



Multi-millennial increased humidity in the Atacama Desert during MIS 5e: evidence from a lacustrine record in southern Peru

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The Atacama Desert, along the Pacific margin of the Central Andes, is one of the driest high-altitude regions on Earth, with hyperaridity persisting for at least 10-12 Ma due to its latitudinal location, Humboldt Current and Andean orographic barriers. This has produced landscapes with exceptionally well-preserved Quaternary geomorphologies, including mega-landslides, alluvial terraces and fans. While the roles of tectonics and climate in shaping and controlling these features remain debated, recent regional studies suggest the occurrence of past humid periods, though their timing, duration, moisture sources and controlling mechanisms remain largely unresolved.

We conducted a multi-proxy study of a 20-30 m thick and 300 m long sedimentary sequence trapped behind the Caquilluco mega-landslide (~2000 m a.s.l., Pleistocene). This site provides a rare exposure of lacustrine deposits and natural dam that have been partially re-incised. To reconstruct depositional conditions, document the paleoenvironment, and constrain the chronology, our analyses included stratigraphy (facies, grain size), geochemistry (XRF) and paleoenvironmental indicators (diatom, pollen) combined with feldspar OSL and ¹⁰Be exposure dating.

Results indicate predominantly lacustrine conditions, through fine and regularly deposited sediments. Slumps in distal deposits suggest minimum water depths of several meters, while desiccation cracks and debris flow layers indicate intermittent drying events. Although only partially preserved, pollen and diatom assemblages point to a semi-humid paleoenvironment, dominated by shallow-water taxa. OSL dates constrain deposition of the exposed sequence to 133 ± 14 ka – 115 ± 16 ka, corresponding to MIS 5e and consistent with ¹⁰Be exposure ages of dam and gorge incision. Given the small catchment area (~10 km²) and high evaporation rates, sustaining lacustrine conditions over ~20 ka would require substantial precipitation. We hypothesize that

strong Pacific surface temperature anomalies during MIS 5e may have induced semi-permanent "El Niño"-type conditions, aligning with other regional proxies supporting enhanced humidity in the Atacama Desert during the last interglacial.

This study highlights the value of high-altitude drylands as archives of Quaternary environmental change and demonstrates the potential of lacustrine deposits in reconstructing past hydroclimatic variability, providing insights into the interplay of climate, geomorphology, and hydrology in dryland evolution.