Project Profile

Project Name:	Evaluating Fugitive Methane Oxidation in Natural Soils of British Columbia through Data Analyses, Field Investigations and Reactive Transport Modelling
Project Number:	ES-Wells-2023-01
Proponent:	Institute of Geoenergy Engineering, Heriot Watt University
Funding Envelope:	Engineering and Safety Research—Wells
Timeframe:	April 1, 2023, to April 30, 2024

Project objectives

The objectives of this project are to evaluate the oxidation of fugitive methane in natural soil structures (within BC or elsewhere) with a focus on its potential for greenhouse gas mitigation at integrity compromised oil and gas wells—considering the following:

- How and where has methane oxidation in natural soils around integrity compromised wells been characterized or evaluated and what does existing data show?
- What factors control natural methane oxidation in soils around integrity compromised wells?
- What rates and extents of methane oxidation can occur in natural soils around integrity compromised wells and how effective could the process be at mitigating greenhouse gas emissions to atmosphere?
- Could methane oxidation in natural soils around integrity compromised wells be used to mitigate greenhouse emissions/as an alternative remedial method and what might such a natural solution look like?

Project description

This project will systematically and rigorously evaluate methane oxidation in natural soils at and around integrity compromised oil and gas wells in B.C. using; a) existing data, b) collecting new data, and c) conducting data informed reactive transport modeling. Learnings will be used to appraise if this natural process could be used as an alternative approach to managing integrity compromised wells and if so, what that might look like, and under which circumstances it may be appropriate.

Project approach

The project will involve the following three phases over the 12-month project:

1. **Evaluation of methane oxidation in natural soils using existing data and literature review**—using publicly available data from experimental field investigations and related research as well as data held by the industry and regulators from real cases of integrity failure. Collated data will be evaluated in the context of characterizing the extents and rates of methane oxidation occurring in natural soils in B.C. or Alberta by 3 methods (depending on quality and availability of data) including; stable carbon isotope enrichment techniques, mass-balance approaches and

carbon dioxide : methane profiles in soils. In addition, a short literature review will be conducted to highlight learnings and findings related to methane oxidation in soils, including from other areas of related research and data such as landfill biocovers and agricultural soil sciences.

2. **Field investigations examining methane oxidation in natural soils of B.C.**— new and uniquely designed field investigations focusing on integrity compromised wells where methane is confirmed as being released into natural soils will be investigated. Overall, more detailed monitoring/sampling and focused data analyses will be performed at approximately 3 to 5 integrity compromised well sites at several times throughout the year as well as a 2 – 3 week duration of highly focused and detailed field campaign over the summer period. During focused field investigations surficial and shallow soil gas concentration measurements and flux estimates will be taken and meteorological parameters monitored. In addition, physical soil gas and sediment samples will be attained for further laboratory analyses including soil gas composition and stable carbon isotope analyses, soil structure, soil-based methane oxidation indicators and byproducts (such as methanol and soil acidity) and microbial community analyses (including use of 16S rRNA gene amplicon sequencing to identify methanotrophic species). Conditions in natural soils away from integrity compromised wells will also be determined to attain a baseline from which to delineate differences in microbial communities and other parameters associated with methane oxidation in natural soils.
3. **Reactive Transport Modelling and Remedial Potential Appraisal and Outline—**analyze findings from the first two phases to generate a model that simulates methane oxidation in a relevant range of soils at and around integrity compromised wells relevant to B.C. over relevant spatiotemporal scales. The model will integrate newly attained information on methane oxidation rates, gas leakage volumes and other controlling factors/parameters such as temperature variations, soil moisture content, soil composition/permeability in addition to any other important B.C. specific properties for reactive gas transport. Once formulated, the model will aid in the evaluation of the extents of methane oxidation that can be achieved in natural soils under relevant conditions in different settings and ultimately provide insight on the potential for natural soil-based oxidation to be used in B.C. as an alternative course of action to re-abandonment.

Project deliverables

The deliverables from this project include the following:

1. Final report—describing the reactive transport model that can simulate methane oxidation in natural soils of BC and a proposed methodology through which the process could be utilized as an alternative to re-abandonment or remedial action provided.