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Relationship between plate convergence direction and kinematics of intercontinental deformation in the Central Andes inferred from fault-slip analyses

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The growth of the central Andean Plateau at a non-collisional plate boundary is not well understood and requires knowledge of deformation mechanisms and kinematics of prominent structures at its margins. In particular, it is debated to what extent variations in shortening directions are related to directions of plate convergence at the Nazca-South American plate boundary or are rather due to the geometry of local, first-order structures. This is addressed through a detailed structural analysis of three key areas, La Poma, Southern Luracatao Valley and Cachi, in the Eastern Cordillera of NW-Argentina. The structural study is based on analyses of 828 small-scale brittle shear faults at 79 stations and is complemented by field mapping, remote sensing and 3D modelling of prominent structures. These structures consist of km-scale, N-S striking thrust and reverse faults as well as structural domes of Cretaceous to late Tertiary strata cored by Paleozoic basement rocks.
Fault-slip analysis shows that NE-SW shortening on W-dipping thrust and reverse faults preceded NW-SE shortening on E-dipping reverse faults. The latter deformation increment induced also a component of left-lateral displacement on N-S striking reverse faults that confirms the kinematics of deformation inferred from paleomagnetic studies conducted by others. Moreover, there is an increment of E-W shortening which precedes thrust and reverse faulting. E-W shortening directions are mostly associated with an upper-crustal dome in the La Poma area. The dome is cut by N-S striking reverse and thrust faults. This suggests that this part of the Eastern Cordillera formed by two deformation regimes: (1) non-cylindrical deformation indicated by doming of upper crust followed by (2) cylindrical deformation, evident by thrust and reverse faults that are kinematically associated with km-scale folds with straight hinge lines. As some of the folds affect Quaternary strata, e.g., in the Cachi area, NW-SE shortening directions are late Tertiary to Quaternary (Pleistocene) in age. This direction is at variance with the present plate convergence direction, which is NE-SW. Although shortening directions can vary greatly with position, they are generally uniform at a given prominent structure. Furthermore, the orientation of brittle fault planes is influenced by the geometry of pre-Tertiary rock anisotropy, such as Paleozoic aplitic dikes and foliation surfaces as well as Cretaceous normal faults, well evident in the Luracatao Valley. We conclude that shortening directions in the Eastern Cordillera seem to depend rather on pre-Andean rock anisotropy and the local kinematic regime, under which first-order structures formed, than on far-field stresses related to plate boundary forces.