

An Early Eocene Deformation Phase in the Alberta Portion of the Canadian Rocky Mountain Fold-and-Thrust Belt; New Evidence from $^{40}\text{Ar}/^{39}\text{Ar}$ Dating of Clay-Rich Fault Gouge

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The Rocky Mountain fold-and-thrust belt of western Canada consists of a series of eastward-propagating thrusts that transported 'miogeoclinal' and foreland basin sediments during Mesozoic and early Cenozoic deformation. In this study, we present new ages of clay-rich fault gouge collected from thrust faults located in the Rocky Mountains and Foothills of Alberta. The ages unravel a major Early Eocene phase of deformation and hint at older Jurassic and Cretaceous tectonic pulses that correlate well with the deposition of major clastic wedges within the adjacent foreland basin. Ages of faults were obtained by extrapolating results of four grain-size fractions with varying percentages of detrital (2M1) and authigenic (1Md) illite polytypes and their $^{40}\text{Ar}/^{39}\text{Ar}$ total gas ages.

In the eastern Front Ranges and western Foothills, gouge samples from four major thrust faults, including the McConnell, Nikanassin, Brule and Muskeg thrust faults, yielded similar ages of 54 Ma. These Early Eocene ages represent the last phase of compressional deformation within the Rocky Mountains fold-and-thrust belt of southern Canada. To the west, in the Front Ranges, the Greenock Thrust yielded an age of 103.3 ± 3.1 Ma. This late Early Cretaceous age coincides within analytical error with the initiation of the deposition of the Fort St. John-Dunvegan 'clastic wedge' with a depocentre in the Peace River region, and with both the emplacement of 'mid-Cretaceous plutons' in the Omineca Belt and deposition of the Crowsnest volcanics in the southern Canadian Rockies. Farther west, in the Main Ranges, a sample of gouge from the Pyramid Thrust (north east of Jasper) produced an age of 162.8 ± 4.9 Ma. This Middle to Late Jurassic age, the oldest faulting age preserved in the foreland, coincides within analytical error with the pre-Oxfordian unconformity recorded in the Fernie Formation and likely represents the age of initiation of thin-skinned deformation in the Rockies.

These new results, combined with recent results from the southern Alberta Rocky Mountains (e.g., ~72 Ma ages obtained from the Rundle thrust system), support the interpretation that the Rocky Mountain fold-and-thrust belt in southern Canada formed through a series of forward-propagating deformation pulses, ranging in age from the late Middle Jurassic to the Early Eocene.