

Optimal Spacing for the Collingwood

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The Collingwood Member of the Trenton Limestone in Michigan demonstrates many of the characteristics of what is known as a resource play for hydrocarbons (natural gas, natural gas liquids, and oil). Resource plays are present over large areas; the source and the reservoir for hydrocarbons is the same rock. Collingwood drilling and production in Kalkaska, Crawford, and Missaukee Counties provides lessons about the relevant considerations in establishing drilling units for resource plays.

The Collingwood underlies most of the upper half of the lower peninsula of Michigan and extends under Lake Huron to Ontario, Canada. Named for the town of Collingwood, Ontario, Canada where it outcrops, the Collingwood was surface mined and heated in retorts to recover oil from 1859 to 1863. This recovery of oil ceased in 1863 because the inefficiency of the process could not compete with the discovery of “free oil” near Sarnia, Ontario.

Successful recovery of hydrocarbons from the Collingwood was not accomplished again until 2010. That is when Encana Oil & Gas (USA) Inc. applied modern high-volume hydrofracturing and a horizontal well bore to recover hydrocarbons in the Petoskey Exploration (Encana) Pioneer 1-3 HD1 Well. Although the Pioneer Well was not an economic success, it was an important proof of the concept that modern high-volume hydraulic fracturing from a horizontal well bore could recover hydrocarbons from the Collingwood.

A September 2014 article in the *Michigan Oil & Gas News* reports that over 9,600 barrels of oil, 300,000 barrels of natural gas liquids, and 4.4 billion cubic feet of gas have now been produced from nine Encana Collingwood wells in Michigan. Encana has been the most active operator in developing the Collingwood in Michigan and is currently the only operator in Michigan with Collingwood production.

The Collingwood is an unconventional reservoir. In rocks like the Collingwood, pathways must be created from the rock strata to a well bore to recover the hydrocarbons. Hydraulic fracturing creates cracks in rocks when water is pumped under high pressure into a wellbore to fracture the rock, and sand is pumped into the cracks to keep the cracks open. Hydrocarbons then are able to flow to the wellbore through the propped cracks in the rock.

Recovering hydrocarbons from the fractured volume of an unconventional reservoir utilizing modern hydrofracturing techniques is more like mining than recovering hydrocarbons from a conventional reservoir where hydrocarbons flow through naturally porous rocks. In a conventional reservoir the flow of hydrocarbons is from an area that usually projects to the surface as a circle. However, in an unconventional reservoir that has been hydrofractured from a horizontal wellbore, hydrocarbons flow from the area adjacent to the perforated length of the horizontal wellbore from an area that usually projects to the surface as a rectangle with slightly rounded ends.

Encana has made dramatic improvement in the hydrocarbons recovered in Collingwood wells since their initial 2010 attempt with their Pioneer Well. Encana's State Beaver Creek 1-23 HD1, hydraulically fractured and placed on production in 2013, appears to be the most successful Collingwood well drilled to date. In nine months of production, the Beaver Creek Well has produced over 1 billion cubic feet of gas and 40,000 barrels of natural gas liquids. However, an estimate of the rate of return on investment for the Beaver Creek Well indicated that its rate of return on investment ranks on the low end of North American resource plays. Encana has stated that at the present time their capital program is focused on six key areas—the Duvernay in Alberta, the Montney in BC/Alberta, the DJ Basin in Colorado, San Juan in New Mexico, Eagle Ford in Texas and TMS in Mississippi and they have not determined their future plans for Michigan.

Regardless of the eventual success of production from the Collingwood, activity to date in developing the Collingwood and research conducted on the stimulated reservoir volume, microseismic data, and the effect of drilling azimuth on production in modern hydraulic fracturing have provided important information regarding what is desirable for drilling units established for resource plays. Resource play drilling units should have the following characteristics:

Shape – rectangular with semicircular ends

Size – long axis of the drilling unit defined by the perforated interval in the well lateral and the short axis defined by the stimulated reservoir created by the fracture pattern. Given a perforated horizontal wellbore of 7,800 feet and an effective stimulated reservoir volume extending 500 feet from the wellbore, the surface projection of the area where hydrocarbons are being recovered would be approximately 200 acres. Information provided by Encana in July of 2014 indicates that Encana has concluded that wellbores of Collingwood wells need to be 880 to 1,200 feet apart in their wells in Kalkaska County, Michigan. Restricting drilling units to the area where hydrocarbons will be recovered from just one well encourages the timely development of leases.

Orientation – long axis of the rectangle needs to conform to the direction that will obtain maximum benefit from natural stresses and fractures existing in the reservoir being fractured.

Adjacent drilling units – drilling units need to stack to avoid gaps left between units. Gaps lead to waste since the short distance for a horizontal wellbore in these gaps does not allow a well that can provide a profitable rate of return on the investment needed for the well.

For the Collingwood to be established as a true resource play more wells need to be completed in the Collingwood to develop a repeatable statistical expectation of ultimate economic recovery from Collingwood wells. Several factors could make future Collingwood drilling attractive:

- Establishment of a uniform drilling order for the Collingwood to address the present regulatory uncertainty as to drilling units for the Collingwood
- Continuation of the improvement in the engineering of the drilling and completion of Collingwood Wells
- Location of the place where the maximum value (highest flow rates containing high-value hydrocarbons) can be obtained from hydrocarbons produced from the Collingwood reservoir. Gas analyses from existing Collingwood wells offer indications of the location of these maximum value areas.
- Offering extensive areas of state leases to allow for the continuous improvement and refinement as to the best locations to drill the Collingwood.

This proposal for drilling units is made based on my review of present production from Collingwood wells in Kalkaska and Crawford County Michigan, review of gas analyses from Collingwood Wells in Kalkaska and Crawford Counties, observations of present practice available from public records in the drilling and completion of Collingwood wells in Michigan, my understanding of the presently available technical literature, and analysis of the current economics of drilling. I requested and have been unable to obtain from Encana or the Michigan Department of Environmental Quality basic data which would have been informative in my review. A uniform spacing hearing for the Collingwood held prior to any new hydrofracturing operations would allow parties to present information that could alter, refine, and / or rebut the above recommendations.

Short List of References

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