Isotopic Fingerprinting of Fugitive Methane and CO_2 from the Western Canada Sedimentary Basin (WCSB): Data Documentation and Impact

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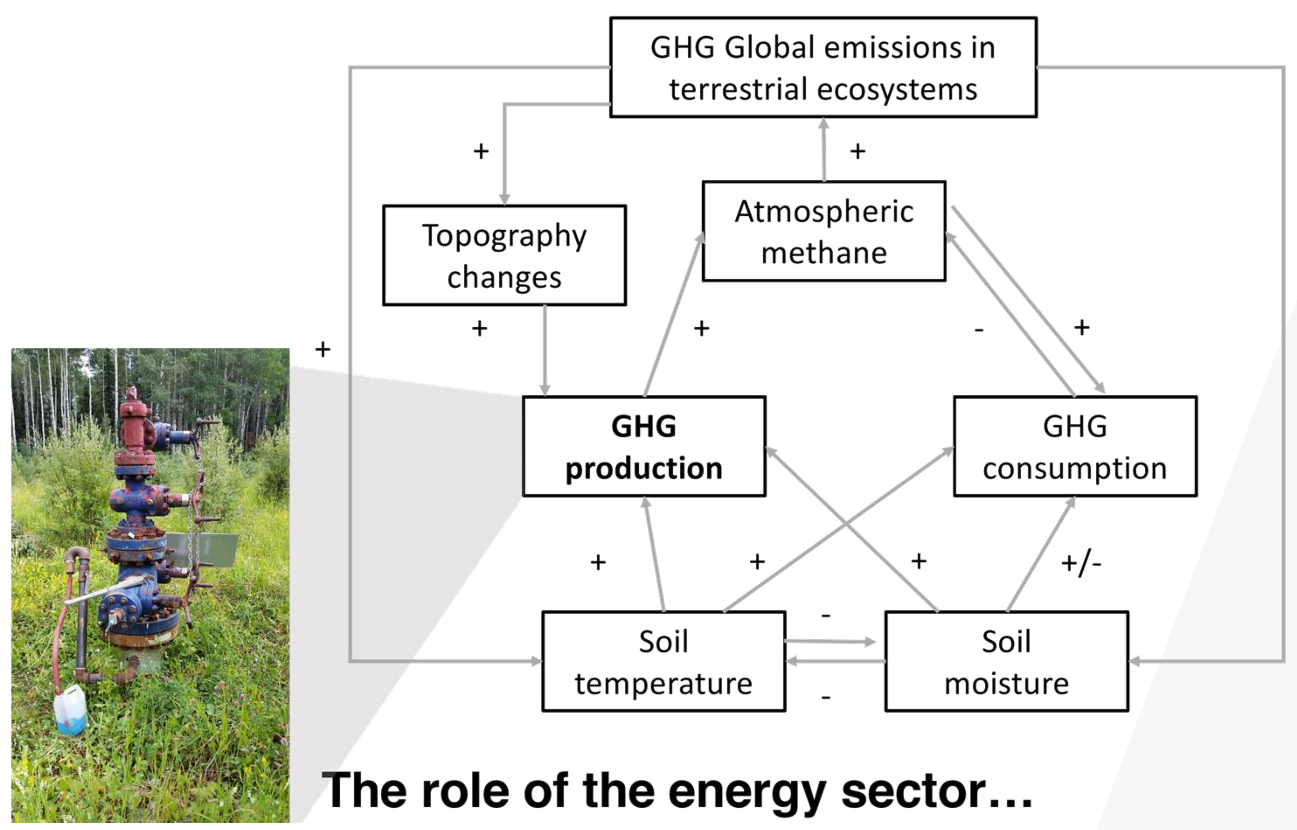
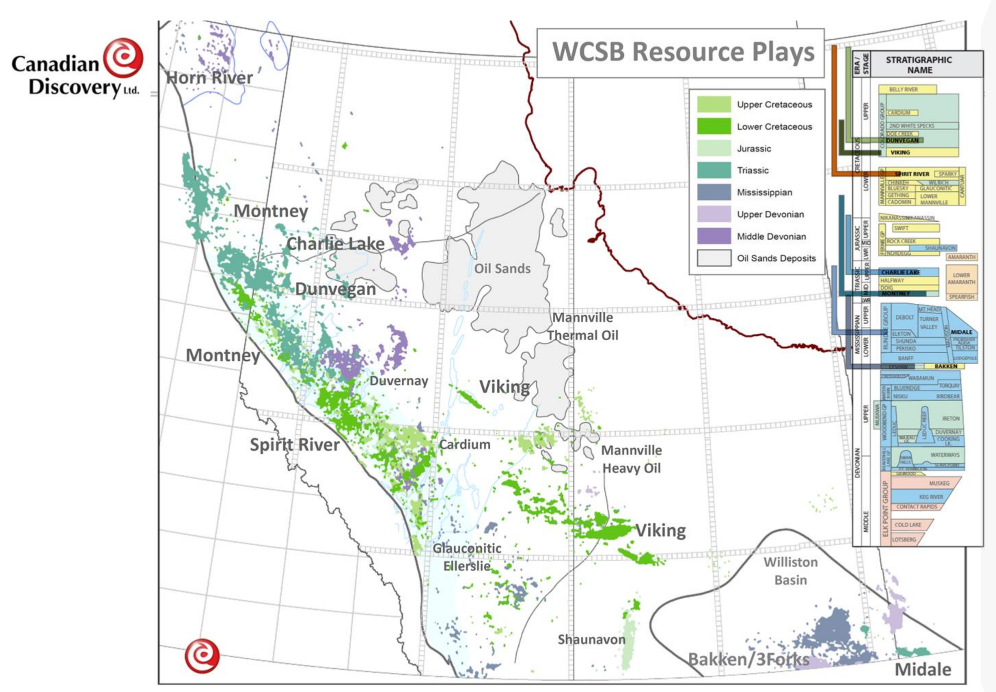
I. Background information



The role of the energy sector…

Figure1. Diagram showing the methane feedback diagram (modified from Lashof et al., 1997) and an energy wellhead in western Alberta, Canada. The greenhouse gas emissions, key environmental factors in continental environments influence the production and consumption of methane and carbon dioxide in continental environments.

(a)



(b)

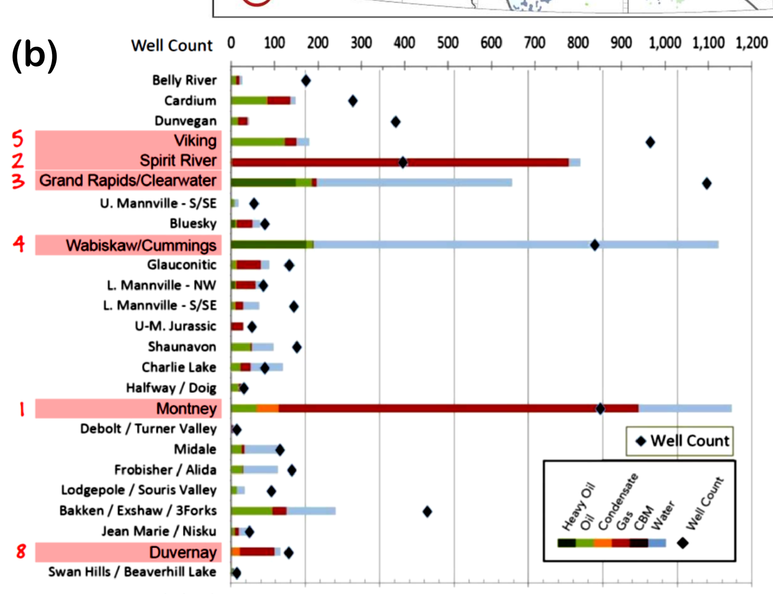
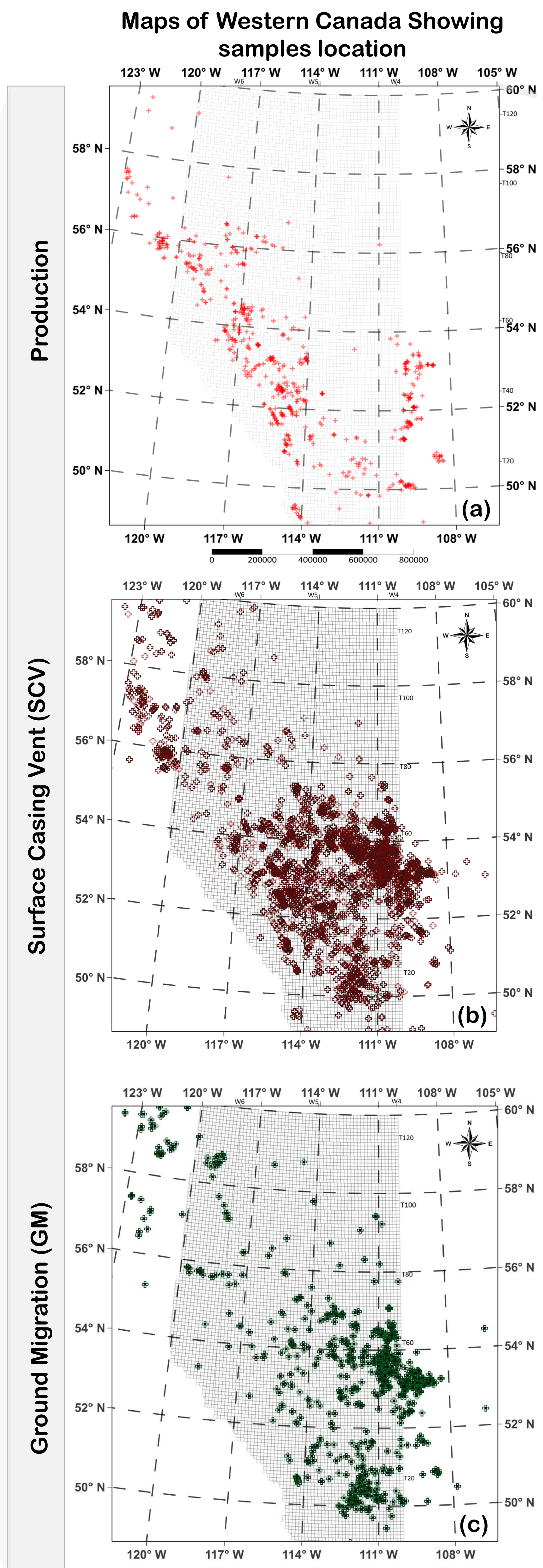


Figure2. Western Canadian Sedimentary Basin (WCSB) highlighting the principal oil and gas production Formations distribution and geologic time table (a) and the number of wells count per Formation and cumulative production per well over three-month in 2015 (b) (modified from Flocker and McKenzie, 2016).

II. Samples source



III. Histogram distribution and average values

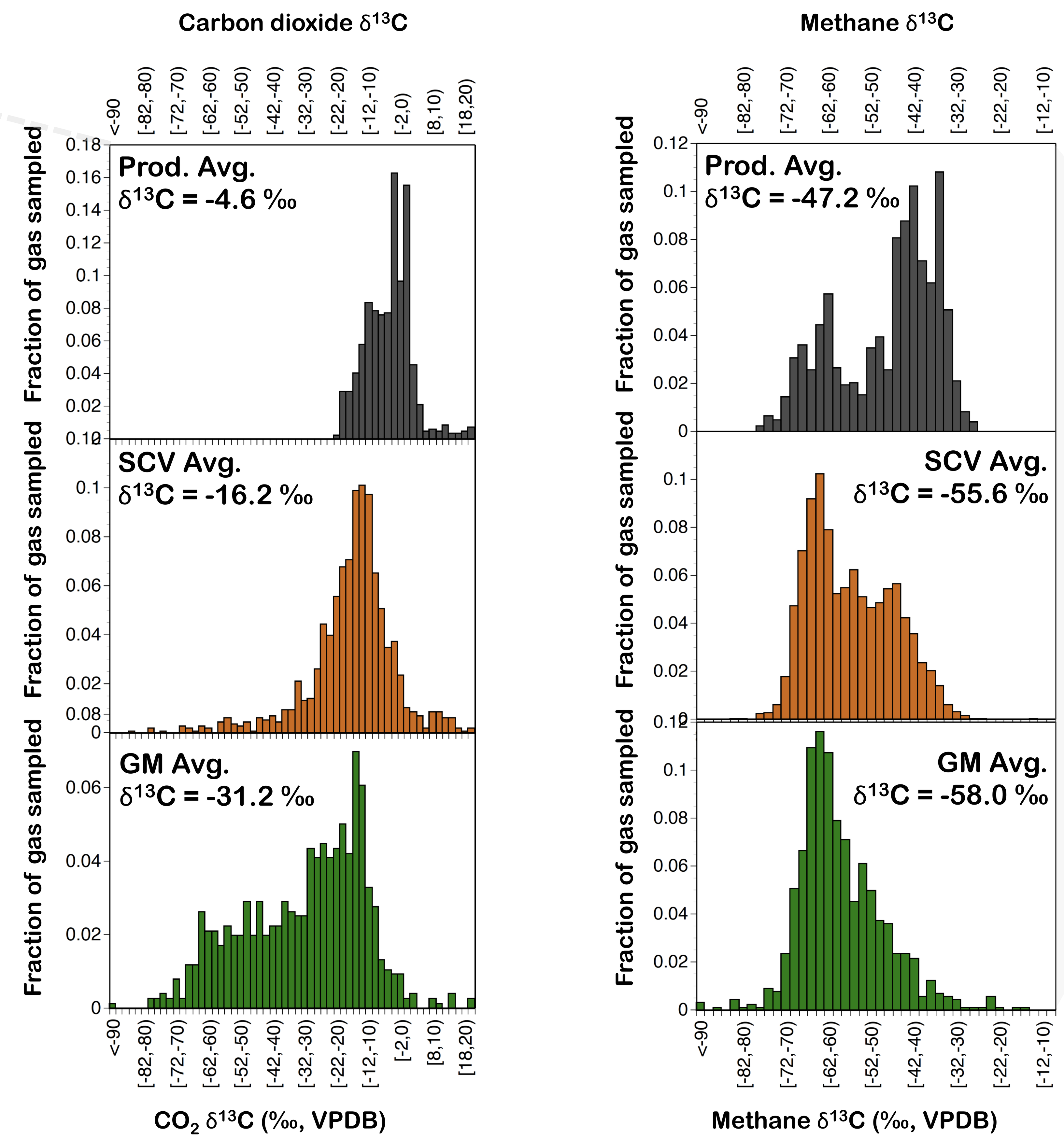


Figure 4. Histogram distribution of carbon dioxide, and methane carbon isotope ratios of produced, surface casing vent (SCV), and ground migration (GM) gases, and average values. Carbon dioxide and methane distribution from production and SCV, indicate that the source of fugitive gas is not always coming from the producing reservoir. GM variability and broader distribution represent complex mixing processes from the vertical and lateral gas migration throughout multi-phase geologic media, and biological input.

Figure 3. Map showing the location of the gas sampling sites and source: produced gas (a), surface casing vent (SCV) (b), and ground migration (GM).

IV. Model: What do we know, and can learn? – Isotopic regional variability

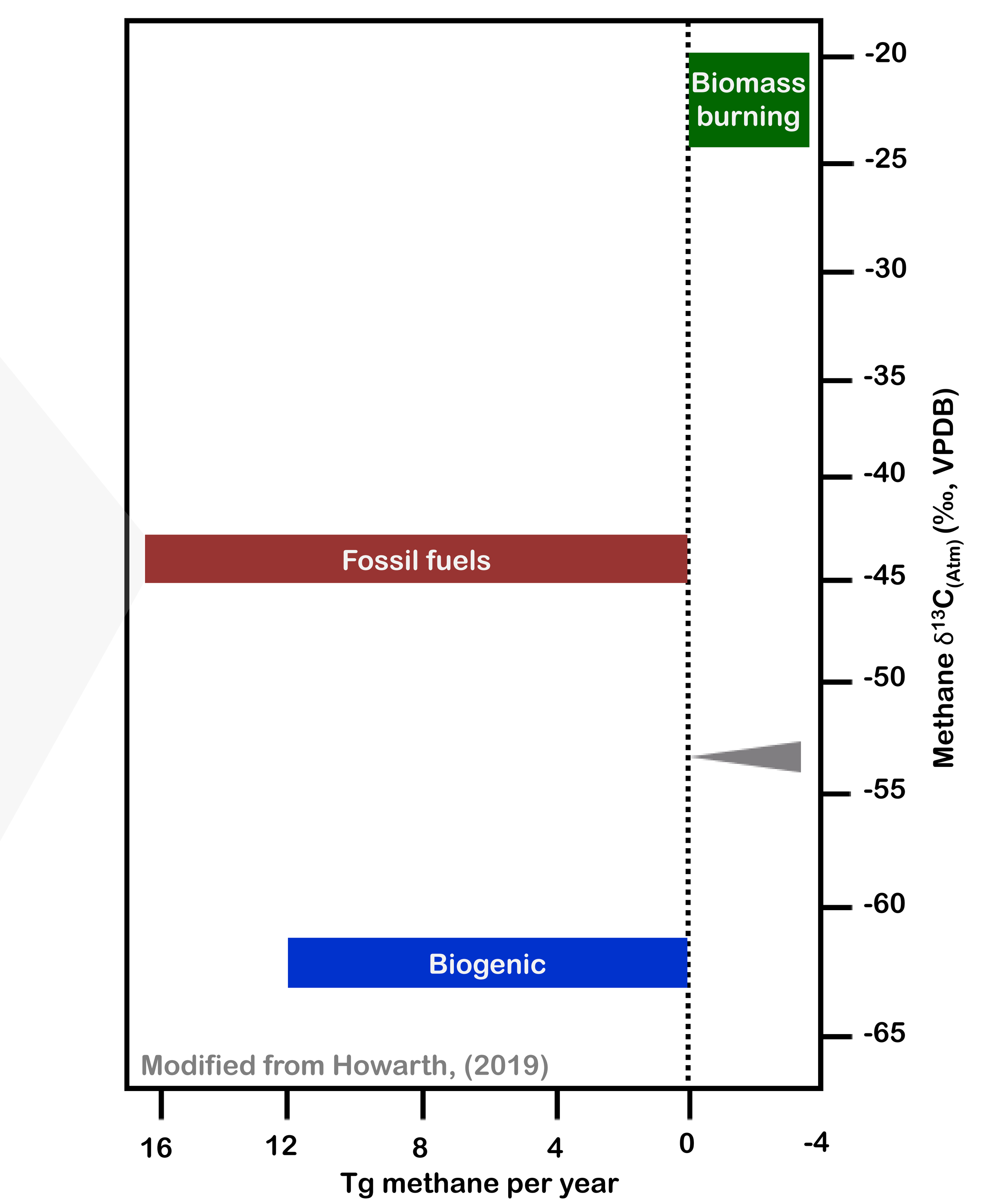


Figure 5. Published model using isotope mass balance of methane to estimate atmospheric input of shale gas into atmosphere considering the isotopic fingerprinting from biogenic, fossil fuels, and biomass burning. Howarth, (2019) uses ~-45 ‰ for fossil fuel methane, whereas this research found fugitive methane from WCSB to be ~-56 ‰. The mapping of the isotope variations shows regional and local control.

V. Outcome:

The observed wide range should warn climate modelers using $\delta^{13}C$ of methane to be extra cautious with their input values. Regulatory agencies may seek insights before using mean $\delta^{13}C$ of methane for attribution purposes. As processes controlling variations may be more complicated than anticipated. In the $\delta^{13}C$ of fugitive and vented methane from the WCSB varies widely, reflecting differing geology, geography as well as topography.

VI. References

Fockler, M., & McKenzie, B. (2016, June). Western Canada Resource Plays: The Phoenix Awaits. *In AAPG Annual Convention and Exhibition*, Calgary, Alberta, Canada, June (pp. 19–22).

Howarth, R. W. (2019). Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane?. *Biogeosciences*, 16(15), 3033–3046.

Lashof, D. A., DeAngelo, B. J., Saleska, S. R., and Harte, J., (1997). Terrestrial ecosystem feedbacks to global climate change. *Annual Review of Energy and the Environment*, 22(1), 75–118.

VII. Acknowledgement

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