

Using Outcrop of the Three Forks Formation in Western Montana as an Analog to the Subsurface Three Forks Reservoir of the Bakken Petroleum System

Luke Schwab¹, P. Ted Doughty², and George W. Grader²

¹University of Idaho, Moscow, ID ²PRISEM Geoscience Consulting, Spokane, WA

ABSTRACT

Outcropping lithologies of the Logan Gulch Member of the Late Devonian Three Forks Formation in Western Montana can be used as an analog to study the equivalent reservoir lithologies of the Three Forks Formation in the Williston Basin Bakken Petroleum System. The western Montana Three Forks Formation is subdivided into two Members: The lower supratidal-to-intertidal Logan Gulch Member, and the overlying marine Trident Member. Only the Logan Gulch Member lithologies are equivalent to the Williston Basin Three Forks Formation lithologies. Unlike in the Williston Basin where the Three Forks Formation exists wholly in the subsurface, the reservoir-equivalent lithologies in Western Montana are spectacularly exposed. Our method was to first locate and describe outcrops of the Three Forks Formation that contain good expressions of correlative reservoir intervals in order to create a workable analog to the Three Forks Formation reservoir. Based on sedimentological and stratigraphic analysis of nine outcrops across western Montana, the Logan Gulch Member was found to contain a heterolithic intertidal facies composed of interbedded dolostone and dolomitic shale that bears a striking sedimentological similarity to the Williston Basin Three Forks reservoir facies. Due to complex basin geometry, the thickest deposits of the intertidal facies occur updip on the margin of the Beartooth Shelf. Elements of this facies are interfingered with supratidal deposits that include massive beds of anhydrite collapse breccia. These supratidal deposits are the depositional equivalent to the anhydrite beds of the lower Three Forks Formation in the Williston Basin and the thick evaporites in the subsurface Potlatch Formation of northwestern Montana. The Logan Gulch Member is composed of a transgressive systems tract that comprises a partial stratigraphic sequence. This partial sequence is bounded by two regionally recognized sequence boundaries. The overlying Sappington Formation progressively truncates the Logan Gulch Member in outcrops to the east. The thickest expressions of the intertidal facies most comparable to the “Apple-Tan” Three Forks reservoir are found in the easternmost outcrops. Detailed study of these outcrops will provide better understanding of lateral lithofacies relationships within Three Forks reservoir lithologies in the subsurface. Outcropping lithologies of the Logan Gulch Member of the Late Devonian Three Forks Formation in Western Montana can be used as an analog to study the equivalent reservoir lithologies of the Three Forks Formation in the Williston Basin Bakken Petroleum System. The western Montana Three Forks Formation is subdivided into two Members: The lower supratidal-to-intertidal Logan Gulch Member, and the overlying marine Trident Member. Only the Logan Gulch Member lithologies are equivalent to the Williston Basin Three Forks Formation lithologies. Unlike in the Williston Basin where the Three Forks Formation exists wholly in the subsurface, the reservoir-equivalent lithologies in Western Montana are spectacularly exposed. Our method was to first locate and describe outcrops of the Three Forks Formation that contain good expressions of correlative reservoir intervals in order to create a workable analog to the Three Forks Formation reservoir. Based on sedimentological and stratigraphic analysis of nine outcrops across western Montana, the Logan Gulch Member was found to contain a heterolithic intertidal facies composed of interbedded dolostone and dolomitic shale that bears a striking sedimentological similarity to the Williston Basin Three Forks reservoir facies. Due to complex basin geometry, the thickest deposits of the

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