Compartmentalization of Mississippian Carbonate Reservoirs within Hangingwall Anticlines, Outlined by Horizontal Drilling in the Alberta Foothills

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For over 50 years, thrust sheets of Mississippian carbonates in the Alberta Foothills Belt have been drilled by near-vertical wells for hydrocarbons. With support of seismic data, the Mississippian sheets are often mapped as single sheets carried 300 to 500 m above the regional carbonate platform. These wells have targeted the crestal position of hangingwall anticlines, where fracture density is most likely the highest. Since the mid 1990's, drilling along the leading edge of those anticlines, with near horizontal well paths of 600 to over 1000 m, have become quite common in the Central Alberta Foothills. The abundance of interconnected open sub-vertical fractures within these low porosity reservoirs that are encountered by a horizontal well will improve deliverability. Initial flow rates for the best horizontal wells can be in the 15-25 mmcf/d range, compared to values of 5-10 mmcf/d in most vertical/deviated wells. This is indicative of larger potential reserves that can be recovered by a single horizontal well, making it more economic and profitable.

Horizontal drilling in the Foothills Belt, specifically in the Stolberg to Basing corridor (Townships 40-50), has documented significant variations along-strike in the structural geometry. These variations include plunge reversal of anticlines (2-5°), parasitic folds, transverse faults (i.e. lateral ramps, normal or strike-slip faults). Multiple repeats of the Turner Valley and Shunda Formations with lateral termination are recognized within a single horizontal well. Many of the transverse faults have a component of vertical displacement of less than 10 meters. In a dip direction, the displacement of these minor fault blocks within the main thrust sheet is presumed to be small. In most cases, the fault that carries the Mississippian imbricate from the main sheet cuts up section from the detachment horizon in the Shunda Formation through the Turner Valley Formation, before climbing up section into the Mesozoic rocks. The reservoir becomes then highly compartmentalized and fractured. In some cases, horizontal wells have been drilled through unsuspected sudden truncation of the Turner Valley reservoir, juxtaposed against Cretaceous clastic rocks.

The three dimensional extent of these compartments are usually too small to be mapped using seismic data. The transverse planes that separate them make it cumbersome to properly geosteer a horizontal well while drilling, as a new fault is encountered. The use of a pilot hole, before to sidetrack a horizontal leg, cannot predict alone what structural surprises may lie ahead. In this paper, we present structural, log and FMI data, from horizontal Mississippian producing gas wells

drilled by Talisman Energy in the frontal foothills. The recognition of these minor transverse features is similar to that identified in the field from an outcrop to regional scale. They were possibly initiated in the early stages of the thrust sheet development, then carried over the frontal ramp above the regional detachment. The reservoir compartments are believed to be in communication, based on well behavior and pressure data. The development of abundant and pervasive fractures is also believed to be a major factor. With only minor offsets across those transverse features, reservoir compartments can remain in communication throughout the thrust sheet.