



## Isotopic fingerprinting of fugitive methane and CO<sub>2</sub> from the Western Canada Sedimentary Basin (WCSB): Data documentation and impact

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The general public, industry and regulators seek information about both intentional and unintentional greenhouse gas (GHG) emissions from energy wells. Minimizing these emissions may be one of the easiest steps to reaching reduction targets.  $\delta^{13}\text{C}$  is a common tool used to assess sources of atmospheric methane. Here we report and map the isotopic composition of 1280 production gases from energy wells in the Western Canada Sedimentary Basin (WCSB), which mark the  $\delta^{13}\text{C}$  of downstream GHG emissions in the production and transmission network. The WCSB is a worldwide recognized hydrocarbon producer, with more than 450,000 energy wells drilled only in Alberta. Produced methane  $\delta^{13}\text{C}$  ranges from -70‰ (VPDB – biogenic source) to -23‰ (VPDB – over mature shale) averaging, -47.2‰. Many of the currently producing, shut-in and abandoned wells also emit fugitive gas through surface casings (SCVF) and soil/ground migration (GM). Their  $\delta^{13}\text{C}$  of the fugitive gases usually indicates a shallower source than the production target (average SCVF  $\delta^{13}\text{C}_{\text{methane}}$  = - 55.6 ‰, GM  $\delta^{13}\text{C}_{\text{methane}}$  = - 58.0 ‰, and average SCVF  $\delta^{13}\text{CO}_2$  = - 55.6 ‰, GM  $\delta^{13}\text{CO}_2$  = -15.8 ‰). Mapping (isoscapes) of isotope values from 2800 SCVF, and 1800 GM gases sampled across WCSB, show that geology and topography constrain the source of leaks. The spatial distribution and wide range of  $\delta^{13}\text{C}$  of fugitive methane across the WCSB provide insights and data to climate modellers seeking to attribute atmospheric methane sources but is also relevant for mitigation of emissions as well as informing regulators.