

A new exploration strategy for lower Paleozoic petroleum systems in Williston Basin

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Petroleum is produced from the Sauk (M. Cambrian-L. Ordovician) and Tippecanoe (M. Ordovician-Silurian) successions in Williston Basin. The best potential reservoirs are found in Deadwood Fm. sandstones (U. Cambrian-L. Ordovician), Winnipeg Gp. sandstones (M. Ordovician), Bighorn Gp. carbonates (U. Ordovician-L. Silurian) and the Interlake Gp. carbonates (Silurian). Large proven and produced reserves occur in the United States, especially in basement-involved, long-lived structures such as Cedar Creek and Nesson anticlines.

Efforts to extend this production into Canada have led to conceptually important discoveries, but reserves and reservoir performance have not matched those of American fields. Petroleum systems analysis indicates at least three petroleum systems in this interval. The most important is the Bighorn-sourced oil from kukersitic source rocks. Other petroleum systems have sources in Winnipeg Gp. shales and an as yet unlocated interval inferred to occur in the Deadwood Fm. The former produces oils resembling those with source rocks in the Bighorn Gp., while the latter produces oils that resemble oils with sources in the Devonian succession, although they have distinctive stable isotopic compositions. Geophysics, organic maturity and apatite fission track thermochronology indicate geographic and temporal variations in basement heat flux controlled by geodynamics. The primary effect of thermal history variations is significant petroleum generation during the Carboniferous and Permian. Exploration success hinges on the timing and preservation of trap formation relative to petroleum generation.

Therefore, the recent strategy of drilling current structural highs should be augmented by a search for ancient structural and stratigraphic traps, of which Cedar Creek Anticline is the best example.