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CHAPTER I
INTRODUCTION

Ll. General Statement

Gabal (G.) Qattar granite as a type locality of Egyptian younger granite is considered a geologic interest that attracted the attention of most authers since the beginning of this century with the discovery of molybdenite deposits. The first description of the old mining operation in the area was given by Jenkins (1931) and later by Hume (1934).

During the last decades a high demand for the search of radioactive raw material, especially uranium, that used mainly for the production of electrical energy. Thus, a great effort had been exerted for uranium prospection and exploration, with the development of the known uranium occurrences in the Egyptian Eastern Desert that hosted by the younger granites.

The granite of G.Qattar is one of the most promising uranium mineralized prospects in Egypt, so the present work is carried out on the northern peripheral zone of G.Qattar area.

1.2. Location and Accessibility

North of Gabal Qattar is a part of Northern Eastern Desert, one of the three arc terranes of the Eastern Desert. These basement provinces represent the western segment of the Arabian-Nubian Shield. This area is delineated by latitude 27° 02' 00" and 27° 08' 00" N, and Longitude 33° 14' 00" and 33° 20' 00"E, covering about 300 km^2. It is located some 60 Km west of the famous Hurghada City at the Red Sea Coast.

The study area could be reached by using light and heavy cars, starting from circular road around Hurghada city, passing through ancient Hurghada—Qena track, running across Wadi Urn Deheiss south of Gabal Abu Shaar EL-Qiebly, then following Wadi Balih till Gabal Qattar (Fig.1.1).

1.3. Topography and Geomorphology

The area of study is characterized by mild to high topography. It includes some mountain ranges and peaks, such as Gabal Qattar 1963 m and Gabal Um Tawat 1655 m. The area is traversed by the major Wadi Balih which trends ENE-WSW and separates Gabal Um Tawat Hammamat Sediments form Gabal Qattar granites. Parallel to Wadi Balih, another important Wadi, Urn El Balad, is encountered. The later runs through the main exposures of the Hammamat sediments. The area is dissected also by Wadi Qattar which is directed WNW-ESE and considered as a tributary of Wadi EL-Atrash. Wadi Balih drains to the Red Sea, while the others draining towards the Nile Valley through Wadi Qena.

1.4. Climate

This area of Gabal Qattar as a part of Eastern Desert of Egypt is characterized by arid climatic conditions all over the year. It is dry and hot in summer and mild, rarely rainy in winter, with almost clear non-cloudy sky. The average temperature in the year is about 25 $^{\circ}$C, and the lowest is 6 $^{\circ}$C, the highest may reaches up to 50C in the summer.

Water resources are very rare in the area, where the nearest water wells (Bir) are Bir Qattar to the north west of Gabal Qattar, Bir Naggat to the south of Gabal Qattar and Bir Um Saida.

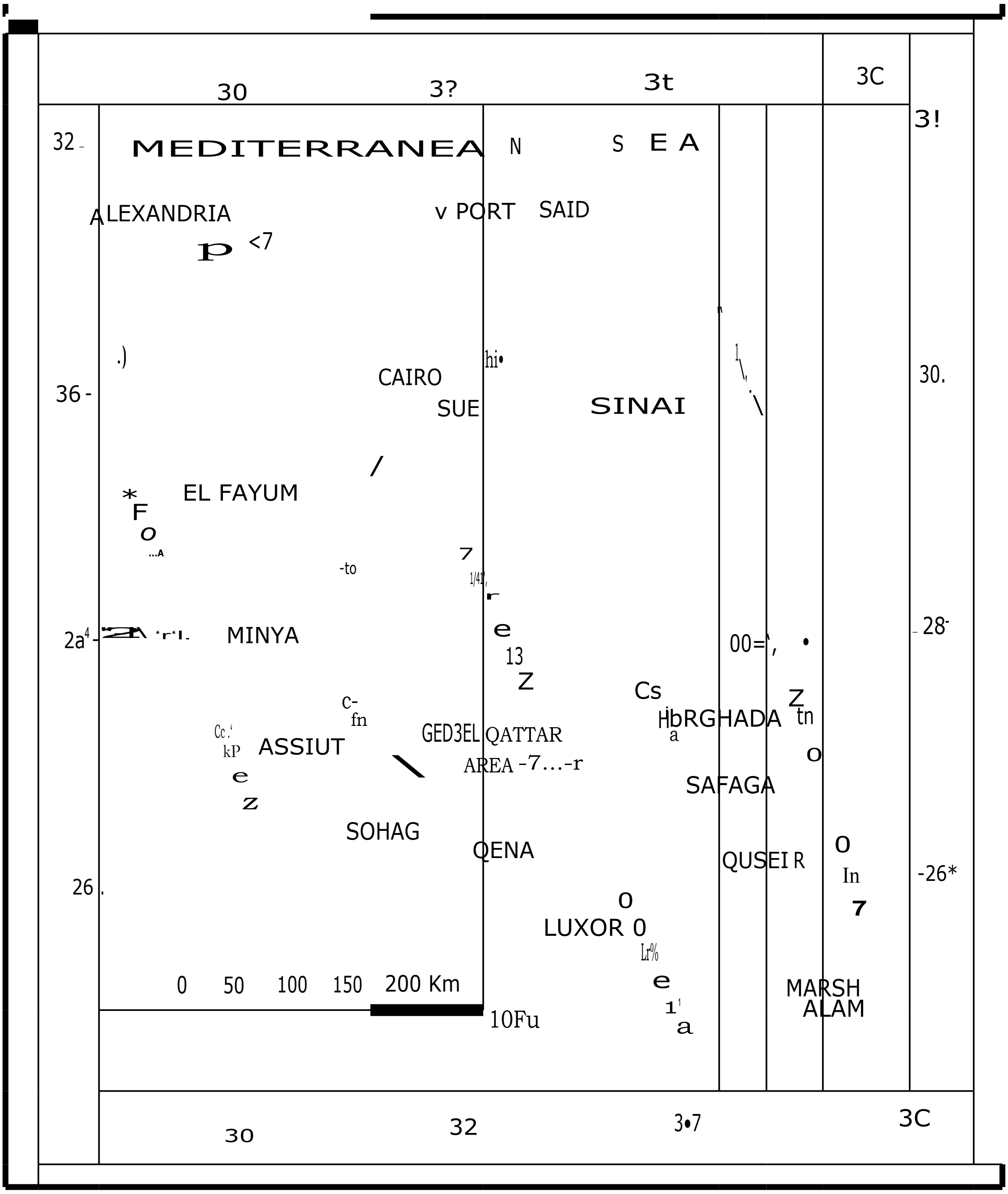

Fig. 1.1: Location Map of Gabal Qattar area.

I.S. Synopsis on the Geology and Evolution of the Egyptian Precambrian Rocks

The Neoproterozoic basement rocks cover vast area (about 93,000 km^2) in the Egyptian landsurface, being exposed mainly in the Eastern Desert and Southern Sinai, as well as small exposures in the south Western Desert and at the extreme southwestern corner of Gabal Oweinat.

In the Eastern Desert, the basement rocks extend as a belt parallel to the Red Sea Coast for a distance of about 800 km, bound by latitudes 22° 00' (the southern border of Egypt) and 28° 40' N (northwest of Ras Gharib). These rocks unconformably overlain on their eastern margin by the Nubia Sandstone and on their western side by the Miocene and younger sediments.

The basement rocks of Egypt have been subjected to several studies by a number of eminent geologists, since the establishment of the Egyptian Geological Survey in 1896. Most of these studies aimed to erect a plausible geochronological classification of these rocks within the frame of the geosynclinal concept, that was prevailing at that time (Hume, 1935; Ibrahim, 1941; El Shazly, 1964; Akaad and El Ramly, 1960; El Ramly and Akaad, 1960; Sabet, 1961, 1972; El Ramly, 1972; Akaad and Noweir, 1969, 1980).

The Precambrian rocks of the Eastern Desert and Southern Sinai occupy the northern part of the Nubian Shield which in turn, covers the northeastern sector of the U-shaped Pan-African orogenic belt (Fig.1.2).

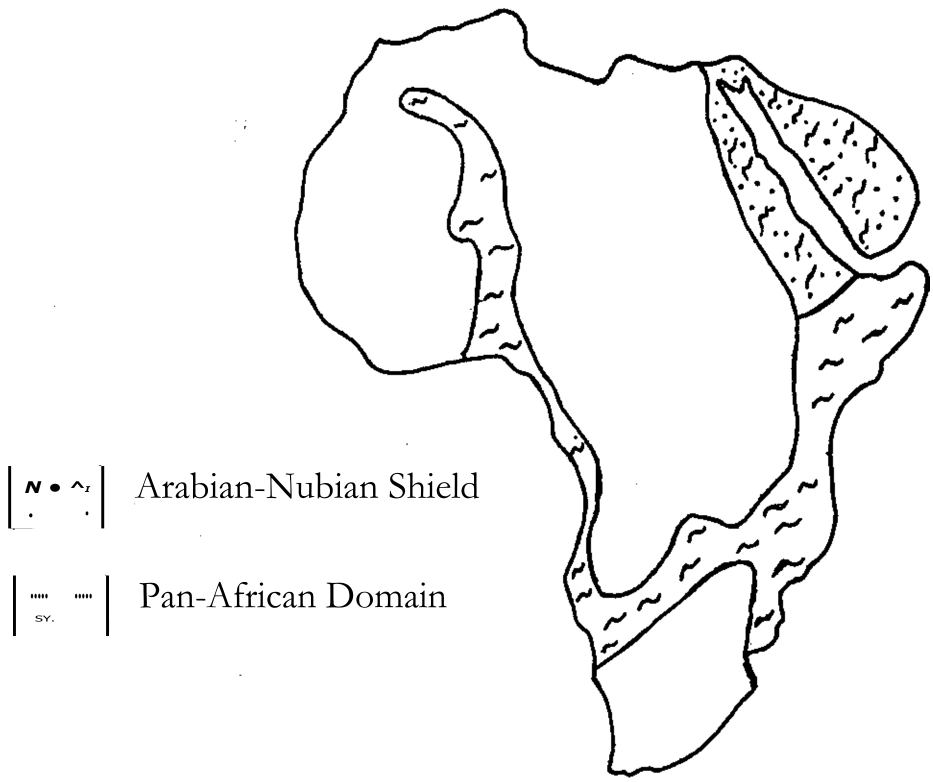

Fig. 1.2: Areas affected by the Late Precambrian to Early Paleozoic Pan-African event *(after Engel et al., 1980)*

The term Pan-African first introduced by Kennedy (1964) defines an important widespread tectono-thermal event, which took place throughout the African continent during the periods of 1100 to about 450 Ma ago (Gass, 1977; Kroner, 1980). Kennedy (1964) believed that the Pan-African episode had led to the structural differentiation of the entire continent into cratons and orogenic areas. Subsequent recent studies on different areas of the shield (e.g. Gass, 1981) have shown that the Pan-African time span could be expanded to 1200 - 450 Ma. Others (e.g. Kroner, 1984) proposed a more limited time span of 950 — 450 Ma.

The evolution of the Pan-African Precambrian rocks, in general, remains a matter of controversy. Specific processes by which these rocks were created, and have subsequently grown, are not well known, but the wealth of geochemical and isotopic data currently available allow some important boundary conditions to be invoked.

Two essential models for the evolution of the Arabian-Nubian Shield have been proposed, with emphasis on the Egyptian part. *The first* was established based on geosynclinal concept (Akaad and El Ramly, 1960; Sabat, 1961; El Shazly, 1964; El Ramly, 1972; Akaad and Noweir, 1980). It was considered that the shield has evolved as intracratonic ensialic geosyncline with a basement of older sialic material. *The second* model is provided from the theories of the plate tectonics. Within the frame of the plate tectonic concept several opinions have been presented to elucidate the evolution of shield. Greenwood et al. (1976) and Gass (1977, 1979, 1981) believed that the shield had evolved on oceanic crust from the welding of a series of island arcs together; a cratonization or continentalization processes.

deformation also led to folding of regional-scale thrusts. Consequently, the high strain deformation is younger than ophiolite emplacement and suturing of terranes.

1.6. Previous Works

The easy accessibility of Gabal Qattar and the presence of some economic mineral deposits, attracted the attention of many researchers to discuss the geology of Gabal Qattar granites and juxtaposing rock units since early in the last century, among them are:

Hume (1935) studied the basement complex of Egypt, including the northern part of the Eastern Desert. He noted that the younger granites are most predominant and well exposed in the North Eastern Desert, north of latitude 27^{0} 00 N. The older or metamorphosed rocks are dominated in the central and southern parts of Eastern Desert.

EL-Ramly and Akaad (1960) introduced the term "younger granitoids" to include the granites previously named as "pink and red Qattarian" or "Shaieb" types.

Shiirmann (1966) compiled his work concerning the Precambrian rocks along the Gulf of Suez and Red Sea hills. He classified the younger pink granites into upper Gattarian and lower Gattarian with the Hammamat formation in between. He considered Gabal Qattar pluton as "upper Qattarian", whereas the surrounding granites and granodiorites represent the "lower Qattarian" granites.

Ghobrial and Lotfi (1967) studied the geology and petrography of Gabal Qattar and Gabal EL-Dokhan areas. They pointed out that the area is mainly consisting of volcanic, Hamammat metasediments (equivalent to those exposed at Wadi Hammamat area) and granites of Qattarian age. The whole succession is dissected by a system of acidic dykes followed by two systems of basic and intermediate dyke intrusions. They inclined to apply the term "Umm Tawat breccias and conglomerates" to define the varieties of metasediments between Gabal Dokhan and Gabal Qattar.

Ghanem (1968) mentioned that faults trending N-S direction, in the northern part of the Eastern Desert, have developed after the emplacement of the late orogenic plutonities.

Rasmy (1969) carried out petrographical and mineralogical studies on twenty-sample collected from Gabal Qattar pluton. She stated that these granites are leucogranites, alaskitic in composition, very poor or nearly free of ferromagnesians, while some samples are enriched in quartz than the normal granites due to latter enrichment.

EL Shazly (1970) related Gabal Qattar batholith to the late orogenic plutonites, which have been emplaced along the major weak structural zones, trending NNW-SSE to N-S

EL Ramly et al., (1971) stated that there are two main phases of rejuvenation which took place along ENE-WSW faults. The older phase is dated to late Carboniferous to Permian and the younger one is dated to late Cretaceous.

of 1000 — 850 Ma and the younger episode covering the period between 675 — 500 Ma.

Meshref et al. (1980) defined the major tectonic trends affecting the northern part of the Arabian-Nubian Shield, north of latitude 22 °N, using statistical magnetic trend analysis. They proposed four major preferred orientations in the area to the east and west of the Red Sea: the E-W, WNW-ESE, ENE-WSW and NW-SE, which may add a new evidence for a single origin of the shield on both sides of the Red Sea.

Greenberg (1981) suggested that all the younger granites of Egypt are post tectonic and epizonal. The granites are commonly homogenous, deviod of tectonic foliation and free of pegmatites. He recognized three petrological-geochemical groups:
Group-I is extensively albitized, silicified, which may result in the modification of the original hypersolvus quartz-feldspar fabric. Group-II is similar to group-I granites, but less albitized and have higher mafics contents. Group-III is subsolvus and contains higher proportion of plagioclase and more mafic phases than group I and II granites.

Mussa and Abu EL Leil (1983) discussed the relationship of the mineral deposits in the northern part of the Eastern Desert with the structural trends. They concluded that the NE-SW, NW-SE, E-W and the N-S trends of the different types of mineralization coincide with their corresponding fault trends. They also assigned a characteristic direction for each type of mineral deposits.

Stern and Hedge (1985) determined the age of 24 rock samples from the Eastern Desert of Egypt using combined Rb-Sr and U-Pb Zircon technique. This study revealed that the granitic rocks are predominant in the northern and southern parts of the Red Sea hills rather than the central part. They mentioned that Gabal Qattar granites have 238 ppm Rb and 6.1 ppm Sr, and its age was estimated 575 by Rb-Sr model.

Salman et al. (1986) studied the radioactivity of the anomalous granites in the area around Gabal Qattar and constructed an isorad map for the radioactive anomalies. They noticed two preferable uranium mineralized trends; the NNE-SSW and NW-SE trends. They added that the prevalent faults dissecting the area are the NE-SW, NNE-SSW, NW-SE and N-S.

El Rakaiby and Shalaby (1988) used integrated field, petrographic and remote sensing studies, and identified three different granitic phases within Gabal Qattar batholith, namely 01, G2 and G3. They stated that Gabal Qattar pluton is occupied by the youngest phase (G3), and is associated with molybdenum and uranium mineralization.

Stern et al. (1988) studied the geology and petrogenesis of dike swarms in the North Eastern Desert. They came to the conclusion that the mafic dykes, ranging in composition from medium to high K-andesites, were hypabyssal feeders for the Dokhan volcanics, while the felsic dykes are rhyolitic in composition and represent the feeders of the epizonal granitic plutons.

Willis et al. (1988) carried out petrographical, geochemical and geochronological studies of Hammamat sediments that exposed at Gabal Qattar area and dated their age to 585 ± 15 Ma. They mentioned also that they are slightly metamorphosed of green schist facies.

EL Sind)/ and Rabie (1989) interpreted qualitatively and quantitatively the airborne magnetic survey data of Gabal Qattar, through the. application of a couple of geophysical interpretation techniques. They suggested that Gabal Qattar area had been affected by five significant tectonic trends, namely: NE-SW, NNE-SSW, N-S, NW-SE and ENE-WSW.

Attawiya (1990) studied the magma type and tectonic setting of the gtanitic rocks of Gabal Qattar by means of geochemical and petrochemical studies. A within-plate magmatic (anorogenic) tectonic setting is proposed for these granites.

Mandy et at. (1990) identified some secondary uranium minerals, such as uranophane and tyuyamunite in Gabal Qattar area, using X-ray diffraction.

Salman et al. (1990) analyzed uranium, total iron, molybdenum and titanium oxide in 78 samples collected from stream sediments around Gabal Qattar—Umm Dissi younger granites. They recognized an intimate relation between iron oxide and uranium in Gabal Qattar area.

Shalaby (1990) studied uranium mineralization at the contact zone between Gabal Qattar and Hammamat sediments, along W. Balih (GV uranium occurrence). He described the petrography of the rocks and highlighted the genesis of uranium mineralization at that occurrence. He also pointed out that the uranium mineralization is controlled by a local ENE-WSW reverse fault dipping 45° to 60° to SSE direction, and the highly mineralized zones are encountered at the intersection between this fault and a N-S trending fault.

Roz (1994) performed geological, structural and radiometric studies on Gabal Qattar area with special emphasis on the uranium mineralized occurrences at Gabal Qattar. He concluded that Gabal Qatar uranium prospect could be classified as vein-type hydrothermal uranium mineralization, and uranophane is the main secondary uranium mineral.

Abu Zeid (1995) studied the relation between surface and subsurface uranium mineralization and structural features of Gabal Gattar. He considered that the presence of uranium minerals at different levels confirms the role of ascending hypogene solutions in the granites and their adjacent Hammamat sediments. He added that the GI, GII and GVI uranium occurrences are located within a large pull-apart basin that help in ascending the hydrothermal solutions carrying uranium mineralization of different uranium occurrences of the area.

Haridy (1995) determined the physical and mechanical properties of Gabal Qattar granitic pluton and its relation to the joint-type uranium mineralization. He statistically treated the collected field measurements of the structural elements affected both the younger granites and Hammamat sediments. Stress analyses were carried out to delineate the paleostresses affecting the area. The obtained data were used to establish the chronological sequence of these paleostresses and clarify the structural evolution of Gabal Qattar area.

Shalaby (1995) mentioned that the presence of potential uranium mineralization in Gabal Qattar granites is greatly affected by the presence of a strong internal tectonic which offered good preparation of the sites for mineralization. He added that Gabal Qattar granite is characterized by its high magmatic uranium background, which ranges from 12 to 25 ppm. Hence, it is considered as uraniferous granite.

Shalaby (1996) study in details the structural relationship and the influence of stress and mechanical properties of the host rocks on the opening of fractures and joints for mineralization. This study revealed that the various uranium occurrences are mostly controlled by NNE-SSW sinistral faults, dipping from 75° to the ESE direction, and NW-SE dextral faults dipping 80° to SW direction. He added that uranium mineralization took place along the AC and BC tension planes and the compressive stress field at Gabal Qattar area indicated that the area was affected by a main compressive force, mostly directed NNW and plunging to the NNW direction, with an angle varying from 20° to 30°.

Youssef (1996) correlated some uraniferous granitic rocks including those recorded in the study area and concluded that Gabal Qattar granites are subsolvus, peraluminous, S-type granites of collision tectonic setting. The autoradiographic technique indicated the probability of the presence of primary uranium minerals in these granites. The pre-existing primary uranium minerals are the source of the present secondary uranium mineralization, with a contribution from the hydrothermal source.

El Kholy (1996) studied the uranium mineralization associated with the desilicification of the granite of Gabal Qattar area. He found that the desilicification and uranium mineralization are controlled by the intersection of some fracture systems striking NNW-SSE and NNE-SSW. The uranium concentration in the area reachs 1195 ppm. The author identified some uranium minerals that associated with the desilicification such-as clarkite, zippeite and uranophane.

El Kholy et al. (1998) carried out geological, geochemical and radioactive studies of some granitoid rocks exposed at the northeastern part of the Qattar batholith. They stated that the contents of the radio-elements, U, Th, eU(Ra) and K increase from the older to the younger granites They added that the Th/U ratio values in the granitioid rocks under consideration are lower than those of the normal granites.

El Kammar et al. (2001) in their study of the geochemical and genetical constraints on rare metals mineralization occurs at the sheared contact between Qattar granite and Hammamat sediments, suggested a possible mobilization of uranium and rare metals from Qattar granite to the Hammamat sediments during alteration. They added that the changing in physico-chemical conditions of the hot fluids due to their mixing with meteoric water and continuous interaction with wallrock caused a complicated series of alteration processes. These include quartz dissolution, albitization, sericitization, chloritization and hematitization. While the kaolinization and oxidation reactions have taken place by late weathering processes.

1.7. Aim and Scope of the Present Work:

The present study summarizes the results of detailed field structural !napping (scale 1:50,000), petrological and structural studies that are carried out on the area just to the north of Gabal Qattar. The area highlights the relationships between the plutonism, faulting and mineralization in the very promising uranium occurrences namely GI, GII, GV and GVI.

This well be fulfilled by the following works :

- Collection and compilation of the previous works.
- Construction of a geologic map at a scale of 1:50,000
- Construction of detailed geologic and radiometric maps for the anomalous zones, scale 1:1000
- Collecting the structural elements for the purpose of structural analysis.
- Collecting representative samples for the petrographical studies.
- Geochemical analysis for the collected samples from the uranium occurrences.
- Correlation between plutonism, faulting and mineralization with emphasis on uranium ore localization.