

Timing and Extent of Oil Generation in the Zubair Formation, Southern and Western Iraq: Results from 1D Petroleum System Models and Geochemical Analysis

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One-dimensional (1D) petroleum system modeling and organic geochemical analysis were performed using well data from four giant oil fields in southern Iraq (Zubair, Nahr Umr, West Qurna, and Majnoon) and Kifl in western Iraq to determine the timing and extent of petroleum generation in the Lower Cretaceous Zubair Formation. The formation consists of interbedded dark-gray shales and porous and permeable (19-28%; 80-2500 mD), fine- to coarse-grained sandstones that were deposited in a deltaic environment. A maximum temperature of 120°C was reached at depths varying from approximately 3100-3800 m after continuous burial. Shales in the Zubair Formation have TOC contents from 0.5-7.0 wt%, T_{max} values from 430-470, and hydrogen indices as high as 466. The S₂ peak varies from 0.4-9.4 of kerogen Type II and Type III, and the petroleum potentials (0.4-9.98) are consistent with 55-95% hydrocarbon efficiency. Sulfur contents of the organic matter range from 1.5-2.18%. Oil biomarkers show a mixed oil source from Upper Jurassic and Lower Cretaceous strata, which includes the Zubair Formation. The 1D model results indicate that petroleum generation in the Zubair Formation began in the Miocene, about 10 Ma, and charged reservoirs that formed from 15-10 Ma. Transformation ratios (TR) based on Type IIS kerogen kinetics reveal that 65% of the petroleum generation potential has been reached in Zubair field, 75% in Nahr Umr field, 55-85% in West Qurna field, and completion (95%) in Majnoon field. In Kifl field, the Zubair Formation generated only 12% of its oil. In all fields, source rocks younger than the Zubair Formation are immature to early mature (TR <20%), whereas source rocks older than the Zubair are mature to overmature (TR >99%).