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Hydrologic history of Lake Tana, Ethiopia: insights from hydrogen isotopes in lipids and models

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To investigate hydrologic changes in eastern North Africa since the Last Glacial, we analysed hydrogen isotope compositions of terrestrial plant lipids from samples of core 03TL3 taken in the center of Lake Tana, Ethiopia. Lake Tana is located at 1840 meters altitude in the Ethiopian highlands and the source of the Blue Nile. Under present-day conditions, the eastern North African highlands only receive seasonal rainfall when the Inter-Tropical Convergence Zone is in its northernmost position during boreal summer. Previous investigations indicated that Lake Tana desiccated at ca. 17,000 years ago (Heinrich event 1) [1].

Compound-specific hydrogen isotope analyses of plant-wax derived n-alkanes with a high Carbon Preference Index reveal large variations (-80 to -155 permil VSMOW). Heaviest hydrogen isotope compositions, suggesting most arid conditions, were detected in sediments from 15,700 years ago. Following desiccation, the lake was reduced to a shallow, central swamp with strong evaporation. Lowest hydrogen isotope compositions, suggesting most humid conditions, were detected for the period associated with the Younger Dryas (ca. 12,000 years ago). These data are in contrast to seismic data, which suggest a lake level regression during this phase [1]. Transport of previously deposited sediments from shallow, near-shore lake areas to the central coring site is a possible explanation for this discrepancy. For the Holocene, in contrast, no evidence for re-deposition of sediments is detected. From 5,200 years ago towards the present, hydrogen isotope compositions increased by about 20 permil. This isotopic change is compared to results from atmospheric isotope modelling. A General Circulation Model (ECHAM4) equipped with an isotope tracer module to directly simulate 18O and deuterium in precipitation was used to generate maps of monthly rainfall amounts and isotope compositions [2]. Calculations were done for the pre-industrial and the mid-Holocene period. Boundary conditions for the mid-Holocene were adjusted to different orbital parameters, i.e., insolation and seasonality, and a changed sea surface temperature pattern. The model results indicate substantially increased rainfall amounts in eastern North Africa (+100 to +200 mm/month in June to August) accompanied with a significantly lighter hydrogen isotope composition of precipitation (-20 to -30 permil VSMOW) in the mid-Holocene compared to the pre-industrial period. This change agrees well with the detected hydrogen isotope variations in plant waxes. Wind vector analyses of the model results reveal that stronger easterly flow of moist air masses from the Atlantic Ocean occurred due to higher boreal summer insolation [2].

This preliminary study shows the large potential of a combined model-data approach to detect and understand (paleo-) hydrologic changes and processes. Future plans include model analyses of more time-slices and incorporation of dynamic vegetation and isotopic leaf-water modules into the model as well as compound-specific isotope analyses of sediment samples in higher temporal resolution.

References

[1] Lamb, H.F, et al. (2007) Quaternary Science Reviews 26, 287-299.
[2] Herold, M., Lohmann, G. (in press) Climate Dynamics