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CONTRIBUTION TO THE GEOLOGY AND RADIOACTIVITY OF THE OLDER GRANITOIDS AND YOUNGER GRANITES OF GABAL EL-URF – GABAL ABU SHIHAT AREA, EASTERN DESERT, EGYPT

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ABSTRACT

The younger granites form an elongated belt following NNE-SSW direction. They intrude the older granitoids with sharp intrusive contacts and carry them as roof pendants. Two varieties of the younger granites are identified. They were intruded in successive pulses. Starting with greyish pink varieties (syenogranites of Gabal El-Urf), which are intruded by the red varieties (alkali-feldspar granites of Gabal Abu Shihat). The contact between them is usually inferred, but several small offshoots of red granites invade the greyish pink variety of Gabal El-Urf.

The pegmatites could be subdivided into zoned and unzoned pockets. Zoned pockets dominate in G. El-Urf as relatively small size subrounded pockets. The unzoned pockets dominate along the southwestern corner of G. Abu Shihat alkali-feldspar granites as relatively large size elongated pockets, which possess dissemination of metallic black and waxy yellow minerals (samarskite, oxinite, fergusonite, betafite and uranophane). It is worth to mention that, the unzoned pegmatites show more than twice the radioactivity level of the enclosing younger granites, while the zoned pegmatite pockets usually show radioactivity level less than the younger granites themselves, suggesting that pegmatite pockets in the studied area represent two successive phases.

The field, petrographic and radioactivity studies revealed that the alkali-feldspar granites of Gabal Abu Shihat originated from uranium-rich magma. Moreover, the secondary processes leached the labile uranium from country rocks and redeposited it in the fractures of the alkali-feldspar granites, especially along hematized zones. Also, the U-rich hydrothermal solutions, which introduced unzoned pegmatites in the southwestern corner of Gabal Abu Shihat, have supplied additional amounts of uranium to the hosting alkali-feldspar granites. Thus, Gabal Abu Shihat younger granites may represent a good environment for uranium resources.

INTRODUCTION

El-Gaby (1975) believed that the Egyptian granites represent one continuous series. Akaad *et al.* (1979) divided the Egyptian granites into older and younger granites intruded in successive phases. El-Gaby *et al.* (1984) differentiated the Egyptian granites into:

a) an older syn- to late-orogenic calc-alkaline granite series comprising the older granitoids and the two feldspar calc-alkaline younger granites, which are respectively equivalent to the G-I (subduction-related) and G-II (collision-related) granites of Hussein *et al.* (1982).

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b) a younger anorogenic alkaline granite series corresponding to G-III granites of Hussein *et al.* (1982).

Ragab *et al.* (1989) described the older granitoids as the plutonic equivalent of the Dokhan volcanics (mature island arcs of low-K calc-alkaline nature) and described the younger granites as products of extensive crustal anatexis due to arc-arc suturing during culmination of the Pan-African orogeny. Takla and Hussein (1995) related the younger granites to continental margins-within plate magmatism.

Gabal El-Urf – Gabal Abu Shihat area (about 90 km^2) is located north of Qena-Safaga asphaltic road at km 85 from Qena. It is bounded by latitudes 26° 36` – 26° 42` N and longitudes 33° 22` - 33° 27` E. This work aims to:

- compare between the mineral constituents of the older granitoids and younger granites,
- compare between the mineral constituents of El-Urf and Abu Shihat younger granites,
- evaluate the radioactivity of the younger granites and the associated pegmatites.

METHODOLOGY

In this work, the equivalent uranium (eU) and equivalent thorium (eTh) contents were radiometrically determined in the field by measuring the gamma-activity of their daughter elements by a portable gamma-ray spectrometer model (UG-130). The measurements were recalculated after the background and stripping corrections and converting the corrected counts per second (cps) to parts per million (ppm).

Mineralization in the pegmatite pockets and ferruginated spots in Abu Shihat alkali-feldspar granites were identified by means of EDAX-SEM technique (Philips XL30 attached with accelerating voltage of 30 kV.) and XRD technique using Philips X-ray unit (Model PW 3710) with generator (Model PW 1830), Cu target tube (Model PW 2233/20) and Ni filter at 40 kV and 30 mA.

Thirteen samples (5 for older granitoids, 4 for Abu Shihat alkali-feldspar granites and 4 for El-Urf syenogranites) were chemically analyzed (Table 2) for trace elements (Rb, Zr, Sr and Nb) using XRF technique (Phillips PW 1410 together with a MO-target tube operated at 50 kV and 30 m A). All the chemical analyses and instrument calibration had been carried out in the Nuclear Materials Authority (NMA), Egypt.

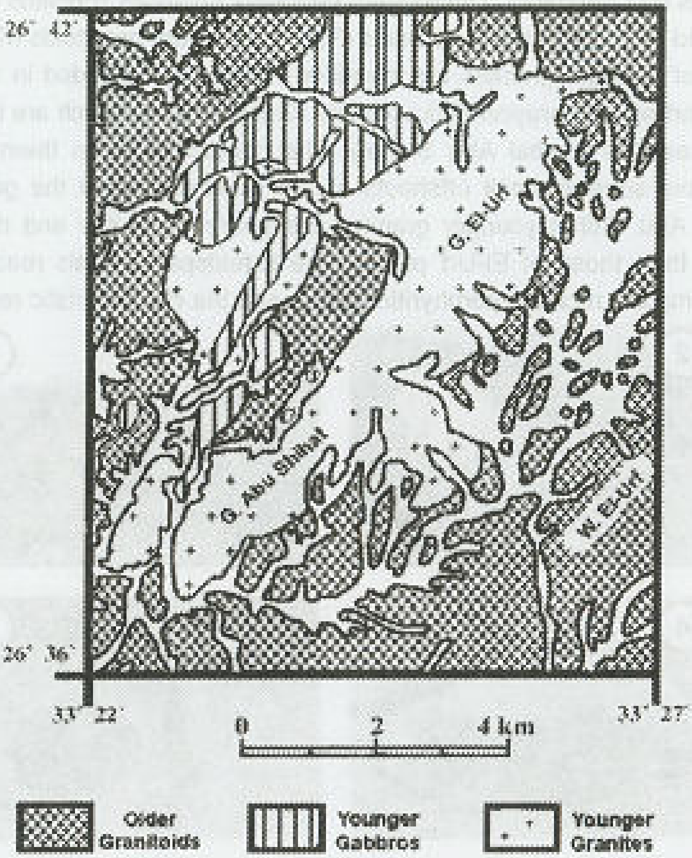
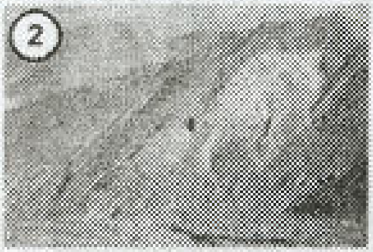
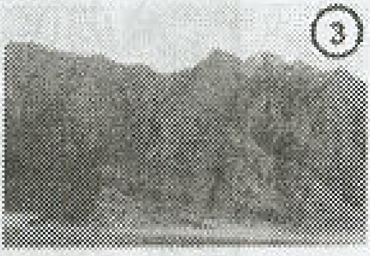


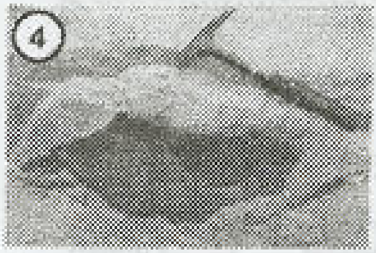
Fig. 1: Geologic map of Gabal El-Urf – Gabal Abu Shihat area, Eastern Desert, Egypt

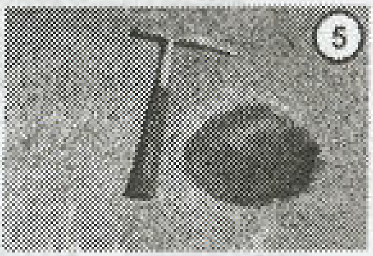
FIELD GEOLOGY

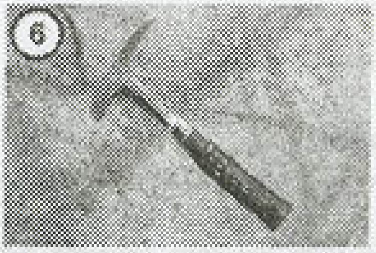
The Precambrian basement rocks in the mapped area, are only represented by three lithologic units, older granitoids, younger gabbros and younger granites (Fig. 1). The older granitoids usually form low-lying separate hills. Their topography gets higher along the contacts with the younger granites and in the areas dissected by felsic dykes (Abdel Ghani, 2001). Their colours range from whitish to dark grey. The younger granites form an elongated belt following NNE-SSW direction (Fig. 1). They are commonly massive and easily distinguished in the field from the surrounding country rocks by their distinctive pink and/or red colour. They form discordant outcrops with sharp intrusive contacts against the surrounding older granitoids (Fig. 2) and younger gabbros (Fig. 3). The central part of the belt carries older granitoids and younger gabbros as roof pendants. The western periphery encloses xenoliths of different shapes and sizes from metavolcanics (Fig. 4) and older granitoids (Fig. 5). Two varieties of younger granites are identified. They were intruded in successive pulses, starting with grayish pink varieties (Gabal El-Urf), which are intruded by the red varieties (Gabal Abu Shihat). The contact between them is usually inferred, but several small offshoots of red granites invade the greyish pink varieties. Abu Shihat younger granites are poorer in biotite and richer in K-feldspars than those of El-Urf pluton. The K-feldspar crystals reach 6 cm in length giving the rock the porphyritic texture and the characteristic red colour.











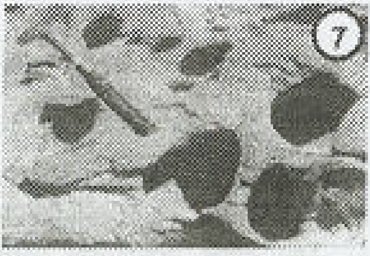


Fig. 2: Younger granites intruding the older granitoids and carry them as roof pendants, northern periphery of Gabal El-Urf, looking north

Fig. 3: Younger granites intruding younger gabbros with sharp intrusive contacts, northern periphery of Gabal El-Urf, looking northeast

Fig. 4: Younger granites enclosing elongated xenolith of metavolcanics, Gabal Abu Shihat

Fig. 5: Younger granites enclosing oval-shaped xenolith of older granitoids, Gabal El-Urf

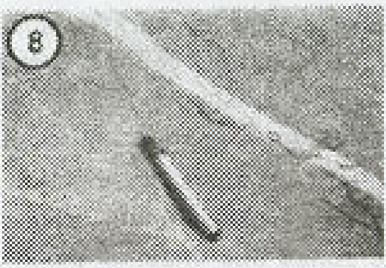
Fig. 6: Younger granites showing brick-red colour due to hematization, southwestern periphery of Gabal Abu Shihat

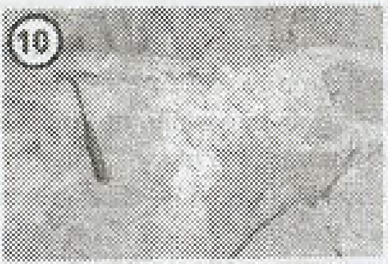
Fig. 7: Older granitoids showing cavernous weathering, Wadi El-Urf

Generally, alteration of the two varieties of younger granites is mainly represented by hematization, which renders the granites brick-red colour (Fig. 6). Other minor alteration features as epidotization, chloritization, silicification and kaolinization are restricted to fault and joint planes. Locally, younger granites show cuboidal weathering and regular jointing. On the other hand, the weathering surfaces of the older granitoids are characterized by a number of subrounded cavities (Fig. 7) with characteristic friable appearance and kaolinization. Several offshoots of younger granites are recorded in the older granitoids. These offshoots are of different thickness that decreases on going away from younger granites.

The feldspar (Fig. 8) and quartz (Fig. 9) veinlets are common in Abu Shihat younger granites but very rare in El-Urf younger granites. The pegmatites could be subdivided into zoned and unzoned pockets. The zoned pockets are represented by relatively small size subrounded pockets. They are mainly composed of milky quartz surrounded by K-feldspars (Fig. 10), while micas are absent or very rare. The unzoned pockets are represented by relatively large size elongated pockets and sheets. They are mainly composed of intergrowth of milky quartz and K-feldspars with large flakes of muscovite (Fig. 11). The fractures in quartz are usually filled with iron oxy-hydroxides and dissemination of metallic black and waxy yellow minerals (Figs. 12 and 13). The unzoned pegmatite pockets are structurally controlled as they arranged in more or less one direction along the fractured and sheared zones with a major fault striking NW-SE, especially along the southwestern periphery of Gabal Abu Shihat. It is worth to mention that, the unzoned pegmatites show more than twice the radioactivity level of the enclosing younger granites, while the zoned pegmatite pockets usually show radioactivity level less than the younger granites themselves, suggesting that pegmatite pockets in the studied area represent two successive phases.

The main directions of the dykes in the area are NE-SW and NW-SE. On the other hand, N-S and E-W strikes are less dominant. Generally, the dykes are fairly straight, vertical with thickness ranging between 0.3 and 8.0 m and lengths less than two km. They could be classified into felsic and mafic dykes, which are mainly represented by basalts (black with reddish brown tarnish), andesites (grey to greenish black) and felsites (deep pink to brick red) in decreasing order of abundance. Most of the mafic dykes are strongly weathered relative to the enclosing rocks resulting in deep grooves, especially where the host rocks are younger granites. The felsic dykes are more resistant to weathering than the enclosing rocks and usually give rise to spines and ridges. The field relationship between felsic and mafic dykes is complicated. The mafic dykes sometimes appear to intersect and/or intersected by the felsic ones, suggesting that these dykes represent more than one phase.





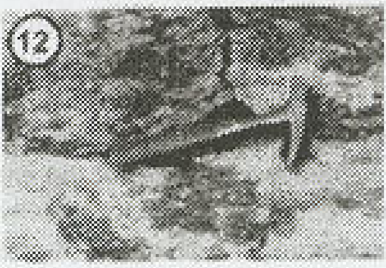


Fig. 8: Feldspar veinlet in the younger granites of Gabal Abu Shihat

Fig. 9: Irregular quartz veinlets in the younger granites of Gabal Abu Shihat

Fig. 10: Zoned pegmatite pocket, composed mainly of milky quartz in the core surrounded by K-feldspars, Gabal El-Urf

Fig. 11: Unzoned pegmatite pocket, showing intergrowth of milky quartz and K-feldspars with dissemination of metallic black mineral, southwestern periphery of Gabal Abu Shihat

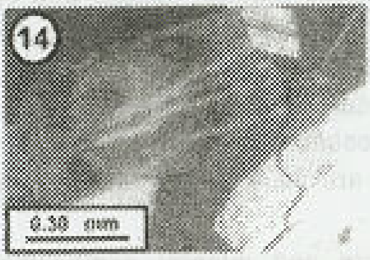
Fig. 12: Unzoned pegmatite pocket showing dissemination of metallic black and waxy yellow minerals in quartz, southwestern periphery of Gabal Abu Shihat

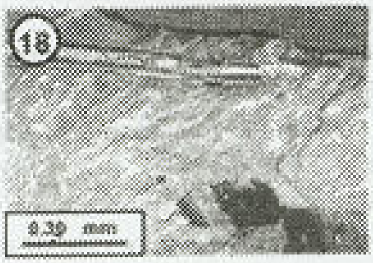
Fig. 13: Metallic black minerals associated with iron oxy-hydroxides filling the fractures of quartz and K-feldspars in the unzoned pegmatite, southwestern periphery of Gabal Abu Shihat

PETROGRAPHY

Older granitoids

It is quite clear that the older granitoids range in composition from quartz diorites through tonalites to granodiorites. Quartz diorites are medium- to coarse-grained, essentially composed of plagioclase (about 65.8 %), quartz (about 13.8 %), hornblende (about 7.1 %), biotite (about 5.9 %) and minor alkali feldspars (about 5.3 %). Titanite, apatite and opaques are accessory minerals (about 2.1 %). Epidote, chlorite, sericite and kaolinite are secondary minerals.In some sections, gneissose texture is observed.





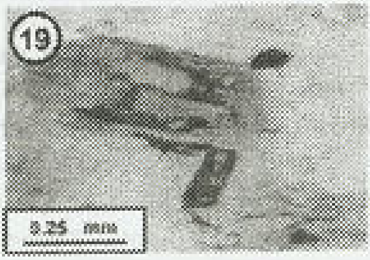


Fig. 14: Plagioclase showing oscillatory zoning (quartz diorites, C.N.)

Fig. 15: Cracked and deformed plagioclase crystal (quartz diorites, C.N.)

Fig. 16: Highly cracked quartz showing wavy extinction (quartz diorites, C.N.)

Fig. 17: Subhedral hornblende enclosing opaques (quartz diorites, P.L.)

Fig. 18: Flame- and patchy-type orthoclase perthite enclosing plagioclase (quartz diorites, C.N.)

Fig. 19: Metamicted zircon, enclosed in quartz (granodiorites, P.L.)

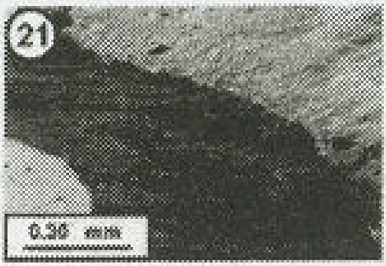
Plagioclase (An_{20}-An_{35}) occurs as subhedral tabular crystals, up to 1×3 mm. Generally, it exhibits various types of twinning such as albite, pericline and combined albite-Carlsbad. Some plagioclase crystals display oscillatory zoning (Fig. 14) with an altered core and fresh rims. Other crystals are highly cracked (Fig. 15). Plagioclase commonly encloses apatite, quartz and sometimes smaller plagioclase crystals. Quartz occurs as interstitial anhedral crystals filling the spaces between the early-formed minerals. Sometimes, it exhibits wavy extinction and/or cracking (Fig. 16). Hornblende, of green colour, occurs as subhedral prismatic crystals, enclosing poikilitically titanite, apatite and opaques (Fig. 17). Biotite occurs as irregular flakes. Most of them are altered to chlorite. The result of alteration is releasing iron oxy-hydroxides, which are precipitated along cleavage planes (Jeong and Kim, 2003). Alkali feldspars are very rare, mainly represented by flame- and patchy-type orthoclase perthites (Fig. 18). They are usually altered to sericite and kaolinite.

Granodiorites resemble (in texture and mineral composition) the quartz diorites, but they constitute more K-feldspars and biotite at the expense of plagioclase and hornblende. Moreover, granodiorites enclose few zircon crystals (Fig. 19) in biotite and quartz.

Younger granites

Younger granites are, petrographically, classified into syenogranites (greyish pink granites of G. El-Urf) and alkali-feldspar granites (red granites of G. Abu Shihat). Syenogranites are equigranular, composed of alkali feldspars (about 44.9 %), quartz (about 37.5 %) and plagioclase (about 13.6 %) with subordinate amounts of biotite (about 2.4 %) and muscovite (about 1.3 %) as essential minerals. The presence of conspicuous amounts of primary muscovite suggests genesis from peraluminous magma. The accessory and secondary minerals are rare (about 0.3 %). They are mainly represented by iron oxy-hydroxides and epidote. Zircon and apatite are very rare or absent. Alkali-feldspar granites are coarse, porphyritic, essentially composed of alkali feldspars (about 66.1 %), quartz (about 24.4 %) and plagioclase (about 5.8 %) with subordinate amounts of muscovite (about 1.2 %) and biotite (about 0.6 %) as essential minerals. The accessory and secondary minerals (about 1.9 %) are allanite, epidote, zircon and fluorite as well as iron oxy-hydroxides.

Alkali feldspars increase in abundance from syenogranites (about 44.9 %) to alkali-feldspar granites (about 66.1 %). The ratios of microcline/orthoclase and orthoclase/plagioclase also increase in the same trend. The former ratio suggests that syenogranites were crystallized at relatively higher temperature than alkali feldspar granites (Read, 1984 and Deer *et al.*, 1992).



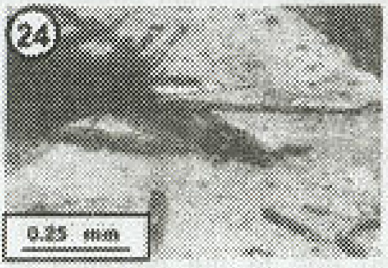


Fig. 20: Cracked patchy-type orthoclase perthite enclosing plagioclase (syenogranites, C.N.)

Fig. 21: Simply twinned flame-type orthoclase perthites (alkali-feldspar granites, C.N.)

Fig. 22: Zircon showing wide pleochroic halo, suggesting high radioelement contents (alkali-feldspar granites, C.N.)

Fig. 23: Allanite enclosed in quartz (alkali-feldspar granites, C.N.)

Fig. 24: Several apatite needle-like crystals enclosed in quartz (syenogranites, P.L.)

Fig. 25: Biotite flake showing pleochroic halo resulted by the damage effect of the radioelements (alkali-feldspar granites, C.N.)

The second ratio may explain the gradation of the rock colours from greyish pink (syenogranites) to red (alkali-feldspar granites). Microcline and orthoclase of patchy- and flame-like perthitic textures are found as anhedral crystals (Fig. 20) enclosing minute crystals of zircon and fluorite. Their cracks are usually filled with epidote, quartz and secondary muscovite. They are mainly unaltered with conspicuous simple twinning (Fig. 21), while the kaolinized and sericitized crystals are rare in the syenogranites and absent in the alkali-feldspar granites.

Quartz decreases in abundance from syenogranites (about 37.5 %) to alkali-feldspar granites (about 24.4 %). Generally, two forms of quartz can be easily identified. The first one is anhedral and contains fine inclusions of clay minerals and iron oxides near peripheries, suggesting overgrowth during a process of silicification. This form encloses minute crystals of zircon (Fig. 22), allanite (Fig. 23), apatite (Fig. 24) and fluorite. Quartz crystals showing undulose extinction in the alkali-feldspar granites are completely absent, indicating that this rock is less affected by stresses than the syenogranites. The second form of quartz is of fine-grained undeformed crystals that may represent a second crystallization stage.

Plagioclase decreases in abundance from syenogranites (about 13.6 %) to alkali feldspar granites (about 5.8 %). In addition, the calcium contents and alteration as well as deformation decrease in the same trend. The majority of crystals show clear lamellar twinning with slight visible alteration. Some crystals represent an older phase corroded by other minerals, while others show zoning, indicating local albitization (Holten *et al.*, 2000).

Biotite flakes of syenogranites are sometimes altered to chlorite with releasing iron oxy-hydroxides along peripheries and cleavage planes. On the other hand, biotite flakes of alkali-feldspar granites are usually unaltered. Most biotite flakes of the alkali-feldspar granites possess several pleochroic halos (Fig. 25) due to the presence of minute radioactive materials.

Primary muscovite flakes are found as irregular, elongated, fan-shaped or leaf-like flakes. The presence of conspicuous amounts of primary muscovite suggests genesis from peraluminous magma. Some primary muscovite flakes show pleochroic halos. In some cases, muscovite appears secondary filling the cracks.

Pegmatites

Zoned pegmatites are mainly composed of quartz surrounded by K-feldspars, while mica are absent or very rare. The unzoned pegmatites are composed of intergrowth of quartz and K-feldspars with large flakes of muscovite. The fractures of quartz are usually filled with iron oxy-hydroxides and dissemination of metallic black and waxy yellow minerals. These minerals were identified by means of XRD and EDAX-SEM techniques as samarskite, oxinite, fergusonite, betafite and uranophane. All of them are partially coated with iron oxy-hydroxides. The presence of these minerals suggests that the hydrothermal solutions or the residual magma from which these pegmatites originated are not only rich in uranium and thorium, but also rich in Nb, Ta and REEs. The scanned fluorite exhibits numerous tiny inclusions mainly represented by barite, jasper (chalcedony) and uranophane. The presence of the previously mentioned association with fluorite reflects the hydrothermal origin of fluorite (Deer *et al*. 1992).

RADIOACTIVITY

Table (1) summarizes the measured eU (equivalent uranium) and eTh (equivalent thorium) contents measured in ppm. These data are illustrated as bar histograms (Fig. 26) to compare between the radioactivity levels of the studied rocks. The radioactivity values reflect a systematic increase in uranium contents from the older granitoids passing through syenogranites of Gabal El-Urf to alkali-feldspar granites of Gabal Abu Shihat.

Uraniferous rocks are defined according to Darnley (1982) as any rock containing uranium at least twice the Clarke value (4 ppm). Assaf et al. (1997) concluded that uraniferous granites should contain more than 18 ppm uranium. The studied alkali-feldspar granites of Gabal Abu Shihat show average eU contents of 21.4 ppm (Table 1 and Fig. 26), suggesting that they originated from magma rich in radioelements (Hussein and Sayyah, 1991). Also, the alkali-feldspar granites show wide range of eU contents (14.0 – 68.3 ppm) if compared with those of El-Urf syenogranites (7.3 – 26.5 ppm); the wide range of eU contents may be attributed to intense redistribution during secondary (post magmatic) processes (Dardier and El-Galy, 2000).

The rocks of eU/eTh average ratios greater than 0.4 are considered to be favourable environment for uranium deposits (Cambon, 1994). The alkali-feldspar granites show eU/eTh average ratios greater than 0.6, while those of the older granitoids and El-Urf syenogranites are 0.26 and 0.39 respectively (Table 1 and Fig. 26).

Normally, thorium is three times as abundant as uranium in rocks (Rogers and Adams, 1969). When this ratio is disturbed, it indicates a depletion or enrichment of uranium during post magmatic processes (Dardier *et al*., 2002 and El-Mansi *et al*., in press). In this work, the average eTh/eU ratios are 3.8, 2.6 and 1.6 for the older granitoids, El-Urf syenogranites and Abu Shihat alkali-feldspar granites respectively, suggesting that the studied rocks have suffered from post magmatic processes to a great extent. Uranium was leached from older granitoids during weathering and alteration processes, which were caused by meteoric water and the heat effect during the intrusion of younger gabbros and younger granites. Syenogranites show slight addition of uranium, while the alkali-feldspar granites were enriched in uranium during pegmatitic-pneumatolytic stage and hematization process. The source of uranium may be related to hydrothermal solutions and/or labile uranium, which was leached from the surrounding country rocks (El-Mansi, 1996). This suggestion is confirmed by the following:

Table 1: Equivalent uranium (eU) and thorium (eTh) measured in ppm as well as eU/eTh ratios for the studied older granitoids and younger granites.

Rock type		Older granitoids	Younger granites	
			El-Urf syenogranites	Abu Shihat alkali-feldspar granites
Number of measurements		128	74	115
eU	Minimum	2.2	7.3	14.0
	Average	3.5	13.1	21.4
	Maximum	6.8	26.5	68.3
eTh	Minimum	9.0	22.0	33.1
	Average	15.4	38.9	47.5
	Maximum	25.1	59.1	71.6
eU/eTh	Minimum	0.21	0.36	0.40
	Average	0.26	0.39	0.61
	Maximum	0.32	0.48	0.85

1. During field studies, several anomalous values of uranium contents (up to 140 ppm) following some unzoned oval-shaped and sheet-like pegmatite pockets (diameter ranges between 1 and 4 m) and ferruginated spots (0.5 – 3.0 m across) in the alkali-feldspar granites; they sometimes show visible mineralization of metallic black and waxy yellow colours in addition to disseminations of green and violet fluorite.

2. Petrographic studies revealed that the older granitoids enclose metamicted zircon without any pleochroic halos, suggesting fracturing of zircon crystals and leaching of radioelement constituents. Taking in consideration that, zircon which is a relatively resistate mineral have

suffered from leaching processes; thus the other minerals in the older granitoids easily lost most of their labile uranium contents. On the other hand, zircon crystals of the alkali-feldspar granites show wide pleochroic halos, suggesting that they enclose adequate amounts of radioelements.

The uraniferous granites are characterized by Zr/Sr ratios greater than 1.65 (Hall and Walsh, 1969). The Zr/Sr average ratios are 0.18, 1.04 and 3.47 for the studied older granitoids, syenogranites and alkali-feldspar granites respectively (Table 2 and Fig. 27). Assaf et al. (1997) discussed the favourable environment, on geochemical basis, for uranium deposition in granitic rocks. They suggested that the uraniferous granites show high Nb (>63.4 ppm), Rb (>184.8 ppm) and Rb/Sr (>5.35) values. By matching the previously mentioned items with those of the studied older granitoids and younger granites, it is clear that Abu Shihat alkali-feldspar granites could be considered as uraniferous granites.

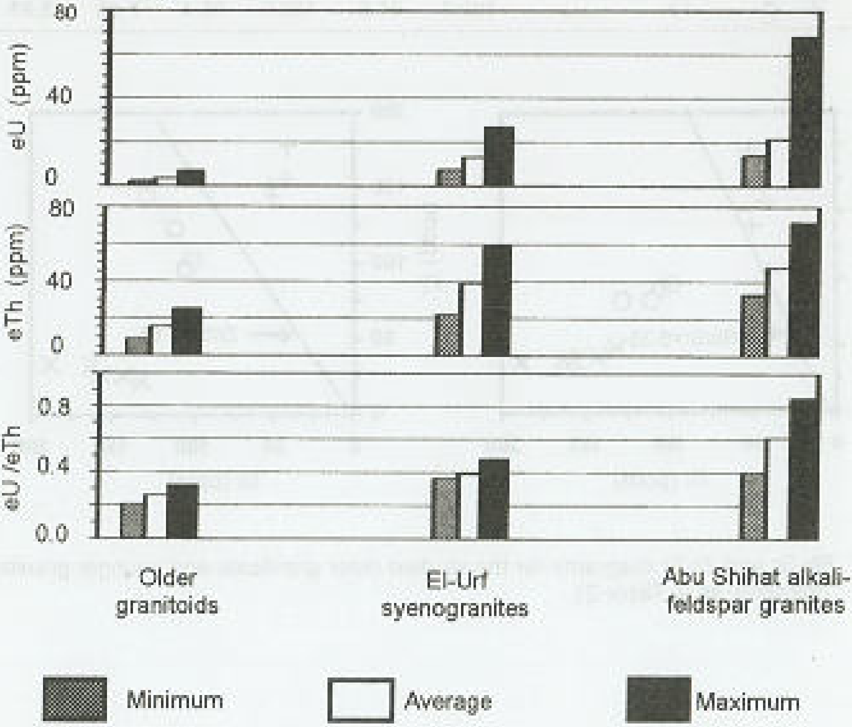


Fig. 26: eU and eTh (ppm) as well as eU/eTh ratios for the studied rocks

Table 2: Some trace element contents (ppm) and Rb/Sr and Zr/Sr ratios for the studied older granitoids and younger granites

Rock type		Sample number	Symbol	Rb	Sr	Zr	Nb	Rb/Sr	Zr/Sr
Older granitoids		1	X	82.8	142.3	25.8	16.3	0.58	0.18
		2		77.3	157.1	26.4	11.5	0.49	0.17
		3		96.9	131.7	21.9	28.5	0.74	0.17
		4		80.0	162.5	32.0	21.9	0.49	0.20
		5		74.8	188.0	33.7	10.3	0.40	0.18
Younger granites	Syeno-granites (G. El-Urf)	6	O	190.3	99.5	101.5	43.9	1.91	1.02
		7		185.7	104.6	95.4	65.1	1.78	0.91
		8		167.1	111	122.6	46.0	1.51	1.10
		9		166.3	128.4	144.0	44.1	1.30	1.12
	Alkali-feldspar granites (G. Abu Shihat)	10	+	278.9	50.6	144.9	65.2	5.51	2.86
		11		315.4	41.9	156.1	71.3	7.53	3.73
		12		209.5	41.0	178.1	62.0	5.11	4.34
		13		392.3	51.5	150.9	76.4	7.62	2.93

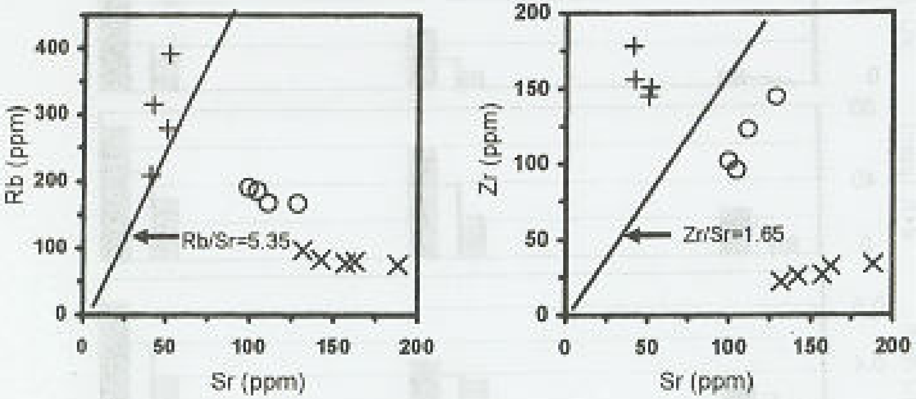


Fig. 27: Rb-Sr and Zr-Sr diagrams for the studied older granitoids and younger granites (symbols as in Table 2).

Table 3: Differences and similarities between the older granitoids, El-Urf syenogranites and Abu Shihat alkali-feldspar granites

		Rock type	Older granitoids	Younger granites	
				G. El-Urf	G. Abu Shihat
Field studies		Topography	- Low-lying hills	- Relatively high topography	
		Field relationships	- Intruded by younger gabbros and younger granites	- Send several offshoots into the older granitoids	- Send small offshoots into El-Urf pink granites
		Hand specimen	-Whitish to dark grey -Friable -Porphyritic	-Greyish pink -Massive -Equigranular	-Red -Massive -Porphyritic
		Weathering	- Cavernous weathering with friable appearance	- Cuboidal weathering	
		Alteration	- Mainly chloritization	Hematization, silicification and kaolinization	
		Veinlets	-Few thin quartz veinlets	-Veinlets are rare	- Feldspar and quartz veinlets
		Pegmatites	- Absent	- Zoned, small, rounded pegmatites	-Zoned, rounded pegmatites -Unzoned elongated pegmatites
Petrographic studies		Petrographic name	- Quartz diorites to granodiorites	- Syenogranites	- Alkali-feldspar granites
	Essential minerals	K-feldspars	-6.3% - Highly altered orthoclase perthite	-44.9 % -Slightly altered orthoclase perthite	-66.1 % -Microcline and orthoclase perthites
		Quartz	-13.8 % -Highly cracked quartz showing wavy extinction	-37.5 % -Slightly deformed quartz showing overgrowth	-24.4 % -Clear quartz without any deformation
		Plagioclase	- 65.8 % -Highly cracked and altered	-13.6 % -Slightly altered	-5.8 % -Clear lamellar twinning
		Hornblende	- 7.1 %	- Absent	- Absent
		Biotite	-5.9 % -Highly chloritized	-2.4 % -Slightly chloritized	-0.6 % -Slightly chloritized
		Muscovite	- Secondary filling the cracks	-1.3 % -Primary flakes corroded by alkali feldspars -Secondary filling cracks	-1.2 % -Primary flakes enclosing pleochroic halos -Secondary filling the cracks
	Accessories	Apatite	- Present	- Rare	- Absent
		Zircon	- Metamicted	- Rare or absent	- Surrounded by wide pleochroic halos
		Titanite	-Sphenoidal and elongated	- Absent	- Absent
		Allanite	- Absent	- Absent	- Present
Radioactivity		eU-contents	- 2.2 – 6.8 ppm -Rocks poor in uranium	- 7.3 – 28.5 ppm - Normal granites	- 14.0 – 68.3 ppm -Uraniferous granites
		eTh-contents	- 9.0 – 25.1 ppm	- 22.0 – 59.1 ppm	- 33.1 – 71.6 ppm
		eU/eTh	- 0.26	- 0.39	- 0.61
		eTh/eU	- 3.8	- 2.6	- 1.6
		U-redistribution	- Uranium leaching	- Slight uranium addition	- Uranium addition from surrounding rocks and hydrothermal solutions

Table 4: Comparison between the zoned and unzoned pegmatite pockets

Type	Zoned pegmatite	Unzoned pegmatites
Location	Gabal El-Urf and northern part of Gabal Abu Shihat	Southwestern corner of Gabal Abu Shihat
Orientation	Random	Arranged in more or less one direction along the fractured zones with major fault striking in the NW-SE direction
Shape	Subrounded	Elongated and sheet-like
Size	Relatively small	Relatively large
Mica	Absent	Mainly muscovite
Mineralization	Absent	Metallic black and waxy yellow disseminations of samarskite, axinite, fergusonite, betafite and uranophane
Radioactivity	Radioactivity level less than the younger granites themselves	More than twice the radioactivity level of the enclosing younger granites

SUMMARY AND CONCLUSIONS

The younger granites form an elongated belt following NNE-SSW direction. They intrude the older granitoids with sharp intrusive contacts and carry them as roof pendants. Two varieties of the younger granites are identified. They were intruded in successive pulses. Starting with greyish pink varieties (syenogranites of Gabal El-Urf), which are intruded by the red varieties (alkali-feldspar granites of Gabal Abu Shihat). The differences and similarities between the older granitoids, El-Urf syenogranites and Abu Shihat alkali-feldspar granites are summarized in table (3). The pegmatites could be subdivided into zoned and unzoned pockets; a comparison between them is summarized in table (4).

The field, petrographic and radioactivity studies revealed that the alkali-feldspar granites of Gabal Abu Shihat originated from uranium-rich magma. Moreover, the secondary processes leached the labile uranium from country rocks and redeposited it in the fractures of the alkali-feldspar granites, especially along hematized zones. Also, the U-rich hydrothermal solutions, which introduced unzoned pegmatites in the southwestern corner of Gabal Abu Shihat, have supplied additional amounts of uranium to the hosting alkali-feldspar granites. Thus, Gabal Abu Shihat younger granites may represent a good environment for uranium resources.

REFERENCES

Abdel Ghani, I. M. (2001): Geology, petrology and radioactivity of Gabal El-Urf area, Central Eastern Desert, Egypt. Ph.D. Thesis, South Valley Univ., Qena, Egypt, 273 p.

Akaad, M.K., Noweir, A. M. and Kotb, H. (1979): Geology and petrochemistry of the granite association of Arabian Desert orogenic belt of Egypt between lat. 25° 35' and 26° 30' N. Delta Jour. Sci., vol. 3, p. 107-151.

Assaf, H.S., Mahdy, M.A. and El Afandy, A.H. (1997): Egyptian younger granites, an approach to define parameters favouring formation of uranium deposits. 3^{rd} Conference Geochemistry, Alexandria Univ., Egypt, p. 409-420.

Cambon, A.R. (1994): Uranium deposits in granitic rocks. Notes on the national training course on uranium geology and exploration. Organized by IAEA and NMA, 8-20 Jan. 1994, Cairo, Egypt.

Dardier, A.M. and El-Galy, M.M. (2000): Contribution to the U-Th distribution in the older and younger granitoids along Qena-Safaga road, Central Eastern Desert, Egypt. Egypt. Jour. Geol., vol. 44, No.1, p.55-64.

Dardier, A.M., Farag, S.S., Abdel Ghani, I.M., Arbab, A.A., Abd El-Shafi, A., Omran, A.A., Ibrahim, S.E. and Zaher, F.Y. (2002): Geological and radiometric prospection for Wadi Hawashiya-Gabal Um El-Tanasub area, North Eastern Desert, Egypt. Internal report in the Nuclear Materials Authority of Egypt (NMA).

Darnley, A.G. (1982): Hot granites, Some general remarks. In : Maurice, Y.J.(ed.), Uranium in granites. Geol. Surv. Canada, paper No. 81-23, p. 1-10.

Deer, W.A., Howie, R.A. and Zussmann, J. (1992): An introduction to the rock forming minerals. Longmans, London, England. Second edition, 696 p.

El-Gaby, S. (1975): Petrochemistry of some granites from Egypt. N.Jb. Mineral. Abh., vol. 124, p. 147-189.

El-Gaby, S., El-Nady, O.M. and Khudeir, A. (1984): Tectonic evolution of the basement complex of central Eastern Desert of Egypt. Geol. Runds., vol. 73, p. 1019-1036.

El-Mansi, M.M. (1996): Petrology, radioactivity and mineralization of Samut-Atud area, Central Eastern Desert, Egypt. Ph. D. Thesis, Cairo Univ., 320 p.

El-Mansi, M.M., Dardier, A.M. and Moussa, E.M (2005): Geology and Uranium Distribution within the Older Granitoids and Some Granitic Masses in the North Eastern Desert, Egypt. Egypt. Jour. Geol., (in press).

Hall, A. and Walsh, J. N. (1969): Rapid method for the determination of fluorine in silicate rocks and minerals. Anal. Chem. Acta, vol. 45, p. 341-342.

Holten, T., Jamtveit, B. and Meakin, P. (2000): Noise and oscillatory zoning of minerals. Geochim et Cosmochim Acta, vol. 64 (11) p. 1893-1904.

Hussein, A.A., Ali, M.M. and El Ramly, M.F. (1982): A proposed new classification of the granites of Egypt. Jour. Volcanol. Geotherm. Res., vol.14, p. 187-198.

Hussein, A.M. and Sayyah, T.A. (1991): Uranium of the younger granites of Egypt. International Atomic Energy. Vienna, Austria 14 p.

Jeong, G.Y. and Kim, H.B. (2003): Mineralogy, chemistry, and formation of oxidized biotite in the weathering profile of granitic rocks. American Mineralogist, vol. 88, p. 352-364.

Ragab, A.I., Meneisy, M.Y. and Diab, M.M. (1989): Petrology and petrogenesis of the older and younger granitoids of Wadi Bezah area, central Eastern Desert, Egypt. Jour. Afr. Earth. Sci., vol. 9, No. 2, p. 303-315.

Read, H. H. (1984): Rutley's elements of mineralogy. Published by S. K. Jain for CBS Publishers and Distributors, Delhi, India, 560p.

Rogers, J.J.W. and Adams, J.S.S. (1969): Uranium. In: Wedepohl, K. H. (ed.) Handbook of geochemistry, New York, Springer-Verlag, vol. 4, p. 92 B1- 92 C10.

Takla, M.A. and Hussein, A.A. (1995): Shield rocks and related mineralizations in Egypt. 11th Sympo. Precamb. Develop., Cairo, Abst., p. 6-7.

مساهمة فى جيولوجية وإشعاعية الجرانيتويدات القديمة والجرانيتات الحديثة بمنطقة جبل العرف – جبل أبو شيحات، الصحراء الشرقية، مصر

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تكون الجرانيتات الحديثة حزام يمتد فى اتجاه شمال شمال شرق- جنوب جنوب غرب حيث تتداخل فى الجرانيتويدات القديمة وتحمل معلقات منها. أمكن تمييز نوعين من الجرانيتات الحديثة والتى تتداخل فى صورة نبضات متتالية تبدأ بالجرانيت ذو اللون الوردى المائل إلى الرمادى (سيانوجرانيت جبل العرف) تتداخل فيها الجرانيت ذو اللون الأحمر (الجرانيت ذو الفلسبار القلوى لجبل أبو شيحات) ويكون خط التلامس بينهما متقطع علاوة على الأذرع الصغيرة من الجرانيت الأحمر والتى تقطع فى الجرانيت الوردى المائل للرمادى لجبل العرف. أما أجسام وجيوب البجماتيت بمنطقة الدراسة أمكن تمييزها إلى جيوب ممنطقة والتى تنتشر فى جبل العرف وتكون ذات أحجام صغيرة شبه دائرية والى جيوب غير ممنطقة تنتشر فى الركن الجنوبى الغربى لجبل أبو شيحات وتكون ذات استطالة وأحجام كبيرة نسبيا والتى تحتوى على معادن ذات بريق معدنى اسود وأصفر شمعى (سمارسكيت، أوكسينيت، فيرجزونيت، بيتافيت ويورانوفين). يبلغ المستوى الإشعاعى للجيوب البجماتيتية غير الممنطقة أكثر من ضعف المستوى الإشعاعى للجرانيت الحاوى لها، بينما تظهر البجماتيت الممنطقة مستوى إشعاعى أقل من الجرانيتات الحاوية لها مما يدل على أن الجيوب البجماتيتية بمنطقة الدراسة تكونت على مراحل متتالية. أوضحت الدراسات الحقلية والبتروجرافية والإشعاعية أن الجرانيت ذو الفلسبار القلوى لجبل أبو شيحات نشأ من مجما غنية باليورانيوم علاوة على اليورانيوم المترسب عبر الشقوق خاصة النطاقات الغنية بالحديد نتيجة للعمليات الثانوية التى أثرت على الصخور المحيطة. كما أن المحاليل الحرمائية الغنية باليورانيوم والتى نتج عنها تكون البجماتيت غير الممنطق بجبل أبو شيحات أضافت كميات من اليورانيوم إلى الجرانيت ذو الفلسبار القلوى ومن ثم فإن جرانيتات جبل أبو شيحات يمكن أن تكون بيئة مناسبة لموارد اليورانيوم.