Wet/dry cycles on the Altiplano as recorded in sediments of the Rio Desaguadero Valley, Bolivia

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The Rio Desaguadero (RD) is the only effluent river from Lake Titicaca (LT). Because it is the link between the wet northern and dry southern Altiplano (including Lago Poopo and Salar de Uyuni), the depositional and erosional history of RD sediments provides a record of changing levels of effective moisture in the basin. During highstands of LT, flow in the RD increases, and fluvial and lacustrine sediments accumulate in the RD valley as the downstream lakes and salars increase in depth and area. During the intervening lowstands of Lake Titicaca, flow in the RD decreases and fluvial sedimentation dominates. Extreme changes in water input throughout the Quaternary have resulted in extreme changes in the character of the RD valley. Geomorphological and sedimentological analysis of terraced strata in the northern and central RD valley, and of subsurface strata (studied in drill cores) in the central and southern RD valley, reveals the record of changing effective moisture on the Altiplano that allows us to determine the history of basinwide precipitation and lake-level variations. Because of the correlation between modern precipitation on the Altiplano and rainfall in the Amazon Basin, these changes are believed to record past periods of increased moisture throughout much of the South American tropics.

River profiles and measured sections in the northern RD valley document the existence of at least fourteen distinct meandering fluvial, braided fluvial, deltaic, and lacustrine lithofacies. These lithofacies are preserved in both paired and unpaired terrace tracts that range from 2 m to 41 m above modern river level. The juxtaposition of fluvial, deltaic, and lacustrine sediments downcut by a modern-day transitional river system indicates that climatic conditions changed repeatedly during the interval recorded in these sediments. The stratigraphic record suggests a middle Holocene climate considerably wetter than modern, succeeded by a dry period and fluvial downcutting that lasted until about 4600 cal yrs BP. This downcutting was followed by another wetter-than-modern period from about 4600 to 4000 cal yrs BP and then by a drier period with deposition of deltaic and braided river sediments until about 3300 cal yrs BP. Finally, downcutting events -- likely corresponding to falls in the level of LT and in the regional base level -- resulted in the modern terrace morphology.

In contrast, Holocene-age terraces in the central RD valley contain no lacustrine strata. They are dominated by braided fluvial strata and only one terrace level is present, indicating that the channel morphology of the central RD valley has not changed significantly in the last 7100 years. Throughout much of the Holocene this central region was controlled more by changes in base level -- by the presence, absence, and extent of paleolakes in the south -- than by changes in the level of LT.

Base level changes are recorded by subsurface strata obtained from eight core holes in the central and southern RD valley. The elevations of the core sites, high shorelines, and other key locations (such as the surfaces of LT and the Salar de Uyuni) provide a framework for

reconstructing the lake-level and water volume history of the southern Desaguadero basin. Sediments recovered in the cores span 3688.72 m to 3771.74 m in elevation – reaching from 38 m to 121 m below the surface of Lake Titicaca and from 34 m to117 m above the surface of the Salar de Uyuni. The sediments consist of interbedded fluvial, deltaic, and lacustrine strata, much like the terraced strata to the north. At least 7 paleolake phases are present in the cored sequence. The youngest of the lake phases is also recorded in northern terraced strata; the oldest is beyond the range of ^{14}C dating. All of the RD paleolakes dated thus far are correlative with periods of high lake level in LT or with the large paleolakes recovered in drill core or mapped from shoreline benches in the southern part of the basin. In addition, these wet phases appear to be correlative with periods of northern hemisphere cooling, such as Heinrich event 1 and the Younger Dryas. By correlating lake margin (silty, plant-rich muds), shoreline (sandy), and open water (dark gray to black laminated clays) lake strata we are currently striving to map the elevation and lateral extent of each of these paleolakes, calculate water volumes for each lake, and better elucidate the large-scale climatic teleconnections.