Neogene evolution of paleoenvironments in the North American Great Plains from a stable isotope study

Livia Manser¹ (lmanser@student.ethz.ch), Jeremy K. Caves Rugenstein¹, Tyler Kukla², Sean Willett¹

¹Institute of Geology, ETH Zürich, CH-8092 Zürich, Switzerland; ²Department of Geological Sciences, Stanford University, Stanford, CA 94305, USA

Summary

Motivation
- The Neogene presents an opportunity to probe hydroclimate and landscape evolution changes in response to long-term changes in climate and atmospheric pCO₂.
- Enhance stable isotope data resolution, especially in the Southern Great Plains.

Possible Mechanisms
- Weakening in moisture supply since the Miocene might have led to an eastward shift of the aridity gradient towards the 100th meridian.
- Strong association between GPLLJ strength and orography of North America (Jiang et al., 2007). The Great Plains during summer (Jiang et al., 2007; Ting & Wang, 2006) (Figure 2).
- Moisture transport by the Great Plains Low-Level Jet (GPLLJ) originating from the Gulf of Mexico towards
- We create maps of δ18O and δ13C to understand the spatial patterns of these isotope systems.

Modern climate in the Great Plains
- Moisture transport by the Great Plains Low-Level Jet (GPLLJ) originating from the Gulf of Mexico towards the Great Plains during summer (Jiang et al., 2007; Ting & Wang, 2006) (Figure 2).
- GPLLJ partly generated due to radiational cooling of the earth’s surface (Parish, 2017).
- Strong association between GPLLJ strength and orography of North America (Jiang et al., 2007).
- In the Great Plains, where evaporation is not energy limited but controlled by precipitation, a hot spot of land-atmosphere coupling strength during June, July, and August (JAX) exists (Koster, 2004).

Sampling material

<table>
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<th>Sample Type</th>
<th>Location</th>
<th>Collection Method</th>
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</thead>
<tbody>
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<td>Groundwater</td>
<td>North Latitude = 47, South Latitude = 29, East Longitude = -107, West Longitude = -95, Type = (Groundwater, River or Stream)</td>
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Spatial distribution of δ18O

Trends in Latitude/Longitude

Conclusions

Moisture supply
- There is not much change in δ18O between the late Miocene and today. This could be due to some countervailing processes like weakening of the GPLLJ resulting in decreasing δ18O values and an increase in moisture recycling along a storm track which would result in increasing δ18O values.

Vegetation
- C4 expansion since late Miocene could explain higher δ13C values towards the east.
- A decrease in productivity since late Miocene, due to aridification or pCO₂ decline could explain the higher δ13C values in the west.
- The Rio Grande Rift shows much less variation in δ18O values compared to the eastern sites on the Great Plains, suggesting that changes in precipitation or elevation that may drive shifts in C3 to C4 plants affected the eastern Great Plains more. Further, the Rio Grande Rift sites have higher δ18O, which shows that plant productivity was lower.

Future Work
- Run soil respiration model using δ13C, to model vegetation evolution.
- Run vapor transport model using δ18O, to solve for water balance through time.
- Thin slices to classify types of carbonate.
- δ13C on selected samples to check for new formed carbonate overprinting carbonate-late precipitated during the Miocene.

References

Any comments or suggestions on the processes or interpretation are welcome! Please contact Livia