The Impact of Seismic Reflection and Well Logging Interpretation In clarifying the near-surface Velocity Variations of El-Fayum Area, Western Desert, Egypt

A THESIS

SUBMITTED FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN GEOPHYSICS 2016

BY

MOHAMED EHAB ABU-SINNA

B.Sc. in Geophysics 2006

Geophysics Department
Faculty of Science
Ain Shams University

(2016)

APPROVAL SHEET

The Impact of Seismic Reflection and Well Logging Interpretation In Clarifying The Near-Surface Velocity Variations Of El-Fayum Area Western Desert, Egypt

A THESIS

SUBMITTED FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF SCIENCE IN GEOPHYSICS 2016

Geophysics Department
Faculty of Science
Ain Shams University

BY

MOHAMED EHAB ABU-SINNA
B.SC. in Geophysics 2006

SUPERVISORS

Prof.Dr.NasserHassan Abu-Ashour

Professor Emeritus of Geophysics
Geophysics Department
Faculty of Science
Ain Shams University

Prof.Dr.Ahmed Sayed Abu El-Ata

Professor Emeritus of Geophysics
Geophysics Department
Faculty of Science
Ain Shams University

(2016)

Supervisors

Prof.Dr.Nasser Mohamed Hassan Abu-Ashour

Professor Emeritus of Geophysics

Geophysics Department

Faculty of Science

Ain Shams University

Prof.Dr.Ahmed Sayed Ahmed Abu El-Ata

Professor Emeritus of Geophysics

Geophysics Department

Faculty of Science

Ain Shams University

Head of Geophysics Department

Prof.Dr. Salah Abdel Wahab

ACKNOWLEDGMENTS

My deep thanks to God to achievement this work. I would never have been able to finish my dissertation without the guidance of my committee professors, help from friends, and support from my family.I would like to thank Petrosilah and Merlon international oil companies.

I would like to express my deepest gratitude to my professor, DR. Nasser Abu Ashour, Professor Emeritus of geophysics,for his excellent guidance, caring and patience. I would like to express my deepest gratitude to my Professor DR. Ahmed Abu El Ata,Professor Emeritus of geophysics, for his excellent guidance, patiently correcting my writing and caring.I would also like to thank Prof.Dr. Salah Abd El-Wahab head of Geophysics Department, for his support, help and encouragement.

I would like express my warm thanks, to my father, Dr. Ehab Abu-Sinna, Consultant of Orthopedic surgery, my mother, Dr. Fawzia El-Bassieony, Consultant of Genecology, my sister Rania, and my brothers, Eng. Ahmed and Eng. Ayman, my wife, Noha Fahim for their encouragement and support.

I would like to thank, Mr. Maged Abdel Halim, exploration manager of Merlon Oil Company, Mrs. Irene Tadros, chief geophysicist of Merlon Oil Company for their support and encouragement. My special thanks, for best friends Mr.Ismail El Wakeel and Mr.Mohamed Fekry for their help and support.

ABSTRACT

El-Fayum field area is located at the eastern part of the North Western Desert of Egypt. The area of study lies at the northern part of El-Fayum field and started to re-exploration in 1960's with Gindi-1x well then, more than 10 wells were drilled by several companies, since that date till the present time, most of them were reported as P&A dry holes. In2004, El-Fayum Field, including the area of study, awarded to Merlon El-Fayum International Oil Company, the company tried success to find oil over El-Fayum concession, where a dry well was drilled in the area of study, regardless the area is considered unexplored.

The main purpose of the present study is to arrive at a solution for the famous un-solved problem concerning the near-surface velocity variations, which create low and/or high velocity anomalies. The surface and near-surface layers act as filter or controlling factor for passing the seismic reflection wave into subsurface layers, with loose sediment (low velocity of the weathered layer) or igneous rock(high velocity of the Basaltic extrusion), resulting wave velocities varying abnormally and continuously with depth, and miss-leading the exploration activity in the area.

To achieve this purpose, the thesis program started with collecting the geological and geophysical data, studying the geologic setting of the concerned area to evaluate the structural elements, critiquing the stratigraphic column to evaluate the lithologic contents and clarifying the tectonic events standing behind the synthesis structural and stratigraphic regimes. Seismic interpretation was done for 2D PSTM data to clarify the structural elements trends and configuration, velocity regime analysis to show the distribution of low and high velocity anomalies and their effect on

the general velocity regime, seismic stratigraphic analysis to illustrate the thickness variations and lithofacies contents of the concerned rock units and their depositional environments across the area of study, combined with the available well analysis. Integrating all the inferred results to find a velocity model for the complex near-surface low and high velocity anomalies.

CONTENTS

Subjectpage No.

Acknowledgments ……i
Abstract……..…...ii

CHAPTER I: GEOLOGIC SETTING

I-1 Introduction …...…….....…….…..1

I-2 Surface Geology…….....……...…….2

I-3 Subsurface Stratigraphy……..…….....…….....5

I-3.1 Paleozoic…….....……...……...…6
I-3.2 Mesozoic.…..……...…….……...….6
I-3.3 Cenozoic….....…….……..…16

I-4 Structural Regime….....……..20

I-5 Tectonic inferences……...…..……22

I-6 Geologic History …….…….……23

I-7 Exploration Activities…….....…….……....26

I-8 Drilling Activities…….…….....……..28

I-9 Scope of the present Work…….....……29

CHAPTER II: VELOCITY REGIME

II-1 Introduction……...……...…….……..….31

II-2 Physical principles…….....…...……....……32

II-2.1 Physical properties ……..…...32
II-2.2 Reflection& transmission coefficients……..…...34
II -2.3Velocity function……..…35
II-2.4 Near surface layer……...……...….35

II-3 Distribution of RMS velocity ……...……...37

II-4 Distribution of average velocity ……..…...…..…...37

II-4.1 Bahariya Formation.....39
II-4.2 Abu Roash Formation.....40
II-4.3 Khoman Formation.....41

II-5 Effect of buried valleys and basaltic occurrences on the velocity style…….....42

Chapter III: SEISMIC STRUCTURAL ANALYSIS

III-1 Introduction …….……...….49

III-2 Seismic Survey…….....…….…….50

III-2-1 Acquisition Parameters…….....51
III-2-2 Processing Parameters…….…..52
III-2-3 Seismic interpretation……...….53

III-3 Delineation of Buried Valley ……....…….....….…..54

III-4 Tracing of basalt distribution…….…….…….... 59

III-5 Impact of Buried valley and basaltic occurrence on structural regime.....….70

III-5.1 Well to seismic tie …….....….71
III-5.2 Near surface Dabaa Formation…….....…73
III-5.3 Khoman Formation.....……..…. 75
III-5-4 Bahariya Formation…….……..…….....…....77

Chapter IV: SEISMIC STRATIGRAPHIC ANALYSIS

IV-1 Introduction……...……..……83

IV-2 Seismic Sequence Analysis…….....…84

IV-3 Isopach Maps….....…..85

IV-3.1 Bahariya Formation.....85
IV-3.2Abu-Roash Formation.....86

IV-3.3 Khoman Formation.....88
IV-3.4 Apollonia Formation.....89
IV-3.5 Dabaa Formation.....90

IV-4 Seismic Reflection Characteristic..... 91

IV-4.1 Bahariya Formation.....93
IV-4.2 Abu Roash Formation.....94
IV-4.3 Khoman Formation.....95
IV-5 Lithofacies conditions.....97

IV-5.1 Sand/Shale Ratio.....97

A- Bahariya Formation.....97
B- Abu-Roash Formation.....98
C- Khoman Formation.....99
D-Apollonia Formation.....100

IV-5.2 Litho - Facies Distributions.....101

A- Bahariya Formation.....101
B- Abu Roash Formation.....102
C- Khoman Formation.....103
D- Apollonia Formation.....104

IV-6 Depositional Environments……..…….105

Summery and Conclusions……..…107

References……...……112

Arabic summary

List of Figures

Figure page No.

Fig. (1.1): Geologic Map of the Western Desert (After Schlumberger, 1984)……....2

Fig. (1-2): Detailed surface geologic map of the study area (El Abd and El Ostam,2014).....5

Fig. (1-3): Generalized lithostratigraphic Column in the North Western Desert (After Schlumberger, 1984)…….....…8

Fig. (1-4): Isopach Map of Wadi Natrun Formation (After Hantar,1990).....9

Fig. (1-5): Isopach map of Khatatba Formation(After Hantar, 1990).....10

Fig. (1-6): Isopach Map of Alam El-Bueib Formation (After Hantar,1990).....13

Fig. (1-7): Isopach Map of Bahariya Formation (After Hantar,1990)….....14

Fig. (1-8): Isopach Map of Abu Roash Formation (After Hantar, 1990)……..16

Fig. (1-9): Isopach map of the Khoman Fm. Contours are in ft(after Moustafa, 2008)….. 17

Fig. (1-10): Isopach map of the Apollonia Formation in the Gindi basin south of the Kattaniya inverted basin (after Abd El-Aziz et al. 1998) …….……19

Fig. (1-11): Simplified regional structural map of the study area. Line width of the faults is proportional to throw value.Dotted lines represent reverse faults (after Moustafa,2008)……..…….....21

Fig. (1-12): Three-Dimensional view of Basement across Northern Egypt (After, Cairo 2002 International Conference and Exhibit…….....…23

Fig (2-1): RMS average velocity at 1850m level with velocity range 1000-8000 m/sec…..38

Fig (2-2): RMS average velocity at 2500m level with velocity range 1800-4000 m/sec.....39

Fig (2-3):Average velocity map of top Bahariya formation..... 40

Fig (2-4): Average velocity map of top Abu Roash Formation.....41

Fig (2-5): Average velocity map of top Khoman Formation….....42

Fig. (2-6): the RMS average velocity along the NW-SE line 9610-Hj54-29 with different velocity bands and vertical lithology succession…….....…45

Fig. (2-7): RMS average velocity along the NE-SW line 9610-Hj60-26 with different velocity bands……..……..……...46

Fig. (2-8): RMS average velocity along the NE-SW line 9610-Hi61-38 with different velocity bands…….……..…….47

Fig. (2-9): RMS average velocity along the NE-SW line 9610-Hh61-50 with different velocity bands……..……...….48
Fig. (3-1): NE-SW seismic line 9610-Hh61-50-F, un-interpreted PSTM section shows the disturbance of near surface zone and hesitation of arrival time …….……...….55
Fig. (3-2): NE-SW seismic line 9610-Hh61-50-F, un-interpreted PSTM section shows the distribution of the existing buried valley in the area of study……...…....56
Fig. (3-3): NE-SW seismic line 9610-Hi62-46-F,interpreted PSTM section shows the buried valley occurrence in NE-SW direction line…….....57
Fig. (3-4): buried valley channels model identified in the area of study ……..……...58
Fig. (3-5): buried valley model identified with the average RMS velocity of 1850 m……..59
Fig. (3-6): NW-SE seismic line9610-Hj58-25-F, un-interpreted PSTM section shows the basalt occurrence over the area of study ……...…61
Fig. (3-7): NE-SW seismic line 9610-Hi60-22-F, un-interpreted PSTM section show the basalt top and base and the lateral extend in the area of study.....62
Fig. (3-8): NW-SE seismic line9610-Hj58-27-F, un-interpreted PSTM section show the basalt top and base and the lateral extend in area of study ……..…..63
Fig. (3-9): location map show the boundary of basalt sheet with delineation of the out crop in the area of study …….…….....64
Fig. (3-10): structure contour TWT map shows top basalt distribution in the area..... 65
Fig. (311): structure contour TWT map show base basalt distribution in the area of study..66
Fig. (3-12): structure contour depth map show top basalt distribution in the area of study..67
Fig. (3-13): structure contour depth map of base basalt the distribution in the area study…68
Fig. (3-14): A 3D model for basalt occurrence without crop in the area of study.....69
Fig. (3-15): A 3D model for basalt sheet and out crop in the area with interpreted line in different directions..... 70
Fig. (3-16): synthetic seismogram for Hediya-X well.....71
Fig. (3-17): synthetic seismogram for Qarun3-1 well.....72
Fig. (3-18): NW-SE LINE 9610-Hj58-27, interpretation near surface marker at base of weathered layer on PSTM section.....74

Fig. (3-19): NE-SW seismic line 9610-Hj58-27fF, interpretation of near surface marker at base of weathered layer on PSTM section.....75

Fig. (3-20): NW-SE seismic line 9610-Hj58-27fF, the continues surface generated for the near surface Dabaa interpretation.....76

Fig. (3-21): TWT map for surface marker at the base of weathered layer over the area…...77

Fig. (3-22): TWT map for surface marker at the base of weathered layer over the area of study the with buried valley model 78

Fig.(3-23): corrected TWT map for Dabaa formation from well data…….....79

Fig. (3-24): Khoman formation TWT map picked by correlation with regional marker in surrounding area..... 80

Fig. (3-25): corrected Khoman formation TWT map from well data..... 81

Fig. (3-26): UP Bahariya formation TWT map 82

Fig. (4-1): Isopach Map for Bahariya Formation showing distribution over the area ….....86

Fig. (4-2): Isopach Map for Abu Roash Formation showing the distribution over the area..87

Fig. (4-3): Isopach Map for Khoman Formation showing the distribution over the area…..88

Fig. (4-4): Isopach Map for Apollonia Formation showing the distribution over the area...89

Fig. (4-5): Isopach Map for Dabaa Formation showing the distribution over the area 90

Fig. (4-6): location map of area of study with the seismic lines of 9610 survey used for seismic characteristics analysis.....92

Fig. (4-7): Seismic Characteristic map for Bahariya formation..... 93

Fig. (4-8): seismic Characteristic map for Abu-Roash formation showing the internal reflection model.....94

Fig. (4-9): seismic Characteristic map for Khoman Formation showing the internal Reflection model.....95

Fig. (4-10): Basin configuration model interpreted from seismic reflection characteristics 96

Fig. (4-11): Sand/shale ratio map for Bahariya Formation.....97

Fig. (4-12): Sand/shale ration map for Abu-Roash Formation.....98

Fig. (4-13): Clastic/Nonclastic ratio map for Khoman Formation.....99

Fig. (4-14): Clastic/Nonclastic ratio map for Apollonia Formation.....100

Fig. (4-15): Litho facies map for Bahariya Formation.....101

Fig. (4-16): Litho facies map for Abu Roash Formation.....102

Fig. (4-17): Litho facies map for Khoman Formation..... 103

Fig. (4-18): Litho facies map for Apollonia Formation.....104

Fig. (4-19): Summery of Depositional Environment of Stratigraphic succession.....107

LIST OF TABLES

Table page NO.

Table (2-1): velocity of deferent type of medium composite and densities..34

Table (3-1): recording parameter for 9610 2D survey ...…….…….51

Table (3-2): source array for 9610 2D survey……..…51

Table (3-3): geophone array parameter ……..…….…….52

CHAPTER I:

GEOLOGIC SETTING