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Variations in Andean tectonic regime and basin evolution during subduction: Evidence from the central and southern Andes

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A long complex history of Andean fold-thrust belt and foreland basin evolution can be reconciled with geodynamic models relating shifts in tectonic regime to variable coupling between the subducting and overriding plates. Emerging results from the central and southern Andes suggest that Mesozoic-Cenozoic construction of the Andean orogenic belt and associated forearc and retroarc basins was governed by fluctuating contractional, neutral, and extensional modes of deformation during contrasting degrees of mechanical coupling along the subduction plate boundary. These contrasting tectonic regimes were likely regulated by (1) first-order geodynamic variations in absolute trenchward motion of the South American plate and (2) second-order episodic regional shifts in the geometry of the subducting oceanic slab (i.e. phases of slab shallowing and steepening). Alternations among the three regimes are revealed in reconstructions of the style and magnitude of upper-crustal deformation, arc magmatism, and basin subsidence for three east-west transects across the Chile-Argentina segment of the Andes at 23°S, 35°S, and 43°S.

Despite considerable along-strike variations in the magnitude of deformation, a relatively uniform tectonic framework defined the early Andean orogenic history, with a regional transition from Late Jurassic-Early Cretaceous postrift thermal subsidence to Late Cretaceous retroarc shortening (San Jorge, Río Mayo-Aysén, Cañadón Asfalto, and Neuquén basins). However, a key contradiction is revealed for the late Eocene to early Miocene, when neutral to extensional conditions during slab retreat/rollback affected most forearc/intraarc regions (Abanico, Cura Mallín, and Loncopué basins) and retroarc regions (El Maitén and Malargüe foreland basins) in northern Patagonia (at 35-45°S), yet principally retroarc shortening characterized the axis of the central Andes (at 15-25°S). This scenario may reflect transient phases along the plate boundary in which selected segments of shallow subduction and inboard arc magmatism (particularly in the southern Andes) or concentrated crustal thickening (such as the highly shortened central Andes) boosted plate coupling and inhibited extension. Comparable temporal and spatial shifts in tectonic regime along the Andes and other convergent margins can be related to variable plate coupling during first-order changes in plate convergence and second-order cycles of slab shallowing and steepening.