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The Mesozoic-Cenozoic history of Andean foreland basins: A continental-scale synthesis

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A continental-scale synthesis of Andean foreland and hinterland basins provides insights into the Mesozoic-Cenozoic history of sediment accumulation, provenance, paleodrainage, and deformation timing. During long-lived subduction along the western margin of South America, retroarc sedimentary basins evolved in a range of structural settings east of the Andean magmatic arc, with robust records of crustal shortening, flexure, and rapid accumulation. However, extensional basins also formed during Triassic–Early Cretaceous (pre-Andean) backarc extension and locally in selected forearc, arc, and retroarc zones during Late Cretaceous-Cenozoic (Andean) orogenesis.

Major transitions in topography and sediment routing are revealed through provenance studies, particularly detrital zircon U-Pb geochronological applications, which distinguish three principal sediment source regions: the South American craton, Andean magmatic arc, and retroarc fold-thrust belt. Following the cessation of Triassic–Early Cretaceous extensional and/or postextensional neutral-stress conditions, a Late Cretaceous-early Paleocene inception of Andean shortening was chronicled in retroarc regions along the entire western margin by rapid flexural subsidence, a wholesale reversal in drainage patterns, and a provenance switch from eastern cratonic sources to Andean sources. An enigmatic stratigraphic hiatus in the Andean foreland succession recorded diminished accumulation and/or regional unconformity development during the Paleogene, contemporaneous with a phase of limited shortening or neutral to locally extensional conditions.

Seemingly contradictory temporal fluctuations in tectonic regimes, defined by contrasting (possibly cyclical) phases of shortening, neutral, and extensional conditions, can be linked to variations in the degree of mechanical coupling along the subduction plate boundary. Along-strike variations in Late Cretaceous-Cenozoic deformation and crustal thickening demonstrate contrasting high-shortening versus low-shortening modes of Andean mountain building. Whereas the central Andes are distinguished by large-magnitudes of east-west shortening (>150–300 km) and corresponding cratonward advance of the fold-thrust belt and foreland basin system, the northern and southern Andes generally experienced low-magnitude shortening (<50-100 km) and relatively limited deformation advance. These temporal and spatial changes in shortening and overall tectonic regime can be related to (1) variable plate coupling during first-order shifts in plate convergence, (2) second-order cycles of slab shallowing and steepening, and (3) second-order cycles of shortening and lithospheric removal and local partial extensional collapse in highly shortened and thickened segments of the orogen.