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Impact of Iron Plaque on PFAS Adsorption by Wetland Plant Roots

LIZETH SILVA, DAMIAN HELBLING AND MATTHEW REID

Cornell University

Presenting Author: lvs26@cornell.edu

Aqueous film-forming foams (AFFFs) constitute a significant source of per- and polyfluoroalkyl substances (PFASs), causing worldwide contamination and human health risks. Wetlands are key landscape features in many facilities where AFFFs are utilized, and the wetland rhizosphere is characterized by sharp redox gradients due to the release of oxygen from the aerenchymal roots. This leads to the formation of iron (Fe) and manganese (Mn) oxide mineral plaques on root surfaces, which play well-recognized roles in controlling the environmental fate of pollutants. The effect of root mineral plaques on PFAS compounds has not yet been explored. In this study, we investigated the role of root mineral plaques as adsorbents for perfluoroalkyl and polyfluoroalkyl “precursor” substances. We report the results of batch experiments on the adsorption of 40 PFAS compounds onto the roots of Typha latifolia and Typha angustifolia with intact mineral plaques and with plaques that were removed using dithionite-citrate-bicarbonate extraction ("bare roots”). Mineral plaques contained an average of 38 mg Fe/g root (dry weight) and 0.7 mg Mn/g root (dry weight). The presence of mineral plaques increased the adsorption by a factor between 1.4 and 2.9, consistent with the knowledge of strong PFAS adsorption onto positively charged Fe oxide mineral surfaces. The kinetics showed faster adsorption for bare roots than for iron. Adsorption onto bare roots increased with increasing chain length of PFAS compounds. However, iron roots did not show an increasing trend, leading to complex interactions between minerals and different functional groups of PFAS. We observed less release of root exudates in systems with root plaques, likely due to exudate adsorption onto the mineral plaques. Future research will explore the competition between root exudates and PFAS compounds for adsorption onto root mineral plaques. Our results indicate that mineral plaques on root surfaces can impact the fate and transport of PFAS in wetland systems and may serve as a reservoir of PFAS in contaminated environments.