Glacial Lake Records from the Central Andes: A Multiproxy Approach to Paleohydrology Studies

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Multiproxy analyses of lake cores from ten alpine watersheds that span ~14 to 20°S in the central Andes provide data to investigate the variability of late Pleistocene and Holocene climate, identify whether climatic shifts are synchronous or time transgressive across the region, and document the spatial pattern of climatic variations (Fig. 1). In addition, we collected modern samples and recorded limnological measurements from 25 watersheds along the transect to help constrain our down-core interpretations. We selected lakes that are representative of different hydrologic settings to document a range of sites with different sensitivities to changes in the moisture balance. These include: (1) lakes directly receiving glacial meltwater, (2) overflowing lakes in glaciated watersheds, (3) overflowing lakes in watersheds without active glaciers, and (4) lakes and ponds that drop below the overflow level during the dry season. Analyses include: (1) sedimentology and geochronology (M. Abbott), (2) geochemistry and stable isotopes (B. Wolfe, R. Aravena, M. Abbott, G. Seltzer, D. Rodbell, and P. Polissar), (3) diatoms (A Wolfe), and (4) sampling of surficial sediments, lake water, and limnological measurements to constrain down-core interpretations and develop simple hydrological models (M. Abbott, B. Wolfe, A. Wolfe, G. Seltzer, and D. Rodbell).

The results of our work on multiple sites in the central Andes indicate that while the overall pattern of Holocene aridity is consistent across the region, conditions were not always stable over century to millennial timescales (Abbott *et al*., in press; Wolfe *et al.*, in review). Comparison of the paleoclimate record from Lago Taypi Chaka Kkota (LTCK), an intensively studied site, with other paleoclimate records within the region including Lake Titicaca and Nevado Sajama illustrates a consistent overall pattern of aridity from the late glacial through the middle Holocene (Fig. 2). The effect of changing insolation patterns on precipitation appears to broadly govern the late glacial and middle Holocene aridity at the regional scale, but does not explain the century-scale variability that demonstrably exists. Furthermore, there is a notable discrepancy between the timing of water level rise in Lake Titicaca around 3.5 ka B.P and the onset of wetter conditions in the LTCK watershed at 2.3 ka B.P. This suggests wetter conditions occurred in the northern reaches of the Titicaca watershed first resulting in rising water levels in Lake Titicaca while the LTCK watershed remained unglaciated. This is supported by the results of oxygen-18 studies on Laguna Paco Cocha and sedimentology studies at Llacho Kkota and Ajuyani (see Fig. 1). In addition, we note that overall the last 2.3 ka has been the wettest period during the Holocene, however there are century-scale lowstands in lakes that are not glacial-fed including Titicaca, Laguna Potosi, Cupextani, and Juntutuyo during this relatively wet period.

References

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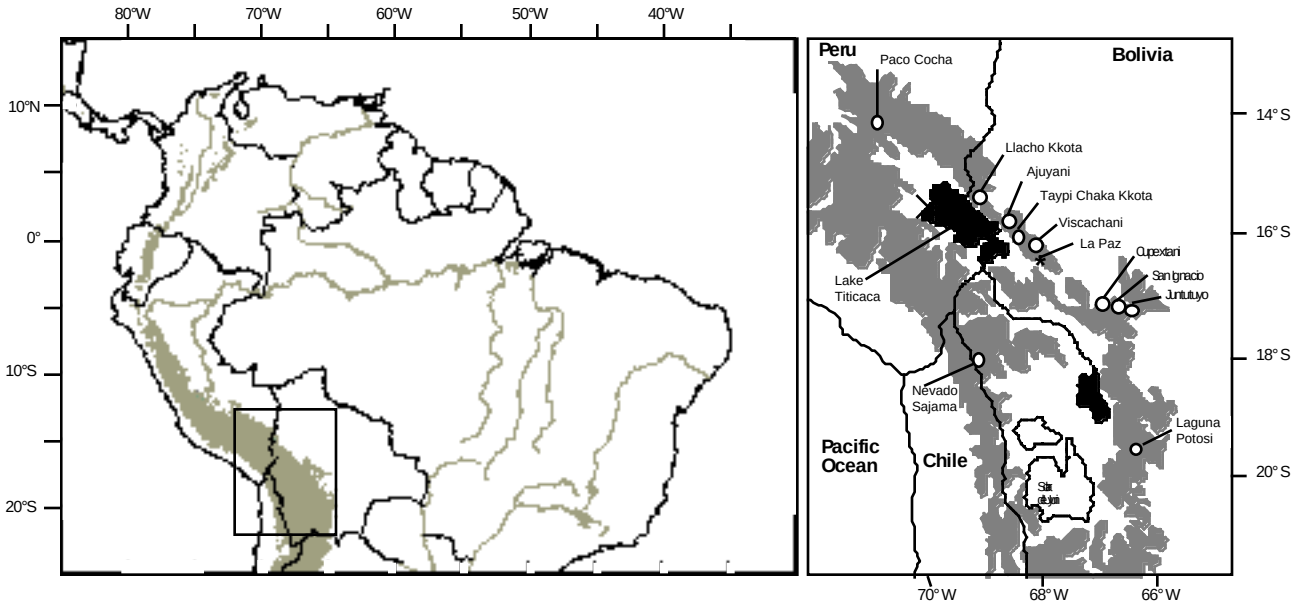

Fig. 1. Location of the study sites in the central Andes. Shaded area represents elevations greater than 3000 m. Modern lake water samples were collected from 25 sites in the Cordillera Vilcanota, Real, Tunari, and Chichas.

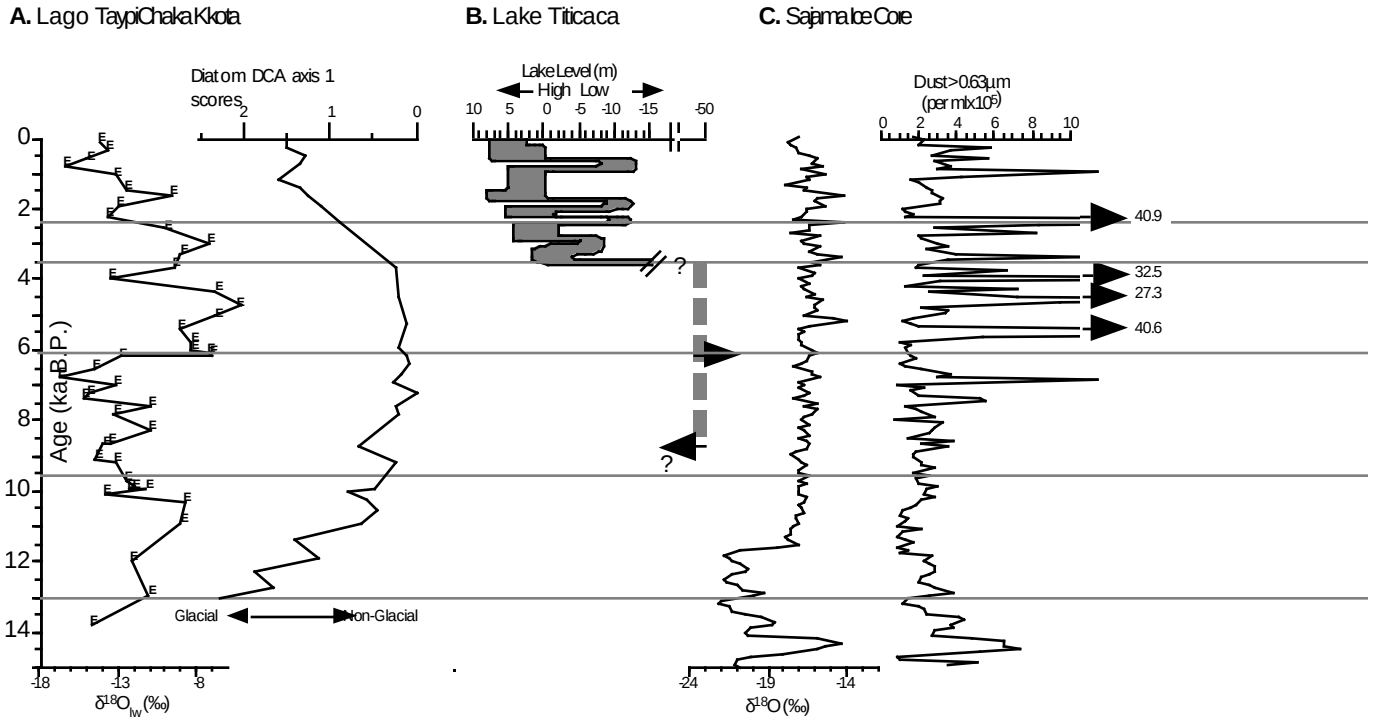

Fig. 2. Summary diagram comparing: (A) the δ18Olw and diatom DCA showing glacial vs non-glacial conditions from the LTCK record, (B) water level fluctuations in Lake Titicaca (Wirrmann and De Oliveira Almeida, 1987; Wirrmann and Mourguiart, 1995; Abbott *et al.*, 1997; Mourguiart *et al.*, 1998, Cross *et al.*, 2000), and (C) the δ18O and dust records from Nevado Sajama (Thompson *et al.*, 1998). Radiocarbon ages from previous studies were calibrated to calendar years for comparison of timescales.