

**STUDY OF THE BASEMENT ROCKS - SEDIMENTS
CONTACT ZONE ,WADI EL-ATRASH AREA,
NORTH EASTERN DESERT, EGYPT,
USING AERIAL MAGNETIC AND
SPECTROMETRIC DATA.**

A Thesis

Submitted to the Department of Geophysics,
Faculty of science,
Ain Shams University, Cairo.

By

ASSRAN SAYED MOHAMED ASSRAN
M. Sc. Applied Geophysics

For

THE DEGREE OF DOCTOR OF PHILOSOPHY
In Geophysics (Applied Geophysics)

Supervisors

Prof. Dr. Ahmed Sayed Abu El-Ata
Geophysics Department, Faculty of
Science , Ain Shams University.

Prof. Dr. Said Ibrahim Rabie
Exploration Division, Nuclear
Materials Authority.

1997

CONTENTS

<i>Subject</i>	<i>Page</i>
CONTENTS	
LIST OF FIGURES.	v
LIST OF TABLES.	xi
ACKNOWLEDGMENTS.	xiii
ABSTRACT.	xiv
CHAPTER I : INTRODUCTION.	1
I-1- GENERAL.	1
I-2- LOCATION AND DESCRIPTION.	2
I-3- TOPOGRAPHY.	2
I-4- MINERALIZATION.	4
I-5- PREVIOUS WORKS.	8
I-6- AIM OF THE PRESENT WORK.	10
CHAPTER II : GEOLOGIC SETTING.	12
II-1- GENERAL.	12
II-2- REGIONAL GEOLOGY OF THE NORTH EASTERN DESERT.	12
II-3- DETAILED GEOLOGY OF THE STUDY AREA.	16
II-3-1- First Basement Volcanics or Main Geosynclinal Volcanics.	16
II-3-2- Second Basement Plutonites or Syn-orogenic Plutonites.	16
II-3-3- Second Basement Volcanics or Emerging Geosynclinal Volcanics.	17
II-3-4- Second Basement Sediments or Post-Geosynclinal Sediments.	18
II-3-5- Third Basement Plutonites or Late orogenic Plutonites.	19



<i>Subject</i>	<i>Page</i>
II-3-6- Paleozoic Volcanicity or Post-orogenic Volcanics.	21
II-3-7- Phanerozoic Cover or Foreland Sediments.	22
A- The Cretaceous-Tertiary group.	22
B- Quaternary sediments group.	24
II-4- STRUCTURES.	25
A- Primary Structures.	26
B- Secondary Structures.	27
II-5- TECTONICS.	28
II-6- GEOLOGIC HISTORY.	28
 CHAPTER III : GEOPHYSICAL SURVEYING AND TECHNIQUES.	 31
III-1- GENERAL.	31
III-2- AIRBORNE GEOPHYSICAL SURVEYING.	33
III-2-1- Aerospectrometric Surveying.	33
III-2-1-1- Instrumentation	33
III-2-1-2- Factors affecting the radiation flux received by spectrometer....	35
III-2-1-3- Stripping ratios	36
III-2-1-4- Compilation and presentation of the spectrometric data	37
III-2-2- Aeromagnetic Surveying.	38
III-2-2-1- Nature of the geomagnetic field.	38
III-2-2-2- Magnetic properties of rocks.	38
III-2-2-3- Magnetometers	39
III-2-2-4- Recording system	39
III-2-2-5- Aeromagnetic data processing.	39
III-3- AIRBORNE GEOPHYSICAL TECHNIQUES.	41
III-3-1- Aerospectrometric Techniques	41

<i>Subject</i>	<i>Page</i>
III-3-1-1- Outlining the uraniferous provinces	41
III-3-1-2- Factor analysis	42
III-3-1-3- Significance factor technique.	45
III-3-1-4- Remobilization of uranium.	46
III-3-2- Aeromagnetic Techniques.	47
III-3-2-1- Power spectrum technique.	47
III-3-2-2- Filtering combined with the analytical downward continuation..	48
III-3-2-3- Normalized total vector (gradient) of the field intensity	49
III-3-2-4- Normalized horizontal vector (gradient) of the field intensity.....	50
III-3-2-5- Horizontal and total phase angles.	51
III-3-2-6- Depth determination techniques.	52
CHAPTER IV : AEROSPECTROMETRIC INTERPRETATION.	53
IV-1- GENERAL.	53
IV-2- QUALITATIVE INTERPRETATION OF AEROSPECTROMETRIC DATA.	54
IV-3- QUANTITATIVE INTERPRETATION OF AEROSPECTROMETRIC DATA.	67
IV-3-1- Statistical Treatment of Aerospectrometric Data	68
IV-3-2- Identification and Outlining of Uraniferous Provinces	77
IV-3-3- Application of Factor Analysis on the Spectrometric Data	94
IV-3-4- Significance Factor Technique	105
IV-3-5- Remobilization of Uranium	113
CHAPTER V : AEROMAGNETIC INTERPRETATION.	119

<i>Subject</i>	<i>Page</i>
V-1- GENERAL	119
V-2- QUALITATIVE INTERPRETATION OF AEROMAGNETIC DATA	120
V-3- QUANTITATIVE INTERPRETATION OF AEROMAGNETIC DATA	131
V-3-1- Power Spectrum Analysis	131
V-3-1-1- Interface determination	131
V-3-1-2- Filtering combined with analytical downward continuation	134
V-3-1-3- Normalized total and horizontal vector (gradient).....	139
V-3-1-4- Horizontal and total phase angles.	145
V-3-2- Depth Determination	150
V-4- BASEMENT TECTONIC MAPS	157
 CHAPTER VI: GEOPHYSICAL TREND ANALYSIS.	162
VI-1- GENERAL	162
VI-2- METHODS OF ANALYSIS	162
VI-2-1- Autocovariance Technique	162
VI-2-2- Overlap Technique	164
VI-3- DISCUSSION OF TREND ANALYSIS	165
VI-3-1- E-W (Mediterranean Sea) Trend.	176
VI-3-2- ENE-WSW (Syrian arc) Trend.	178
VI-3-3- NE-SW (Trans African) Trend.	179
VI-3-4- N-S (Meridional) Trend	180
VI-3-5- NW-SE (Red Sea) Trend	181
VI-3-6- WNW-ESE (Najd) Trend.....	181
 SUMMARY AND CONCLUSIONS.	184
 REFERENCES.	192
 ARABIC SUMMARY.	

LIST OF FIGURES

Fig. No.	Subject	Page No.
1	A map of Egypt showing the location of Wadi El-Atrash area, north Eastern Desert, Egypt.....	3
2	Topographic map of Wadi El-Atrash area, north Eastern Desert, Egypt.....	5
3	Surface drainage pattern of Wadi El-Atrash area, north Eastern Desert, Egypt.....	6
4	Compiled geological map of Wadi El-Atrash area, north Eastern Desert, Egypt. (After Zalata, 1972, Khalaf et al., 1992 and Geological Survey of Egypt, 1983 &1992).....	13
5	A typical airborne gamma ray spectrum showing the gamma ray peaks of the three radioelements, along with the energy windows used to detect them at 120 m above the ground (After Grasty,1987).....	32
6	Block diagram showing main components of airborne gamma ray spectrometer (After Bristow, 1979).....	34
7	Total - count contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service, 1984).....	55
8	Equivalent uranium contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service, 1984).....	56
9	Equivalent thorium contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service, 1984).....	57
10	potassium (%) contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service, 1984).....	58
11	e Uranium / e Thorium ratio contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service,1984)....	59
12	e Uranium / Potassium ratio contour map, Wadi El-Atrash area, north Eastern Desert, Egypt(After Aero Service,1984).....	60
13	e Thorium / Potassium ratio contour map, Wadi El-Atrash area, north Eastern Desert, Egypt (After Aero Service,1984).....	61

Fig. No.	Subject	Page No.
14	Uranium point anomaly map, Wadi El-Atrash area, north Eastern Desert, Egypt.....	80
15	Stacked profiles taken along flight line 8820 (Anomaly No.1).....	82
16	Stacked profiles taken along flight line 8850 (Anomaly No.2).....	84
17	Stacked profiles taken along flight line 8840 (Anomaly No.3).....	85
18	Stacked profiles taken along flight line 8800 (Anomaly No.4).....	87
19	Stacked profiles taken along flight line 8640 (Anomaly No.5).....	89
20	Stacked profiles taken along flight line 8730 (Anomaly No.6).....	90
21	Stacked profiles taken along flight line 8610 (Anomaly No.7).....	92
22	Stacked profiles taken along flight line 8590 (Anomaly No.8).....	93
23	Contour map of factor 1 score data, Wadi El-Atrash area, north Eastern Desert, Egypt.....	100
24	Contour map of factor 2 score data, Wadi El-Atrash area, north Eastern Desert, Egypt.....	101
25	Contour map of factor 3 score data, Wadi El-Atrash area, north Eastern Desert, Egypt.....	103
26	Rock unit map interpreted from factor scores, Wadi El-Atrash area, north Eastern Desert, Egypt.....	104
27	Significance factor contour map of uranium data, all values have been based upwards to yield only positive significance factor values.....	106
28	Significance factor contour map of thorium data, all values have been based upwards to yield only positive significance factor values.....	108
29	Significance factor contour map of potassium data, all values have been based upwards to yield only positive significance factor values.....	109
30	Significance factor contour map of eU / eTh data, all values have been based upwards to yield only positive significance factor values.....	110

Fig. No.	Subject	Page No.
31	Significance factor contour map of eU / K data, all values have been based upwards to yield only positive significance factor values.....	111
32	Significance factor contour map of eTh / K data, all values have been based upwards to yield only positive significance factor values.....	112
33	Variations of eU and eTh with their ratio for : north W. El-Ghozah metavolcanics (a), west W. El-Atrash granodiorite (b), Kollet El-Naqa Dokhan volcanics (c) and Talaat Hamda Hammamat sediments.....	115
34	Variations of eU and eTh with their ratio for : north W. Hammad Nubia Formation (a), Thebes Formation (b) and Issawia Formation (c).....	117
35	Variations of eU and eTh with their ratio for : Wadi deposits (a), Umm Dissi younger granites (b) and Bab El-Mekhenaq younger granites (c).....	118
36	Total intensity magnetic map reduced to the northern pole, Wadi El-Atrash area, north Eastern Desert, Egypt(After Aero Service, 1984).....	123
37	The locations of the interpreted magnetic zones, Wadi El-Atrash area, north Eastern Desert, Egypt.....	124
38	Local power spectrum for interface determination of total magnetic intensity map reduced to the northern pole, Wadi El-Atrash area, north Eastern Desert, Egypt.....	133
39	Residual magnetic component map at interface 0.78 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	135

Fig. No.	Subject	Page No.
40	Regional magnetic component map at interface 0.78 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	136
41	Residual magnetic component map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	137
42	Regional magnetic component map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	138
43	Horizontal gradient map at interface 0.78 km Wadi El-Atrash area, north Eastern Desert, Egypt.....	140
44	Horizontal gradient map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	141
45	Total gradient map at interface 0.78 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	143
46	Total gradient map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	144
47	Horizontal phase angle map at interface 0.78 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	146
48	Horizontal phase angle map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	147
49	Total phase angle map at interface 0.78 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	148
50	Total phase angle map at interface 2.2 km, Wadi El-Atrash area, north Eastern Desert, Egypt.....	149
51	Spectral analysis decay curves for anomaly no. 15 (A) Treitel et al., (1971) method (B) FFT (1987) method.....	151
52	A tentative basement relief map, based on aeromagnetic anomalies, Wadi El-Atrash area, north Eastern Desert, Egypt..	154
53	The locations at which the depths to the causative bodies were determined, El-Atrash area, north Eastern Desert, Egypt.....	156

Fig. No.	Subject	Page No.
54	Interpreted basement tectonic map at interface 0.78 km. Wadi El-Atrash area, north Eastern Desert, Egypt.....	158
55	Interpreted basement tectonic map at interface 2.2 km. Wadi El-Atrash area, north Eastern Desert, Egypt.....	159
56	Suggested general geometrical classification of the various directions in correlation with the terminology of main structural trends adopted by various authors in northeast Africa and Arabia (After Rabie and Ammar, 1990).....	166
57	The two - dimensional autocorrelograms and their interpreted trend directions for the radiometric maps : (A) total count (B) equivalent uranium.....	167
58	The two - dimensional autocorrelograms and their interpreted trend directions for the radiometric maps : (A) equivalent thorium (B) potassium.....	168
59	The two - dimensional autocorrelograms and their interpreted trend directions for the magnetic maps : (A) RTP map (B) residual magnetic component map at interface 0.78 km. and (C) regional magnetic component map at interface 0.78 km....	169
60	The two - dimensional autocorrelograms and their interpreted trend directions for the magnetic maps (A) residual magnetic component map at interface 2.2 km. (B) regional magnetic component map at interface 2.2 km. and (C) horizontal gradient map at interface 0.78 km.....	170
61	The two - dimensional autocorrelograms and their interpreted trend directions for the magnetic maps (A) horizontal gradient map at interface 2.2 km. (B) total gradient map at interface 0.78 km. and (C) total gradient map at interface 2.2 km.....	171

Fig. No.	Subject	Page No.
62	Frequency distribution curves of the statistical analyzed trend for the radiometric maps : (A) total count (B) equivalent uranium (C) equivalent thorium and (D) potassium.....	172
63	Frequency distribution curves of the statistical analyzed trend for the magnetic maps :(A) RTP map (B) residual magnetic component map at interface 0.78 km. and (C) regional magnetic component map at interface 0.78 km.	173
64	Frequency distribution curves of the statistical analyzed trend fo the magnetic maps : (A) residual magnetic component map at interface 2.2 km. and (B) regional magnetic component map at interface 2.2 km. and (C) horizontal gradient map at interface 0.78 km.....	174
65	Frequency distribution curves of the statistical analyzed trend for the magnetic maps : (A) horizontal gradient map at interface 2.2 km(B) total gradient map at interface 0.78 km. and (C) total gradient map at interface 2.2 km.	175

LIST OF TABLES

Table	Subject	page
No		No
1	Spectral Windows Used to Measure Gamma-Rays (IAEA, 1976).....	31
2	Results of statistical treatment for total count in the various rock units.....	69
3	Results of statistical treatment for equivalent uranium in the various rock units.....	70
4	Results of statistical treatment for equivalent thorium in the various rock units.....	71
5	Results of statistical treatment for potassium (%) in the various rock units.....	72
6	Results of statistical treatment for e Uranium / e Thorium in the various rock units.....	73
7	Results of statistical treatment for e Uranium / potassium in the various rock units.....	74
8	Results of statistical treatment for e Thorium / potassium in the various rock units.....	75
9	The radioelement concentrations in crustal rocks (after IAEA, 1979 and Boyle, 1982).....	78
10	Correlation coefficient matrix among the seven data variables of Wadi El-Atrash area, north Eastern Desert, Egypt.....	96

Table No	Subject	page No
11	Matrix of unrotated loading of Wadi El-Atrash area, north Eastern Desert, Egypt.....	96
12	Matrix of rotated loading, Wadi El-Atrash area, north Eastern Desert, Egypt.....	98
13	Factor scores characterizing the rock units, Wadi El-Atrash area, north Eastern Desert, Egypt.....	98
14	Results of depth determination, in meters, for some selected major anomalies as recorded on the R.T.P. aeromagnetic map.....	152
15	Summary of the trend directions as interpreted from the application of autocorrelation and overlap techniques on the radiometric and magnetic maps, Wadi El-Atrash area, north Eastern Desert, Egypt.....	177

ACKNOWLEDGMENTS

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

I would like to express my great indebtedness and deep gratefulness to **Prof. Dr. Ahmed S. A. Abu El-Ata**, professor of Geophysics, Geophysics Department, Faculty of Science, Ain Shams University, for his supervision of this study, for doing his best in solving all the problems which I'd faced during the long run of research work, the interpretation and guidance in the preparation of this thesis.

The author is especially grateful to **Prof. Dr. Said I. Rabie**, professor of applied Geophysics, Exploration Division, Nuclear Materials Authority, Cairo, Egypt. Who suggested this point of research ,for kind supervision and for his continuous encouragement and providing me all possible facilities during the preparation of this study.

Deep appreciation is due to **Prof. Dr. Magdy L. Meleik**, Prof. of Applied Geophysics and head of Exploration Division, Nuclear Materials Authority for his cooperation.

The author would like to express his gratitude to **Prof. Dr. Samir N. Wasif**, president of the Nuclear Materials Authority, Cairo, Egypt.

The author is also grateful to all members of the Exploration Division, Nuclear Materials Authority, Cairo, Egypt. Special thanks are also to my family.