A Multiple Isotope (C, H, S & O) Approach to Characterizing Crude Oil Families Within Oil Basins*

Craig D. Barrie¹, Kyle W.R. Taylor², John Zumberge¹, and Kimberlee L. Sparks³

Search and Discovery Article #42242 (2018)**
Posted July 23, 2018

*Adapted from poster presentation given at AAPG 2018 AAPG Annual Convention and Exhibition, Salt Lake City, Utah, May 20-23, 2018
**Datapages © 2018 Serial rights given by author. For all other rights contact author directly.

1GeoMark Research Ltd, Houston, TX, United States (cbarrie@geomarkresearch.com)
2Elementar UK Ltd, Stockport, United Kingdom
3Cornell University Stable Isotope Laboratory, Cornell University, Ithaca, New York, United States

Abstract

Stable isotope analyses of crude oil samples have been part of the petroleum geochemists tool kit since at least the 1950’s. Although a range of isotopic systems; carbon (δ¹³C), sulfur (δ³⁴S) and hydrogen (δ²H), have been utilized previously to help understand the origin of and relationships between petroleum samples, this has largely given way to studies focusing upon bulk (or compound-specific) δ¹³C signatures. That is not to say that there is not a body of work on these additional bulk isotopic signatures in petroleum studies, there is, but the majority of it is dated. Although carbon is the dominant constituent of crude oils (>80%) the other constituent hydrocarbon and non-hydrocarbon elements (Hydrogen, Nitrogen, Sulfur, and Oxygen) offer potential insight into understanding the origins and history of complex petroleum systems. This study looks at the potential range of C, H, N, and S isotopes in petroleum samples, from a global context before focusing on δ¹³C/δ³⁴S and δ¹³C/δ³⁴S/δ²H correlation case studies from a number of complex oil basins. The oil basins discussed (Williston Basin and Western Canada Sedimentary Basin) have previously been analyzed and the petroleum systems within the basins defined via principal component analysis (PCA) of genetic-biomarkers and stable carbon isotopes. All of the results suggest that a multi-isotope approach (CHNOS) can separate petroleum samples into distinct oil families which closely mimic those generated by multivariate statistics of genetic biomarkers in the same oils. Not all of the oils analyzed match their biomarker defined oil families, but this can be explained by a combination of subtle mixing between petroleum systems, enhanced maturity separation - from concentrating on the isotopes exclusively - and the limitations of using just 3 parameters to define as many as 8 individual petroleum systems. The results of this study emphasize the important role that combining δ¹³C, δ²H, δ³⁴S and potentially δ¹⁸O composition and isotopic signatures can play in helping to define individual petroleum systems within complex oil basins and the potential in correlating oil-oil and oil-source rock relationships.
A Multiple Isotope (C, H, S & O) Approach to Characterizing Crude Oil Families Within Oil Basins

1. Introduction

2. Isotope Systems & Crude Oils

3. Case Study 1: The Williston Basin

4. Case Study 2: The Western Canadian Sedimentary Basin

5. Summary

6. Future Research