

New Insights into the Effective Petroleum Source Rocks in the Beaufort-Mackenzie Basin from an Integrated Molecular and Isotope Approach

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Oil industry routinely uses biomarker ratios and “fingerprints” to classify genetically related oils, to correlate oils with source rocks, and to identify petroleum source horizons and kitchens. This application is valuable in allowing explorationists to identify end member petroleum sources even in cases where the source rocks have not been penetrated. Without the knowledge of the concentrations of the biomarker classes in question among source rocks of different organic facies or thermal maturity, however, oil source determination using this approach may unwittingly relate an oil to the wrong source rock. The aim of this study was to refine the genetic classification of discovered oils in the Beaufort-Mackenzie Basin, through an integrated, quantitative, molecular and isotopic approach. Although our results generally support the oil classification scheme accepted widely by industry, the discrepancies observed in the molecular and isotopic signatures in many of the studied oils indicate that most of the earlier interpreted oil-source relationships are incorrect. For example, biomarker evidence suggests marine source rocks in Upper Cretaceous Smoking Hills/Boundary Creek formations for the oils from the Kugpik, Imnak, Tuk and Mayogiak discoveries, in contrast to the stable carbon and hydrogen isotope values of individual n-alkanes in these oils which display clear affinity with the marine source rocks in the Upper Jurassic Husky Formation and Lower Cretaceous Kamik Formation but not with the presumed Upper Cretaceous source rocks. The presence of bisnorlupanes and oleananes and the distributions of regular steranes in most of the offshore Kugmallit-reservoired oils appear to suggest an immature Tertiary deltaic non-marine source. However, the presence of 24-n-propylcholestanes, a large unresolved complex mixture and the mismatch in the stereochemistry and relative distributions of regular steranes and diasteranes indicate that these oils have most likely been derived from a mature Upper Cretaceous marine source, undergone varying degrees of biodegradation, and subsequently mixed with new hydrocarbon fluids from the shallower Tertiary strata. Interpretation of the newly acquired geochemical data within the context of petroleum mass fractions provides important source rock information for exploration geologist to address trap filling issues.