Optimizing Field Development in the Powder River Basin Using Geochemical Fingerprinting Technology

E. M. Bergin[1], M Jin[2], Y Liu, J Wu, and F Liu

[1]Anschutz Exploration Corporation
[2]RevoChem

Abstract

Thousands of hydrocarbon compounds naturally occur in produced oil and oil extracted from core or cuttings samples. These compounds carry a tremendous amount of information on reservoir properties and subsurface fluid flow. In this study, we present a methodology based on high-resolution GCXGC geochemical data collected from cuttings and produced oil samples, to provide quantitative zonal contribution and vertical drainage height information, identify shared contribution between stacked wells, decipher the effectiveness of believed frac barriers, and optimize landing selections.

Water-based mud cuttings samples were collected and used to extract geochemical fingerprint data to establish a vertical baseline to identify where each formation showed a distinct geochemical pattern. A group of geochemically derived Reservoir Characterization Indices (RCI) were also calculated to provide key reservoir properties such as permeability and oil saturation. Time-lapse produced oil samples were then collected from multiple producers landed in different targets of the Niobrara and Turner formations. These oil samples were allocated back to the appropriate contributing zones using regression models, based on the geochemical fingerprint data established from the vertical baseline wells, to reveal the temporal and spatial variation of the effective drained rock volume (DRV) of each well. The probability of inter-well fluid communication between well pairs is also calculated based on the similarity of the geochemical fingerprints of the produced oils.

A case study in the southern Powder River Basin demonstrates how Anschutz integrated the data into spacing, landing, and reservoir workflows. The three main takeaways so far are: 1) limited fluid communication is observed between Niobrara-landed wells and the offset Turner-landed wells in the study area, leading to different infill and well management decisions, 2) Turner wells showed limited upward drainage from the Niobrara, indicating either limited upward frac growth or frac closure, 3) Data from wells landed within different benches of the Upper Niobrara all showed contribution from the entire Upper Niobrara interval, but the contribution from the higher bench diminished through time, leading to a review of landing targets, 4) P80 drainage frac heights of Niobrara producers varied between ~155’ to 235’ while frac heights for Turner producers are smaller at ~100’ to 190’. Results from this study were validated with pressure, completions, and tracer data, and confirmed that geology, adjacent well placement, and well completions all have impacts on drainage profiles in both formations.

Results from this studies has facilitated the optimization of future landing zones and well spacing, and may lead to improved economic recovery of stacked plays in the Powder River Basin.

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