

Regional stratigraphy of the Bakken, Pronghorn, and Three Forks in the Williston Basin and equivalent sections in the South Alberta and Sappington Basins

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ABSTRACT

The construction of a regional stratigraphic framework provides insight into how the Bakken, Pronghorn and Three Forks unconventional plays of the Williston Basin extend into the South Alberta Basin. This regional framework includes the three primary basins for these units in the northern Mid-Continent and Rocky Mountain area: the Williston Basin, the South Alberta Basin, and the Sappington Basin. The regional stratigraphic framework is characterized by ten depositional sequences that are separated into two distinct groups by the Acadian Unconformity. The lower group, below the unconformity, consists of four sequences dominated by dolostones or evaporites. The upper group, above the unconformity, consists of six sequences dominated by fine-grained clastics. Originally defined in the Williston Basin, the lower group consists of four sequences that comprise the dolostone-dominated Three Forks (TF4, TF3, TF2 and TF1 in ascending stratigraphic order). The upper group consists of six sequences characterized by either sandy siltstone or shale that comprise the Pronghorn and Bakken. The basal sequence of the Pronghorn is called the lower Pronghorn and is subdivided into two systems tracts: the Lower Pronghorn siltstone and the overlying Lower Pronghorn limestone. The Upper Pronghorn sequence is characterized by brown, silty shale. The third sequence in the upper group is the Lower Bakken which is characterized by black, organic-rich shale. The fourth and fifth sequences are both characterized by sandy siltstones and comprise the Middle Bakken. These two sequences partition the Middle Bakken into two parts: the Lower Middle Bakken and the Upper Middle Bakken. Both of these sequences are further subdivided into three systems tracts each. The sixth sequence of the upper group is the Upper Bakken, which marks a return to black, organic-rich shale deposition. The Williston Basin sequences can be correlated northwest into the South Alberta Basin. The sequence boundary between the TF1 and TF2 is among the key stratigraphic relationships identified. This unconformity marks the top of the Potlatch/Stettler evaporitic section with the TF1 corresponding to the basal, dolomitic part of the overlying Big Valley. The boundary between the dolomitic Big Valley and the succession of limestones and shales that comprise the remaining portion of the Big Valley marks the Acadian Unconformity. This overlying section is partitioned into two sequences: a lower, carbonate-dominated sequence and an upper, shale-dominated sequence that are correlated to the Lower and Upper Pronghorn, respectively. The overlying Exshaw, with its lower black shale and upper siltstone, resembles the Lower and Middle Bakken, while the Lower Exshaw is correlated with the Lower Bakken. However, in South Alberta the Upper Exshaw is only correlative to the Lower Middle Bakken. The section of shale and siltstone overlying the Exshaw, often referred to as Banff, is correlated with the Upper Bakken black shale. In the Sappington Basin, the Acadian Unconformity has been identified within the Logan Gulch. It is expressed by the characteristic change from dolostones and evaporites below the unconformity to a succession of limestones and shales above. The boundary itself is placed at the base of the informally named Knoll limestone which forms the top of the Logan Gulch. The Knoll limestone is correlated to the Lower Pronghorn and the lower carbonate

sequence of the upper Big Valley. The overlying shale-dominated Trident is correlated with the Upper Pronghorn and the upper shale sequence of the upper Big Valley. The Sappington overlies the Trident and consists of three parts: a black shale-dominated Lower Sappington that is correlated with the Lower Bakken and Lower Exshaw; a sandy siltstone-dominated Middle Sappington that is correlated with the Lower Middle Bakken (and is similarly subdivided into three systems tracts) and the Upper Exshaw; and a black shale-dominated Upper Sappington/Cottonwood Canyon that is correlated with the Upper Bakken and Banff.