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Climate beats from Africa: a statistical analysis of the 620 kyr Chew Bahir climate record, eastern Africa

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The sediment cores of the Chew Bahir drilling project, part of the Hominin Sites and Paleolakes Drilling Project (HSPDP), from southern Ethiopia, were used to reconstruct climatic changes by analyzing the sediment geochemistry with high-resolution XRF scanning. To interpret the multidimensional XRF dataset we computed a principal component analysis. We used the first principal component (PC1) to detect changes in variability by running a windowed standard deviation analysis and additionally a change point analysis to detect the exact timing of variability changes.

Additionally we used the established Chew Bahir $\log(K/Zr)$ aridity proxy, representing clay mineral chemistry- detrital input ratio and compared it to a new Chew Bahir climate indicator, the $\log(Ca/Ti)$ proxy, an evaporation signal that is probably inversely related to lake level stands. We find that the $\log(Ca/Ti)$ record is also an exceptionally good climate indicator because, compared to the established $\log(K/Zr)$ proxy, it reacts with greater amplitude to insolation-controlled signals such as orbital precession. This is confirmed by the $\log(Ca/Ti)$ record showing a very clear signal during the African Humid Period, which is however less pronounced in the $\log(K/Zr)$ record.

To gain a deeper understanding of the climate cycles and their temporal evolution, we computed a continuous wavelet transformation (CWT) for each of the climate proxies, and studied temporal changes in their cyclicity. Our results indicate that in addition to the precession cycle (~ 20 kyr), the Chew Bahir climate record contains earth eccentricity cycles (~ 100 kyr), as well as half-precession cycles during high eccentricity. During low eccentricity (450-350 kyr ago), we find reduced variability, three of five changes in standard deviation, damped precession and half precession cycles, and an abrupt transition from dry to wet climate, possibly due to climatic change in high latitudes which may be related to the Mid-Bruhnes event (MBE).

The results confirm that during high eccentricity the tropics are insolation controlled, largely

independent of the high latitudes, whereas during low eccentricity the climate of tropical eastern Africa is sensitive to climatic drivers other than precession, possibly originating from high latitudes. Such a period occurring 450 to 350 kyr ago could have led to large regional differences in moisture availability and may have affected early humans by habitat separation, which by isolating populations, resulted in technological diversification. This possible scenario may help to explain the technological transition from Middle Stone Age (MSA) to Acheulean technology that was documented in the Olorgesailie basin during the same time period.