

Sources of groundwater methane in proximity to legacy coal extraction sites in Nova Scotia, Canada

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Recent studies have recorded elevated concentrations of dissolved methane in groundwater in proximity to hydrocarbon developments. High methane concentrations in groundwater pose a number of health and safety concerns such as the deterioration of water quality and explosive hazards. Methane may also be exacerbated by oil, gas and coal developments, which can lead to the migration of stray gas that can contaminate aquifers and escape to the atmosphere, contributing to poor water quality and greenhouse gas emissions.

Currently, there are limited data on groundwater methane concentrations in Nova Scotia. A previous study identified areas with elevated methane concentrations in groundwater near coal formations. However, the specific sources and local distribution of methane in those areas remain unknown. With a lack of baseline data and an abundance of coal, and historic mines, Nova Scotia is an excellent location to study the spatial relationship between methane concentrations in groundwater and legacy coal-extraction sites.

In this study, we sampled 96 wells across the Cumberland, Stellarton and Sydney basins. Preliminary results on a subset of the wells are presented here. In the Cumberland Basin, 5 domestic wells had CH₄ concentrations less than the 10 mg/L hazard threshold. Carbon ($\delta^{13}\text{C}$) and hydrogen ($\delta^2\text{H}$) isotopic analysis of methane, along with non-detectable ethane or propane, indicate a microbial origin of the gas. In the Stellarton Basin, 46 domestic water wells were sampled with methane concentrations in 18 wells <1 mg/L, 16 wells in the 1 mg/L–10 mg/L range, 10 wells in the 10 mg/L–28 mg/L range and 2 wells exceeded the 28 mg/L hazard mitigation threshold. Isotopic measurements of $\delta^{13}\text{C}$ and $\delta^2\text{H}$ of methane and ethane indicate a thermogenicbiogenic mixed origin of the gas. In the Sydney Basin, 3 domestic water wells sampled contained very low methane <1 mg/L. In contrast, 42 mine water monitoring wells in the Sydney Basin sampled as part of an ongoing environmental remediation program show evidence of thermogenic gas origin, at least from preliminary isotopic analysis on a small subset of these samples.

The findings from this groundwater methane investigation will help to better understand methane sources, migration pathways, and risks in Nova Scotia. The data acquired in this study may be used to monitor and assess groundwater quality should hydrocarbon exploration operations advance in the future.