Calibration of δ²H$_{\text{n-alkane}}$ and δ¹⁸O$_{\text{sugar}}$ for paleoclimate reconstructions in South Africa and its first application to peat sediments from Vankervelsvlei

Paul Strobel, Roland Zech, Marcel Bliedtner, Julian Struck, Bruno Glaser, Michael Zech, Michael E. Meadows, Torsten Haberzettl

*Physical Geography, Institute of Geography, Friedrich Schiller University, Jena, Germany, ²Institute of Agronomy and Geoinformatics, Shanghai Institute of Applied Physics, CAS, Shanghai, China, ³Physical Geography, Institute of Geography and Geology, University of Greifswald, Greifswald, Germany

Background and study site

- the climatic evolution and ecosystem dynamics in South Africa have been highly debated.
- three major rainfall zones occur in South Africa today:
  1) Summer Rainfall Zone (SRZ; >66% rainfall during austral summer), isotopically enriched in H and O
  2) Winter Rainfall Zone (WRZ, >86% rainfall during austral winter), isotopically depleted in H and O
  3) Year-round Rainfall Zone (YRZ)
- 62 topsoils (0-5 cm) from each rainfall zone were sampled and analysed for their isotopic signature of leaf wax-derived n-alkanes (δ²H$_{\text{n-alkane}}$) and hemicellulose-derived sugars (δ¹⁸O$_{\text{sugar}}$)
- Vankervelsvlei (VVV) is located in the YRZ and ideally suited to reconstruct past environmental and climate variability

Calibration study

- Are oxygen and hydrogen apparent fractionation (i.e., the difference between δ²H$_{\text{sugar}}$ and δ²H$_{\text{n-alkane}}$) and δ¹⁸O$_{\text{sugar}}$ and δ¹⁸O$_{\text{n-alkane}}$ affected by environmental conditions?
- Does the coupling of δ²H$_{\text{sugar}}$ and δ¹⁸O$_{\text{sugar}}$ enable to reconstruct the precipitation and relative humidity?

Paleoenvironmental study

- Which paleoenvironmental changes can be reconstructed in the YRZ during the last 7 ka cal BP?
- Does the application of the coupled δ²H$_{\text{n-alkane}}$ - δ¹⁸O$_{\text{sugar}}$ approach shows changes in the plants source water and relative humidity (RH) and how do this complement standard (in)organic (bio)geochemical analyses?

Objectives

- coupling δ²H$_{\text{n-alkane}}$ and δ¹⁸O$_{\text{sugar}}$ allows to reconstruct δ²H$_{\text{sugar}}$, δ¹⁸O$_{\text{sugar}}$ and relative humidity
- terrestrial dust (Al concentration) as wind indicator
- δ²H$_{\text{sugar}}$ influenced by evaporation and source effect
- summer and winter precipitation contribution is reflected by plant source water δ²H and δ¹⁸O
- VVV = evapotranspiration controlled system
- three major climatic phases:
  1) moist phase with high summer precipitation contribution and strong wind between 7.0 and 4.7 ka cal BP
  2) drier phase accompanied by less summer precipitation contribution and less wind intensity (4.7 - 2.0 ka cal BP)
  3) since 2 ka cal BP moisture have been increased with high summer precipitation contribution but decreasing wind intensity

Conclusions

References: