Chapter 4: The Turner Valley structure – 100 years of lessons

An old field teaching new tricks

Notes for slides:

Slide 1: The Turner Valley Oil Field was discovered in 1914 with the drilling of the well Dingman #1. That well found the first significant accumulation of hydrocarbons in western Canada and is largely responsible for the oil industry head office location being in Calgary, the local commercial centre with rail access.

Slide 2: The discovery of the field follows decades of work involving many of the early founders of Canadian Geology.

Slide 3: The Turner Valley Field is contained in a leading edge structure found at the eastern edge of the southern Canadian Thrust Belt

Slide 4: Dingman #1 was drilled on the flood Plain of the Sheep River within walking distance of the village of Turner Valley. Following the discovery (out of Lower Cretaceous and Jurassic sandstones) several follow-up wells were drilled. The drilling pace was interrupted by WWI as many of the men were sent to Europe to fight in the trenches. Western Canada suffered appreciable casualties and the scaricity of men during and after the war slowed down the pace of development of the oil field.

Slide 5: In the 1920's Royalite #4 was drilled deeper and penetrated the underlying Fractured Carbonates of Paleozoic Age. This created a second boom in the field with rapid expansion of the field. In the 1930's "black oil" was discovered in the southern portion of the field near the drilling settlement of Little Chicago just north of Longview (also known as Little New York). This created another drilling rush. Up to that time liquid rich gas had been the main product. There was no market for the gas but the oil and condensate could be separated and taken to Calgary in Barrels and shipped on the train. The gas was flared. It is estimated that up to 2.0 TCF of gas has been flared from the pool.

Slide 6; There have been numerous interpretations of the Field over the past 100 years. R.G.McConnell was the first recorded interpretation noting that the Turner Valley structure was a reversal of dips along the Sheep River. This was recorded as part of the original Dawson Geologic Expeditions of the 1880's. By the 1930's Link and Moore suggested that the Turner Valley structure was a decapitated anticline to try to explain that well were penetrating older upright section over younger upright section. Hume who had mapped the surface structure for the GSC created a cross-section in 1040 that challenged the decapitaded Anticline model and inferred the existence of another anticline to the east (the Tower Anticline).

Slide 7: A considerable debate emerged over the timing of hydrocarbon migration and structural development. Part of this debate was trying to explain why the Turner Valley structure was charged with oil and the Highwood Structure do the west was wet.

Slide 8: The definitive cross-section for Turner Valley was made by Gallup in 1948. This section shows a thrust fault carrying folded Paleozoic strata with a footwall syncline and a hanging wall anticline.

Slide 9: By the 1940 the western and northern portions of the field had been drilled such that the drilling of new wells was essentially stopped by the 1950's.

Slide 10: The section by Gallup endures and is still used by many studies. This section does not balance and contains numerous errors. Displacements along the thrust are highly variable and the Thrust faults do not come to surface.

Slide 11: Fox modified Gallup's section with the recognition of east dips and hinterland directed thrust faults on the east flank of the Turner Valley Structure.

Slide 12: Little drilling occurred through the 1960's and the drilling in the 1970's was trying to take advantage of infill opportunities at the eastern crest of the structure.

Slide 13: By the 1970's the issue of east dipping faults had become a more pressing issue. Peter Jones suggested that these were older thrusts that had simply been folded by deeper younger thrusts.

Slide 14: A later model involved the development of a wedge and the thrust belt was no longer a series of overlapping thrust "overthrust" but rather a foreland propagating wedge.

Slide 15: This model had been hinted at in the late 1940's by Ted Link on a cross-section through the Coalspur area to the north.

Slide 16: Through the 1980's and 1990's no significant drilling occurred in the field.

Slide 17-20: In the 1990's another mapping project was undertaken by MacKay through the University of Calgary. In this study the Turner Valley Structure is described as a foreland propagating with a lateral ramp at its southern edge.

Slide 21: The wedge shape is likely controlled by the fundamental anisotropy of the system which is controlled by the basic orientation of bedding.

Slide 22: A resurgence in drilling occurred in the 21st century. This new drilling effort has been predominantly using new technology of horizontal drilling. The bulk of the drilling has

been focused on the west side of the structure on the down-dip flank at or near the field water line.

Slide 23: Productivity of the wells does not correlate with the distance drilled and there is a large variance in the types of fluids produced from the new wells.

Slide 24: The mean (50th percentile) of the water/oil ratio is ¾ (0.75). Meaning that for every 3 barrels of water produced from these horizontals, 4 barrels of oil is produced. This is a surprizing value considering that the general area has been a water disposal area for approximately 50 years. The distribution of recovery is also surprizing in that some wells are producing only water while other are producing predominantly oil. Many of these wells are at or near the previously mapped water line, yet still produce oil.

Slide 25: The reservoir is a fractured enhanced reservoir and is likely dependent on the fracture distribution for the bulk if not all the flow capacity of the reservoir. The older vertical wells did not adequately drain the reserves and the converted vertical wells to injectors likely do not uniformly flood the reservoir hence it is possible to drill horizontals into the pool at a much later date and still find untapped oil reserves.

Slide 26: A warning and encouragement.