Progressive fracturing in Late Paleozoic rocks of the northeastern Brooks Range: Implications for conditions of burial, deformation and unroofing in an evolving fold-and-thrust belt

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The distribution, character and relative age of fractures in detachment-folded Carboniferous and Permian carbonate and clastic rocks in the northeastern Brooks Range of northern Alaska provide important constraints on the regional thermal and deformational history of this young fold-and-thrust belt. Field, petrographic and fluid inclusion data suggest fractures formed repeatedly during deformation, at different temperatures and depths. These Paleozoic rocks probably initially entered the oil generation window during Early to middle Cretaceous time when the Colville basin formed and filled in response to thrust loading by the growing Brooks Range to the south. Regional fractures formed in the Paleozoic rocks as a result of high pore pressures and low differential stresses ahead of the Brooks Range deformation front as it advanced northward into the Colville basin during Paleocene time. Detachment folding of the Lisburne Group began as previously undeformed rocks passed through the deformation front and were incorporated into the fold-and-thrust belt. Early folding was by flexural slip, with associated fracturing. Structural thickening during continued shortening resulted in deeper burial of the lower part of the deforming wedge so that early fold-related fractures were overprinted by penetrative strain during peak folding at temperatures up to ~280°C. Subsequent deformation eventually led to uplift and erosional unroofing. Late fold-related fractures formed as folds tightened at reduced depths and temperatures. The latest observed fractures are pervasive extension fractures that formed at relatively shallow depths and low temperatures. These fractures are probably related to unroofing and/or regional stresses. A similar fracture history would be expected in the foothills to the west of the northeastern Brooks Range, but less uplift and unroofing in that area suggest less shortening and strain.