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TITLE: Mid-Pleistocene Erosion-Deposition Cycles in the Hyperarid Atacama Desert of Northern Chile

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ABSTRACT BODY: In arid and semi-arid landscapes, cut and fill sequences in alluvial deposits are often used to draw inferences between climatic forcing and erosional processes. However, erosion and deposition cycles within a fluvial system may simply be the result of internal forcings. In either case, little work has investigated the expression of wetting and drying cycles in hyperarid environments. We focus here on the Atacama Desert, known for a long history of extremely dry climate, to examine the processes recorded by cut and fill deposits and gain some insight into potential climatic forcings. In this region, the presence of highly soluble anions in Miocene paleosols informs estimates for the onset of hyperaridity prior to 10 Ma. Extremely slow erosion rates, inferred from cosmogenic nuclide abundances in sediment, and Miocene exposure ages of stable landforms support such an antiquity for the region's climate. In contrast, recent evaluations of geomorphic and pedogenic features suggest a late Pliocene shift to hyperaridity was synchronous with the onset of the present El Niño-Southern Oscillation climate system. Entangled with the puzzle of when the Atacama entered its current period of hyperaridity is the question of how active fluvial geomorphic processes can be under such dry conditions. Despite the extremely slow erosion rates mentioned above, recent work near our study area, latitudes 21°- 25°S, finds evidence for active fluvial processes throughout the Pleistocene.

We present a unique dataset of in situ produced cosmogenic ^{10}Be and ^{21}Ne profiles in alluvial sediment from the central, hyperarid Atacama Desert that quantify the timescale of erosion and deposition for the mid-to-late Pleistocene. A ^{10}Be depth profile in the bed of a modern channel suggests active aggradation rather than the stability one might hypothesize for a fluvial setting in a hyperarid landscape. We find these data are explained by a deposition rate of 0.0003 cm/yr, which agrees with upland erosion rates of ≤0.0001 cm/yr inferred from ^{10}Be abundances in sediment at the same site. Based on our modeled deposition rate, we determine that this fluvial system has been continuously aggrading for at least 250,000 years. In a low terrace adjacent to this channel, cosmogenic nuclide concentrations are constant as a function of depth. We fit this profile with an inferred initial condition similar to the modern channel followed by 250,000-300,000 years of stability subsequent to the fluvial system incising, and then aggrading, to its modern channel elevation. Our final depth profile, in a nearby alluvial fan surface, also supports active fluvial processes in the Pleistocene. An active layer approximately 50 cm thick overlies a truncated attenuation profile. Surface ^{10}Be concentrations are similar to concentrations at the base of the truncated attenuation profile suggesting that modern upland erosion rates of <0.0001 cm/yr (1 m/Ma) are comparable to erosion rates during the last period of significant aggradation in this fan system.

These findings suggest that fluvial cycles have alternated between deposition and incision/erosion over at least the past 250,000 years, a period thought to be of undisputed hyperaridity.

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