

Structural and Stratigraphic controls on Hydrocarbon Accumulations in the Viking Formation, West-central Saskatchewan

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Abstract

The Viking Formation has become one of the most important oil-producing reservoirs in Saskatchewan and has shown to be very resilient to fluctuations in oil price. This is a result of a relatively shallow depth and its high API gravity, ranging from 30 to 36° (specific gravity 876 to 845 kg/m³).

The distribution of the Viking Formation's hydrocarbons in Saskatchewan is controlled by both structural trapping and stratigraphic pinch-out of the reservoir facies. Topographic features created by the sub-Cretaceous erosional surface have significant control on Viking structural traps. The structural surface of the Viking top mimics the sub-Cretaceous erosional surface, draping over its erosional highs, in particular, the structural surface of the Madison Group and its subcrop edge. The Viking mimics the sub-Cretaceous as a result of differential compaction of the underlying Joli Fou Formation and Mannville Group.

Viking oil plays are generally found either differentially trapped up-dip from natural gas pools within a series of successive traps along the Viking's hydrocarbon migration pathway, or within structural lows below trapped natural gas. Using cross-sections and a series of production, structure and isopach contour maps, the nature of Viking Formation hydrocarbon trapping and distribution has been identified and explained.

Introduction

The study area is located within an area bounded on the southeast corner by Township 28, Range 17 west of the third meridian (17W3) and on the northwest corner by Township 34, Range 29W3. This area includes 29 Viking Formation oil and gas pools.

The area was chosen based on recent drilling activity that successfully uses horizontal drilling technology combined with multistage fracturing to extract oil from shallow, tight reservoirs of the Viking Formation. As of January 2016, the use of these technologies has created a renewed interest in the Viking Formation oil reservoirs, resulting in over 4655 new horizontal wells drilled since 2007, which averaged 9056 cubic metres (m³) (56,989 barrels) of oil per day in 2015.

Methods

Several contour maps in this study were produced using Ministry of the Economy data. In particular, over 15 000 Viking Formation tops were used to generate isopach and structure contour maps. Oil and natural gas production

rates and 'oil cut' values were also calculated and contoured, to illustrate the spatial distribution of the Viking Formation's oil and gas production and to identify production 'sweet spots', areas where the highest oil cuts and gas production exist.

Conclusions

- Viking Formation oil has a higher than average API gravity than is typically found in the west-central area of Saskatchewan. The API gravity ranges from 30 to 36° (specific gravity 876 to 845 kg/m³), compared to the low API gravity oils found in the Mannville Group, Success, Bakken and Birdbear formations, which average between 12 to 18° (specific gravity 986 to 946 kg/m³).
- Viking Formation reservoirs are found at a relatively shallow depth, ranging from 560 to 840 metres below surface within the study area. This makes the Viking a very attractive target especially during times of low commodity prices.
- The Viking structural surface mimics the sub-Cretaceous erosional surface, draping over remnant erosional highs.
- Oil and natural gas distribution is controlled both by the structural features created by the sub-Cretaceous erosional surface, where the hydrocarbons are trapped in structural roll-overs (anticlines) and by reservoir facies pinch-outs.
- Oil can be found differentially trapped up-dip from natural gas pools within successive traps along the hydrocarbon migration pathway. Oil can also be found trapped in structural lows below trapped natural gas.