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Snapshots of the Canadian Foothills: Gliding with Style and Detachment into a Wedge

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Summary (All headings should be Arial 12pt bold)

This paper provides some retrospective of research undertaken in the late 1980s to 1990s that contributed insights on the structural geology and kinematics of the Central and Southern Canadian Rocky Mountains, focused on advancing the understanding of thin-skinned thrust belt development in general. It describes some of the conduct and conclusions related to the structural dissection of the Rocky Mountains and the recognition of several new detachment faults. These faults, ranging from sharp to broad deformation horizons, were found to be more numerous than previously described, and interconnected in complex ways across Central and Southern Alberta.

Background

In an earlier retrospective (Lebel 2012), I described part of some of a protracted research endeavor that eventually led to the development of a new models of development of the Canadian Cordilleran thrust and fold belt (Figure 1 and 2, Lebel, 1993). The original goal of this research was to unravel the underlying mechanisms of Rocky Mountain thrust tectonics such as the "thrust transfer zones" proposed in the seminal paper by Dahlstrom (1969). That paper primarily focused on the principles supporting the construction of balanced cross-sections to constrain the geometry of deep structure as revealed through industrial oil and gas exploration and the description of a Foothills family of structures (further elaborated by Dahlstrom, 1970). In our research, two-dimensional computer modeling of thrust deformation (Lebel and Mountjoy, 1995) proved a determinant tool to navigate various conceptual experiments to outline an alternate model of thrust belt development. Instead of 'transfer zones', we invoked a new lateral and differential spreading of deformation in each thrust sheet along their map length from their center to their tips, based on David Elliott 'Bow and Arrow Rule'. In parallel with this research, we explored the field and subsurface relationships between the various faults across the stratigraphy present in the area. The observations made in Central Alberta also proved fundamental in recognizing the detachment horizons in the Triangle Zone of the Turner Valley Area Foothills that were mapped and researched from 1993 to 1998 (Figure 1- Study area 2, Stockmal et al, 2001). We compare the two styles of deformation in this paper.

Method and Findings

Inherently, the reductionist 2D modeling approach outlined in Lebel and Mountjoy (1995) makes abstraction of the upward migration of faults through the sedimentary pile observed in nature. Such computer modeling is also limited in its ability to represent and understand comprehensively the complex network of faults and folds observed in the Foothills. Achieving the understanding of the kinematic evolution of the Foothills thrust belt is extremely difficult in light of the general challenge of integrating sparse geological data over the wide study area of Central Alberta. This proved equally difficult in the Southern Alberta. A better three-dimensional description of the Foothills structures was achieved and a kinematic framework was outlined following systematic field mapping and photointerpretation, and the development of several regional balanced cross-sections supported by a set of industry seismic and borehole data. This integration provided a new understanding of the distribution and extent of some nine (9) major fault detachment horizons in the Central Foothills (Figure 3a) and five other ones in Southern Alberta, (Figure 3b). Most of these detachment match each other in being of great areal extent in both Central to Southern Alberta (where stratigraphic matches). They also appear to have played a major kinematic role in providing long glide horizons for major thrust faults that eventually ramp up through stratigraphy and merge with other detachment horizons. This can be observed from the surface to the subsurface and help explain various peculiar geometries as well as suggest a connectivity and important role in the development of various intercutaneous wedge (or triangle zones) observed or interpreted in the inner and outer Foothills of Alberta

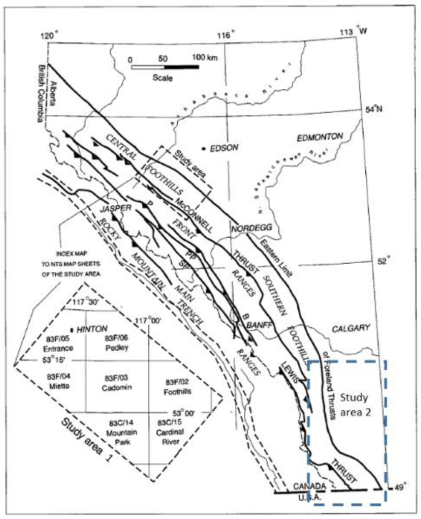

Figure 1: Broad geomorphological zones of the Canadian Rocky Mountains, with the outline of the Central (1) and Southern Foothills (2) study areas.

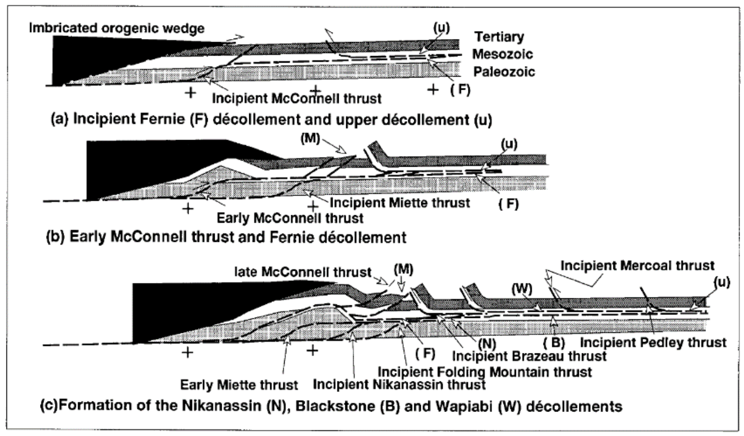

Figure 2: Evolutive model of the Central Foothills integrating observations of multiple fault décollements (or detachments) connected with hinterland-oriented fault and intercutaneaous wedges or triangle zones (from Lebel et al. 1996).

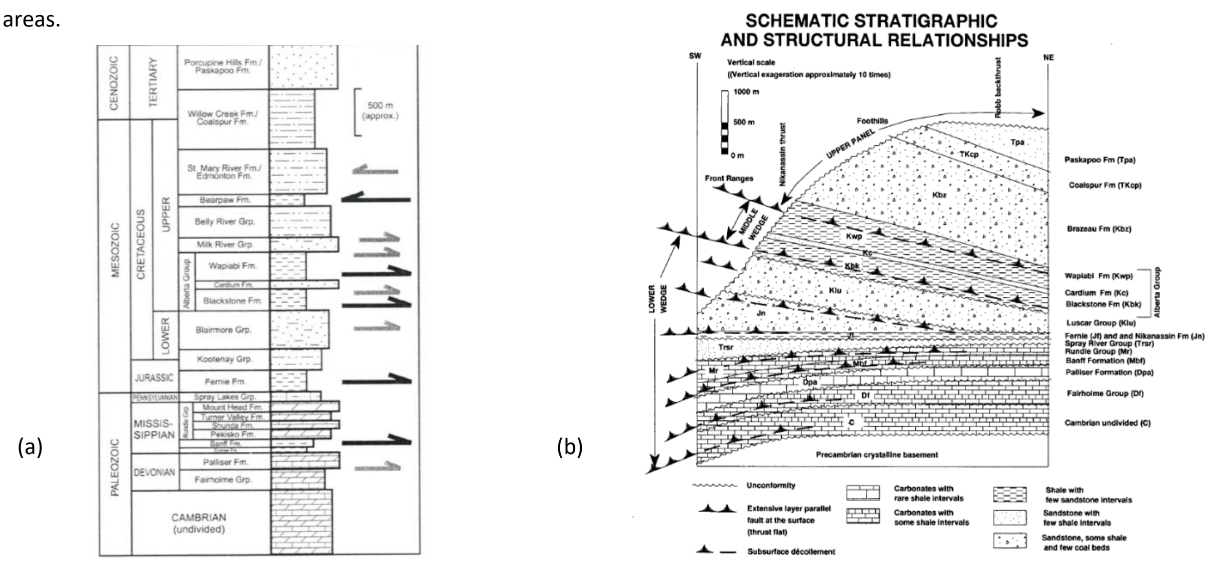

Figure 3: Comparison of stratigraphy and detachment horizons in the Foothills of (a) Southern (a) and (b) Central Alberta (Stockmal et al, 1998; Lebel et al. 1996).

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