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Tectonic evolution of the North Patagonian Andes, from the exhumed crystalline rocks to the foreland basin

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Our general goal is to analyze the main tectonic and climatic factors that controlled the late Cenozoic geodynamic evolution of the North Patagonian Andes at about 41°S. To achieve this objective, we conducted an integrated and multidisciplinary study by analyzing the structural architecture, age, and evolution of deformation and exhumation within the fold and thrust belt. The North Patagonian fold and thrust belt at these latitudes shows a general thick-skinned structural style, with involved basement blocks comprised of highly exhumed Paleozoic to Cenozoic metamorphic and plutonic rocks. Local thin-skinned tectonics is also present near the thrust front, where it deforms synorogenic deposits represented by the upper section of the Ñirihuau basin infill. Here we present new thermochronologic and structural data from the exhumed basement blocks, as well as U-Pb dating, structural observations, and sedimentary provenance data from the foreland basin.

Zircon and apatite fission track data from Mesozoic to Cenozoic plutonic rocks record a complex and episodic exhumation history of the basement blocks, showing diverse cooling ages that range from the Early Cretaceous until the late Miocene. In the central and eastern sectors of the orogen, the youngest pulse of exhumation recorded by these analyses is constrained between ~14 and 8 Ma.

A multiphase evolution has been interpreted for the Ñirihuau basin. It originated as an extensional basin during the Oligocene to early Miocene, registering a later change to a foreland-type basin under a compressional regime. Our structural, geochronologic, paleoenvironmental and provenance data from the basin infill constrain the timing of this tectonic switching to between 15 and 13 Ma. Coeval shortening and sedimentation are registered between 13 and 11 Ma, during the foreland basin stage.

Our data record a relatively short pulse of shortening in a narrow fold and thrust belt during the middle to late Miocene (~15 to 8 Ma) in this sector of the North Patagonian Andes. We observe a relatively slow frontal thrust propagation, with important slip focused along a few reverse faults that uplifted basement rocks, favoring differential exhumation in their hanging walls. In the adjacent foreland basin, high sedimentation rates and little lateral migration of the depositional focus is registered. These characteristics suggest a fold and thrust belt – foreland basin system where the rate of surface processes (erosion and sedimentation) is rapid relative to the rate of deformation (Simpson, 2006), possibly under a steady-state erosional efficiency setting typical of humid climates (Yagupsky et al., 2014).

Simpson, G.D.H., 2006. Modelling interactions between fold-thrust belts deformation, foreland flexure and surface mass transport. Basin Research 18: 125-143.

Yagupsky, D.L., Brooks, B.A., Whipple, K.X., Duncan, Ch.C., Bevis, M., 2014. Distribution of active faulting along orogenic wedges: minimum-work models and natural analogue. Journal of Structural Geology 66: 237-247.