Timing of Laramide deformation onset in northern Arizona-New Mexico and its tectonic implications

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Observations from the southern Laramide region (Arizona-New Mexico) have figured prominently in deducing the tectonic processes that culminated in the formation of classic Colorado Plateau and Rocky Mountain basement-involved structures ~90-45 million years ago. Previous work has delineated eastwardly migrating magmatism that progressed from the late Cretaceous plate margin in southern Arizona/California to as far inboard as southern New Mexico. This sweeping pattern, and observations by subsequent researchers, has been attributed to flat slab subduction of the Farallon plate that transferred magmatism and orogenic compressional stresses >1000 km from the trench. An inferred eastward sweeping pattern of Laramide deformation has been more difficult to discern, and models suggest both sweeping (directed W-E or SW-NE), sporadic (i.e., lacking pattern), or episodic deformation timing across the region. Thus, the mechanisms that resulted in deformation still need additional testing to evaluate whether subduction processes can completely explain Laramide deformation timing. Here, we address these mechanisms by refining the timing of Laramide deformation onset (when significant deformation began) along a west-to-east transect in northern Arizona and New Mexico. The methods integrate (1) continuous time-temperature path models from a regional dataset of new, published, and unpublished apatite thermochronology data (fission-track and (U-Th)/He) on Laramide arches, (2) stratigraphic accumulation/basin subsidence histories on adjacent basins (San Juan and Raton) where present, and (3) compilation of onset estimates from previous geologic studies. This integrated approach allows for a comprehensive analysis of Laramide deformation timing. Results are consistent with an eastward sweep of deformation onset, originating in westernmost Arizona at the Kingman arch ~90 Ma and progressing to the San Luis-Sangre de Cristo arch and Raton basin in north-central New Mexico by ~75-71 Ma. These data lead to a model for Laramide orogenesis whereby deformation onset regionally migrated east-northeast (consistent with regional kinematic studies), a process that was guided by Farallon flat slab subduction that weakened the stable cratonic interior via progressive dewatering in conjunction with transmission of stresses inboard past the Sevier fold-thrust front. Comparison with transects produced in Montana and Wyoming show a similar onset pattern, though with early (~90-80 Ma) and late (~65-60 Ma) deviations to the onset trend that may be related to preexisting weaknesses within the Wyoming foreland. Later deformation starting ~75 Ma in Grand Canyon is interpreted to have occurred following passage of the conjugate Shatsky Rise, a feature that may have impeded dewatering and cratonic weakening that resulted in lower-amplitude Laramide structures coincident with the modern-day Colorado Plateau.

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Laramide, tectonics, thermochronology, stratigraphy, structural geology

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