Cyclicity and variability changes in eastern African paleoclimate during the last ~600 kyrs

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Abstract: We have established a new wet-dry climate proxy for the Chew Bahir basin, designed to capture climatic cyclicity and variability changes. Long term climate changes are seemingly driven by orbital eccentricity, with low eccentricity preconditioning increased aridity and a more variable climate in eastern Africa whereas during high eccentricity the climate is less variable and wetter. Continuous frequency analyses showed the occurrence of precession and half precession cycles during increased eccentricity, pointing towards an insolation-driven climate in eastern Africa. While during low eccentricity abrupt climate shift occurred that were not explainable by insolation changes the climate of eastern Africa might be more sensitive to climate factors other than insolation, e.g. atmospheric CO2 levels. Early population of humans are more likely to have experienced evolutionary pressures during episodes of low eccentricity, during a dry conditions with high variability, which may have led to technological innovation, such as the transition from the Acheulean to the Middle Stone Age.

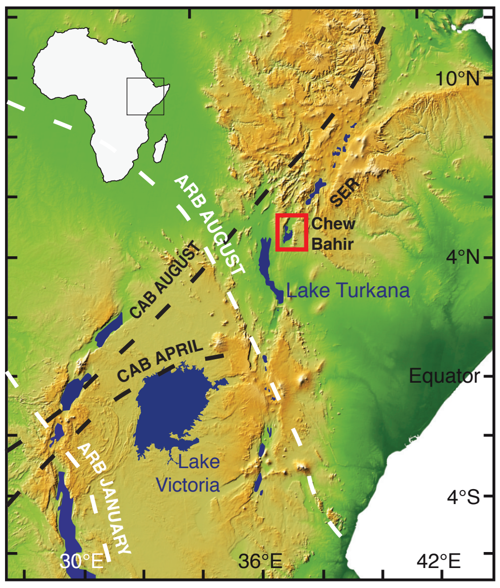

Figure 1: Study area and drill site location. The Chew Bahir basin (CHB) is marked by a red square. The different seasonal latitudinal positions of the African rain belt (ARB) are marked by white dashed lines. The seasonal position of the Congo Air Boundary (CAB) is marked by a black dashed line (modified after Foerster et al., 2012).

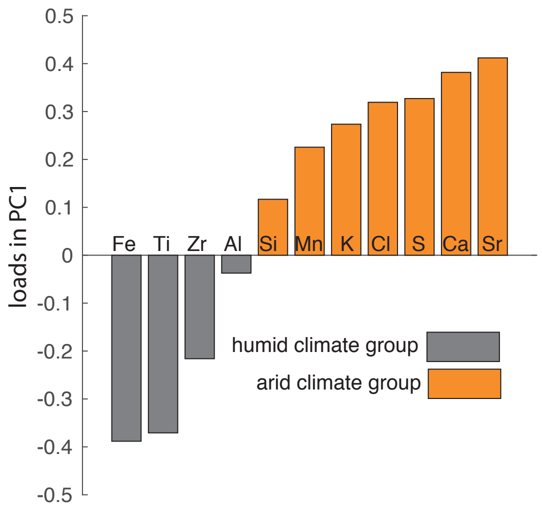

Figure 2: Results of the PCA of the selected XRF elements. We distinguished between a humid climate group represented by Ca, Sr, S, Cl, K, Mn and Si, and an arid climate group consisting of Ti, Fe, Zr, Al, based on the PC1 loads (33% of total variance explained).

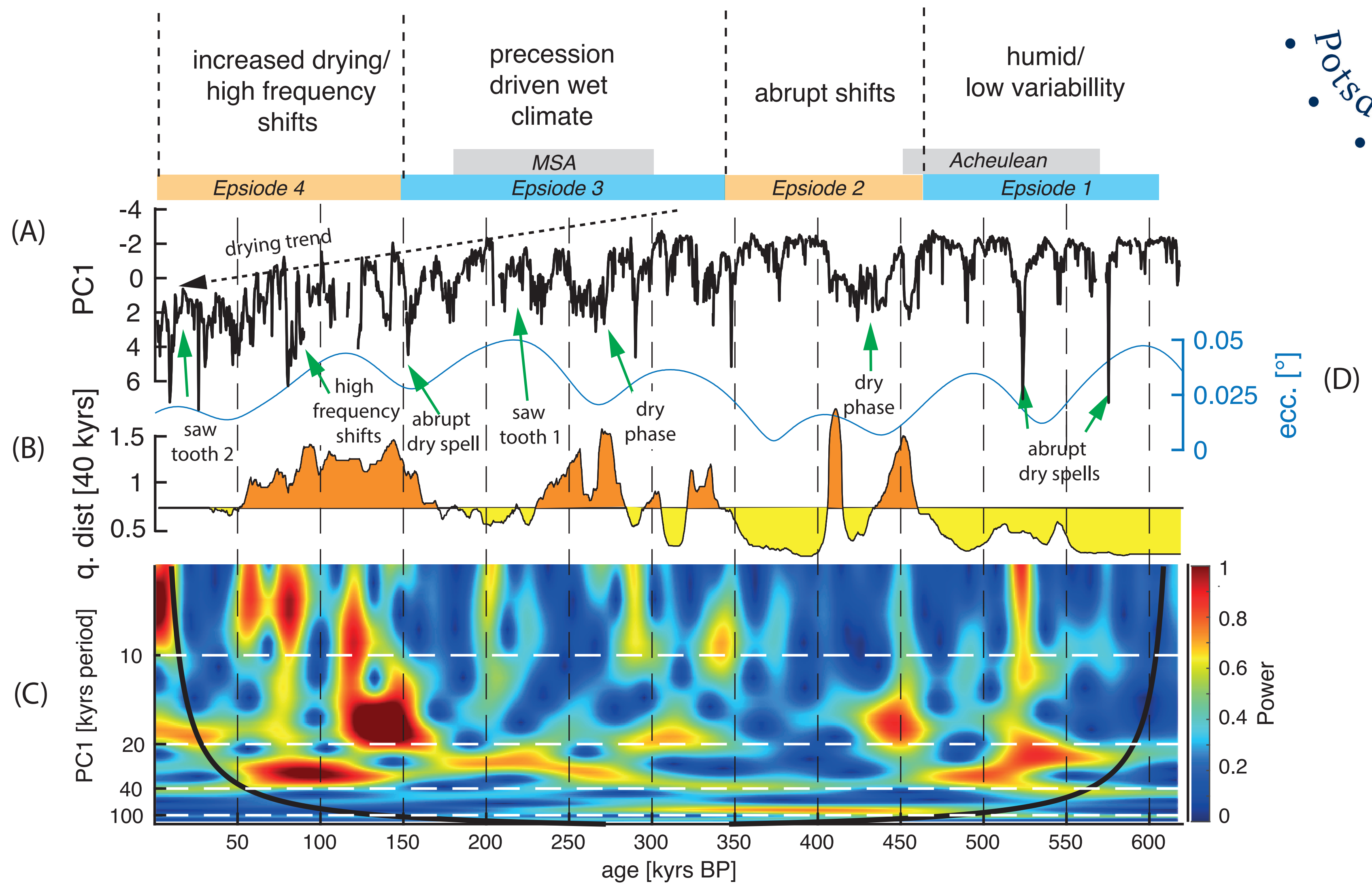

Figure 3: Results of the time-series analysis of the CHB composite core. (A) PC1 (33% of variance explained); positive values indicate increased aridity whilst negative values indicate humid climate conditions. The grey boxes represent the archaeological epochs Middle Stone Age (MSA) and Acheulean. (B) The windowed variability analysis using a window size of 40 kyrs; the yellow colour indicate variability values above the median distance between the first quartile and the median of the distribution, while orange colours indicate variability values below the median. (C) Wavelet power spectrum of the PC1 scores. The frequencies of orbital precession (~20 kyrs period), eccentricity (~100 kyrs period), obliquity (~40 kyrs period) and half precession (~10 kyrs) are marked by white dashed lines. The black line marks the cone of influence (COI) of the wavelet power spectrum. Results outside the COI are influenced by edge effects and should therefore be excluded from the interpretation.