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# Impressive display of deformation features at the base of the Lewis Thrust Sheet in the Kananaskis Area: example of a large-scale strain gradient in a compressional regime

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## Summary

The Lewis Thrust Fault extends over 450 km in mapped view length, from the Rockies in Montana to the Southern Canadian Cordillera (Mudge and Earhart, 1980; Price, 1981), where it dies into folded carbonate beds of the Mississippian-age Rundle Group at Mount Kidd in the Kananaskis Area (McMechan, 1995; Price, 2000). South of Mount Kidd and along the Highway 40, the thrust juxtaposed steeply SW-dipping (50-75 degrees) carbonaceous units of the Rundle Group in the hangingwall, against also steeply SW-dipping clastic units of Mesozoic-age in the footwall. Although complex folding is somewhat visible in the hangingwall, when driving by the highway and looking up to the various summits of the Lewis Range, hiking and scrambling up peaks and ridges reveal far more spectacular views of the deformation features in the basal part of the Lewis Thrust Sheet. Collectively, the outcrops visited in the field outline: 1) a strain gradient from higher to lower structural level across the thrust sheet; and 2) evidence of back-rotated thrusts and folds in Rockies of the Kananaskis Area.

## Method

In the summer of 2019, several named and unnamed summits from King Ridge and northward to Opal Ridge South were climbed, visiting outcrops and capturing a series of photos that outlines a range of complex deformation features for about 5 km along-strike in the Lewis Thrust Sheet. This was compared to far simpler geometry observed in previous years, further south along strike of the Lewis Range in the vicinity of Highwood Pass. There, an essentially simple homocline panel of Mississippian-age carbonates is juxtaposed above highly folded Jurassic-age clastics. The complexity of the structures observed in the field across and along the basal part of Lewis Thrust Sheet reaches beyond the resolution of seismic data, in a deformation setting with a similar compressional regime. Similar complex structural thickening at the base of the Lewis Thrust Sheet, such as multiduplexes fault zone, has been documented along strike further south in southeastern British Columbia and southwestern Alberta (Fermor and Price, 1987).

## Observations

In the area studied northeast of Highway 40, three main structural packages are observed across the Lewis Thrust Sheet. The first package is heading up from the highway to about three quarters of the way up the summits, in the structurally highest levels of the Lewis Sheet. There, a train of broad open folding (100's meters in wavelength) with essentially no thrust faulting is observed. The axial plane of those megascopic folds is vertical steeply dipping (75°) to the foreland, which is opposite to major fault-related folding observed in the main ranges of the Bow and Kananaskis valleys. A subvertical plane interpreted as normal fault, cuts through the NE limb and core of major syncline in the hangingwall of the Lewis Thrust at Grizzly Peak. The normal fault could extend up to 700 m along strike, pretty much coinciding where the axial plane of megascopic folds is steeply dipping to the foreland. The second package is higher up towards the summits and structurally lower. The deformed panel gets at its steepest for this portion of the Lewis Range examined, with duplexes and ramp anticlines common observed. Thrust faults have m's to 10's m of displacement with a NE sense of displacement. Multiple detachment horizons are present in the thinly laminated carbonaceous units, with faulted offsets on thick and massive carbonate layers. The third and basal most package in the Lewis Thrust hangingwall section, is located on the backside (NE) of the summits and ridges. There, folded units with the interlimb angle typical of a tight to almost isoclinal/recumbent geometry. C-S fabrics (top to the NE) in cataclasites, steeply-dipping to the SW (> 70°), are also observed in thinly laminated interbeds of the basal most package.

## Conclusions

Collectively, those structures described above are interpreted to represent a broad strain gradient from higher up to lower down toward the basal most part of the Lewis Thrust Sheet in the Kananaskis Area. The folds and their axial plane, detachment and other shear-related structures would have been passively tilted to the SW, as a result of motion on the easterly and underlying major imbricates of the Paleozoic stratigraphy, like the Rundle and Misty thrust sheets. A similar evolution has been described in Mountjoy (1992) for back-rotated thrusts and folds in Alberta Rockies of the Jasper area. Hinterland tilt in the frontal part of the Lewis Thrust Sheet may have contributed to local collapse (SW side down) in the hangingwall section, leading locally to the development of a normal fault, as interpreted in the field. It is possible that the shortening in some of those compressional structures were part of a strain buildup, before displacement on the Lewis Thrust Fault was initiated, carrying the Mississippian units and cutting up through the Triassic units. Further south in the Lewis Range such as Little Highwood Pass, the hangingwall section structurally above the Jurassic units consists mainly of a SW-dipping homocline in Mississippian units, with a much thinner sheared package above the Lewis Thrust.

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