Petrography and Formation Evaluation of the Bahariya Reservoir, Yasser Oil Field, Western Desert, Egypt.

A Thesis Submitted for Partial Fulfillment of the Requirements of the Master Degree in Science in "Geology"

By

Amr Moustafa Abdelaziz Abuzeid

(B. Sc. in Geology-Chemistry, Faculty of Science Ain Shams University, 2009)

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NOTE

The present thesis is submitted to the Geology Department, Faculty of Science, Ain Shams University for partial fulfillment of the requirements of the Master degree in Science in Geology.

Beside the research work materialized in this thesis, the candidate has successfully passed the final examinations of the post-graduate courses covering the following topics:

1. Field Geology and Geostatistics.
2. Sedimentary Petrology and Sedimentation.
3. Mineralogy and Geochemistry.
4. Igneous Petrology and Metamorphic Petrology.
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DEDICATION

This work is dedicated

To Allah and I hope to Accept it from me

To my Parents

To my wife

To my brothers

ABSTRACT

Bahariya Formation is a complex thinly bedded sequences which is difficult to characterize using wireline logs only. This study defines the petrographical and petrophysical characteristics of the formation in Yasser oil field which is located between Longitudes 26° 57' 28" and 26° 59' 60", and Latitudes 30° 37' 54.85" and 30° 39' 27.63", about 80 km south of Matrouh city, Western Desert, Egypt.

In case of petrographic characteristics, core photos of selected intervals were demonstrated thin stacked sequences of sandstone, siltstone, shale and limestone. The sandstone is described as greenish grey, very fine to fine grains, well sorted, variable bioturbation, ripples and wavy argillaceous lamination. The investigated cored sandstones display vertical stacked sanding up with cleaner and rippled sandstone at the top, grading down to dominantly mud laminated sandstones, sideritic nodules and glauconitic lamina are observed. Core photos also exhibit the place where samples were taken with respect to surrounding layering and microstructure.

The representative sandstone samples under investigation which were obtained from upper Bahariya of wells Yasser-6 and Yasser-4, were examined by thin section and scanning electron microscopy. They are classified within three facies types, quartz arenite, subarkose, and phosphatic lithic arenite. The first consists mainly of quartz grains with minor k-feldspar, pyrite aggregates and glaucony pellets. These grains are very fine sand size and well sorted. The detrital components of this rock are well bounded by argillaceous matrix and lozenges of siderite. Some parts show highly glauconitic lamina. Three subtypes of quartz arenite were found,

siliceous, argillaceous and sideretic argillaceous quartz arenite. The subarkose differs from the quartz arenite by high percentages of k- feldspar, two subtypes of subarkose were found, glauconitic calcareous subarkose and dolomitic argillaceous subarkose. Phosphatic lithic arenite characterized by abundance of phosphatic fragments and quartz grains, k-feldspars are less common.

Electrical logging tools used in the study for all studied wells are gamma ray, caliper, bit size, deep, medium and shallow resistivity, density, neutron, photoelectric curves. Sonic logs were recorded in only two wells. The tools were proceeded through different intervals inside Bahariya Formation in the studied wells, thus after correlation, the common equivalent interval between them is the upper Bahariya plus the first 150ft of the lower Bahariya, where petrophysical investigation considered. The investigation occurred firstly by crossplot relations. Secondly by calculating petrophysical parameters and displaying their value variations vertically and horizontally. These petrophysical parameters are total porosity, effective porosity, shale volume, gross sand, net pay, flushed zone saturation, water saturation and hydrocarbon saturation. Two crossplot relations were performed on the upper and lower units of Bahariya reservoir to identify lithology. Density/ Neutron Crossplots which were performed in the four wells show that the majority of plotted points are between sandstone and limestone lines, the shale effects are in the southeast quadrant of the crossplots. The other relation indicates lithology clearer, because it combines all three porosity logs to provide the lithology – dependent quantities (M and N). M/N crossplots show that the majority of points are distributed to fill the space between quartz and calcite regions, but closer toward quartz, it also indicates the presence of secondary porosity. The vertical distribution illustrates lithology and fluid content. The reservoir is

composed of sandstone and siltstone as a major lithological constituent with appearing layers of shale and carbonate. Lithology tend gradually to be more shaly and calcareous at the expense of sandstone toward deeper depths. Maximum flooding surface separates the two units (upper and lower Bahariya). The hydrocarbon saturation in upper Bahariya is found to be good in Yasser-46 and Yasser-6, fair in Yasser-4, and very low in Yasser-44 well. Oil saturation is abundant in lower Bahariya in Yasser-6 and Yasser-46. Horizontal distribution of parameters were mapped for upper and lower Bahariya separately. These iso-parametric maps illustrate the lateral variation, consequently offer the most favorable parts for oil accumulation, it is recommended to drill other development wells due east of the study area.

The petrographically- investigated sandstone facies of the reservoir revealed the presence of various cementation types and mineral association that reflected in petrophysical crossplots, and logs. The recorded abnormal gamma ray (GR) response in the sandstone of the Bahariya Formation is related to the abundance of glauconite and k- feldspar in almost all investigated samples. M/N and Density/ Neutron crossplots derived from litho-porosity logs of the studied formation suggest the presence of calcareous cement and argillaceous matrix. Fe- bearing minerals like glauconite, chlorite, pyrite and siderite which were found in the investigated thin sections have a great rule for raising the density responses toward sandstone. The abundance of argillaceous laminate or matrix in the studied sandstone significantly raises the Neutron curve and enlarges the difference between the effective porosity and total porosity as well. Secondary porosity derived from the M/N crossplots is clearly reflected in the studied samples as a result of dissolution of k- feldspar and glauconite.

LIST OF CONTENTS

SUBJECT **PAGE NO.**

LIST OF FIGURES

Figure No. **Page No.**

LIST OF TABLES

Table No. **Page**