Experimental Design

A series of microcosm experiments was conducted with Hg contaminated floodplain soil, biochar (sulfurized or untreated), and river water in three stages representing the following flooding and drying conditions: 1. Continuously wet in an anoxic environment (up to 200 d); 2. Dry in an oxic environment (90 d); 3. Rewet in an anoxic environment (90 d).

Results and Discussion

Increases in concentrations of MeHg in river water and solid-phases were observed in MOAK-amended systems after drying and wetting. The increases in MeHg were associated with elevated concentrations of Mn^{2+}, Fe^{2+}, SO_4^{2-}, and HS^- in river water as well as shifts in predicted Hg methylators towards sulfate-reducing bacteria (SRB). Results of S K-edge X-ray absorption near edge structure (XANES) analyses for solid materials suggest oxidation of S during drying and increases in polysulfur after rewetting. The increase in polysulfur may form Hg species that are more bioavailable to methylating microoganisms. Results of this study indicate dynamic microbial and geochemcial conditions in floodplain soilsmay affect MeHg production in sulfurized biochar-amended systems.