



Impact of Geomechanics on Hydraulic Fracture Geometry and Well Spacing in the East Duvernay Shale Basin, Canada

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Summary

The East Duvernay Shale Basin is the newest addition to the list of prolific reservoirs in Western Canada. Over the last three years, horizontal drilling and multistage hydraulic fracturing has increased drastically. Because the play is still in its infancy, a lot of the drilling activity has been single wells or limited to two wells per pad, and due to the low permeability of the matrix, hydraulic fracturing is needed to unlock the full potential of the East Duvernay. Since geomechanics is a critical factor in determining the effectiveness of hydraulic fracture propagation, we describe how varying pore pressure profiles affects modeled in situ stresses, hydraulic fracture geometries, and overall field optimization.

Theory / Method / Workflow

The pore pressure varies across the East Duvernay Shale Basin with the maturity of the reservoir. Higher tier logging, core measurements and field data are used to build a mechanical earth model, which is used as an input for hydraulic fracture simulations. Because pore pressure is a direct input into the interpretation for in situ stresses, we sensitized on multiple pore pressure profiles through the Ireton, Upper and Lower Duvernay, and Cooking Lake reservoirs. Pumping design currently being implemented in the Upper Duvernay is used to determine hydraulic fracture geometry based on the various in situ stress profiles. Numerical reservoir simulation forecasts are performed to understand how variations in geomechanical profile affect modeled stresses and fracture geometry. The effect of the varying hydraulic fracture properties on well spacing is also investigated by combining hydraulic fracturing and reservoir simulation.

Results, Observations, Conclusions

Results clearly indicate the need to better understand how in situ stress profiles vary with changes in pore pressure models. Fracture length is higher within the Upper Duvernay when a higher pore pressure is modeled in the Ireton and the Cooking Lake. If a normal pore pressure is modeled in the Ireton, a hydraulic fracture has 80% more length in the Ireton than in the Duvernay. When the modeled pore pressure is gradually ramped up from the top of the Duvernay into the Ireton, slightly higher fracture length is created in the Duvernay. Modeling higher pore pressure at the top of the high kerogen content (rather than the top of the Duvernay) results in drastically different fracture geometry. By increasing the modeled pore pressure in the Lower Duvernay, the downward fracture growth behavior changes. All the above modeled fracture geometries impact the optimum number of wells per section, which range from 4 to 8 depending on the pore pressure model used.

Novel/Additive Information

As more wells come on production and the economic viability of the play is proved, operators will drill more wells per section. Thoroughly understanding the variations in pore pressure across the various stacked reservoirs is important. This study is meant to drive the conversation about the data that needs to be collected and tests that should be run to ensure the play remains economically viable for years to come.