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Research Paper

The role of mechanical stratigraphy in the lateral variations of thrust development along the central Alberta Foothills, Canada

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ABSTRACT

Fold-thrust belts generally exhibit significant variations in structural styles such as differences in thrust geometries and frequencies in imbrication. A natural laboratory of this pattern is preserved in the central Alberta Foothills of the Canadian Rockies, where differences in thrust geometries are represented by the existence vs. non-existence of triangle zones. To seek the factors that make this difference in these regions in terms of structural geometry, stratigraphic thickness variations and mechanical stratigraphy of the sedimentary layers, structural interpretation is conducted based on admissible cross-sections and well log interpretations. In northern region, a backthrust is detached from an incompetent layer (viz. Nomad Unit of the Wapiabi Formation), which gets thinner from the Foothills to the Plains, indicating that it is developed where the shale layers are pinched out where triangle zone is developed. Backthrust is also developed in the southern region, where mechanical strengths of strata (viz. Bearpaw Formation) increase toward the foreland. In the central region, however, only forethrusts are developed along the weak continuous decollement layers (viz. Turner Valley and Brazeau formations), forming an imbricate fan without development of the triangle zone. Incompetent layers such as the top Wapiabi (Nomad), Brazeau (Bearpaw), Coalspur and Paskapoo formations are also pinched out laterally, forming fault glide horizons in different stratigraphic levels in each region. These results indicate that, along the transport direction, triangle zone is developed in relation to the stratigraphic pinch out of the Nomad Unit in the northern region, and is formed associated with the variations in strengths of the layers constituting the Bearpaw Formation in the southern region. It is notable that all the glide horizons are developed along incompetent layers. However, triangle zones are not developed in the areas of continuous stratigraphy of the Nomad Unit, which does not serve as a glide horizon in the central region. This suggests that factors such as stratigraphic thickness changes of incompetent layers and mechanical stratigraphy of the sedimentary layers play an important role in the development of lateral variations in thrust system evolution in terms of triangle zone vs. imbricate fan in the central Alberta Foothills.

1. Introduction

The central Alberta Foothills lies along the eastern margin of the Rocky Mountain fold-thrust belt (Fig. 1). A prominent structural feature in this area is the existences of triangle zone vs. imbricate fan that are mostly observed in seismic sections at the boundary between the Foothills and the Plains (e.g. Gordy et al., 1977; Price, 1986), preserving lateral variations in structural styles like most fold-thrust belts in general (e.g. Mitra, 1997). The triangle zone is defined by triangular geometry in cross-sectional view consisting of two thrusts (hinterland and foreland directed) with opposing vergence between the para-autochthonous strata above and the autochthonous strata below (Gordy et al., 1977; Price, 1986), while imbricate fan consists of emergent thrusts that diverge upwards from a decollement layer with a single vergence (McClay, 1992). Numerical models have been constructed to explain the controlling factors that affect the formation of triangle zones in terms of

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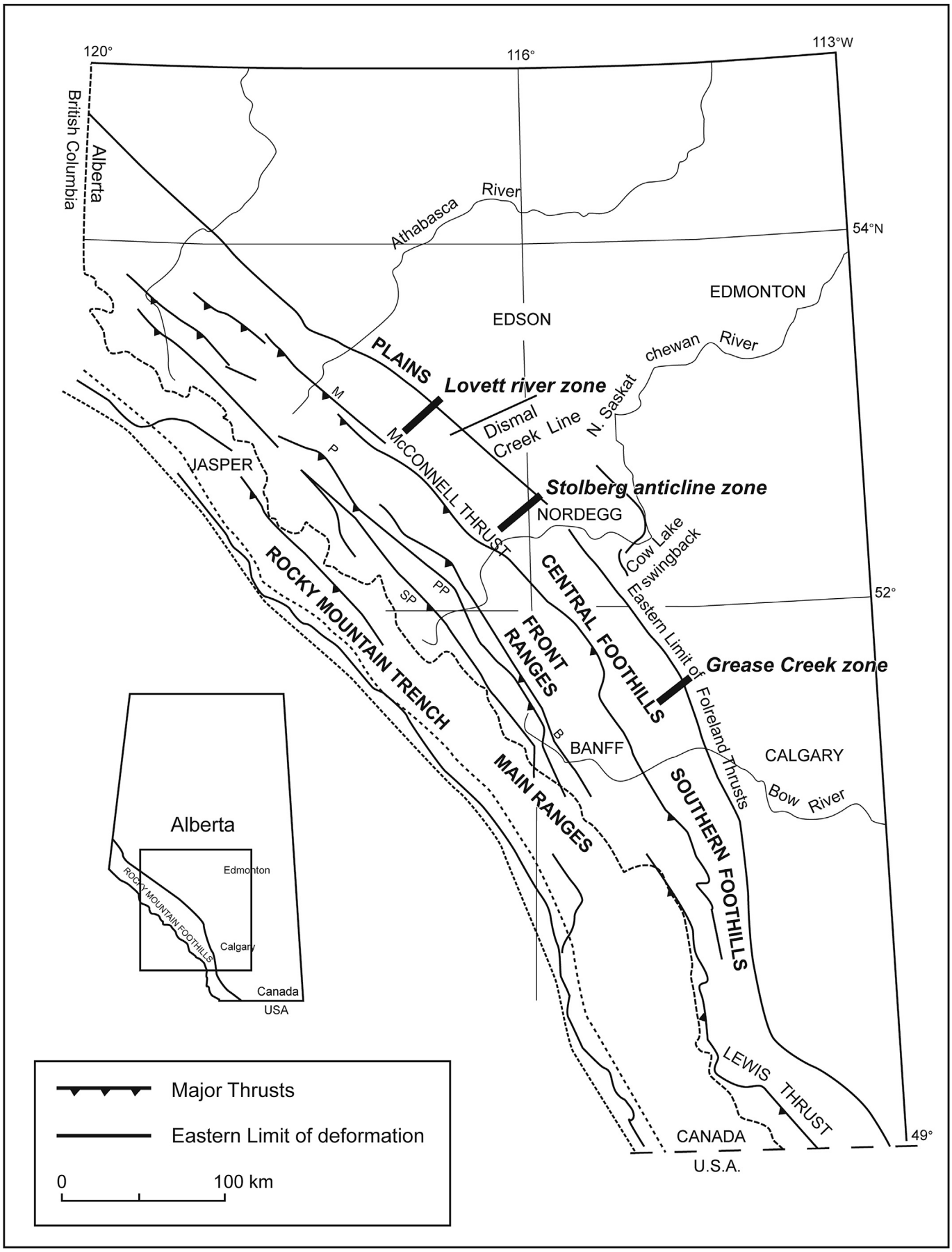
120°
116°
113°W
British Columbia
Alberta
Athabasca River
54°N
EDMONTON
EDSON
PLAINS
Lovett river zone
Dismal Creek Line
N. Saskatchewan River
M
McCONNELL THRUST
P
JASPER
Stolberg anticline zone
NORDEGG
Cow Lake
Swingback
CENTRAL FOOTHILLS
ROCKY MOUNTAIN TRENCH
SP
PP
FRONT RANGES
52°
Eastern Limit of Folreland Thrusts
Grease Creek zone
B
BANFF
CALGARY
Bow River
MAIN RANGES
SOUTHERN FOOTHILLS
LEWIS THRUST
CANADA
U.S.A.
49°
Alberta
Edmonton
ROCKY MOUNTAIN FOOTHILLS
Calgary
Canada
USA
Major Thrusts
Eastern Limit of deformation
0
100 km