

Along-strike Structural Variation and the Kinematics and Relative Ages of Veins, Fractures, Faults and Folds in Thrust-Related Structures, Southern Livingstone Range, Alberta

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The southern Livingstone Range anticlinorium is situated above a hanging wall ramp across which the Livingstone Thrust cuts up section from a bedding detachment in Upper Devonian Palliser Formation into Mesozoic strata. The anticlinorium comprises a series of overlapping fault-propagation folds and related thrust faults that splay from the underlying Livingstone Thrust and terminate upward and along strike into the cores of the anticlines. The southward termination of the Livingstone Range at Crowsnest pass coincides with a major lateral ramp where the Livingstone Thrust abruptly cuts up section to the south. Along its southern termination the anticlinorium is characterized by other abrupt along-strike changes:

- The Green Creek fault-propagation fold dies out to the north and overlaps with the Caudron Creek fault-propagation fold in an en-echelon manner. As a consequence the anticline of one fold pair passes along-strike into the syncline of the next.
- North of Morin Creek, a northeast-trending tear fault truncates structures with an apparent dextral offset of 250 metres, representing a possible transfer mechanism between fault-propagation folds.
- A tight anticline immediately west of Centre Peak changes into a broad open fold just one kilometre south.

Associated with the anticlines, synclines and thrust faults are calcite veins, many of which contain bitumen. The presence of bitumen indicates that hydrocarbons were moving through the fractures during the formation of the veins. Cross-cutting relationships between vein sets indicate reactivation of structures accompanied by multiple episodes of fluid migration. Large, steeply-dipping cross faults, including the Morin Creek tear fault commonly contain veins of clear, relatively undeformed calcite with no trace of bitumen. These cross structures are interpreted to be late features that may have breached the oil-bearing structures.