Biogeochemical evidence for climatic and environmental change from the sedimentary record of Paleolake Olduvai (~1.80 - 1.88 Ma)

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Over the past century, extensive studies in East Africa have yielded an unprecedented wealth of information that has shaped our understanding of hominin evolution, including evidence for the critical role played by climatic and environmental variability. Sediment cores recovered by the Olduvai Gorge Coring Project (OGCP) provide a long-term record of paleolacustrine systems extending through most of the Pleistocene in the Olduvai region, a location in northern Tanzania rich in hominin fossil discoveries. The sediments include a stratigraphic interval from the Bed 1 lavas (1.877 Ma) to the Tuff 1F volcanic horizon (1.803 Ma) that comprises an extensive lacustrine sequence of laminated dark anoxic claystones containing pyrite ultimately transitioning into light colored sandy claystones as the lake shallowed.

Molecular and isotopic analyses of the sediment cores document variations throughout this interval that correspond to climatically driven shifts in the sources of organic matter (OM) from terrestrial and aquatic sources. The carbon isotopic composition of OM ($\delta^{13}$C$_{TOC}$) varies between values representative of more forested (~27 ‰) and open grassland (~15 ‰) ecosystems with ~21 kyr rhythms, consistent with the Milankovitch precession cycle. Biomarker profiles, including $n$-alkane distributions and the relative proportions of components diagnostic of aquatic OM all record shifts in the productivity of the lake within the laminated claystone interval that echo the precession cycle observed in the $\delta^{13}$C TOC. By contrast, biomarkers in the sandy claystones are dominated by $n$-alkanes derived from leaf waxes and other biomarkers diagnostic of contributions from terrestrial OM, including soils.

Variations in biomarker compositions record shifts in the aquatic and terrestrial sources of OM that parallel the stratigraphic profiles for $\delta^{13}$C TOC and the C/N ratio. Collectively these records provide evidence for sub-millennial-scale changes superimposed on the precession cycle and indicate changes in climate and in the environments inhabited by hominins during a critical time in their evolutionary history.