# VARIABILITY OF THE NORTH AMERICAN MONSOON DURING THE LAST 20,000 YEARS REFLECTED IN LIMNIC SEDIMENTS FROM THE CHIHUAHUA DESERT

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Over the last glacial-interglacial cycle lateral shifts of the North American Monsoon (NAM) caused significant changes in precipitation patterns over subtropical northern Mexico that are reflected in lacustrine environmental archives across the region. The main aim of this study is to reconstruct late Pleistocene and Holocene hydrological and climatic variability in Central North Mexico, using organic matter (OM) inputs to lake sediments and the carbon and oxygen isotopic composition ($\delta^{13}C$, $\delta^{18}O$) of endogenic carbonates, allowing a better understanding of the spatiotemporal variability of the NAM.

The study area includes two paleolakes, Santiaguillo and El Potosi, located at the western and eastern fringes of the Chihuahua Desert, respectively. A 3-m long sediment core was obtained from each basin and radiocarbon-dated. Accordingly, the Santiaguillo core spans the last 27 ka (7 AMS dates), and the El Potosi core spans the last 20 ka (9 AMS dates). We determined the abundances and distributions of lipid biomarkers in 62 sediments (31 from each lacustrine basin), as well as $\delta^{18}O$ and $\delta^{13}C$ values of bulk calcite in 122 sediments (61 from each basin). The sediments were solvent-extracted for biomarker analyses (GC-MS) and compound-specific stable carbon isotope analyses (GC-irmMS) to determine quantity and character of OM inputs and to identify its specific sources.

Significant differences in biomarker composition over time, as well as between the sites, reveal contrasting environmental dynamics along the mountain ranges bordering the Chihuahua Desert. In the East (El Potosi), a change from mainly terrigenous OM to aquatic/bacterial OM suggests that the deglaciation was associated with a switch to drier climate and/or reduced terrestrial productivity, whereas the opposite occurred in the West (Santiaguillo catchment). The carbon and oxygen isotope records of endogenic carbonates also corroborate this premise.

The biomarker records of the Santiaguillo Basin reveal clearly distinguishable phases of ecosystem development. Lipid distributions in sediments from the last glacial reflect a highly productive perennial lake setting; the alkyl lipids are dominated by short-chain ($C_{16}$, $C_{18}$) fatty acids (FA), assumed to represent algal input, while unusually high proportions of even-numbered short-chain *n*-alkanes ($C_{18}$, $C_{20}$) likely derive from microbial sources in the water column (Grimalt and Albaiges, 1986). A seasonal lake characterised by variable productivity and OM preservation and increased terrestrial input developed since the deglaciation and during the Holocene. An interesting feature is the temporary occurrence during the end of the glacial, Bølling-Allerød and the Younger Dryas (16-9 cal ka BP) of 13-methoxy-heneicosanoic acid, which is rare in lacustrine ecosystems and was identified in the red alga Schizymenia dubyi collected in Sicily, Italy (Barnathan *et al*., 1998). This could indicate an increase in lake water salinity and temperature. The vegetation in the catchment of the lake also appears to have undergone significant changes in response to changes in regional

hydrology, more specific during the last 3 ka, as indicated by a shift of main $C_{18}$ FA to $C_{16}$ FA.

In contrast, the main OM source in El Potosi Basin during the glacial is terrestrial vegetation. Dominant amounts of $C_{23}$ *n*-alkane, presumably derived from *Sphagnum,* confirm the visual evidence of detrital plant matter input from peats, implying a year-round humid climate. Unusual amounts of $C_{23}$, $C_{25}$ and $C_{27}$ fatty acid were detected during Termination 1, the source of which is also terrestrial as indicated by compound specific $\delta^{13}C$ values. The early to mid-Holocene is characterized by unusually high amounts of the $C_{24}$ *n*-alkane, and a remarkable increase in $C_{20}$ ω-hydroxy acid was also detected. Marked shifts in concentration and composition of lipids at around 4.5 ka, that indicate a change to drier climate, are likely related to the onset of the neoglaciation.

Overall, the biomarker data reveals clear compositional changes that appear related to changes in hydrology and climate. The records of some unusual compounds in the El Potosi Basin, in particular, the $C_{24}$ *n*-alkane and $C_{20}$ ω-hydroxy acid, also show a clear relation to hydrological changes. However, their exact sources have so far remained elusive. However, we can determine that the response of the vegetation (lacustrine and terrestrial) to the same global climatic events was very different in Santiaguillo and El Potosi lacustrine environments. This can be a reflection of how variable the NAM was during the last glacial-interglacial period in the north of Mexico.

References

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