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Unraveling the contribution of the west mountain front to Andean mountain-building in North Chile (20°S)

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The Andes are the case example of an active Cordilleran-type orogen. The construction of orogens in such contexts is still poorly understood and the Andean orogen is notably at the heart of a controversial debate. It is generally admitted that, in the Central Andes (~20°S), mountain building started ~50–60Ma ago, close to the subduction margin, and then propagated eastward (e.g. McQuarrie 2002; Armijo et al. 2015). Though early suggested by some geological cross-sections (Mpodozis & Ramos 1989; Muñoz & Charrier 1996), the structures sustaining the uplift of the W flank of the Altiplano have been largely dismissed, and the current main-stream vision theorizes that the Andes grow only by E-vergent deformation along the E margin of the Andes. However, recent studies emphasized and quantified the significant contribution of the W front of the orogen to Andean mountain-building and crustal thickening, in particular at the latitude of Santiago de Chile (~33.5°S) (Armijo et al. 2010; Riesner et al. 2018). However, the contribution of such structures elsewhere in the Andes to the kinematics of the orogen is still poorly solved, because not yet well synthesized nor quantified.

Here, we focus on the western front of the Andes at 20°S. Two recent field-trips have targeted accessible sites where structures crop out particularly well. Two main structures have been confirmed: (1) a W-vergent major thrust contact between the Andean basement and Mesozoic strata, and (2) a fold-and-thrust belt involving Mesozoic units. We combine these field observations with geological maps and observations on satellite images. Structural maps are then provided, and combined with high-resolution elevation models calculated from Pléiades images to build quantitative geological sections.

The multi-kilometric E–W shortening reported on both structures represents a fraction of the total shortening accommodated along the W Andean flank. Indeed, we calculated ~4km of shortening only related to the folding in the ~10km-wide zone where the fold-thrust belt of Mesozoic units crops out. Additional shortening related to slip on faults (especially on the major basement thrust) and in the covered part of the fold-thrust belt cannot be quantified at this stage of work, but we infer that 4km is only a small fraction of the total shortening along the W flank in the Central Andes. The age of this deformation is bracketed between ~68Ma (most recent folded Mesozoic layers) and 27–29Ma (oldest unconformable deposits above the regional erosional surface called Choja Pediplain). This large time span of ~30Myr is to be refined from thermochronological constraints on the timing of basement exhumation along the W Andean front. Minor shortening (a total of ~3km) associated to this W fault system has been recorded in the late Cenozoic deposits, indicating that deformation continued up until ~7Ma (Victor et al. 2004), but remained limited compared to the more intense deformation during the Paleogene. Altogether, the data presented here will provide a first quantitative evaluation of the contribution of the W flank of the Andes to mountain-building at this latitude, for a subsequent precise comparison and discussion with findings derived further south.