



Cyclo-sequence stratigraphy of siliciclastic-carbonate mixed facies of the Upper Cretaceous system in Southeast Mediterranean and its impacts on the hydrocarbon reservoir potentiality

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BY

FARAG SHABBAN AHMED SOLIMAN

B.Sc. in Geology, Cairo University (Fayoum Branch)

M.Sc. in Geology, Fayoum University

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Thesis Title:

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By

Farag Shabban Ahmed Soliman

Supervision Committee:

Prof. Dr. Ahmed Gaber Shided (Main Supervisor)

President of Fayoum University and Professor of Geology,
Geology Department, Faculty of Science, Fayoum University.

Prof. Dr. Mohamed Said Abu Elghar

Vice- President of Fayoum University and Professor of Sedimentology,
Geology Department, Faculty of Science, Fayoum University.

Prof. Dr. Mohamed Darwish

Professor of Sedimentology and Petroleum Geology, Geology
Department, Faculty of Science, Cairo University.

Prof. Dr. Micheal Pope

Head of Geology & Geophysics Department, Texas A&M University and
Professor Carbonate Stratigraphy.

8. Summary and Conclusion

The study area lies east to west of the Nile River, bounded by latitudes $28^{\circ} 23'$ - $29^{\circ} 09'$ N and longitudes $29^{\circ} 06'$ - $30^{\circ} 53'$ E in Qarun, Wadi El-Rayan and Beni-Suief oil fields that considered one of the focal prospective portions for petroleum exploration in Egypt. Stratigraphically, the study sequences includes The Abu Roash Formation in nine subsurface wells Qarun 2-2, Qarun-17 and Qarun-18, Wadi El-Rayan 2X, Wadi El-Rayan 5X , Wadi El-Rayan 6X, Beni Suief -1X and Beni Suief 6X. The Abu Roash Formation is of Cenomanian-Turonian age and subdivided into seven members; A, B, C, D, E, F and G Member that are recorded in all studied wells except in Qarun-17 well as C and D Members are absent from the succession. The raw data of the selected wells, include well logs, well tops, mud logs, several ditch cutting samples, core, and paleontological reports.

Based on the high resolution biostratigraphic zonation of the studied wells the definition of foraminiferal and Palynozones have been adopted for the study sequences. These have also been calibrated with the equivalent biostratigraphic schemes of the Western Desert. There are some wells with no bio-data and accordingly, their cyclog pattern and cycles definition have been interpreted and correlated with the results reached in other wells.

The CycloLog® software program has been applied in the study areas using the Gamma Ray log of the concerned sequences. The PEFA patterns and INPEFA curves of Abu Roash Formation supported the definition and distinction of eight 3rd order cycles UZA-2 (2.2, 2.3, 2.4, 2.6 and 2.7) and UZA-3 (3.1, 3.2 and 3.3). These cycles could be divided into high order cycles 2.3 (2.3.1, 2.3.2 and 2.3.3) sub-cycles, 2.4 (2.4.1 and 2.4.2), 2.5 (2.5.1 and 2.5.2), 2.6 (2.6.1 and 2.6.2), 3.1 (3.1.1, 3.1.2 and 3.1.3) and 3.2 (3.2.1 and 3.2.2) sub-cycles. This study is focused on discussion of Members and some of "F" The Abu Roash "G" and Abu Roash their cycles (2.4.1, 2.4.2, 2.5.1 and 2.5.2) due to their importance as source rock and reservoir units.

were "G" The sedimentary sequences of Abu Roash identified by the analysis of the different lithofacies types being recorded in the cored intervals in Wadi El-Rayan 6X well. The overall view revealed the recognition of the following facies groups: sandstone facies group, mudstones facies group and heterolithics facies group, under which some facies types could be distinguished with some other facies types as Conglomerates (Gms and Gmc), Coal (C) and Limestone (L).

The facies associations of the studied successions combined indicate to "G" with cyclicity evolutionary trends of Abu Roash

tidally-dominated estuarine environment with six genetic units, namely, sand-dominated tidal flats, mud-dominated tidal flats, tidal channel, tidal bar, swamp and lagoon. The Sand-dominated tidal flat, Mud-dominated tidal flat and Tidal channels are the main genetic units of Cycle 2.4.1 however, the tidal bar, lagoon and swamp are the most genetic units in Cycle 2.4.2.

The lithofacies types recorded within the analyzed carbonates cored intervals in Cycle 2.5.1 and 2.5.2 of Abu Roash Member are lime Mudstone (**M**), Wackestone (**W**), Packstone "F" (**P**), Grainstone (**G**) and Laminated shale (**MI**) that interpreted to have been deposited in a wide, open marine shelf probably the middle-shelf zone and the the shale intervals may represent prevalence of lagoonal conditions as a result of ephemeral drop in the sea-level.

"G" The Petrographic investigation of the Abu Roash Member revealed that The sandstone facies in the cycle 2.4.1 is a quartzarenite/quartzwacke complex in the lower and middle parts while most upper part facies is mainly subarkose. The sandstone in Cycle 2.4.2 ranges from feldspathic quartzarenite to subarkose with fresh and altered plagioclase. Most samples of Abu Roash Member contain variable proportions of mica flakes and minor "G" proportions of mica schist rock fragments. This may indicate that mica schist and phyllites were among the source rocks for the studied successions. The main diagenetic alterations of the studied

rocks of Abu Roash "G" Member are: Compaction, Pressure solution, Silica Cementation, Calcite Cementation, Mineral Replacement and Mineral Authigenesis.

The thin-section petrographic investigation of the Abu Roash "F" Member samples indicates that the limestone facies in cycle 2.5.2 of Abu Roash "F" Member are with wackestone and packstone texture while cycle 2.5.2 is made up of bioclastic limestone of wackestone texture grading downwards into argillaceous lime mudstone. The allochems are dominated by medium to fine calcarenite-sized, moderately sorted, moderately rounded bioclasts of planktonic foraminifers such as globs, *Hedbergella* sp. and *Heterohelix* sp. forams. The main diagenetic alterations of the studied carbonates of the Abu Roash "F" Member are cementation, compaction, pressure solution and neomorphism.

The geochemical analysis results of Wadi El-Rayan 6X well in the intervals of Cycles (Cycle 2.5.1 and 2.5.2) refers to that The cycle 2.5.1 is the lower part of AR/F member is characterized with low TOC, high density, low GR and low in density, while cycle 2.5.2 has high TOC, low density, high GR and high resistivity.

The reservoir possibilities of Cycle 2.4.1 sandstones of Abu range between 16 to 25%. The net pay thickness ranges "G"Roash

from 3 to 32.5m. The porosity of the Cycle 2.4.2 sandstones ranges from 18 to 22% and the net pay thickness ranges from 2.5 to 17m. Generally, Cycle 2.4.1 are of moderate to good reservoir qualities and Cycle 2.4.2 are of moderate quality.