Characterizing Upper Colorado River Basin Sediments

Kolyne S. De Jesus¹, Emily L. Cardarelli², Christopher A. Francis², John R. Bargar³
¹Department of Biological Science, California State University, East Bay; ²Department of Earth System Science, Stanford University; ³SLAC National Accelerator Laboratory

Background

More than 35 million people in the western United States depend on the Colorado River as a resource for drinking water, irrigation systems, and hydropower. Recent climate change reports predict average water levels within the Colorado River Basin will decrease throughout the next century. Decreased river flow may have major impacts within the subsurface that are two-fold: 1) decreased water flow may result in greater issues of water quality due to accumulation and concentration of some elements within the subsurface, and 2) a lower water stage may significantly alter the redox cycling within the subsurface and affect major biogeochemical elemental cycles. Therefore, a greater understanding of current subsurface elemental distributions throughout the Upper Colorado River Basin is needed.

Methods

334 samples from five DOE-LM sites of the Upper Colorado River Basin were characterized by:

Homogenization → Elemental Analysis (EA) → X-Ray Fluorescence (XRF) → Water Extraction → Refractometer

UV-Vis Spectrophotometry → Discrete Analyzer (DA) → pH Meter → Filtration → Centrifuge

Results

Characteristics of the 334 samples were identified using the following methods:

- EA: C%, N%, C:N
- XRF: K, Ca, Mn, Co, U, Cu, V, S, P, Fe, Ni
- Refractometer: Salinity (psu)
- pH probe/meter: pH
- DA: NO₃⁻, NO₂⁻
- UV-Vis: N₂H₄

Table 1. Maximum, minimum, mean, and standard error values of soil characteristics of each respective core from the five sites, collected between 5-10 m depth from the surface.

![Figure 1. Map of the five study sites (▲), managed by DOE-LM within the Upper Colorado River Basin.](image)

![Figure 2. Non-metric multidimensional scaling ordination plot with ammonia-oxidizing archaea and ammonia-oxidizing bacteria abundances as the response variables (○). A high correlation between the % N and the ordination values exists, and the abundances seem to follow the direction of the % N gradient corresponding to depth. Adapted from E.L. Cardarelli, with permission.](image)

![Figure 3. Plots showing elevated peaks between the concentration of uranium in micrograms per gram with respect to total percent nitrogen (○), and micrograms per gram of iron (○), copper (○), and nickel (○) found from all five DOE-LM sites of the Upper Colorado River Basin.](image)

![Figure 4. Concentrations of uranium, copper, ammonium, iron, nitrate and carbon:nitrogen (C:N) ratios for each site: Rifle (●), Riverton (●), Shiprock (●), Naturita (●), and Grand Junction (●).](image)

Conclusion

- Elements that show elevated peaks corresponding to uranium concentrations are: nitrogen, vanadium, iron, copper, nickel, sulfur, and phosphorus.
- Overall, the C:N ratio ranged from 0-771.
- Salinity values, excluding Rifle, ranged from 0-17 psu; Riverton having the highest salinity.
- Our samples had an average pH of 8.2, a maximum of 9.0 and a minimum of 6.7.

This study enhances greater knowledge of elemental distributions throughout the Upper Colorado River Basin, and may help DOE-LM develop regional and site-specific management strategies for future climate scenarios.

Acknowledgements

This project was supported by a grant to the CSU STEM Teacher Researcher (STAR) Program from the Howard Hughes Medical Institute and by the SLAC Science Focus Area program, “Coupled Cycling of Organic Matter, Uranium, and Biogeochemical Critical Elements in the Subsurface Systems”, funded by the Department of Energy. Special thanks to the Francis Lab, ArcGIS staff of Branner Earth Sciences Library, and the STAR Bay Area Cohort 2016.