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Orbital forcing of glacial/interglacial variations in chemical weathering within the White Nile basin: stable-isotope and biomarker evidence from Lakes Victoria and Edward

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The continental Si cycle on Quaternary time scales has been largely neglected. Emphasis has been placed on long-term geochemical processes of silicate-rock weathering and the resulting drawdown of atmospheric CO_2, rather than on shorter-term biogenic processes occurring along the land-ocean continuum.

Si-accumulating plants (notably tropical rainforest hardwoods, savanna and wetland grasses, and Papyrus) and aquatic organisms (such as diatoms and sponges in lakes, rivers and swamps) have the potential to take up, store and recycle significant amounts of Si, thereby modifying the riverine flux of Si to the oceans, the productivity of siliceous marine organisms and the rate of atmospheric CO_2 drawdown on an orbital time scale.

The main aim of this study was to investigate spatial and temporal patterns of Si cycling along the Nile system during the last 20ka BP. Utilising sediment cores from Lakes Victoria and Edward, coupled measurements of stable Si and O isotopes on cleaned diatom separates were employed to reconstruct millennial-scale variations in biotic Si cycling and palaeohydrology, respectively. Abundance ratios of lipid biomarkers (n-alkanes) were used to track major changes in terrestrial and aquatic ecosystems. The results have been interpreted in the light of multi-isotope analyses (2H,18O,30Si) of modern water samples collected along the courses of the modern White and Blue Niles during both wet- and dry-season conditions.

During drier intervals (the Last Glacial Maximum and the late Holocene: high 18Odiatom), Si cycling was greatly reduced. Diminished vegetation cover, reduced biotic rock weathering, a declining soil stock of amorphous silica (ASi) and decreased runoff resulted in reduced dissolved silica (DSi) supply to the lakes in relation to aquatic demand (high 30Sidiatom). In contrast, enhanced monsoon rainfall (low 18Odiatom) during the early to mid-Holocene promoted a substantial increase in terrestrial biomass within the White Nile headwaters, which in turn accelerated silicate-rock weathering and the mobilization of DSi into surface runoff, thereby providing a plentiful supply of Si for aquatic ecosystems (low 30Sidiatom). Our analyses of both White Nile palaeorecords and modern Nile waters imply that the riverine flux of Si down the Nile to the eastern Mediterranean varied significantly on an orbital time scale, with significant implications for the continental stratigraphical record and the marine Si budget.