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Unveiling Compartmentalization, Intricate Filling Histories, And Operational Oil Changes From EOR Techniques Through Advanced Multivariate Geochemical Fingerprinting In A Mature Abu Dhabi Oilfield, UAE

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1 ADNOC Onshore

[2] Stratum Reservoir

Theory / Method / Workflow

The aim of this study was to evaluate reservoir continuity and filling history of the mature oilfield using innovative oil geochemical fingerprinting technology and chemometrics on produced oils from new step-out wells, taking into account oil alteration due to WAG and CO2 flood operations. The oilfield located in Abu Dhabi is a stratigraphic anticlinal accumulation hosted by multiple stacked pay zones, separated by a major fault. Recently, step-out appraisal wells were drilled up-dip to the northwest to assess contingent resources potentially trapped against the fault and into a downdip fringe resource to the southwest of the main field

Samples were analyzed for molecular geochemical fingerprints (GCMS, HRGC, isotopes) and statistically assessed (PCA and HCA) for reservoir continuity and charge history. The northwest (Well A) and southwest (Well B) step-out areas, crest and southwest of the main field (across the minor fault from Well B), and additional wells across the main field were sampled from production separators. Two scenarios were considered: Light HC compounds affected by WAG (nC8-nC19) and those likely unaffected (nC11-nC20). All samples were moderate maturity oils, showing evidence of WAG/CO2 operation alteration, production fractionation, and variability in thermal maturity. Long-term WAG had stripped lighter hydrocarbons, so these assessments were limited to C11-C20 inter-paraffin peaks.

Results, Observations, Conclusions

HRGC, GCMS, and isotope data indicate that all oils are genetically similar, with marginally higher thermal maturity observed in crestal wells compared to the rest of the main field oils. Southwestern oils exhibit notably lower thermal maturity and greater alteration due to WAG operations, likely attributable to thinning of pay and proximity to the FWL. Well A oil displays slightly lower maturity than the oil from the nearest well in the main field, indicating a potential fill and spill scenario up-dip. Similarly, Well B oil is less mature than the southwestern oils nearby, confirming fill-and-spill and more substantial alteration. The vertical compositional grading and maturity variations of genetically similar oils suggest charge stacking and incomplete vertical fluid equilibration across the field. However, Well A and B oils do not show hydraulic

connectivity to the main field reservoirs to the east. Main field and nearby fields are considered compositionally homogeneous and laterally connected, representing "classic" conventional petroleum accumulations. The compositional grading identified statistically in the geochemical fingerprints of this study has assisted to define both geological controls on fluid quality and the effects of enhanced oil recovery.

Novel/Additive Information

Compositional variations and compartmentalization in the Rumaitha field were linked to geological and operational processes through simple and cost-effective geochemical analysis. This study's findings enhance exploration, resource recovery, and well planning. Integrating geochemical data with geological models benefits exploration and field development throughout a field's life cycle

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