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Significance of the northern Andean Block extrusion and genesis of the Interandean Valley: Paleomagnetic evidence from the "Ecuadorian Orocline"

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GPS data suggest that the NW South America corner forms a semi-rigid and distinct tectonic block (Northern Andean Block) drifting at 0.6 cm/yr NE-ward along regional dextral strike-slip faults that bound an oceanic terrane accreted in Late Cretaceous times to western Ecuador and Colombia. This is consistent with an average 0.76 cm/yr Quaternary slip rate obtained from field investigation along the main strike-slip faults. Nevertheless, pure thrust tectonics characterize the external (eastern) Northern Andes deformation front from Ecuador to Colombia. Thus, the relevance of strike-slip versus thrust tectonics during Cenozoic times and their relation with oceanic terrane accretion are unclear.

The incertitude on the magnitude of a hypothetical Cenozoic strike-slip deformation is reflected by the variable interpretations of the tectonic regime that generated the Ecuadorian Interandean Valley. This tectonic depression, blanketing the eastern side of the Cordillera Occidental, has been variably considered as due to extensional, thrust, or strike-slip tectonics.

Paleomagnetism may represent an important tool to unravel the Cenozoic tectonic history of the Northern Andean Block, as peculiar patterns of vertical axis rotations arise from strike-slip and thrust tectonics.

Here we report on the paleomagnetism of 31 mid-upper Eocene to upper Miocene mainly volcanic sites from the Cordilleras Occidental and Real of southern Ecuador. Eleven sites show that the western Cordillera Occidental underwent a 24°±10° clockwise (CW) rotation with respect to South America after late Miocene, while no rotation occurred further east. We relate the regional CW rotation to the emplacement of the Cordillera Occidental nappe onto the continental sediments of the Interandean Valley. As rotation and continental sedimentation onset ages are similar, we interpret such tectonic depression as a narrow flexural basin formed ahead of the advancing nappe front.

Previous authors find a post-Cretaceous 28°±9° CW rotation of the Coastal forearc that is statistically indistinguishable from the 24°±10° Neogene CW rotation documented by us in the Cordillera Occidental and Interandean Valley, implying that the whole W Ecuador Andean chain

was detached and rotated over a mid-crustal detachment during the last 10 Ma. Eocene-Miocene paleomagnetic inclination values are systematically consistent with those expected for South America, thus excluding latitudinal terrane drift. Our results show that thrust tectonics prevailed over strike-slip displacement in the southern Ecuadorian Andes during the late Cenozoic.

Finally, we note that the orogenic reentrant-salient sequence of the Nazca trench / Andean chain from northern Chile to Ecuador mimics closely the margin of the Archean–Paleoproterozoic Amazonian Craton and other minor cratons of South America. Considering our results on a continental scale and in combination with previous paleomagnetic data from the Andean belt we infer that the stiff crust of the Amazonian Craton behaved as a foreland indenter, hampered inland deformation propagation, and caused the formation of what we call the “Ecuadorian Orocline”, arisen by opposite-sign nappe rotations around the Craton apex.