Kinematic Gravity Modeling of the Crustal-Scale Evolution of the Central Brooks Range and Colville Basin

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A kinematic model of crustal-scale evolution of the Brooks Range demonstrates the progression of gravity anomalies and topography during ocean basin closure and subsequent arc-continent collision and post-collisional contraction. The Bouguer gravity low that develops across the orogen is related by wavelength to the amount of post-collisional shortening, and by amplitude to the combined effects of erosional unroofing and isostatic rebound. An end-member model based on a continent-continent collision represents one potential starting configuration. This model requires 150 km of crustal overlap and 16 km of erosion and rebound to produce a 40 mGal Bouguer low as is observed across the central Brooks Range. However, geometric inconsistencies exist between the modeled solution and the present-day crustal structure in the southern Brooks Range. Obduction of the Koyukuk arc and the Angayucham terrane onto the late-Paleozoic-early Mesozoic south-facing passive continental margin of northern Alaska must be incorporated into the model to bury the Coldfoot subterrane to ~25 km depth early during evolution of the orogen.

A second iteration of the model that includes an overriding arc also exhibits 150 km of crustal overlap during a first phase of collision. Extensional unroofing in the upper arc crust, and up to 10 km erosion of topography immediately follow collision, rapidly elevates the Coldfoot subterrane. The Ruby terrane enters the model by strike-slip motion from the east, replacing the majority of the oceanic arc. Later northward movement of the Ruby terrane by ~50 km causes a second period of contraction and produces the Doonerak duplex. Erosion and isostatic rebound again follow at the conclusion of tectonic shortening with a further 10 km removed from the highest topography in the Brooks Range. This model achieves a closer match to the observed gravity profile than does the first, more idealized model.