Elucidating the regional spatiotemporal characteristics of Laramide deformation through low-temperature thermochronology

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Several tectonic models involving different geodynamic mechanisms have been proposed to explain the tectonic evolution of the western United States and the formation of Laramide basement-involved arches ~90 to 45 Ma. Flat slab eastward subduction of the Farallon plate remains the most viable model to account for this enigmatic deformation up to 1000 km from the plate margin, though alternative models do persist in the literature. These include west-dipping subduction, lithospheric buckling, and terrane accretion. These diverse models can be tested through timing of deformation, spatial distribution and timing of magmatism, kinematic analysis of faults, and paleostress estimates. We focus here on timing of deformation, as each model should produce markedly different kinematic signatures (e.g. sweeping vs. dynamic deformation). In order to elucidate the spatiotemporal characteristics of Laramide deformation, we utilize apatite fission track (AFT) and apatite (U-Th)/He (AHe) thermochronology for their ability to determine rock cooling histories from ~120 ºC (AFT) to ~40 ºC (AHe). These methods are ideal for interpreting the timing of uplift and exhumation of Laramide arches, and many Laramide thermochronology studies have been completed. These data are now compiled, and identified gaps have been sampled in order to supplement the regional dataset at key locations. We model these data from many of the Laramide ranges with the program HeFTy to produce continuous time-temperature path models. Models are constrained and evaluated through integration of various geologic data, and are used to help interpret the onset, duration, and cooling rates of deformation for individual Laramide arches. An automated script is used to calculate these characteristics, allowing for quick and statistically meaningful results. Our goal is to then analyze this information geospatially to produce regional cross sections and maps at various time slices to show the spatiotemporal evolution of Laramide structures across the foreland. Through this regional analysis, the plausibility of proposed Laramide geodynamic mechanisms may then be kinematically assessed, and will provide key details for moving forward with understanding the orogenic evolution of western North America and the formation of Laramide arches.

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