ABSTRAK

IDENTIFIKASI ZONA PROSPEKTIF HIDROKARBON, ESTIMASI SUMBER DAYA, DAN ANALISIS RISIKO GEOLOGI FORMASI WARDAN, CEKUNGAN LAUT MERAH SEKTOR SUDAN

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Kegiatan eksplorasi hidrokarbon pada cekungan *rift* memerlukan evaluasi terpadu untuk mengurangi ketidakpastian geologi dan meningkatkan peluang keberhasilan eksplorasi. Cekungan Laut Merah sektor Sudan merupakan bagian dari *system rift* aktif yang memiliki potensi hidrokarbon signifikan, tetapi belum terkarakterisasi secara optimal. Formasi Wardan dipilih sebagai objek penelitian untuk mengevaluasi karakteristik reservoir, keberfungsian sistem petroleum, serta identifikasi zona prospektif yang berpotensi mengandung akumulasi hidrokarbon.

Penelitian dilakukan melalui pendekatan kualitatif dan kuantitatif. Analisis kualitatif meliputi interpretasi litologi, fasies, dan lingkungan pengendapan. Analisis kuantitatif mencakup evaluasi petrofisika untuk menentukan volume serpih, porositas efektif, dan saturasi air. Dilakukan pula integrasi data sumur dan seismik melalui *well seismic tie* dan penarikan *fault* serta *horizon* guna menghasilkan peta struktur waktu dan peta struktur kedalaman. Zona prospektif kemudian ditentukan berdasarkan keterdapatan *lead* dan area prospek, dilanjutkan dengan estimasi sumber daya menggunakan pendekatan probabilistik, serta evaluasi risiko geologi untuk menentukan peluang keberhasilan eksplorasi.

Hasil penelitian area prospek Wn 1, Wn 2, Wn 3, dan *lead* Wn 4, menunjukkan bahwa variasi potensi gas dan gas kondensat signifikan antar skenario sumur D-1 *(dry hole)*, sumur S-1 *(discovery)*, dan skenario dengan nilai rata-rata. *Lead* Wn 4 merupakan potensi sumber daya terbesar dan risiko geologi paling optimal. Pada skenario S-1, *Gas Initially In Place* (GIIP) sebesar 1,178,630 MMSCF, *recoverable gas* 765,643 MMSCF, dan *recoverable liquid* 128,563,431 STB, sekaligus memiliki probabilitas keberhasilan tertinggi (Pg 0.1339) dengan kategori *moderate risk*.

Kata kunci: evaluasi risiko, Formasi Wardan, Laut Merah, sektor Sudan, sumber daya.

ABSTRACT

IDENTIFICATION OF PROSPECTIVE HYDROCARBON ZONES, RESOURCE ESTIMATION, AND GEOLOGICAL RISK ANALYSIS OF THE WARDAN FORMATION, RED SEA BASIN (SUDAN SECTOR)

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Hydrocarbon exploration activities in rift basins require integrated evaluation to reduce geological uncertainty and increase the probability of exploration success. The Red Sea Basin Sudan sector is part of an active rift system that has significant hydrocarbon potential which has not been optimally characterized. The Wardan Formation was selected as the object of this study to evaluate reservoir characteristics, petroleum system functionality, and to identify prospective zones.

Quantitative analysis included petrophysical evaluation to determine shale volume, effective porosity, and water saturation as reservoir quality parameters. Qualitative analysis involved interpretation of lithology, facies, and depositional environment. Well and seismic data integration was also carried out through well seismic tie and fault and horizon picking to generate time structure maps and depth structure maps. Prospective zones were identified based on the presence of leads and prospect zones. This was followed by probabilistic resource estimation and geological risk evaluation to determine the probability of exploration success.

The results indicate that prospect zones Wn 1, Wn 2, Wn 3, and lead Wn 4, demonstrate significant variations in gas and gas-condensate potential across the well D-1 (dry hole), well S-1 (discovery), and average value scenarios. Among these, lead Wn 4 represents the best resource estimation. Under the S-1 scenario, yields a Gas Initially In Place (GIIP) of 1,178,630 MMSCF, recoverable gas of 765,643 MMSCF, and recoverable liquid of 128,563,431 STB, while also showing the highest probability of geological success (Pg 0.1339) within the moderate risk category.

Keywords: *geological risk, Wardan Formation, Red Sea, Sudan sector, resource estimation.*