OIL FAMILIES IN SOUTHWESTERN SASKATCHEWAN

KIRK G. OSADETZ, LLOYD R. SNOWDON AND PAUL W. BROOKS

Institute of Sedimentary and Petroleum Geology,
3303 - 33rd Street N.W.,
Calgary, Alberta T2L 2A7

ABSTRACT

Three stratigraphically restricted oil families dominate the area south of the Carboniferous subcrop in southwestern Saskatchewan. Oils in the stratigraphic interval of the Mississippian Madison to Lower Cretaceous Mannville of the Battle Creek, Rapdan-Battrum area have > 210°C boiling point, saturate fractions characterized by pristane/phytane ratios < 1, a predominance of even/odd n-alkanes, high C_{23} tricyclic/C_{30} pentacyclic terpanes, a C_{35} hopane prominance, and diasterane/regular sterane ratios <1. These oils are compositionally similar to Family C oils of the Madison subcrop petroleum province in southeastern Saskatchewan and southwestern Manitoba. Work in the eastern Williston Basin has correlated such oils to a Lodgepole source rock. Trisnorhopane thermal maturity ratios (Ts/Tm) suggest that Family C oils in southwestern Saskatchewan are of low thermal maturity (commonly 0.72 < VR < 0.78), and that they were derived from source rocks near their onset of significant hydrocarbon generation (VR = 0.7%). Low thermal maturities result in oils of high density, such that subsequent biodegradation has a more serious affect on oil quality than would be observed if the oils had initially been more mature.

A pervasively biodegraded oil family occurring in the Bakken Formation, particularly near its subcrop edge, has a > 210°C boiling point saturate fraction characterized by pristane/phytane > 1.0 and diasterane/regular sterane > 1.0. In these ways this family of oils resembles Family B oils, an oil family also stratigraphically restricted to the Bakken Formation of southeastern Saskatchewan and southwestern Manitoba. Family B oils in southeastern Saskatchewan are derived from Bakken source rocks. There they have consistently high thermal maturities, Ts/Tm > 1.1, that have been attributed to a delayed expulsion threshold. A noticeable difference between Bakken oils in southwestern Saskatchewan and Family B oils is their consistently low thermal maturity indicators (generally C_{29} sterane S/R < 1.0 and Ts/Tm < 0.6). This suggests either derivation from a source rock of comparable maturity to Lodgepole sources feeding the Rapdan-Dollard Mesozoic oilfield trend or an alteration of thermal maturity indicators by biodegradation.

The third oil family is restricted to Viking reservoirs and is also characterized by pristane/phytane ratios > 1.0 and high diasterane/regular sterane ratios. These oils can be distinguished from oils in the Bakken Formation by their consistently higher percentage of hydrocarbons, high saturate/aromatic hydrocarbon ratios, enrichment in C_{28} steranes and high thermal maturities. Other workers have suggested that the source of these oils is the overlying Upper Cretaceous portion of the Lower Colorado Group shale succession. High thermal maturities result in oils of low density and high quality, such that subsequent biodegradation of these oils, although as pervasive as that affecting other oil families, is not perceived as equally detrimental to oil quality in the Viking.

All three families exhibit variable degrees of biodegradation or water washing. Water washing is inferred by the selective removal of more soluble hydrocarbons, particularly benzene and toluene. Biodegradation is recognized by the selective removal of n-alkanes in both the > 210°C boiling point saturate fraction and the gasoline range. Decreasing heptane value appears to be one of the most systematic variations that accompanies increasing biodegradation. Oil density and API gravity generally vary with heptane value indicating that biodegradation is a dominant control on oil quality in the region. Similar patterns of variation are observed in Bakken oil pools, but the degradation of Viking oils provides one of the strongest correlations between progressive changes in heptane value and API gravity. Biodegraded oils are generally water washed, but water washing is not always accompanied by biodegradation.