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Sedimentological evidences for progressive drying of the Sahara during the last 6000 years from the annually laminated record of Lake Yoa

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Lake Yoa is a perennial lake entirely fed by groundwater and located in the Saharan desert of Northern Chad. It contains a unique continuous and high-resolution record of the climate history of the eastern Sahara for the last 6000 years (Kröpelin et al. 2008). Analyses of aquatic and terrestrial paleoecosystems revealed a slow and progressive drying of the region since mid-Holocene (Kröpelin et al. 2008 and Eggermont 2008). Here, we describe the sedimentological evolution of this finely laminated, undisturbed, 7.5 m-long sequence. Comparison of lamination counts with radiocarbon and 137-Cs dates indicates that these couplets are annual, i.e. varves. Counts were made using Fe, and Ca/Ti profiles as well as radiographs acquired using an Itrax μ-XRF core scanner with 100 μ resolution.

Three facies could be distinguished. From 6 ka until 1.1 ka, couplets are: (1) a dark brown layer composed of organic matter, aeolian sands and finer detrital material; (2) a light brown layer of neoformed calcite. After 1.1 ka, couplets are formed by (1) a detrital layer consisting of a mixture of aeolian and resuspended material rich in both Fe and Ca and (2) organic-rich material. The change in varve facies corresponds to an abrupt decrease in Ca content and the simultaneous disappearance of neoformed calcite. This may be attributed to exhaustion of carbonate sources in the aquifer or surrounding dry lake beds as well as to a decrease of primary productivity triggering the precipitation of neoformed calcite. The laminated facies are intercalated with the third facies, of which there are relatively few. It consists of few coarser beds indicative of higher energy events due to changes in lake level or dune migration towards the coring site.

Magnetic susceptibility broadly increases from bottom to top and may be indicative of the combined effect of changes in the sediment source and redox conditions in the water column. The clay fraction is interpreted to be of aeolian or fluvial origin. Gradual decrease of clay content over the entire core and changes in clay assemblage indicate progressive exhaustion of clays formed in soils of the surrounding landscape as well as the transition from a humid towards a hyperarid landscape. There is also a simultaneous and steady increase of the fine sand fraction. Both clay and fine sand content vary in parallel with solar insolation at 20° N, the former being proportional and the latter inversely proportional. In brief, results from the sedimentological study support our previous conclusions that the eastern Sahara dried progressively from mid-Holocene until now and provide a robust chronology for paleoenvironmental reconstructions.

References

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