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Cordilleran-type orogens and plateaus: new views from a quantitative re-evaluation of mountain-building in the western Central Andes.

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The processes driving Andean mountain-building and crustal thickening have been largely questioned since the ~1970's but have remained relatively unclear. However, the discovery of an active fold-and-thrust belt along its western flank at the latitude of Santiago (Chili, ~33.5 °S) has launched a recent vigorous debate on the relative contribution of these structures to Andean mountain-building. Based on an original approach for structural mapping, we have quantitatively investigated the structure of this fold-and-thrust belt, as well as that of the other structural units of the range at this latitude. By combining these data to published structural geometries of the eastern mountain flank, together with constraints on the timing of faulting and exhumation, we were able to revise the overall structure of the range and to quantify the kinematics of Andean orogenic growth at ~33°S-33.5°S. We find that crustal shortening has first primarily been sustained along the western mountain flank by west-vergent structures, synthetic to the subduction zone, with the subsequent increasing contribution of out-of-sequence thrusting, followed by late east-vergent thrusting along the eastern mountain flank. This pattern seems not to be specific to the Andes at this latitude, as similar observations can be made to the first-order by ~20°S, ie ~1300 km further north. There, the kinematics of the fold-and-thrust belt forming the western flank of the Andes cannot be as precisely documented because most structures are hidden beneath the later Cenozoic Atacama gravels. However, first-order quantitative results indicate similar kinematics, where Andean mountain building initiated on west-vergent structures synthetic to the subduction zone and where the later significant cumulated take-over by east-vergent structures towards the South American continent has led to the building of the Altiplano-Puna Plateau.

We propose that such kinematics - ie deformation initially on west-vergent structures along the western mountain flank, with significant later back-arc antithetic deformation - are first-order characteristics of Andean mountain-building, and result from the limited mechanical flexure of the underthrusting forearc, eventually locally modulated by climate-driven erosion.