

Hydrocarbon Systems and Basin Analysis of Central Alberta – Saskatchewan Border Plains Region – Fluid Flow and Petroleum Biodegradation Trends Based on Produced Fluid Sampling and Analysis

Mathew Fay*

Petroleum Reservoir Group

University of Calgary, Calgary, Alberta

mcfay@ucalgary.ca

and

Dr. Steve Larter and Dr. Barry Bennett

University of Calgary, Calgary, Alberta

Summary

The Border Plains region of central Alberta and Saskatchewan contains rich deposits of medium to heavy oil in Cretaceous and Paleozoic age formations. Oil quality varies between formations and within pools, ranging from light biodegradation alteration to complete removal of low molecular weight saturated and aromatic hydrocarbons. Oil, gas and water geochemistry of fifty-three produced fluid samples from wellheads in the region indicate a heterogeneous distribution of oil quality, gas wetness, and water salinity. The variability of oil quality is the result of the interaction of numerous processes over the past 60 Ma. Geochemical data indicates that oil mixing, groundwater flow and mixing, oil biodegradation, and even asphaltene precipitation are all factors in controlling fluid properties in the basin. Oil quality ranges from dead oil viscosities of 130 to 98,300 cP (@ 20°C), and 8.2 to 21.8 degrees API Gravity (@ 60°F) these properties tracking broadly with extent of oil biodegradation.

The timing and direction of petroleum and groundwater flow is an important aspect of basin analysis, especially for biodegraded oil reservoirs. In the Western Canada Sedimentary Basin and surrounding Border Plains, oil charge and high salinity groundwater flowed up-dip to the east due to compaction drive and petroleum buoyancy drive during the Columbian and Laramide Orogeny. Meteoric water in-flux due to topographic drive around the basin margin has migrated to depths > 800m through Cretaceous and Paleozoic formations, and water salinity in the region varies from 12,700 to 110,500 mg/L. The extent of meteoric water recharge and nutrient flux into Paleozoic and Mesozoic reservoirs is controlled by several factors including regional surface topography and formation outcrop, thickness of shale or impermeable interbeds, and Pleistocene glaciation patterns. The combination of oil, gas and water data and numerical modeling of biodegradation processes allows for a broad assessment of dynamic fluid flow and the controls on geochemical processes that control oil quality. We discuss this and the WCSB setting as an analog to other foreland basin systems on Earth.

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