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A CONTRIBUTION TO THE GEOLOGY AND PETROCHEMISTRY OF ABU HAMMAM GRANITIC MASS, SOUTH EASTERN DESERT, EGYPT

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ABSTRACT

The field, petrographic and major-element chemistry of the Abu Hammam granitoid mass (140 km^2) latit. 24° 46' & Long. 34° 1', are inclined to consider it as a monzogranite pluton belonging to the younger granite suite reported elsewhere in the Eastern Desert of Egypt. The main chemical characteristics of the massif are its low TiO_2 ($< 0.2\%$), low P_2O_5 (aver. 0.10%) content with a K_2O/Na_2O ratio (<1) and a FeO(t)/FeO(t)+ MgO) ratio > 0.8 characteristic of post-tectonic suite. Magmatic crystallization at low water-vapour pressures under extensional tectonic regime is the favoured genesis for this granitoid mass. The low P_2O_5 contents, however, tend to preclude anatexis in low crustal environment.

INTRODUCTION

The Abu Hammam granitic mass lies approximately at the intersection of latitude 24° 46' N and longitude 34° 1' E (key map, Fig. 1). Air photographs show this area as a conspicuous oval sandy plain (14x10 km.) with densely and randomly distributed granite islets concenrated mainly in its western half. In the southern part of the mass, a major weathering resistant quartz vein protruds forming the famous Urf Abu Hammam land mark (Fig. 2). The granitoid rocks occupying the main part of the area form low land tor-like masses with distinct bouldery weathering. Colour variations within the different islets are prominent and the content of peripheral xenoliths are always incontestable. Despite these features, considered by most authors as characteristic of Older Granite, the Abu Hammam granitoid mass has been described and mapped as a younger granite pluton [4,5,6].

Faced with this divergence in opinion, the present study-based mainly on a combination of field, petrographic and petrochemical investigations-aimed primarily to gain additional information about the geological set up of this important granitoid mass.

Twelve chemical analyses are presented in this paper (Table 2). The samples were analyzed for major elements by rapid rock wet-chemical methods at the Nuclear Materials Corporation using colurimetric, titerametric, and flame-photometric techniques according to the procedures outlined by Shapiro and Brannock [12]. The chemical analyses have aided in building up some of the useful variation and discriminant diagrams that have been used to substantiate the microscopic and field investigations.

GEOLOGICAL OUTLINE

The Abu Hammam granitoid mass has been described in the previous literature as a post-tectonic younger granite mass surrounded by a host country formed mainly of geosynclinal metasediments and metavolcanics, serpentinites, metagabbro-diorite complex, old granitoids and old volcanics [4,6,]. Soliman [13] described the Abu Hammam mass as lying on the border of, or crossing, a deep- seated tectonic zone that has controlled its emplacement. More recently Zaghloul et al. [20,21] investigated the granitoid mass and considered it as a xenolithic cataclastic younger granite showed sharp contacts with the country rocks.

In the field, the Abu Hammam granite appears as a greyish pink, coarse- to medium- grained hornblende biotite granite suggestive of a granodiorite to monzogranite rather than syeno-granite. The islets often attain steep walls and rugged roofs studded by exfoliated boulders (Fig. 3). Evidence of strong deformation is lacking in the field; and despite the abundance of rupture effects manifested by the overwhelming faulting and jointing, true foliation is practically absent. Several phases of hydrothermal veins of quartz, feldspar and barite do frequently reside the previous fracture systems particularly the latitudinal ones. The western half of the mass, however, is characterized by a set of meridional dykes of intermediate composition. Acidic micrógranite and granophyre dykes are subordinate and attain varying trends. The majority of the previously mentioned dykes and veins die out rapidly before reaching the contact with the neighbouring rocks. The latter contact is devoid of any obvious thermal effects but the granitoids themselves are characteristically xenolithic. Changes in grain size or development of hanging wall pegmatites that may be indicative of contact effects are utterly lacking. In outline, the contacts-particularly the northern and western ones- are straitly extending and knife-sharp (Fig. 4) suggesting a type of structural control, The prevailing structural trends in the host rocks along the northern and southern boundaries of the contact are more or less eastwesterly extending in approximate parallelism with the sharp contacts. This is not, however the case with the rocks along the eastern and western contacts where the easterly extending trends of the host rocks intersect at steep angles with these contacts. Along contacts, the xenoliths are large-sized, up to several meters in length, and always angular (Fig. 5). In these large xenoliths one could notice fine veinlets of granitic material extending along the older cleavage and fracture planes imparting for the xenolith a nice net-veined pattern. Towards the center, these xenoliths decrease in dimension and loose their angularity. Some of them become rimmed with fine and brittle haloes which may reflect varying degrees of digestion (Fig. 6). In some others, however, new porphyroblasts of feldspar develop particularly along the xenolithic peripheries (Fig. 7). As the core is further approached, the xenoliths die out progressively and finally disappear.

The core zone is occupied by a small mass of fine-grained granite that is seemingly free of xenoliths. The exact nature of this mass is difficült to determine with certainly due to the recent sand cover along most of its boundaries hidding the contacts with the surrounding granitoids out of direct observation. It seems probable, however, that this mass of porphyritic fine-grained granite represents a younger granitoid upsurg related to the microgranite dykes early mintioned.

MICROSCOPIC INVESTIGATIONS

(a) The main granitoid mass:

The bulk of the main Abu Hammam granitoid mass is grey to pink equigranular to porphyritic medium-to coarse-grained monzogranite and granodiorite, The mafic silicate content is fluctuating in the various parts of the mass but it do rarely exceed the approximate 10% level by volume.

In thin sections, the rocks posses hypidiomorphic to xenomorphic granular texture; and composed mainly of quartz, plagioclase and alkali feldspars.

Ferromagnesian minerals, mainly variably chloritized biotite with or without hornblende are subordinate but essential constituents Iron oxides and apatite are persistent accessories. Modal analysis (Table 1) shows these granitoids to range in mineralogical composition between 21-27% quartz, 32-38% alkali feldspares, 36-40% plagioclase, 5-11% mafic components and 1-3% accessories, and fall within the granite field just near that of quartz monzonite (Fig. 8).

Quartz in the most common varieties occurs as large anhedral grains (2x1.2 mm) interlocking with the other components particularly the feldspars (Fig. 9a). In certain cases, particularly closer to the core of the mass, it takes a graphic to micrographic form against the background alkali feldspar in which it is embedded and occasional quartz crystals with characteristic hexagonal cross-sections have been observed in some slides.

Plagioclase (An_{24-35}) forms the major component in most of the examined samples. It occurs as long tabular crystals bounded often with well-defined crystal faces against the anhedral quartz defining a hypidiomorphic granular texture. In size, the plagioclase crystals vary much and a length range between 3.0- and 5.0 mm is measured. Always, the feldspar is zoned and zonation is better defined by the varying degrees of alteration in the successive zones (Fig. 9b).

Alkali feldspars are highly variable both in type and in amount in the various samples examined. Although orthoclase appears as the most common alkali feldspar in many of the samples, but sodiopotassic microcline perthite is quite common in several others. It is not uncommon also to observe large crystals of one of the alkali feldspars embaying smaller subhedral fresh crystals of the same, or of another feldspar type. Graphic relationships with quartz have been early mentioned, and all these features are sounding mineralogical evidences of instability and complex history of formation.

Biotite is the most important mafic silicate in all the examined samples. It forms roughly ovaloid nests of randomly distributed flakes often associated with oxides, chlorite and sphene with or without hornblende. This mode of occurrence is perhaps suggestive that these ferromagnesian rich nests are the nebulitic remains of some pre-existing mafic xenoliths. Biotite, however. may also form discrete crystals within, or along the borders of the large feldspar

Table 1: Modal analysis of Abu Hammam granitoids and the included xenoliths.

Rock type	Serial No.	Plagioclase	Alkali Feldspar	Quartz	Hornblende	Biotite	Accessorics	Ratio % Plagioclase	Ratio % A.feldspar	Ratio % Guartz
Abu Hammam Granitoid Rocks	1	37.07	34.30	21.04	-	5.93	1.66	40.11	37.12	22.77
	2	36.23	32.06	27.18	0.42	2.99	1.12	37.95	33.58	28.47
	3	38.19	32.72	23.02	1.11	4.28	0.68	40.66	34.83	24.51
	4	35.77	32.05	21.16	-	11.02	-	40.20	36.02	23.78
	5	40.06	32.00	22.27	0.52	2.17	2.98	42.47	33.92	23.61
	6	36.15	31.51	24.06	0.98	6.27	1.03	39.42	34.35	26.23
	7	37.80	38.04	20.82	-	2.98	0.36	39.11	39.35	21.54
The central Granitoid mass	8	37.23	38.89	22.11	-	1.65	0.12	37.65	39.37	22.98
Amphibolitic Xenoliths	9	46.18	4.86	5.89	41.06	-	2.01	81.12	8.53	10.35
	10	44.96	4.50	3.06	46.12	-	1.36	85.60	8.57	5.83
	11	49.52	4.10	3.96	35.26	4.12	3.04	86.00	7.12	6.88
	12	50.13	2.56	3.39	43.05	-	0.96	89.54	4.57	5.89

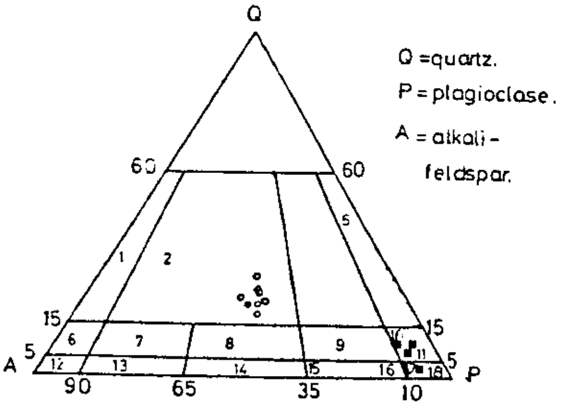

Fig. 8: Triangular diagram showing the modal composition of the granitic rocks (Streckeisen ,1967).
1) alkali granite; 2) granite; 3) granodiorite
4) monzotonalite; 5) tonalite; 6) quartz alkali granite
7) quartz syenite; 8) quartz monzonite; 9) quartz monzodiorite; 10) quartz gabbro; 11) quartz diorite
12) alkali syenite ; 13) syenite; 14) monzonite
15) monzo diorite; 16) monzo gabbro; 17) diorite and
18) gabbro.

Symboles:
o Abu Hammam granitoid rocks,
• The central granitoid mass and
■ Amphibolitic xenoliths.

crystals, and in this case its formation as a primary magmatic constituent cannot be safely-discarded.

Hornblende, when found, is either restricted to the above mentioned ferromagnesian-rich nests or as discrete crystals in a poikilitical relationship with the feldspars. In the first case it is always a greenish tremolitic variety that may be intimately integrown with chlorite, biotite and sphene (Fig. 9 c); but in the second case it is a common greenish brown hornblende variety.

Muscovite and sericite are common as small laths and the sericitization process is frequently accomponied with ubiquitous kaolinization imparting for the potash feldspars a cloudy appearance.

(b) The central porphyritic granitoid mass:

This mass appears to be formed of the same mineralogical composition as the main mass except for chlorite and amphibole which are completely absent. Besides, the effects of the late dueteric alteration as saussuritization, kaolinization, and sericitization are less prominent. Alkali feldspar, with micro-perthitic bands, seem also to be the common feldspar type in these rocks. Other important microscopic variations are the textural relationships prevailing and the relative impoverishment in mafic components which imparting to this granite a lecuocratic nature. Porphyritic textures are characteristic in this granite type but graphic textures are not also uncommon. The matrix phase is visibly granular quartz and feldspars with some small greenish biotite flakes. Within this matrix large porphyritic feldspar crystals (1.8x1 mm.) are fluxionally disposed (Fig. 9d).

(c) Xenolithic Rocks:

Attention has been made in the present context to the mafic xenoliths with large porphyroblasts of feldspars or mafics. Practically all the examined four xenolithic samples are hornblende-plagioclase rocks (fall closed to the P corner of Fig. 8) for which the ponderous term " amphibolite" can be used. As regards matrix, it is usually medium-grained and Feldspar have a slight perponderance above amphiboles (Table 1). Texture is typically hypidiomorphic granular. Plagioclase (An_{28-39}) is the more abundant feldspar in the matrix phase but interstitial orthoclase is quite common. The first of these minerals is always subhedral and may be polikically enclosed in the latter which is always anhedral. Common hornblende, mostly twinned on (100), exists as euhdral moderate-sized crystals often enclosing primary granules of magnetite (Fig. 10a).

Quartz, apatite, and sphene are commenly found in very subordinate amounts. Both of feldspars and amphibole constitute large porphyroblasts in the previous matrix. The microscopic evidence suggests that these 1 cm. long porphyroblasts (Fig. 10.b) have grown in situ within the modified host. The inter-relationships with the surrounding matrix minerals convey the impression that the growing porphyroblasts have crowded aside the surrounding minerals or have embayed some of them, partly or wholley, displaying thus a diablastic texture. The latter is characteristic among the amphibols and in the feldspars it is quite common to observe minute quartz grains embaying the core zones of earlier feldspares. In, at least two cases, the outer plagioclase zones of the porphyroblasts are seem to be made of labradorite (An_{56}) enclosing inner andesine (An_{39}) zones. This inverted zonation pattern, with calcic borders and more sodic cores, is completely contrary to normal magmatic zonation and can only be explained as due to metasomatic " in situ " growth.

(d) The Dyke Rocks:

Four important types of dykes have been microscopically distinguished. These include: microdiorites, andesites, micro-granites, and granophyres.

Microdiorites are fine-to medium-grained feldspar-amphibole rocks with or without minor quartz and/or biotite, the textures may be aphyric or porphyritic. Some of the latter are over saturated and quartz is intergrown with alkali feldspars displaying a graphic texture. Within these, hornblende and plagioclase (An_{27-34}) form the phenocrystic phase, and the rock is thus a"markfieldite". The feldspars in these microdioritic rocks are mostly altered and red-stained and have a general syenitic aspect. The amphibole occurs as aggregates of small crystals often masked with a reddish tent. The larger porphyritic amphiboles, however are rather fresh but with corroded borders (Fig. 10. c).

Andesites are much similar in mineralogical composit--ion to microdiorites but the ground mass is markedly finer. So, little is required by way of discription of the minerals of which it is composed.

Microgranites are of the porphyritic type and are very similar to the central core of the main mass in mineralogical composition. The phenocrysts, notably feldspars, are euhedral and plane-faces and are quite often zoned palgioclase. Alkali feldspar phenocrysts are rare and belong to the orthoclase perthite type. Biotite is the sole mafic component in the examined rocks and is common both in the matrix and phenocrystic phases. The matrix consists of microcrystalline granular mosaic of nearly all the previous minerals.

Granophyres are mineralogically equivelent to the previous microgranites but micrographic and spherulitic textures are characteristic (Fig.10.d).

Petrochemistry

Table 2 presents twelve new analyses for the granitoid rocks of Abu Hammam area. The majority (10) of these analyses are of alkaline granites on Wrights, [19] alkalinity diagram (Fig. 11), only two analyses plot in the calc-alkaline field. This alkalic tendency on Wright's diagram seems to be consistent with the younger granitoid suite of Egypt rather than being a chemical characteristic of the old "grey" granitoid suite [7]

Figure 12 is a standard AFM triangular digram which illustrates that the Abu Hammam granitoids are concentrated near the A corner of the traingle rather than attaining a typical calc-alkaline trend. The AFM diagram substantiates then the above interpretation.

Normative compositions of the analyzed rocks are inclined also to strengthen the previous results as can be clearly depicted from the An-Or-Ab diagrams Figs. 13, 14.and 15). Based on Oconnor's [9] classification, the low normative anorthite and relatively high albite contents rank these rocks in the granite field very close to the

Table 2 : Chemical analyses and CIPW normative composition of Abu Hammam granitoid rocks

Serial No.	1	2	3*	4	5	6	7	8	9	10	11	12
Sample No.	2A	6A	7	9A	10	12	18	20A	21	22	23	25
SiO_2	71.23	72.00	73.92	71.55	71.70	71.05	71.18	71.50	68.62	70.11	70.11	70.02
Al_2O_3	14.03	13.90	13.20	13.50	14.03	13.80	14.03	13.50	13.80	14.20	14.03	14.18
Fe_2O_3	1.70	1.50	0.70	1.31	0.73	1.80	1.57	1.24	2.02	1.80	1.71	1.65
FeO	1.06	0.65	0.42	0.85	1.52	0.75	0.32	0.75	0.75	0.64	0.64	0.58
MnO	0.01	0.018	0.01	0.013	0.015	0.02	0.017	0.015	0.014	0.014	0.011	0.017
MgO	0.64	0.37	0.47	0.49	0.54	0.28	0.65	0.81	1.28	1.07	1.07	0.92
CaO	1.10	1.22	1.25	1.45	1.45	1.50	1.40	1.42	1.77	1.81	1.81	1.40
Na_2O	4.70	4.60	4.10	4.60	4.50	4.60	4.70	4.50	4.88	4.00	4.33	4.65
K_2O	4.00	3.80	4.10	3.76	3.95	3.73	3.80	4.05	4.00	3.60	3.65	3.81
TiO_2	0.18	0.19	0.13	0.15	0.155	0.165	0.145	0.13	0.14	0.145	0.155	0.12
P_2O_5	0.07	0.07	0.07	0.09	0.08	0.14	0.09	0.07	0.25	0.16	0.09	0.12
H_2O^-	0.48	0.43	0.49	0.86	0.28	0.36	0.30	0.42	0.30	0.48	0.59	0.36
H_2O^+	0.54	1.00	0.72	1.10	0.90	1.50	1.66	1.33	1.83	1.85	1.63	2.01
Total	99.74	99.74	99.61	99.72	99.85	99.70	99.86	99.74	99.65	99.88	99.83	99.84
Weight norms:												
Qz	23.67	26.21	29.48	25.55	24.28	25.54	24.40	24.57	19.50	26.83	24.59	23.19
Or	24.10	23.00	24.80	22.85	23.75	22.75	23.05	24.55	24.30	22.05	22.25	23.20
Ab	43.05	42.35	37.65	42.55	41.10	42.65	43.30	41.45	45.05	37.20	40.10	43.00
An	5.05	5.70	5.65	5.23	6.53	6.18	6.13	4.78	4.05	8.20	8.35	6.30
C	0.17	0.20	-	-	-	-	-	-	-	0.93	-	0.19
ap	0.16	0.16	0.16	0.19	0.16	0.29	0.19	0.16	0.53	0.35	0.19	0.27
il	0.26	0.28	0.18	0.22	0.22	0.24	0.20	0.18	0.20	0.20	0.22	0.18
mt	0.90	0.81	0.38	0.71	0.39	0.98	0.48	0.66	1.08	1.01	0.93	0.89
wo	-	-	0.14	0.62	0.10	0.24	0.16	0.76	1.34	-	0.12	-
en	1.80	1.04	1.32	1.40	1.52	0.80	1.84	2.30	3.64	3.06	3.04	2.62
fs	0.84	0.26	0.24	0.68	1.94	0.34	-	0.60	0.30	0.16	0.20	0.16
Ht	-	-	-	-	-	-	0.24	-	-	-	-	-
An/Or Ratio	0.21	0.25	0.23	0.23	0.27	0.27	0.27	0.19	0.17	0.37	0.38	0.27
Alkalinity Ratio	0.57	0.54	0.56	0.55	0.53	0.53	0.56	0.57	0.56	0.45	0.48	0.53
K_2O/Na_2O Ratio	0.85	0.83	1.00	0.82	0.88	0.81	0.81	0.90	0.82	0.90	0.84	0.82
$Fe^{(t)}O/Fe^{(t)}O+MgO$ Ratio	0.80	0.84	0.69	0.81	0.80	0.89	0.72	0.70	0.67	0.68	0.67	0.69

* Sample represents the central porphyritic granitoid mass.

granite-trondhjemite boundary (Fig. 13). Likewise, their low normative An/Or ratios swinging around 0.30 have rendered them to cluster preferentially in the monzogranite and to a lesser extent in the syenogranite fields of Streckeisen [16] (Fig. 14). On petrogenetic bases other field occupied by these rocks close to the isobaris univariant curve in figure 15 is suggestive for a crystal-liquid equilibrium mechanism [8].

A magmatic crystallization mechanism is also favoured on the Qz-Ab-Or diagram (Fig. 16). The majority of the analyses cluster close to the centre of the field of magmatic granites of Tuttle and Bowen [17]. Figure 17 shows the plots gathering close to the minimum melting point at low to moderate water vapour pressure. This may indicate selective melting followed by crystallization at low to moderats water-vapour pressures [3].

Genesis of the Abu Hammam granites by partial melting of the crust seems very possible. Figure 18 presents an additive confirmation to this idea. All the analyses lie close to the a side of the a.b minimum melting curve of Presnal and Bateman [11]. Their localization further away of the low crust compositional (LC) precludes the significant involvement of the latter in the genesis of these rocks.

If this interpretation is broadly correct, the field occupied by the granitoid analyses on the AFM diagram(Fig. 12) and its marked closeness to the AF side of the diagram is perhaps indicative of emplacement under possible extensional regiems. Following Petro et al. [10], granites emplaced under compressional conditions scatter in an elongated field that is nearly perpendicular to the FM side of the AFM triangle.

SUMMARY AND CONCLUSIONS

The bulk of the Abu Hammam granitoid mass is a massive unfoliated biotite-hornblende granite forming a low-land xenolithic massif simulating much in the field the old batholithic granodiorite-diorite complex. The thorough field investigation however revealed that the mass attains cross-cutting relationships with the surrounding host rocks although evidence of shouldering aside of these rocks is lacking. However, the contact zones are characterized by the presence of large angular xenoliths suggesting that rupture had preceeded, or had accompanied, the emplacement of this granitoid mass.

Petrographically, the rocks are rather fresh and primary minerals of andesine plagioclase, perthite, orthoclase and biotite are often incompletely replaced by secondary calcite, epidote, chlorite and sericite. The minor hematitization, kaolinization and sericitization of the feldspars, sphenitization of the oxides and the subordinate chloritization of the biotite can, however, be attributed to the effect of hydrothermal alteration. It can be assumed, then that elemented mobility accompanying these alterations is very restricted. Mafic constituents are of minor importance (<10%) and are more important in the border zones of the mass where they cluster in nests of amphibole, biotite, oxides and sphene suggestive of being xenolithic versions at arrested stages of digestion.

Chemically, the rocks contain 68-74% SiO_2 (Table 2) and some of them contain modest normative corundum (<1%). The K_2O/Na_2O ratio is generally 1 or <1 and the $FeO^{(t)}/FeO^{(t)}+MgO)$ ratio for most samples is < 0.8 characteristic of post-tectonic suites [1]. The TiO_2 content is low (<0.2%) reflecting the subordinate importance of mafics and excluding their classification as I-type granites [7]. P_2O_2 is conspicuously low (0.07-0.25 ; average = 0.10) arguing against formation by crystal anatexis [18] unless if the lower crustal source contained much less P_2O_5 than would otherwise be expected as suggested by Stern and Gottfried [14].

The above data and the other conclusions obtained during the present study can be summarized as follows:

1. The Abu Hammam mass is a post-tectonic biotite two-feldspar granite ranked as monzogranite with subordinate syenogranite varieties on [11] diagram.

2. It is a Ti-poor Alkali-rich granite with alkalic tendencies on Wright's [19] diagram- a character that allows to classify it as a " younger " granite pluton (Bassiony et al. [2] in press; Hussien et al., [7], p. 193).
3. The chemical analyses of the granites gather in a restricted field close to the (A) corner of the AFM diagram and as such probably manifest an extensional tectonic setting.
4. Magmatic crystallization, perhaphs by selective melting followed by crystallization, at low water-vapour pressures is favoured on Qz-Ab-Or and An-Ab-Or diagrams.
5. Although plagioclase, alkali feldspar and quartz are predominant (Normative Ab + An + Or + Qz = 92.3 - 97.6%); anatexis in lower crustal regime is not favoured on account of the low P_2O_5 content,(Watson and Capobianco, [18]).

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FIGURE CAPTIONS

Fig. 2: Urf Abu Hammam quartz vein standing out as a weathering-resistent land mark in the low lying Abu Hammam granitoid mass. looking south. Fig. 3: Spheroidal weathering and jointing as viewed in one of the small islets constituting the Abu Hammam granitoid mass.

Fig. 4: A view showing a knife-sharp contact between Abu Hammam granitoids in the foreground and the metavolcanics in the background . Looking north.

Fig. 5: A tectonically reworked large-sized mafic xenolith with knife-sharp and angular contacts, net-veined with granitic material. Few meters from the eastern periphery of the granitoid mass, looking east.

Fig. 6: A close-view showing a subrounded xenolith at an arrested stage of alteration as suggested by the concentric colour zonation. The eastern part of the mass, some 2kms from the contact. Fig.7: A near view showing the newly-formed feldspar porphyroblasts developed along the peripheries of one of the mafic xenoliths imparting to it a distinct porphyritic texture. The south-eastern side of the mass, some 300 m. away from the contact.

Fig. 9a-d: Four microphotographs for the Abu Hammam granitoids representing both the main mass (a,b& c) and its micrographic central core (d): (a) Photomicrograph showing a nested aggregate of biotite "B" and opaques set in a quartz "Qz" -plagioclass "P" matrix (O.L. x 35). (b) Photomicrograph showing a nest of well-wedged sphene and opaques surrounded by oscillatory zoned plagioclase laths (O.L., x 35). (c) Photomicrograph showing a four-sided ferromagnesian-rich nest composed mainly of tremolitic amphibole enclosing biotite, iron oxide and zircon (O.L., x 60). (d) Photomicrograph showing the characteristic micrographic texture displayed by the central core of Abu Hammam mass. Intergrown quartz and feldspar form the main field observed (C.N., x 60).

Fig. 10-(a&b): (a) Photomicrograph of amphibolitic xenolith in which plagioclase and amphiboles (simple twinned and sieved) adjoin each other to give a network in which biotite is lodged imparting to the rock a pseudodoleritic texture (C.N. x 35). (b) Photomicrograph of amphibolitic xenolith showing a part of a large plagioclase porphyroblast crowding aside the groundmass composed mainly of plagioclase and hornblende, minor sphene, iron oxide, chlorite and quartz (C.N. x 22).

Fig. 10 (c&d): (c): Photomicrograph of a microdiorite dyke. The phenocrystic phase is represented mainly by plagioclase and hornblende, and is set in a fine-grianed matrix of the same minerals

(C.N. x 60). (d): Photomicrograph of a granophyre dyke showing a characterstic micrographic and spherulitic textures. The euhedral crystals enclosed in the sphereoles are feldspars (C.N. x 22).

Fig. 11: Alkalinity variation diagram of Wright (1969).

Fig. 12: AFM diagram for the granites. Curves show trend proposed by Petro et al., 1979 for compressional suites

Fig.13 : Normative feldspar ratios (after O'connor, 1965).

Fig.14: Quartz-feldspar rocks (After Strakeisen, 1976). [2a- Alkali granite, alkali rhyolite, 2b- Alkali feldspar granite, rhyolite, 3a- (Syeno-) Granite, rhyolite, 3b- (Monzo-) Granite, rhyodacite, 4- Granodiorite, dacite, 5- Tonalite, plagidacite, Trondhjemite].

Fig. 15: Normative Or, Ab and An proportions for the investigated granitic rocks. The solid line represents the two feldspar boundary curve for the quartz saturated ternary feldspar system at 1,000 bars water-vapour pressure (after James and Hamilton, 1972);

Fig. 16: Contoured Triangular diagram showing the distribution of normative Ab-Or-Qz in all analysed rocks (1269) in Washington's tables containing 80% or more Ab+Or+Qz. (After Tuttle and Bown, 1958, p. 128.

Fig. 17:Normative Qz , Or and Ab proportions

for the investigated granitic rocks. The solid line represents the variation in position of the minimum melting points in the granite system at water-vapour pressures from 500 to 10,000 bars (after Tuttle and Bowen, 1958); Fig. 18: Normative proportions of Ab, An and Or for the investigated granites. Minimum melting curve (a-b) and assumed lower crust composition (LC) of Presnall and Bateman (1973) are shown.

Fig. 1: Photogeological map of Abu Hammam granitic mass (made with the guidance of the geological map of Aswan Quadrangle, Geological Survey of Egypt, with some modifications).

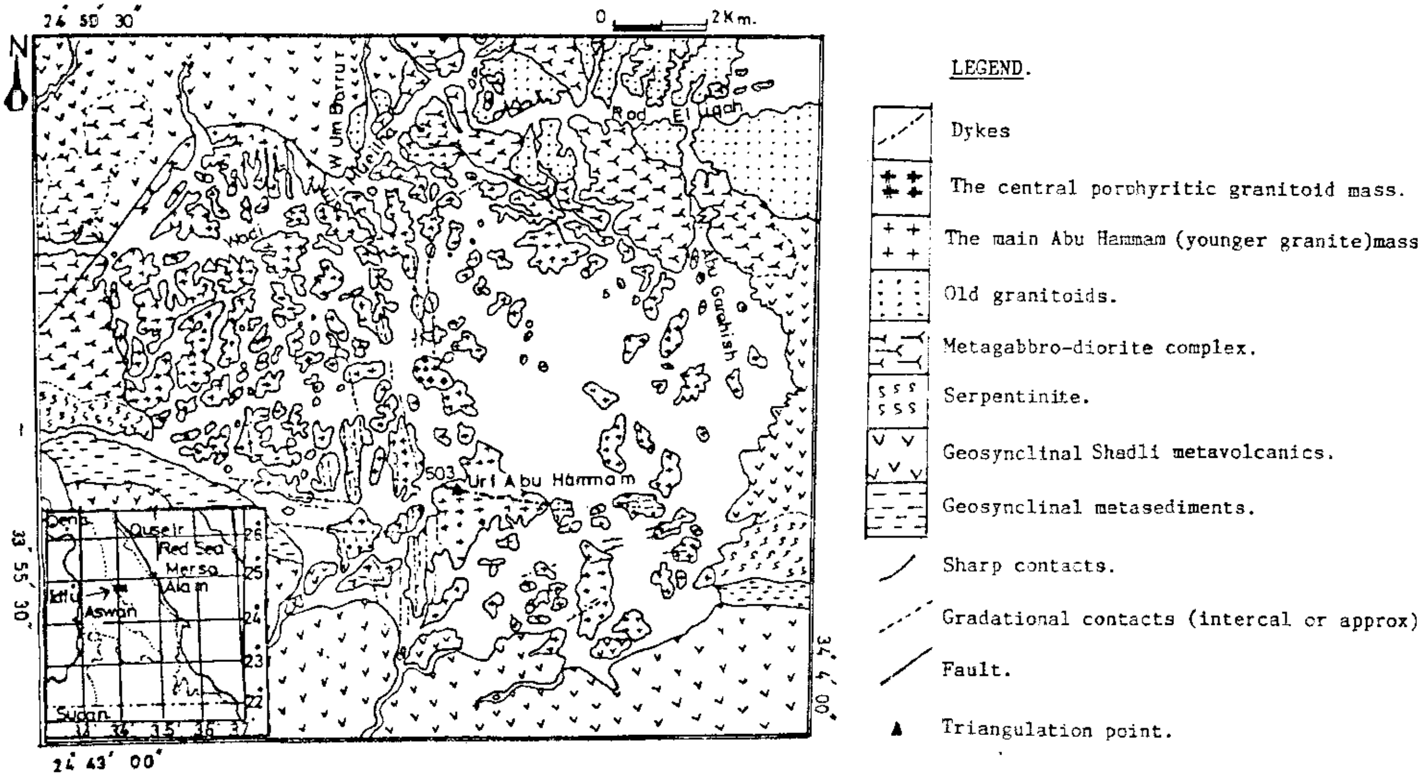


Fig. 2

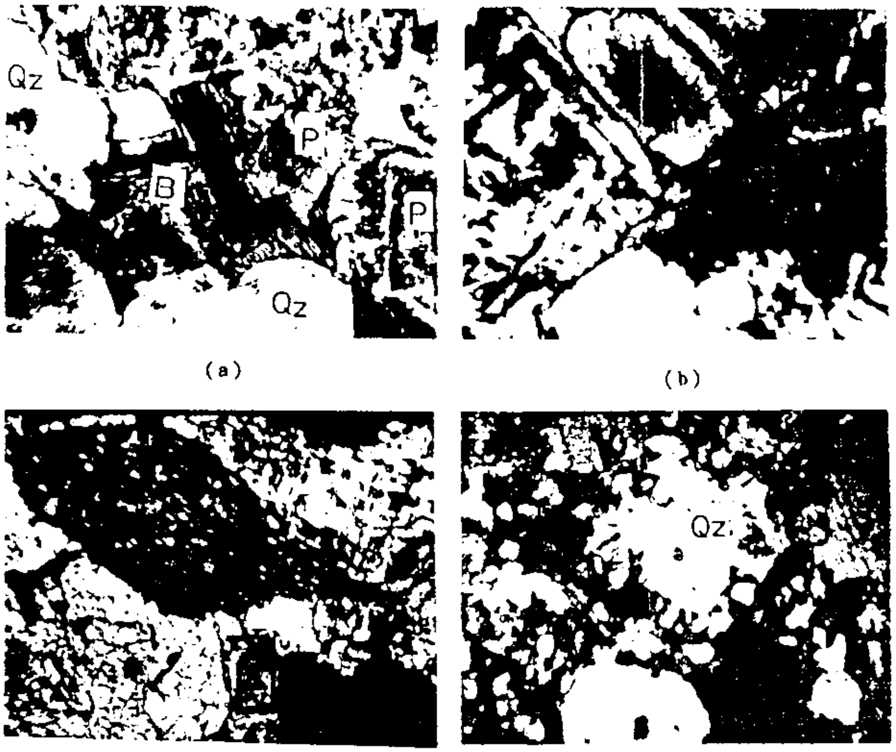
Fig. 3

Fig. 4

Fig. 5

Fig. 6

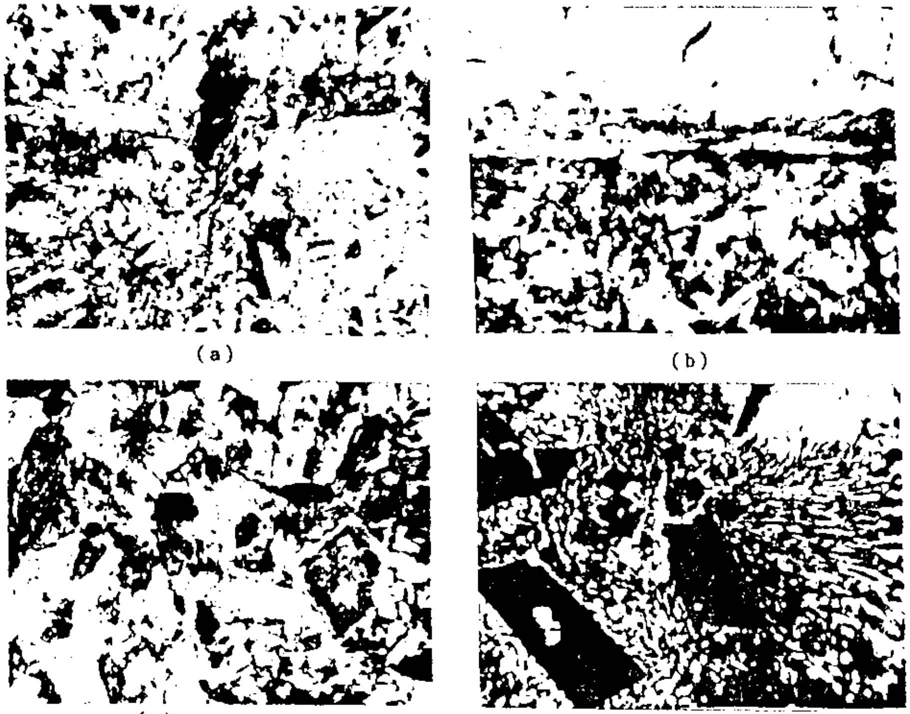
Fig. 7



(a) (b)

(c) (d)

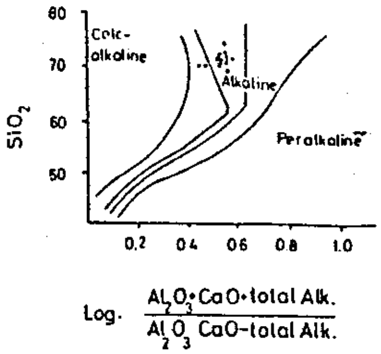
Fig. 9



(a) (b)

(c)

Fig. 10 (d)



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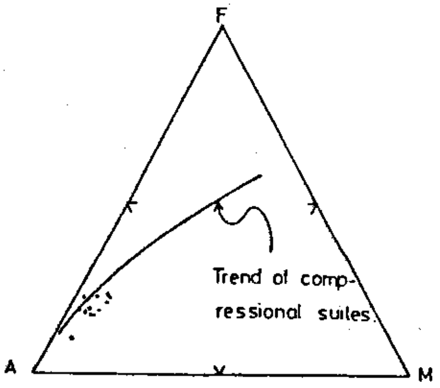

Fig. (12)

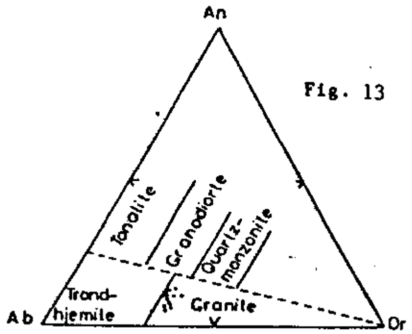

Fig. 13

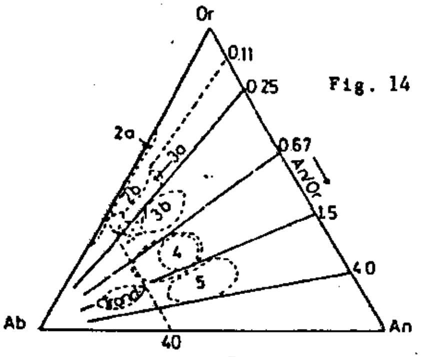

Fig. 14

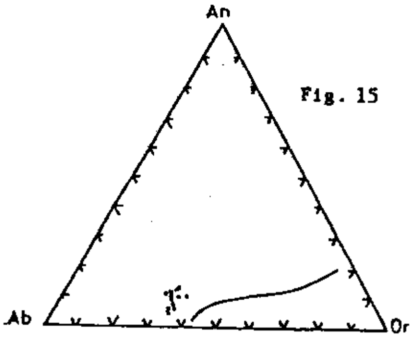

Fig. 15

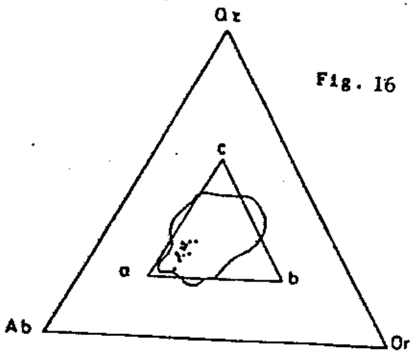

Fig. 16

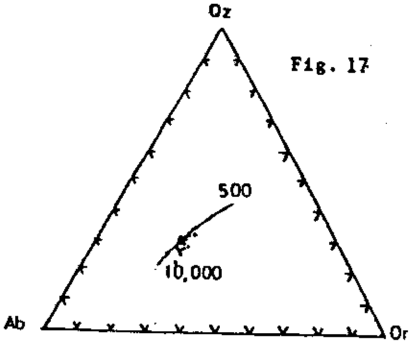

Fig. 17

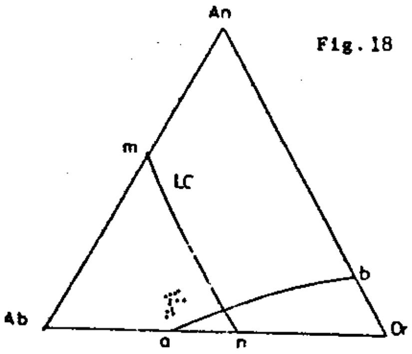

Fig. 18

اضافه جديدة لجيولوجيه وبترو كيميائيه كتله جرانيت ابو حمام

جنوب الصحراء الشرقيه · مصـــر

محمود غزالى ، وفاء الدين بسيونى ، منير محمد على

يقدم هذا البحث دراسه حقليه وبتروجرافيه وبتروكيميائيه جديدة ومستفيضه لكتلة جرانيت ابو حمام والتى تغطى مساحه تصل الى ١٤٠كم٢ من المعقده القاعيه للصحراء الشرقيه ·

وبالرغم من ان الشواهد الحقليه لهذه الكتلة الجرانيتيه الكبيرة والتى تتمثل فى انتشار الجرانيت على هيئه جزر منخفضه الارضيه وسط بحر من الرمال وما يميزها من تعريه كتليه وتغير فى اللون وانتشار المكتنفات الدخيلة Xenoliths خاصة على الحافه الخارجيه لتلك الكتله· بالرغم من تلك الشواهد التى قد تشير فى مدلولها الى انتماء هذا الجرانيت الى مجموعة الجرانيت القديمة "Old Granite" · فقد اثبتت الدراسة ان جرانيت ابو حمام له صفه التداخل فى الصخور المحيطه وانه مجماوى النشأة يغلب علـــى تركيبه المنزوجرانيت وانه من توغ "A-Type" الجرانيت الحديث الذى ينتشر فى الصحراء الشرقيه · هذا وتشير نسب التيتانيوم والفوسفور TiO_2 & P_2O_5 وكذلك نسب K_2O/Na_2O & $FeO^{(t)} / FeO^{(t)} + MgO$ الى ان هذه الكتله الجرانيتيه قد تداخلت فى منطقه اتساع Extensional Regime فى مرحله تاليه لعمليات التشوه Post -tectonic وتحت ضغط منخفض ·