CHAPTER ONE

INTRODUCTION

The present work deals with the geological setting and radio-elements distribution in Gabal (G.) El Resha – Wadi (W.) El Atrash area, north Eastern Desert (NED), Egypt.

The study area is delineated by latitudes, 27º 06′ 00″ - 27º 15′ 00″ N, and longitudes 33º 00′ 00″ - 33º 11′ 30″ E (Fig. 1). It covers an area of about 414 Km^2, mainly occupied by the Neoproterozoic Pan-African basement rocks.

1.1. Topography and Accessibility

The area under investigation is covered by Late Precambrian crystalline basement rocks of a relatively high and rugged topography. G. Um Guruf (1089 m.a.s.l.), G. Al Hamra (968 m.a.s.l.) and G. El-Resha (869 m.a.s.l.) represent the most pronounced peaks. They are occupying the central and southern parts of the area.

Several main wadis pass through the area, such as W. El Atrash and W. Um Khurs. They run nearly in a N-S direction. W. Hamad and W. Abu Harbah are running in a NE-SW direction. While W. Al-Misdar is running roughly in an E-W direction (Fig. 2). These wadis are filled with rock debris derived from the basement country rocks.

The study area can be reached from the famous Hurghada City on the Red Sea coast, through a desert track passing through W. Bali and then northward to the track of W. El Atrash, from which to the study area. The area is arid, very hot in summer and cold in winter. Cultivation and natural vegetation are scarce, except some grasses and scattered trees.

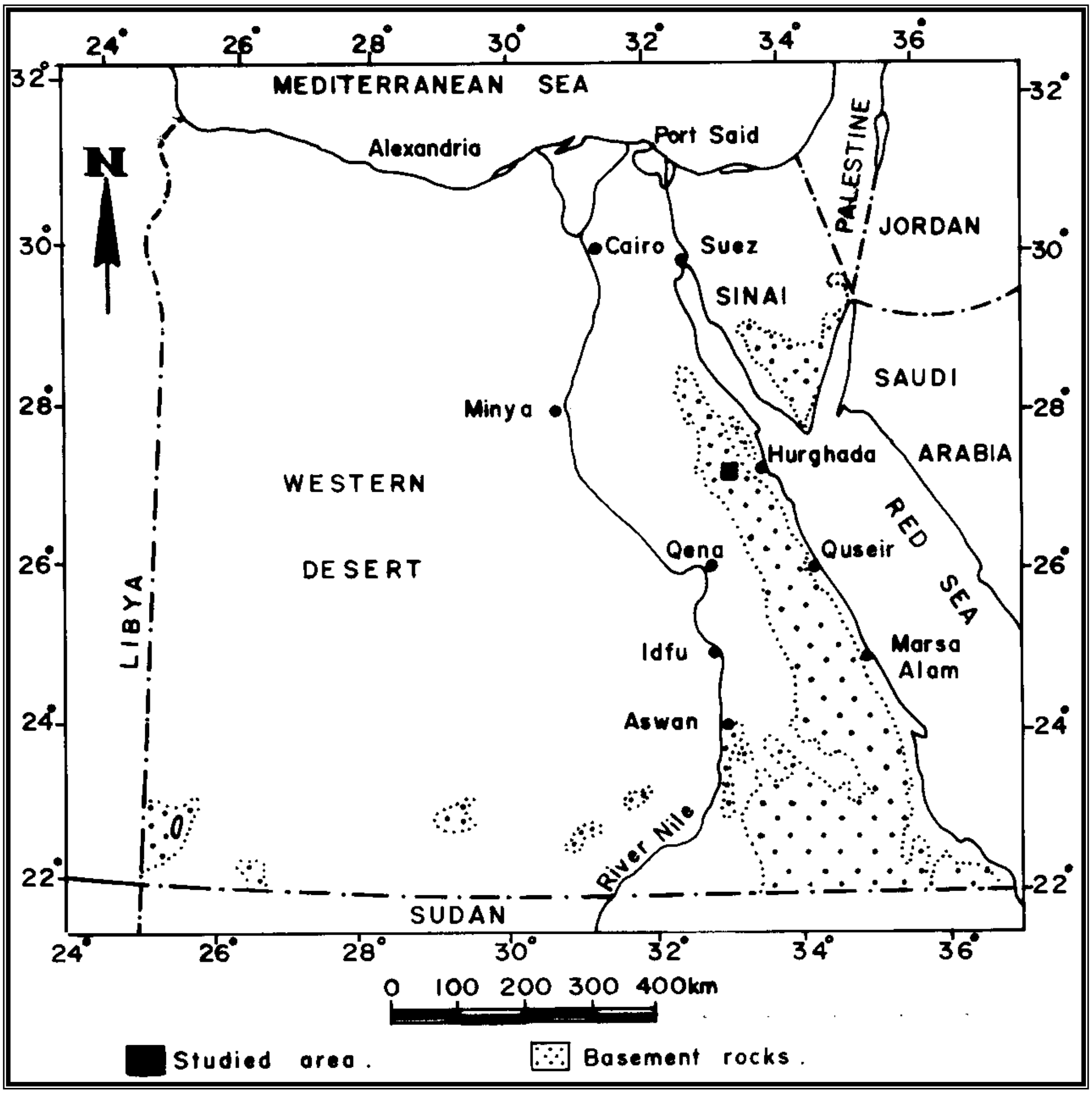

Fig. (1): Location map of G. El Resha-W. El Atrash area, north Eastern Desert, Egypt.

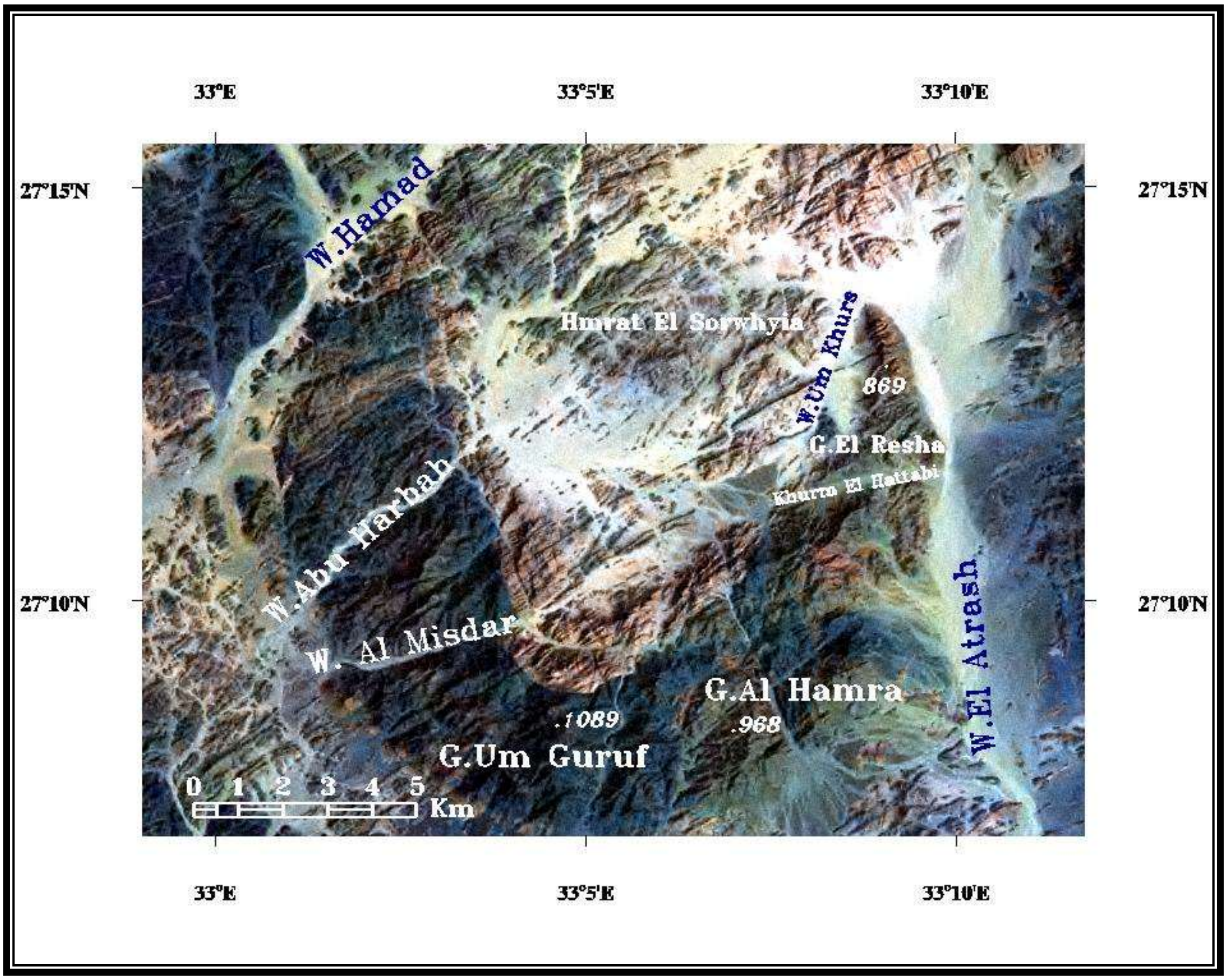

Fig. (2): Landsat Satellite Image of G. El Resha-W. El Atrash area, north Eastern Desert, Egypt, showing the directions of the main wadis.

1.2. Synopsis on the Basement Rocks of Egypt

The Arabian-Nubian Shield occupies the northeastern part of Africa and the western part of the Arabian Peninsula (Fig. 3). There is now general agreement that the Arabian-Nubian Shield represents one of the best documented examples of Late Proterozoic to Early Paleozoic (Pan-African, 950-450 Ma age; Kroner, 1984) crustal growth through processes of lateral arc-arc terrane accretion, comparable to the present evolution of the SW pacific (Roobol et al., 1983; Camp 1984; Kroner, 1985; Stoeser and Camp, 1985). The term Pan-African was originally proposed by Kennedy (1964) to denote a specific tectono-thermal event nearly at the close of the Precambrian, 400-600 Ma age, which caused deformation and remobilization of Archaean and Proterozoic, metamorphism to higher grades as well as migmatization, anatexis and wide scale intrusions of granites. The construction of the Arabian-Nubian Shield during the Pan-African Orogeny offers an excellent opportunity to study the formation of continental crust. Studying the petrogenesis and tectonic setting of volcanic sequences in which these rocks were erupted, as well as determining their magma source are crucial for reliable reconstruction of crustal evolutionary pathways. Besides, a mantle-derived magma interacted with an older continental crust is important for addressing the controversy of whether the Arabian-Nubian Shield is a juvenile crust or involved reworking of substantial amounts of older continental crust. The basement complex of Egypt, that forms a part of the Arabian-Nubian Shield, is predominantly composed of volcanosedimentary sequences. These supracrustal rock types extend from primitive oceanic island arcs to higher evolved continental arcs (Gass, 1982; Camp, 1984). The later stages of magmatic activity were characterized by the emplacement of post-orogenic alkali granites and

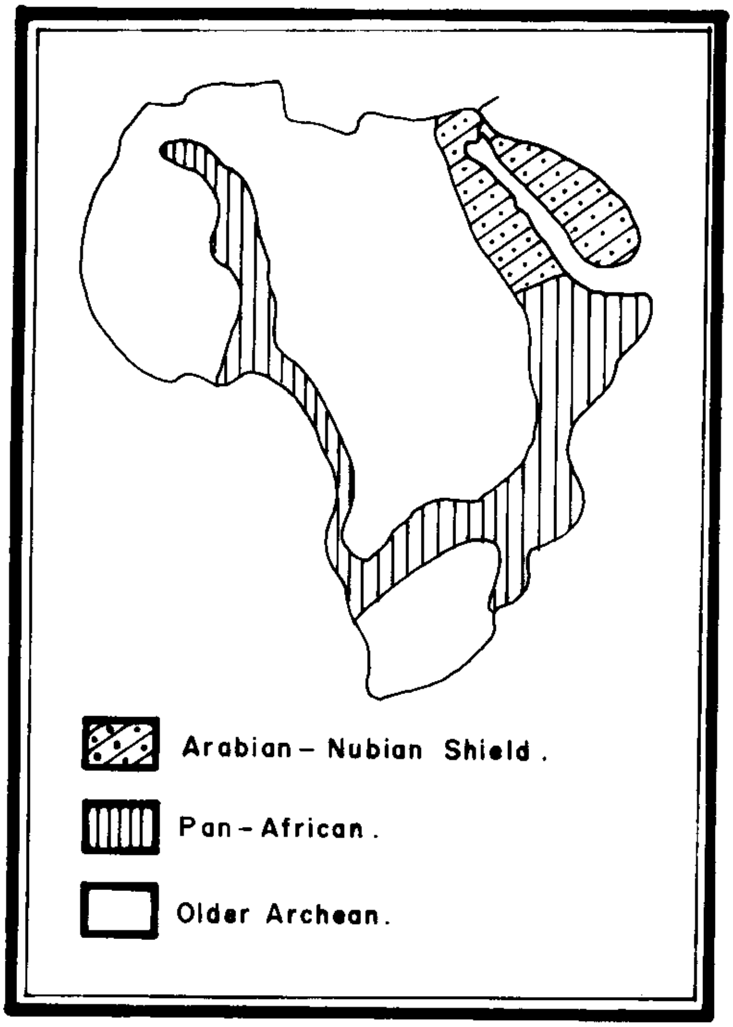

Fig. (3): Distribution of the Pan-African rocks (after Engel et al., 1980).

synchronous dykes during events of crustal extension, affecting vast areas of the Eastern Desert of Egypt and Central Arabia by the end of the Pan-African Orogeny (Stern, 1985; Stern and Hedge, 1985).

The Late Proterozoic Pan-African rocks occupy about one tenth of the land surface of Egypt. They form mountainous terrains in the Eastern Desert and south Sinai, as well as a limited area in the southwestern corner of the Western Desert (Oweinat area).

Klerks and Deutsch (1977) dated the high-grade charnokitic gneisses at G. El Oweinat in the extreme southwestern part of the Western Desert and gave them an age up to 2673 ± 21 Ma.

Schandelmeier and Darbyshire (1984) suggested that the basement rocks exposed at G. El Oweinat area are the oldest among the basement rocks of Egypt and are thought to be old continental Pre-Pan-African rocks.

The basement rocks represent the northeastern part of the Pan-African orogenic belt that displays evidence of a complex crustal evolution which took place in several phases during the period from 1100 Ma to about 450 Ma age (Kennedy, 1964; Kroner, 1981). Igneous and tectonic processes in this region resulted in the development of primitive ensimatic crustal terrains, which were formed collapsed together and were engulfed by granites during the final 400 Ma of the Precambrian (Engle et al., 1980).

The basement rocks in the Eastern Desert extend as a belt parallel to the Red Sea coast for a distance of about 800 km between latitudes 22° 00′ 00″ and 28° 40′ 00″ N. The rocks are unconformably overlain on their western and eastern margins by Nubian sandstone, Miocene and younger sediments.

Geographically, Qena-Safaga and Aswan-Ras Banas roads divide the Eastern Desert into three domains namely, the northern Eastern Desert

(NED), central Eastern Desert (CED) and southern Eastern Desert (SED); these domains were developed in different tectonic settings in an independent, but a very similar manner (Kroner et al., 1987) and show a characteristic younging from (SED) to (NED). Geologically, these domains also differ from each other to their main exposed rock types.

The SED, south of Aswan-Ras Banas, south of lat. 24º 30´ N, is dominated by Pre-Pan-African rocks of gneisses, migmatites and schists as the oldest rock types, followed by arc assemblages of Pan-African ophiolitic rocks and intrusive granitoids. The presence of older granitoids in this domain is more than the younger granites (Akaad and El Ramly, 1960). Reliable radiometric ages, 800 Ma to 580 Ma (Hashad et al., 1972; Dixon, 1981; Stern and Hedge, 1985), have been given to the rocks.

The amount of Pan-African ophiolites increases and forms with the arc metavolcanic the main types in the CED, between Aswan-Ras Banas and Qena-Safaga roads, between lat. 25º 00´ to the south of lat. 27º 00´ N. (Skackelton et al., 1980; Church, 1983, Ries et al., 1983; and El Gaby et al., 1990). The ophiolites and the metavolcanics are occasionally unconformably overlain by Dokhan volcanics and molasse sediments (Hammamat sediments). The older gneisses and migmatites form prominent domal structures, e.g. G. Meatiq (Struchio et al., 1983; Habib et al., 1985 and El Gaby et al., 1988) and G. El Shalul (Hamimi et al., 1994). Older granitoids and younger pink granites are also present.

The NED, north of Qena-Safaga road, north of lat. 27º 00′ is characterized by the presence of the younger rocks, such as younger Gattarian granites, Dokhan volcanics and Hammamat molasse sediments, while the older rock types are rarely occurred. The oldest rocks exposed are granodiorites, 610 – 680 Ma in age (Stern and Hedge 1985).

El Gaby (1994) considered Qena-Safaga road as a megashear that separates the NED from CED. This megashear causes an uplift of the

NED against the CED and then the erosion form strong up-heaving for the older rocks (ophiolites, arc volcanics and schists) and swept them away and consequently exposed the roots of the younger granitic batholiths dominating the NED.

Stern and Hedge (1985) proved that the ages determined indicated a general progression with time of igneous activity from south to north. In addition to the restricted distribution of the oldest rocks to the south and the youngest rocks to the north, the most intense magmatic episodes also appear to have migrated northward with time. The bulk of the crust of the SED was created prior to 650 Ma, while the major pulses of the CED occurred in the interval (685 to 575 Ma). In the NED and Sinai, the crust was principally formed in the period (625 to 575 Ma).

Several attempts have been made to classify the basement rocks and to elucidate the geologic and tectonic history of the Precambrian rocks in Egypt. Some of these classifications are based on the classical geosynclinal concept (e.g. Hume, 1934; Akaad and El Ramly, 1960; El Shazly, 1964; El Ramly, 1972; Akaad and Noweir, 1969, 1980; Akaad, 1996). In the light of the plate tectonic concept, some classifications are proposed to interpret the crustal evolution of the basement rocks in Egypt, (e.g. Ries et al., 1983 and El Gaby et al., 1984 and 1988 and Ragab et al., 1993).

Hume (1935) classified the basement rocks of Egypt into four main divisions:

4- Late Precambrian (Qattarian)……………………………….(youngest)

3- Eparchean

2- Metarchean

1- Protarchean ……………………………………………….(oldest)

He presented a model for the evolution of the basement rocks and believed that Qattarian plutonic rocks were intruded into Archean sedimentary and volcanic series.

Schürmann (1966) classified the basement rocks along the Gulf of Suez and the northern part of the Red Sea into Meatiq gneiss series (oldest), Atalla series, Shaitian series, Abu Had series, Shadli series, Dokhan series, Lower Qattarian series, Hammamat series and Upper Qattarian series (youngest). He placed the Hammamat series between the lower and upper Qattarian.

El Ramly (1972) compiled a geologic map for the basement rocks (scale 1: 1000, 000) and gave a new classification for the basement. A younger gabbroic type is included in this classification.

On the other hand, more recent classifications introduced the aspects of plate tectonics after recording ophiolites in the Eastern Desert.

Ries et al. (1983) considered the Meatiq group to be the oldest type, followed by the ophiolitic melange, tonalite-quartz diorite (of about 987-700 Ma age), and syntectonic to late tectonic granodiorites, Dokhan volcanics, Hammamat group, younger granites (615-570 Ma age) and alkali granites.

Bentor (1985) proposed four main evolutionary phases for the development of the Egyptian shield rocks:

1- An oceanic phase (about 1100-900 Ma age), represented by the emplacement of oceanic tholeiites, mainly pillow basalts and their plutonic equivalents.
2- An island arc phase (about 950-650 Ma age), manifested by andesitic volcanism and dioritic intrusions.
3- A calc-alkaline, silica-rich magmas and the cratonization of the shield.
4- A per-alkaline batholithic phase (about 590-550 Ma age), produced per-alkaline high-level granites and rhyolites.

El Gaby et al. (1988) classified the basement rocks in Egypt into four main groups, starting with the oldest:

1- Pre-Pan-African granites, gneisses and schists and their mylonitized and remobilized equivalents.
2- Pan-African ophiolites and island arc assemblage.
3- Dokhan volcanics and molasse-type Hammamat sediments.
4- Foreland assemblage of Wadi Allaqi.

The second group was thrusted from the east over the Pre-Pan-African rocks, which were largely mylonitized at shallow depths or remobilized at greater depths.

The application of the plate tectonic theory threw more light on the evolutionary history of Egyptian basement complex.

Ragab et al. (1993) classified the basement rocks of Egypt into: Pre-Pan-African rocks (oldest), Pan-African rock assemblages and Post-Pan-African magmatism (youngest).

Takla and Hussein (1995) proposed a simplified tectono-stratigraphic classification of shield rocks of Egypt (Table 1).

Moustafa (1996) classified the Eastern Desert into different petrotectonic rock assemblages bounded together by regional shear-zone mostly of thrust type displaying sinuous folded and thrust belt extended in NW-SE direction and generally steep dipping to NE direction.

Akaad (1996) has proposed the following orogenic stages subsequent to the formation of the arc systems:

A- Accretionary-transpressional main stage of the orogeny:

1- Disruption of the oceanic crust and its up thrusting into and/or onto the magmatic arcs and accretion against a Pre-Pan-African craton to the west.
2- Extended emplacement of huge syn-orogenic plutons (older granites) affecting the initial stage of cratonization.

3- Regional fault-thrust-shear movements affecting some members of the older granites.

B- Post-accretionary stage of orogeny:

1- Regional dilatory uplift and rift affect the newly cratonized basement and its segmentation into new-born mountains and intermountain tectonic depressions.

2- Late (second) episode of folding and thrusting marked by drastic folding of the Hammamat Group and earlier formations.

3- Extended transpressional-extensional phase, including prolonged emplacement of calc-alkaline to alkaline younger granites to alkali granites.

De Wall et al. (2001) characterize the nature of the prominent Late Pan-African Hamizana high strain zone by applying the anisotropy of magnetic susceptibility method along with field and microstructural investigations. They demonstrated that deformation in the Hamizana shear zone is dominated by pure shear under upper greenschist/ amphibolite grade metamorphic conditions, producing E-W shortening, but with a strong N-S extensional component. This deformation also led to folding of regional-scale thrusts. Consequently, the high strain deformation is younger than ophiolite emplacement and suturing of terranes.

Hamimi and El Kazzaz (2002) studied the geometry and mechanical relations between Pan-African thrusting and folding in Um Shilman area, (SED) of Egypt, and performed a physical model. Their model highlighted how that thrust-related folds evolved and nucleated progressively from layer-parallel shortening developed into decollement folding, thrust ramp folding and finally underwent foreland ward translation by thrust-tip folding.

Table (1): Classification of the Egyptian shield rocks (Takla and Hussein, 1995).

IV- Continental margins-within plate magmatism and sedimentation
- Younger "G_{II}" granites
- Younger gabbros
- Hammamat sediments "Clastic molasse facies"
-Younger volcanics "Basaltic andesite – andesite - rhyolite* association"
III- Older " G_I" granitoids "Diorite-tonalite-granodiorite association"
II- Ophiolitic melange and island arc association
- Metasediments
- Intermediate to felsic metavolcanics and metapyroclastics
- Ophiolitic mafic volcanics
- Ophiolitic metagabbros
- Metaultramafites
----------------------------- Thrust contact ---------------------------------
I- Gneisses, migmatites, amphibolites and high grade schists
N.B. Pre – Pan-African (association I)
Pan-African (associations II, III and IV)
*Rhyolite is post Hammamat

1.3. Previous work on the study area and Its Environs

The literatures on the NED, including the study area, are few in number if compared with the published works on the central and southern parts of the Eastern Desert. Some localities, such as G. Abu Harbah (1705 m), G. Dokhan (1661 m), G. Um Tawat (1655 m), G. Gattar (1963 m), and the area of W. Hamad (Fig. 4), which lie around the area under investigation, have attracted the attention of the earlier geologists. A brief review of some of these studies is given in the following paragraphs

Hume (1935) studied the basement complex of Egypt including the northern part of the Eastern Desert. He noted that the younger granites are the most predominant and well exposed in the NED of Egypt north of latitude 27º 00′ N. The older metamorphosed rocks are dominated in the central and southern parts of Eastern Desert.

Ghobrial and Lotfi (1967) studied the geology and petrography of G. Gattar and G. Dokhan area. They classified the rocks of the area into slightly metamorphosed sediments, resembling those of the Hammamat sediments group, including slates, schists, greywackes and conglomerates, in addition to the volcanic series of Gabal Dokhan volcanic tuffs, andesite porphry, Imperial porphry, dacite, quartz- diorite porphry, and vesicular porphyritic andesite. They (op.cit.) also reported dioritic rocks including both quartz-diorites and diorite, Gattarian type granites comprising grey, pink and red granites and dyke swarms traversing the area.

Dardir and Abu Zeid (1972) studied the geology of the basement rocks in the Eastern Desert between 27º 00´ and 27º 30´ N. They published a geologic map on a scale 1:100,000. They classified the rocks of the area into: metavolcanics, diorite-granodiorite rocks, Dokhan volcanics, felsites, Hammamat sediments and equivalent rocks, gabbros, different types of younger granites and post granite dykes. They described

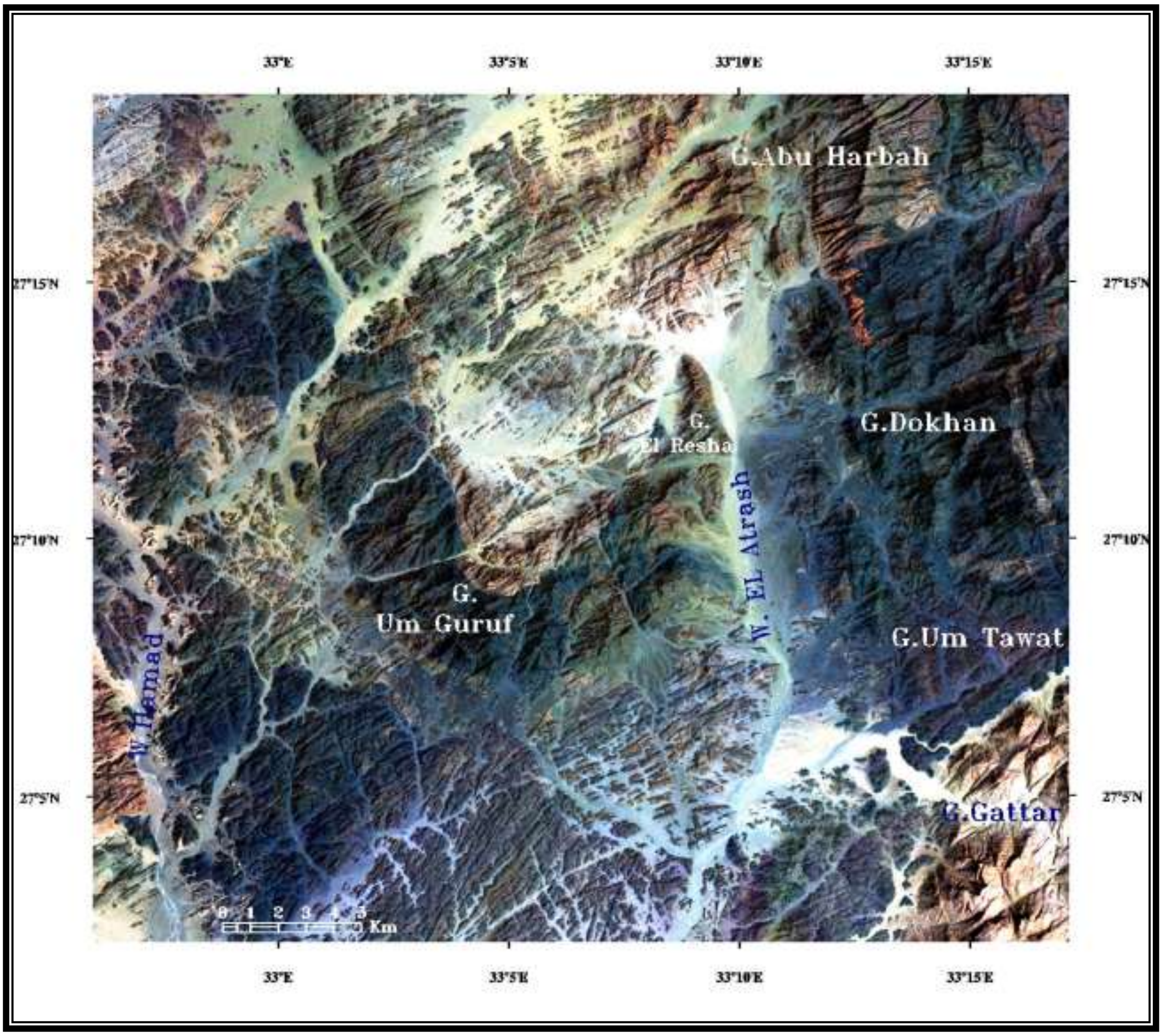

Fig (4): Landsat Satellite Image of G. El Resha-W. El Atrash area and its environs.

G. El Resha as felsite sheet, while Abd El Nabi and Prokhorov (1977) identified it as granophyric microgranite.

Dardier (1973) related both the Dokhan volcanics and the Hammamat sediments to the consolidation stage of orogeny. The rocks were described as being essentially unmetamorphosed and belonging to epeirogenic phase with an age of 600-700 Ma (Akaad and Noweir, 1985). Later, several authors gave ages for the Dokhan volcanics ranging between 639 Ma and 581 Ma (Dixon, 1981; Bentor, 1985; Stern and Hedge, 1985).

Sabet et al. (1977) studied the structure controls in the NED. They mentioned that, in most cases, the intersection of NNW-SSE and NE-SW faults is followed by the intrusion of some late tectonic granite masses.

Basta et al. (1979) studied the Dokhan volcanics at its type locality, G. El Dokhan, and classified them petrographically into andesite, quartz andesite (including the Imperial porphyry), dacite, rhyodacite, quartz trachyte and pyroclastics. The former three rock types are the most dominant. Accordingly, the Imperial porphyry contains appreciable amounts of piedmontite (withamite) and basaltic hornblende that are responsible for the characteristic purple colour. These andesitic Dokhan volcanics occasionally suffered some propylitization that can be considered as a post-magmatic regional metasomatic process.

Abu El Leil (1980) classified the granitic rocks in the northern part of the basement complex of Egypt into two phases comprising four granite varieties. He proposed that the granite varieties are differentiated forming a continuous granitic series according to the following sequence; biotite-hornblende adamellite, coarse-grained calc-alkaline granites, coarse-grained alkali-calcic-alkaline granites and/or medium-grained alkali-calcic-alkaline granites.

Basta et al. (1980) studied the petrochemical and geochemical characteristics of Dokhan volcanics. They suggested that these volcanics have a non-iron concentration trend and are calc-alkaline with mild tholeiitic tendency.

Mussa and Abu El Leil (1983) concluded that the NE-SW, NW-SE and the N-S trends of the different types of mineralization coincide with the corresponding fault trends in the northern parts of the Eastern Desert.

Stern and Gottfried (1986) re-interpreted the Dokhan volcanics and pink granites as extrusive and intrusive components of a bimodal suite and these rock associations occurred in a strongly extensional environment during the interval 575-600 Ma.

Willis et al. (1988) divided the Hammamat series in the NED into two parts; a lower part composed mainly of polymictic breccias derived from rapid uplift and erosion of a nearby "ensimatic" terrain and an upper part composed of sandstone and shale. These sediments contain granitic clasts derived from rapid reworking of bimodal igneous rocks; Dokhan volcanics and pink granite. They attributed the Hammamat deposition to an extensional tectonic environment some 590 Ma ago.

Stern et al. (1988) studied the bimodal dyke swarms in the NED, at the area of W. El Atrash and east of W. Hamad. They concluded that the dyke swarms 590 Ma represent evidence of NW-SE directed crustal extension accompanied by bimodal igneous activity. The mafic dykes represent hypabyssal conduits for surfacial eruptions of the Dokhan volcanics, while the felsic dykes, namely rhyolites, could represent the feeders of the magma of the younger granites.

Salman et al. (1990) discovered uranium mineralization in G. Gattar massif and gave a short account on the geology of the area and a brief description of the discovered mineralizations.

Shalaby (1990) concluded that G. Gattar granites can be considered as fertile uraniferous granite forming a potential source of uranium by the effects of hydrothermal circulating fluids. Uranium was mobilized by leaching and redeposited along cracks and fissures.

Abu Zeid (1991) stated that the Dokhan volcanics evolved in subduction related volcanic arc environment on a crustal thickness intermediate between island arc and active continental margin setting during the final stages of the late Precambrian Pan-African Orogeny in Egypt.

El Sharkawy et al. (1991) distinguished two contrasting volcanic rock sequences of G. Dokhan volcanics: (1) an old slightly metamorphosed (lower green schist facies) Dokhan volcanics subduction related sequence and (2) a younger unmetamorphosed volcanic sequence which is tied to an extensional tectonic regime.

Nossair (1993) studied the geology and radioactivity of G. Abu Harbah granites. He stated that it is essentially formed of two different types of granites emplaced from two successive phases of igneous activity. The late leucogranite is relatively high in its background radioactivity relative to the early hornblende-biotite granite. The author added that abnormal values and secondary U-minerals, uranophane and β-uranophane, are recorded. Their distribution is structurally controlled by NNW-SSE and NE to ENE major fractures.

Hussein et al. (1995) studied the felsite rocks, north of G. Um Guruf area. They divided them into two generations: -

1- The pre-Hammamat older felsites, are exposed at G. El Resha and G. Um Guruf, that form large size intrusives cutting through the older granites and Dokhan volcanics

2- The post-granite younger felsites, that occurs mainly as dykes cutting through the older felsites and younger granites.

Khamis (1995) studied the radioactivity and structure of W. Hamad area that lies to the west of the study area. He classified the rock types as follows, (from oldest to youngest); metasediments-metavolcanics associations, metagabbro-diorite complex, older granitoids (G_1), Dokhan volcanics, younger granite (G_2) and post granite dykes. He also discovered four radioactive anomalies in the younger granites, three of them at G. El Guluf. He added that the areas of anomalous radioactivity are structurally controlled by joint sets trending N-S, NNE-SSW and NNW-SSE.

Nossair (1996) studied the structural analyses of the basement rocks between latitudes 28º 00″ – 28º 30″ N, and its relation to radioactivity. He stated that three prevailing joint sets following NNE-SSW, NE-SW and NNW-SSE can be distinguished. The NE-SW, NNW-SSE and NW-SE directions are the most common fault trends. He added that the NNW-SSE, NW-SE and N-S fractures are the main trends controlling most of the recorded radioactive anomalies and occurrences.

El Feky (1996) studied the geology, petrography and geochemistry of the different types exposed in Um Guruf area. He classified them as follows, (from oldest to youngest); older granitoids (granodiorite), Dokhan volcanics, Hammamat molasse sediments, younger gabbros, younger granites and dykes (felsic dykes and basic dykes). The same author classified the felsic dykes into granophre and quartz feldspar porphyry, and basic dykes into dolerite and basalt.

Wetait (1997) studied petrology, geochemistry and tectonic evolution of the Pan-African rocks of W. Um Balad – W. El Urf area, NED. He stated that the area is covered by volcanosedimentary succession intruded by younger gabbro-diorite and younger granites during the Pan - African orogeny. The volcanics are of Dokhan type including andesite, dacite and rhyodacite ignimbrite. They are partly synchronous with the Hammamat sediments include conglomerates interbedded with greywackes, siltstone and tuffs deposited in intermontain basin in a fluviatile environment.

Nossair (1998) mentioned that G. Abu Harbah is formed of two successive younger granite phases, namely biotite- hornblende granite and biotite granite with a hybrid zone between them. He added that these two phases belong to the A-type uraniferous granites.

Moussa (1998) carried out geochronological studies on some granitoid rocks in the NED of Egypt. He reported Rb-Sr age of 841 Ma for the older granites, while the younger granites are restricted between 641 and 556 Ma.

El Kholy (1999) mentioned that the Dokhan volcanics are mainly composed of andesites, dacites, rhyodacites and rhyolites. He also stated that G. Um Tawat Hammamat sedimentary rocks are composed of conglomerates, greywackes and siltstones.

Nossair and El Galy (1999) classified the granitic rocks intruding G. Dokhan volcanics into three types; granodiorite, monzogranite and syenogranite. They also stated that the most secondary products, silicification, chloritization and albitization are related to the hydrothermal processes. These alteration products are more common in the granodiorites.

Khalaf and Ammar (2000) mentioned that Um Guruf volcanics and Dokhan volcanics in general, are deformed stratovolcanoes. These volcanics have erupted in an active continental margin environment at the end of the orogenic cycle into thick crust. The diversity of lava compositions within Dokhan volcanics is the result of several processes occurring in the crust and mantle.

Roz (2001) mentioned that the younger granites of G. Abu Harbah environs NED form cogenetic granite suite, ranging in composition from biotite granites to highly differentiated perthitic leucogranites. He also studied the uranium occurrences of G. Abu Harbah prospect, and discussed the probabilities that led to uranium enrichment of this granite.

Ayoub (2003) studied geology and radioactivity of the different basement rocks exposed in G. Um Tweir area that lies to the north of the investigated area. He classified the rocks of the area from oldest to youngest into; metavolcanics, quartz diorites, Dokhan volcanics, Hammamat sediments, gabbro-granophyre associations, younger granites and post granitic dykes. The same author mentioned that the three significant joint and fault sets predominate in the area are NE-SW, NW-SE and E-W for the joints, and NE-SW, N-S and ENE-WSW for the faults.

Moghazi et al. (2004) identified two distinct Pan-African granitoids suites at W. Hamad, NED: an arc-related granodiorite suite and post-orogenic younger granitoids suite. They also concluded that the granodiorite resembles I-type granite with calc-alkaline nature, while the younger granites have a highly fractionated calc-alkaline affinity similar to those of the post-orogenic A-type granite.

1.4. Aim and scope of the present study

The present thesis deals with the geological setting and radio-elements distribution at G. El Resha-W. El Atrash area in the NED of Egypt. The work was held to accomplish part of the program of the north Eastern Desert Development Department (NEEDD) of the Nuclear Materials Authority (NMA) of Egypt in carrying out field radiometric surveying of the basement rocks north of lat. 27° 00″ N.

The present work aim to:

1- Reviewing the previous works for the study area and its environs.
2- Construction of a photo-geological map for the area at a scale 1:40,000.
3- Studying the tectonic setting and structural elements of study area.
4- Detailed microscopic studies for the different rock exposures, with emphases on the granitic rocks.
5- Geochemical studies for the granitic rocks.
6- Radiometric field and laboratory studies for the different rock types with emphasis on the granitoid rocks.
7- Delineating factors controlling radio-elements distribution in the study area.
8- Integrated and interpretation of the obtained results on the light of the geological history of the area.

1.5. Methodology

In order to achieve the previous aims, extensive and detailed field works have been carried out through several field trips. Topographic sheet at a scale of 1: 50, 000 and aerial photographs at a scale of 1: 40, 000 were used during the field mapping.

The field radiometric study was carried out using GR-110 Portable Gamma Detector serial No. 24163. The recorded readings are statistically treated and some radiometric parameters are determined. Selected samples of the different rock types were radiometrically analyzed to detect their contents of U, Th and Ra in (ppm) and K (%).

More than 450 rock specimens representing metagabbros, older granitoids, Dokhan volcanics, Hammamat sedimentary rocks, younger granites and dykes were collected; from which 85 thin sections were prepared. The petrographic studies were carried out using Nikon

(Optiphot-Pot) Polarizing Microscope equipped with an automatic photomicrographic attachment (Microflex AFX-II).

Twenty-two samples, representing all granitic rocks and two samples from the radioactive pegmatites were selected for chemical analyses. The major element oxides were determined using wet chemical analysis technique (Shapiro and Brannock, 1962). The trace elements were analysed using the X- ray fluorescence technique (XRF) of Philips, model Pv 1410 together with a MO-target tube operated at 50 kv and 30 m A.

Electron Scanning Environmental Microscope (ESEM) was used to show the radioactive elements which are responsible for the high radioactivity in the pegmatites. All these analyses were carried out in the laboratories of the Nuclear Materials Authority (NMA), Egypt.