AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE
GEPHYSICS DEPARTMENT

PETROPHYSICAL CHARACTERISTICS OF THE NUBIA SAND STONE: GEBEL ABU HASSWA, SOUTH WESTERN SINIA, EGYPT

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

BY
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(B. Sc. in Geophysics, 2014)

To

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Cairo, 2019

Note

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

Beside the research work materialized in this thesis, the candidate has attended ten post-graduate courses for one year in the following topics:

1) Geophysical field measurements.
2) Numerical analysis and computer programming.
3) Advanced Well Logging.
4) Formation Evaluation.
5) Physical properties of rocks.
6) Basin analysis.
7) Subsurface geology.
8) Geophysical exploration.
9) Reservoir evaluation.
10) Fluid dynamics.

He successfully passed the final examinations in these courses.

In fulfillment of the language requirement of the degree, he also passed the final examination of a course in the English language.

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Approval Sheet

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Acknowledgment

In the beginning, I want to thank Allah, what was a good deed is from Allah and what was bad is from me.

I wish to thank **Dr. Abdel Moktader A. El Sayed** Professor of Petrophysics, Geophysics Department, Faculty of Science, Ain shams University for his valuable comments and supporting me to produce the best in this thesis.

I wish to thank **Dr. Salah El Din Abd El Wahab** Professor of Petrophysics and Electricity at Geophysics Department, Faculty of Science, and Ain shams University for his valuable comments and sharing his precious time to reviewing and leading his comments in this thesis.

I want to thank **Dr. Nahla A. El Sayed** assistant professors in geophysics department (Exploration division), EPRI, for her helpful suggestions in the planning of this study.

I would like to express my sincere thanks to **Dr. Mohamed Kassab** Professor of Petrophysics, Department of Exploration, Egyptian Petroleum Research Institute for his valuable comments and sharing his precious time to reviewing and leading his comments in this thesis.

In addition, I appreciate the helping of **Dr. Abeer Ahmed** assistant professors in Petrophysics, EPRI, in petrographical description problem.

Finally, I appreciate the helping of **Moataz Mohamed** Lecturer Assistant, Geophysics Department, Faculty of Science, Ain shams University, for sharing his precious time to teach me software skills.

A special thanks to **Dr. Mohamed Maher** Department of Geology, Faculty of science, Zagazig University for helping in sampling Acquisition, preparation and handling.

Dedication

I would like to dedicate my work to my parents, my sister, my dear Husband, my daughter and my son whose love, help and support kept me going.

Abstract

This study is used to investigate the relationships between different geological attributes and petrophysical properties in order to detect the different rock types using various techniques such as HFU, EFU, and measured petrophysical parameters for the Paleozoic (Nubia sandstone) rocks, they are presented by Araba, Abu Durba, and Ahemir, and the Lower Cretaceous rocks represented by Malha Formation in Southwestern part of Sinai, Egypt.

The sedimentological features of the Nubia sandstone in the Abu Hasswa section were discussed using petrography, X-ray diffraction analysis, and the previous results of scanning electron microscope (SEM). The correlation between petrography and XRD results concluded that the samples had been suffered from dissolution process that caused increasing porosity. In addition to, the cementation process with various types of cements like silica overgrowth, ferruginous, and calcite minerals are investigated.

In the present work, fifty (51) rock samples were obtained, where thirty-two samples from Araba Fm, 3 samples from Abu Durba Fm, 10 samples from Ahemir Fm, and 6 samples from Malha Fm. The investigation of these samples reveal that the Nubia sandstone samples reflect high storage and flow capacity properties at some intervals, while in other some intervals show fair to bad storage and flow capacity properties. The hydraulic flow unit (HFU) discrimination was carried out based on permeability-porosity empirical relationship. the diagenetic processes have an important role to enhance or reduce the pore size and controlling the petrophysical behavior.

The porosity measurements of the samples of Abu Hasswa section showed that the porosity of the Paleozoic rocks of Abu Hasswa are varied from 2.69 to 29.6 % with mean value of 21.3 % and standard deviation of 5.367 %, variance value of 28.8 %, and median value of 22.4 %,while the permeability measurements of the samples of Abu Hasswa section showed that the permeability of the Paleozoic rocks of Abu Hasswa are varied from 0.0013 to 4027.66 md with mean value of 877.7 md and standard deviation of 1030.02 md, variance value of 1060943.74 md, and median value of 602.1 md, The results were collected together to build-up different petrophysical models. The petrophysical models were represented in cross plots between the different petrophysical properties, in which the reservoir facies and petrophysical properties can be imagined. Such models can support the detection of the potentiality of Paleozoic rocks to acquire different economic fluids.

Electrical properties of sedimentary rocks depend on the pore geometry, chemical and physical properties of rock-forming minerals, and fluid type and saturation and rock type. In this study, the electrical resistivity (ρ) measurements were carried out on 46 samples of Abu Hasswa section to estimate formation resistivity factor and cementation exponent (m). The relationship between porosity- formation resistivity factor redrawn using the electrical flow unit discrimination technique. This study indicates five HFU of different rock qualities, on the other hand it found three EFU. This differences in flow units' number was driven due to the effect of diagenetic processes represented by the cementation process of iron oxides that might act like pore bridges for electrical current.

Sonic wave velocity was measured for all studied samples with calculation of different elastic moduli and their relations with sonic wave velocities, such as Young's modulus (E), uniaxial stress state, shear wave modulus (μ), Poisson's ratio (σ), Bulk modulus (K), and Lame's constant (λ). The compressional have mean values of samples of Malha Fm, Araba Fm, Abu Durba Fm, and Ahemir Fm are 2.76, 2.26, 3.63, and 2.28 m/sec, while shear wave velocities have mean values of samples of Malha Fm, Araba Fm, Abu Durba Fm, and Ahemir Fm are 1.7, 1.59, 2.37, and 1.59 m/sec respectively. Each sample is attached to the P-Wave and S-Wave transducers to get V_P and V_S, and further leads to the calculations of the dynamic elastic properties of the different rock samples. The elastic parameters revealed that there is a significant relationship to the nature of rocks and the diagenesis processes of the study samples,

Finally, this research used the correlation between the different petrophysical parameters and the concluded sedimentological discrimination to construct multi regression models to predict the different petrophysical parameters with high correlation coeeficients.

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