Quantitative Whole Oil Gas Chromatography as a Tool for Understanding Biodegradation Processes in Oil Reservoirs

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Quantitative whole oil gas chromatography of oils has been used to examine the effect of moderate biodegradation on 18 oils from the Barrow Island oilfield, Australia. The Barrow Island oils came from different production wells, reservoir horizons and compartments, but have a common source (the Upper Jurassic Dingo Claystone Formation), with some organo-facies differences. Biodegradation resulted in strong depletion of n-alkanes (>95%) from most of the oils, and water washing partially or completely removed benzene and toluene. Other C5–C9 hydrocarbons were variably affected by biodegradation. Quantitation (mg hydrocarbons / g oil) has enabled comparison with less or non-biodegraded oils, and thus estimation of relative % losses of each C5–C9 hydrocarbon.

Adjacent methyl groups reduce the susceptibility of an isomer to biodegradation. 2-Methylalkanes are the most susceptible branched alkanes to biodegradation, 3-methylalkanes are the most resistant and 4-methylalkanes have intermediate resistance. For example, 2-methylpentane is depleted ~15% quicker than 3-methylpentane, and 2-methylhexane is depleted ~10% quicker than 3-methylhexane. Similarly, trans-1,2-dimethylcyclopentane is depleted ~35% quicker than 1,1-dimethylcyclopentane, and cis-1,3-dimethylcyclohexane is depleted ~35% quicker than 1,1-dimethylcyclohexane, because cyclic alkanes with gem-dimethyl substituents inhibit bacterial attack. In addition to the position of alkylation, the carbon skeleton and the degree of alkylation also control susceptibility to moderate biodegradation of cyclic, branched and aromatic C5–C9 hydrocarbons.

Quantitative data help to better understand bacterial processes operating in petroleum reservoirs. This study shows that the distribution of low molecular weight hydrocarbons in oils is very useful for understanding the dynamic oil migration, mixing and alteration processes that affect many petroleum reservoirs.