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Once upon a time, a geochemist said. Pitfalls of modern versus traditional geochemistry

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Summary

This study will present a refresher of some geochemistry methods you might have heard in the past, the assumptions then and now. Are these methods still around? Have they evolved? Are they as useful today? We will also introduce a summary of the most current geochemical practices for resource assessment. For example, whereas traditional geochemistry was heavily focused on the analysis of biomarkers, we notice that modern geochemistry may consider many other molecules to accomplish the same goals, particularly polycyclic aromatic hydrocarbons. Likewise, petroleum system analysis based on geochemistry used to give high importance to the identification of the source rock, whereas the source seems to be less relevant in unconventional plays of today. The ultimate goal is to foster discussion about the direction that geochemistry should follow in present and future energy.

Methods

We have conducted a systematic revision of some of the most popular organic geochemistry methods to characterize hydrocarbon reservoirs, what they were before (in the conventional and early unconventional realms) and what they are now. Some statistics using public data have also been included.

Results

If we perform a search of the words “petroleum geochemistry Canada” in one of the most popular platforms of peer review publications, we will find 326 results in 2024 (Fig. 1). That means there were indeed new inputs about petroleum systems in Canada, or these were at least mentioned in other studies around the world. However, it is yet a question whether those 326 findings are currently being used or will be; same for the 294 results from 2023 and the 288 from 2022.

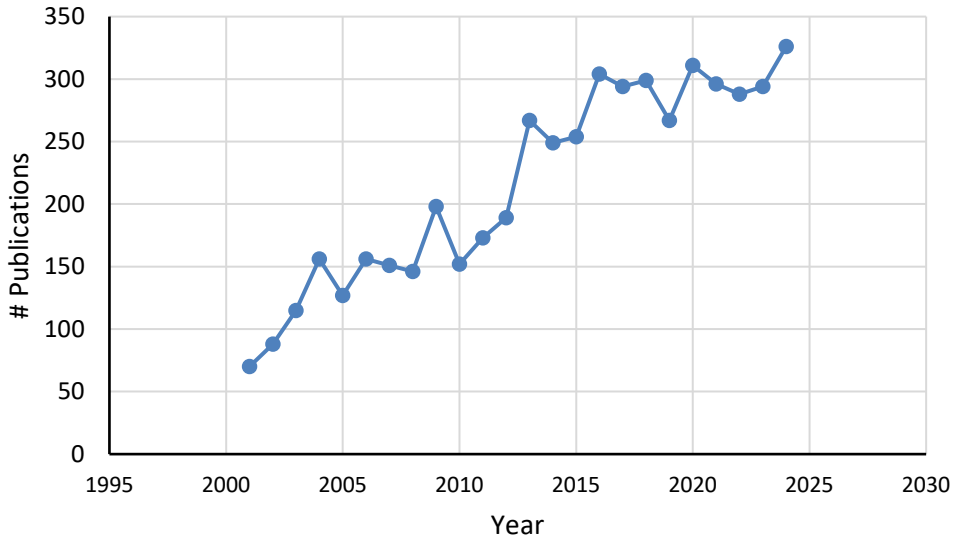

Figure 1. Number of publication results when conducting the search "petroleum geochemistry Canada" on the ScienceDirect.com platform.

A closer look on these contributions to petroleum geochemistry with time, allows us to find important differences between now and then. The key aspects we have chosen for this study are described below.

Machine Learning

Like in the chicken or egg story, we ask ourselves what was first, machine learning or geochemometrics, or both came together. How do these disciplines support each other to characterize hydrocarbon reservoirs nowadays? Another common thought is that geochemistry applications today rely heavily on data libraries, which is actually not the case. A pitfall of using modern geochemistry is the assumption of dependability on data comparisons with pre-existing patterns in a data driven world. A current study case using molecular and isotope data will be included.

Molecules

The study of molecular fossils, more popularly called biomarkers, has been around for decades. However, their contribution to petroleum geoscience has evolved. One of the main pitfalls of using traditional geochemistry for unconventional Canadian plays is the low biomarker abundance.
For example, have you looked at an unconventional gas-condensate play and received a biomarkers report with too many zeros in it (i.e. not detected)? Furthermore, there are hundreds of other molecules (non-biomarkers) that inform important geochemical processes, which are seldom considered for investigation. More interestingly, and to provide a fun fact, did you know that some of the alcohols from phytoplankton in the sea today can also be found well preserved in Montney cores? What is that telling us?

Environment and New energy

Organic geochemistry principles became increasingly applied in environmental science in the last decade, sometimes even surpassing the number of applications in petroleum systems. However, major efforts are still required to address carbon emissions and the carbon cycle in general. Developing new energy sources definitely requires going back to basics; it demands the comprehension of geochemical cycles of elements such as Helium, Hydrogen, and certain metals (i.e. critical minerals). As much as we need geochemistry to understand the carbon cycle, we need it to drive the future of natural resources that will energize societies.

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