Concentrations and speciation of potentially toxic trace elements in waters of an urban estuary; Bayou Bienvenue, New Orleans, Louisiana

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Why Study Heavy Metals in Estuaries?

- Estuaries serve as nurseries for marine organisms
  - Commercially important shell- and fin-fishes
  - Shrimp, oysters, redfish

- Estuaries can act as natural “filters” for heavy metals and other pollutants

Bayou Bienvenue, Louisiana
Why Study Heavy Metals in Estuaries?

- **Current paradigm** → estuaries filter heavy metals

- **Reality** → little is actually known about the biogeochemical cycling and transport of heavy metals in Louisiana’s numerous estuaries
Metal Speciation

- It’s not enough to measure the concentrations of heavy metals
  - Tells us little about their bioavailability, toxicity, mobility

- Need to determine speciation
Metal Speciation

- The particular chemical form that an element exists in water
  - Free ion, e.g., $[\text{Cu}^{2+}]_F$
  - Bound to organic ligands
  - Complexed to inorganic ligands
  - Different redox species, e.g., $\text{As}^{3+}$ vs. $\text{As}^{5+}$
Metal Speciation

- Speciation controls trace element’s:
  - Bioavailability
    - Free-ion activity model
  - Toxicity
    - As$^{3+}$ is 10 – 60 more toxic than As$^{5+}$
  - Effective solubility
  - Mobilization and transport in the environment
Methods/Description

- Collect series of surface waters samples along Bayou Bienvenue
- Ultra clean trace element techniques
- Clean hands – dirty hands
Bayou Bienvenue
Bayou Bienvenue

Dr. Alex Kolker from LUMCON will assist us with boat time
Blue dots show sampling sites on Bayou Bienvenue
Speciation Analysis

- Filtration
- Unfiltered samples
- Filtered through 0.45 um
  - colloidal
- Filtered through 0.02 um
  - “truly dissolved”
Trace Element Analysis

- Inductively Coupled Plasma Mass Spectrometry
- As, Se, Sb, Cr, Pb, Ni, Zn, Tl, Mo, W, V, U
- Fe, Mn
- Measure in each filtration aliquot

Organic carbon will be determined in each aliquot too.
Partition Coefficients

- \( K_{d}^{\text{POC-DOC}} = \left\{ \frac{[M_{\text{POC}}]}{[\text{POC}]} \right\}/\left\{ \frac{[M_{\text{DOC}}]}{[\text{DOC}]} \right\} \)

- \( K_{d}^{\text{COC-DOC}} = \left\{ \frac{[M_{\text{COC}}]}{[\text{COC}]} \right\}/\left\{ \frac{[M_{\text{DOC}}]}{[\text{DOC}]} \right\} \)

- \([\text{POC}], [\text{COC}], \text{ & } [\text{DOC}]\) are the concentration of particulate, colloidal, and dissolved organic carbon, respectively.

- \([M_{\text{POC}}], [M_{\text{COC}}], \text{ & } [M_{\text{DOC}}]\) are the concentration of individual trace elements associated with different size fractions of OC.

- \(M_{\text{POC}} > 0.45 \text{ um}\)
- \(0.45 \text{ um} \geq M_{\text{COC}} \geq 0.02 \text{ um}\)
- \(M_{\text{DOC}} < 0.02 \text{ um}\)
Lanthanide Series
Anthropogenic Gd anomalies

- Gd is used in medical magnetic resonance imaging
- Gd has high magnetic moment
- Administered as:
  - Gadodiamide
  - Gadopentetic acid
  - Gd-diethylenetriaminepenta-acetate, i.e., Gd(DPTA)
Anthropogenic Gd anomalies

• We will measure the lanthanide series elements in aliquots of our Bayou Bienvenue samples

• Direct measure of anthropogenic influences on these waters
Anthropogenic Gd anomalies

- Non-impacted estuaries do not have substantial Gd anomalies
- Indian River Lagoon in Florida

Johannesson et al. (in prep)