

Contents

Subject	Page
ACKNOWLEDGEMENTS.....	
LIST OF FIGURES.....	VII
LIST OF TABLES.....	XIV
LIST OF PLATES.....	XV
ABSTRACT.....	XXV

CHAPTER I

INTERODUCTION.....	1
I.1 Location, Topography and Physiography	1
I.2 Accessibility	5
I.3 General Review of the Tectonic Evolution of	
the Arabian-Nubian Shield	5
I.4 Classification of the Basement Rocks in Egypt.....	6
I.5 General Review on the Tectonic Evolution of the Eastern Desert.....	18
I.6 General Review on the Structural Evolution of the Eastern Desert.....	20
I.7 Previous Work on the Studied Area and the Environ.....	27
I.8 Aim and Scope of the Present Work.....	32

CHAPTER II

FIELD GEOLOGY.....	33
II.1 Introduction.....	33
II.2. Field Characteristics of the Main Rock Types.....	35
II.2.1 Metasediment-metavolcanic associations.....	35
II.2.2 Older granitoids.....	36
II.2.3 Hammamat sedimentary rocks.....	40

Subject	Page
II.2.4 Younger Granites.....	44
II.2.5 Post granitic dykes, veins and Post-orogenic volcanics	46
II.2.5.1 Basic dykes.....	48
II.2.5.1.1 Basalt dykes.....	48
II.2.5.2 Quartz veins.....	48
II.2.5.3 Post-orogenic volcanics	49
II.2.5.3.1 Trachyte dykes and sills.....	49
CHAPTER III	
PETROGRAPHY	51
III.1 General Statement.....	51
III.2 Metasediment-Metavolcanic Associations.....	51
III.2.1 Metasediments.....	51
III.2.1.1 Slates and phyllites.....	51
III.2.1.2 Graphite schists	53
III.2.1.3 Muscovite schists	53
III.2.2 Metavolcanics.....	55
III.2.2.1 Meta basalts	55
III.2.2.2 Meta dolerites.....	56
III.2.2.3 Meta andesites.....	56
III.3 Serpentinites.....	57
III.4 Older Granitoids.....	57
III.4.1 Quartz diorites.....	57
III.4.2 Granodiorites.....	60
III.5 Hammamat Sedimentary Rocks	61
III.5.1 Hammamat polymictic conglomerates.....	61
III.5.2 Greywackes.....	61

Subject	Page
III.5.3 Siltstones.....	63
III.6 Younger Granitoids.....	63
III.6.1 Monzogranite.....	63
III.7 Post-orogenic Volcanics	65
III.7.1 Trachyte.....	68
III.8 Modal mineralogical composition.....	68
CHAPTER IV	
STRUCTURE.....	71
IV.1 Introduction	71
IV.2 Ductile Deformation Structures	72
IV.2.1 Foliation.....	72
IV.2.2 Folds	75
IV.2.2.1 Major Folds.....	75
IV.2.2.2 Mesoscopic Folds.....	76
IV.2.2.3 Minor Folds.....	77
IV.3 Phases of Deformation.....	77
IV.3.1 First phase of deformation (NW-SE folds).....	77
IV.3.2 Second phase of deformation (N-S folds).....	78
IV.3.3 Third phase of deformation (NE-SW folds).....	78
IV.3.4 Fourth Phase of Deformation (E-W folds).....	81
IV.4 Geometrical Analyses of the Field Data.....	81
IV.4.1 Planar fabric elements.....	84
IV.4.1.1 Bedding.....	84
IV.4.2 Linear fabric elements.....	84
A) - Axes of minor folds.....	85
B) -Pencil and mullions structures.....	85

Subject	Page
IV.5 Structural Analysis.....	89
Domain (I).....	90
Domain (II).....	95
Domain (III).....	96
Domain (IV).....	96
Domain (V).....	97
Domain (VI).....	97
Synoptic diagrams	98
IV.6 Brittle Deformation Structures.....	100
IV.6.1 Faults.....	102
The NW-SE Fault trend.....	102
The NE-SW Fault trend.....	102
IV.6.1 .1 Paleostress analyses of faults.....	103
IV.6.1 .1 .1 Introduction and Historical Background.....	103
IV.6.1 .1 .2 Theoretical background	105
IV.6.1 .1 .3 Faults.....	106
IV.6.1 .1 .4 Classification of faults.....	107
IV.6.1 .1 .5 State of stress and slip of faults.....	108
IV.6.1 .1 .6 Relation between stress axes and fault slip.....	108
IV.6.1 .1.7 Methodology.....	109
IV.6.1 .1.8 Field procedures and methods of analysis.....	110
IV.6.1 .1.9 Data collection.....	112
IV.6.1 .1.10 Separation of data sets.....	112
IV.6.1.1.11 Paleostress analysis of fault population	114

Subject	Page
IV.6.1.1.11.1 Paleostress analysis of fault population.....	
in the younger granites.....	114
Extensional events.....	116
Compressional events.....	121
IV.6.1.1.11.2 Paleostress analysis of fault population.....	
in the trachyte.....	126
Extensional events.....	126
Compressional events.....	130
Paleostress analysis of radioactive faults.....	
in trachyte.....	133
IV.6.1.1.11.3 Paleostress analysis of fault population	
in the Hammamat sedimentary rocks.....	138
Compressional events.....	139
Extensional events.....	142
IV.6.2 Joints.....	151
IV.6.2.1 Metasediment- Metavolcanic associations.....	153
IV.6.2.2 Older granites.....	157
IV.6.2.3 Hammamat sedimentary rocks.....	157
IV.6.2.4 Younger granites.....	159
IV.6.2.5 Post granitic dykes.....	160
IV.6.2.5.1 Trachyte.....	160
IV.6.3 Shear zones.....	163

CHAPTER V

RADIOACTIVITY.....	168
V.1 Introduction.....	168
V.2 Field procedures.....	169
V.3 Distribution of Radioactivity.....	176
V.3.1 Metasediments – Metavolcanics Associations.....	176
V.3.2 Older Granitoids	176

Subject	Page
V.3.3. Hammamat sedimentary rocks.....	177
V.3.4 Younger Granites.....	178
V.3.5 Post – orogenic Volcanics.....	179
V.3.6: Radioactive anomalies.....	181
V.4: Factors controlling radioactive anomalies.....	
and mineralization.....	193

CHAPTER VI

SUMMARY AND CONCLUSIONS.....	197
REFERENCES.....	205
APPENDICES.....	235
ARABIC SUMMARY.....	

LIST OF FIGURES

Figure no.	Page
I.1: Location map of Wadi El-Atshan area, Central Eastern Desert,..... Egypt, and the outline of basement outcrops in Egypt.....	2
I.2: Landsat TM image of Wadi El-Atshan area and its environ, Central Eastern Desert, Egypt.....	3
I.3: General view of Bir El Tarfawy (potable water)W. El Atshan area,..... Looking NE.	4
I.4: Geologic sketch map showing the distribution of major Precambrian rock units in Egypt and northern Sudan and the two major shear zones; Qena- Safaga and Idfu-Mersa Alam shear zones.....	22
I.5: Major shear trends in the Eastern Desert of Egypt.....	24
I.6: Northern approach of Africa toward Laurasia has resulted in an N-S to..... N-NW/S-SE horizontal compression upon northeastern Africa, including Egypt, since early Tertiary time.....	24
I.7: Stress model for Suez and Aqaba shears	26
II.1:- Geological map of W.El Atshan area, Central Eastern Desert, Egypt.....	34
III.1: QAP triangular diagram for the granitoid rocks of the study area.	70
IV-1: Rose diagrams of foliation data (1= strike and 2= dip direction)..... and lower hemisphere stereographic projection showing..... the main stress trends.....	74
IV-2a: Pi (π) diagram for the bedding planes of the Hamamat sedimentary rocks.....	86
IV-2b: Strikes of the bedding planes of the Hamamat sedimentary rocks.....	86
IV-2c: Dip directions of the bedding planes of..... the Hamamat sedimentary rocks.....	86
IV-2d: Dip angles of the bedding planes of the Hamamat sedimentary rocks.....	86

Figure no.	Page
IV-3: Fold axes data representations as lower hemisphere stereographic projection of W. El Atshan area. (a-F1. NW-SE trend, b-F2. N-S trend, c-F3. NE-SW trend and d-F4. E-W trend).....	87
IV-4: Synoptic diagram for the distribution of structural elements in domains I, II and III.....	99
IV-5: Synoptic diagram for the distribution of structural elements..... in domains IV, V, and VI.....	101
IV.6:- Block diagrams for different conjugate faults system..... and causative stress field	107
IV.7:- Diagram showing principle stresses with respect to slip lineations on a single fault plane.....	109
IV-8:- Locations map for the studied sites in W. El Atshan area, Central Eastern Desert, Egypt.....	115
IV-9: Analysis of the normal fault planes data corresponding to NW-SE, NNW- SSE to WNW-ESE tension paleostress tensors in younger granites, W. El Atshan area.....	117
IV-10: Analysis of the normal fault planes data corresponding to N-S tension paleostress tensors in younger granites, W. El Atshan area.....	118
IV-11: Analysis of the normal fault planes data corresponding to E-W tension paleostress tensors in younger granites, W. El Atshan area.....	119
IV-12: Analysis of the normal fault planes data corresponding to NNE-SSW to ENE-WSW tension paleostress tensors in younger granites, W. El Atshan area.....	120

Figure no.	Page
IV-13 : Analysis of the strike slip and reverse fault planes data corresponding to N-S to NW-SE compression paleostress tensors in younger granites, W. El Atshan area.....	122
IV-14 : Analysis of the strike slip and reverse fault planes data corresponding to E-W compression paleostress tensors in younger granites, W. El Atshan area.....	123
IV-15 : Analysis of the strike slip and reverse fault planes data corresponding to NNE-SSW to NE-SW compression paleostress tensors in younger granites, W. El Atshan area.....	124
IV-16: Analysis of the normal fault planes data corresponding to ENE-WSW to NE-SW tension paleostress tensors in trachyte, W. El Atshan area.....	127
IV-17: Analysis of the normal fault planes data corresponding to N-S tension paleostress tensors in trachyte, W. El Atshan area.....	128
IV-18: Analysis of the normal fault planes data corresponding to WNW-ESE to E-W tension paleostress tensors in trachyte, W. El Atshan area.....	129
IV-19 : Analysis of the strike slip and reverse fault planes data corresponding to NNE-SSW to ENE-WSW compression paleostress tensors in trachyte , W. El Atshan area.....	131
IV-20 : Analysis of the strike slip and reverse fault planes data corresponding to WNW to NW-SE compression paleostress tensors in trachyte , W. El Atshan area.....	132
IV-21: Analysis of the strike slip and reverse fault planes data corresponding to E-W compression paleostress tensors in trachyte , W. El Atshan area.....	134
IV-22: Analysis of the strike slip fault planes data corresponding to N-S compression paleostress tensors in trachyte, W. El Atshan area.....	135
IV-23: Analysis of radioactive normal fault planes data and their paleostress tensors in trachyte, W. El Atshan area.....	136

Figure no.	Page
IV-24: Analysis of reactivated radioactive fault planes data and their paleostress tensors in trachyte, W. El Atshan area.....	137
IV-25: Analysis of the strike slip and reverse fault planes data corresponding to NE-SW to ENE-WSW compression paleostress tensors in Hammamat sedimentary rocks , W. El Atshan area.....	140
IV-26: Analysis of the strike slip and reverse fault planes data corresponding to E-W compression paleostress tensors in Hammamat sedimentary rocks , W. El Atshan area.....	141
IV-27: Analysis of the strike slip and reverse fault planes data corresponding to NNW-SSE to WNW-ESE compression paleostress tensors in Hammamat sedimentary rocks , W. El Atshan area.....	143
IV-28: Analysis of the strike slip and reverse fault planes data corresponding to N-S compression paleostress tensors in Hammamat sedimentary rocks , W. El Atshan area.....	144
IV-29: Analysis of the normal fault planes data corresponding to NNW-SSE to NW-SE tension paleostress tensors in Hammamat sedimentary rocks, W. El Atshan area.....	145
IV-30: Analysis of the normal fault planes data corresponding to E-W tension paleostress tensors in Hammamat sedimentary rocks, W. El Atshan area.....	147
IV-31: Analysis of the normal fault planes data corresponding to NE-SW to ENE-WSW tension paleostress tensors in Hammamat sedimentary rocks, W. El Atshan area.....	148
IV-32: Analysis of the normal fault planes data corresponding to N-S tension paleostress tensors in Hammamat sedimentary rocks, W. El Atshan area.	149

Figure no.	page
IV-33a: Rose diagram for joints in metasediment-metavolcanic associations (vector mean is N-S trend).....	155
IV-33b: Rose diagram for joints in older granites (vector mean is ENE trend).....	155
IV-33c: Rose diagram for joints in Hammamat sedimentary rocks (vector mean is NW trend).....	155
IV-33d: Rose diagram for joints in younger granites (vector mean is NE trend).....	155
IV-33e: Rose diagram for joints in trachyte (vector mean is NW trend).....	155
IV-34a: Contour diagram for an equal area stereographic projection of poles of shear joints in metasediment-metavolcanic associations at W. El Atshan area, lower hemisphere.....	156
IV-34b: Three principle stress axes for the two major conjugate sets of shear joints in metasediment–metavolcanic associations.....	156
IV-34c: Contour diagram for an equal area stereographic projection of poles of shear joints in older granites at W. El Atshan area, lower hemisphere.....	156
IV-34d: Three principle stress axes for the two major conjugate sets of shear joints in older granites.....	156
IV-35a: Contour diagram for an equal area stereographic projection of poles of shear joints in Hammamat sedimentary rocks at W. El Atshan area.	158
IV-35b: Three principle stress axes for the two major conjugate sets of shear joints in Hammamat sedimentary rocks.....	158
IV-35c: Contour diagram for an equal area stereographic projection of poles of shear joints in younger granites at W. El Atshan area, lower hemisphere.....	158
IV-35d: Three principle stress axes for the two major conjugate sets of shear joints in younger granites.....	158
IV-36a: Contour diagram for an equal area stereographic projection of poles of shear joints in post granitic dyke (trachyte) at W. El Atshan area.....	161

Figure no.	Page
IV-36b: Three principle stress axes for the two major conjugate sets of shear joints in post granitic dyke (trachyte).....	161
IV-37a: Three principle stress axes for the two major conjugate sets of shear joints in metasediment –metavolcanic associations.....	162
IV-37b: Three principle stress axes for the two major conjugate sets of shear joints in older granites.....	162
IV-37c: Three principle stress axes for the two major conjugate sets of shear joints in Hammamat sedimentary rocks.....	162
IV-37d: Three principle stress axes for the two major conjugate sets of shear joints in younger granites.....	162
IV-37e: Three principle stress axes for the two major conjugate sets of shear joints in post granitic dykes (trachyte).....	162
IV-38 :(a.) The orientation of the maximum principle compressive stress with respect to a shear zone and the strain ellipse associated with the first increment of shear deformation. The eccentricity of the ellipse is exaggerated for clarity. (b- f) The formation of en echelon tension gashes within a shear zone in response to this stress.....	165
IV-39a: Three principle stress axes for shear zone plane with tension quartz vein in Hammamat sedimentary rocks.....	167
IV-39b: Three principle stress axes for shear zone plane with tension quartz vein in younger granites.....	167
V.1:- Bar diagram showing the distribution of normal gamma radioactivity in different rock types at W. El Atshan area.....	171
V-2a: Frequency histograms for the distribution of ground gamma radioactivity by Ur of metasediment-metavolcanic rocks at W. El Atshan area.....	172

Figure no.	Page
V-2b: Frequency histograms for the distribution of ground gamma radioactivity by Ur of quartz diorite to granodiorite at W. El Atshan area.....	172
V-2c: Frequency histograms for the distribution of ground gamma radioactivity by Ur of Hammamat sedimentary rocks at W. El Atshan area.....	172
V-2d: Frequency histograms for the distribution of ground gamma radioactivity by Ur of monzogranites at W. El Atshan area.....	172
V-2e: Frequency histograms for the distribution of ground gamma radioactivity by Ur of normal trachyte at W. El Atshan area.....	172
V-3: Geological sketch map of anomaly (No.II), W. El Atshan area.....	188
V.4: Isorad map of anomaly (No.II), W. El Atshan area.....	188
V.5: Geological sketch map of anomaly (No.III), W. El Atshan area.....	189
V.6: Isorad map of anomaly (No.III), W. El Atshan area.....	189
V.7:- Geological sketch map of anomaly (No.V), W. El Atshan area.....	191
V.8:- Isorad map of anomaly (No.V), W. El Atshan area.....	191
V.9:- Geological sketch map of anomaly (No.VI), W. El Atshan area.....	192
V.10:- Isorad map of anomaly (No.VI), W. El Atshan area.....	192
V.11:- Isorad map shows the radiometric distribution for W. El Atshan area.....	194

(In The Pocket)

Figure IV-I: - Structural map of Wadi El Atshan area, Central Eastern Desert, Egypt.

Figure IV-II: - Detailed structural map of metasediment-metavolcanic associations belt.

LIST OF TABLES

Table No.	Page
Table (I-1): The main classifications of the Egyptian basement rocks.....	8
Table (I-2): Classification of the Egyptian shield rocks.....	9
Table (I-3): Classification and characterization of the..... shield rocks of Egypt.....	10
Table (I-4): The main classifications of the Egyptian Granitoids.....	16
Table III 1: Modal analysis of the studied granitic rocks,..... W. El Atshan area.....	69
Table IV-1:- Structural fabric elements in domain (I) of metasediment- metavolcanic associations.....	91
Table IV-2:- Structural fabric elements in domains (II) and (III) of metasediment-metavolcanic associations.....	92
Table IV-3:- Structural fabric elements in domains (IV) and (V) of metasediment-metavolcanic associations.....	93
Table IV-4:- Structural fabric elements in domain (VI) of metasediment- metavolcanic associations.....	94
Table.V.1: Ranges of gamma radioactivity in Ur of the different rock types, Wadi El Atshan area.....	171
Table.V.2: Radiometric analyses of some samples collected from Wadi El Atshan area.....	173,174
Table.V.3 Radiometric analyses of samples collected from radioactive anomalies in trachyte, W. El Atshan area.....	186

LIST OF PLATES

Plate No.	Page
II-1a: Foliations and recumbent fold in muscovite schist at W. Um Guruf, W. El Atshan area, looking SW.....	37
II-1b: The contact between granodiorite (Gr) and metasediments (M.S.) at W. Um Guruf, W. El Atshan area, looking NE.....	37
II-1c: Intermediate metavolcanics covered by screes of their weathering products at W. Um Guruf, W El Atshan area, looking SW	37
II-1d: Alternation of basic (B.mv) and intermediate (I.mv) metavolcanics at W. Um Guruf, W. El Atshan area, looking NW.....	37
II-2a: Interlayering between metavolcanics (M.V.) and metasediments (M.S.) at W. Um Guruf, W. El Atshan area, looking SW.....	38
II-2b: Hammamat sedimentary sequence (Ha) unconformably overlaying metasediment-metavolcanic associations (M.s-v) at W. Um Guruf, W. El Atshan area, looking NW.....	38
II-2c: Serpentinized rocks (S) or lens trending N-S at W. Um Guruf, W. El Atshan area, looking SE.....	38
II-2d: Hammamat sedimentary sequence (Ha) unconformably overly quartz diorite (Q.D) along W. El Atshan, W. El Atshan area, looking NE.....	38
II-3a: Cold sharp intrusive contact between granodiorite (Gr) and Metasediments (M.S) at W. Um Guruf, W. El Atshan area, looking NE.....	39
II-3b: Quartz vein sets trending NE traversed through granodiorite, at W. Um Guruf, W. El Atshan area, looking SW.....	39
II- 3c: Repeated cycles of siltstone (Si) and sandstone (Sa) in Hammamat sedimentary sequence at W. Um Gir, W. El Atshan area, looking NW.....	39
II- 3d: Purple (Igla Formation) and green (Shihimya Formation) beds of Hammamat sedimentary rocks, at W. El Ghawaby, W. El Atshan area, looking E.....	39