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Diatom-inferred δ18O of a Bolivian paleolake during the last deglaciation (18.6-11.7 ka): impact of the paleolake evaporation and water recycling on the isotopic composition of Andean glaciers

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During the last deglaciation, on the Bolivian Altiplano ($\sim$16°S), a wide paleolake covering at least 51,000 km2, named lake Tauca reached its maximum highstand between 16.5 and 15 ka. Overlooking this site, an ice-core from the Sajama ice-cap (covering the last 25,000 years) evidenced an oxygen 18 isotopic excursion of +7‰ matching with the end of the Tauca phase, and more pronounced by about +5‰ compared with the neighboring Andean ice-cores isotopic records. Here we i) provide a new and original experimental use of lacustrine diatoms (n=21) at medium resolution ($\sim$300 years) together with ostracods (n=4) for isotopic δ18O paleolake water reconstruction (δ18Olake), ii) detail a simple hydro-isotopical model with constraints given by literature to explain the strong features in the δ18Olake signal and iii) explore whether the Tauca paleolake could contribute as a moisture source to precipitation at Sajama site when it disappears at 14.2 ka.

Based on a new chronostratigraphy, the sedimentary sections cover lake Tauca phase ($\sim$18.7-14.1 ka) and lake Coipasa phase ($\sim$12.6-11.7 ka). On centuries time scale, strong features consistently appear in δ18Olake: an abrupt decrease during lake filling phases immediately followed by an increase during lake level stable phases. The highest variation occurred at $\sim$15.9 ka with a δ18Olake fall of about $\sim$14‰ concomitant with lake Tauca highstand, and followed by a δ18Olake increase of a similar amplitude four centuries later. We also show that this unexpected re-enrichment of δ18Olake can be partly explained with a simple hydro-isotopic model, based on Craig and Gordon's model, with coherent constraints by a re-equilibration of isotopic fluxes in lake steady-state. Based on an evaporative lake model and a simple water stable isotopic balance between two potential moisture sources for Sajama precipitation (eastward advected moisture and lake evaporation), we show that total or partial (from 5 to 60%) evaporation of the lake during the Tauca regression phase could explain the extra 5‰ Sajama isotopic excursion. These results suggest that local hydrological cycle of lacustrine areas could substantially affect the interpretation of near-by archives of past isotopic composition of precipitation (e.g ice cores or speleothems).