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Cenozoic exhumation of the western Brooks Range, Alaska, USA, revealed from apatite fission track data

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Widespread Cenozoic deformation of interior Alaska occurs across a north-south (N-S) cross-sectional width of approximately 1,000 kilometers (km), a spatial scale that is similar to other convergent margins in continental crust. The widespread deformation of Alaska appears to be related to northward subduction of oceanic crust at the southern continental margin, and a spectrum of kinematic and geodynamic models has been proposed to describe this deformation. The Brooks Range, a 1000-km long east-west (E-W)-striking mountain belt, and its foreland define the northern limit of the broadly deforming Alaskan continental interior, and therefore contain an important archive of Cenozoic tectonism. The Cenozoic tectonic history of the range is known primarily from extensive thermal and structural analysis of its central portion. This analysis reveals that the central part of the Jurassic-Cretaceous arc-continent collisional orogen experienced a tectonic rejuvenation by about 65 million years ago (Ma), with several subsequent phases of tectonism throughout the Cenozoic. However, the ~300-km portion of the range that extends west of 156°W remains a geologic frontier.

We report apatite fission track (AFT) age and length data for 112 outcrop samples, collected over the course of ~20 years of U.S. Geological Survey energy and minerals research projects, along a transect that spans the far western Brooks Range fold and thrust belt. Broadly, these samples reveal a) continuous exhumational cooling within the western Brooks Range starting at ~90-80 Ma and lasting until at least 30 Ma, b) widespread, likely accelerated, exhumational cooling of the western Brooks Range that initiated between 65-55 Ma, seemingly related to structures accommodating N-S shortening, similar in orientation to the E-W-striking Jurassic-Cretaceous collisional structural fabric of the range, and c) a widespread phase of rapid exhumational cooling at ~45 Ma, apparently associated with west-northwest (WNW)-vergent contractional- and north-northeast (NNE)-directed extensional structures.

We compare our AFT data to 353 previously reported AFT ages from the central and eastern parts of the orogen. Due to the fact that the 65-55 Ma increase in exhumational cooling related to contractional tectonism also has been widely reported in the central and eastern Brooks Range, evidence for orogen-scale tectonic rejuvenation at this time seems unequivocal. WNW-vergent shortening and NNE-directed extension at 45 Ma in the western part of the range were coeval with formation of the Hope and South Chukchi basins by similarly oriented extension along the southwestern and western flanks of the range. Collectively, we interpret these observations to indicate a counter-clockwise rotation in the stress field of northwestern Alaska between ~65 and ~45 Ma. These 65-45 Ma deformational events overlap in time with key events at the southern Alaskan plate boundary, including ridge subduction beginning in the mid-Paleocene and a subsequent counter-clockwise rotation in the orientation of plate convergence in the Eocene. These observations reinforce interpretations that the Brooks Range has represented the northern part of a diffuse convergent margin in Cenozoic Alaska.

