Lacustrine ostracodes and carbonates from the High Altiplano (18-27°S) as stable isotope recorders of environmental dynamics and climate

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Stable oxygen- and carbon-isotopic signatures from benthic ostracodes and authigenic carbonates from three shallow (< 10 m), saline lakes along a transect (18-27°S) of the northern Chilean Altiplano, and from authigenic carbonates from a lake on the northwestern Argentinian Altiplano (Figure 1), document similar arid mid-Holocene to less arid late Holocene trends. Climatic signals however are partially masked by local environmental systems. Isotopic signatures for each lake group in discrete $\delta^{18}O$ vs. $\delta^{13}C$ populations (Figure 2). High isotopic variability results from episodic flooding and brine evolution in the shallow lakes.

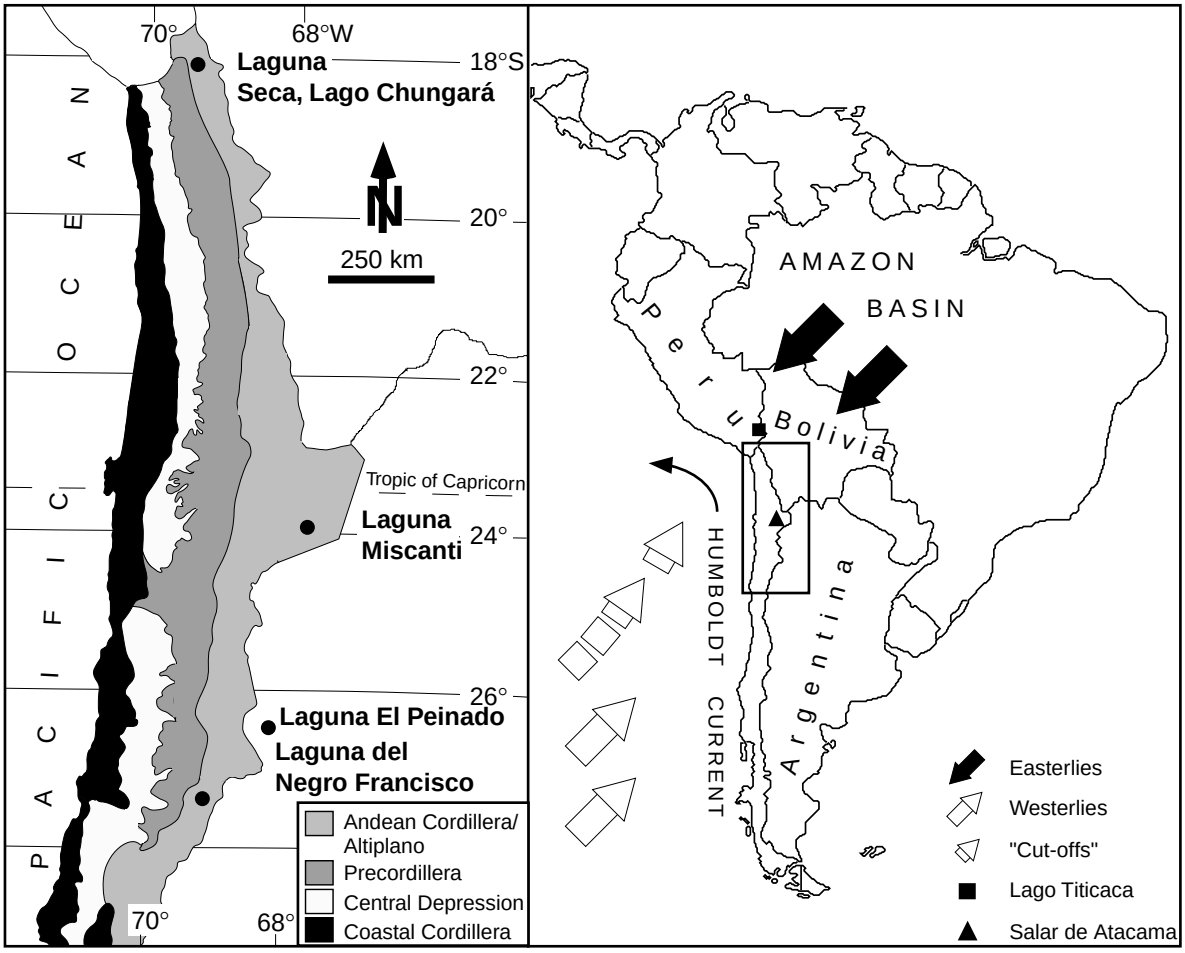

Figure 1: Right: Major airstreams and Humboldt current affecting climate of the study area (rectangle) in South America. Left: Geology and location of lake sites in Northern Chile and Northwestern Argentina.

Laguna Seca at 18°S displays the highest moisture level derived from convective tropical precipitation as shown by the presence of at least 8 ostracode species. Generally higher salinities in comparison to Laguna Seca are indicated at Laguna Miscanti and Laguna del Negro Francisco by the presence of only one ostracode species, *Limnocythere sappaensis,* although sediment facies and ostracode continuity and abundances imply a history of higher effective moisture at Laguna del Negro Francisco. The presence of both female and male specimen indicates that in these ephemeral lakes, sexual reproduction seems to be the more successful reproduction strategy to persist seasonally high and variable salinities.

Laguna Seca and Laguna El Peinado are characterized by strikingly high $\delta^{13}C$ values (Schwalb et al., 1999; Valero-Garcés et al., 1999). High $\delta^{13}C$ values are the result of continuous evasion of CO_2

derived from volcanically charged ground waters and springs, evaporation effects in arid environments plus the formation of travertine and photosynthetic activity in the lake. Travertine is currently deposited in the lakes and is indicative for enhanced hydrothermal flow along fracture traces (Hancock et al., 1999). The sedimentological evidence provides thus further evidence for physical processes as major controls on ^{13}C enrichment. The dilution effect by large quantities of ^{14}C - free CO_2 hinders accurate ^{14}C chronology of these lake records based on lacustrine organic matter and aquatic plants.

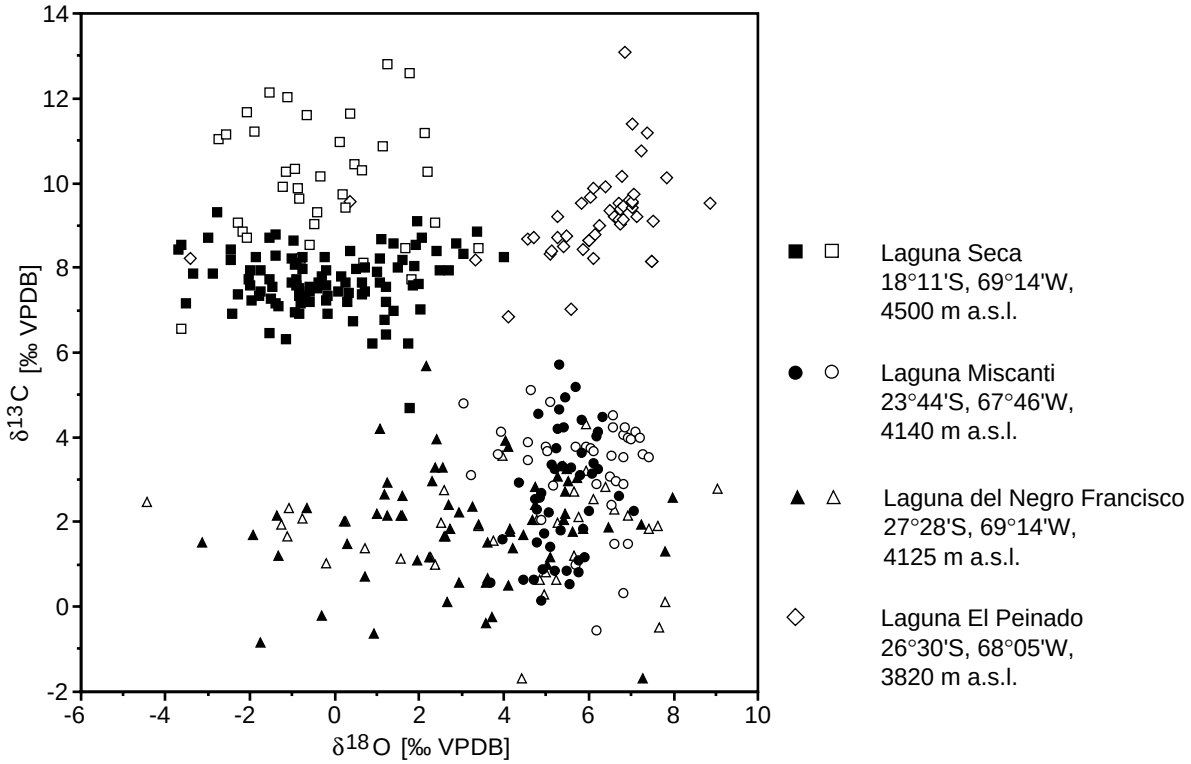

Figure 2: Crossplot of $\delta^{18}O$ versus $\delta^{13}C$ for Laguna Seca (squares), Laguna Miscanti (circles), Laguna del Negro Francisco (triangles) and Laguna El Peinado (diamonds) for ostracodes (solid symbols) and authigenic carbonate (open symbols). Note high $\delta^{13}C$ values for Laguna Seca and Laguna El Peinado, narrow $\delta^{18}O$-range for Laguna Miscanti and wide $\delta^{18}O$-range for Laguna del Negro Francisco.

Laguna del Negro Francisco at 27°S has throughout the Holocene received less precipitation than Laguna Seca but more precipitation than Laguna Miscanti at 23°S, hinting at a precipitation mechanism triggered from the south. In the north, convective tropical precipitation dominates Laguna Seca, as for lakes in the Titicaca region. Effective moisture for Lagunas del Negro Francisco and Miscanti follows a south to north gradient generated by cold airmasses from “cut offs” of Pacific Westerlies colliding with moist and warm tropical airmasses. Extreme aridity during the mid-Holocene was probably caused by decreased summer insolation that resulted in reduced tropical convective precipitation, reducing the moisture source to the lakes. During the late Holocene, increased summer insolation led to stronger monsoons and to an increased pressure gradient between the Pacific and the continent, resulting in an increased frequency of "cut-offs" and cold fronts colliding with tropical air masses. Coherent shifts in past moisture balance therefore depend on availability of tropical airmass moisture.

References

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