Impacts of altered silicon on soil biogeochemistry and plant-uptake of arsenic in flooded rice paddy soil

ANGELIA L. SEYFFERTH[1]*, EVANISE PENIDO[2], RATTANDEEP GILL[1], MICHELLE PAUKETT[1] AND GANG LI[1]

[1]University of Delaware, Department of Plant and Soil Sciences, Newark, DE, 19716, USA
*angelias@udel.edu

[2]Universidade Federal de Lavras, Lavras, MG, Brazil

Arsenic is a ubiquitous element in soils worldwide and has the potential to negatively impact human and ecosystem health under certain biogeochemical conditions. While arsenic is relatively immobile in most oxidized soils due to a high affinity for soil solids, arsenic becomes mobilized under reduced soil conditions due to the reductive dissolution of iron(III) oxides thereby releasing soil-bound arsenic. Since arsenic is a well-known carcinogen, this plant-soil process has the potential to negatively impact the lives of billions of rice consumers worldwide upon plant uptake and grain storage of released arsenic.

One proposed strategy to decrease arsenic uptake by rice plants is via an increase in dissolved silicon in paddy soil solution (pore-water), since silicic acid and arsenous acid share an uptake pathway. However, several soil processes that influence arsenic cycling may be affected by silicon including desorption from bulk soil, formation and mineralogy of iron(III) oxide plaque, and adsorption/desorption onto/from iron plaque; the effect of silicon on these soil processes will ultimately dictate the effectiveness of altered dissolved silicon in decreasing arsenic uptake at the root, which in turn dictates the concentration of arsenic found in grains. Furthermore, the source of silicon may impact carbon cycling and, in particular, methane emissions.

Here, impacts of altered dissolved silicon on processes that affect rhizospheric biogeochemical cycling of arsenic and subsequent plant-uptake, and how it influences other biogeochemical cycles such as carbon and iron are investigated. We show that silicon can decrease arsenic uptake and grain storage under certain conditions, and that altered silicon affects the type of iron (III) oxide that comprises iron plaque.