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Kuparuk Field, Alaskan North Slope: Did Alteration by Evaporative Fractionation Really Occur during Trap Filling?

Kuparuk is a giant oilfield located on the Colville-Prudhoe High, west of the Prudhoe Bay Field, in the Alaskan Arctic plain. Bulk (sulfur-API relationship) and molecular geochemical characteristics of the high molecular weight fraction of the Kuparuk oils suggest derivation from a single source rock: the Triassic Shublik Formation.

Using Thompson's (1987) light hydrocarbon scheme, the Kuparuk oils have values > 0.5 for the "aromaticity" B parameter ($=\text{toluene}/n\text{-C7}$) and < 1 for the "paraffinity" F parameter ($=n\text{-C7}/\text{MCH}$). Using this scheme in isolation, one would interpret Kuparuk as the residue from repeated episodes of phase segregation and gas-cap leakage. This process -- termed "evaporative fractionation" -- is experimentally proven to concentrate naphthenic and aromatic hydrocarbons with low fugacity in the parent oil phase, while enriching the daughter gas-condensate phase in alkanes.

We revisited the geochemistry of the Kuparuk field within the context of a regional evaluation of North Slope petroleum systems. Our integrated study suggests a very simple charge / filling model, in which the Kuparuk reservoir has remained single phase throughout. Lipid-derived oil and solution gas from the Shublik, together with lignin-derived gas and very light, naphthenic-aromatic condensate from Kekituk coals shared a common migration path into Kuparuk. The interpretations are consistent with the results of a proprietary light hydrocarbon classification scheme, which in contrast to Thompson's scheme places emphasis on source rock organofacies than rather than maturity or phase segregation. The study illustrates the pitfalls in using light hydrocarbons in isolation to understand the filling history of petroleum accumulations.