geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Insights on fugitive gas migration from Bayesian multilevel logistic regression using oil and gas well records from British Columbia, Canada

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Summary

Fugitive gas migration (GM) occurs when methane-rich natural gas is mobilized from deep underground to the shallow subsurface and the atmosphere by an oil and gas well. These methane releases contribute to greenhouse gas emissions and have the potential to contaminate shallow groundwater resources. There are approximately 25,000 oil and gas wells in British Columbia, Canada (BC), and a limited number of these wells (0.6%) have reported cases of GM. Using probabilistic statistical models, we analyzed public well records to identify geological environments and well characteristics that have a higher likelihood of GM in BC. Generally, results show that well characteristics described in the public well records are not associated with a significant increase in the likelihood of GM. Geologic factors appear to be significant, as spatial clustering of GM cases is observed, but was not explained by well engineering characteristics considered in the study.

Theory / Method / Workflow

There has been little research investigating the occurrence or environment of GM in BC (Cahill et al., 2019). In BC, oil and gas producers are required to report well drilling, completion, production, and abandonment records for all oil and gas wells to the provincial regulator. This well data provides a unique opportunity to identify well characteristics with higher likelihoods for GM to develop.

We conducted a comprehensive data investigation to identify the associations between observed occurrences of GM and various local well constructions, geological environments, and operational practices. This study included the development of statistical models to predict and explain the presence or absence of GM at wellbores in BC. We used a contemporary statistical modeling methodology, drawing on Bayesian inference and hierarchical model structures. To account for variation among geological environments and spatial data clustering, the analyses were conducted at multiple spatial scales and assessed variations in effects between regional oil and gas fields. Our approach allows us to reduce the effects of spatial correlation within the data, as well as investigate the variations between different groups of wellbores, rather than making generalized conclusions at the provincial scale.

Results, Observations, Conclusions

Rigorous statistical analysis did not reveal obvious predictors of GM in the oil and gas well data analyzed in this study. Our results indicate that hydraulic fracturing and directional drilling were not correlated with the occurrence of GM. The best predictors of GM are indicators of well integrity loss (i.e., surface casing vent flow, remedial treatments, and blowouts) and geographic location. We ascribe the spatial clustering of GM cases to the local geologic environment, and we speculate that there are links between particular intermediate gas-bearing formations and GM occurrence in the area near Fort Nelson, BC.

Acknowledgements

We would like to thank the British Columbia Oil and Gas Commission (BCOGC) for collaboration, support, and data. We would also like to thank the British Columbia Oil and Gas Research and Innovation Society (BCOGRIS) for providing the funding for the research.

References

Cahill, A.G., Beckie, R., Ladd, B., Sandl, E., Goetz, M., Chao, J., Soares, J., Manning, C., Chopra, C., Finke, N., Hawthorne, I., Black, A., Ulrich Mayer, K., Crowe, S., Cary, T., Lauer, R., Mayer, B., Allen, A., Kirste, D., Welch, L., 2019. Advancing knowledge of gas migration and fugitive gas from energy wells in northeast British Columbia, Canada: In the Field: Advancing knowledge of gas migration and fugitive gas. Greenh. Gases Sci. Technol. https://doi.org/10.1002/ghg.1856