

**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

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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.

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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 Lamé's constant (λ). The compressional wave velocities 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 coefficients.

CONTENTS

Subject	Page No.
Acknowledgment.....	III
Abstract.....	V
CONTENTS.....	VIII
LIST OF FIGURES.....	XII
LIST OF PLATES.....	XV
LIST OF TABELS	XV

CHAPTER ONE : INTRODUCTION

1. Literature Review of Geology.....	1
2. Objective and Aims of the Study.....	6
3. Methodology.....	7
4. Summary	7

CHAPTER TWO : PETROGRAPHY AND MINERALOGY

1. Lithostratigraphy.....	8
2. Petrography.....	11
2.1. Quartz Arenite.....	11
2.1.1. Calcareous Quartz Arenite	12
2.1.2 Ferruginous Sandstone.....	12
2.1.3. Highly Ferruginous Quartz Arenite	13
2.1.4 Siliceous Quartz Arenite.....	13
3. Scanning Electron Microscope (SEM).....	19
4. X-Ray Diffraction Analysis (XRD).....	20
5. Summary.....	25

CHAPTER THREE : STORAGE AND FLOW CAPACITY

1. Preparation of Abu Hasswa Samples for Petrophysical Measurements	28
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1.1. Cutting of samples.....	28
1.2. Cleaning of samples.....	28
1.3. Drying after extraction.....	29
2. Rock Density.....	30
2.1 Bulk density.....	30
2.2 Grain density.....	31
3. Packing Index (PI).....	33
4. Porosity.....	34
4.1 Classification of porosity.....	35
5. Permeability.....	37
6. The relation between grain density and bulk density.....	39
7. The relation between bulk density and porosity.....	40
8. The relation between grain density and porosity.....	41
9. The relation between grain density and permeability.....	41
10. The relation between bulk density and permeability.....	42
11. The relation between permeability and porosity.....	43
12. Heterogeneity Quantification Methods.....	45
12.1 Lorenz Coefficient.....	45
12.2 Dykstra Parson Method.....	47
13. Hydraulic Flow Unit (HFU).....	49
14. WINLAND R35 METHOD.....	56
15. Summary.....	59

CHAPTER FOUR : ELECRCIC PROPERTIES

1. Electrical Resistivity.....	61
2. Formation Resistivity Factor (F).....	65
3. Electrical Tortuosity (τ).....	66
4. The Relation between Formation Resistivity Factor (F) and Porosity ($\emptyset$)	67
5. The Relation between Formation Resistivity Factor (F) and Permeability (k)	68

6.	Relation between Formation Resistivity Factor (F) and Bulk Density (ρ_b)	69
7.	The relation between Tortuosity (τ) and bulk density (ρ_b).....	70
8.	The Relation between Tortuosity (τ) and porosity (ϕ).....	71
9.	The relation between Tortuosity (τ) and permeability (k).....	71
10.	Electrical Flow Unit Concept (EFU).....	72
11.	Cementation Exponent.....	76
12.	Summary.....	77

CHAPTER FIVE : ACOUSTIC PROPERTIES AND ELASTIC MODULI

1.	Introduction.....	79
2.	Compressional Wave Velocity (V_p).....	81
3.	Shear Wave Velocity (V_s).....	81
4.	Dynamic Elastic properties.....	82
4.1	Poisson's Ratio (σ).....	83
4.2	Young Modulus (E).....	84
4.3	Rigidity Modulus (μ).....	84
4.4	Bulk Modulus (K).....	85
5.	Acoustic Properties and Storage, Flow Capacity and Rock Density Relationships.....	85
5.1	The relationship between acoustic wave velocities (v_p and v_s) and bulk density (ρ_b).....	85
5.2	Relationship between Acoustic Wave Velocities (V_p and V_s) and Porosity (ϕ).....	86
5.3	The relationship between Compressional Wave Velocity (V_p) and Shear Wave Velocity (V_s)	87
5.4	The relationship between the Ratio of Compressional to Shear Wave Velocities (V_p/V_s) with Compressional and Shear Wave Velocities (V_p and V_s).....	88

5.5	The relationship between Slowness of Compressional Wave ($1/V_p$) to Slowness of Shear Wave ($1/V_s$).....	89
5.6	The relationship between the square of the compressional wave (V_p^2) to the square of the shear wave (V_s^2).....	89
5.7	The relationship between Young's modulus (E) and compressional (V_p) and shear wave (V_s) velocities.....	90
5.8	The relationship between rigidity modulus (μ) and compressional (V_p) and shear wave (V_s) velocities.....	91
5.9	The relationship between bulk modulus (K) and compressional (V_p) and shear wave (V_s) velocities.....	91
5.10	The relationship between Poisson's ratio (σ) and (V_p/V_s) ratio	92
5.11	The relationship between elastic moduli and porosity.....	93
6.	Velocity-Porosity Chart for Cementation Exponent prediction.	93
7.	Summary.....	95

CHAPTER SIX :CORRELATION OF THE MEASURED PHYSICAL PARAMETERS AND PETROPHYSICAL MODELING

1.	Porosity Modeling.....	97
2.	Permeability Modeling.....	98
3.	Compressional Wave Velocity Modeling.....	99
4.	Shear Wave Velocity Modeling.....	99
5.	Resistivity Modeling.....	100
6.	Vertical profiles of measured petrophysical parameters.....	100
7.	Summary.....	108
SUMMARY		109
REFERENCE		113

APPENDIX

LIST OF FIGURES

Fig (1- 1): Location map of the study area.....	3
Fig (1- 2): Location map showing the areas of exposed Lower Paleozoic rocks in Egypt (modified after Abdallah, 1992).....	3
Fig (1- 3): Correlation chart showing the vertical and lateral lithological changes of the Araba Formation in Sinai and Gabal El-Zeit modified after (Khalifa et al., 2006).....	5
Fig (2- 1): Lithostratigraphic section of Nubia sandstone at Gebel Abu Hasswa.....	10
Fig (2- 2): Ternary diagram of samples of Abu Hasswa section.....	11
Fig (2- 3): X-ray diffraction cross plot of the studied bulk sample 100.....	21
Fig (2- 4): X-ray diffraction cross plot of the studied bulk sample 103.....	21
Fig (2- 5): X-ray diffraction cross plot of the studied bulk sample 110.....	22
Fig (2- 5): X-ray diffraction cross plot of the studied bulk sample 112.....	22
Fig (2- 7): X-ray diffraction cross plot of the studied bulk sample 116.....	22
Fig (2- 8): X-ray diffraction cross plot of the studied bulk sample 118.....	23
Fig (2- 9): X-ray diffraction cross plot of the studied bulk sample 132.....	23
Fig (2- 10): X-ray diffraction cross plot of the studied bulk sample 147.....	23
Fig (2- 11): X-ray diffraction cross plot of the studied bulk sample 156.....	24
Fig (2- 12): X-ray diffraction cross plot of the studied bulk sample 159.....	24
Fig (3-1): Histogram and cumulative frequency percentage curve bulk density of all samples of Abu Hasswa section.....	31
Fig (3-2): Histogram and cumulative frequency percentage curve of grain density of all samples of Abu Hasswa section.....	32
Fig (3-3): Histogram and cumulative frequency percentage curve of PI of all samples of Abu Hasswa section.....	33
Fig (3-4): Histogram and cumulative frequency percentage curve of porosity of all samples of Abu Hasswa section.....	36
Fig (3-5): Histogram and cumulative frequency percentage curve of permeability of all samples of Abu Hasswa.....	39
Fig (3-6): The relation between the bulk density and the grain density, (a) Araba fm, (b) Abu Durba fm, (c) Ahemir fm, and (d) Malha fm.....	40
Fig (3-7): The relation between porosity and bulk density.....	40
Fig (3 - 8): The relation between grain density and porosity.....	41

Fig (3 - 9): The relation between grain density and permeability.....	42
Fig (3 - 10): The relation between bulk density and permeability.....	42
Fig (3 - 11): The relation between log permeability and porosity of Abu Hasswa samples..	43
Fig (3 - 12): Flow capacity vs storage capacity distribution (Craig, 1971).....	46
Fig (3 - 13): Fraction of flow vs. storage capacity for determination of Lk.....	46
Fig (3 - 14): Characterization of reservoir heterogeneity by permeability variation (Willhite, 1986).....	48
Fig (3 - 15): permeability distribution for the Burbank Sandstone.....	49
Fig (3 - 16): RMS calculation of HFU clusters.....	52
Fig (3 - 17): The relationship between cumulative permeability and flow zone indicator...	52
Fig (3 - 18): Histogram and cumulative frequency percentage curve of RQI of all samples of Abu Hasswa section.....	53
Fig (3 - 19): Shows the relation between RQI and pore to grain volume.....	54
Fig (3 - 20): Histogram and cumulative frequency percentage curve of FZI of all samples of Abu Hasswa section.....	54
Fig (3 - 21): Porosity–permeability relationship of all the study samples with HFU.....	55
Fig (3 - 22): The relation between actual and predicted permeability.....	56
Fig (3 - 23): Porosity–permeability relationship of all the study samples with R35 (Winland) lines.....	57
Fig (3 - 24): The relation between Win R35 and FZI.....	58
Fig (3 - 25): shows the relation between Win R35 and FZI with permeability (ck).....	59
Fig (4 - 1): Histogram and cumulative frequency percentage curve of Resistivity at 6000 ppm of all samples of Abu Hasswa section.....	63
Fig (4 - 2): Histogram and cumulative frequency percentage curve of Resistivity at 30000 ppm of all samples of Abu Hasswa section.....	64
Fig (4 - 3): Histogram and cumulative frequency percentage curve of Resistivity at 60000 ppm of all samples of Abu Hasswa section.....	64
Fig (4 - 4): Histogram and cumulative frequency percentage curve of electrical tortuosity of Abu Hasswa samples.....	67
Fig (4 - 5): The relation between the formation resistivity factor of three different concentrations and porosity of Abu Hasswa samples.....	68
Fig (4 - 6): The relation between the formation resistivity factor of three different concentrations and permeability (mD) of Abu Hasswa samples.....	69
Fig (4 - 7): The relation between formation resistivity factor of three different concentrations and bulk density (gm/cc) of Abu Hasswa samples.....	70

Fig (4 - 8): The relation between tortuosity and bulk density (gm/cc) of Abu Hasswa samples.....	70
Fig (4 - 9): The relation between tortuosity and porosity of Abu Hasswa samples.....	71
Fig (4 - 10): The relation between tortuosity and permeability of Abu Hasswa samples....	71
Fig (4 - 11): The comparison between RQI (red) and QRI (blue).....	73
Fig (4 - 12): The relation between ERI and RQI.....	73
Fig (4 - 13): The relation between formation resistivity factor and porosity with CZI.....	74
Fig (4 - 14): The relation between tortuosity and porosity with EFUs.....	75
Fig (4 - 15): The relation between tortuosity and permeability with EFUs.....	76
Fig (4 - 16): Histogram and cumulative frequency percentage curve of the cementation exponent of Abu Hasswa section samples.....	77
Fig (5 - 1): Histogram and cumulative frequency percentage curve of Vp of all samples of Abu Hasswa section.....	81
Fig (5 - 2): Histogram and cumulative frequency percentage curve of Vs of all samples of Abu Hasswa section.....	82
Fig (5 - 3): Elastic moduli with stress directions.....	83
Fig (5 - 4): The relationship between bulk density (x-axis) and Vp (y-axis).....	86
Fig (5 - 5): The relationship between porosity (x-axis) and Vp (y-axis).....	87
Fig (5 - 6): The relationship between Vp (x-axis) and Vs (y-axis).....	87
Fig (5 - 7): The relationship between Vp (x-axis) and Vp/Vs (y-axis).....	88
Fig (5 - 8): The relationship between Vs (x-axis) and Vp/Vs (y-axis).....	88
Fig (5 - 9): The relationship between (1/Vp) (x-axis) and (1/Vs) (y-axis).....	89
Fig (5 - 10): The relationship between (Vp) ² (x-axis) and (Vs) ² (y-axis).....	90
Fig (5 - 11): The relationship between (Vp and Vs) (x-axis) and (Young's modulus) (y-axis).	90
Fig (5 - 12): The relationship between (Vp and Vs) (x-axis) and (rigidity modulus) (y-axis).	91
Fig (5 - 13): The relationship between (Vp and Vs) (x-axis) and (bulk modulus) (y-axis).	92
Fig (5 - 14): shows the relation between σ (y-axis) and Vp/Vs (x-axis) ratios.....	92
Fig (5 - 15): The relationship between porosity (x-axis) and (Lambda*Rhob) (Rigidity*Rhob) (y-axis).....	93
Fig (5 - 16): Velocity- porosity chart of El-Sayed, 1995 with the study samples of Abu Hasswa Section.....	94