BIOGEOCHEMICAL EVIDENCE FROM SEDIMENTARY RECORDS OF SHORT-TERM CHANGES IN THE DEPOSITIONAL ENVIRONMENT OF LAKE OLDUVAI (~1.86 MA)

S. Brassell[1], D. Colcord[1], A. Shilling[1], K. Freeman[2], J. Njau[1,3], I. Stanistreet[3,4], H. Stollhofen[5], K. Schick[1,3], N. Toth[1,3]

Indiana University, Bloomington, IN, USA; [2]The Pennsylvania State University, University Park, PA, USA; [3]Stone Age Institute, Bloomington, IN, USA; [4]University of Liverpool, Liverpool, U.K.; [5]Friedrich-Alexander-Universität, Erlangen, Germany

Hominin Evolution and the Sedimentary Record of Olduvai Gorge, Tanzania

Environmental drivers likely play a pivotal role in hominin evolution (e.g., Potts, 1996), especially adaptive episodes during key time intervals characterized by environmental changes. Thus, determination of the dynamics of environmental and climatic change associated with spatial and temporal evidence for hominin habitation provides vital contextual evidence of their significance as a key influence on evolutionary development (Potts, 2012). Recovery of an extensive sequence of lacustrine sediment cores by the Olduvai Gorge Coring Project (OGCP) affords an exceptional opportunity to employ biogeochemical approaches in assessment of the nature and scale of climatic and environmental changes in locations associated with hominin habitats and at time intervals characterized by high hominin diversity. Specifically, extensive prior research of sediment outcrops at Olduvai Gorge aided by an extensive sequence of dated volcanic units, predominantly tuffs (Deino, 2012; McHenry et al., 2016) has (i) yielded hominin fossils (e.g., Hay, 1990; Clarke, 2012) and evidence of intensive hominin activity (Blumenschine et al., 2012), (ii) provided evidence of abrupt transitions from open C4 grasslands to closed C3 forests on precession cycles (Magill et al., 2013), and (iii) confirmed a patchwork landscape of wetlands and woodland related to the *Zinj* horizon (Magill et al., 2016).

Biomarker and Isotopic Compositions of Lacustrine Sediments from Olduvai Gorge

The C_{org} contents (max. 5.8 %; ave. ~2.3 %) and $\delta^{13}C_{org}$ values (range ~-13.5 ‰ to -30 ‰) for samples from OGCP Core 2A that correlate to Upper Bed I (Stanistreet et al., 2012) support previous research that identified transitions from grassland to woodland on precession cycle timescales from ~1.8 to 1.9 Ma (***Figure 1***). Core 2A samples afford markedly higher resolution, and record short-term environmental changes, including rapid variation in $\delta^{13}C_{org}$ at ~79m associated with a parasequence that is characterized by rootlets and desiccation cracks at its onset. Examination of biomarker compositions across this interval characterized by a marked decrease then increase in $\delta^{13}C_{org}$ reveals trends (***Figure 1***) in some compound abundances relative to C_{31} *n*-alkane (*n*-C_{29} – constant; *n*-C_{33} – decreasing; hop-17(21)-ene – increasing) that appear unaffected by environmental changes. In contrast, γ-carotane and triMeMTTC only occur when $\delta^{13}C_{org}$ minimizes, corresponding to woodland/forest setting, whereas steradienes (C_{28} and C_{29} $\Delta^{4,22}$), likely derived from phytoplankton sterols, and a C_{28} A-norsterane sourced from sponges increase during transitions from woodland to grassland and vice versa.

Conclusions

Biogeochemical investigations of sediment cores recovered by OGCP help characterize short-term changes in the depositional environment of lake Olduvai, including variations in terrestrial vegetation (grassland to woodland) and in aquatic biota perhaps linked to nutrient supply.

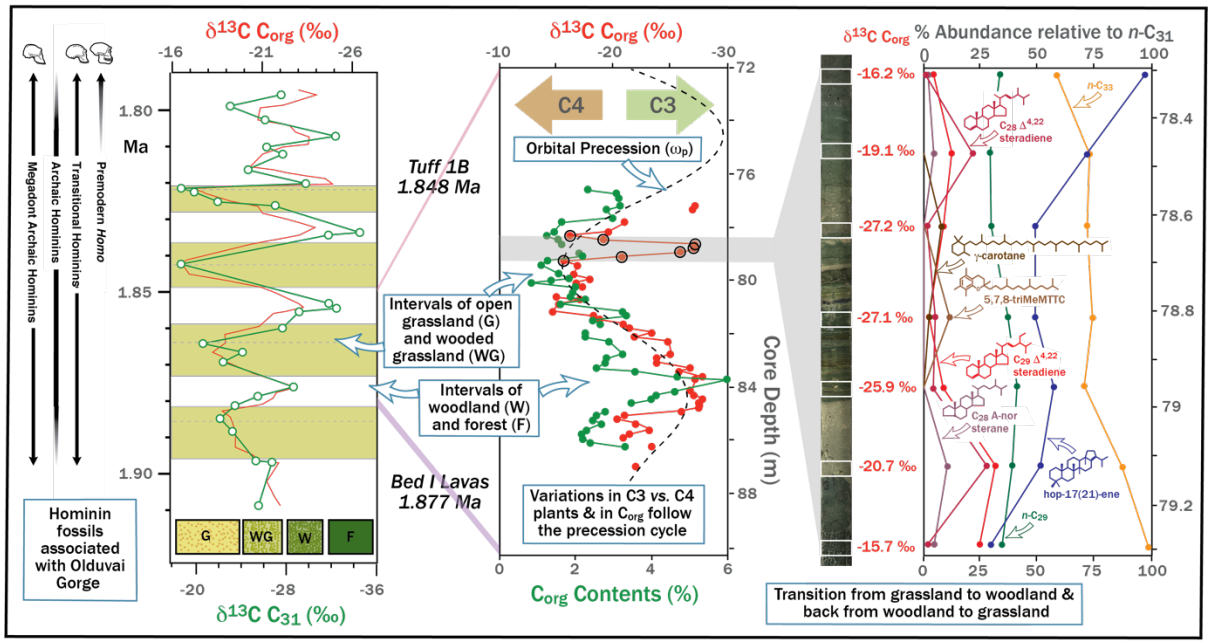

Figure 1 *Stratigraphic profiles of $\delta^{13}C_{org}$ and $\delta^{13}C_{31}$ (leaf wax lipid) for sediment outcrops from Olduvai Gorge associated with changes in vegetation on precession cycles [Magill et al., 2013] during significant time interval in hominin evolution. OGCP Core 2A exhibits similar variations reflecting changes in the proportion of contributions from C4 and C3 plants. At ~79m Core 2A exhibits a rapid transition from grassland to woodland and back to grassland immediately above a horizon with desiccation cracks and rootlets. The hydrocarbon compositions through this sediment interval record temporal changes in aquatic and terrestrial sources of organic matter that reflect lake dynamics.*

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