

Structural Interpretation of Seismic Data in the Southern Peel Plateau and Plain, Northwest Territories and Yukon: Linking the Northern Mackenzie and Franklin Mountains

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Introduction

Peel Plateau and Plain lie within the Interior Plain of the northern mainland sedimentary basin in the Northwest Territories and Yukon (Fig. 1). The region is bounded by the Mackenzie Mountains, Mackenzie Plain and Franklin Mountains to the south, and the Anderson Plain to the east. The area is largely underexplored and its geological history and hydrocarbon potential remain poorly understood. To expand geoscience knowledge of the area, thematic studies have been initiated by the Northwest Territories Geoscience Office and collaborators to address knowledge gaps pertaining to basin evolution, tectonic history, and petroleum potential of the area. The geometry and kinematics of Phanerozoic regional structures are being re-examined in light of recent detailed fieldwork and preliminary interpretation of seismic data.

Structural Geology

The southern Peel Plateau and Plain region marks a profound change in structural style from broad anticlines with intervening narrow synclines in the northern Mackenzie Mountains, to linear and narrow ridges in the northern Franklin Mountains to the east-northeast. Although south-vergent structures are observed locally, the Mackenzie Mountains are dominated by north to northeast-vergent thrust faults and commonly expose Proterozoic strata of the Katherine Group and Tsezotene Formation in the core of broad anticlines, suggesting translation above a “deep” detachment. The northern Franklin Mountains, however, are marked by drape folds, reversal of fold asymmetry and direction of faulting, and expose no strata older than Cambrian Saline River Formation, above which they appear to be detached. Dominant structures typically trend northwest-southeast, but swing to the west near Carcajou Ridge, mimicking those of the Mackenzie Mountains. The contrast in structural style between these two belts has been attributed to a physical link between a deep detachment beneath the Mackenzie Mountains and a shallow one underneath the Franklin Mountains, but the nature of this transition remains poorly understood.

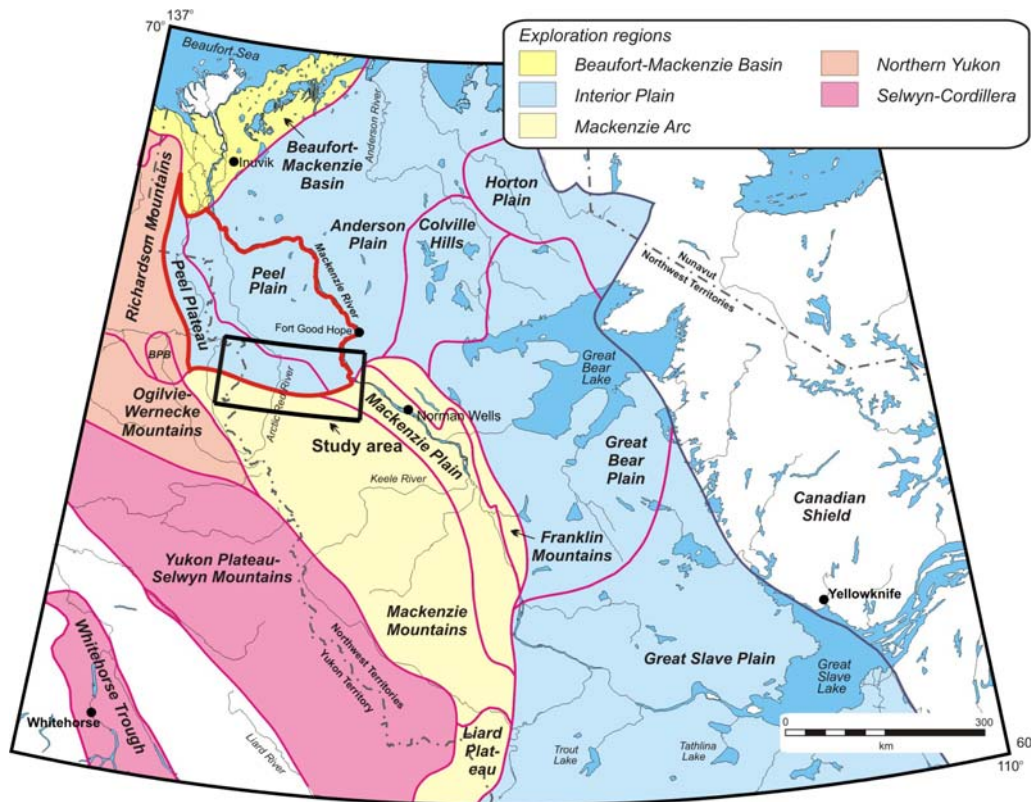


Figure 1: Main exploration regions of the Mackenzie River Valley area. Exploration regions are subdivided into exploration areas (e.g., Great Slave and Great Bear plains) on the basis of physiographic and/or geologic features. Figure shows the location of Peel Plain and Plateau (thick red outline). Location of the study area is shown as a solid outline. BPP, Bonnet Plume Basin.

Discussion

The Whirlpool fault, a southeast-vergent thrust fault of regional extent, has been identified as a Laramide structure potentially linking the western termination of the Franklin Mountains to Southbound Ridge, a structurally complex area marking the Mackenzie Mountain front near Hume River. Preliminary observation of subsurface data along the Whirlpool fault indicates that it is a complex transfer zone marked by southeast-vergent thrust faults, northeast- and southwest-striking reverse faults, and northeast-trending folds that can be mapped continuously from Carcajou Ridge to Southbound Ridge. The northeast-southwest structural trend of this transfer zone is in marked contrast with those in adjacent areas, and may suggest some degree of oblique contraction.

Analysis of subsurface structures suggests left-lateral transpressive deformation associated with the zero edge of Saline River evaporites (Fig. 2). East of the evaporite zero edge, the Franklin Mountains sheet moved northward above a weak basal detachment; to the west, where the Saline River Formation is absent, the Mackenzie Mountain front, and Peel Plateau and Plain sheet was “pinned” to its substratum. Pre-existing basement structures may have influenced the development of this northeast trending transfer zone.

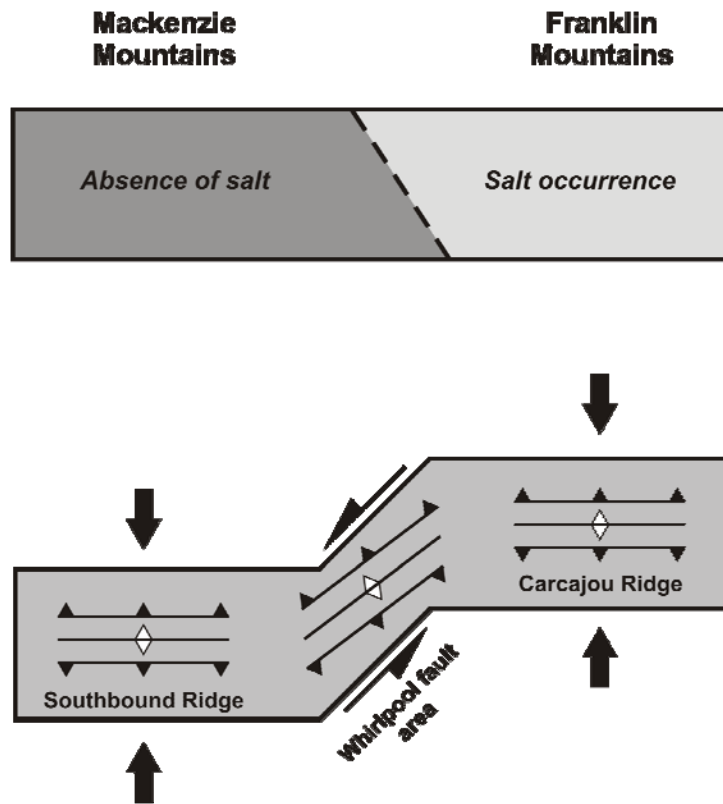


Figure 2: Map view diagram illustrating the development of left-lateral transpressive deformation between the Mackenzie and Franklin mountains. Upper diagram: initial pre-Laramide configuration; lower diagram: syn- to post-deformation configuration.