Qatar Univ. Sci. J. (1995), 15 (2) : 419 - 430

AERORADIOMETRIC AND PHOTOGEOLOGIC CHARACTERIZATIONS OF THE YOUNGER GRANITES IN THE NORTH EASTERN DESERT, EGYPT AND IMPLICATIONS FOR MINERAL DEPOSITS

By

Mohamed A. Abdel Maksoud*, Ahmed A. Abdel Meguid, Hassan T. Abuzied*****
Magid L. El Rakaiby and Adel Z. Bishta****
* Geology Department, Faculty of Science, Qatar University, Doha, Qatar
** Nuclear Materials Authority, Cairo
*** Faculty of Science, Cairo University

خصائص المسح الإشعاعي الجوي والجيولوجيا التصويرية لصخور الجرانيت الحديث في شمال الصحراء الشرقية بمصر - وتطبيقاتها للكشف عن الرواسب المعدنية

محمد عبد المقصود ، أحمد عبد المجيد ، حسن أبو زيد ، ماجد الركابي ، عادل بشته

أثبتت الدراسة من التصوير الجوي لوصور الأقمار الصناعية كتل الجرانيت بشمال الصحراء الشرقية في مصر وجود ثلاث أطوار متتالية من متداخلات الجرانيت كل منها له خواص تصويرية وإشعاعية وجيولوجية متميزة. الطور الأول يتميز بلون بني غامق، نسيج سطحي دقيق ، منخفض التضاريس وله منحدرات لطيفة وأعراف مستطيلة وذا حجم كبير (٣ كم^3) . أما شبكات الصرف الموجودة بداخله فهي اما شجرية الشكل أو متوازية النسيج وهذا الطور له اشعاع بسيط (٦٠ - ١٠٠ ميو). الطور الثاني يتميز بلون بنى مصفر فاتح ، نسيج سطحي متوسط الى خشن ، متوسط التضاريس وله منحدرات عميقة وأعراف مستطيلة وحجمه نسبياً أصغر (١,٧ كم^3)، أما شبكات الصرف فهي من النوع الشجري ويحتوى هذا الطور على قدر متوسط من الاشعاع (١٠٠ - ١٨٠ ميو). الطور الثالث يتميز بشكل بيضاوى ولون بنى محمر فاتح، نسيج سطحي ناعم ومرتفعات عالية مع منحدرات شديدة وفحم مستديرة وحجم صغير (١,٤ كم^3)، أما شبكات الصرف فقليلة ومن النوع الشجري والمتقاطع. أما المحتوى الاشعاعي فإنه يزيد عن ١٨٠ ميو في بعض المواقع. ويعتبر الطور الأول جرانو دايوريت من التداخل المبكر للجرانيت الحديث بينما الطور الثالث يمثل أكثر الأطوار تفارقا وآخر المتداخلات من الجرانيت الحديث حيث تتركز فيه الهالات الاشعاعية العالية والتي سببها اليورانيوم والموليدنيت. وتتركز الاشعاعات على الاتجاهات التركيبية شمال - جنوب ، شمال ، شمال ، غرب، شمال، غرب وخاصة مع تقاطعاتهم مع الاتجاه التركيبي شمال ، شرق.

Key Words : Aeroradiometric, Photogeologic, Younger Granites, Eastern Desert, ore Deposits

ABSTRACT

Photogeologic studies of the younger granites in the North Eastern Desert of Egypt using both aerial photographs and satellite images revealed the separation of three successive phases of younger granites with different photogeological radiometrical and geologiical characteristics.

The first phase plutons (YG1) are characterized by brown colour, dark tone, fine surface texture, low relief with gentle slopes, elongated ridges, large size (3 km^3), and high density -dendritic to paralled-drainage patterns. They have high density and frequency of photo lineaments. Radiometrically these plutons are the lowest radioactive (60 - 100 μ R/h).

The second phase plutons (YG2) are characterized by its yellowish brown colour, light tone, moderate to coarse surface, texture, moderate relief with deep slopes, elongated ridges, relatively smaller size (1.7 km^3) and moderate density trellis to dendritic-drainage patterns. Plutons of this phase have moderate density and frequency of photo lineaments. They display higher radioactivity (100 - 180 μ R/h).

The third phase plutons (YG3) are distinguished by oval shapes reddish brown colours, light white tone, smooth surface texture, high relief with steep slopes and rounded peaks, smallest size (1.4 km^3) among the other types and low density dendritic to trellis - drainage patterns. They have low density and frequency of photo lineaments. They display radioactivity similar to the second phase but with anomalous zones more than 180 μ R/h.

The YG1 is considered as an early (granodioritic) phase of the younger granites while the YG3 is the highly differentiated latter phase where most of the radioactive anomalies are restricted to. Tht YG3 of the North Eastern Desert comprise mineralization of U and molybdenite.

Anomalous radioactivity are concentrated along the NS, NNW, and NW fractures and especially at their intersections with the NE trend.

INTRODUCTION

The present study aims to integrate photogeologic and aeroradiometric studies in order to differentiate the different phases of the younger granites (YG) and characterizing plutons favoured for radioactive minerals in the North Eastern Desert of Egypt between latitudes 27° 00' and 28° 40' N.

In this task satellite images were used for regional investigation and aerial photographs were used for detailed photogeologic studies of some selected example areas. Five Landsat composite coloured images MSS bands 3,4 and 5 of scale 1: 250,000 have been used for constructing oregional photogeological and structural map of the study area (Fig, 1). The characteristics of landforms, their shape, pattern, orientation and relation to topographic environment are carried out using the stereoscopic techniques [1]. Also aeroradiometric maps of the area [2] were studied for different radiometric patterns of the YG. Lithological and structural characteristics were depicted from both aerial photograps and radiometric maps, using trend analysis technique [3].

PHOTOGEOLOGICAL INVESTIGATIONS

Photogeological interpretation of Landsat Satellite images and aerial photographs in this study, include the fundamental recongition of the photographical elements such as tone, colour, topographic expression, surface texture, drainage network and lineament system. According to these features the younger granites which range in composition between granodiorites and granites were classified into three photogeological phases; YG1, YG2, and YG3 (Fig. 1) The YG1 (Um Tweir type) includes the granitic plutons of G. Um Treir and G. Abu Marwa. The YG2 (Salaat Belih type) includes the granitic plutons of G. Salaat Belih, and G. Dara. The YG3 (Gattar type) includes the plutons of G. Gattar, G. Um Disi, G. Abu Harba, G. Abu Khashaba and G. Homrat El Girigab. The close up photogeologic study of these YG types characterized them by different photogelogic features which could be used for differentiating them on aerial photographs clearly. The following is a brief description of the features.

A - Tone and Colour .

On the Landsat composite images the YG1 type possess brown colour, while the YG2 displays yellowish brown colour and the YG3 type possesses reddish brown colour. On the aerial photographs, the YG1 type possesses dark grey tone while the YG2 possesses grey tone and the YG3 possesses light grey tone. According to Ray [4] these colour and tone features reflect increase of the felsic mineral content from the YG1 towards the YG3.

B - Surface Texture and Topographic Expression :

According to Denny [5] classification of the surface textures to coarse, fine, rough, and fully, surface texture is fine in the YG1, moderately coarse in the YG2 and smooth and coarse in the YG3. The YG1 type generally

forms easily weathered and gentle slope hills of low relief (G. Um Tweir 821 m a sl). The YG2 type is usually characterized by several small pointed peaks with deep slopes affected largely by fractures and joints. The YG3 plutons commonly forms high relief (G. Gattar 1962 m a sl) with sharp slopes and less dense fractures than the other types. Speight [6] determined and described regions of homogeneous landform pattern as perceived in aerial photographs, The defined several landform attributes depending on altitude, relationship to planes of accordance lineament networks proportional occurrence and arrangement of landform elements in toposequences. Wood and Snell [7] stated that the average vertical separation of the two surfaces of accordance is a measure for the relief of the mountaneous summits. The average horizontal spacing of the summits and stream channels that approach the upper and lower surfaces respectively is defined as the grain.

Topographic profiles have been photogrametrically constructed for the three granitic types (Fig. 2). The YG1 examplified by G. Um Tweir (Fig. 2a) possesses poor accordance. The average relief is about 80m a w l, and average grain is about 3 km. The relief/ grain ratio is 0.03. Topographic profile along G. Salaat Belih as an example of YG2 (Fig. 2b) shows discordance character of this pluton with differentially elevated peaks. The average relief of the (YG2) is 35m a w l and the average grain is 1.6km. The relief/grain ratio is about 0.322. The topographic profile of the YG3 examplified by G. Gattar (Fig. 2c) shows high relief (540m a w 1) of slighty variable summits, deep slopes and good accordance. The average grain is 1.4 km, while the relief/grain ratio is 0.4.

C - Drainage Network :

The drainage network of YG1 (G. Um Tweir, Fig. 3a) is dendritic of high density (9.3 km/km^2) and frequency (62 lines/km^2). The angle of junction between the secondary drainage lines ranges beween 60° to 80° The mapped major wadis are of fourth to fifth order tributaries and are of moderate sinuously. The drainage networks of the YG2 (G. Salaat Belish, Fig. 3b) is a trellis pattern. This pattern is of relatively moderate density (8km/ km^2) and frequency (54 lines/km2). The angle of junction between the secondary drainge lines ranges from 50° to 70°. The major wadis is a fourth to fifth order of transitional sinuously. The drainage network of the YG3 (G. Gattar, Fig. 3c) is dendritic with low density (abouut 6.3 km/km^2) and frequency of about 28 lines/km^2. secondary drainage lines are very narrow with steepwalls. The angle of junction between the secondary drainage lines 55°. The major wadi are of fourth order with moderate sinuous.

D - Structural Lineaments :

In the present study the lineaments observed on the aerial photographs are interpreted as fractures and classified as : macro-lineaments (> km), meso-lineaments (1- 0.4 km) and micro-lineaments (> 0.4 km). Some low dip angle faults crop out as curved lineaments on the aerial photographs due to the intersection with the highly elevated topography. These lineaments are measured as their mean trend perpendicular to their dip. The statistical analysis of the interpreted lineaments are summarized in Table-1 and Fig. (3). In the YG1 the average density of total lineaments is 10.9 km/km^2 and their frequency is 48.5 lines/km2 with average interspace distance of 48m and ratio of L/N= 0.22. The relative abundance of micro -: meso- : macro-lineaments is 8.1 : 1.8: 1 as lengths and 76.9 : 5.5 : 1 as numbers.

This indicates that the meso and more likely the micro-lineaments represent older faults sliced by the younger macro-lineaments (major faults). Also they include the second order fractures associated with the major fault systems (Fig. 3 and Table 1). In the YG2 the density of all lineaments is 10.5 km/km^2 and their frequancy is 37.4 L/km^2 with average interspace distance 75m and the ratio of L/N = 0.28. The relative abundance of micro-: meso-: macro-lineaments is 6.1:2.6 : 1 as lengths and 45.4 : 6.2 : 1 as numbers (Fig. 3e and Table 1). In the YG3 the density of all lineaments is 7.2 km/km^2 and their frequency is 26.7 L/km^2 with average interspace distance 100m and ratio of L/N=0.27. The relative aboundance of micro-: macro-lineaments is 3.9 : 1.7 : 1 as lengths and 33.0 : 4.4 : 1 as numbers (Fig. 3f and Table 1). The lengths and numbers of the micro- and meso-lineaments with respect to the macro lineaments decrease from YG1 to YG2 and become least in YG3, reflecting a decrease in the second order fractures and the segmented faults. This relation has chronological implications where the YG1 is expected to be the oldest and YG3 is the youngest according to the present investigations.

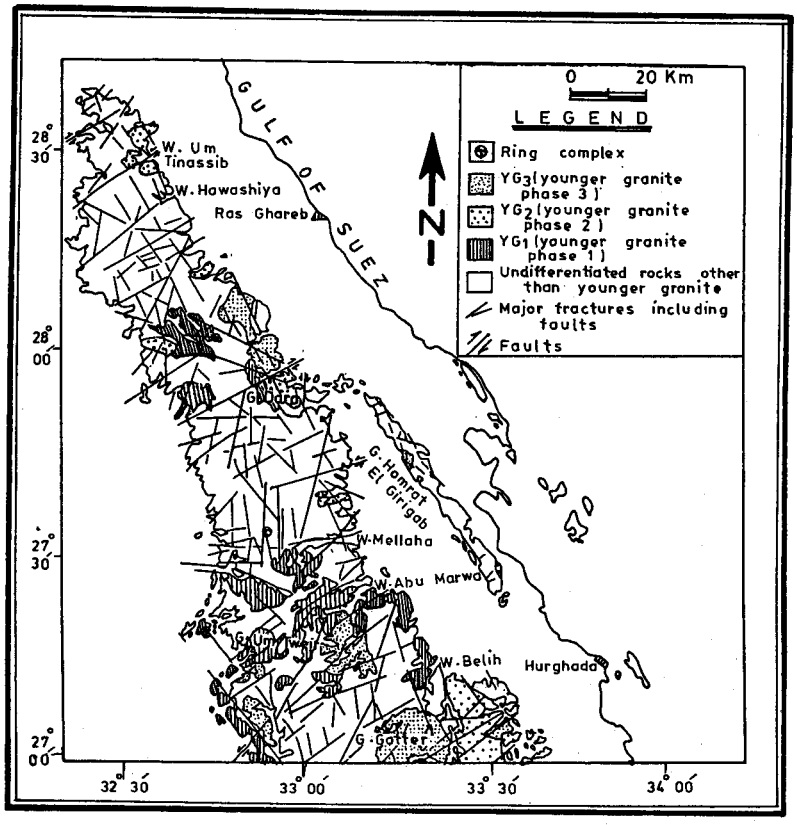

Fig 1 : Photogeological map oof the northern part of the basement belt, Eastern Desert, Egypt.

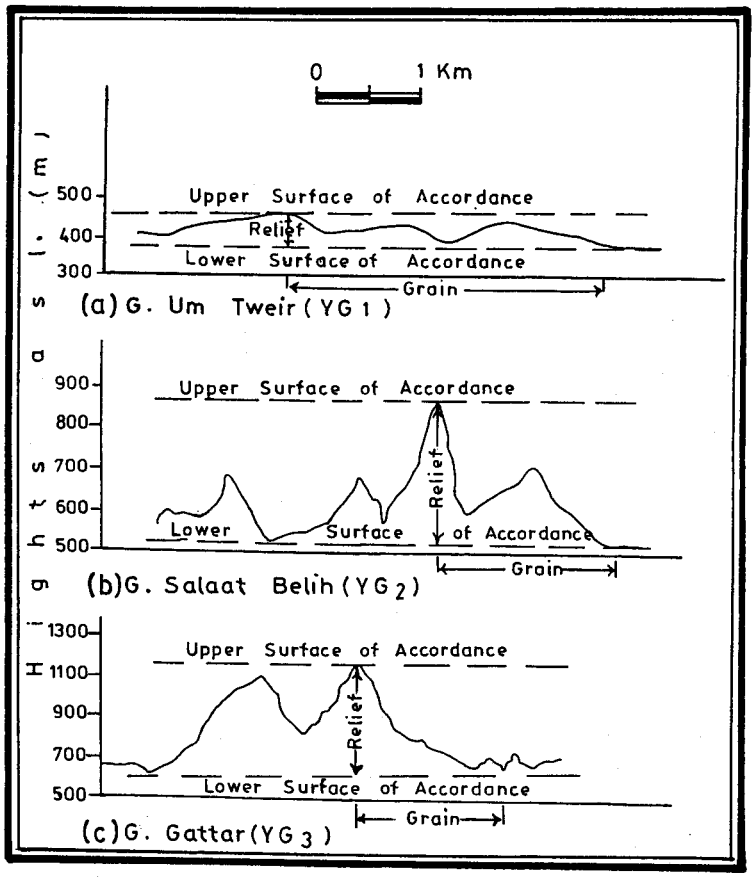

Fig. 2 : Topographic profiled of G. Um Tweir (YG1), G. Salaat Belih YG2) and G. Gattar (YG3) plutons.

Table (1) : Structural analyses of lineaments in the selected samplesareas of YG1, YG2 and YG3 type.

	YG1 (average of 2 areas)	YG2 (average of 2 areas)	YG3 (average of 2 areas)
Micro - Lineaments			
Length (L)	130.4	100	68
Number (N)	715	506	366
Denisty (D)	8.1	6.3	4.2
Frequency (F)	44.7	31.6	22.9
length %	74.5	63	59
number %	92.3	86.3	85.9
Meso - lineaments			
L	28.3	44.1	30
N	51	76	49
D	1.8	2.8	1.9
F	3.2	4.8	3.1
length %	16.2	26.7	26
number %	6.6	11.8	11.5
Macro - lineaments :			
L	16.1	22	17
N	9	15.5	11
D	1	1.4	1.1
F	0.6	1	0.7
length %	9.2	10.3	15
number %	1.2	1.9	2.6
Total Lineaments :			
Average L	175	166.1	115
Average N	775	598	426
Average D	10.9	10.5	7.2
Average F	48.5	37.4	26.7
L / N ratio	0.22	0.28	0.27

E - Directional Analyses of Lineaments :

1 - NE trend : Is the predominated trend in the whole area and is well developed in the older phases YG1 and YG2 (Fig. 4 a,b). It is presented in the youngest phase (YG3) but deviated 10° north and is older than the NNW ternd. Started as tension fractures rejuvenated several times in oblique slip movement, where the direcion to the lateral component changes from right lateral to left lateral depending on the original attitude of the normal faults with respect to the proceeding stress attitude. Seemingly the culmination of the NE dyke swarms dispose was contemporanous to controled by the activation of this trend as tensions fracture due to NW extensions in the crust.

2 - NNW Trend : This is the youngest trend in the area. It is more developed in the youngest phase (YG3) than in the YG1 and YG2 phases. The NNW trend governing the outcrops elongation in the North Eastern Desert. It is the second dominated trend on the whole area (Fig. 4) Faults of this trend are normal faults parallel to the Red Sea and the sets of grabens governing the main outcrops elongation in the area. Few dykes have been recognized filling the trend.

3 - N-S trend : Is the third well developed trend in the area and comprises also some dykes, usually has strike slip striation. They are low angle faults more developed in the older phase (YG1) and dominately dissected along the other trends.

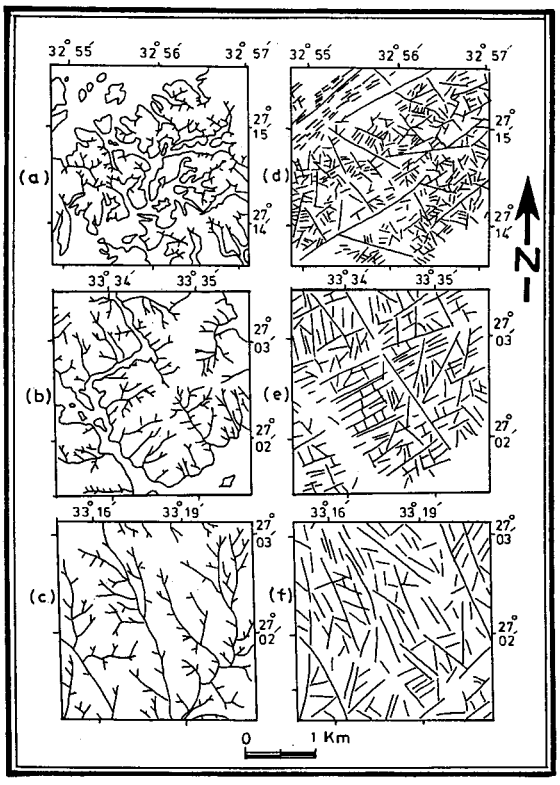

Fig. 3 : Representative drainage networks and structural lineament maps of the sample areas of the younger granitic types YG1, YG2 and YG3 in the North Eastern Desert, Egypt.

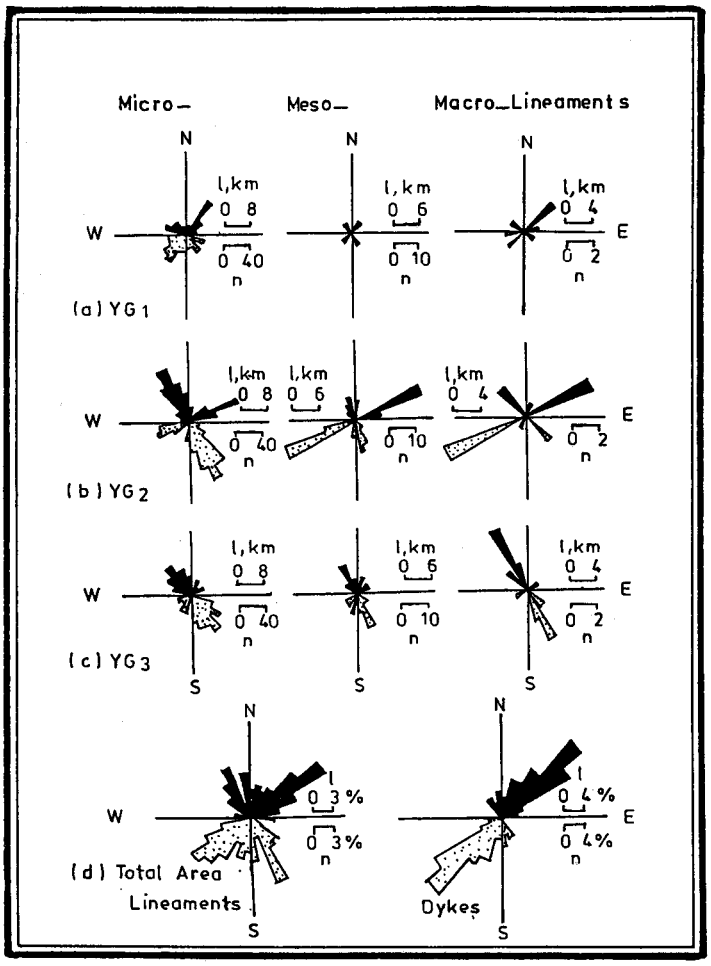

Fig. 4 : Rose diagrams of lineaments of the sampled area of the granitic types YG1, YG2 and YG3.

Statistical study of about 444 mapped lineaments having a total length of 345 km and about 649 dykes having a total length of 609 km was carried out. The rose diagrams (Fig. 4d) show three well defined maxima of lineaments with the two prominent trends at N55° - 65° E, N25° - 35°W and moderately prominent one at N5° W. The dominant trend of dykes is N35° - 55°E . The existance of dykes in trend indicates that they represent mainly tensional fractuures and associated normal faults. The ENE predominant trend in the Eastern Desert indicate an extension in the crust in the NNW direction and may be associated with the N35W transcurrent faults parallel to the Najed system in the sense of Stern [8] The existance of dykes (mainly tertiary) in the N-S and NNW trends indicate the rejuvination as extensional fractures due to E-W to ENE tensional force perpendicular to the Red Sea trend.

RADIOACTIVITY

Thorium and uranium generally increase towards the more silicic and more differentiated members of a magmatic series. The Th/U ratio has been found to increase with differentiation, [9]. So, radioactivity can be used as a tool for geological mapping. Accordingly, the combination of the aeroradiometric and photogeological techniques is a good preliminary mapping prospecting tool for localizing target areas for uranium and thorium ores as well as other types of ore deposits.

Rock Characterization

Study of the aeroradiometric maps of the area reveals that the younger granitic rocks display higher radioactivity levels over all the other basement rock units. Within these higher radioactivity levels of the younger granites, two main groups can be differentiated radiometrically : plutons of relatively low ranges of radioactivity between 60 and 100 μ R/h (LRG), include all the plutons of the YG1 type, and plutons of relatively high ranges oof radioactivity between 100 and > 180 μ R/h (HRG), comprise the YG2 and YG3 types. Moreover, the (HRG) group can be subdivided radiometrically into two subgroups; plutons of normally high levels of radioactivity between 100 and 180μ R/h (HRG1), which cover all plutons of the YG2 type, and pludons of anomalously high levels of radioactivity (HRG2) with zones of radioactivity more than 180 μ R/h which cover the plutons of the YG3 type (Fig. 5).

Example of the LRG group is the Um Tweir (YG1) which is characterized by relatively low ranges of radioactivity, from 60 to 100 μ R/h (Fig. 6). In this figure the intrusive relation of the HRG2 pluton of Abu Harba is expressed by the interference of high radioactive contours in Abu Marwa pluton at the contacts.

The HRG1 plutons have radioactivity ranges from 100 to 180 μ R/h, with spots (over pegmatitic veins) reaching up to 185μ R/h. However, the HRG2 plutons possess radioactiivity ranges between 100 and > 180μ R/h and are characterized by the presence of anomalous spots having radioactivity levels in the study area giving more than 180 μ R/h and reach up to 220 μ R/h (Fig. 7). It is worth mentioning here that the Homart El Girigab is an odd example. Photogeologically it should be classified with the YG1 group of the less differentiated highly fractuured plutons. On the aeroradiometriic maps it gives characteristics of HRG2 which is corresponding to the YG3. Field and geologic investigations of this pluton indicates that this pluton lies along the western side of Esh El Mellaha horst where the bounding major fault zone down through the western part of the pluton and cause extensive fracturing in the eastern croped out part (Figs. 1 & 5). Accordingly the radioactivity can correct some misleadingly features of the photogeology due to local phenomena.

Trend Analyses

The radioactivity trend analysis of the study area show a dominant trend in the N 45° W direction (Fig. 8). This direction is nearly to he NW-trending facture system of the study area. The trend represents 90% of the radioactive lineations with total length of 495 km. The N 45° E represents the next subdominant radioactiive trend which is transverse to the Red Sea. There are subordinate trends of minor existence ranging between N-S and NNW directions. The description of the different trends for some representative younger granitic plutons (Fig. 8) are given hereafter :

A - The NW trend :

Elongation of the radioactivity in this trend and its predominance over the other trends is a striking feature

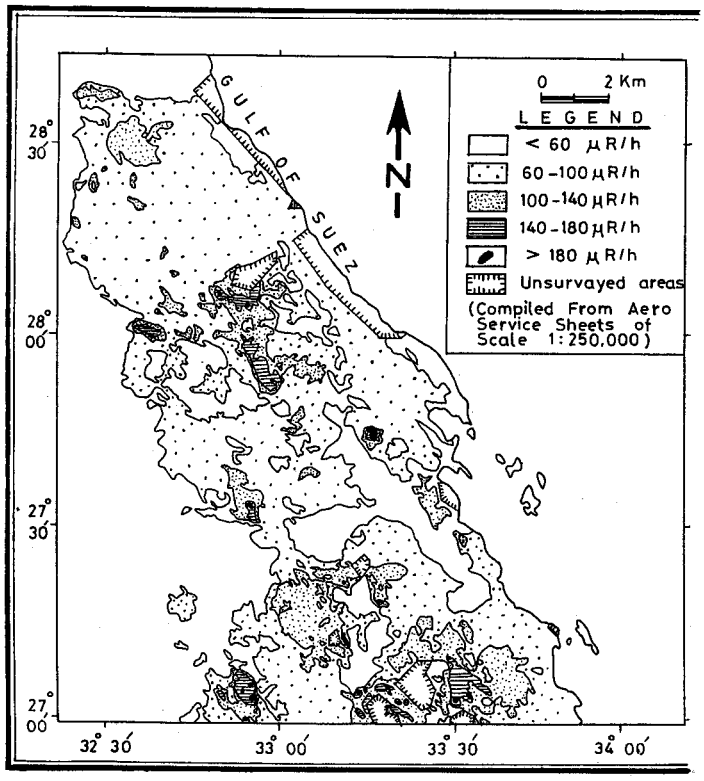

Fig. 5 : Aeroradiometric total count contour map of the northern Eastern Desert, Egypt.

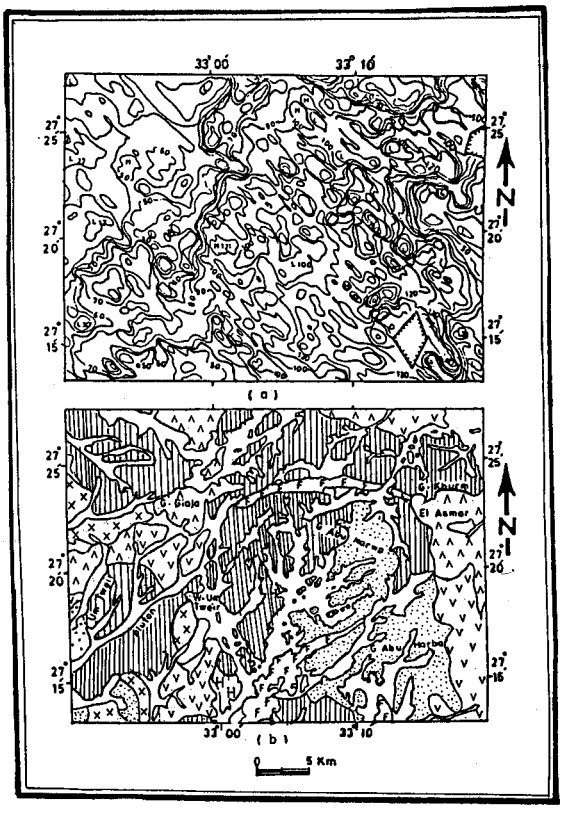

Fig. 6 : (a) Aeroradiometric total count map of G. Um Tweir. and G. Abu Marwa plutons (LRG). Note, the radioactive anomalies are associate with HRG2 pluton of G. Abu harba.
(b) The corresponding photogeological map of the same plutons. (AA Metavolcanics, LL Metagabbros, XX Older Granites, VV Dokhan Volcanics, Hammamat Sediments, FF Felsite).

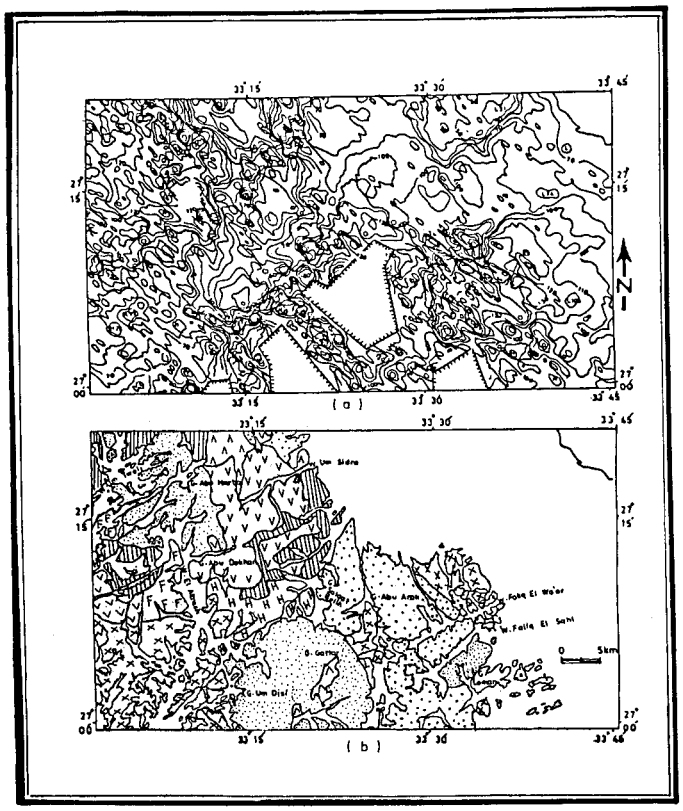

Fig. 7 : (a) Aeroradiometric total count contour map around G. Salaat Belih HRG1 pluton, G. Gattar HRG2 pluton and G. Abu Harba HRG2 pluton. (b) The corresponding photogeological map of the same plutons.

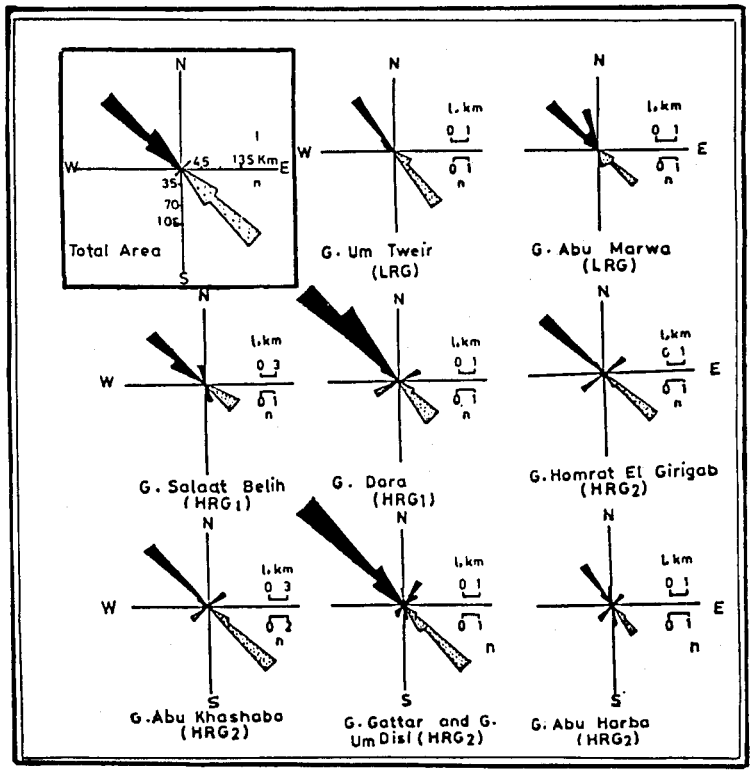

Fig. 8 : Rose diagrams showing the aeroradiometric trend directions for some representative younger granitic plutons, from the three radioactivity differentiated groups in the North Eastern Desert, Egypt.

in the area. This can be explained considering the general elongation of a basement outcrops especially the younger granite plutons in a NW trend-along the general folding axes. Most low and moderatte radioactive contours elengate parallel to this trend. The steep gradients observed at the contact between the rock groups are generaly elongated in a NW direction (Fig. 6a & 7a). This reflects a lithologic expression of this radioactivity trend. On the other hand most of the high contours inside the HRG plutons are elongated NW reflecting a structural control of the radioactivity along this trend.

These permit to consider the predominancy of radioactivity lineations along the NW-trend as lithologically and structurally controlled.

B - The NE trend :

This trend is of minor existence and cut through the boundaries of the different younger granitic plutons. It cuts also through some of the NW-trending higher contour levels as in G. Gattar Loman (Fig. 7), where the NW-trending contours of 160 μ R/h right laterally at the southern part of Gabal Loman.

C - The N-S to NNW trends :

These trends are well represented in the northern part of G. Gaffar Salaat Belih and G. Abu Harba (Fig. 7 & 8). They are represented by contours > 160 μ R/h within areas of about 120 and 130 μ R/h. In G. Abu Harba, The N-S and NNW radioactivity trends are related to the major macro-lineament structures, In G. Salaat Belih, they occur along the micro- lineaments.

In conclusion, the anomalously high levels of radioactivity are controlled by the NW, NNW and N-S trends (Fig. 5). The NE trend is considered as a secondary important, helping in concentration of the highest anomalies along its intersection with the main NW, NNW and N-S trends.

GEOLOGIC IMPLICATIONS

Field and petrographic studies of these photogeologically and radiometrically identified three younger granitic types, indicate some chronological and compositional differences between them. The YG1 type is grayish pink to rosy in colour, large size and exhibits a well developed exfoliation. It ranges in composition from granodiorite to adamellite. The YG1 (LRG) granitic rocks are usually intruded by swarms of NE trending dykes Microscopically, they consist mainly of plagioclases (32.9%) and K-feldspars (30.5%) in nearly equal amounts and quartz (26.6%). Mafic minerals (10%) are mainly biotite and hornblende. The accessory minerals include sphene, apatite, zircon, epidot and iron oxides.

The YG2 (HRG1) granites are pinkish in colour, hard, massive, of smaller size and occasionally exhibit coarse porphyritic texture. They are composed essentially of k-feldspar (39.5%) with quartz (26%) and plagioclase (27.5%) in nearly equal amounts. Mafics (7%) are biotite and muscovite. The accessory minerals are sphene, apatite, zircon, allanite and iron oxides.

The YG3 (HRG2) granites are reddish in colour, hard, massive, leucocratic and of medium to large size They consist mainly of potash- feldspars (> 50%), quartz (30%) and plagioclase (15%) Mafics (< 5%) are mainly biotite and muscovite. The accessory minerals are sphene, zircon, apatite, chlorite and iron- oxides with fluorite (particularly in G. Gattar).

Field and petrographic investigations indicate the sequence of emplacement of the younger granitic types in the area which started by the YG1 type. Their relative composition also indicates that the YG3 type represents the highly and latest differentiated phase, while the YG1 type is the early and least differentiated phase. There is a tendencey towards enrichment in alkali feldspars over plagioclase from YG1 to YG3. Late magmatic hydrothermal and / or metasomatic alterations have been recognized in the YG3 granites as indicated by the development of secondary albite and quartz as well as the presence of fluorite.

A Summary of the main photogeologic, radioactivity and geologic characteristic featuures of the three younger granitic types (YG1, YG2 and YG3) are shown in table 2.

Table (2) : Summary of the photogeological features of the three younger granitic types in the north Eastern Desert, Egypt

	YG1 (Um Tweir Type)	YG2 (Salaat Belih - Type)	YG3 (Gattar - Type)
Drainage Network : 1 - Density (km/km^2) 2 - Pattern 3 - Texture 4 - frequency (lines/km^2)	Hig (9.3) dendritic or paralled Fine 62	Moderate (8.8) trllis or dendritic Moderate 54	Low (6.3) dendritic or trellis Coarse 28.
Surface Texture	Fine	moderate to coarse	Smooth to coarse.
Colour	Brown	Yellowish brown	Reddish brown
Relief	Low	Moderate	High
Slope	Gentle	Deep	Steep
Ridge	elongated	elongated	rounded peaks
Shape	circular	elongated	Oval
Lineaments Network	High density & frequency	moderate density & frequency	Low density & frequency
Dykes	Extensive No. of NE-trending dyke swrme	moderate No. of NE & NW- trending dykes.	few No. of NE & NW trending dykes.
Essential Minerals	Plag. > K-Felds. > Qz	K - felds. > plag. > Qz	K-felds. > Qz > plag.
Mafics	Biotite & Hornblende 10%	Biotite 7%	minor contents of muscoviite & Biotite < 5 %
Accessory Minerals	iron oxides, apatite, zircon, sphene & epidote	iron oxides, zircon, sphene, apatite and allanite	Fluorite, zircon, sphene, apatite and iron oxides.
Radioactive group	LRG	HRG1	HRG2
Radioactivity ranges	60 - 100	100 - 180	100 - > 180

CONCLUSION

The increase in radioactivity values from YG1 to YG3 through YG2, beside field and petrographic criteria indicate the emplacemment of the Egyptiian younger granites on at least three successive phases. The younger granite intrusions in the Eastern Desert of Egypt cover a time span range between 600 and 575 Ma [10]. The same authors dated the younger granites of Gabal Dara and Gabal Salaat Belih (YG2 of the present study) at 596 and 583 Ma respectively while Gabal Gattar granites (YG3 type) gave an age of about 579 Ma. This age data indicate that the YG2 granitic rock type is followed chronologically by the YG3 type. The low initial ^{87} Sr (0.7030) of the younger granites indicates that the source of their melts is either metasomatically enriched mantle or first -cycle geosynclintal sediments and igneous rocks [10].

The observed increase in radioactivity values from least differentiated YG1 phase through the more YG2 phase to the latest YG3 phase differentiated indicates lithological control of the observed radioactivity where U and Th tend to concentrate in the latter stages of magmatic diffenentiation. The highly differentiated YG3 phase shows evidences for the existence enrichment by late solutions rich in U ant Th. These late stage magmatic hydrothermal and /or metasomatic stage is responsible for the observed alterations of the high anomalous sports in the YG3 younger granites. These alterations are also responsible for the formation of the secondary albite and quartz as well as the fluorite in the YG3 phase. The increase of radioactivity from the YG2 (HRG1) plutons to YG3 (HRG2) plutons which include the anomalously spots

having the highest radioactive values of the study area indicate progressive differentiation in the source of the younger granites and concentration of U and Th in the late stage. Late solutions were trapped on the surface through the NW, N-S and NE-trending fracture systems of the emplacement area forming anomalous radioactive sports. From the preceeding, it is clear that the mineralization is lithologically and tectonically controlled.

It is worth to recommend that the late phase of the younger granites (the YG3 type) is a potential source for the radioactive materials in the North Eastern Desert of Egypt. Within the YG3 plutons, areas of the intersection of the NE fracture system with the NW, NNW and N-S fracture systems should be considered as areas of redistribution of U-bearing solutions.

REFERENCES

[1] Colwell, R. N., 1960. Manual of photographic interpretation American society of photogrammetry Fallo church, Virginia, 868 P.

[2] Aero Service, 1984. Final operational report of airborns magnetic / radiation sursey in the Eastern Desert, Egypt, for the Egyptian General petroleum Corporation. Aero Service, Houston, Texas, April, 1984, six Volumes.

[3] Linsser, H., 1967. Investigation of tectonics by gravit detailing, Geoph. Prosp., 15; 480 - 515.

[4] Ray, R. G. 1965. Photogeologic procedures in geologic interpretation and mapping, U. S. G. S. Bull. 1043 A, 29p.

[5] Denny, c.s., 1952. Late Quaternary geology and frost phenomena along Alsaka Highway, northern Brit. col. and southeastern Yukon, Bull. G. S. A., 63 (2), 883 : 992.

[6] Speight, J. G., 1977. Landform pattern description from aerial photographs, official journal of the international seciety for photogrammetry, 32 (5) : 161 - 182.

[7] Wood and Snell, 1960. A quantitative system for classifying landforms, Quarter - master Res. and Eng. Command, U. S. Army, Tech. Rep. E. P. 124, 20 P.

[8] Stern, R.J., 1985 : The Najd fault system of Sadi Arabia and Egypt, a late precambrian rift-relate transform system, Tectonics, 4 : 497 - 511.

[9] Aswathanaryana, U., 1985 : Principles of nuclear geology, oxonian press pvt. Ltd New Delhi, 397 p.

[10] Stern, R. J., and Hedge, C. E., 1985 : Geochronologic and isotopic constraints on Late precambrian crustal evolution in the Eastern Desert Egypt American Journal of science, 285; 97 - 127.