Redox biogeochemistry at high temporal resolution in a freshwater delta

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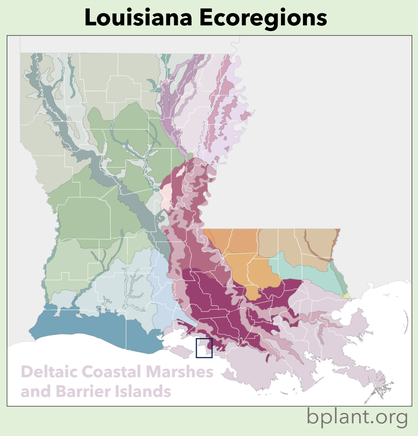
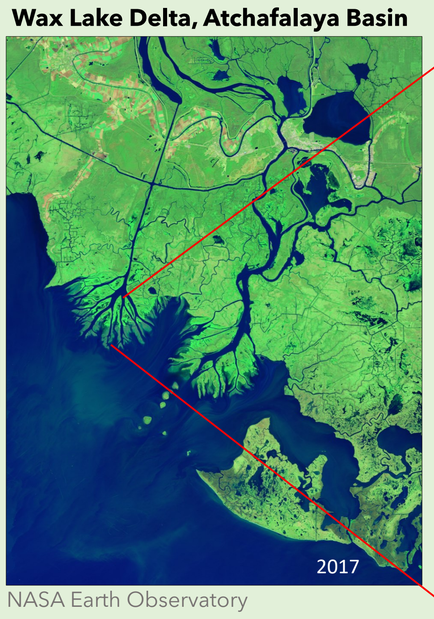
Louisiana Ecoregions



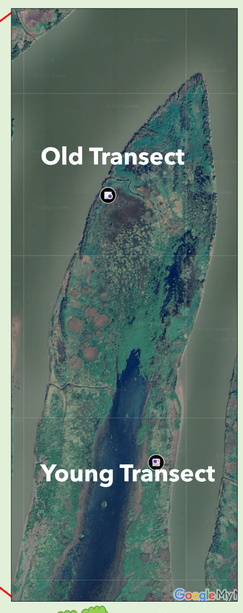
Above: This study was conducted in Wax Lake Delta, a freshwater delta recently formed as a consequence of river diversions

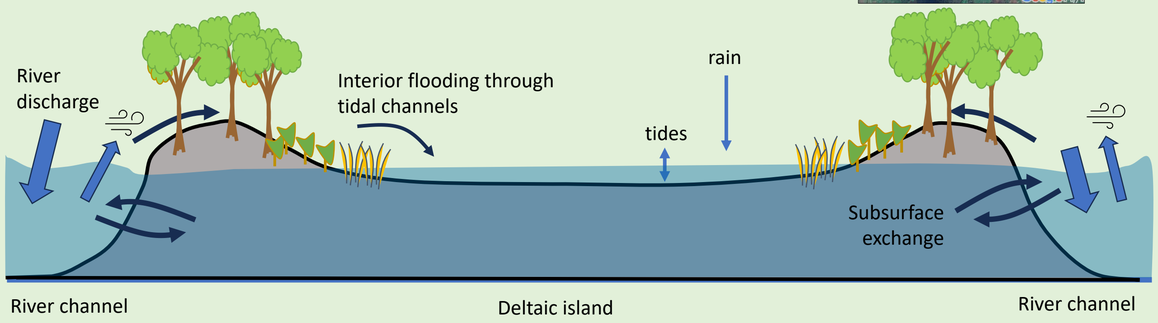
Wax Lake Delta, Atchafalaya Basin



NASA Earth Observatory

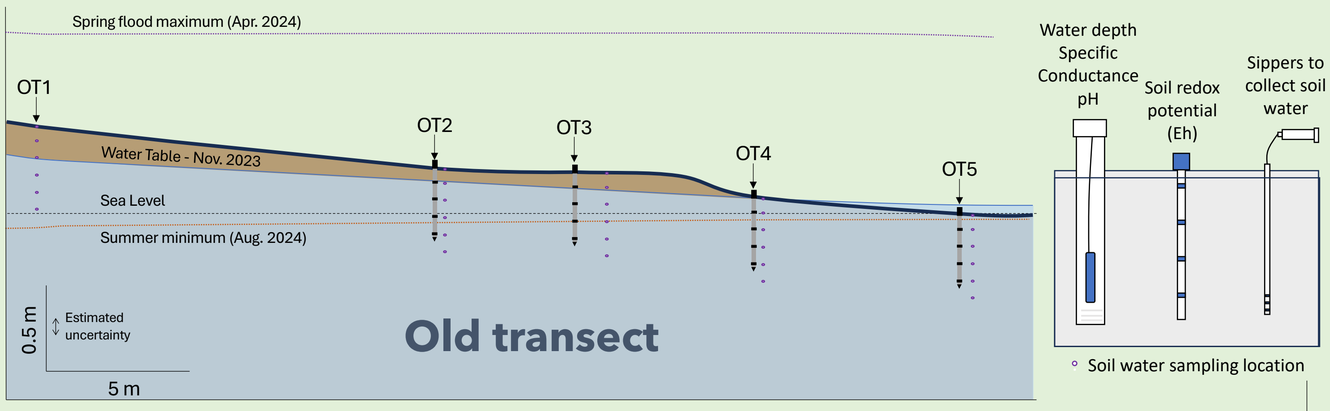
Mike Island





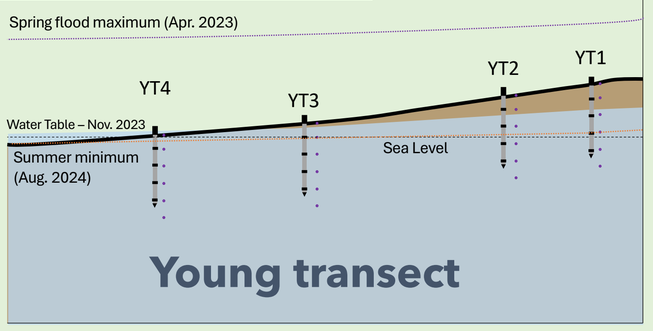
How does biogeochemistry respond to variable inundation?

- Water level and redox potential were measured at 15-min intervals along two elevation transects spanning tidal zones on proximal and distal portions of Mike Island in Wax Lake Delta
- Soil water was analyzed for pH, conductivity, oxidation-reduction potential, base cations, nutrients, dissolved organic and inorganic carbon, major anions, and minor and trace elements.



Left: Delta soils experience complex hydrodynamics driven by interactions between river discharge, wind, storms, and tides.

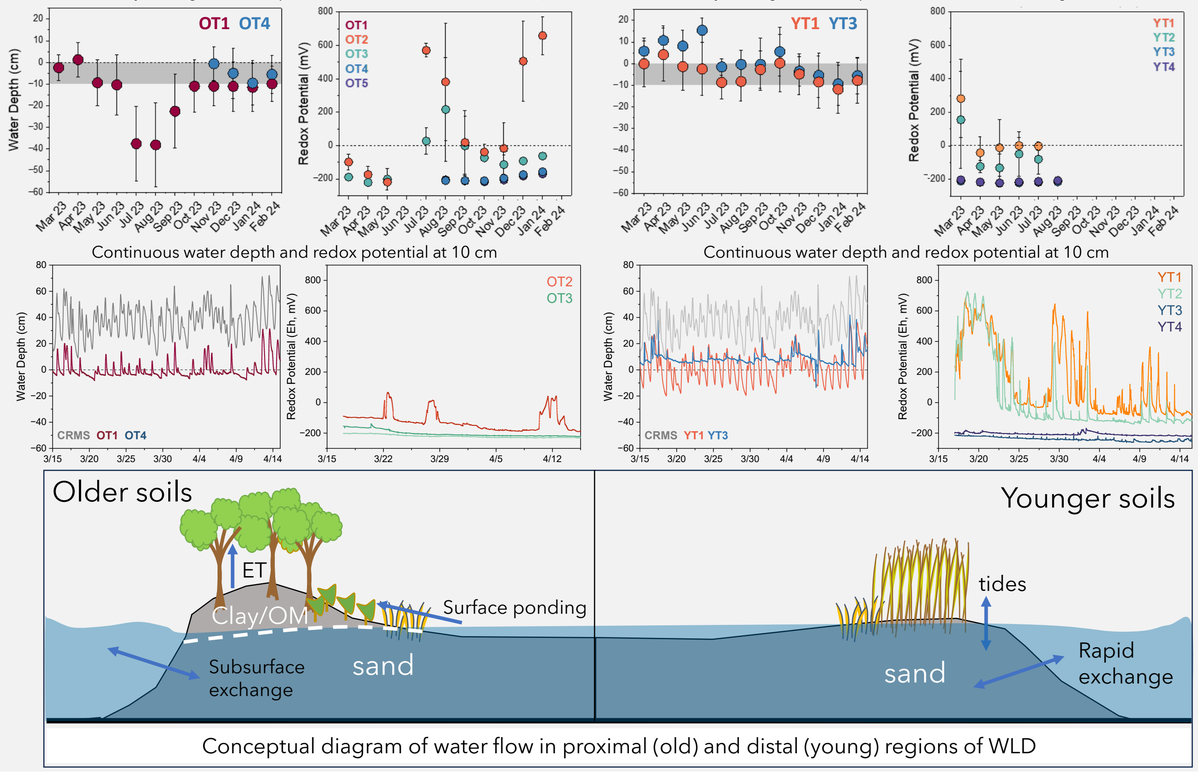
Right/Above: Schematic of water sampling and redox sensor placement along two elevation transects on Mike Island in WLD. Note the vertical exaggeration. The water table is shown for the November sampling campaign and for summer low and spring high water table.



Redox patterns reflect seasonal and tidal fluctuations in the water table that vary across the delta

Old transect

- Water table exhibits large seasonal changes, likely driven by high river discharge in the spring and high evapotranspiration in the summer, but minimal response to tides, possibly due to low permeability in surface soils
- Shallow intertidal soils experience prolonged oxidizing periods when the water table drops to >50 cm below the ground surface, while subtidal soils are persistently saturated and reducing



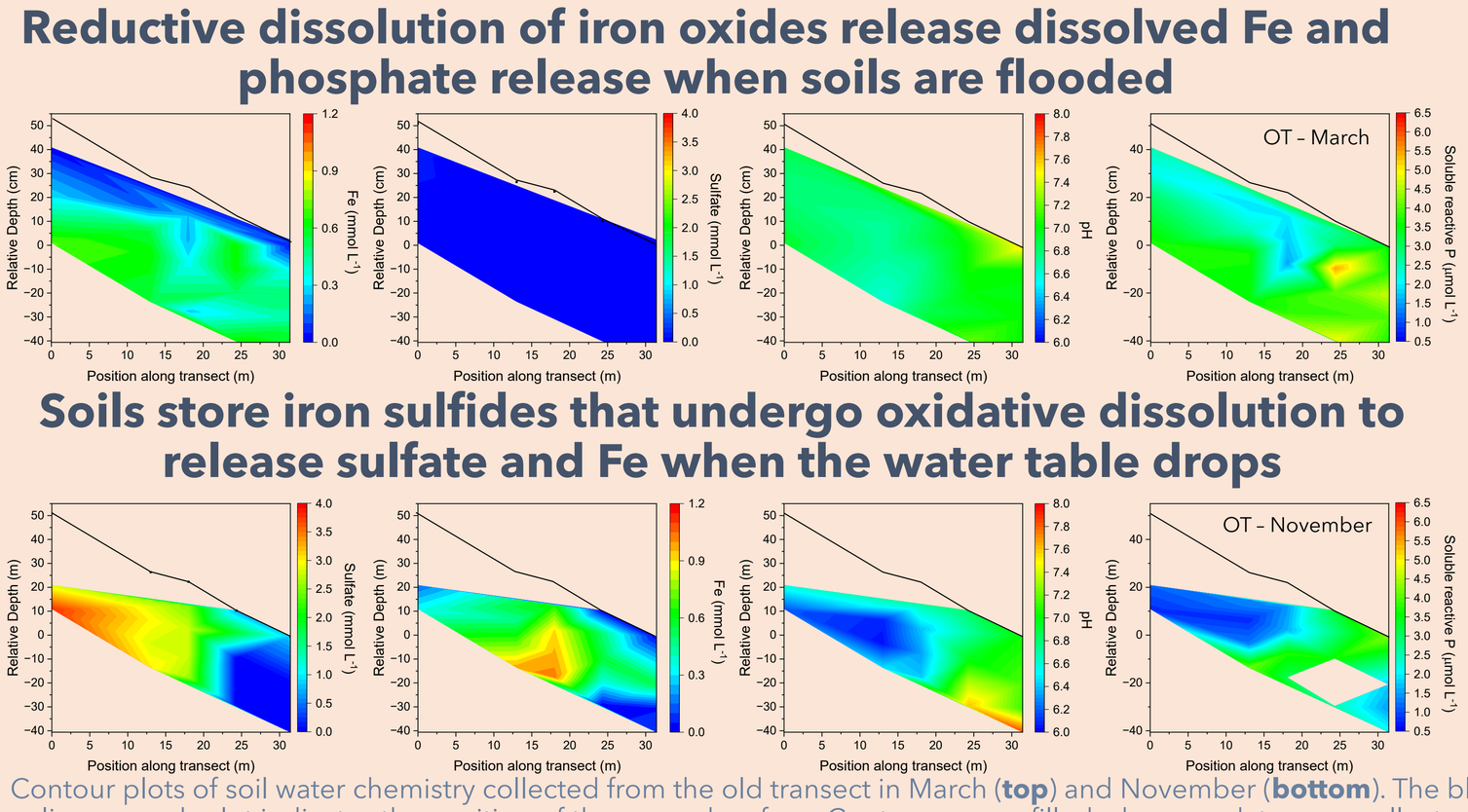
Young transect

- Seasonal variability in the water table is small but tidal variation (~30-40 cm) is pronounced, potentially due to sandier soils and higher connectivity with the river channel
- Soils remain predominantly reducing throughout the year, but shallow intertidal soils experience rapid redox fluctuations in response to tides

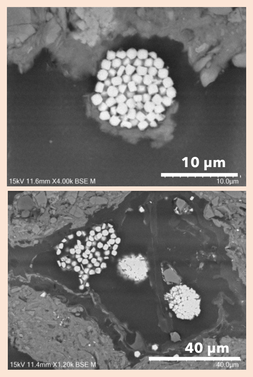
Top: Average (±stdev) water depth relative to the ground surface and Eh at 10 cm depth for each month over one year for the OT (left) and YT (right). Grey bars indicate the soil depth over which no redox data were recorded. **Middle**: 15-min measurements of water depth and Eh recorded over one month. **Bottom:** Modified from O'Connor et al. (2015) *J Hydrol.*

Reductive dissolution of iron oxides release dissolved Fe and phosphate release when soils are flooded

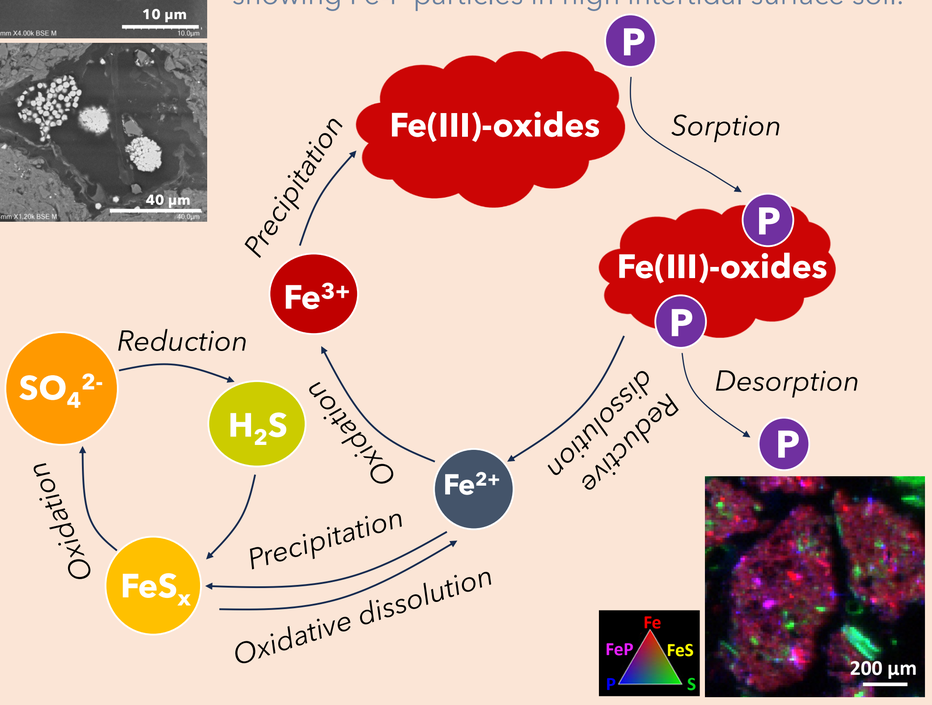
Soils store iron sulfides that undergo oxidative dissolution to release sulfate and Fe when the water table drops



Contour plots of soil water chemistry collected from the old transect in March (**top**) and November (**bottom**). The black line on each plot indicates the position of the ground surface. Contours are unfilled where no data were collected.



Left: Scanning electron microscopy images of iron sulfide grains stored in delta soils. **Below**: Conceptual diagram of redox-sensitive Fe-S-P interactions that vary with water level. **Bottom**: X-ray microprobe map showing Fe-P particles in high intertidal surface soil.



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