

Looking for Stratigraphic Traps in Under-Explored Mississippian Rocks in Southeastern Saskatchewan

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The Mississippian regional mapping phases of the Weyburn CO₂ Monitoring and Storage Project, Phase 1, and the TGI-2 Williston Basin Architecture and Hydrocarbon Potential Project created awareness of potential stratigraphic trapping conditions in the Souris Valley, Tilston and Alida beds as well as in the Kisbey Sandstone that had not previously been given much consideration. Each of these units yields oil from their subcropping rocks but there has been little attempt to find reservoir rocks in them away from the subcrop.

The Souris Valley Beds are the least explored. This unit is considered to be well represented by its type location the Souris Valley Oil Gordon White well in 5-14-1-28WPM in which it is described as a 176-metre unit that is dark grey, sparsely fossiliferous, thin bedded, argillaceous limestone and calcareous shale with abundant chert nodules distributed through the upper portion of the interval. However, these strata are more variable than indicated by the type well. In the area near the Manitoba-Saskatchewan border the rocks are similar to those in Manitoba. West of the 102nd meridian of longitude there is an interval between 35 and 150 m thick having a subdued gamma-ray log signature that covers a region extending 200 km east-west and 145 km north-south. The rocks in this interval are not cored, but drill cuttings indicate they are primarily lime mudstones and skeletal wackestones. Where this interval thins into North Dakota, it becomes equivalent to the L2 limestone of the Lodgepole Formation. This non-argillaceous unit is overlain by a mix of interbedded argillaceous and non-argillaceous carbonates. In places, the latter has high concentrations of crinoid columnals and the non-argillaceous rocks may have a variety of skeletal remains including crinoid columnals, bryozoa, brachiopods and tubular algae. These interbedded argillaceous and non-argillaceous carbonates dip in clinoformal fashion off the thick previously described non-argillaceous interval. It is the clinoformal rocks and the L2 limestone that are thought to represent the best potential reservoir rocks. The L2 limestone is productive in several locations in North Dakota. In addition, the thick non-argillaceous portion of the Souris Valley is flanked by Waulsortian-type mounds. There are a number of these mounds in the vicinity of the Manitoba-Saskatchewan border. Although they have not as yet yielded large volumes of oil, these mounds are potential exploration targets.

Both the Tilston and the Alida beds have coated-grain grainstone and dolomitized skeletal wacke/packstone reservoir rocks at their respective subcrops. However, away from the subcrop, they become primarily lime mudstone and wackestone with a variable argillaceous component, but in places gamma-ray logs display the presence of a clean carbonate that may represent buildups of crinoid debris. These may be possible stratigraphic traps.

The Kisbey is an interval with a variable rock composition that includes, singular beds of quartz sandstone, interbedded quartz sandstone and dolomicrite, or interbedded quartz sandstone and allochemic grainstones. The thickness of the quartz sand accumulations ranges from a metre to 30 m. In places, two thick quartz sand bodies separated by a thin carbonate may total 50 m in thickness. The quartz sand grains are commonly very fine to fine grained and angular to subangular. There are small proportions of feldspar and microcrystalline quartz all of which are supported by a matrix of 5-20% dolomicritic interstitial filler. The reservoir capabilities of the sandstone are best in close proximity to the subcrop, suggesting that diagenetic fluids associated with the subcrop may have enhanced the reservoir quality of these sandstones.

Finding stratigraphic traps in any one of these units away from the subcrop could be nothing more than a serendipitous exercise unless some form of model is used to aid in the identification of exploration targets. Like the Kisbey, each of the other units produce oil at the sub-Mesozoic unconformity, which suggests that reservoir enhancement may have taken place there. Reservoir enhancement could also occur away from the subcrop in any one of the target beds if they were encountered by appropriate fluids migrating along deep-seated fracture systems. Employing an exploration model similar to that used to discover a significant gas field in the Ferrier area of Alberta, stratigraphic traps might be found in these under-explored Mississippian rocks in Saskatchewan.

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