

Linking the spatial variability of carbon isotopic composition of surface casing vent flow gases to geology and well characteristics in an interactive map of the Lindbergh heavy oil field, Alberta, Canada

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Measurements of carbon isotopic compositions of hydrocarbon gases have proven to be valuable to the oil and gas industry in exploration, development, and remediation. Here we concentrate on remediation, where the isotope fingerprint of fugitive gases reveals their geological source. The $\delta^{13}\text{C}$ of the reservoir gases reflects thermal maturity, alteration, and mixing histories. Thus, the $\delta^{13}\text{C}$ of production gases varies with location in an understandable way, whereas the $\delta^{13}\text{C}$ of SCV and GM gases also reflect well integrity failures of the respective wells. Not only will the $\delta^{13}\text{C}$ of fugitive gases vary with location, but at any given location, it will also vary with the depth of the source of the leak. The depth of the source of the migrating gas will depend not only on the local geology, or on topography but also on the well's engineering characteristics, such as drilling history, cement amount, and type, among others. Remediation would be optimized by understanding all these factors in a regional, digital geospatial context.

We will present a beta version of an interactive geospatial map displaying the carbon isotopic composition of oil-associated ground migration and surface casing vent flow gases from the Lindbergh heavy oil field. The digital map will combine the isotopic signatures of fugitive gases with information about the wells and their cleanup histories that can be found in public records. The map will demonstrate that, in most cases, the source of leaks is not from the production target, but from given intermediate formations. At any one location, the surface casing vent flow of adjacent faulty wells tends to have the same source, which varies with location and topography. Overall, the source depth as well as the flux of SCVF relate to the volume of cement. Inspection of the maps should lead to identifying patterns and correlations which reveal new understandings of the complexities associated with fugitive gas emissions.

Our tool will provide important information ahead of any remediation efforts on faulty wells in our study region, thus optimizing the chances of successful remediation on the first try. An ancillary benefit could be new insights into the reservoirs themselves gained from examining the isotope fingerprint of the oil-associated gases. Furthermore, these maps may become invaluable in current efforts to identify and attribute methane emissions.