Impact of phosphate on arsenic mobility and sediment microbial community in wetland mesocosms

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Arsenic (As) release from soils into aqueous phases in the environment can be enhaced by phosphate (PO_4^{2-}). Abiotic competitive sorption between PO_4^{2-} and AsO_4^{3-} onto iron minerals has been reported as a dominant mechanism for As(V) fate and behavior in the enviornment. However, the impact of PO_4^{2-} on As(V) *biotransformation* coupled to Fe in a wetland system has not been fully understood so far. In this work, a variety of well-controlled greenhouse wetland mesocosm experiments were performed for 4 months to find the effect of PO_4^{2-} on As mobility and sediment microbial community. Experimental conditions were as follows: [low PO_4^{3-} (10 μM) or high PO_4^{3-} (100 μM); low Fe(III) (no external ferrihydrite added) or high Fe(III) (25 μmol ferryhydrite/g solid medium added); and in the presence or absence of wetland plants. Results showed that increased PO_4^{3-} levels contributed to more As desorption, and that the interactions between high PO_4^{3-} and wetland plants played a synergistic role in the microbially mediated As mobilization under reducing conditions. High levels of PO_4^{3-} promoted plant growth, resulting in more labile organic carbon to be exuded from plant roots subsequently leading to more bacterial mobilization of As via Fe and As reduction. It is interesting to note that the pore-water As level ultimately became distinctively higher when treated with high Fe, high PO_4^{3-}, and in the presence of plants, coinciding with a microbial community profile of more As and Fe reducing bacteria (i.e. *Geobacteraceae*) for these specific conditions. Pyrosequencing data further confirmed that in the presence of plants, the profile of the microbial community for the high PO_4^{3-}, high Fe treatment is distinct from other treatments (e.g. high PO_4^{3-} and low Fe, low PO_4^{3-} and high Fe), showing more As-related bacteria species (e.g. *Sediminibacterium* and *Granulicella*) and more P removal-related bacteria species (i.e. *Genera Sulfuritalea*) for the treatment of high PO_4^{3-} and high Fe with plants.