

Holocene Lake Level Fluctuations of Lago Aricota, Southern Peru

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The evolution of tropical circulation patterns can be best tracked with chronologically well-constrained paleoclimate records from the fringes of the tropical rainfall belt. The scarcity of such records from the northern Atacama and central Andes leaves open many questions about the evolution of Holocene climate in this critical region. We document lake levels during the Holocene at Lago Aricota (17° 22' S), southern Peru.

Lago Aricota is 2800 m above sea level on the western flank of the Andes between the arid Atacama Desert and wetter Altiplano. Elevation and precipitation gradients are steep in the 620 km² catchment, which captures mostly summer precipitation from the South American Summer Monsoon (SASM). Lago Aricota formed when debris flows blocked the Río Callazas, and no evidence of modern or paleospillways exists. Diatomite located 10 to 11 m above the modern lake level (aml) marks highstands of Lago Aricota and contains dateable material. Vascular plants, wood, and charcoal provide reliable ¹⁴C dates. Results from an aquatic mollusk (1820±40) and associated wood (1474±40), show reservoir effects to be less than 350 years. Highstand diatomite was sampled and described at four sites (fig.1).

Site A is a small, closed topographic depression that was an embayment of the paleolake. It was filled only when the level of Lago Aricota was 8-11 m (aml). At this site we were able to expose the base of the diatomite, and deduce that the lake was within a few meters of the maximum highstand by 6100 ¹⁴C yr B.P., and receded from this highstand shortly after 3200 ¹⁴C yr B.P. This mid-Holocene highstand is confirmed by dates at Sites B and D (4400 and 2700 ¹⁴C yr B.P.). Moderately high lake levels are recorded in diatomite at 1700 and 1300 ¹⁴C yr B.P.

Lago Aricota's main delta is exposed by a recent artificial drop in base level, revealing ~40 m of foreset beds overlain in places by ~8 m of topset beds along a sharp truncation (fig 2). A pervasive paleoerosion surface is cut into the foresets and is capped by a coarse, horizontal gravel. The age of this truncation surface can be bracketed by dates on wood between 1900 and 300 ¹⁴C yr B.P. We interpret the shift from foresets to topset gravel to reflect a drop in lake level during the late Holocene. The lowstand probably persisted for several hundred years, and is tentatively placed after the moderately high lake levels recorded in diatomite (fig.3).

Evidence for greater effective moisture during the mid-Holocene agrees with some records in the region, but contrasts strongly with others. The contrast between Lago Aricota's record and Lake Titicaca's mid-Holocene lowstand (1,2) is striking (fig. 3), but the proximity of these two lakes makes it unlikely that they experienced drastically different shifts in climate. We speculate that mechanisms intrinsic to the larger lake may produce lags and nonlinear responses to climate change.

Results from Lago Aricota suggest that the mid-Holocene wet episode documented in the central Atacama (22-24°S) (3,4) extended well into the northern Atacama, and the likely cause both wet intervals is an increase in summer precipitation. A northward shift in the extratropical rainfall belt (>26°S) is an unlikely moisture source as far north as 17°S. Summer insolation in the Southern Hemisphere was relatively low during the middle-Holocene, so increased solar heating over the Altiplano could not have produced the wet interval through a direct response of the South American Summer Monsoon.

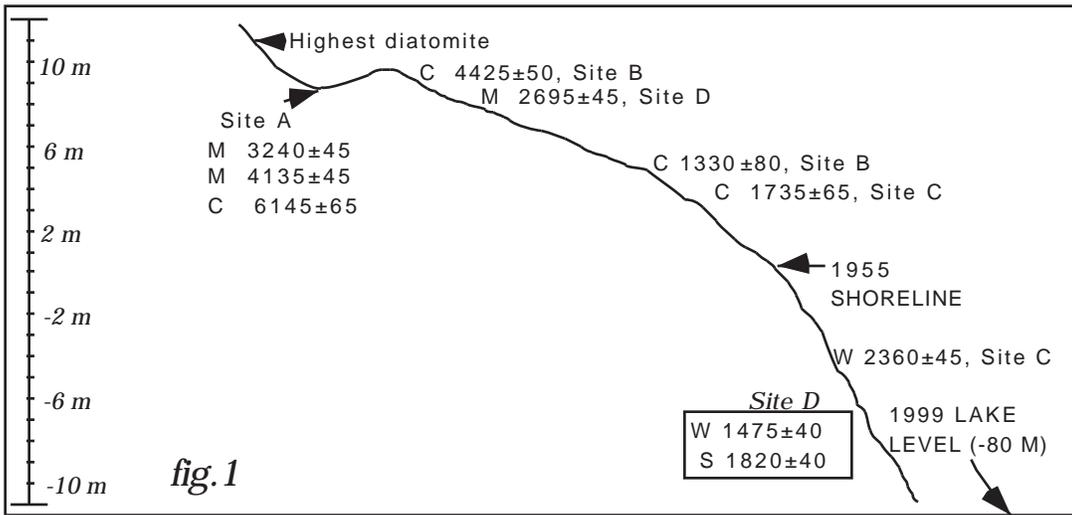


fig. 1

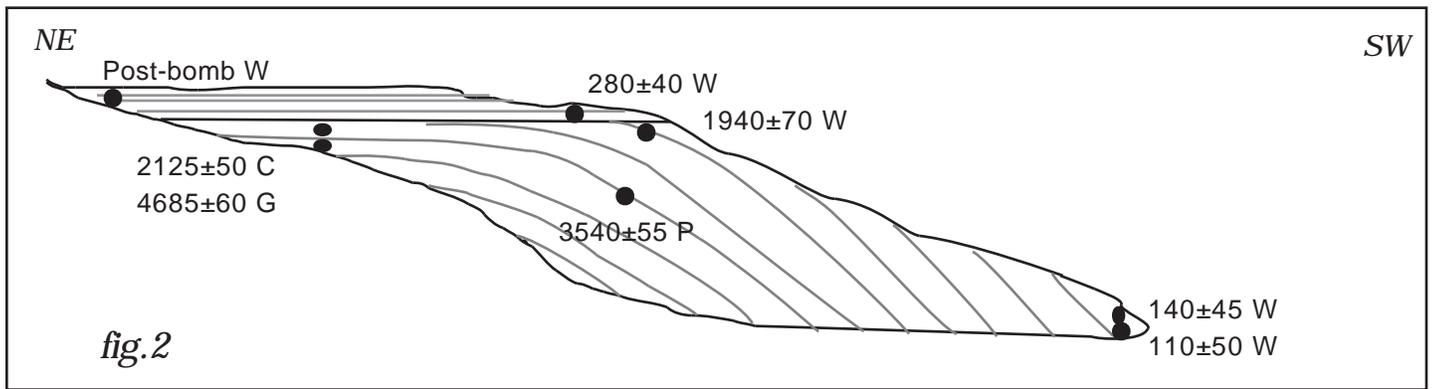


fig. 2

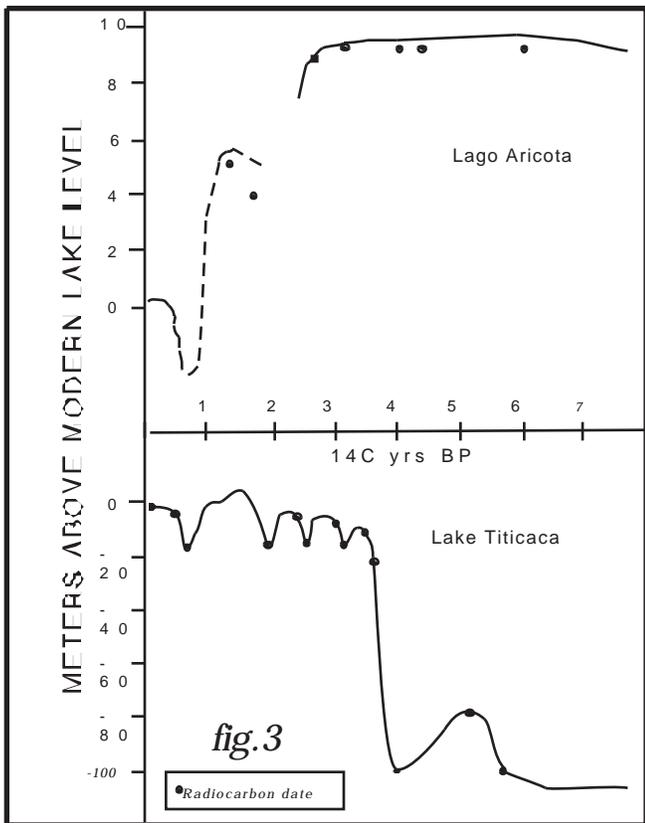


fig. 3

Fig. 1: Composite diagram of radiocarbon dates from diatomites. Letters preceding dates indicate the type of material dated: C: charcoal, P: vascular plant, W: wood, G: organic rich clay, M: organic rich mat., S: gastropod shell. Boxed samples are from the same stratigraphic level.

Fig. 2: Main paleodelta of Lago Aricota. Diagram is ~40m high and 3.5 km long.

Fig. 3: Holocene lake-level curves of Lago Aricota and Lake Titicaca (after 1-late Holocene, 2)

- 1) Abbott, B.M., et al., 1997, Quaternary Research, 47:169-180.
- 2) Cross, S.L., et al., 2000, The Holocene, 10: 21-32.
- 3) Bobst, A., et al., in press, Palaeogeography, Palaeoclimatology, Palaeoecology.
- 4) Betancourt, J.L., et al., 2000, Science, 289:1542-1545.