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Using Geoscience to Optimize completions in the Montney Formation, N.E British Columbia.

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Summary

The Montney formation in British Columbia and Alberta has gained prominence in recent years due to the exploration and production boom which has yielded more than 3.5 billion bcf/d in production output and in excess of 440 TCF of reserves. It is one of the largest unconventional plays in N. America, covering 130,000km^2 with 5600 wells drilled to date. The figure below illustrates the Montney reservoir trend.

The depositional history, subsequent burial and hydrocarbon generation have created a world-class unconventional reservoir, not of shale but of higher permeability siltstone (Nieto etal 2009). The thickness and reservoir characteristics of the Montney Formation lend themselves to horizontal wells which are extremely productive when hydraulically fractured.

This work highlights the use of 3D seismic, calibrated to various petrophysical and rock mechanical properties as a tool to optimize well completions.

Introduction

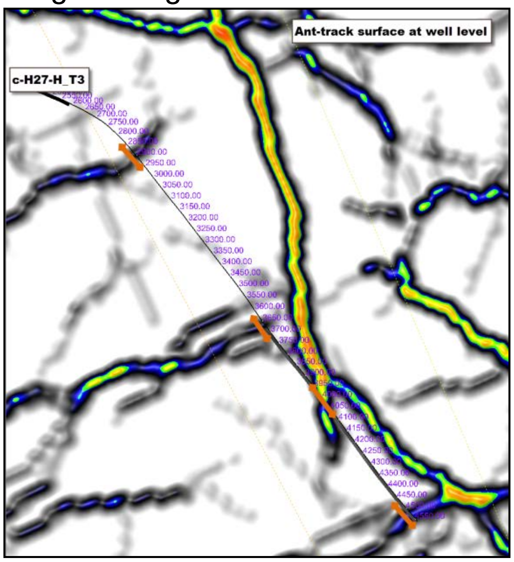
This presentation describes a workflow designed to improve completion efficiency by fully integrating petrophysics, geology, geophysics and completions engineering. This in turn improves productivity and increases capital efficiency in one of the biggest cost areas in Montney production, namely completions.

Reservoir quality in the Montney is variable. As the water deepens away from the shelf, the intrinsic reservoir quality deteriorates as the predominantly deep water very fine grained 'pelagic rain' and finer grained aeolian sediment take precedence at the expense of the coarser nearer shore/source quartz sand/silt grains. Inter-fingered with this background sedimentation are numerous turbidite deposits. These coarser grained turbidite deposits provide elongate, thin and continuous reservoir fairways which make attractive exploration targets. In addition the enhanced permeability associated with these deposits allows for the drainage of large areas and thicknesses of lower permeability, finer grained rock. (Davies 1997, Moslow etal 1997)

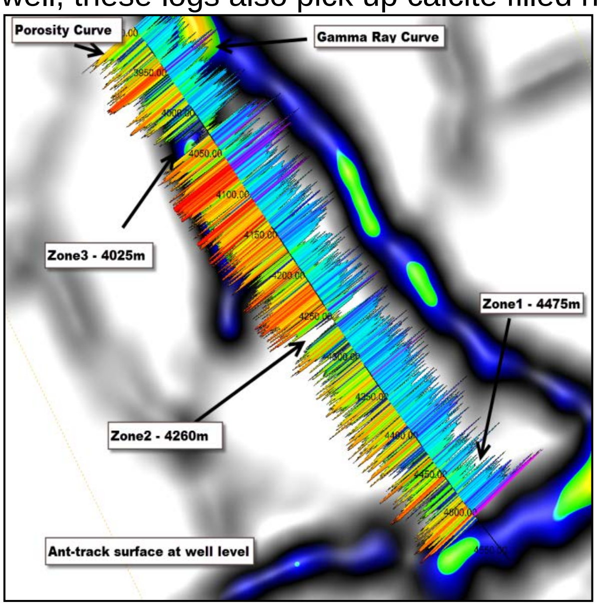
It is important to understand this variability in the subsurface as rock types behaves slightly differently under stimulation. The majority of the Montney Formation in the study area appears to frack extremely well as evidenced by the treatment charts on each well. The corresponding mechanical properties, Young's modulus and Poisson's ratio have excellent frack treatment characteristics and production results. In some cases however, there is a change in the way the rock treats leading to lower proppant concentrations and poorer results. This work identifies the causes of the variability in treatment and suggests a method to optimize the completions.

Theory and/or Method

We optimize our completions by integrating all disciplines, Geophysics, Geology and Engineering. Detailed work on our 3D seismic volumes gives indications of the presence of natural fracturing over the land base, common throughout the Montney play. Analysis of this data prior to drilling and completions allows us to optimize placement of the well path and then identify the natural fractures which may cut across the well. These fractures can be seen in the figure on the left, the brighter the line the larger the fracture. In addition, the well path is shown with depths of sliding sleeves. The orange arrows on the well path indicate sleeves which would remain closed during a completion job.



The figure below zooms-in and shows density porosity and gamma ray logs along the horizontal well, these logs also pick up calcite filled natural fractures, defined by low porosity, low gamma ray response. These intervals would not complete well, all the energy would travel along the fracture and not break new rock. In addition, energizing these fractures during the completion could cause the rock faces to slip, leading to 'crimping' of the well casing. Missing out selected sleeves over these intervals therefore gives us both better well productivity and better capital efficiency



Conclusions

The integrated workflow performed has identified the best rock in each wellbore and demonstrated:

- Improvements in proppant concentration placed,
- Absence of well crimping
- Less inter-well communication.

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