Measuring Fugitive Methane Gas across Well Pads in Northeastern British Columbia, Canada

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ABSTRACT
Shale gas development has led to concerns on the potential environmental impacts associated with resource extraction by hydraulic fracturing. Leaking oil and gas wells due to compromised well casings are a current and historical issue that can result in subsurface fugitive methane (CH_4) migration and greenhouse gas (GHG) emissions to the atmosphere through surface gas efflux. In this study, the occurrence and magnitude of fugitive CH_4 was measured on active and abandoned oil and gas well pads in Northeastern British Columbia, Canada. Surface effluxes for CH_4 and carbon dioxide (CO_2) were measured using a flux chamber method. In addition, soil gas and surface casing vent flow samples were collected and analyzed for composition and stable carbon isotopes (^{13}C) in CH_4 and CO_2. Based on soil gas and efflux measurements, fugitive CH_4 associated with gas migration was detected at 15 of the 17 well pads. The appearance and magnitude of surficial effluxes was influenced by subsurface heterogeneity. At 5 of the 8 sites, fugitive gas migration was identified at distances greater than 5 m from the well head, and in one instance up to 20 m away. The highest measured effluxes were also temporally variable across the well pads. Spatiotemporal variations in fugitive gas migration have significant implications for accuracy in monitoring gas migration. This research suggests that accurate measurement and quantification of fugitive gas migration requires: i) subsurface characterization of geological heterogeneities, ii) a dense monitoring network and, iii) consideration of temporal variability in measurements.