Geochemical Controls of Uranium Dissolution into Groundwater on the Pine Ridge Reservation, South Dakota

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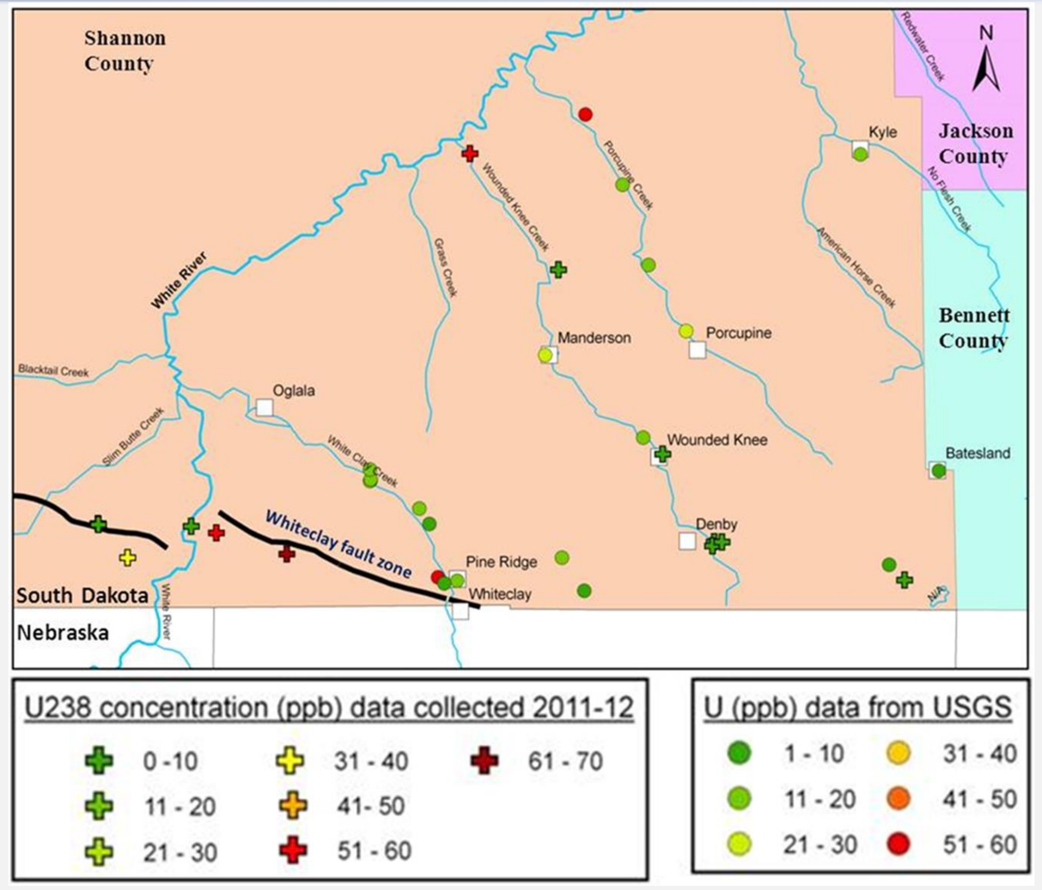
Motivation

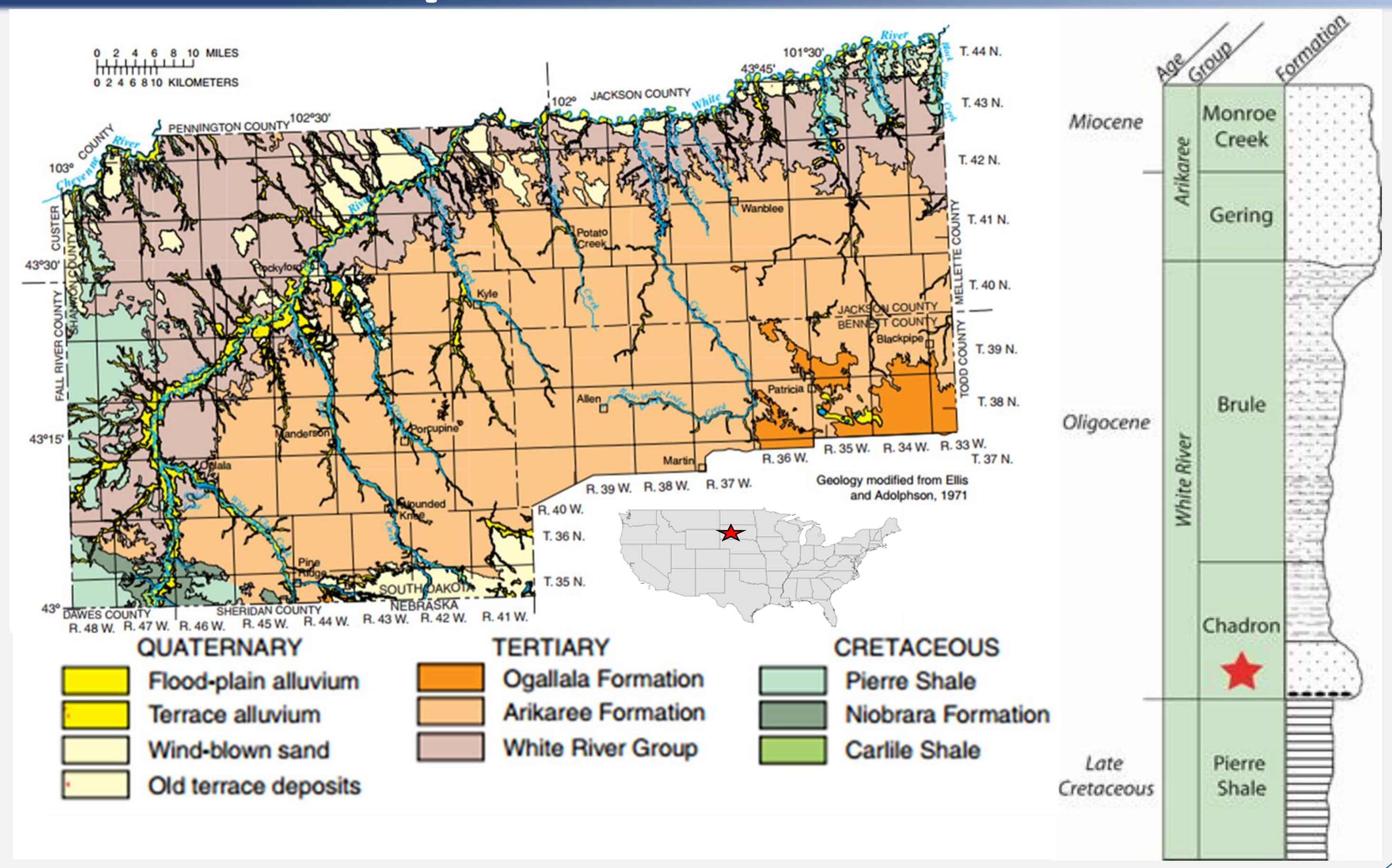
- High levels of uranium (U) have been found in groundwater (GW) and surface water (SW) on the Pine Ridge Reservation (PRR)
- Subsurface transport of uranium can be influenced by several geochemical and hydrological factors including pH, alkalinity, nitrate, sulfate and redox state
- The goal of this project is to determine geochemical and hydrological parameters that co-control U mobilization and transport and assess if U levels can be spatially correlated with local geology and geochemistry



(LaGarry and Yellow Thunder, 2012)

Site Description

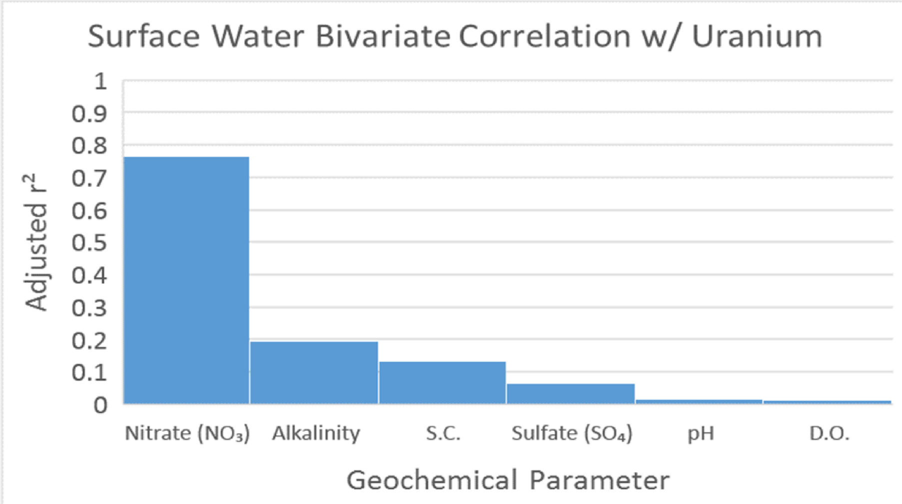
- The Pine Ridge Reservation is located approximately near Badlands National Park and 50 miles southeast of Rapid City, SD and the Black Hills
- Uranium mineralization in the area occurs in the White River Group, typically in the basal portion of the Chadron Formation



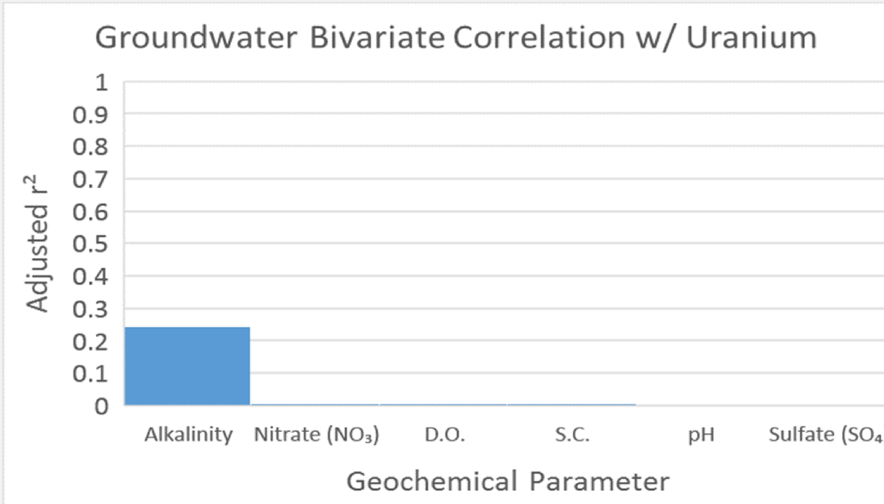
Materials and Methods

- 100 samples were compiled from the USGS NWIS containing detailed geochemical and physical parameters (U, NO_3, SO_4, alkalinity, pH, D.O. and S.C.)
- Bivariate and multivariate correlations were analyzed in MATLAB for surface water and groundwater samples to assess potential co-controls of uranium mobilization

Results



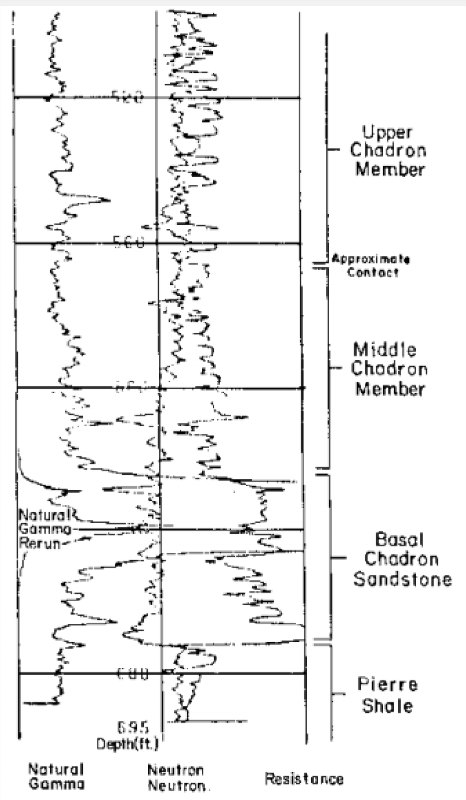
Bivariate Correlation w/ Uranium	
Paramater	Adjusted r^2
Alkalinity (Alk)	0.193
D.O.	0.011
Nitrate (NO_3)	0.766
Sulfate (SO_4)	0.064
pH	0.014
S.C.	0.134
Multivariate Correlation w/ Uranium	
Parameter	Adjusted r^2
NO_3	0.766
NO_3 + S.C.	0.785
NO_3 + S.C. + Alk	0.794
NO_3 + S.C. + Alk + SO_4	0.788
NO_3 + S.C. + Alk + SO_4 + pH	0.781
All Parameters	0.778



Bivariate Correlation w/ Uranium	
Paramater	Adjusted r^2
Alkalinity	0.244
D.O.	0.005
Nitrate (NO_3)	0.006
Sulfate (SO_4)	0.001
pH	0.002
S.C.	0.005
Multivariate Correlation w/ Uranium	
Parameter	Adjusted r^2
Alk	0.244
Alk + N	0.246
Alk + N + S.C.	0.248
Alk + N + S.C. + D.O	0.237
Alk + N + S.C. + D.O + pH	0.23
All Parameters	0.224

- Surface water uranium concentrations were strongly correlated with nitrate (r^2=0.77)
- Correlation with geochemical parameters could not account for uranium concentrations in GW
- Only alkalinity displayed a weak correlation w/ uranium in GW (r^2=0.24)
- Multivariate regression did not significantly improve correlations for SW or GW

Conclusions and Future Work



(Hansley et al., 1989)

- Strong correlation between uranium and nitrate in surface water may be the result of coupled uranium-nitrate redox reactions
- Weak correlation with groundwater parameters indicates that subsurface mobilization is more complex and may involve microbial activity or another measurement that was not considered
- Future work will include expanded sampling of geochemical parameters and gamma logging of groundwater wells as a proxy for bedrock uranium concentrations

Acknowledgements and References

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References

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