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Isotopic composition of gases from the Unconventional Duvernay Formation

Gabriela, Gonzalez Arismendi[1, 2]
Karlis, Muehlenbachs[1]
[1] *Earth and Atmospheric Sciences, University of Alberta*
[2] *Geoscience, University of Calgary*

The Duvernay Formation is one of the most prolific bituminous rock in the Upper Devonian Alberta Basin. This type II source rock exhibits a distinctive maturity trend across the region, with total organic carbon values of up to 17% and the potential to produce a total of 2.17 trillion m^3 of marketable gas (Adams et al., 2013; Lyster et al., 2017). Emerging prospecting technology and a more detailed resources assessment and re-evaluation of the Duvernay Fm., in both the northwest and eastern sections, have led to a better understanding of this unconventional oil and gas play. In addition to its economic interest, the so-called "closed" Devonian petroleum system possesses a facies architecture with great potential for novel technological developments aimed at improving gas recovery (*e.g.,* Klewiah et al., 2020). In an effort to better constrain the source, fate, and composition of light hydrocarbons (C_1 to C_4) produced by the Duvernay Fm., we analyzed and mapped the *n*-alkanes isotope composition from evenly distributed wells in the region. The data showed the following isotopic values ($\delta^{13}C$, ‰ V-PDB): C_1 -50.2 to -35.1 ‰, mean -42.4 ‰; C_2 -35.6 to -24.1 ‰, mean -31.4 ‰; C_3 -31.5 to -23.1 ‰, mean -28.6 ‰; *i*C_4 (i-butane) -40.5 to -24.2 ‰, mean -30.0 ‰; *n*C_4(*n*-butane) -33.1 to -21.9 ‰, mean -27.6 ‰; and CO_2 -17.9 to 12.5 ‰, mean -2.5 ‰. The isotope data reflect increasing maturity NE to SW. Interestingly, the maturity of gas in the shales inferred from our isotope geothermometry corresponds with that reported for conventional gases along the Rimbey–Leduc reef trend (James, 1990), which transects the unconventional Duvernay. Natural gas plots showed geographic differences between the western and the eastern Duvernay. The plots reveal that most Duvernay gases are *in situ* but also suggest potential changes in syndepositional kerogens. Moreover, further inspection reveals more gas mixing in the south towards the reefs. Our work seeks to use geochemical tools to understand this unconventional play, by reassessing current knowledge.

References

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