Datapages/Search and Discovery Article #90224 GeoConvention © 2014, FOCUS - Adapt, Refine, Sustain Calgary, Alberta, Canada, May 12-16, 2014

Finding New Oil in Old Oil Fields – The Doig Formation at Valhalla

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Abstract

In our current era of seemingly perpetually depressed gas prices, the drive for oil has never been greater. In a dominantly gas-rich basin such as the Western Canadian Sedimentary Basin, finding new oil, not just hydrocarbons, is a challenge. While grass-roots exploration is glamorous and exciting, the low chance of success and lack of low hanging fruit makes it a less favorable economic option, especially for a dividend-paying, junior or intermediate sized company.

Smaller companies have made excellent progress in unlocking new oil reserves by infilling existing historical oil fields, especially those where the permeability in a portion of the reservoir rock is less than 1mD. Once thought to have been fully developed by only one vertical oil well per quarter section, new technology such as horizontal wells and multistage fracture stimulations are unlocking new reserves from existing fields. The production data is proving that these old oil fields had been nowhere close to fully developed, and that there is more oil in place than was ever thought before.

The Triassic-aged Doig Formation at Valhalla is one such example of a field where infill horizontal drilling and multistage fracturing is finding new reserves. Discovered in 1983, the field was initially developed vertically. By 2010, when the field was purchased by Surge Energy, the field had 23 active or suspended producing verticals, had taken 27 years to recover 2.8 mmbbls of oil, and the observed reservoir pressure had dropped by 75%. In just over three years Surge has drilled 22 horizontal wells, recovered and additional 1.5 mmbbls of oil, and discovered areas of virgin reservoir pressure.

The Doig reservoir at Valhalla is known as an Anomalously Thick Sand Body (ATSB) in literature and is ~1.3km wide, 18km long, and up to 50m thick. The Doig Formation consists of interbedded strata of reservoir quality dolomitically-cemented fine-grained sandstones, and partially-leached dolomitic cochina deposits. These sediments were likely deposited by debris flows into a listric (normal) fault created depression in a tectonically active shelf. The large amount of accommodation space created by this fault depression allowed for thick sections of reservoir quality sediment to be preserved with a minimum amount of reworking.

The Doig sediment displays both high angle and contorted bedding, which are indicative of gravity flows and slumping. Interbedded with the reservoir quality sediments are cemented zones and layers of shale that create permeability baffles and barriers within the Doig reservoir. These baffles cause a high degree of reservoir compartmentalization and segregation, which impede hydrocarbon flow from one compartment to another.

Due to the high angle bedding seen in the Doig, these compartments have a very limited size. A fracture stimulated vertical well might only connect with a few. However, a fracture stimulated horizontal well produces from many compartments, increasing the chances of contacting undepleted reservoir. This is apparent by the disparity in current reservoir pressure in the historical vertical producers compared with the new horizontal wells, which in some cases show up to 100% of original reservoir pressure.

Great opportunities exist in infilling existing oil fields. However care must be taken to ensure that the new development is not just accelerating the production of reserves that would already have been recovered by existing wells. Some of the best opportunities exist in fields where natural permeability barriers and reservoir compartmentalization have left entire areas of the old pools undrained, even at one well per quarter. Sometimes there is still some fruit on the bottom branches that no one’s noticed.