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Near steady-state relief in the Andes of northern Chile

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The western margin of Northern Chile is an active plate-boundary zone. Therefore, substantial morphological modifications are anticipated to have occurred in most recent geological times. Here, we illustrate that the relief of the Andes of northern Chile has nearly been constant at least since the Pleistocene. The data are information about channel and valley morphologies in relation to surface erosion rates. Surface erosion in valleys is quantified using differences in elevation between dated terraces. On hillslope-interfluves, surface erosion rates are measured using concentrations of multiple cosmogenic nuclides (^{10}Be, ^{26}Al, and ^{21}Ne) from bedrock samples and depth profiles.

The morphological data show that the longitudinal stream profiles of Andean rivers reveal two graded segments separated by knickzones. Above and beneath these knickzones, the channels are braided and covered by gravel bars. This suggests that sediment flux has been transport-limited in these segments. In the areas surrounding these flat segments, incision rates in valleys and erosion rates on adjacent hillslope-interfluves have been at the similar low magnitudes since the late Miocene in the lower portions of the western margin, and since the Pleistocene in the headwaters. Consequently, there has been no substantial modification in the magnitudes of the local relief in these portions of the Andes. In the segment immediately beneath the knickzones, however, the presence of bedrock and mixed bedrock-alluvial channels implies the occurrence of fluvial incision. Also, fluvial incision rates have exceeded erosion rates on hillslope-interfluves in the range of two orders of magnitudes. This implies substantial growth of the local relief in this part of the Andes. Consequently, except for the segments immediately beneath the knickzones, the hillslope relief has been constant at least since the Pleistocene. The stable relief in the areas surrounding the flat segments reflects both the hyperarid climate that prevents efficient erosion on the

hillslope-interfluves, and the limit in tectonic growth.