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Late Miocene to Early Pleistocene Paleo-Erosion Rates and Provenance Change in the NE Argentinian Andes: Apparent Coupling of Sediment Fluxes with 400-kyr Eccentricity Cycles

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Proposed linkages among climate, erosion, and tectonics provide an appealing framework for interpretation of the interplay among tectonic forcing, topographic form, climatic inputs, and rates of erosion. More rapid deformation is hypothesized to create higher and steeper topography that focuses precipitation, drives faster erosion, and enhances slip rates. But, a determination of cause and effect or synchrony in any proposed tectonic-climate-erosion coupling is commonly difficult to extract. Typically constraints on age and provenance are too loose, or records are too short, irregular, or sparse to permit nuanced interpretations. In fact, clear records in active orogens that reveal a persistent climatic imprint on erosion rates (such as ones scaled by Milankovich-type cyclicity) are rare, especially for pre-Quaternary intervals.

Here, along the Rio Iruya on the eastern flank of the NE Argentinian Andes, we exploit a unique field setting in which a 100-m-deep canyon has been cut during the past century through a 6-km-thick tilted sequence of upper Cenozoic synorogenic strata. Sample ages in the Iruya gorge are provided by a high-quality magnetostratigraphy ($\sim$100-kyr resolution) that is calibrated with U-Pb zircon ages of interbedded tephra. Detrital zircon ages and quartz trace elements provide a provenance record for the sampled section. Here, we report 49 new detrital 10Be cosmogenic paleo-erosion rates spanning from the Late Miocene to Early Pleistocene ($\sim$5.8 to 1.8 Ma). Paired with each 10Be sample that is younger than $\sim$3.3 Ma, 23 26Al samples provide a second proxy for paleo-erosion rates. 20th-century canyon cutting obviates the typical uncertainties associated with unconstrained Late Quaternary cosmogenic production due to exhumation prior to sampling.

Three different erosion-rate regimes are apparent: from 1.8 to 2.3 Ma, rates are high with few oscillations; from 2.3 to 4.0 Ma, rates oscillate by a factor of 5 on a $\sim$400-kyr timescale; and from 5.8 to 4.0 Ma, rates are again high with little variability. These different regimes correspond with provenance changes revealed by quartz chemistry and detrital zircon populations. Notably, erosion rates during the middle and late Pliocene in the Eastern Cordillera appear to correlate with the 400-kyr eccentricity-paced orbital frequency. Previously, no terrestrial records have revealed such a clear (and surprising) correlation; one that suggests coupling of long-term (>100-kyr) climate fluctuations to synchronous sediment fluxes. Consistent with some recent numerical models, this cyclicity lends support for frequency-dependent responses of Andean sediment fluxes to climate oscillations.