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Surface uplift of the western margin of the Altiplano revealed through canyon incision history, southern Peru

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The Altiplano plateau in the Central Andes of South America has powerful effects on atmospheric circulation in the southern hemisphere, and feedbacks between regional climate and erosion patterns have probably played a significant role in the evolution of the orogen. However, the feedback and interaction among tectonics, surface processes, and climate are difficult if not impossible to assess without detailed knowledge of the timing and magnitude of deformation events. The difficulty of directly assessing surface uplift requires independent constraints on how this major barrier to atmospheric circulation developed through time.

We present results of a study that employs 40Ar/39Ar geochronology and (U-Th)/He thermochronology to constrain river incision and inferred surface uplift. In southwest Peru, large rivers cut deep canyons through the western margin of the Altiplano. Ocoña/Cotahuasi Canyon is the deepest of these, incising more than 3 km below the surrounding surface. Minimal erosion on the interfluves in this semiarid to hyperarid environment makes incision history an excellent proxy for surface uplift. In the deepest reaches of the canyon, surface uplift through time has resulted in the creation of a localized, incision-induced, rapidly-cooled zone that can be discerned with low-temperature thermochronology. Apatite-He thermochronology reveals a 1-km thick, rapidly-cooled zone that shows a minimum of 1 km of canyon incision occurred between c. 9 and 5.1 Ma. Additional incision – down to the depth of the closure temperature isotherm, an estimated 1.4 km - must have occurred after 5.1 Ma in order to exhume the youngest apatite. The presence of a 2.3 Ma infilling-volcanic flow 125-m above the present valley floor lends an additional constraint, showing that the canyon had incised to near its present depth by that time. Hence, the final 1.4 km of incision

must have occurred between 5.1 and 2.3 Ma. In total, a minimum of 2.4 km of incision and inferred surface uplift occurred in this region between c. 9 and 2.3 Ma.