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GEOLOGY, GEOCHEMISTRY AND RADIOACTIVE ELEMENTS BEHAVIOR STUDY OF THE BASEMENT ROCKS AT BIR EL SHAB AREA, SOUTH WESTERN DESERT, EGYPT

By

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ABSTRACT

Bir El Shab area lies at the extreme middle part of the south Western Desert of Egypt. It covers an area of about 3876 km^2, between longitudes 29^o 00` and 29$^o$ 30` E, and latitudes 22^o 00` and 22$^o$ 30` N. Bir El Shab area is one of the areas studied by the Nuclear Materials Authority for radioactive minerals. It is located between Bir Safsaf frontier and Gebel (G.) Nusab Balgoum volcanic rocks in the west and Toshki Project area in the east. Also, it represents a junction between the older Cretaceous formations in the west and younger Cretaceous and Paleocene formations in the east.

Petrographically, the rocks in the study area are granites. The Geochemical study of the samples shows geochemical characteristics of the granite type.

The younger granites of the study area are characterized by their relatively high silica content and potash contents and slightly exceed the soda content. This type are considered as high calcium granite and low total iron oxides and MgO contents.

Keywords: Bir El Shab, Western Desert, geochemistry, radioactivity

INTRODUCTION

Study area is accessible through three main asphaltic roads. The first road is that previously known as the Camel track Darb El Arbain (Caravan Road), which extends from Kharga Oasis at north and runs in an approximately south direction to Selima Oasis in Sudan. The second road starts from Aswan, branched westerly at a point 50 km of Abu Simbel City to cross the north of Gebel El Nabta. This desert road continues further west passing through Bir Nakhlai and joins Darb El Arbain at Bir El Shab. The third road is parallel to Darb El Arbain track, which starts from Dakhla Oasis through Bir Tarfawi to the East of El Uweinat Farms. In addition, there is a subsidiary asphaltic road connects Bir Tarfawi with the Camel road at Bir Abu El-Hussein. Desert tracks cross the south Western Desert which joins the study area with the famous Bir Nakhlai, Dungul and Kurkur Oases (Fig. 1).

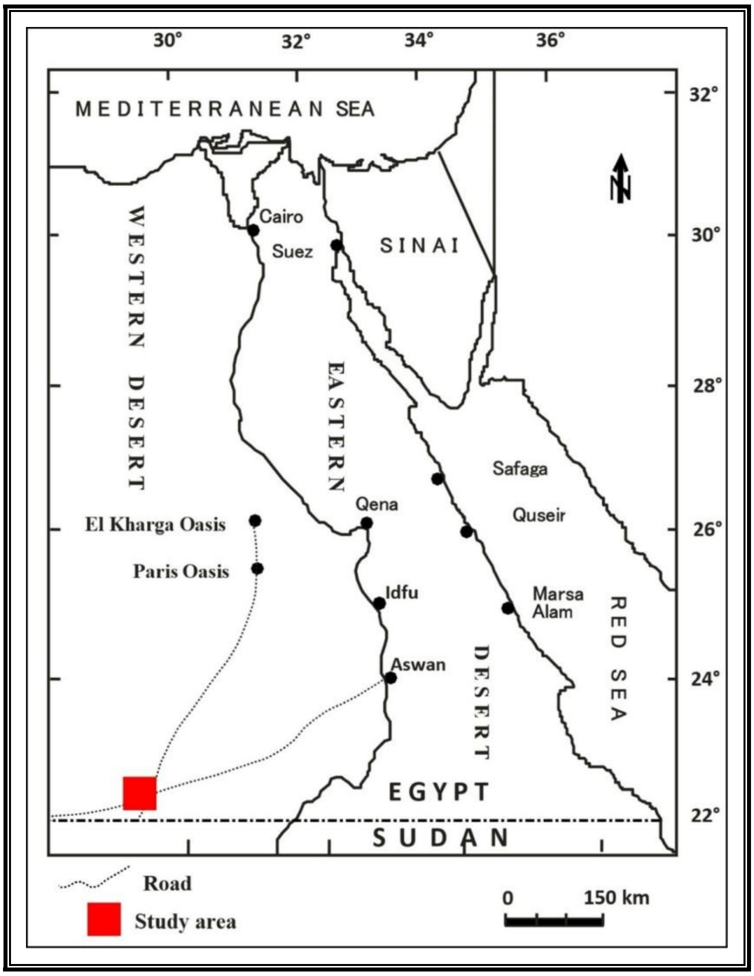


Fig. 1: Location map of the study area.

Most of the basement rocks are made up of low lands of granitic gneiss and younger granites (Figs. 3a, b and c).

Their contacts with the overlying sedimentary rocks are mostly marked by some faults that follow the general E-W and NE-SW trends (Issawi, 1971). The granitic gneiss occurs as elongated body extending east-west. It is characterized by grey color and foliated-crystals which is cut by many dykes and veins. The younger granite occurs as an elongate mass of biotite granite covering an area reaching about 2Km in length and 1Km in width and trending NE-SW. It is characterized by pink color and medium to coarse grained-size. The basement rocks (granitic gneiss and younger granite) are cut by syenitic dykes extending east-west in gneiss and NE-SW in the younger granite. The area is intersected by several dykes includes Quartz porphyry dykes, Aplite and pegmatite dykes have been observed, but they contain only quartz with a little feldspar (Figs. 3d and e).

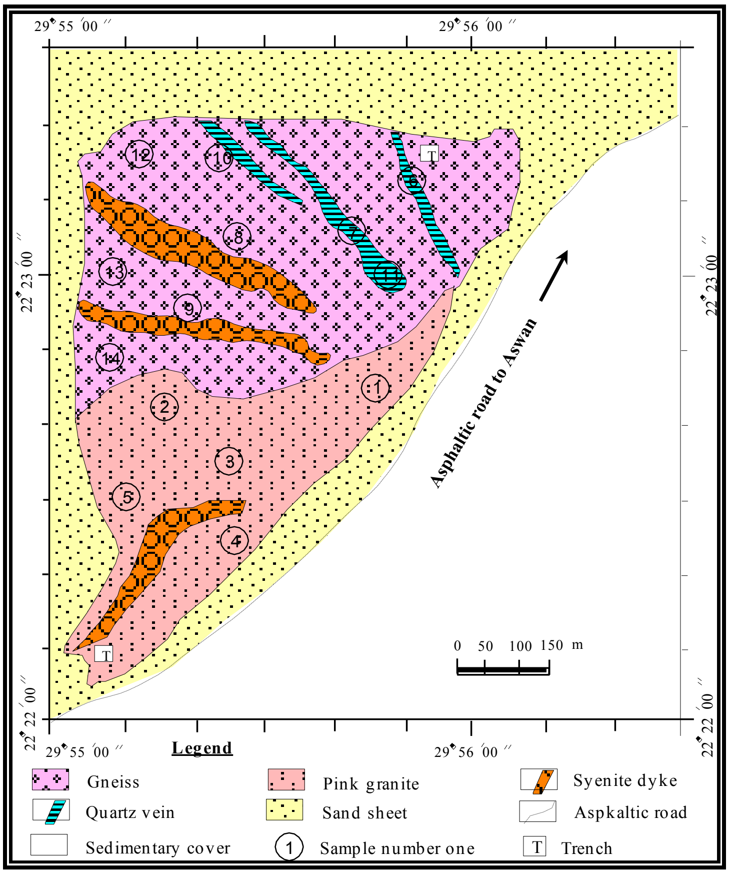


Fig. 2: Detailed geological sketch map of the basement rocks to the northeast of Bir El Shab area, south Western Desert, Egypt.

The granitic rocks are cut by some basaltic dykes of NE-SW trend. These basaltic dykes are mainly of Tertiary age.

From field radiometric measurements, it can be noted that the southern part of granitic rocks ranging in radioactivity measurements from 150 cps, to 200 cps but in the northern part, the intensity increases to reach about 300 cps to 350 cps. Also it is noted that, the dykes gives high measurements from 1000 cps to 3000 cps specially dykes of northern part. Two trenches have been dug at the high radioactive dykes, first trench dug in the southern part and second in the northern part (Fig. 3f).

Hills The most prominent topographic features within the depression are the large number of residual hills. These hills are usually isolated, conical and/or have flat topped surfaces. Several hills of low relief composed of sandstone, siltstone, clay stone and shale are laid down on the western side of the depression.

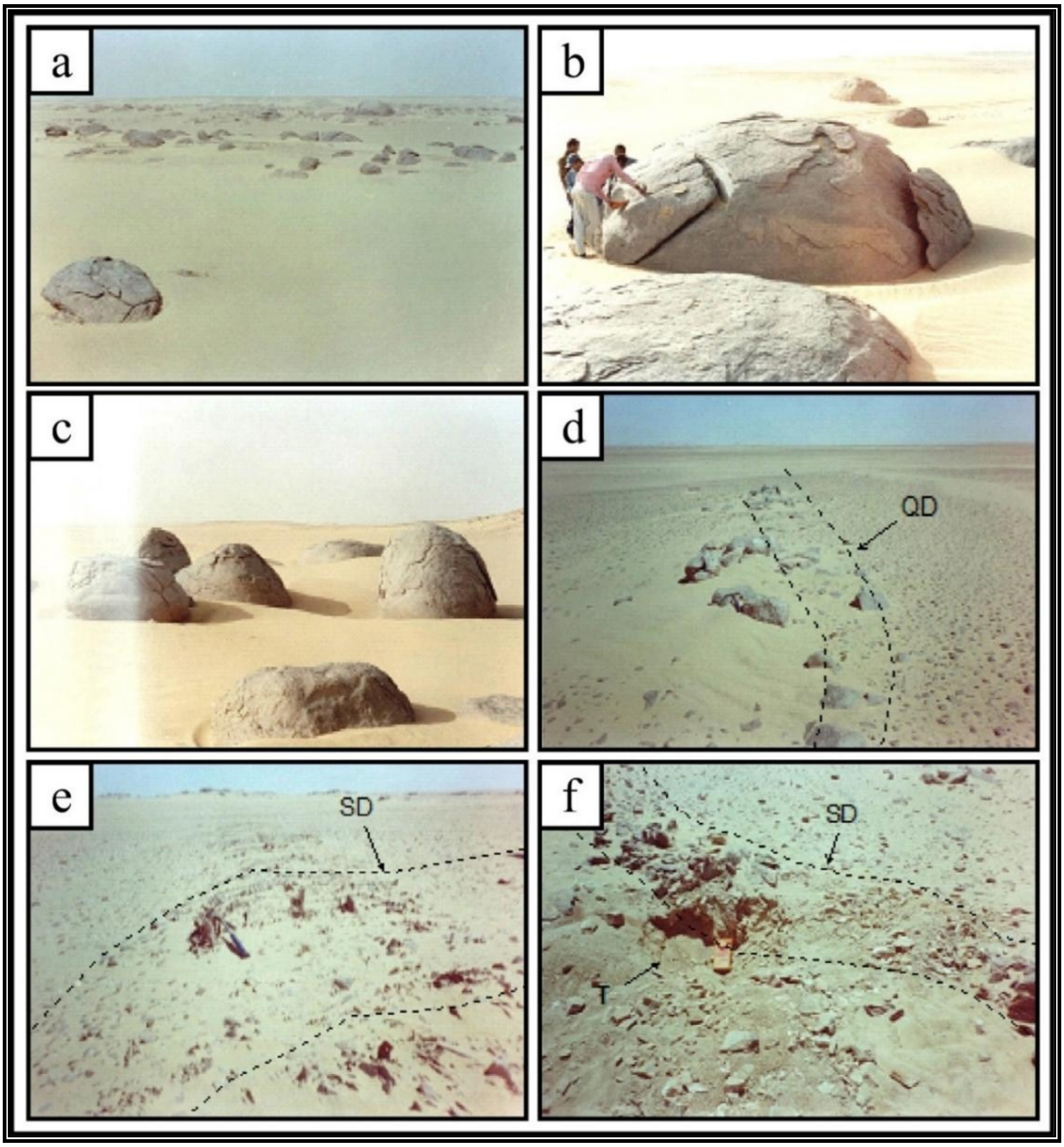


Fig. 3:
(a): Large exposure of granite, northeast of Bir El Shab, S. W Desert.
(b): Exposure of weathered granite, northeast of Bir El Shab, S. W Desert.
(c): Exposure of weathered granite appear with sand sheet, northeast of Bir El Shab, S. W Desert.
(d): Quartz porphyry dyke (QD) in NE-SW direction, northeast of Bir El Shab S. W Desert.
(e): Weathered syenite dyke (SD) in NE-SW direction, northeast of Bir El Shab, S. W Desert.
(f): Trench (T) showing high radioactive syenite dyke (SD) locked at W direction, Northeast of Bir El Shab, S. W Desert.

In 1996, a field team from Nuclear Materials Authority was established for prospecting new occurrences of uraniferous deposits in south Western Desert in Egypt. These are Bir Safsaf frontier, Nusab El Balgoum volcanic rocks in the west, Bir Abu El Hussein granite, EL Garra- El Hamra ring dyke, El Garra Soda ring dyke and in other ring dykes located in the southeastern part. Bir El Shab area is one of these areas studied for radioactive minerals. It is located between Bir Safsaf frontier and Gebel (G.) Nusab El Balgoum volcanic rocks in the west and Toshki National Project area in the East.

Afifi (2001) discussed the northern part of Bir Safsaf granite and Permo-Triassic volcanic rock, and Cretaceous sedimentary rocks surrounding G. Nusab El Balgoum. He made a geological map and recorded several radioactive occurrences in this area.

Shabana et al., (2006) studied comparatively the hydrogeology of Nubia sandstone aquifer system in east El-Oweinat and Bir El Shab area, south Western Desert, Egypt.

PETROGRAPHY and MINERALOGY

Granitic rocks are represented by nine samples and could be extinguished through the microscopic investigation into fresh granite and reworked altered granite. It is characterized by hypidiomorphic equigranular texture and composed essentially of potash feldspar, plagioclase, quartz and mafic minerals as biotite and hornblende.

Potash feldspars represent about 78% of the total feldspar occurring as subhedral crystals of microcline exhibiting its characteristic crossed hatching twining (Figs. 4a and c). The crystals are medium-grained measured about 4mm length and enclose quartz in between. Plagioclase (An12) occurs as fine euhedral crystals of oligoclase showing albitic twining and occasionally zoned. Quartz represents about 34% of the rock occurring as subhedral crystals often strained and cracked (Fig. 4b).

Mafic minerals are mainly biotite and hornblende. Biotite occurs as medium flakes, characterized by moderate pleochrism from pale brown to dark brown; it is occasionally encloses zircon and apatite (Fig. 4b).

Hornblende is characterized by pleochrism from brown to green exhibiting its characteristic two sets of cleavage and it occasionally encloses apatite (Figs. 4c and d).

Accessory minerals are essentially zircon and apatite occurring as well-formed crystals included in or associating biotite (Figs. 4b and e) and hornblende (Fig. 4d). Rutile is also occurring as euhedral crystals associating quartz and characterized by deep red color (Fig. 4f).

Granitic samples along faults and sheared zones are characterized by deformation of the constitute potash feldspars showing undulose extinction (Fig. 5a). Quartz is also affected by tectonics showing elongation and fragmentation (Figs. 5b and c).

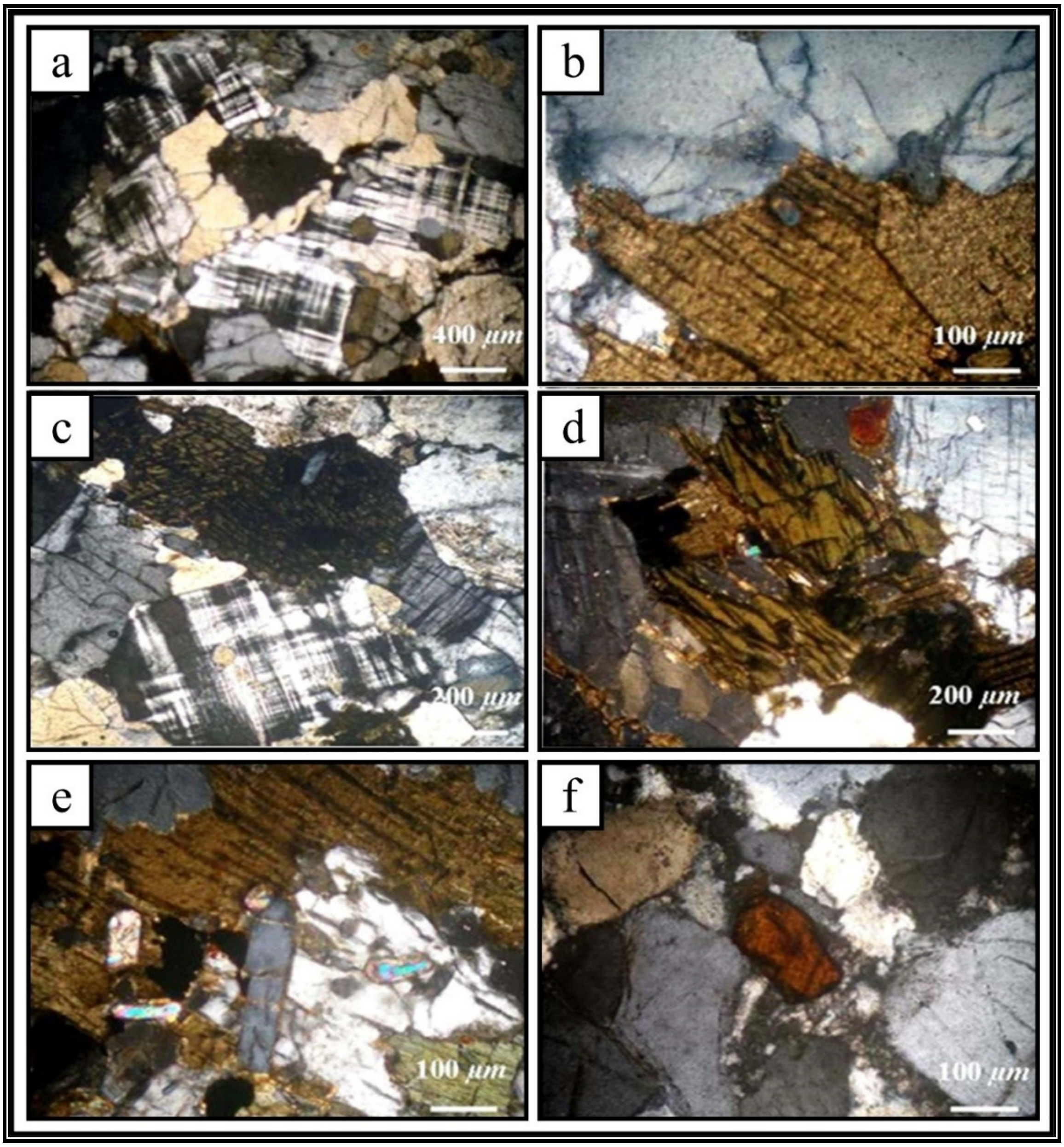


Fig. 4: Photomicrographs of younger granite of Bir El-Shab area showing:
a): Subhedral crystals of microcline showing cross-hatched twining and associating quartz. C.N.
b): Fine euhedral crystals of zircon and apatite included in biotite associated with strained quartz. C.N.
c): Basal section of hornblende showing two sets of cleavage and encloses euhedral apatite. C.N.
d): Basal section of hornblende associating zoned and lamellar plagioclase. C.N.
e): Well-formed crystal (Cigar-shaped) of apatite and zircon included in biotite and quartz. C.N.
f): Well-formed crystal of rutile associating quartz. C.N.

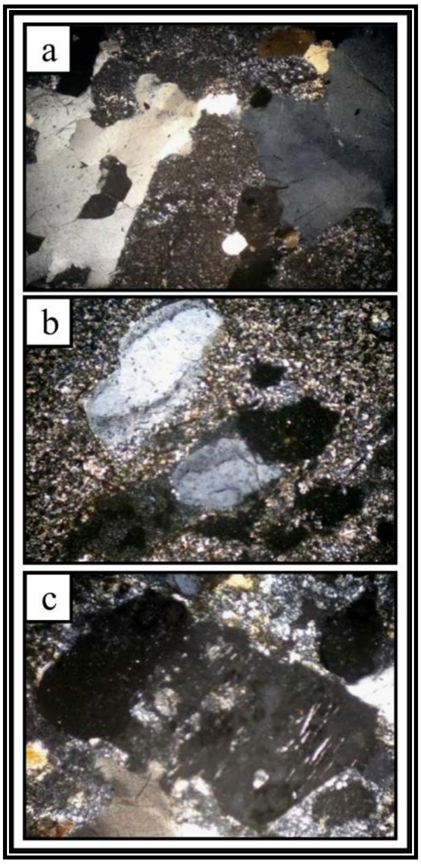


Fig. 5: Photomicrographs of sheared granite of Bir El-Shab area showing:
a): Strained quartz showing undulose extinction and associating clays. C.N.
b): Reworked quartz and cryptocrystalline silica. C.N.
c): Strained crystal of perthite affected by deformational stresses (probable tectonic effect) and characterized by undulose extinction. CN.

POST-GRANITE DYKES

Dykes cutting granitic rocks are acidic in composition and they are mainly bostonite and quartz veins. Bostonite dykes are characterized by sub-trachytic texture (Figs. 6a and b) and bostonitic texture (Figs. 6c and d). In the first type; it is composed of very fine lathes of orthoclase and sanidine exhibiting their characteristic simple twining and aligned showing flow texture (subtrachytic texture). The rock is characterized by scarcity of quartz (less than 2% of the rock) occurring as skeletal crystals (Fig. 6a). Also there is a dominance of iron oxides occurring as iron staining for potash feldspar or as secondary iron oxides formed by post-magmatic processes (Fig. 6b). In the second type, the potash feldspar lathes are randomly oriented or present in radiated form (Fig. 6c) and quartz is more existent (more than 7% of the rock) occurring as minute crystals spreading in the rock (Fig. 6c). The last type is characterized by presence of heavy minerals; mainly sphene and rutile, occurring as euhedral to subhedral prismatic crystals with reddish brown color (Fig. 6d).

Quartz vein is composed essentially of quartz crystals with few crystals of carbonate (Fig. 6e) and zircon (Fig. 6f).

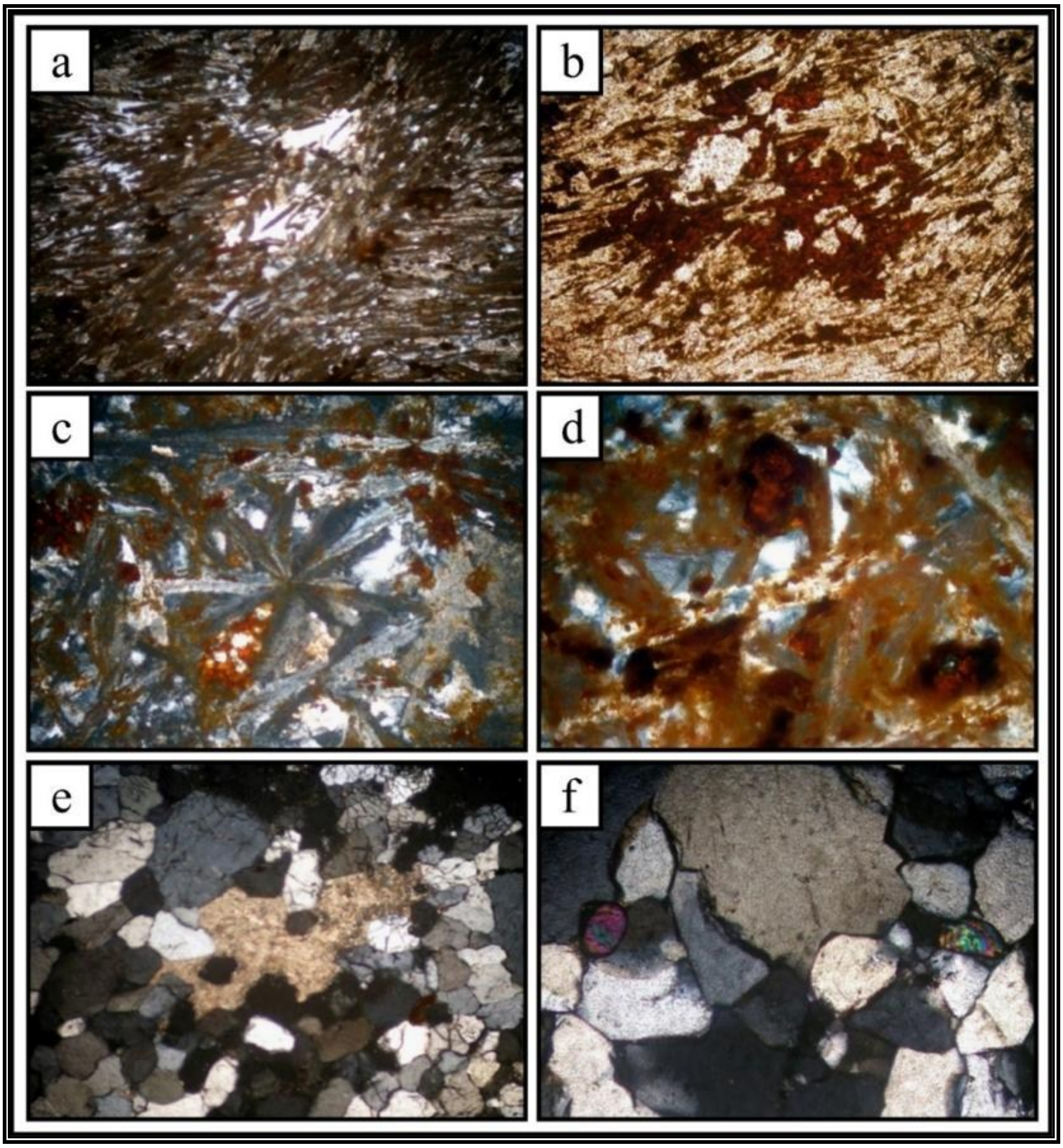


Fig. 6: Photomicrographs of post- granitic dykes of Bir El-Shab area showing:
a): Very fine lathes of potash feldspar with rare crystals of quartz showing subtrachytic texture. CN.
b): Potash feldspars stained by and associated with iron oxides showing subtrachytic texture. CN.
c): Radiated crystals of potash feldspar showing bostonitic texture. CN.
d): Potash feldspars stained by iron oxide and associates euhedral crystal of rutile. CN.
e): Anhedral crystals of quartz associating carbonate in quartz vein. CN.
f): Euhedral crystals of zircon associating quartz crystals in quartz vein. CN.

MINERALOGY of BIR EL SHAB AREA

The constituting minerals of El Shab complex and the detritus minerals are identified and analyzed by Scanning Electron Microscope (SEM, Model Philips®XL30) in the Nuclear Materials Authority. It is used for examination of some individual mineral grains with resolution of 3.5 nm at 30kV. In addition to the acquired SEM photo-micrographs, semi-quantitative microchemical analysis of the examined mineral grains was also performed using the Energy

Dispersive X-Ray (EDAX) system of the SEM. More precise results were obtained by the basic EDAX automatic peak identification and the true standard less quantification using ZAF matrix correction routines.

Sphene {$CaTiSiO_5$}:

It is a calcium titanium silicate mineral. It is identified microscopically by its very high relief and brownish color. It is also recognized by the EDAX spectrograph and image (Fig. 7).

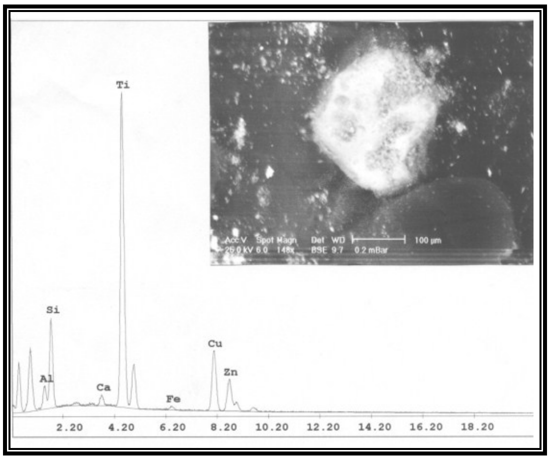


Fig. 7: EDAX spectrograhp and image of sphene

MAJOR OXIDES and TRACE ELEMENTS GEOCHEMISTRY

This section deals with the geochemical characteristics of the granite type, 16 representative samples were analyzed granite**.** The chosen samples were then subjected to chemical analysis using wet chemical technique of Shapiro and Brannock (1962) for major oxides and X-Ray Fluorescence technique (XRF) for trace elements.

MAJOR OXIDES

The younger granites of the study area were petrographically examined and classified, as fresh granite represented chemically in samples from 1 to 8 (Table 1). Chemically, all the studied samples characterized by their relatively high silica content (ranging from 71.32% to 74.54%). The Al_2O_3 and CaO of granite (ranging from 12.01% to 13.64%, and CaO from 0.38% to 1.56%). The K_2O, Na_2O and FeO of granite (ranging from 3.22 % to 4.8% K_2O, and from 2.31% to 3.34%, Na_2O and from 0.23% to 0.51% FeO respectively. The Fe_2O_3 of granite (ranging from 2.31% to 4.83%). The data of trace elements of both types are nearly similar, suggesting that the two types are intruded from the same magma which is supported by the petrographic studies and major oxides content.

(Fig. 8) represented the relation between SiO_2 and other major oxides. The relation between SiO_2 and major oxides revealed strong positive relation with K_2O, Na_2O, and Sr, and normal with TiO_2 AL_2O_3, P_2O_5, Nb, Pb. while negative relation with MgO, CaO and Fe_2O_3.

TRACE ELEMENTS

The behavior of large ions lithophile elements (K, Rb, Ba and Sr) in the granites melt is greatly influenced by the degree of fractionation of major phases, plagioclase, potash feldspars and micas. Sr, initially, enters the Ca-feldspars while Rb accommodates in the alkali feldspars and mica. Therefore, Sr concentration tends to decrease with increasing Rb during differentiation of igneous rock series. (Fig. 9) On the other hand, the trace elements such as Zr, Nb, Ga, Y, and Cr, show positive correlations with SiO_2. This is due to the high resistant of the accessory minerals to weathering such as zircon, apatite and rutile. The negative correlations of Ba, Rb, and Co with SiO_2 are due to their mobility whereas the random correlations of Sr, V and Ni with SiO_2 are attributed to their immobility.

Table 1: Major oxides (wt. %) and trace elements (ppm) of the granitic rocks in the study Area

S. No	1	2	3	4	5	6	7	8
SiO_2	73.77	73.26	72.12	72.41	73.22	72.03	71.32	74.54
TiO_2	0.09	0.04	0.08	0.06	0.05	0.03	0.05	0.09
Al_2O_3	13.08	13.63	13.64	12.85	12.56	13.04	12.01	13.11
Fe_2O_3	2.67	2.31	3.42	3.06	2.66	3.89	4.83	3.33
FeO	0.25	0.23	0.33	0.34	0.28	0.45	0.55	0.33
MnO	0.13	0.14	0.15	0.17	0.16	0.14	0.13	0.16
MgO	0.42	0.36	0.16	0.51	0.34	0.67	0.71	0.32
CaO	0.38	0.73	1.21	1.32	0.45	1.22	1.56	0.41
Na_2O	2.67	2.4	2.21	2.32	2.56	2.86	2.97	3.14
K_2O	4.78	4.36	3.58	3.76	4.62	4.01	3.44	3.25
P_2O_5	0.03	0.04	0.06	0.04	0.09	0.05	0.01	0.08
LOI	1.34	1.68	1.69	1.62	1.76	1.47	1.66	1.49
Total	**99.61**	**99.18**	**98.65**	**98.46**	**98.75**	**99.86**	**99.24**	**100.25**
Ba	381	701	740	147	176	282	336	456
Rb	144	112	59	33	22	134	137	31
Sr	92	82	500	85	113	63	33	349
Y	19	19	3	5	8	53	70	11
Zr	106	179	355	120	314	667	1503	569
Nb	2	7	32	24	44	152	176	176
Pb	11	6	10	6	21	5	5	21
Ga	14	13	8	2	2	33	36	30
Zn	32	48	66	24	19	165	18	18
Cu	11	11	11	9	11	11	12	11
Ni	4	6	13	7	5	5	7	7
V	5	7	20	6	70	4	5	18
Cr	8	6	19	10	12	8	7	16
Co	3	4	9	3	3	6	6	2
Ca/Y	0.02	0.04	0.40	0.26	0.06	0.02	0.02	0.04
Ca/Sr	0.00	0.01	0.00	0.02	0.00	0.02	0.05	0.00
Rb/Sr	1.57	1.37	0.12	0.39	0.19	2.13	4.15	0.09
Ba/Rb	2.65	6.26	12.54	4.45	8.00	2.10	2.45	14.71
Sr/Ba	0.24	0.12	0.68	0.58	0.64	0.22	0.10	0.77
K/Rb	0.03	0.04	0.06	0.11	0.21	0.03	0.03	0.10
K/Ba	0.01	0.01	0.00	0.03	0.03	0.01	0.01	0.01
K/MgO	11.38	12.11	22.38	7.37	13.59	5.99	4.85	10.16

Show the variation of trace elements (as ppm values). Trace elements it is clear that this may indicates the strong effect of weathering on the less resistant feldspars to form clay minerals which leached away from the granite leaving the more resistant quartz.

Rb/Sr, K/Rb, K/Ba and Ba/Rb RELATIONS

Rb/Sr ratio is a good guideline of typical magmatic differentiation where Rb tends to remain in the liquid phase while Sr tends to incorporate into plagioclase during fractional crystallization (Houghton, 1985 and Jelink et al., 1989).

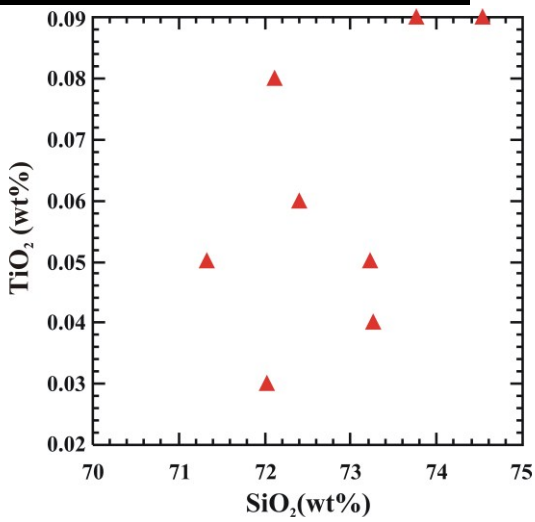
Table 2: ratio for some trace elements of the granitic rocks in the study area

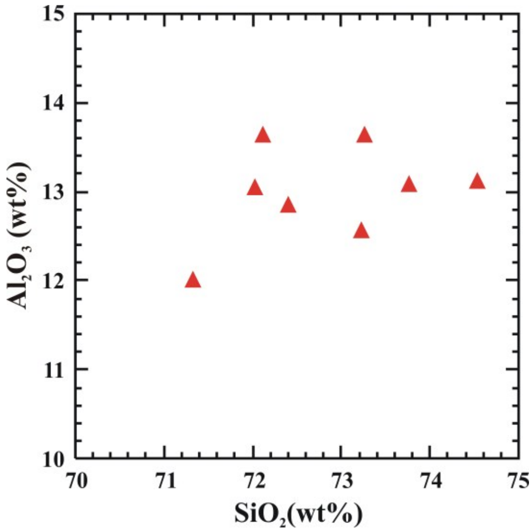
S. No.	Ca/Y	Ca/Sr	Rb/Sr	Sr/Ba	K/Rb	K/Ba
1	0.02	0.00	1.57	0.24	0.03	1.25
2	0.04	0.01	1.37	0.12	0.04	0.62
3	0.40	0.00	0.12	0.68	0.06	0.48
4	0.26	0.02	0.39	0.58	0.11	2.56
5	0.06	0.00	0.19	0.64	0.11	2.63
6	0.02	0.02	2.13	0.22	0.03	1.42
7	0.02	0.05	4.15	0.10	0.03	1.02
8	0.04	0.00	0.09	0.77	0.10	0.71
A. R	**0.11**	**0.01**	**1.25**	**0.42**	**0.08**	**1.34**

The ratio of **Rb/Sr** increases with magmatic differentiation due to Sr Depletion in liquid magmas as a result of crystallization of feldspars, while Rb is higher in the liquid phase.

In the present study, the alkali feldspar granites have a high and wide range of Rb/Sr ratios (from 0.09 to 4.15) suggesting that they are originated from highly differentiated magma.

Ca/Sr ratio values in the studied granitoids obey the behavior of the two elements during the magma fractionation as suggested by Taylor (1960), where Sr tends to increase relative to Ca during the fractionation in these rocks hence Ca/Sr ratio values decrease during its magmatic crystallization.





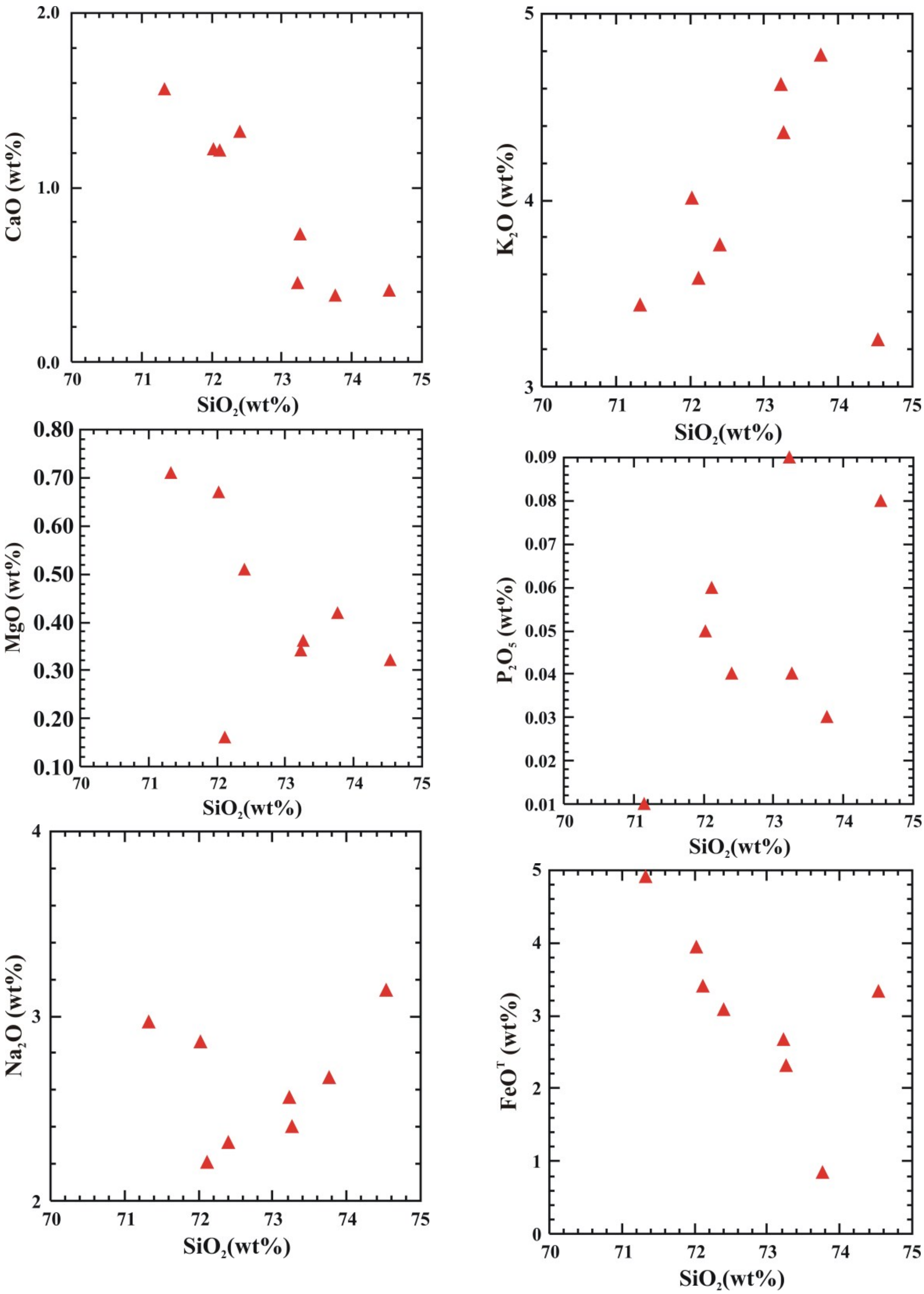
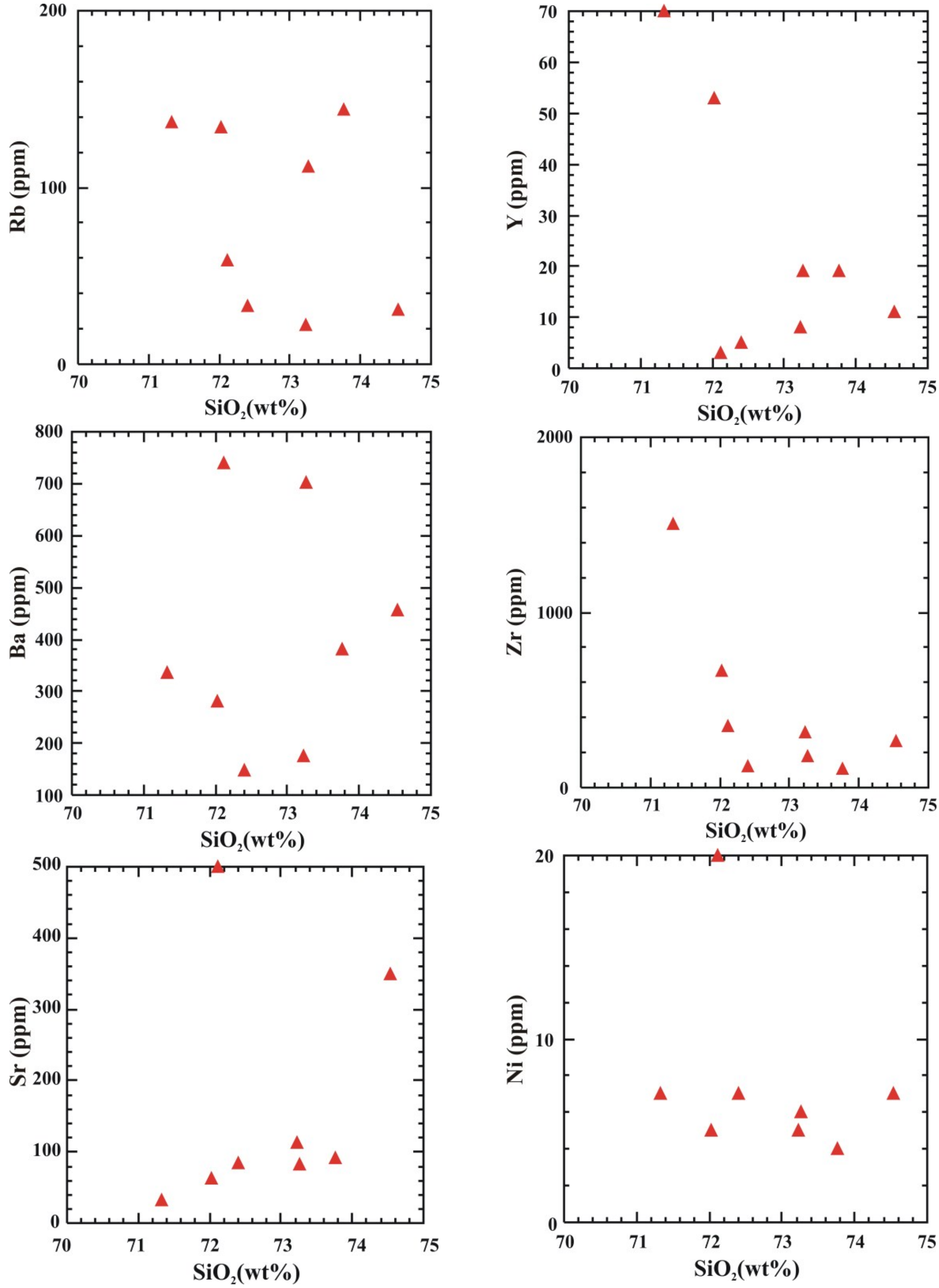
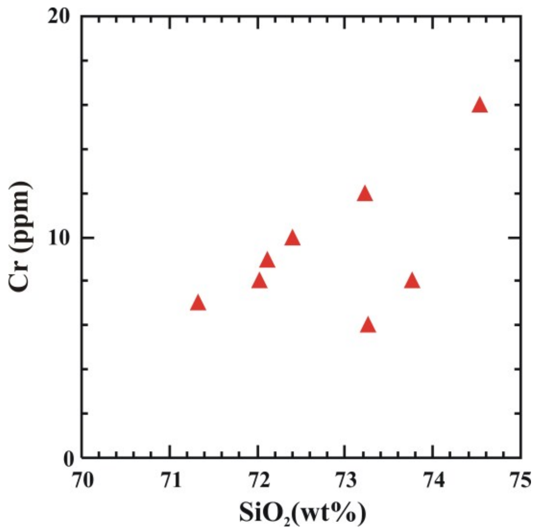
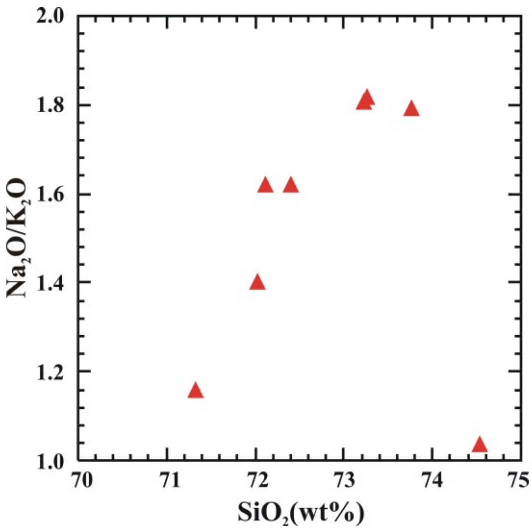
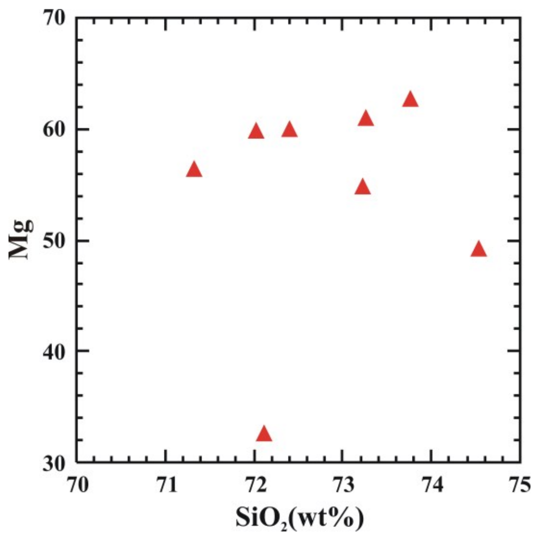


Fig. 8: Harker-type variation diagrams of some selected major vs SiO_2 of the studied granitoids


Rb (ppm)
SiO2(wt%)
Y (ppm)
SiO2(wt%)
Ba (ppm)
SiO2(wt%)
Zr (ppm)
SiO2(wt%)
Sr (ppm)
SiO2(wt%)
Ni (ppm)
SiO2(wt%)







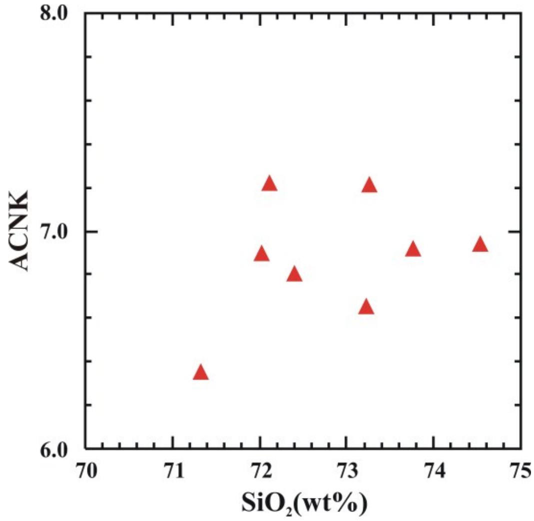


Fig. 9: Harker-type variation diagrams of some selected Trace elements (ppm) vs SiO_2 of the Studied granitoid

El-Gaby and Habib (1982) suggested that **Ca/Y** decreases continuously and reaches its minimum value in the most differentiated granites.

Rb tends to enrich relative to **K** in strongly differentiated granites (Taylor et. al., 1956). Thus, it is quite possible to expect that the **K/Rb** ratio would be low in highly differentiated granites. **K/Rb** ratios in igneous rocks that result from upper mantle materials range from 700 to 1500 (Heier, 1973). In the present study, Table (6-9) shows that **K/Rb** ratios in the studied alkali feldspar granites ranging from 0.03 to 0.11 (less than Heier's values); this may be attributed to the significant contribution of sialic crustal materials.

Gast (1965) and Heier (1973) have shown that, high **K/Rb** ratios and low Rb/Sr ratios are characteristic features for rocks that formed from lower crust or Upper mantle. On the contrary, the studied alkali feldspar granites have low **K/Rb** ratio, and high **Rb/Sr** ratio indicating their formations from the sialic crust.

The **K/Ba** ratio of granitic rocks in the crust suggested by Mason (1966) is 65. In the studied alkali feldspar granites the **K/Ba** ratios are higher than Mason's value (Table 6-9) reflecting depletion of **Ba** in source magma and /or advanced degree of magma differentiation and contribution of sialic crustal materials.

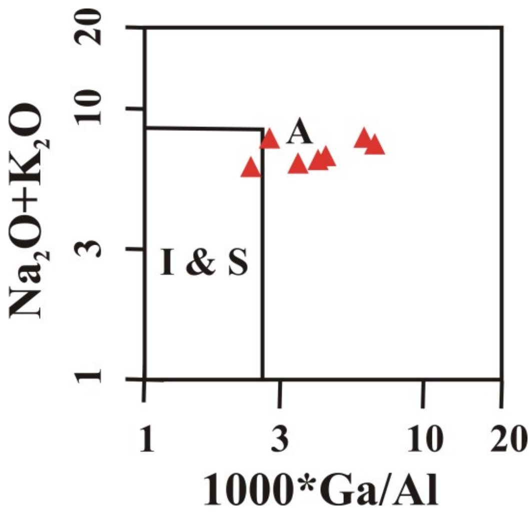
TYPE of GRANITE

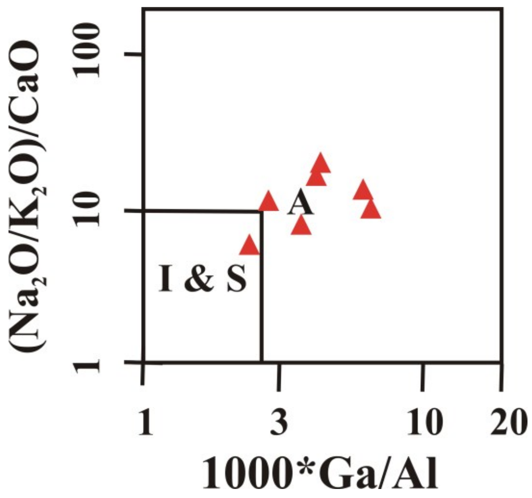
Whalen (1984) used Mol. 10000*Ga/Al with (Na_2O+K_2O/CaO), (Na_2O+K_2O), Zr, Nb, K_2O/MgO, FeO^t/MgO, Y and Zn to differentiate between types of Granites; using these relations (Fig.13), all the studied granitoids rocks plot in the A-type field indicating igneous precursors of the studied granitic rocks (Fig. 10).

Granitoids rocks are described using on the studied granites, Peccerillo and Taylor (1976) and Sylvester (1989) suggesting the granitoids Cal-alkaline and peraluminous but Villaseca et al., (1998) suggesting the granitoids in peraluminous. Ragab and El-Gharbawi (1989) suggested that most of peraluminous Egyptian younger granites have been formed from crustal materials (Fig. 10). The granitoids rock classified by Middlemost (1985) and (1994) and O'Connor (1965). (Fig. 11).

TECTONIC SETTING

Maniar and Piccoli (1989) variation diagrams used to discriminate between the different tectonic settings. (Fig. 13) shows that the studied granitic samples are mainly plot in the POG field. This interpretation could be supported by the field relationships and observations because the younger granites intrude all the pre-existing rock types exposed in the area and also they do not show any sign of large scale metamorphism or even foliation. By using the R1-R2 diagram after Batchelor and Bowden (1985) the all samples are plotted in syn- collision Post orogenic. (Fig. 12).





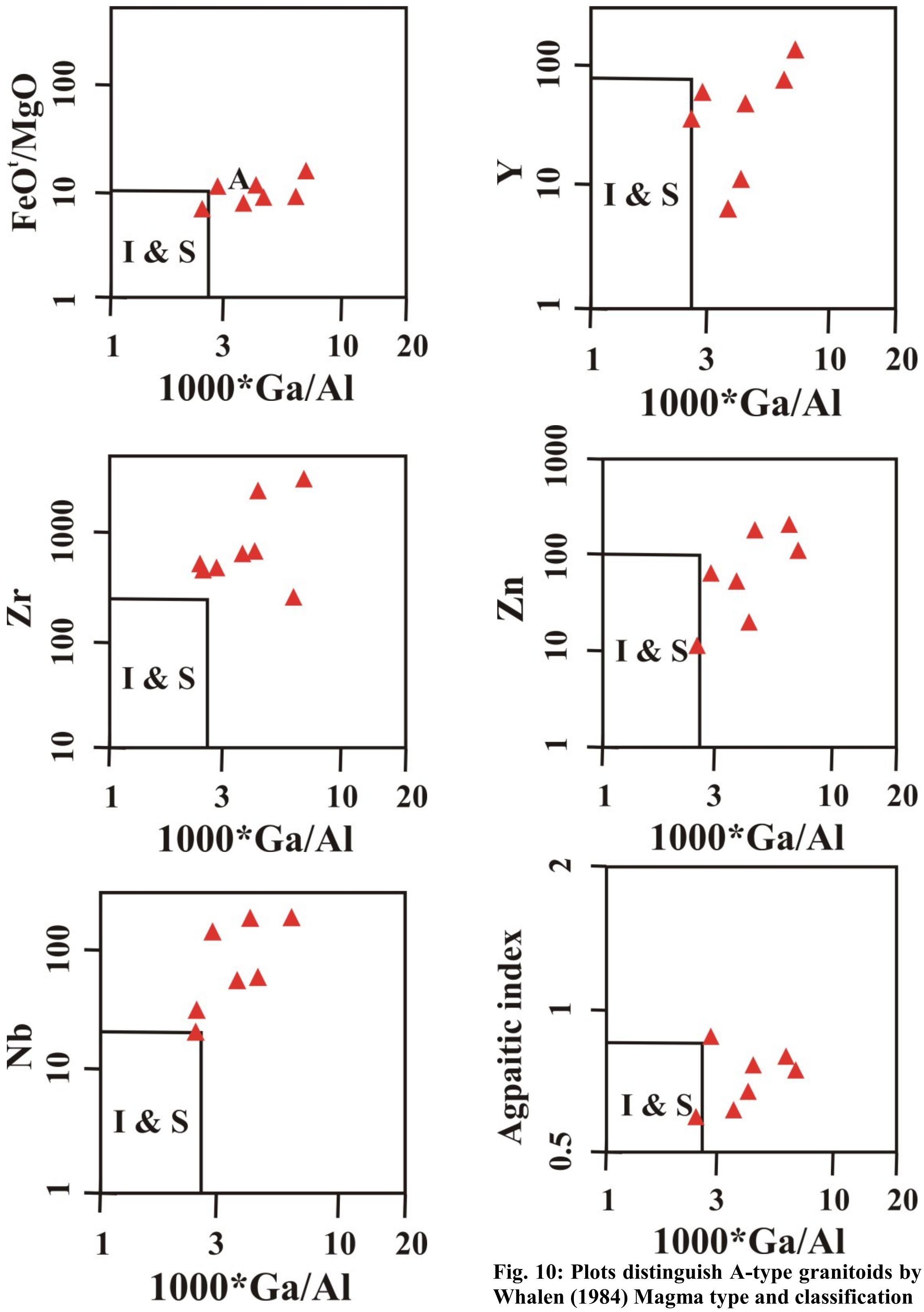
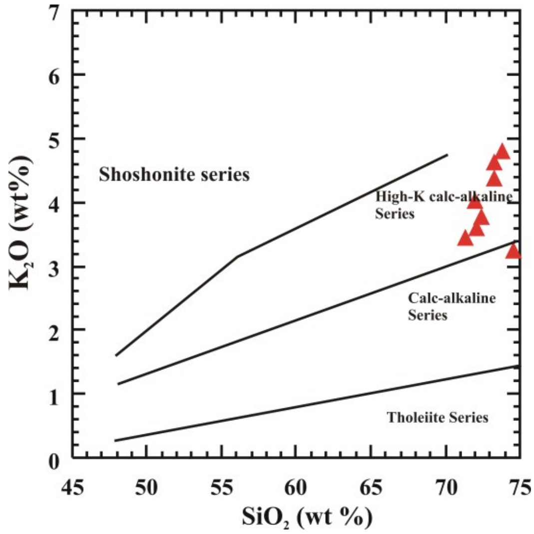
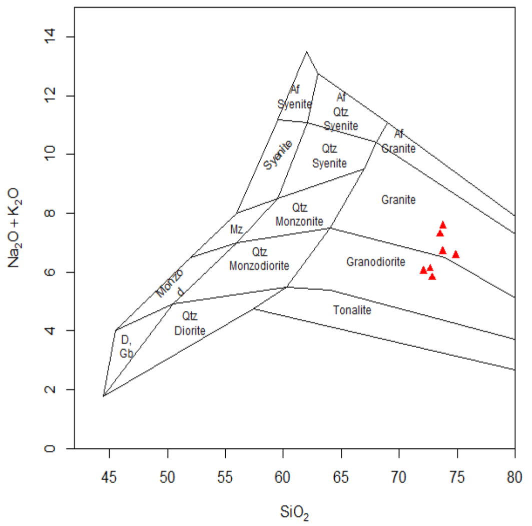


Fig. 10: Plots distinguish A-type granitoids by Whalen (1984) Magma type and classification





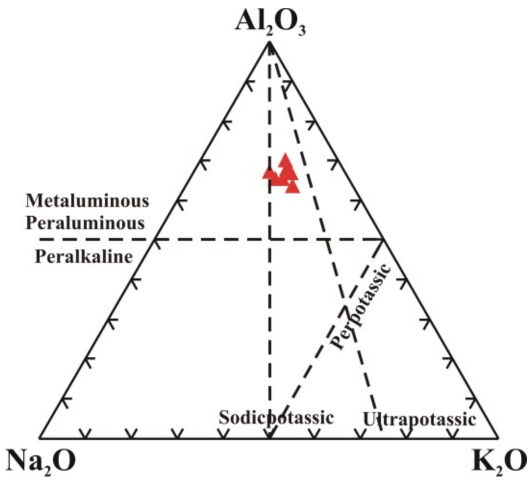
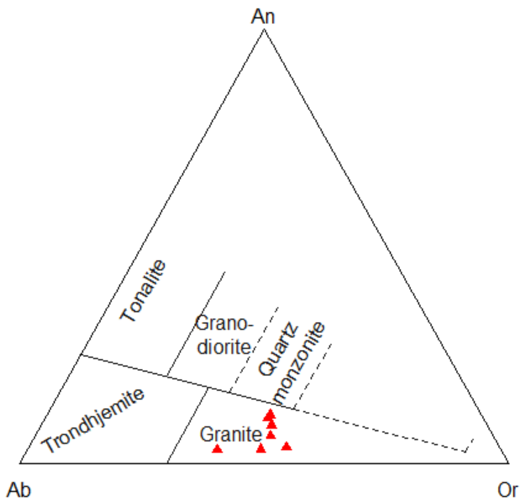
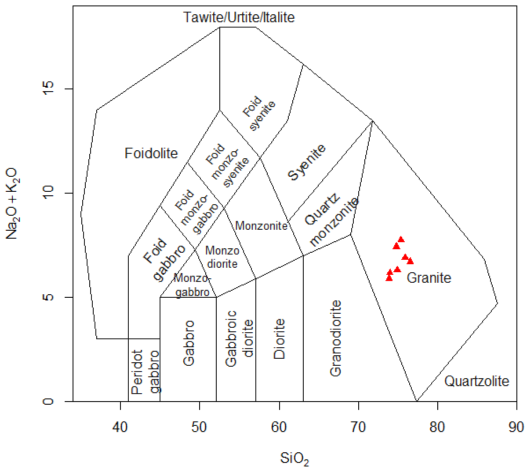


Fig. 11: types of magma by Peccerillo and Taylor (1976); Sylvester (1989) and Villaseca et al., (1998)





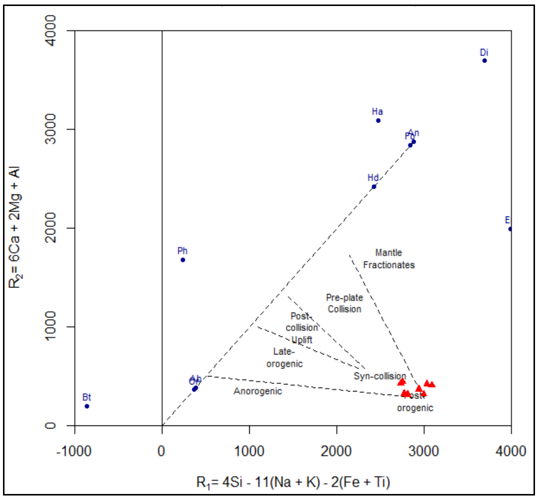
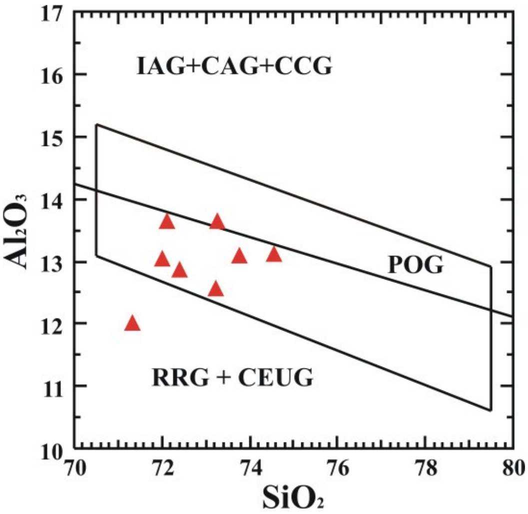


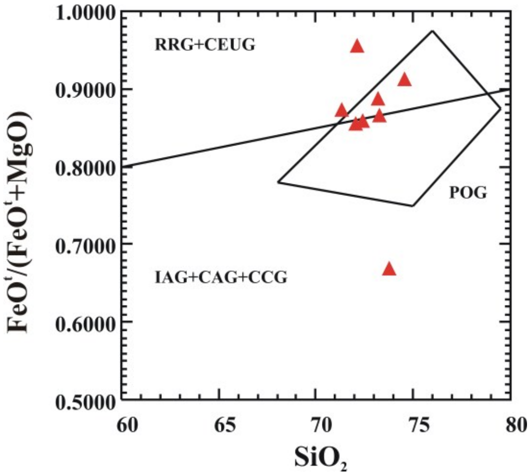
Fig. 12: Classification of granitoids by Middlemost (1985), (1994), O'Connor (1965); and R1-R2 Batchelor and Bowden (1985)

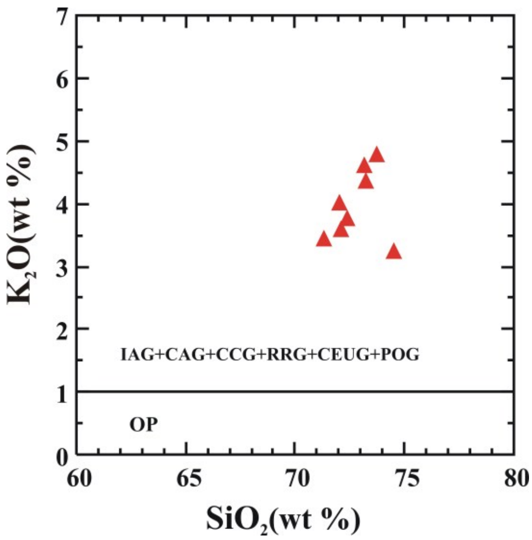
RADIOACTIVITY

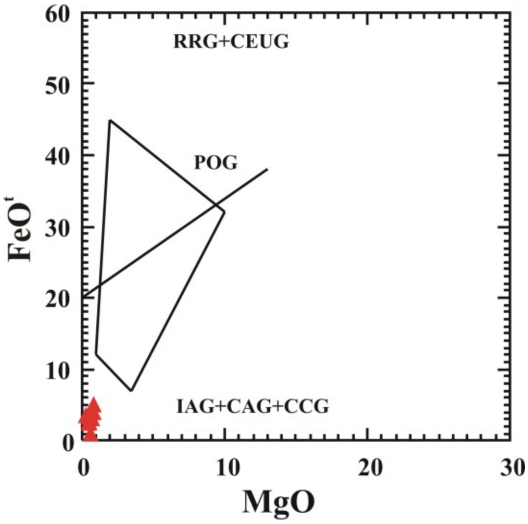
Radioactivity is a random phenomenon associated with the decay of naturally occurring radioactive elements. This radioactive decay is accompanied by the emission of alpha and beta particles and gamma radiation. The fundamental sources of gamma radiation are the isotopes of uranium, thorium and potassium. Uranium occurs in three isotopes ^{238}U, ^{235}U and ^{234}U whereas thorium occurs in two isotopes ^{232}Th and ^{230}Th.

Uranium and thorium have similar chemical properties due to their similar electronic configuration. Both of them are members in the actinide family. Because of the position of uranium and thorium in the periodic table and their electronegativity, they show lithophile characteristics. Although uranium can mainly exist as U^{4+} or U^{6+}, thorium can only exist as Th^{4+}.









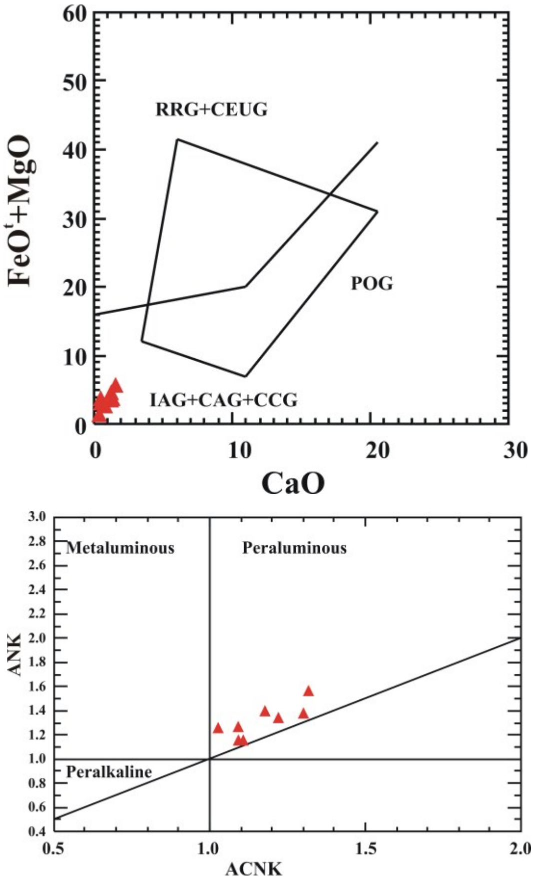


Fig. 13) Tectonic setting diagrams Maniar and Piccoli (1989) for the studied granitoids,

The natural gamma radiation emitted from the radioactive materials is the most useful phenomenon for the detection of the ground radioactivity. This is due to the considerable range of penetration that reaches several hundred feet in air, and so it can be detected from such distances.

In the magmatic cycle, both U and Th concentrated in the most potassic and silica-rich differentiates (pegmatites). In granites and acid volcanic, the average abundance of radioactive elements is 3.5 ppm U, 2.8 ppm Th and 3.34% K (Vingradov, 1962 and Rogers and Adams, 1969).

As mentioned before, basement rocks in the study area (Fig. 3) are found as scattered exposures or forming low ground of limited extension. They dissected by dykes in the northeast Bir El Shab. Also, the basement rocks are composed of younger granites, being pinkish, medium to coarse-grained potash feldspar, quartz and biotite with small amount of hornblende. Radioactive measurements range between 180 and 200 (cps) in the granite, but in the dykes range between 500 and 2500 (cps). Few samples are collected and radiometrically analyzed reflecting 2 to 57 ppm eU content. This range of eU is relatively high compared to the world granite rocks which are 4.7 ppm eU (Rich et al., 1977). The distributions of the radiometric measurements in the basement rock are tabulated (Table 2).

U and Th RELATIONSHIPS

The behavior of U, Th and Th/U ratio during the fractionation of a granitic magma can be studied by plotting these data. U, Th and Zr and behave incompatibly in a granitic melt so that; where U concentration is controlled by magmatic processes; these elements would be expected to increase. The relation between U and Th may indicate the enrichment or depletion of U because Th is chemically stable (Rogers and Adams, 1969). Normally, thorium is three times as abundant as uranium in all rock types. When this ratio is disturbed, it indicates either depletion or enrichment of uranium.

Table 3: Laboratory spectrometric measurements of eU, eTh, Ra and K in samples representing granitic rocks in Bir El Shab area.

Sample No	eU (ppm)	eTh (ppm)	Ra (ppm)	K (%)	eTh/ eU
1	2	19	2	4.54	9.50
2	27	32	29	3.86	1.19
3	32	37	27	4.60	1.16
4	11	35	5	0.15	3.18
5	8	31	7	0.06	3.88
6	57	38	44	3.8	0.67
7	32	36	33	4.22	1.13
A.R	**24.14**	**32.57**	**21.00**	**3.03**	**2.96**

The granites of the study area show positive correlation between uranium and thorium (Fig. 14a). This indicates that magmatic processes played an important role in the primary uranium enrichment of these granites. The granites also show negative correlation with much higher uranium contents than thorium (Fig. 14b). This indicates that uranium enrichment in granites is mainly affected by secondary processes. The granites have lower Th/U ratios and both of them shows strong negative relationship. This indicates that the enrichment of U in granites is related to secondary processes (Fig. 14b).

The U-Zr variation diagram shows poor positive correlation in granites (Fig. 14c). The uranium and zirconium contents in the granites are higher indicating that U enrichment may be related to hydrothermal fluids rich in both U and Zr. The positive correlation between U and Zr supports the concept that U was trapped in the accessory minerals.

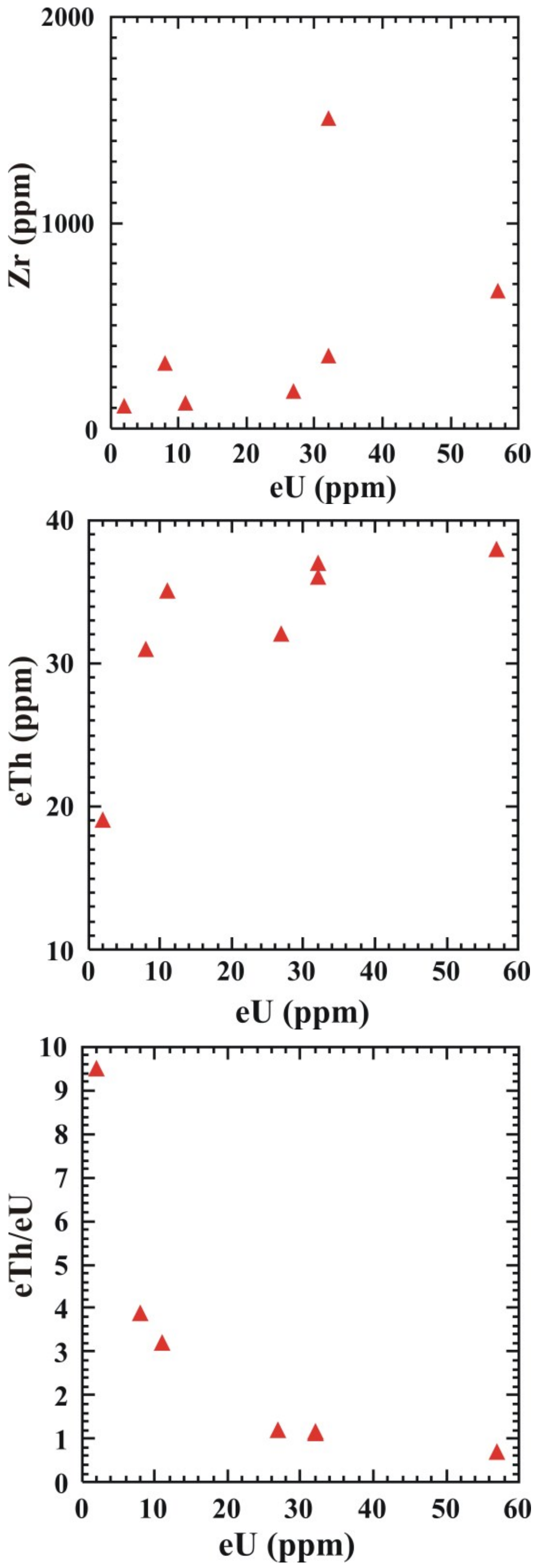


Fig. (14): Zr, eTh and eTh/ eU ratio versus eU of Bir El Shab granites.

URANIUM POTENTIALITIES:

The Western Desert of Egypt covers almost 2/3 of the Egyptian territory. It witnesses almost a complete geologic column starting from the pre-Cambrian rocks till the recent deposits.

According to the study of Bir El Shab area, it is clear that he granitic rocks occurred in the northern part of the study area is the main source of the uranium in the area. The majority of samples indicate that the detritus minerals control and contribute the uranium contents. However, there are several radioactive anomalies confined in the syenite dykes cutting the granitic rocks and in the adjacent the clastic and quaternary deposits. These radioactive anomalies are mainly related to secondary processes. The shallow water table in the area helps greatly in the mobility and redistribution of uranium.

The redistribution of uranium in the granitic rocks is post magmatically and indicated by the high Th/U ratio of some samples. Uranium is leached from granites and concentrated in shear zones filled with syenite and quartz dykes.

Although the amount of uranium in most samples is not sufficient to form its own minerals. The presence of higher concentrations of secondary uranium minerals at depth of the shear zones of the granitic rocks and also at the unconformity surface between granite and the clastic sediments is possible.

It can be said that, the south Western Desert, including the study area, has a good potentialities for hosting uranium resources. The younger granites and the associated acidic and alkaline volcanic exposures are potential provinces for hosting uranium, especially at their contact zones; also, they can act as sources for uranium (Salman et al., 1995).

SUMMARY and CONCLUSIONS

Bir El Shab area lies between Long. 29° 00` and 29° 30` E, and Lat. 22° 00` and 22° 30` N. The basement outcrops in the study area localities northeast of Bir El Shab between Long. 29° 55` 00 to 29° 56` 30 E and Lat. 22° 22`00 to 22° 23` 30 N. It is an elongated mass cover an area reaching 2 km in length and 1 km in width. The igneous rock is represented by small patches of very coarse grained biotite granite. The area intersected by several dykes includes quartz porphyry dykes. Apatites and pegmatite dykes have been observed.

Granite, is represented by nine samples and could be extinguished through the microscopic investigations into fresh granite and reworked altered granite. It is characterized by hypidiomorphic equigranular texture and composed essentially of potash feldspar, plagioclase, quartz and mafic minerals as biotite and hornblende.

Quartz is more existent occurring as minute crystals spreading in the rock. Granite is characterized by the presence of heavy minerals; mainly sphene and rutile. Quartz vein is composed essentially of quartz crystals with few crystals of carbonate and zircon.

The major and trace elements geochemistry of the younger granites of the study area are characterized by their relatively high silica content and potash contents and slightly exceed the soda content. This type are considered as high calcium granite and low total iron oxides and MgO contents. The comparison of major oxides and trace elements of both granite and post-granitic dyke could be summarized as follow:

1. The SiO_2, Al_2O_3 and CaO of granite less than post-granitic dyke.
2. The K_2O, Na_2O, FeO and Fe_2O_3 of granite slightly higher than post- granitic dyke.
3. The data of the trace elements of both types are nearly similar, suggesting that the granite are intruded from the same magma which is supported by the petrographic studies and major oxides content. On the other hand, the trace elements such as Zr, Nb, Ga, Y, and Cr show positive correlations with SiO_2. This is due to the high resistant of the accessory minerals to weathering such as zircon, apatite, sphene and rutile. The negative correlations of Ba, Rb, and Co with SiO_2 are due to their mobility whereas the random correlations of Sr, V and Ni with SiO_2 are attributed to their immobility

Radioactivity measurements range between 180 and 200 (cps) in the granite. Few samples are collected and radiometrically analyzed reflecting 2 to 57 ppm eU content. This range of eU is relatively high compared to the world granite rocks which are 4.7 ppm eU

Although the amount of uranium in most samples is not sufficient to form its own minerals, The presence of higher concentrations of secondary uranium minerals at depth of the shear zones of the Granitic rocks and also at the unconformity surface between granite and the clastic sediments is possible.

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دراسات جيولوجية واشعاعية لصخور الجرانيت القاعدية بمنطقه بير الشب جنوب الصحراء الغربية، مصر.

محمود محمد بدران

هيئة المواد النووية

تقع منطقة بير الشب في الجزء الجنوبي من الصحراء الغربية وتحد بخطى طول ٠٠´ ٢٩° و٣٠´ ٢٩° شرقا وخطى عرض ٠٠´ ٢٢° و ٣٠´ ٢٢° شمالا وتغطى مساحة قدرها٢٥٠٠ كم[٢]. ويمكن الوصول الى المنطقة عن طريق الخارجة "طريق درب الاربعين" او عن طريق ابو سنبل-شرق العوينات او طريق الداخلة-شرق العوينات. من الناحية الجيولوجية تتألف المنطقة من انواع صخرية متباينة السحنة الحجرية وهى صخور القاعدة والصخور الرسوبية، وتتكون صخور القاعدة في المنطقة من صخور الجرانيت وتوجد شمال شرق بير الشب. تأثرت المنطقة بالعديد من الفوالق المختلفة وهى كما يلى تركيبها حسب اقدميتها (شرق- غرب ، شمال شرق- جنوب غرب ، شمال غرب- جنوب شرق).

تم قياس الاشعاع بالمنطقة ثم تم اخذ عينات وعمل قياس الاشعاع بالمعامل وذلك لتحديد نسبة اليورانيوم والثوريوم وقد وجد ان المنطقة ليس بها اى شاذات اشعاعية ولكن وجد ان نسبة وجود الثوريوم اكبر من نسبة وجود اليورانيوم مما يعنى ان اليورانيوم كان موجودا اصلا وتم غسله وانتقاله الى اماكن اخرى (يمكن ان تكون فى احواض الترسيب)