

CONTINENTAL CLIMATE CHANGE IN TROPICAL AFRICA SINCE THE LAST GLACIAL: ORGANIC PROXY RECORDS FROM THE MT. KILIMANJARO AREA

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Climate-proxy records from across Africa and Asia underscore the fact that tropical climates have been anything but stable during the late Quaternary, but the regional synchrony and extra-tropical links of late-Glacial and Holocene moisture-balance variations remain uncertain because of the lack of complete, highly-resolved continental archives with good age control from the Equator. Also contentious is to what extent reconstructed lake-level fluctuations, and oxygen-isotope signatures in tropical archives such as glacier ice and fossil diatoms, mostly reflect variations in rainfall and drought, or also of temperature and its effect on evaporation. The EuroCLIMATE project CHALLACEA aims to answer some of these questions by reconstructing -with excellent time resolution and age control- a continuous 25-kyr history of temperature and moisture-balance variation in equatorial East Africa from the sediment record of Lake Challa, a 4.2 km², 92 m deep crater lake on the lower East slope (altitude ca. 880 m) of Mt. Kilimanjaro. This freshwater lake has a permanently stratified water column and its water budget is controlled by subsurface in- and outflow. Three parallel piston-core profiles of 20 to 22 m length consist of banded to finely laminated sediments intercalated with some homogenous sections, from which a 21.65 m long continuous composite profile was constructed which was dated using 34 AMS ¹⁴C measurements.

We applied the TEX₈₆ proxy for lake surface-water temperature based on fossilized crenarchaeotal membrane lipids¹. A centennial record for lake temperature of the past 25 kyr was obtained: TEX₈₆ values ranged from 0.48 during the Last Glacial Maximum (LGM) to 0.78 at the end of the Holocene, with a distinct warming phase between 19 and 8 kyr ago (Fig. 1). With the TEX₈₆ calibration for large lakes², this translates into a warming from ca. 14 °C at the LGM to 31 °C in the Holocene. Core-top sediments give TEX₈₆ temperatures of 28-30 °C, slightly above the peak (stratified-season) lake surface temperature of 27.5 °C. The low temperatures at the LGM are somewhat surprising, but are possibly related to the greater regional influence of the Kilimanjaro ice cap, which at the LGM reached down to ca. 3500 m altitude on the south-east slope. Terrestrial organic matter input had a distinct effect on the TEX₈₆ values as archaeal lipids from soils interfered with lipids produced in the lake. This is

evident from the Branched and Isoprenoid Tetraether (BIT) index³, which is high when the amount of soil-derived branched tetraethers is high (Fig. 1). High BIT indices (>0.60) occur particularly during the 14-8.5 kyr interval except for the Younger Dryas episode when BIT values fall back to those during the last Glacial. This probably indicates a period of extensive input of soil-derived organic matter into the lake associated with greater sub-surface inflow during wetter conditions. The high-resolution record of $\delta^{13}\text{C}_{\text{org}}$ indicates a rapid shift towards more ^{13}C -depleted values between 16 and 15 kyr (Fig. 1). Compound-specific isotopes of the C_{31} *n*-alkane suggest that this sudden shift is probably related to a rapid change in vegetation cover from dominance of C_4 -grasses towards a greater component of C_3 plants as a response to more humid conditions. We are currently performing δD measurements on the *n*-alkanes to reconstruct changes in humidity.

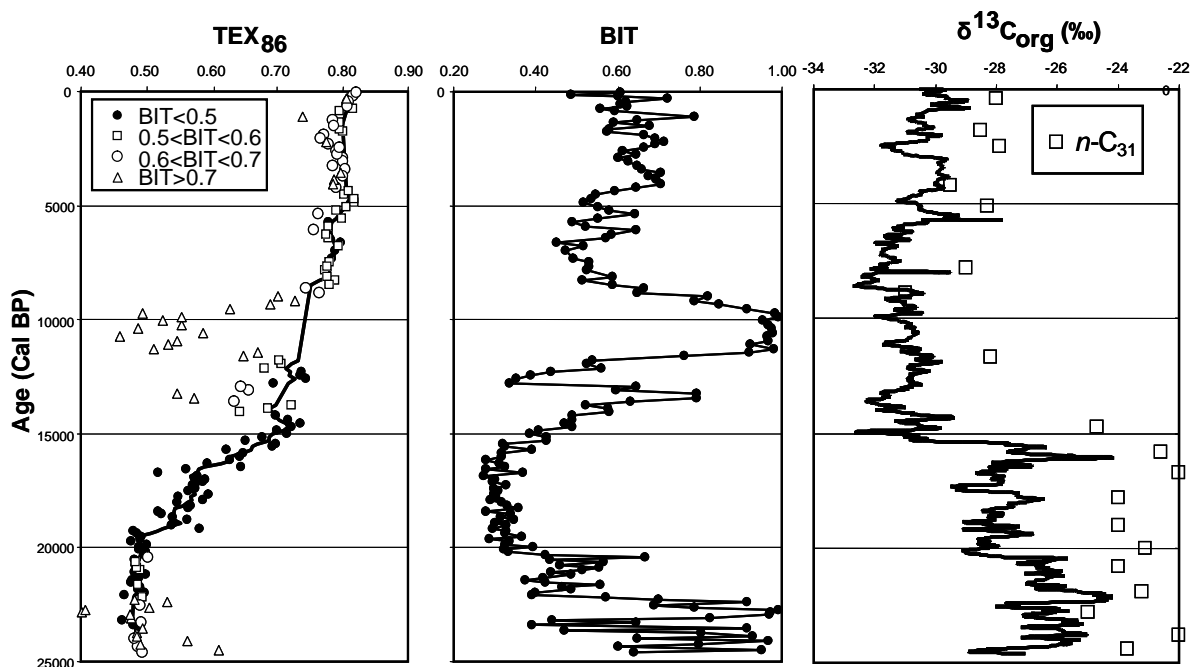


Figure 1. Sedimentary record of TEX_{86} , BIT and $\delta^{13}\text{C}_{\text{org}}$ of Lake Challa. The solid line in the TEX_{86} plot represents the 5-point moving average for data points with $\text{BIT} < 0.6$. $\delta^{13}\text{C}$ values of the $n\text{-C}_{31}$ alkane are plotted in the $\delta^{13}\text{C}_{\text{org}}$ plot. The solid line represents the 5-point moving average of $\delta^{13}\text{C}_{\text{org}}$.

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