How Modern Variability in Fluvial $\delta^{13}C_{DIC}$ May Impact Fundamental Assumptions in Carbon Isotope Stratigraphy and Neoproterozoic Carbon Cycling Interpretations

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Background:
- The Neoproterozoic carbon isotope record is characterized by large variations in $\delta^{13}C$ values ranging from +10‰ to -15‰. The origin of this variability cannot be easily explained by the traditional steady state carbon cycle model (Figure 1), which is often used to interpret such records.
- Neoproterozoic carbonates are shallow-water carbonates (i.e., deposited on continental crust).
- Such carbonates often form in marginal marine and mixed carbonate-siliciclastic systems, where water column DIC values may be more sensitive to local river input.

Methods:
- Data mining for papers useful to this study using GeoDeepDive (https://geodeepdive.org/)
- Data compilation of $\delta^{13}C_{DIC}$ and other relevant river chemical data including DIC, alkalinity, Ca concentrations, and river discharge rates from 135 papers
- Data analysis using Python
- Bedrock geology maps made using QGIS and Macrostrat®
- Full bibliographic metadata for 135 papers is available via GDD

Objectives/Hypotheses:
- Objectives:
  - Quantify the variability of modern $\delta^{13}C_{DIC}$ values in rivers and describe the dominant controls on the observed variability
- Hypotheses:
  - Where river basin lithology is carbonate dominated and/or where Ca concentrations in river waters are high, associated $\delta^{13}C_{DIC}$ measurements will be heavier than $\delta^{13}C_{ DIC_{organic}}$
  - Where river basin lithology is siliciclastic dominated, associated $\delta^{13}C_{DIC}$ measurements will be lighter than $\delta^{13}C_{ DIC_{organic}}$

Conclusions:
- The weighted mean from this study is lighter than the assumed riverine $\delta^{13}C_{DIC}$ input in the classic carbon cycle model by 4‰.
- Variability in $\delta^{13}C_{DIC}$ tends to decrease with increasing DIC concentrations.
- Ca concentrations do not appear to have any significant affect on $\delta^{13}C_{DIC}$ values.
- “Light” $\delta^{13}C_{DIC}$ values recorded from the Klamath River may be linked to siliciclastic/igneous dominated bedrock lithology upstream of the sampling site.
- Bedrock lithology does not appear to be the dominant variable controlling $\delta^{13}C_{DIC}$ in the Fraser and Lower Mississippi rivers.
- Variables affecting $\delta^{13}C_{DIC}$ in river water is too complex to test using only these methods.

Future Directions:
- Constrain lithology map to a smaller area upstream of the sampling site(s)
- Break down lithology further (shale vs. sandstone)
- Describe river catchment bedrock lithology quantitatively (% Carbonate, % igneous ...)

References: