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Stress patterns of the Plio-Quaternary brittle deformation along the Calama-Olacapato-El Toro Fault, Central Andes

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Understanding the geometry and kinematics of the major structures of an orogen is essential to elucidate its style of deformation, as well as its tectonic evolution. We describe the temporal and spatial changes in the state of stress of the trans-orogen area of the Calama-Olacapato-El Toro (COT) Fault Zone in the Central Andes, at about 24°S within the northern portion of the Puna Plateau between the Argentina-Chile border. The importance of the COT derives principally from the Quaternary-Holocene activity recognized on some segments, which may shed new light on its possible control on Quaternary volcanism and on the seismic hazard assessment of the area. Field geological surveys along with kinematic analysis and numerical inversion of $\sim$ 280 new fault–slip measurements have revealed that this portion of the COT consists mainly of NW-SE striking faults, which have been reactivated under three different kinematic regimes: 1) a Miocene transpressional phase with the maximum principal stress (σ_1) chiefly trending NW-SE; 2) an extensional phase that started by 9 Ma, with a horizontal NW-SE-trending minimum principal stress (σ_3) – permutations between σ_2 and σ_3 axes have been recognized at three sites – and 3) a left-lateral strike-slip phase with an $\sim$ ENE-WSW σ_1 and a $\sim$ NNW-SSE σ_3 dating to the late Pliocene-Quaternary. Spatially, in the Quaternary, the left-lateral component decreases toward the westernmost tip of the COT, where it transitions to extension; this produced to a N-S horst and graben structure. Hence, even if trascurrence is still active in the eastern portion of the COT, as focal mechanisms of crustal earthquakes indicate, our study demonstrates that extension is becoming the predominant structural style of deformation, at least in the western region. These major temporal and spatial changes in the tectonic regimes are attributed in part to changes in the magnitude of the boundary forces due to subduction processes. The overall perpendicular-orogen extension might be the result of vertical stress larger than both the horizontal stresses induced by gravitational effect of a thickened crust.