Pitfalls of Model-Driven Unconventional Development – The Stratigraphic Trends that Drive Oil & Gas Productivity in Divide County, North Dakota

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Abstract

In the early development of unconventional oil and gas plays, it is often deemed economically necessary to begin large-scale development before a complete understanding of the play's geology is established. Unfortunately, perm variability related to stratigraphic complexities almost invariably creates significant pressure differences in the targeted reservoirs. These higher perm rocks drain preferentially, producing the bulk of the fluids recovered from early wells. The higher perm, lower pore-pressure zones attract much of the frac energy of later infill wells, making subsequent development difficult or completely uneconomic. Early quantification of the contributing stratigraphic intervals is essential to help operators develop the resource more efficiently. Models of the producing zones are often created to identify which reservoir rocks contribute to each well's production. Unfortunately, these models almost always prove to be overly simplistic and much too small compared to later measured pore-pressure data.

In 2011 operators began to target the stratigraphic pinch-out of the best dolostones in the first bench of the Three Forks Formation in Divide County in the extreme NW corner of North Dakota. The best production of the area was eventually established from the thinnest Three Forks reservoirs from which the large volumes of oil produced from these wells could not be reconciled to the limited reservoirs mapped in the pinch-out. This study utilized core-facies mapping from the large core inventory available at the ND Core Repository to build a comprehensive stratigraphic model to explain Bakken/Three Forks production trends found across the margins of the Williston Basin. The combination of reservoir pressure, facies mapping, geochemistry, and production data all points to the existence of a large stratigraphic trap within the Middle Bakken that correlates with horizontal well productivity trends in both the Three Forks and Middle Bakken. The trap extends from SE Saskatchewan into Divide-Williams counties (NW North Dakota) where the lowest water cuts and best production per lateral foot is found along the trap's NW-SE trend while water cut gradually increases and well performance decreases downdip towards the SE. This presentation will also show the extent of the trap, the internal character, evidence for its contribution to both Three Forks and Middle Bakken wells, evidence for its uneven depletion, how it fits with the low maturity data and what operators can do improve future infill wells.

Furthermore, the extent and internal character of the Middle Bakken strat trap can be used to explain the uneven depletion in the area, low thermal maturity of the Bakken shales, and provide operators with insights to improve future infill well development.

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