

Earliest tectonic inversion in the northern Andes: Structure and thermochronometry of the hinterland Middle Magdalena Valley basin, Colombia

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ABSTRACT: Low-temperature thermochronometric data and cross-cutting structural relationships identified in reflection seismic data reveal a previously unrecognized zone of early Andean shortening associated to the initial stages of tectonic inversion in central Colombia. We explore the mechanisms of selective reactivation and abandonment of pre-existing normal faults in a partially-buried Cenozoic fold-thrust belt in the Middle Magdalena Valley basin. Apatite fission track, zircon (U-Th)/He, and vitrinite reflectance data coupled with thermal modeling help define a 60-50 Ma onset of rapid exhumation along the present boundary between the Magdalena Valley hinterland basin and Eastern Cordillera fold-thrust belt. Subsurface angular unconformities localized above fold-thrust structures indicate Paleogene deposition in a wedge-top depozone containing doubly vergent reverse faults. Retrodeformation of a cross section based on interpreted seismic profiles and thermochronometric data indicates Paleocene to early Eocene shortening and exhumation occurred through simultaneous activation of east- and west-directed reverse faults across a broad orogenic front. Subsequent middle Eocene-Miocene orogenesis was characterized by abandonment and burial of the Middle Magdalena thrustbelt and eastward transferal of deformation to west-directed inversion structures in the Eastern Cordillera. These relationships reveal that deformation operated in a disparate manner, rather than following a systematic progression from hinterland to foreland. We explore the role exerted by the length of Mesozoic normal faults and their obliqueness with respect to the principal compressive stress in controlling the selective reactivation of Mesozoic normal faults during Cenozoic contraction. The multi-method study of Cenozoic deformation in the Middle Magdalena Valley basin underscore the importance of buried structural records in elevated hinterland basins—cases in which the low-relief stratigraphic cover belies a complex subsurface record of potentially large-magnitude deformation during early orogenesis. The northern Andes also exemplify the potential effects of hinterland sediment loading and fault strength on deformation advance in contractional orogens.

KEYWORDS: COLOMBIA, ANDES, THERMOCHRONOLOGY.