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Petroleum System Modeling and Risk Assessments of Ad'daimah Oil Field in Mesan Governorate

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SUMMARY

This study is concerned with Jurassic – Cretaceous succession of oil field called Ad'daimah (local Arabic word meaning rainy clouds and might be abbreviated to Dima field) to explore the hydrocarbon potential in the Ad'daimah structure that formed mainly by salt diapir of the pre-Cambrian Hormz Formation. The sedimentary column thickness of Jurassic comprises up to 1100m, and 500-700m of lower Cretaceous.

Extended Abstract

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Oil biomarkers and isotope values, of the analyzed samples from the Saadi and Yamama Formation reservoirs of Santonian and Valanginian ages respectively from well Da-1 as well as Yamama Formation extracts are plotted on sterane triangle, hopane diagram, tricyclic terpane diagram, Pristane to phytane ratio with canonical variables, δC_{13} saturate and aromatic, and pristane-phytane diagrams have indicated source environment and lithology of marine algal type II that are non biodegraded and deposited in anoxic environments of carbonate and shale. Source maturation at the time of the oil generation are assessed by plots of oil and Yamama source rocks analyzed values on pristane-phytane diagram indicate mature with T_{max} equivalent of 435°C based on plots of MDR (Methyldibenzothiophene ratio) and vitrinite reflectance of $R_o = 0.70-0.85$ based on MPI (Methylphenothrene ratio). Source age assessment are taken from δC_{13} (‰) and the calculated C28/C29 sterane ratio which indicate early Lower Cretaceous age. The Yamama Formation Showed in this study excellent hydrocarbon potential with extracted organic matter of up to 16674 ppm of TOC equivalent of 16.64 wt%. Correlation of the analysis data from Ad'daima field with other oil fields in Mesan Governorate indicate same characters and clustered in one place in all the diagrams but the source age are showing two oil families that the first is source from Upper Jurassic- Lower Cretaceous as the case in Ad'daimah Field while the second is sourced from Middle and Upper Jurassic as the case in Halfaya field.

Source-oil correlation are confirmed in this study by plots of values from the analysis of Saadi and Yamama oil of well Da-1 with the extracts from the Yamama-Sulay Formation in isotopic δC_{13} saturate and aromatics, calculated C28/C29 sterane ratio diagram, sterane triangle and MPI versus R_o . These showed grouping of the oil and extracts of the analyzed data into one place of environmental, maturation and age characters that indicate the very good correlation with excellent hydrocarbon generation from the Yamama formation that measure up to 16674 ppm extracted organic matter. Petromod software basin modeling has confirmed hydrocarbon generation from the Yamama Formation under burial thermal temperature of 114-120°C with 285- 300 mgHC/gTOC for 95% hydrocarbon transformation from the disseminated organic matters with critical point of hydrocarbon migration and accumulation at 10 million years ago. Palynomorphs have indicated ages of Valanginian-Berriassian for the Yamama and Tithonian-Berriassian for the Sulay Formations.

Marking places of source rocks and oil reservoir on seismic section across well Da-1 for the Jurassic and Cretaceous strata have showed model assessments of the hydrocarbon generation places of the Yamama Formation, migration pathways and accumulation site as well as places of enriched oil to assess reservoir sites and suggestion for risk assessments of drilling sites for hydrocarbon production from the Yamama and Saadi Formations. On the other hand, seismic sections in Halfaya and Buzargan field showed hydrocarbon migration from the Sargelu Formation.

It have been concluded from this article the followings:-

- 1- Oil-source correlation could be performed between Yamama and Sa'adi Formations oil with organic matter type, environment of deposition, enclosed lithology, maturity and age of Yamama Formation especially for the Ad'daimah oil field and this case might be repeated in other oil fields of Mesan Governorates.
- 2- Oils of Ad'daimah Field is belonging to one family, and these oils are of non- biodegraded, marine, and non-waxy which derived from carbonate and marl rocks deposited in marine environment.
- 3- Yamama Formation is a source and reservoir rocks at the same time with high quantity of oil.
- 4- The seismic section in Ad'daimah Oil Field shows the occurrence of fractures and faults which act as a pathways for horizontal and vertical migration of hydrocarbons from late Jurassic - early

Cretaceous Sulaiy and Yamama Formations source rocks to the Cretaceous reservoirs of the Yamama, Zubair, Nahr Umr, Mishrif, Sa'adi and Hartha Formations.

5- Disseminated organic matter of Ratawi, Yamama and Sulaiy Formations are mature with high (excellent economically) hydrocarbon generation and expulsion to the reservoirs. The Zubair Formation is transitional mature with intermediate (economic) hydrocarbon generation with no expulsion and hence stored in the same formation while the formations above Zubair Formation such as Nahr Umr and Shuaiba Formations are of immature with low (non economic) hydrocarbon generation.

6- Fuzzy places, maturation and hydrocarbon pathways in the seismic section of figure confirm reservoirs in Najmah, Yamama, Ratawi, Nahr Umr, Mishrif and Saadi Formations.

Key words: Oil Biomarkers, Isotopes, Extract Organic Matters, Ad'daimah oil field, Petroleum System, Migration path, Risk assessment, South Iraq.

Figure 1: Location maps of oil and gas fields of Mesan Governorate in South Iraq.

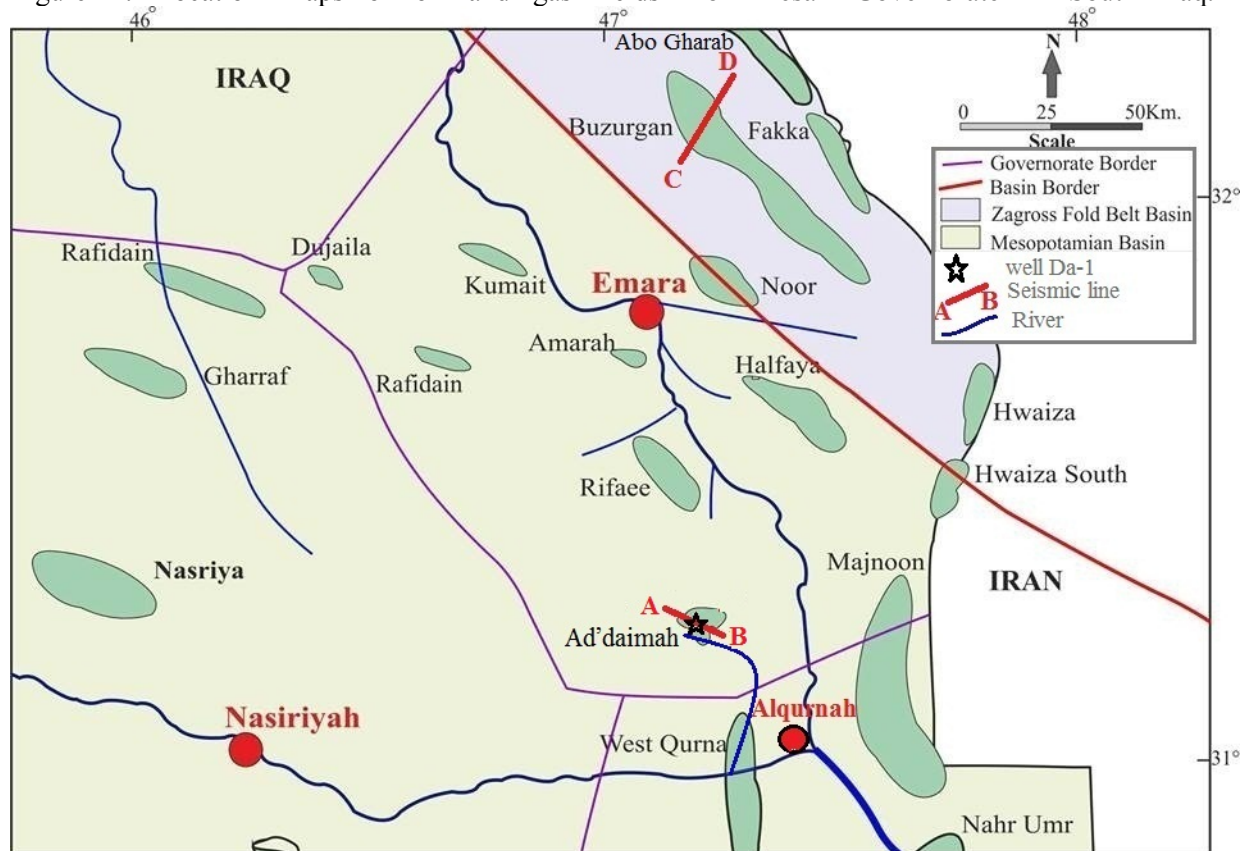


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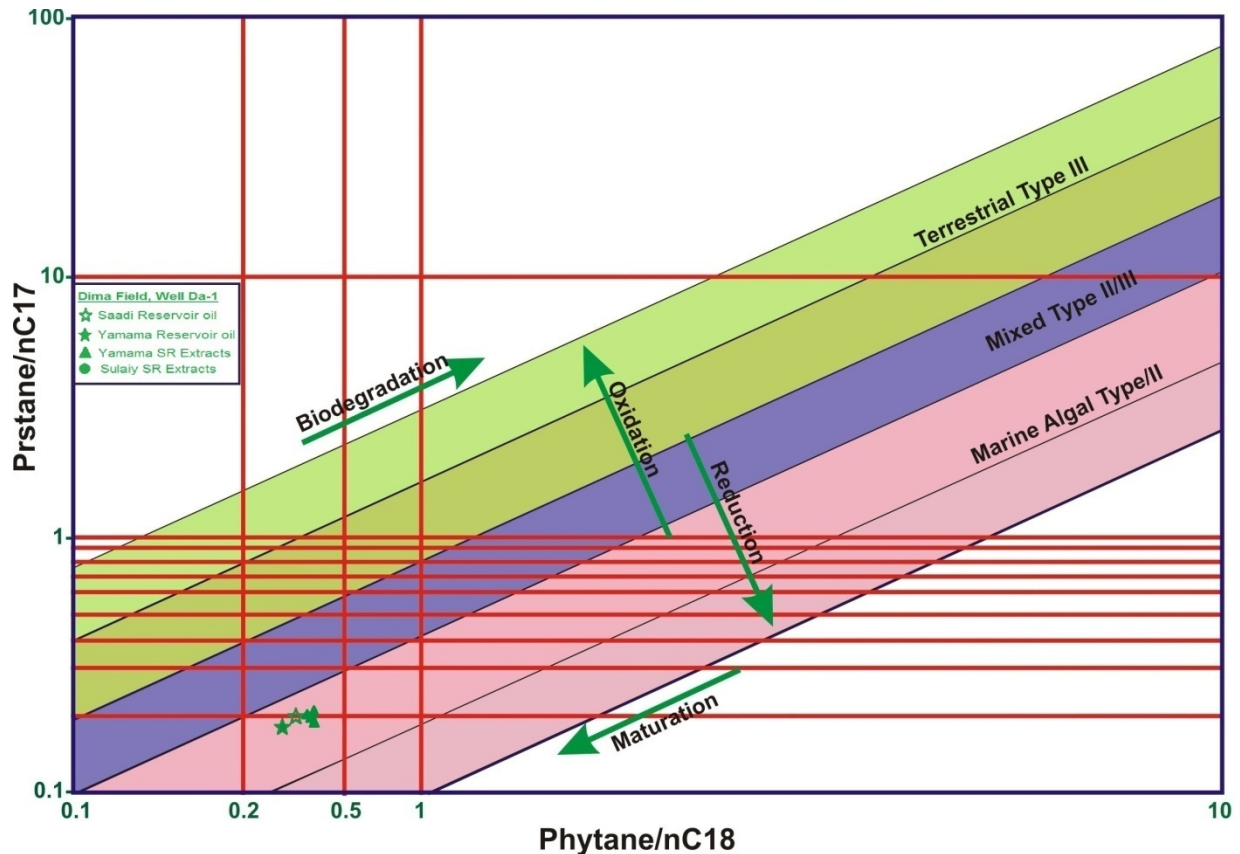


Figure 2 Maturation and organic types diagram represent Plots of pristane- n C_{17} versus phytane- n C_{18} (after Peters et al., 2005) for Cretaceous oils and Yamama Formation extracts from the studied wells in Ad'daimah Field (well Da-1). The plots indicates that the oils from the reservoirs are mature, not biodegraded, and are derived from marine algal organic matter of kerogen Type II and III, deposited in a reducing environment.

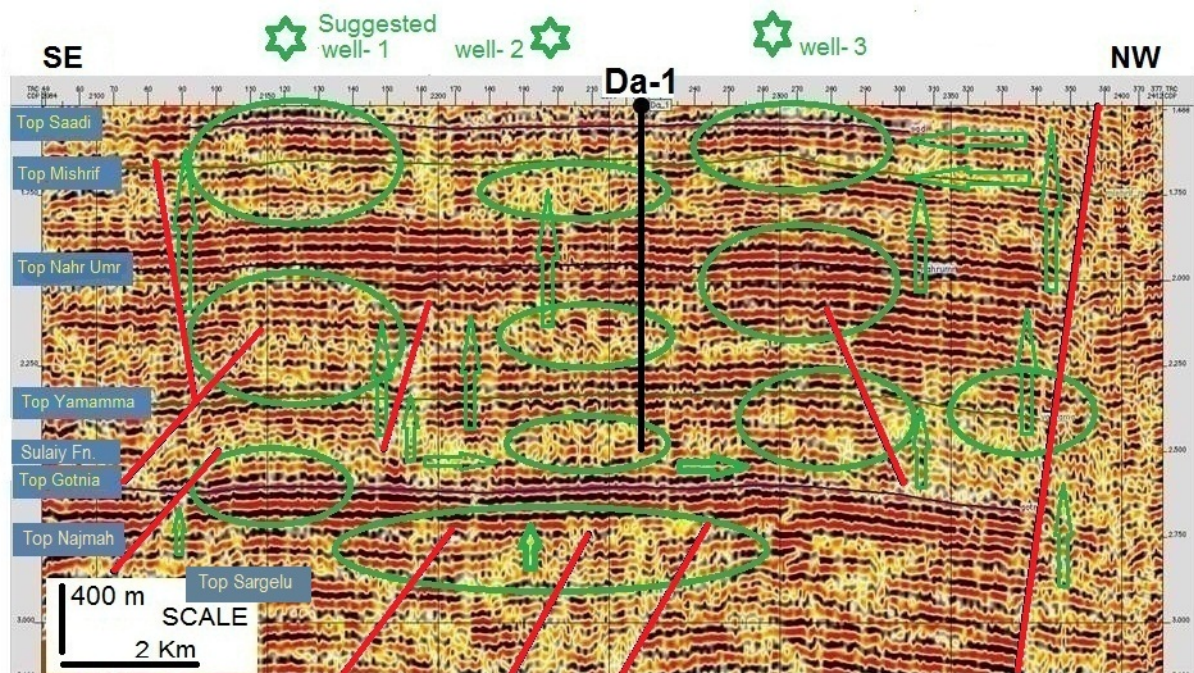


Figure 3 Seismic section of Ad'daimah Field along well Da-1 in NW-SE direction and 18 Kilometers traverse illustrating stratigraphic tops of formations and faults showing, by arrows, the hydrocarbon migration pathways from the Yamama Formation, with accumulation sites for suggesting production wells in the reservoirs of Yamama, Nahr Umr, Mishrif and Sa'adi Formations.