

**IDENTIFICATION AND DETERMINATION OF
VARIOUS HYDROCARBON PRODUCTS IN THE
VICINITY OF EL-RAZZAK FIELD, WESTERN
DESERT-EGYPT, USING WELL
LOGGING ANALYSIS**

A THESIS

**IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE**

**IN
GEOPHYSICS**

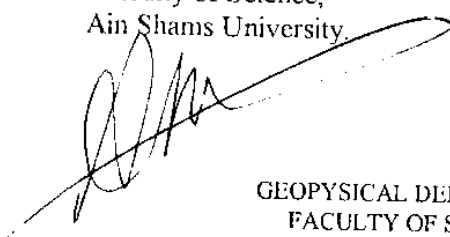
BY

**MOHAMED ABD EL-FATTAH MOHAMED
(B.SC. DEGREE)**

SUPERVISED BY

PROF. DR. : A. S. A. ABU EL-ATA
Prof. of Geophysics
Faculty of Science,
Ain Shams University.

DR. MAHER ALI EL-AZONI
Ass.Prof. of Geophysics,
Egyptian Petroleum
Research Institute


**GEOPHYSICAL DEPARTMENT
FACULTY OF SCIENCE
AIN SHAMS UNIVERSITY**

CAIRO 1997



ACKNOWLEDGMENT

In the first place, praise be to **Allah** and gratitude is due to almighty Allah who guided me to bring forth this thesis to light.

Thanks **Allah**

The author wishes to express his gratitude to Prof. Dr. **Ahmed Said Abu El-Ata**, Prof. of Geophysics, Department of Geophysics, Faculty of Science, Ain Shams University, for his stimulating supervision of this work, the unlimited assistance in interpreting the results, criticizing the final manuscript, and for the valuable computational facilities kindly offered by him.

Special thanks are due to Prof. Dr. **Samira Hassan Abdel Baki**, Prof. of Geophysics and Head of Exploration Sector, Petroleum Research Institute, for her great help and continuous encouragement.

Deep thank are due to Dr. **Maher Ali El-Azoni**, Assist. Prof. of Geophysics, Exploration Department, Petroleum Research Institute, for valuable discussions, reading of the entire manuscript and for generous advice offered by him at various stages of the work

Deep thanks are also due to my colleagues for their great help and continuous encouragement.

Finally, from all my heart, I feel indebted to my family for their great help and permanent care

ABSTRACT

***Mohamed Abd El-Fattah Mohamed Ramadan .
Identification and Determination of Various Hydrocarbon
Products in the Vicinity of El-Razzak Field, Western
Desert-Egypt, Using Well Logging Analysis. A Thesis
Submitted to the Faculty of Science, Ain Shams
University for the Degree of M. Sc. of Science in
Geophysics, 1997.***

The objective of the present logging evaluation is the identification and determination of the various hydrocarbon products of the Abu Roash Formation in the vicinity of El-Razzak Field, northern Western Desert, Egypt. The area of study is bounded by Long. 27° 50' and 28° 40' E. and Lat. 30° 25' and 30° 55' N. Nine wells (IJ 30-1, IG 30-1, IG 33-1, IH 35-2, IG 34-1, IF 32-1, IF 34-2, IE 34-6 and IE 36-1) were utilized for accomplishing this assessment. Such a study is performed using the different types of open-hole well logs, such as : Resistivity, Neutron, Density, Sonic, Self-potential and Gamma-Ray for the determination of the included petrophysical parameters and the evaluation of the inherited source rocks.

Such a work is conducted through several stages, started by reviewing the geologic setting of the study area through the previous geologic works and literatures, to shed lights on the geomorphology, surface geology, subsurface stratigraphy, structures, tectonics and geologic history.

From these wells, the source rock indicators were defined through the calculation of the organic content (ORG, Vol. %), the total organic carbon (TOC, wt %) and discriminant function to differentiate between the source rocks and the non-source rocks of the shales and shaly rocks of the Abu Roash Formation in the investigated area. Their results were presented in organo-source

logs and gradient maps to show the distribution of the implicated organic materials vertically and laterally. Added, the reservoir formation porosities (total and effective) were determined from the available porosity tools (density, sonic and neutron). Moreover, the cap rocks are recognized over the reservoir rocks.

Transformation cycle of hydrocarbons was started by studying the hydrocarbon maturation of the area through burial history curves of the studied wells and thermal maturation of the implied rock unit, from which the Time-Temperature Index (TTI) and Vitrinite Reflectance (R_o %) were estimated. From these it can be deduced that, the area of maturation is located around IF 34-2 well. Moreover, the times of onset, peak and end of oil generations were detected for the studied wells. Also, the migration characteristics of the synthesized hydrocarbons were studied through the migration types (primary and secondary), direction and mechanisms for transporting the hydrocarbons to the final accumulation places.

Hydrocarbon differentiation and hydrocarbon saturations for the various types of hydrocarbon products (heavy tar, liquid oil and gas) were defined through logging analysis in the form of iso-parametric maps. The hydrocarbons of Abu Roash Formation show an increase from the southwestern to northeastern parts. Besides, the comparison between the trends of variation of the movable and residual hydrocarbons indicates that, most of the initiated hydrocarbons are from the movable type. Added, the heavy tar (resins) increases toward the southern part. Moreover, the gas is not encountered in the Abu Roash Formation of the studied wells.

LIST OF CONTENTS

<i>Subject</i>	<i>Page</i>
ACKNOWLEDGMENTS.	
ABSTRACT.	
CHAPTER I. GEOLOGIC SETTING.	
I-1- INTRODUCTION.	1
I-2- GEOMORPHOLOGY.	4
I-3- SURFACE GEOLOGY.	7
I-4- SUBSURFACE STRATIGRAPHY.	7
I-5- STRUCTURES.	15
I-6- TECTONISM.	17
I-7- GEOLOGIC HISTORY.	19
I-8- PREVIOUS EXPLORATION ACTIVITIES.	21
I-9- AIM OF THE PRESENT STUDY.	23
CHAPTER II. WELL LOG DATA CORRECTIONS.	
II-1- INTRODUCTION.	24
II-2- AVAILABLE WELL LOGGING DTA.	25
II-3- MEASUREMENT AND CORRECTION OF FLUID RESISTIVITIES.	26
II-3-1- Determination of Formation Temperature.	26
II-3-2- Corrections of Mud Resistivity (R_m), Mud Cake (R_{mc}) and Mud Filtrate Resistivity (R_{mf}).	27
II-3-3- Determination of Water Resistivity.	27
II-4- DETERMINATION OF ROCK RESISTIVITIES.	28
II-4-1- Flushed-Zone Resistivity (R_{xo}).	28
II-4-2- Uninvaded-Zone Resistivity (R_t).	30
II-5- CORRECTION OF POROSITY TOOLS.	35

<i>Subject</i>	<i>Page</i>
II-5-1- Bulk Density Correction.	35
II-5-2 Neutron Porosity Correction.	36
CHAPTER III. STRATIGRAPHIC SEQUENCE ANALYSIS.	
III-1- INTRODUCTION.	40
III-2- SOURCE ROCKS.	41
III-2-1- Volume of Shale Determination.	41
III-2-2- Source Rock Identification.	44
III-3- RESERVOIR ROCKS.	62
III-3-1- Porosity.	65
III-4- CAP ROCKS.	68
CHAPTER IV. TRANSFORMATION CYCLE ENUMERATION.	
IV-1- INTRODUCTION.	71
IV-2- HYDROCARBON MATURATION.	72
A- Burial History.	72
B- Thermal Maturation.	82
C- Time of Generation.	91
D- Oil Window.	93
IV-3- HYDROCARBON MIGRATION.	96
IV-4- HYDROCARBON ACCUMULATION.	102
CHAPTER V. HYDROCARBON DIFFERENTIATION.	
V-1- INTRODUCTION.	103
V-2- HYDROCARBON PRODUCTS.	104
V-3- DETERMINATION OF FLUID SATURATIONS.	104
V-3-1- Water Saturation.	106
V-3-2- Hydrocarbon Saturations.	107
A) Tar saturation.	107
B) Gas saturation.	109
V-4- FLUID SATURATION MAPS.	120

<i>Subject</i>	<i>Page</i>
SUMMARY & CONCLUSIONS.	123
REFERENCES.	127
APPENDIX I.	
APPENDIX II.	
ARABIC SUMMARY.	

LIST OF FIGURES

<i>Fig. No.</i>		<i>Page</i>
1	Location map of the study area.	2
2	Location map showing the distribution of the studied wells.	3
3	Topographic map of the study area.	6
4	Generalized stratigraphy of the northern Western Desert.	10
5	Isopach map of Abu Roash Formation in the study area.	13
6	Shale distribution map of Abu Roash Formation.	45
7	Organo-source analysis of Abu Roash Formation in IJ 30-1 well.	51
8	Organo-source analysis of Abu Roash Formation in IG 30-1 well.	53
9	Organo-source analysis of Abu Roash Formation in IG 33-1 well.	54
10	Organo-source analysis of Abu Roash Formation in IH 35-2 well.	55
11	Organo-source analysis of Abu Roash Formation in IG 34-1 well.	56
12	Organo-source analysis of Abu Roash Formation in IF 32-1 well.	58
13	Organo-source analysis of Abu Roash Formation in IF 34-2 well.	59
14	Organo-source analysis of Abu Roash Formation in IE 34-6 well.	60
15	Organo-source analysis of Abu Roash Formation in IE 36-1 well.	61
16	Organic content (vol %) of Abu Roash Formation.	63
17	Total organic carbon (wt %) of Abu Roash Formation.	64
18	Total porosity map of Abu Roash Formation.	69

<i>Fig. No.</i>		<i>Page</i>
19	Effective porosity map of Abu Roash Formation.	70
20	Burial history curve of IJ 30-1 well.	73
21	Burial history curve of IG 30-1 well.	74
22	Burial history curve of IG 33-1 well.	75
23	Burial history curve of IH 35-2 well.	76
24	Burial history curve of IG 34-1 well.	77
25	Burial history curve of IF 32-1 well.	78
26	Burial history curve of IF 34-2 well.	79
27	Burial history curve of IE 34-6 well.	80
28	Burial history curve of IE 36-1 well.	81
29	Empirically-derived porehole temperature correlation curves to approximate static BHT.	83
30	Geothermal gradient map of the study area.	84
31	Thermal residual map of the study area.	86
32	Time-temperature index (TTI) map on the top of Abu Roash Formation.	88
33	Time-temperature index (TTI) map on the base of Abu Roash Formation.	89
34	Calculation of vitrinite reflectance.	90
35	Calculated vitrinite reflectance map on the base of Abu Roash Formation.	92
36	Oil window thickness map of the study area.	94
37	Source rock characterization panel through the wells : IJ 30-1, IG 34-1, IF 34-2 & IE 36-1.	95
38	Source rock characterization panel through the wells : IG 30-1, IF 32-1, IE 34-6 & IE 36-1.	97
39	Source rock characterization panel through the wells : IH 35-2, IG 34-1, IF 34-2 & IE 34-6.	98
40	Maturation indices and hydrocarbon products of Abu Roash Formation.	105
41	Neutron-density crossplot of Abu Roash Formation in IJ 30-1 well.	111

<i>Fig. No.</i>		<i>Page</i>
42	Neutron-density crossplot of Abu Roash Formation in IG 30-1 well.	112
43	Neutron-density crossplot of Abu Roash Formation in IG 33-1 well.	113
44	Neutron-density crossplot of Abu Roash Formation in IH 35-2 well.	113
45	Neutron-density crossplot of Abu Roash Formation in IG 34-1 well.	114
46	Neutron-density crossplot of Abu Roash Formation in IF 32-1 well.	114
47	Neutron-density crossplot of Abu Roash Formation in IF 34-2 well.	115
48	Neutron-density crossplot of Abu Roash Formation in IE 34-6 well.	115
49	Neutron-density crossplot of Abu Roash Formation in IE 36-1 well.	116
50	Water saturation map of Abu Roash Formation.	118
51	Hydrocarbon saturation map of Abu Roash Formation.	119
52	Movable hydrocarbon saturation map of Abu Roash Formation.	120
53	Residual hydrocarbon saturation map of Abu Roash Formation.	121
54	Tar distribution map of Abu Roash Formation.	122

