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Erosion hotspot in the south-western Central Andes revealed by low-temperature thermochronology

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On Earth, only few field sites exist where the coupling of climate, tectonics, and erosion can be studied on a regional scale. The Central-Southern Andes strike north-south for more than 7000 km along the Chilean subduction margin, cross all global climate zones from the Atacama Desert to the Antarctic pole and show mean elevations in excess of 4000 m.a.s.l. They are thus a suitable natural laboratory to study the large-scale interactions between climate, erosion, and active tectonics. At about 33.5°S, the orogen's width narrows significantly from about 340 km to 100 km, its mean height decreases, and the regional climate changes from semi-arid to humid. The tectonic activity of the Andean thrusts in this transitional part initiated around 23 Myr ago and was relatively constant since then, with average orogenic shortening rates of about 2 mm/yr. This area is therefore a key region to study the influence of climate on erosion in a geologically well constrained, tectonically active setting. Here, where the orogen is narrow, 11 new apatite (U-Th)/He and 8 new apatite fission-track (AFT) ages from middle Miocene intrusions in the Western Cordillera are reported. AFT ages show erosional cooling below their closure temperature between 6.7 – 9.8 Ma, while (U-Th)/He ages are extremely young and range from 0.5 to 3.5 Ma. Our results imply a significant Pleistocene increase in erosion rates, with rates being an order of magnitude higher than their Pre-Pleistocene values and higher than erosion rates inferred from thermochronological data in the north. Using a thermo-kinematic model constrained by fault kinematics and observed shortening rates, we cannot explain this change of erosion nor the magnitude of Pleistocene erosion rates by tectonically-driven rock uplift. Thus, our results indicate that it is possible to observe the impact of Pleistocene glaciations even in tectonically active areas. We hypothesize that the establishment of the modern atmospheric circulation pattern in the late Pliocene led to an increased moisture transport as far north as 33.5°S latitude, resulting in glacial growth and enhanced erosion. In consequence, this part of the mountain chain may have entered non-steady state conditions due to increased precipitation and erosion in the Pleistocene, as evidenced by the youngest apatite (U-Th)/He ages observed so far in the Central-Southern Andes.