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GEOCHEMISTRY AND RADIOACTIVITY OF GABAL EL MONAGAH A-TYPE GRANITES, SOUTH SINAI PENINSULA, EGYPT

Magdy S. Basta

Faculty of Petroleum and Mining Engineering, Suez University

ABSTRACT

Gabal El Monagah granites form roughly an oval shaped pluton with NW-SE orientation in the central part of Katharina Complex. It comprises two types of granites, syenogranites and alkali granites

Petrographically, the alkali granites of G. El Monagah are medium- to coarse-grained, and are mainly composed of well-developed perthitic orthoclase, microcline, quartz, and albite as well as biotite and amphiboles as accessory minerals.

Mineralogical studies using X-Ray diffraction (XRD) and Environmental Scanning Electron Microscopy (ESEM), revealed the presence of spessartine garnet, zennwaldite, titanite (sphene) and apatite.

Geochemically, G. El Monagah alkali granites are A-type granites of alkaline nature, generated in an extensional within plate (WPG) environment. They originated from calc-alkaline highly fractional crystallization of mafic magma. This magma is also rich in Rb and Nb indicating low pressure condition.

Radiometrically these granites are characterized by their high uranium content (eU range from 8 to 21 ppm), and hence they are considered as uraniferous granites ($\geq$ 4ppm), originated from highly fractionated uranium-rich magma with trapping high concentration of uranium in accessory minerals; such as zircon, allanite, apatite and sphene in these granites of Gabal El Monagah.

Keywords: Alkali granites; syenogranites; uraniferous granites.

INTRODUCTION

The basement rocks of Egypt are exposed in three areas: 1- Along Red sea coast, 2- South Sinai Peninsula, and 3- at Owinat area at the south western part of Egypt. The Arabo-Nubian Shield (ANS) is a part of the East African orogeny formed in the late Proterozoic by accretion and amalgamation of oceanic and continental magmatic arcs during subduction and obduction of oceanic crust and closure of the Mozambique Ocean (Kröner, 1985; Kröner et al. 1987; Stern 19^4; and Loizenbauer et al. 2001). The Egyptian granites are classified into two main types, the older (Syn-tectonic) granites and younger (Late tectonic to post tectonic) granites (Akaad and El Ramely, 1960, Stern et al., 1984).

The granitic rocks in Southern Sinai which represent the northwestern crystalline rocks of the Arabian-Nubian Shield, show an evolution trend from the older calc-alkaline (subduction-related) granites (GI) to the younger alkaline (post orogenic) granites (GII) and finally the peralkaline (anorogenic) granites (GIII) according to Takla (2002).

The composition of A-type granites is diverse; they comprise syenogranites, peralkaline and alkali-feldspar granite and syenite, rapakivi granite, monzogranite and F-rich topaz granites (e.g. Collins et al., 1982; Whalen et al., 1987 and 1996; Eby, 1992; Wu et al., 2002, Bonin, 2004, Katzir, 2006 and Samaan, 2009).In the Arabian-Nubian Shield three types of A-type granites are dominant; metaluminous syenogranites, alkali-feldspar granite and peralkaline granite (Zanvilevich et al., 1995; Whalen et al., 1996; Jahn et al., 2000; Litvinovsky et al., 2002; and Jahn et al., 2004).

This paper deals with the petrography, geochemistry and geochemical behaviors of U and Th of the studied granitic rocks and the relation between the A-type granites and radioactivity.

GENERAL GEOLOGY

Gabal El Monagah mountain lies between latitudes 28°31 ′- 28°32′ N and longitudes 33°58′ - 33°59′ E and covering area of about 70 km^2 (Fig. 1). It forms a sequence of granitoid intrusions in the NW-SE trend and minor masses of metavolcanic rocks. It rises up to 2260 m above sea level (a.s.l.) through the relatively low lying adjacent areas. The main rock types in the mapped area exhibit the following chronological sequence emplacement, metavolcanics, granodiorites and younger granites (alkali feldspar granite).

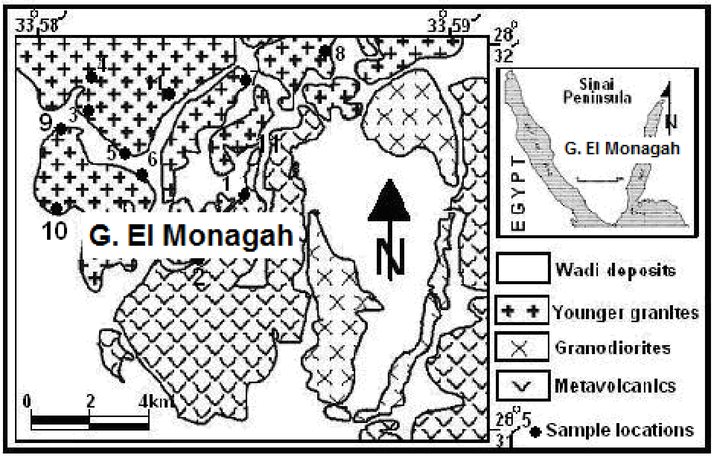


Fig. 1: Geological map of G. El Monagah area South Central Sinai Peninsula, Egypt. (modified after Katzir et al., 2007)

The metavolcanics cropout at the southern and eastern parts of the studied area, with tow bodies. They are hard and dark green in color and cut by quartz veins (Fig. 2).These volcanics located in the central part of southern Sinai, they show two types: the old volcanics (alkali basalt) and the young volcanic (alkali rhyolites and syenites).

The alkali feldspar granite forms the main mass of Gabal El Monagah and covers about 60 % of the whole area. It lies at the western and northern parts of the mapped area and forms conspicuous topographic features in the district rising up to 2260 m above sea level (a.s.l.). It is red to pink in colour, coarse-grained, hard and massive. The alkali feldspar granite in the marginal zone is generally porphyritic, with sericitized orthoclase and quartz phenocrysts in quartz-plagioclase groundmass. Gabal El Monagah granites are of surficial slump structure (Fig. 3), and are commonly cut by numerous post granitic dikes of different thickness and composition (Fig. 4). Occasionally, they include dispersed pegmatite pockets (Fig. 5) and quartz veins. They are highly dissected by faulting and well jointed in various directions. The contact of granites with the country rocks is sharp, without evidence of metasomatic alteration.

Analytical techniques and methodology

The petrography was carried out using a polarizing microscope attached by refracted light Olympus Modal C5060- ADU Japan, attached by digital camera Model C-7070 WIDE ZOOM. The mineralogy is studied by X-ray diffraction **(XRD),** and Environmental Scanning Electron Microscope **(ESEM)** attached by Energy Dispersive Analytical X-ray **(EDAX)** units. The major oxides are analyzed by method of Shapiro and Branook (1962) by pression 5%. The trace elements were carried out by using X-ray fluorescence spectrometer model (X-Unique II) by perssion 10%. The uranium and thorium are detected by gamma ray spectrometry. All these analyses carried out in laboratories of Nuclear Materials Authority **(NMA)**, except the major oxides which analyzed in Central International Research **(CIR).**

PETROGRAPHY AND MINERALOGY

The granitic rocks of G. El Monagah are pink to light red in color, course- grained and of hypidiomorphic texture. Microscopically, the rocks are composed of alkali feldspar, quartz and plagioclase as essential minerals, while, zircon, allanite, mafic (amphiboles and biotite), opaque, sphene, calcite and apatite as accessory minerals, and secondary minerals as sericite, chlorite, calcite, saussurite and epidote.

G. Moussa granites are recognized as a two feldspar type, i.e. have subsolvus texture. In general, the rocks are classified as perthitic leucogranites.

Fig. 2: Quartz vein cutting Metavolcanics

Fig. 3: Surficial slump structure in younger granites

Fig. 4: Numerous post granitic dikes of different thickness and composition cutting the younger granites

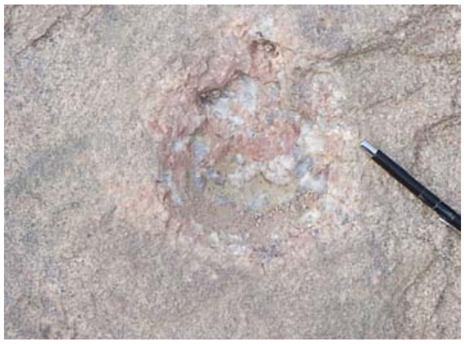


Fig. 5: Pegmatite quartz pocket in younger granites

The average contents of alkali feldspar, quartz and plagioclase are 65, 25 and10 vol. % respectively. Alkali feldspar is represented by perthite (orthoclase and microcline) and microcline. The orthoclase perthite is characterized by flame, feather and string types (Fig. 6). Microcline perthite is characterized by dense brown turbid patchy zones and is partially altered to sericite. The quartz occurs as unhedral coarse grains showing wavy extension and show graphic texture (Fig. 7). The quartz enclosed feldspars, mafic, opaques, apatite, garnet, zircon, allanite (Fig. 8), and sphene. Plagioclase is represented by pure albite, forming prismatic elongate crystals and characterized by Carlsbad twining and few are saussuritized. Rare zoned plagioclase crystals are observed. The mafics are represented by amphiboles and biotite. Garnet occurs as subhedral to anhedral crystals performed with quartz. Zircon is found as very minor amounts, as minute prismatic crystals occasionally enclosed in quartz. Apatite is found as euhedral prismatic and needle crystals enclosed in feldspars. It is generally found as inclusion in quartz. Sphene forms subhedral rhombic-cracked and elongated crystals having light brown color, exhibiting very high relief (Fig. 9). It associated with zircon, apatite and iron oxides. Opaques occur as small anhedral grains scattered all over the rocks and represented by magnetite and ilmenite.

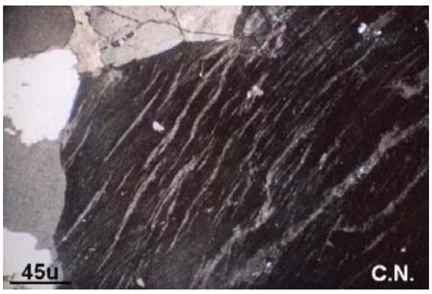


Fig. 6: Flame perthite in A-type granites

Fig. 7:Graphic texture in quartz

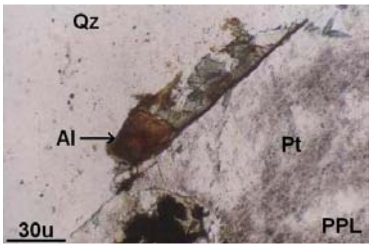


Fig. 8: Allanite (Al) crystal between quartz (Qz) and perthite (Pt) crystals

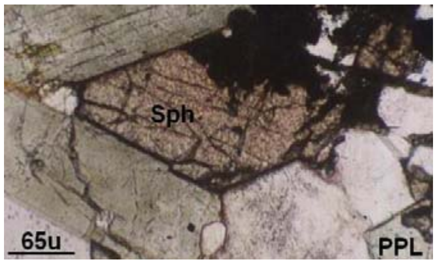


Fig. 9: Rhombic sphene (Sph) crystal

Mineralogically **XRD** showed spessartine garnet and zinnwaldite (Fig.10), and titanite (Fig. 11), The **ESEM** identified spessartine (Fig.12 a&b), sphene (Fig. 13 a&b) and apatite (Fig. 14 a&b). The apatite contains UO_2 (0.95%), TiO_2 (1.13%) and high Y_2O_3 (21.55%).

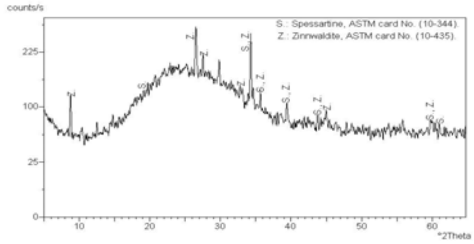


Fig. 10: XRD diffractogram of spessartine garnet and zinnwaldite in G. El Monagah granites

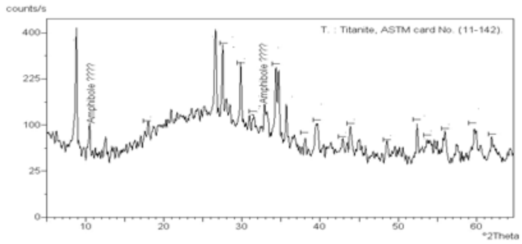


Fig. 11: XRD diffractogram of titanite in G. El Monagah granites

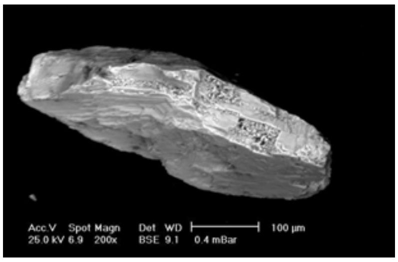


Fig. 12a: ESEM image of spessartine garnet grain in G. El Monagah granites

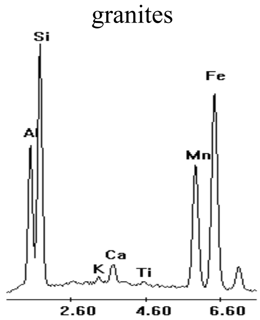


Fig. 12b: EDAX chart for grain in 12a

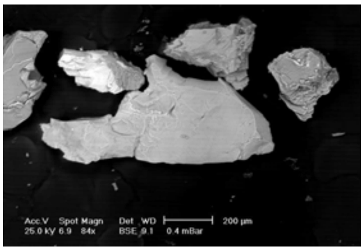


Fig. 13a: ESEM image of sphene grain in G. El Monagah granites

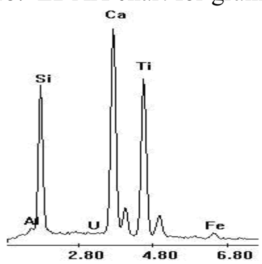


Fig. 13b : EDAX chart for grain in 13a

Fig. 14a: ESEM image of apatite grains in G. El Monagah granites

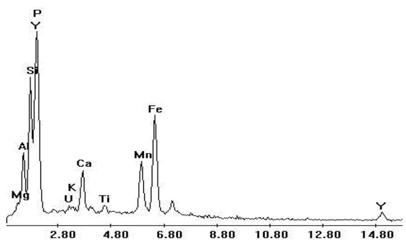


Fig. 14b: EDAX chart for grain in 14a

GEOCHEMISTRY

General characteristics

Chemical composition of eleven representative granitic samples is shown reported in Table (1). The granites of G. El Monagah are characterized by their high SiO_2. (68.78-76.03 wt %), K_2O (3.63-5.96 wt %), Na_2O (3.01-5.31 wt %) and low in CaO (0.23-0.94 wt %), MgO (0.06-1.01 wt %), Fe2O3 (1.21-3.82 wt %), while FeO is less than 0.12 wt%. They exhibit Fe_2O_3/MgO ratio ranging from 3.69 to 38.78 and total alkali between 8.24 and 9.91 Table (2). The comparison of the average major elements of the studied granites with other similar world granites (Table 3), shows a close similarity with the average for granites of Oscela (Eby, 1990), Zug El Buhar granites (Meena, 1992); and the average of the Egyptian younger granites El Gaby (1975).

Table 1: Major oxides and trace elements for the A-type granites of Gabal El Monagah area

Sample no.	1	2	3	4	5	6	7	8	9	10	11
Major Oxides (wt %)											
SiO_2	68.78	69.71	70.02	75.9	74.33	76.03	72.98	75.03	75.77	74.4	73.55
TiO_2	0.46	0.51	0.56	0.11	0.31	0.16	0.23	0.17	0.16	0.08	0.23
Al_2O_3	14.16	14.01	13.73	13.01	13.14	12.17	12.63	12.88	12.49	13.41	14.01
Fe_2O_3	3.49	3.21	3.82	1.21	1.26	1.98	1.88	1.57	1.65	1.70	1.63
FeO	0.01	0.02	0.015	0.014	0.013	0.01	0.012	0.05	0.011	0.011	0.12
MnO	0.07	0.1	0.05	0.02	0.5	0.06	0.04	0.06	0.03	0.04	0.03
MgO	0.09	0.79	1.01	0.09	0.19	0.08	0.51	0.11	0.07	0.06	0.29
CaO	0.74	0.61	0.84	0.57	0.62	0.81	0.9	0.23	0.29	0.79	0.94
Na_2O	3.91	3.95	4.5	3.01	4.96	3.72	4.6	4.51	4.53	4.44	5.31
K_2O	5.55	5.96	4.96	5.86	3.81	4.52	3.89	4.6	4.46	4.55	3.63
P_2O_5	0.12	0.11	0.09	0.03	0.06	0.04	0.03	0.05	0.03	0.03	0.06
L.O.I	1.2	1.02	0.99	0.32	1.31	0.57	1.6	0.72	0.51	0.97	0.51
Total	99.38	99.95	100.57	100.13	100.04	100.04	99.4	99.93	99.99	100.47	100.19
Trace elements (ppm)											
Ba	1011	1197	943	255	998	39	671	191	162	84	775
Rb	163	156	126	167	103	194	93	121	132	265	90
Sr	229	211	178	104	106	73	242	33	36	16	75
Y	31	35	37	21	29	78	14	41	37	46	27
Zr	369	431	446	76	229	374	121	315	283	135	201
Nb	210	240	260	170	120	420	180	160	117	100	190
Ce	100	110	140	180	150	130	150	125	135	120	115
Pb	130	131	29	26	160	113	4	97	78	137	36
Zn	69	73	82	19	62	136	39	53	56	52	42
Cu	31	49	29	5	7	4	7	11	3	3	16
Ni	7	9	8	6	6	9	13	12	5	7	6
V	21	25	27	5	8	3	19	7	4	1	8
Cr	8	6	5	4	1	2	11	7	3	3	5
Co	6	7	4	3	2	2	3	2	3	3	5
eU	21	22	18	12	11	8	9	15	12	14	15
eTh	24	25	22	15	15	10	12	20	20	18	19

Typology and Magma type

The studied granitoid rocks are chemically classified using the following relationships:

On the normative Ab-An-Or triangular diagram (O'Conner, 1965 and Barkar, 1979), the granite samples plot in granite field (Fig. 15). In the relation between alkalis (Na_2O+K_2O) wt% and SiO_2wt% (Fig.16), according to Wilson (1989), all the granitic rocks fall in the granite field.

The AFM diagram, according to Irvine and Baragar (1971), is used to distinguish between the tholeiitic suites and the calc-alkaline suites (Fig. 17). The data of all rock types plot parallel to extential trend.

The relation between SiO_2 and K_2O (Fig. 18), according to La Matire (1989), most of granitic samples fall in High-K field.

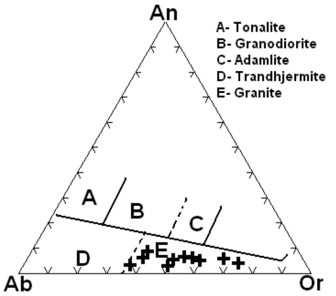


Fig. 15: Ab-An-Or , triangular diagram O'Conner (1965) and Barkar (1979)

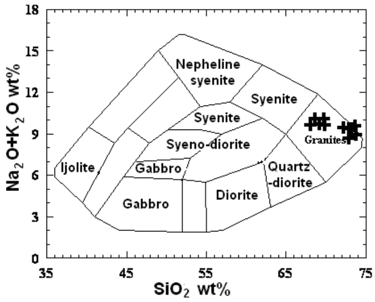


Fig. 16: (Na_2O+K_2O) wt% vs SiO_2 wt% diagram (Wilson, 1989)

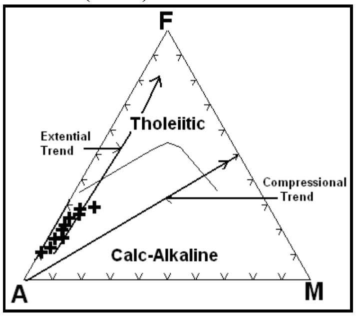


Fig. 17: AFM diagram Irvine and Baragar (1971)

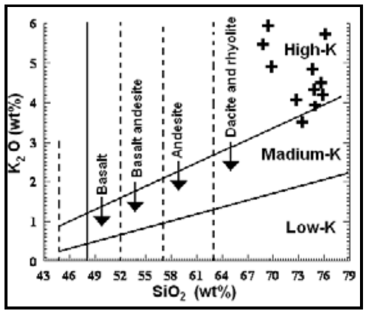


Fig. 18: SiO_2 (wt%) vs K_2O (wt%) La Matire (1989)

Tectonic setting

According to Maniar and Piccoli (1989), Figures (19 & 20), show the relation between K_2O and Al_2O_3 (wt %), against SiO_2 respectively. Figure (15), shows that all data of G. El Monagah granites plot in the field of (IAG + CAG + CCG + RRG + CEUG +POG), while in Figure (16), all data fall in the field of POG except one sample plot in RRG + CEUG field.

In the relation between Y vs. Nb and (Y+Nb) vs. Rb (Fig. 21 & 22) according to Pearce et al. (1984), all the granitic rocks fall in WPG field. The triangular diagram Al_2O_3- (Na_2O+K_2O) - CaO (Fig. 23), according to Shand (1951), all the data plot in peraluminous field.

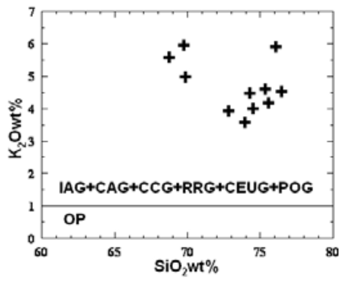


Fig. 19: SiO_2 wt% vs K2O wt% (Maniar and Piccoli, 1989).

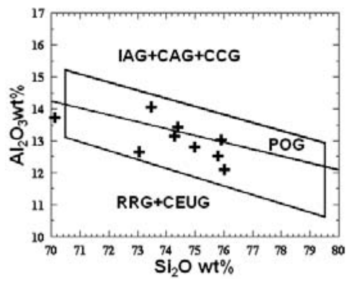


Fig. 20: SiO_2 wt% vs Al_2O_3 wt% Maniar and Piccoli, 1989).

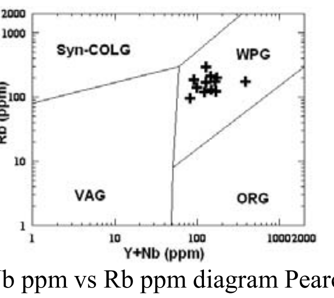


Fig. 21: Y+Nb ppm vs Rb ppm diagram Pearce et al. (1984)

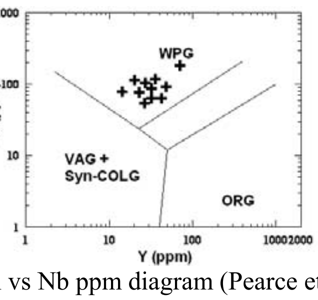


Fig. 22: Y ppm vs Nb ppm diagram (Pearce et al. (1984)

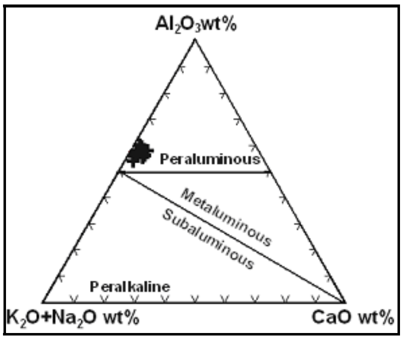


Fig. 23: K_2O+Na_2O-Al_2O_3-CaO diagram (Shand, 1951).

Petrogenesis

Zr, Nb, Ce, Y, Rb and Sr are probably the most informative elements used in evaluating the fractionation of granitic rocks, because their behavior in these systems is strongly tied to the major minerals, e.g., plagioclase, K-feldspars, biotite and muscovite.

In the relation between Zr+Nb+Ce+Y and both FeO*/MgO and (K_2O+Na_2O)/CaO according to Whalen, et al, (1987), show that the data of all granitic rocks of G. El Monagah fall in the A-type granites (Figs. 24 and 25).

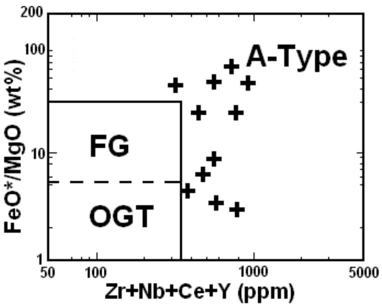


Fig. 24: Zr+Nb+Ce+Y(ppm) vs FeO*/MgO (wt%)(Whalen, et al, 1987)

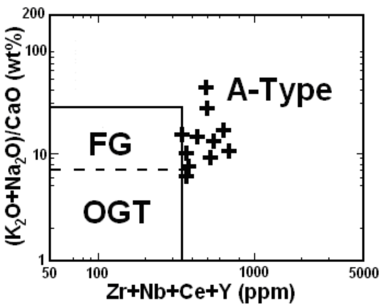
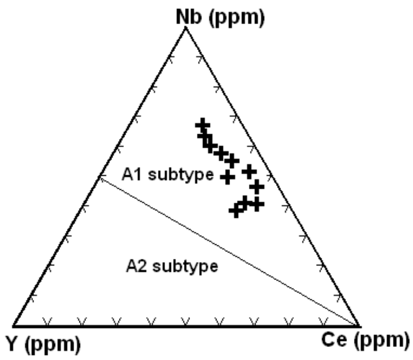


Fig. 25: Zr+Nb+Ce+Y (ppm) vs K_2O+Na_2O)/CaO (wt%) Whalen, et al, 1987)

A-type granites were emplaced within tenstional (non-compressive) environments at the end of orogonic cycles (post-orogenic) either in continental rift zone or in oceanic basin (Eby, 1990). The A-type granites classified according to Eby (1992), into two subgroups on a geochemical basis; those associated with continental rift zone magmatism (A1-subgroup) and those associated with stage of oceanic arc-magmatism (post collision; A2-subgroup).

In the Y-Nb-Ce ternary diagram according to Eby (1992), all the granitic rocks of G. El Monagah plot in the A1-subtype field (Fig. 26).

Fig. 26: Y-Nb-Ce ternary diagram (Eby, 1992)



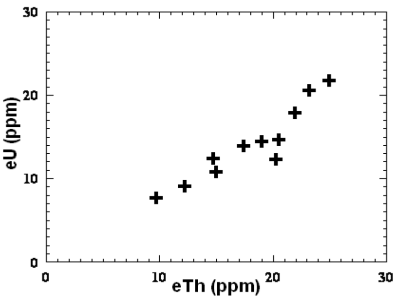


Fig. 27: eTh ppm vs eU ppm

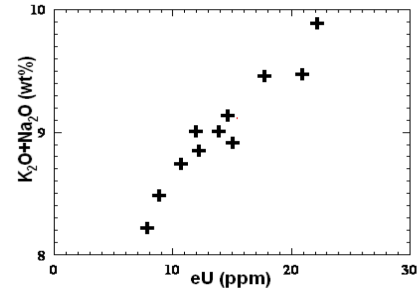


Fig. 28: eU ppm vs K_2O+Na_2O wt%

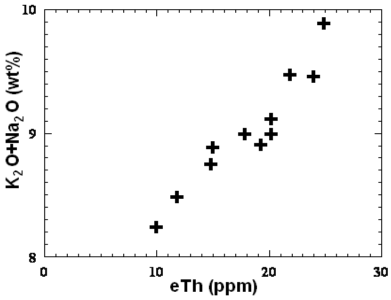


Fig. 29: eTh ppm vs K_2O+Na_2O wt%

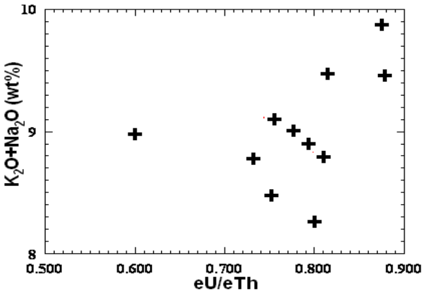


Fig. 30 : eU/eTh vs K_2O+Na_2O wt%

Table 2 Some geochemical parameters of A-type granites of Gabal El Monagah area

Sample no.	1	2	3	4	5	6	7	8	9	10	11
Albite	33.93	33.73	38.19	25.48	42.26	31.57	39.79	38.40	38.48	37.71	44.97
Anorthite	3.05	2.41	2.59	2.66	2.32	3.13	2.35	0.85	0.54	3.20	3.65
Orthoclase	33.71	35.62	26.46	34.72	22.72	26.85	23.55	24.41	26.52	27.05	21.51
Na_2O+K_2O	9.35	9.91	9.64	8.87	8.77	8.24	8.49	9.11	8.99	8.99	8.94
K_2O /Na_2O	1.42	1.51	1.10	1.95	0.78	1.22	0.85	1.02	0.98	1.02	0.68
K_2O+Na_2O/CaO	12.78	16.25	11.62	15.56	14.15	10.17	9.43	36.61	31.00	11.38	9.51
FeO*/MgO	35	3.68	3.42	12.25	6.04	22.40	3.34	13.30	21.37	25.68	5.47
Fe_2O_3/MgO	38.78	4.06	3.78	13.44	6.63	24.75	3.69	14.27	23.57	28.33	5.62
Rb/Sr	0.71	0.74	0.71	1.61	0.97	2.67	0.38	3.67	3.67	16.56	1.2
Y/eTh	1.29	1.4	1.68	1.4	1.93	7.8	1.17	2.05	1.85	2.56	1.42
eTh/eU	1.14	1.14	1.22	1.25	1.4	1.25	1.33	1.33	1.67	1.29	1.27

Note. FeO* Calculated by Newpet program

Table 3 Comparison of average chemical composition of the studied granites with some world granite rocks

Locality	1	2	3	4	5	6	7	8	9	10
SiO_2	73.31	75.04	72.70	73.61	72.12	74.27	74.58	73.91	74.42	74.36
TiO_2	0.27	0.22	0.18	0.21	0.15	0.20	0.35	0.11	0.28	0.07
Al_2O_3	13.24	13.11	14.07	13.81	12.48	13016	14.05	13.68	11.79	11.88
Fe_2O_3	2.13	1.67	0.78	0.82	1.55	0.81	0.99	1.55	1.26	0.95
FeO	0.03		0.63	0.28		1.10	0.60	0.48	0.66	0.72
MnO	0.09	0.05	0.08	0.06	0.07	-	0.05	0.06	-	-
MgO	0.30	0.26	0.38	1.13	0.19	0.27	0.27	0.22	0.48	0.12
CaO	0.67	0.75	1.62	1.09	0.63	0.71	0.73	1.48	1.42	0.49
Na_2O	4.31	3.87	5.36	4.09	4.01	3.43	3.95	4.04	4.64	4.48
K_2O	4.71	4.41	3.49	4.9	5.51	5.06	4.99	3.82	4.10	5.27
P_2O_5	0.06	0.04	0.03	0.14		0.14	0.05	0.15	-	0.05

1- Average of the studied granites. 2- Egyptian younger granites (El Gaby, 1975). 3- A-type granites G. Mueilha area (Samaan 2009) 4- Zug El Buhar granites (Meena, 1992) 5- Mount Oscela granites (Eby, 1990). 6- Low-Ca granites (Turekian and Wedepohl, 1961) 7- Younger granites group III (Greenberg, 1981). 8- Perthitic leucogranites (Takla et al., 1991). 9- Precambrian granites (Worled, Daly, 1933). 10- Granites of Abu Durba area, south Sinai, (Soliman and Soliman, 1989).

Geochemistry of U and Th in the studied granites

The studied samples were analyzed using gamma spectrometry in Nuclear Materials Authority (NMA) in Egypt (Table 1). The eU of Gabal El Monagah granites ranges from 8 to 22 ppm with an average of 14.27 ppm, while, eTh varies from 10 to 25 ppm with an average of 18.18 ppm and the eTh/eU ratio of G. El Monagah alkali feldspar granites ranges from 1.14-1.67 with an average of 1.30, this eTh/eU ratio is significantly lower than 4.73 ratio of the USA granites (Stuckless and Farreira 1976). It is also significantly lower than 2.93 mean value for the post orogenic granites of the Arabian Shield (Stuckless et al, 1984).

Darnley (1982) recognized uraniferous granites containing uranium at least twice the Clarke value (4ppm) for the normal granites. Therefore, granite containing 4ppm eU and/or 8ppm these is termed as uraniferous granites.

Assaf et al (1997) mentioned that the most important parameters as a guide for the exploration of uranium in the younger granites in Egypt include the relative enrichment in silica (>74%), Rb (>185 ppm), Nb (>63 ppm), and U (>18 ppm) and depletion in aluminum oxides (<13%), Ca (<0.97%), Sr (<99 ppm), and Ba (<298 ppm). In addition, they may be also characterized by high values for the ratios of Y/Th (>2.17), and low values for the ratios K_2O / Na_2O (<1.11), and Th/U (2.32).

The parameters of Assaf et al (1997) more or less similar to the study data K_2O/Na_2O= 1.14, Th/U= 1.3, and Y/Th =2.23.

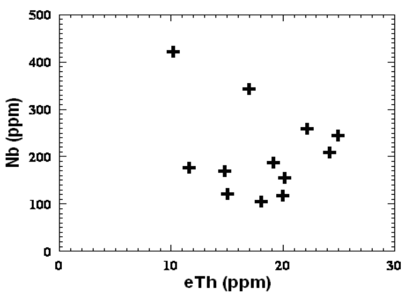


Fig. 33: eTh (ppm) vs Nb (ppm)

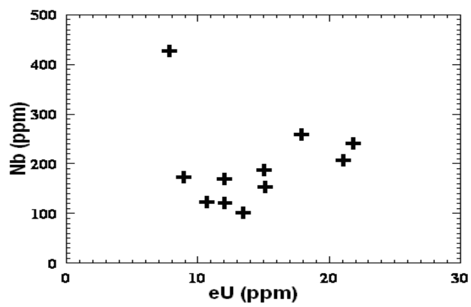


Fig. 34: eU (ppm) vs Nb (ppm)

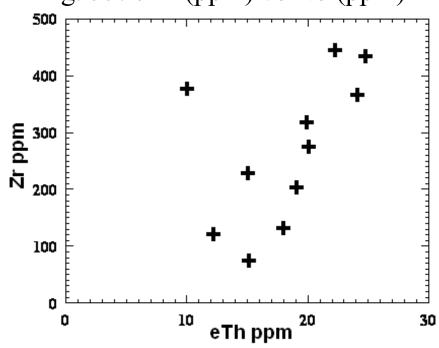


Fig. 35: eTh (ppm) vs Zr (ppm)

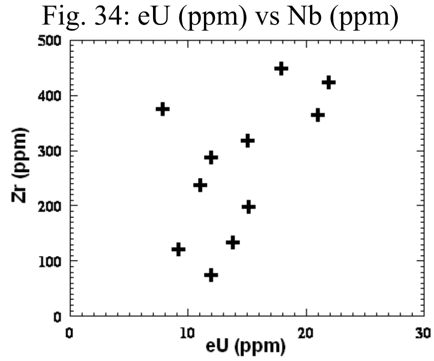


Fig. 36: eU (ppm) vs Zr (ppm)

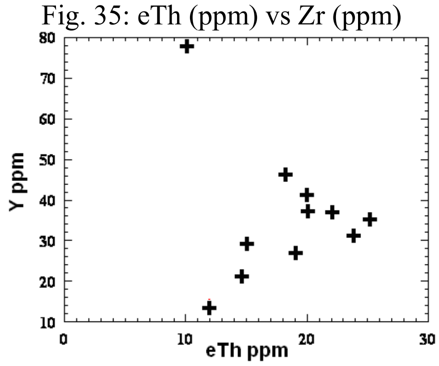


Fig. 37: eTh (ppm) vs Yppm)

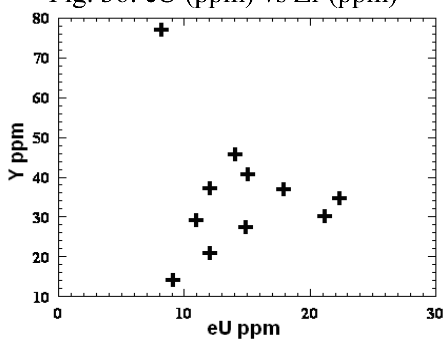


Fig. 38: eU (ppm) vs Y (ppm)

The relation between eU and eTh (Fig.27) shows that eU is increasing with increase of eTh. This normal behavior between eTh and eU is due to magmatic origin, also relation between alkalis (Na_2O+K_2O) wt% and eU, eTh and eU/eTh (Fig. 28, 29 &30) shows positive relations as well as the relation between eU ppm and eTh ppm with different trace elements such as Nb, Zr and Y (Figures. 33 to 38) also shows positive relations.

The granites which are rich in accessory minerals such as sphene, allanite, apatite and zircon, are carriers of uranium mineralization (Saleh and Ayoub, 2008). In the studied area, gamma-ray spectrometric analyses revealed that Gabal El Monagah granites possess high abundances of U, Th and K (U range 3-21 ppm with average 8 ppm; Th range 10-43 ppm with average 26 ppm; K range 1.2-5.2% with average 4.0%). Thus, they belong to the class of uraniferous.

CONCLUSION

Gabal El Monagah is a granitic pluton with an oval shaped pluton with NW-SE direction in the central part of Katharina complex. Katzir et al., (2007) noted that the area of G. El Monagah shows a vertical compositional zoning; syenogranite makes up the bulk of the pluton and grades upward to alkali feldspar granite. The latter form two horizontal subzones; albite alkali feldspar granite and uppermost perthite granite, these two varieties are chemically indistinguishable. The transition from syenogranite to alkali feldspar granite is poorly discernible in outcrops and only recognized by the decrease in plagioclase content. Going upwards in the pluton, the proportion of plagioclase in granite decreases systematically. The contact between albite alkali feldspar granite and perthite granite is also gradational, and it becomes more distinguishable due to the colour contrast with the redder perthite granite.

El Tokhy (1998) believed that the riebekite granites of Gabal El Monagah are belonging to phase III of Egyptian younger granites, these granites are alkaline, peraluminous and have a sodic-potassic character with high silica and alkalis content. They are of a magmatic origin, typically A-type granites and are zoned by partial melting and fractional of another alkaline or calc-alkaline magma. They crystallized under low temperature and low pressure (3-4km), and were emplaced as shallow intrusive in the continental crust.

The younger granites of G. El Monagah are alkali feldspar granites mainly composed of alkali feldspar, quartz and plagioclase as essential minerals, while zircon, mafic (amphiboles and biotite), opaque, sphene, calcite, garnet (in the sample which contact with metavolcanics), and apatite as accessory minerals, and secondary minerals as sericite, chlorite, saussurite and epidote. The rocks of G. El Monagah comprise alkali granites which are classified as perthitic leucogranites exhibiting subsolvus textures.

Their major oxides chemistry is high potassium and low calcium granites. These granitic rocks are depleted in the compatible trace elements (Sr, Ba and Pb), and enriched in the incompatible ones (Rb, Y, Zr, Nb, Th and U), which suggest origination from calc-alkaline peraluminous highly fractionated magma developed in a within plate (A-type) anorogenic tectonic setting in post-orogenic environment. King et al. (1997) suggested that aluminous A-type granites resulted from partial melting of crustal source rocks, while peralkaline A-type granites were formed through fractionation of mafic magma. Such magma was formed by high temperature partial melting of deep residual sources in the presence of volatile rich fluids. These melts later underwent significant crystal-liquid fractionations

The geochemistry of U and Th indicates that G. El Monagah granites are characterized by their high magmatic uranium content and hence they are considered as uraniferous granites originated from highly fractionated U-rich magma with trapping high concentration of uranium in accessory minerals; since their average contents of uranium and thorium are more than twice the Clark value; also due to the high content of radioactive accessory minerals (e.g. zircon, allanite, apatite and sphene) in these granites.

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Geochemistry and radioactivity of Gabal El Monagah A-type granites

جيوكيميائية وإشعاعيه جرانيت جبل المناجاه ، جنوب سيناء ، مصر

مجدي سامي بسطا

الخلاصة

يشكل جرانيت جبل المناجاة تقريبا بلوتون بيضاوي الشكل مع اتجاه شمال غرب – جنوب شرق في الجزء المركزي من مجموعة كاتارينا. وهو يتألف من نوعين من الجرانيت : ساينو جرانيت والجرانيت القلوي.

و من الدراسة البتروجرافية ، تكون حبيبات الجرانيت القلوي متوسطة إلي كبيرة الحجم . و تتكون من : الأورثوكليز و المايكروكلين و الكوارتز , والألبايت مع معادن ثانوية مثل: البيوتايت و الأمفيبولز .

وقد كشفت الدراسات المعدنية باستخدام حيود الأشعة السينية (XRD) والمجهر الإلكتروني (ESEM) ، وجود العقيق السبيسارتيني ، الزينوالدايت ، التيتانايت والأباتيت.

ومن الدراسة الجيوكيميائية ، وجد أن الجرانيت القلوي لجبل المناجاة هو من النوع الأول من حيث الطبيعة القلوية ، ونشأت في بيئة ممتدة داخل اللوحة (WPG). لقد تكونت من عملية التكسير البلوري الكلسي القلوي للمجما الغنية بالحديد والمغنسيوم (المافية). كما أن هذه المجما غنية أيضًا بالروبيديوم والنوبيوم ، مما يشير إلى حالة الضغط المنخفض.

و أيضا من الدراسة الإشعاعية ، يتميز هذه الجرانيت بشكل بمحتواه العالي من اليورانيوم (تتراوح بين ٨ إلى ٢١ جزء في المليون) ، وبالتالي فهي تعتبر جرانيت إشعاعي (4 جزء في المليون) ، نشأت من مجما غنية باليورانيوم المكسور مع احتجاز تركيز عالٍ من اليورانيوم في معادن ثانوية مثل : الزركون ، الألانايت ، الأباتيت والسفين في جرانيت جبل المنجا.