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Fugitive gas emission rates and distribution from efflux measurements around an energy well with known gas migration

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Summary

Methane gas emissions are a widely reported environmental impact arising from well integrity failures, including Surface Casing Vent Flow (SCVF) and Gas Migration outside the surface casing (GM). Typical SCVF emission rates are reasonably well quantified, however full-site GM emissions are rarely recorded commercially leading to uncertainty in magnitude of impacts resulting from GM emissions. The migration behaviour and rate of methane emissions through soils at sites with GM also have implications for the reliability of testing procedures, as most GM detection is based on measurements of above-background methane concentrations around the well.

We present results from field measurements around an energy well with known gas migration. Methods include CH_4 and CO_2 efflux measurements using automated dynamic flux chambers (LI-COR Inc.). Additional insights into gas movement behavior including methane oxidation were provided through compositional and isotopic analysis of soil gases. Measurements and sampling were repeated across several months, and an intensive two-week record of soil gas effluxes provided a greater understanding of the short-term temporal variation in gas effluxes.

Presented results indicate primarily vertical gas movement (along the wellbore) and estimated total methane emissions of < 1 m^3/day, which is within the range of previous scientific studies of GM at the low end of average Albertan SCVF flow rates. Analysis of compositional and isotopic gas profiles in the unsaturated zone surrounding the leaking well indicate oxidation of methane and different gas movement patterns depending on the proximity to the well. We conclude that a greater understanding and incorporation of factors affecting the behaviour of migrating gases, including wind speed and the potential for methane oxidation, will lead to greater success in tests for GM detection.