Stratigraphy, Depositional Setting, and Reservoir Quality Variations of the Devonian Three Forks Formation – Bakken-Three Forks Petroleum System: Williston Basin

Timothy O. Nesheim[1] and Edward (Ted) Starns[1]

[1]North Dakota Geological Survey

Abstract

The Late Devonian Three Forks Formation comprises part of the prolific Bakken-Three Forks Petroleum System within the Williston Basin of North America. More than 6,500 horizontal Three Forks wells have been drilled and completed in western North Dakota that have combined to cumulatively produce approximately 2 billion barrels of oil to date. Most of these horizontal wells have targeted the upper Three Forks (6,000+) while a lesser, but still notable number, have targeted the middle Three Forks (~400). Production results from Three Forks wells, particularly wells targeting the middle Three Forks, have varied significantly over short distances within portions of the basin. Variation in well production is likely in part a function of variations in reservoir quality, which in turn is a function of the depositional setting. Three general rock types comprise most of the Three Forks section. The first is poorly laminated silty mudstones that are commonly oxidized (terrestrial, coastal plain), which commonly contain anhydrite nodules in the lower Three Forks. Second, laminated, wave rippled to cross-bedded silty dolostones (high energy subaqueous, above normal fair weather wave base). Third, conglomeratic deposits that appear to be a mixture of the previous two facies types (combination of coastal debris flows and storms events). Additionally, laminae to thin beds of green mudstone to claystone are commonly intercalated with the silty laminated dolostone. The thin beds of green claystone comprise the finest grained, lowest energy deposits in the entire formation (deposited below fair-weather wave base). Three Forks deposition is interpreted to have occurred along a low-angle ramp in which the laminated dolostone was deposited within a predominantly shallow, subaqueous tidal/mudflat setting adjacent to a coastal plain (silty mudstone). The conglomeratic deposits developed primarily along the shoreline, intermediate of the laminated dolostone and silty mudstone. The best reservoir facies of the Three Forks consist of laminated dolostone with minimal green mud/claystone intercalations and conglomeratic deposits with overall low clay content. The upper Three Forks reservoir primarily consists of the laminated silty dolostone, which is more consistent in moderate to high reservoir quality. Meanwhile, the middle Three Forks reservoir generally is comprised of predominantly the conglomeratic deposits, which are more variable in reservoir quality.