Inherited Tectonics — Control on Late Devonian Deposition in the Williston Basin

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Abstract

The Williston Basin is an intracratonic basin located atop the structurally complex suture zone between the Archean Superior province to the east and the Archean basement of the Wyoming structural provinces to the west. The basin in general has a very homogeneous subsidence history throughout most of the Paleozoic, that can be largely explained by simple thermal subsidence. This simple subsidence model should result in a very predictive facies distribution with more proximal facies near the basin margin and the more distal deposition near the basin center. Although this type of regional facies distribution is present during large parts of the Devonian, including the Famennian Lower Bakken Shale deposition, the Pronghorn Member of the Bakken Formation does not adhere to this model. Results from detailed (sub-centimeter scale) lithofacies descriptions and chemostratigraphy from 26 cores from North Dakota and Saskatchewan suggests that the Pronghorn Member was more widespread across the Williston Basin and was more lithologically complex than previously recognized. To the south classic bioturbated Pronghorn facies is present, but to the north the facies changes to an organic rich mudstone with intermediate TOC content, with some resemblance of the Lower Bakken Shale facies. In addition to this regional northward fining trend, the Pronghorn facies, composition and thickness also changes locally. These local changes occur along known structural lineaments, such as the Weldon-Brockton-Froid Zone and the Goose Lake Trend. Our data suggests that these lineaments were active during the latest Devonian and dissected the Williston Basin into multiple sub-basins during Pronghorn deposition. This detailed facies and chemostratigraphy study provides a new detailed look on the controls of late Devonian deposition in the Williston Basin. It provides food for

thought how tectonics might influence deposition in an intracratonic basin located hundreds of miles from an orogenic front, and might help explain some production heterogeneities that have previously been hard to explain.