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Holocene variations in the Si cycle in the Nile River Basin: stable-isotope evidence from natural waters and lacustrine diatoms

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Until recently the continental Si cycle at Quaternary (decadal to million-year) time scales has been largely neglected. Emphasis was placed on silicate-rock weathering and resulting CO_2 drawdown on geological time scales, rather than on shorter-term biogenic processes occurring along the land-ocean continuum. The ability of some terrestrial plants (e.g. tropical rainforest trees, savanna and wetland grasses, *Papyrus*) and aquatic organisms (e.g. diatoms and sponges in lakes, rivers and swamps) to take up, store and recycle significant amounts of Si is increasingly being recognised, although their impact on the continental Si cycle and Si export to the oceans under different climatic regimes remains unquantified. The main aim of this project is to reconstruct spatial and temporal patterns of Si cycling in the Nile Basin during the last 15 ka BP. O and H isotopes have been measured on 80 water samples and Si isotopes on 41 samples, collected along the White, Blue and Main Niles during both wet- and dry-season conditions, in order to investigate the downstream evolution of their stable-isotope compositions in response to seasonal changes in moisture balance and Si cycling. Wet-season δ^{18}O values (measured by dual inlet-IRMS) ranged from -4.74 to +8.03 ‰ and δ^{30}Si values (by MC-ICP-MS) from +0.54 to +3.50 ‰. During the dry season, both δ^{18}O (+0.64 to +8.81 ‰) and δ^{30}Si (+1.47 to +4.54 ‰) increased, due to enhanced evapotranspiration and to decreased Si supply relative to biological demand, respectively. This study has increased the measured upper limit of δ^{30}Si for dissolved Si in the world's rivers by a further 1 ‰. Both δ^{18}O and δ^{30}Si showed progressive enrichment downstream, reflecting cumulative evaporation losses from swamps and open water, and preferential uptake of ^{28}Si by Si-accumulating aquatic organisms. All river- and lake-water samples fell on the same evaporative line, along which individual sampling points shifted seasonally. Holocene variations in Si cycling and hydrology have been reconstructed from Si- and O-isotope analysis of preserved diatom silica in cores from Lake Edward (Uganda-DRC), situated in the equatorial headwaters of the White Nile (∼0°23'S, 29°35'E). For isotope analysis it is necessary to isolate pure, contaminant-free diatom silica from the host lake sediments, which can lead to a lengthy extraction procedure. Standard palaeoecological methods were used to remove organics and carbonates, followed by sample-specific application of wet sieving, sonication, SPLITT and SPT to remove remaining contaminants (e.g. tephra, clays, green algae (*Botryococcus*), mineral aggregates), before simultaneous measurement of O and Si isotopes using the stepped-fluorination technique plus IRMS. Depleted $\delta^{30}Si_{diatom}$ values during the early to mid-Holocene, when monsoon rainfall was enhanced by orbital forcing (depleted $\delta^{18}O_{diatom}$), suggest that dissolved Si supply to the lake ecosystem increased significantly relative to biological demand, in agreement with the modern isotope data.