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Statistical Assessment of Operational Risks for Induced Seismicity from Hydraulic Fracturing in the BC Montney: Interpretation

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Summary

This presentation details an open-source data science workflow for assessing the effect of operational parameters on induced seismicity risk. This is the second of two presentations, with the first detailing the data science workflow. This presentation focuses on the results and interpretation of the statistical assessment, with a focus on operational and geomechanical implications for operators and regulators.

Introduction

Induced seismicity from oil and gas development in northeast British Columbia is a serious concern for industry, regulators and the general public. While it is clear that some induced events are caused by hydraulic fracturing, the specific operational practices that pose the highest risk are not yet understood, making it difficult to implement effective mitigation measures and communicate with the public.

Statistical approaches have been used successfully to link induced seismicity to geologic risk factors in the Duvernay in Alberta (Pawley et al., 2018) and to link well completion factors to higher hydrocarbon production in the Swan-Elmworth area of the Montney in Alberta and BC (Lenko and Foster, 2016). In this study we apply a similar workflow to link specific completion practices and limited geologic factors in Montney wells to induced seismicity. The ultimate goal of this workflow is to provide clarity in development of specific mitigation measures and potential pitfalls for operators.

Results, Observations, Conclusions

We show that up to 30% of the horizontal wells in the Montney can be seismogenically associated with induced seismicity. This value quantifies the correlation of wells to seismicity, likely over representing the percentage of wells that directly induce seismicity by a large amount due to the duplication of association of production-style development with larger seismic events. The majority of these associations only involve a handful of events (<5), but over 50 events can be associated to a single well due to overlapping areas of spatiotemporal well influence.

Our preliminary results show both likelihood and severity are moderately predictable using complex models (such as gradient boosted methods). These results show that structure, unsurprisingly, is a major driver of both induced seismicity likelihood and magnitude, especially the Paleozoic structure and third order residual.

There appears to be a link between likelihood and well density, the average stage length, and total fluid injected, which all make physical sense. The minimum distance between the treatment well and adjacent wells and other well spacing features also show relatively high importance when attempting to predict severity. This may be a confounding variable though, as spacing correlated strongly with other factors that are more difficult to quantify yet maybe more predictive (such as fluid maturity and well deliverability).

Additional results will be added and discussed as the project completes prior to the conference.

Acknowledgments

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References

Lenko, M. and S. Foster, Multivariate Statistical Analysis of Montney Completions: Taking Aim at Design Improvements, Unconventional Gas Technology Forum, 2016.

Pawley, S., R. Schultz, T. Playter, H. Corlett, T. Shipman, S. Lyster and T. Hauck, The Geological Susceptibility of Induced Earthquakes in the Duvernay Play, Geophysical Research Letters, 45, 2018.