Use of $\delta^{34}S$ of sulfate in hydrogeochemical investigations of a Prairie Pothole salt ring

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The Prairie Potholes region is comprised of millions of internally-drained wetlands extending from Alberta, CAN to Iowa, USA. Topographically low groundwater discharge wetlands tend to be high in Ca-Mg-SO_4-HCO_3 due to reaction of groundwater with glacial till rich in pyrite and calcite/dolomite. Salt rings with elevated groundwater salinity and gypsum can form around discharge wetlands. Controls on this stored salinity and its impact on wetland water chemistry are not well-understood. Transpiration by plants at the wetland edge can concentrate solutes and temporarily reverse hydrologic gradients. Alternatively, the salts may have been precipitated during previous dry periods. Due to the dominance of SO_4 and the wide range of $\delta^{34}S_{SO4}$ values in these systems, we are using $\delta^{34}S_{SO4}$ values in combination with $\delta^{18}O_{H2O}$, $\delta^{2}H_{H2O}$, and water chemistry to investigate processes associated with a salt ring in the Cottonwood Lake study area near Jamestown, North Dakota (USA).

The study area is a ~600 m^2 stand of bulrushes and cattails at the edge of a discharge wetland (P1). Drive point soil water samplers were installed along two transects (parallel and perpendicular to the wetland edge) at depths from ~0.5 to 3 m. $\delta^{34}S_{SO4}$ values ranged from -18‰ (reflecting the source pyrite) in up-gradient groundwater to ~-4‰ (reflecting bacterial SO_4 reduction) in ponded water. $\delta^{34}S_{SO4}$ values from the drive points were in between these two end-members. Along with $\delta^{18}O_{H2O}$ values and total dissolved solids, the $\delta^{34}S_{SO4}$ values clearly show mixing between three distinct waters: relatively dilute up-gradient groundwater, brackish pore water extending several meters below the study area, and surface water. Diurnal and seasonal fluctuations in hydrological gradients and mixing ratios are also apparent.