The role of sulfur in the geochemical evolution of the Praire Potholes wetlands

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The oxidation of pyrite (FeS_2) dominates the geochemistry of the Prairie Pothole Region (PPR). This ecologically important region occupies extensive portions of the north central U.S. and south central Canada and hosts millions of small internally drained wetlands whose anionic composition evolves to SO_4^{2-} dominant. It is underlain by glacial till containing abundant pyrite-bearing shale fragments. We studied a 92 ha site near Jamestown ND. Our data document a laterally extensive, iron oxide-rich (pyrite depleted), gypsum ($CaSO_4 \bullet 2H_20$)-bearing zone in the till (mean depth 6.1 m). This oxidized zone overlies pyritic till, which is underlain by marine shale. $\delta^{34}S_{SO4}$ values indicate the marine pyrite (i.e. isotopically light) origin of SO_4^{2-} in the system. Pyrite in the unoxidized till and shale has a mean $\delta^{34}S$ of -19‰ which is similar to gypsum in the overlying oxidized till (-17‰). Sulfate in groundwater (-11‰) and wetland water (-6‰) are slightly heavier but positively correlated $\delta^{18}O_{SO4}$ and $\delta^{34}S_{SO4}$ values in these samples suggest microbial reduction is responsible for this positive shift.

We confirmed that oxidation of pyritic till is widespread in the region using data from nearly 500 well logs in a 10^3 km^2 area surrounding the ND study site which document oxidation of surface till to an average depth 7.8 m . The widespread extent of marine pyrite as a sulfur source for PPR wetlands is also confirmed by $\delta^{34}S$ values for SO_4^{2-} from 163 wetlands spanning four U.S. States with a mean $\delta^{34}S$ value of -9‰. Our data point to a major role for sedimentary sulfur transformations in defining PPR upland and wetland sulfur geochemistry.