Structural Geology of Southern Peel Plateau and Plain Region, Northwest Territories and Yukon

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Frontal structures of deformed belts throughout the world, such as the Alberta Foothills, are known to contain significant hydrocarbon reserves. Therefore, understanding the internal structure and kinematics of mountain fronts has direct implications for petroleum exploration. Peel Plateau and Plain lie within the Interior Plains exploration region of the Northern Mainland Sedimentary Basin in the Northwest Territories and Yukon. The region is bounded by the Mackenzie Mountains to the south, the Richardson Mountains to the west, the Mackenzie Delta to the north, and the Mackenzie River and Anderson Plain to the east. The area has a widespread hydrocarbon potential and has been identified by industry stakeholders as a high-priority exploration region, yet it is underexplored and its geological history remains poorly understood. Insufficient stratigraphic, structural, and geochemical data preclude a comprehensive assessment.

As part of the project "Regional Geoscience Studies and Petroleum Potential, Peel Plateau and Plain, Northwest Territories and Yukon" of the Northwest Territories Geoscience Office (NTGO), in collaboration with the Geological Survey of Canada (GSC) and Yukon Geological Survey (YGS) (http://www.nwtgeoscience.ca/petroleum/PeelPlateau.html), fieldwork was conducted during 2006 in the southern Peel Plateau and Plain and northern front of Mackenzie and Franklin mountains. This work focused on reevaluating the geometry, kinematics, and timing of key Phanerozoic regional structures that underlie the area. The region is structurally complex where linear, narrow ridges and shallow thrust faults of Franklin Mountains meet broad, flat-topped anticlines with intervening narrow synclines, and deeper contractional structures of northern Mackenzie Mountains. The transition from shallow to deeper structures appears to coincide with the westernmost occurrence of Cambrian Saline River Formation evaporites; however, much work is needed to elucidate the surface and subsurface geometry at the transition.

Detailed structural mapping was carried out along major structures, such as 1) the Tabasco Fault, a north-northeast-dipping thrust fault exposed on the northern flank of the Tawu anticline and interpreted as a major backthrust, akin to the triangle zone of the southern Alberta Foothills. Along most of its length, the Tabasco Fault juxtaposes Proterozoic units in its hangingwall against Lower Paleozoic carbonates in the footwall; 2) the Deadend Fault, a north-verging thrust, which juxtaposes Proterozoic strata in the hangingwall against Paleozoic carbonates in the footwall. It defines the front of the Mackenzie Mountains in the Arctic Red River area; 3) the Southbound Fault, located in a structurally complex area where structures of the Franklin Mountains meet those of the Mackenzie Mountains. It is a south-verging, high-angle fault (at surface) exposed on the southern flank of Southbound Ridge. It commonly juxtaposes the Cambro-Ordovician Franklin Mountain Formation above the late Devonian Imperial Formation; and 4) the Imperial anticline, an arcuate, northwest to west trending regional feature located between the Mackenzie and Franklin mountains, and which mimics the regional curvature of the Franklin Mountains. The Imperial anticline, in particular, has significant petroleum potential implications as its geometry allows for possible structural traps involving sub-Saline River Formation siliciclastic reservoir rocks. Reconnaissance work was also conducted west of the Cranswick River, within the organic-rich Canol Formation shale, a potential source rock. Our work has revealed several south-verging thrust faults, which structurally thicken the succession. Additional work is warranted to evaluate the regional significance of these structures.