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Reconstructing the moisture availability of Central Mexico over the past 500,000 years using borehole logging data

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Assessing the moisture history of Central Mexico reveals the responses of tropical areas to variation in past climate. Central Mexico has several long-lived lakes, which are potentially important paleoclimate archives. Lake Chalco in Central Mexico contains a ~300 m lacustrine sequence, which were deposited over a period of ~500,000 years. We conducted Spectral Gamma Ray (SGR) measurements across the lacustrine deposits of Lake Chalco to reconstruct the moisture availability over the past. The SGR data reflect the presence of naturally occurring radioactive elements including potassium (^{40}K) and the equilibrium decay series of uranium (U) and thorium (Th). Natural sources of gamma radiation in lacustrine deposits of Lake Chalco are from volcanic ash deposition and detrital input of eroded sediments containing radioactive elements. However, redox conditions in the lake water influence the mobility of soluble U through conversion to more stable reduced phases. To extract the primary non-volcanic signals, we detected and removed signals from embedded tephra layers in the lacustrine sediments of Lake Chalco. We developed a moisture proxy by calculating the probability of authigenic U distributed across the lake sediments. We expect that an increasing U content in proportion to the content of K and Th indicate redox conditions in lake bottom water as a result of rising lake level. To evaluate this moisture proxy, we examined differences in the percent of the diatom species that are indicative of a deeper lake from literature. Results suggest that Lake Chalco likely formed prior or within MIS13, and the lake level rose gradually over time until the interglacial period of MIS9. Moisture levels are higher during the interglacial than glacial periods and interglacial periods show higher moisture variability. While glacial periods have less moisture, two periods, MIS6 and MIS4, still have a higher likelihood of authigenic U and more moist conditions. In order to determine potential regulators of moisture, we compared models containing the drivers of Earth's orbital cycles, carbon dioxide and sea surface temperature. Carbon dioxide, eccentricity, and precession are all key drivers of the moisture content of Lake Chalco over the past 500,000 years. High levels of atmospheric CO_2 have a positive effect on the moisture in Mexico while eccentricity and precession consistently have negative effects on lake moisture. Obliquity and δ^{18}O have weaker effects on moisture in Mexico, probably due to the equatorial high-altitude region far away from poles, oceans and ice sheets.