

بسم الله الرحمن الرحيم



# شبكة المعلومات الجامعية التوثيق الالكتروني والميكرو فيلم



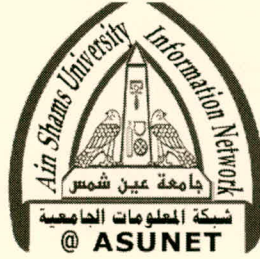
شبكة المعلومات الجامعية

# جامعة عين شمس

التوثيق الالكتروني والميكرو فيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها  
علي هذه الأفلام قد أعدت دون أية تغيرات



## يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

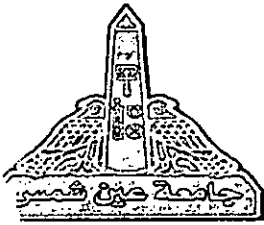
في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of  
15-25- c and relative humidity 20-40%



# بعض الوثائق الأصلية تالفة

# بالرسالة صفحات لم ترد بالاصل



Faculty of science  
Geophysics Department

# **A COMPREHENSIVE THREE DIMENSIONAL CRUSTAL STRUCTURE STUDY OF ABU-DABBAB AREA, EASTERN DESERT, EGYPT**

**A THESIS**

Submitted to Faculty of Science, Ain Shams University  
for PhD Degree in Geophysics

***BY***

**AHMED HOSNY ALI MORSY**

***Supervised By:***

**Prof. Mahdy Mohamed Abd- Elrahman**

Professor of Geophysics, Head of Geophysics  
Department, Faculty of Science, Ain Shams  
University.

**Prof. Abu-Elela Amin Mohamed**

Professor of Geophysics, Head of Seismology  
Department, National Research Institute of  
Astronomy and Geophysics, Helwan.

**Prof. Ali Abd-El-Azim Tealeb**

Professor of Geophysics, National Research Institute of  
Astronomy and Geophysics, Helwan

**Dr. Mohamed Shokry Mohamed**

Lecturer of Geophysics, Geophysics Department,  
Faculty of Science, Ain Shams University

✓ EK



## ACKNOWLEDGEMENTS

My all gratitude is due to Almighty Allah who guided and helped me to bring forth the present study.

I wish to express my deepest gratitude to Prof. Mahdy M. Abd Elrahman. Professor and Head of Geophysics department, Faculty of Science, Ain Shams University, Prof. Dr. Ali A. Tealeb, Professor of geophysics, National Research Institute of Astronomy and Geophysics (NRIAG), Prof. Dr. Abu-Elela A. Mohamed Professor of Geophysics, Head of Seismolgy Department, National Research Institute of Astronomy and Geophysics (NRIAG), and Dr. Mohamed Shokry, lecturer of Geophysics, Faculty of Science, Ain Shams University for their kind supervision and encouragement during the progress of the whole work.

All my deepest gratitude to the supervision of Prof. Panza G. for all He taught me, the help I got from my colleagues at DST, University of Trieste, and particularly from Dr. Guidralli M. as well the kind assistance and support from the officers from OEA, office of external activities, ICTP, Trieste, Italy.

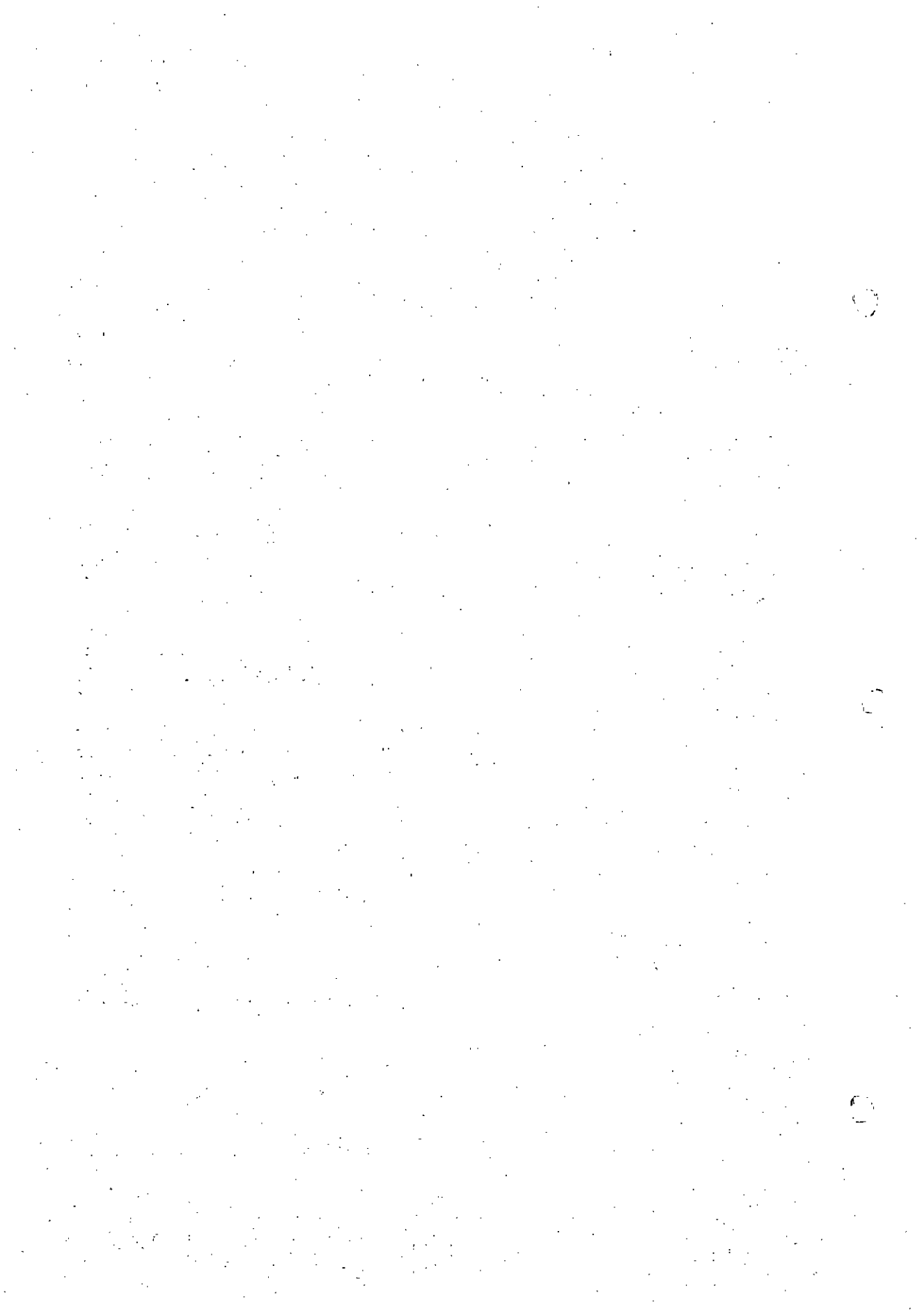
I wish also to extend my thanks to Prof. Dr. Salah M. M., president of the National research institute of Astronomy and Geophysics for his continuous encouragement for the young Researchers at NRIAG.

I would also like to express my honest, sincere gratitude and heartily appreciation to my colleagues at Seismolgy Department, Egyptian National Seismological Network ENSN who worked hard in establishing the mobile arrays Network around the study area in order to collect the data, Dr. Ahmed Dief Gomaa, Associate Professor, Dr. Sayed Fergany, Researcher all Researchers Assistant, Assistant researchers, Engineering stuff, Technical stuff, and Drivers at NRIAG.

My deepest thanks to Dr. Sherif M. Elhady, Dr. Kamal M. Abu-Elenean, Dr. Hesham H. M. for their friendly, helpful and valuable constructive comments during the course of this work.

Thanks to all my colleagues at all Departments of the National research institute of Astronomy and Geophysics.





# CONTENTS

<b>Page</b>	
<b>Acknowledgements</b>	<b>I</b>
<b>Contents</b>	<b>II</b>
<b>List of Figures</b>	<b>IV</b>
<b>List of Tables</b>	<b>VI</b>
<b>Abstract</b>	<b>VII</b>
<b>CHAPTER ONE: Introduction</b>	<b>1</b>
1.1 Aim of the Study	1
1.2 Geological Setting of Abu-Dabbab Area	1
1.2.1 The Stratigraphic Section	4
1.2.2 Country Rocks	4
1.2.3 Tectonics and Surface Structures	7
1.2.3.1 Tectonic Settings	7
1.2.3.1.1 Tectonics of the Red Sea	7
1.2.3.2 Local structural Geology	9
1.3 Deformation of Serpentine Rock and its Tectonic Implication	11
1.3.1 General Information	11
1.3.2 Physical Properties of Serpentinite	12
1.3.3 Distribution and Type of Serpentine Rocks in Abu-Dabbab Area	13
1.3.4 Tectonic Implications of Serpentinite	14
1.4 Previous Geological Studies of Abu-Dabbab Area	16
1.4.1 Previous seismological studies	16
1.4.1.1 Abu-Dabbab Seismicity	16
1.4.2 Crustal Structure Studies along Red Sea Margin	22
1.4.3 Red Sea Coastal Zone Thermal Anomaly	24
<b>CHAPTER TWO: Data Collection</b>	<b>28</b>
<b>CHAPTER THREE: The Local Earthquake Tomography and Moment Tensor Inversion</b>	<b>33</b>
<b>A: Local Earthquake Tomography Technique</b>	<b>33</b>
3.1 Introduction	33
3.2 Basic Theory	35
3.3 Aspects of the Local Earthquake Tomography	44
3.3.1 Representation of Structure	44
3.3.2 Ray-Path and Travel-Time Calculation	45

3.3.3 Solution Quality	48
3.3.4 Shear Waves and $V_p/V_s$	49
<b>B: Moment Tensor Inversion Technique</b>	<b>51</b>
3.4 Introduction	51
3.5 Retrieval of Moment Tensor Rate Functions (MRTFs)	52
3.6 Moment Tensor Rate Function Factorization	55
3.7 Error Analysis:	56
 <b>CHAPTER FOUR: Three Dimensional Velocity Structures</b>	 <b>59</b>
4.1 Introduction	59
4.2 Data Selected	60
4.3 The 1-D Model	63
4.4 Inversion Method and Procedure	66
4.5 Inversion Results	69
 <b>CHAPTER FIVE: Moment Tensor Inversion</b>	 <b>82</b>
5.1 Introduction	82
5.2 The Method	84
5.3 Data	86
5.4 Moment Tensor Inversions	88
5.5 Results and Discussion	92
 <b>CHAPTER SIX: Summary and Conclusion</b>	 <b>100</b>
Appendix A	104
References	135
Arabic Summary	

## List of Figures

Fig.	Page
<b>Chapetr 1</b>	
1.1 Key map of Abu Dabbab area	3
1.2 Geological map close to Abu-Dabbab	6
1.3 Lineaments map of the study area located on satellite image	10
1.4 Azimuth frequency diagram of surface lineaments close to the study area.	11
1.5 Histogram of number of events/day at Abu Dabbab seismic station.	17
1.6 Location map for fall 1976 Abu Dabbab micro-earthquake array and recorded epicenters	18
1.7 Location map for fall 1977 Abu Dabbab micro-earthquake array and recorded epicenters	19
1.8 Plot of spring 1977 Abu Dabbab epicenters showing depth of Events	21
1.9 Location map of the deep seismic sounding profiles	23
1.10 Interpretation of profile V, after Marzouk et al 1988	24
1.11 Location map of heat flow sites in Egypt and northern Red Sea	26
<b>Chapter 2</b>	
2.1 Base map and local network around Abu Dabbbab area	30
2.2 seismicity map of the study area, (a) Base map and (b) space image with surface lineaments	32
<b>Chapter 3</b>	
3.1 Schematic representation of the local earthquake Tomography (LET) problem	36
3.2 Representation of the two basic approaches to ray-tracing shooting (top), and bending (bottom)	47
<b>chapter 4</b>	
4.1 Map showing the major geographical features of the study area	62
4.2 Comparison between the derived one dimensional reference model and the starting model	65
4.3 wadati diagram for an event	66
4.4 Trade-off curve for the variance of the velocity perturbations and root mean square travel time residuals	68
4.5 Distribution of the number of the rays passing through each grid node (hit counts)	73

4.6 P-wave velocity image at each depth slice (in percent difference from the average velocity)	74
4.6 continue	75
4.7 Vp/Vs velocity ratio image at each depth slice	76
4.7 continue	77
4.8 Profile A, vertical cross-section, of Vp, Vs and Vp/Vs variations and relocated hypocenters	78
4.9 Profile B, vertical cross-section, of Vp, Vs and Vp/Vs variations and relocated hypocenters	79
4.10 Profile C, vertical cross-section, of Vp, Vs and Vp/Vs variations and relocated hypocenters	80
4.11 Topographic map with the location of the earthquakes before (a) and after (b) the inversion using the new 3-D models	81
 Chapter 5	
5.1 Seismicity map of the recorded microearthquakes	87
5.2 Synthetic tests to evaluate the effect of the number of triangles and damping parameters on the solution of the moment tensor, (a) 20 triangles, (b) 10 triangles, and (c) 5 triangles	90
5.4 Map of the study area with the surface lineaments and the seismicity of different depths	99
(Appendix A) Moment tensors inversion results for the selected 15 earthquakes	



## **List of Tables**

<b>Table</b>	<b>Page</b>
<b>4.1 Simplified refraction base model used as starting model.</b>	<b>64</b>
<b>4.2 The derived 1-D <math>V_p</math> crustal reference model for the area.</b>	<b>64</b>
<b>5.1 1-Ddimensional velocity model used in the INPAR inversion.</b>	<b>94</b>
<b>5.2 List of the focal parameters of the selected events from arrivals by HYPO 71</b>	<b>94</b>
<b>5.3 Comparison between source depth and O.T. given in table 5.2 and results obtained with method INPAR (fixed Lat., and Lon.).</b>	<b>95</b>
<b>5.4 Comparison between source location parameters given in Table 5.2 and results obtained with method INPAR (inverted; O.T., Depth, Lat., and Lon.)</b>	<b>96</b>
<b>5.5 Comparison between source parameters (O.T., Lat., Lon., and depth) of the selected events determined by method INPAR with fixed and inverted Lat., and Lon.</b>	<b>97</b>
<b>5.6 List of the finally chosen inversion results of Fault plane solution parameters of selected earthquakes</b>	<b>98</b>

