Using Geochemical Fingerprinting to Optimize Williston Basin Infill Development and Inform Uinta Basin Exploration

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Abstract

Understanding where produced oils are draining from is a powerful tool to guide proper development and exploration of any basin. Geochemical Reservoir Characterization Indices (RCIs) also offer important insight to the reservoir quality, providing key information that aids in understanding mobile oil saturation (Oil-in-Place-Index; OIPI) and matrix permeability (Reservoir Quality Index; RQI). In this study we present a comprehensive geochemical approach to evaluate best development infill practices and a useful methodology to guide exploration. Middle Bakken (MB) and Three Forks (TF) reservoirs in Williston Basin have proven very difficult for traditional production allocation due to the limited geochemical differences between MB and TF produced oils. Through multi-dimensional gas chromatography, the number of compound ratios available to distinguish these reservoirs is increased by an order of magnitude, allowing for 10' vertical resolution of production allocation. This high-resolution data identifies even slight drainage differences and aids in proper infill development. Once parent well drainage is understood, child wells can be properly placed. Key learnings from one case study include: 1) Wells landed in both the MB and TF produce oils from all stratigraphic zones with the primary landing zone producing about 1.5× more oil than the other main landing zone; 2) Wells with smaller sliding sleeve completion jobs have more landing zone contribution while larger Plug-n-Perf jobs have more equal MB & TF allocation and see more contribution from Upper and Lower Bakken Shales; and 3) Completion timing and grouping (simul-frac vs solo frac) impact Simulated Rock Volume (SRV) and resulting Drainage Rock Volume (DRV). This high-resolution methodology is also a valuable tool for exploration. A Uinta Basin case study is shown that utilizes RCIs to understand intervals with highest oil saturation and permeability within the Parietta Bench and Douglas Creek intervals; key appraisal targets above traditionally targeted Castle Peak, Uteland Butte and Wasatch formations. Though Parietta Bench and Douglas Creek pay zones are more discrete, there are many intervals with as high of OIPI and RQI as the Uteland Butte. Production allocation was then done for vertical test wells and reveal 6 intervals with excellent reservoir qualities, ranging from ~10 – 120' thick, that contribute to ~85% of total oil production for the ~1000' tested interval. Tighter intervals with lower oil saturation contribute the remaining ~15% to overall production. These results provide pivotal information that help pinpoint best landing zones for future horizontal wells.