

ORIGIN OF DEEP OIL ACCUMULATIONS IN RESERVOIRS WITHIN NORTH TARIM BASIN: INSIGHTS FROM MOLECULAR AND ISOTOPIC COMPOSITIONS

B, Cheng^a, H, Liu^a, Z, Cao^b, X, Wu^b, Z, Chen^a

^a China University of Petroleum (East China), China

^b Northwest Oilfield Company, SINOPEC, China

Introduction

Deep petroleum accumulations are defined as those occurring at or below 4.5 km (Dyman et al., 2002). They have been found in about a quarter of petroliferous basins around the world (Bai and Cao, 2014). Of petroliferous basins in China, the Tarim Basin have the largest proven plus probable deep liquid petroleum reserves (Bai and Cao, 2014; Wang et al., 2012). Very large amounts of light oil have been producing from the carbonate reservoirs below 7 km in the recently discovered Shunbei and Yuecan oil fields within the north Tarim Basin. Eighteen samples in total were collected and investigated for molecular and isotopic compositions to help understand the origin of deep oil accumulations in this area.

Results and conclusions

High concentrations of light fractions and several ratios based on C₆- and C₇-hydrocarbons (e.g., toluene/*n*-heptane and *n*-heptane/methylcyclohexane) suggest that they were not affected by evaporative fractionation process. Great linear relationships between the carbon number and the log of mole fraction for *n*-alkanes support none alteration of the fractionation process. Correlation between concentrations of 3- + 4-methyldiamantane and stigmastane 20R indicates that they were not severely cracked and probably at the beginning or early stage of intense oil cracking. Thermal maturity parameters C₂₉ sterane 20S/(20S + 20R) and $\beta\beta/(\beta\beta + \alpha\alpha)$ of these oils have reached their equilibrium points while a good linear relationship between the concentrations of terpanes and steranes suggests variations in maturity among them. Calculated vitrinite reflectance of source rocks based on phenanthrene and diamondoid hydrocarbons ranges from 0.8 to 1.1% and 1.2 to 1.5%, respectively. Their differences may reflect multiple oil charges to these deep oil accumulations. A narrow range of $\delta^{13}\text{C}$ values of whole oil and oil fractions suggest a genetic correlation among these oils. Triangular plots based on C₆- and C₇-hydrocarbons and diamantanes indicate a very similar source which appears to be a main shale/mudstone source with significant marine type II organic matter inputs. Values of pristane/*n*C₁₇ and phytane/*n*C₁₈ and several other ratios based on tri-, tetra-, and pentacyclic saturated hydrocarbons (e.g., C₂₂/C₂₁, C₂₄/C₂₃, and C₂₆/C₂₅ tricyclic terpane) support the genetic correlation of these oils. On the other hand, the oil SB7 seems to differ from the residuals in terms of the redox condition and availability of reactive sulfur of source rock environments, indicated by its much higher pristane/phytane ratio and lower dibenzothiophene/phenanthrene ratio as well as lower concentrations of dibenzothiophenes.

References

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