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GEOLOGY

GEOLOGICAL STUDY OF EL-ESH GRANITIC PLUTON TO ELUCIDATE THE SUITABILITY OF ITS PLACER FELDSPARS FOR CERAMIC INDUSTRY IN EGYPT

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Abstract: The two mica syenogranites of Gabal El Esh being emplaced into Dokhan volcanics. These leucogranites are peraluminous in composition, Fe-rich sub-alkaline with low contents of Ba and high contents of Rb and K_2O. These facts substantiate the geochemical characteristics of S-type granites. They contain both orthoclase perthites and plagioclase; thus, they can be classified as subsolvus granites. Placer feldspars are the youngest unit in the area and represented by surficial cover in the main dry wadis and their tributaries.

Placer feldspars can be used as a new material for ceramics and sanitary wares. It is naturally occurring blend of feldspars and quartz resulting from the erosion of particular kind of granitic rock characterized by low quartz to feldspar ratio ($\pm$1 free quartz to 1- 4 free feldspars). The studied placer feldspars were found to have good grinding ability that more than 75% of the charge were found over than 300 μm and less than 500 μm., the dust is less than 0.5%. These results are the required grain size with a release of both Na^+ and K^+ in the solution which, in turn, enhance the rheological properties of the ceramic slip. The results of the physical tests illustrated by water absorption %, shrinkage and bending strength beside their good resist for thermal shock and crazing suggest that the feldspars of the studied area can be used for only wall ceramic industry due to their high content of water absorption %.

Introduction:

The granitoid rocks of the Egyptian Eastern Desert are mainly of Pan African age. They are classified into older (synorogenic) and younger (late to post orogenic) granites. Most of the late orogenic younger granites are two mica, K -enriched, calc-alkaline to midly alkaline rocks (Ragab, 1991). Placer feldspars are naturally occurring from the erosion of particular kind of granitic rocks that are an important glaze raw material in ceramic industries (Singer, 2001). Placer feldspars can be used as a new flux material for ceramics and sanitary wares.

This work is a contribution to the understanding of petrology of one of two mica granitic pluton in the Eastern Desert as well as the suitability of its placer feldspars for ceramic industry in Egypt.

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GEOLOGIC SETTING

Gabal El Esh area lies between latitudes 27° 26` and 27° 34` N and longitudes 33° 30` and 33° 36` E covering about 107 km^2 (Fig. 1). The area lies 37 km to the north of Hurghada city. The basement rocks, of Pre-cambrian age, cropping out

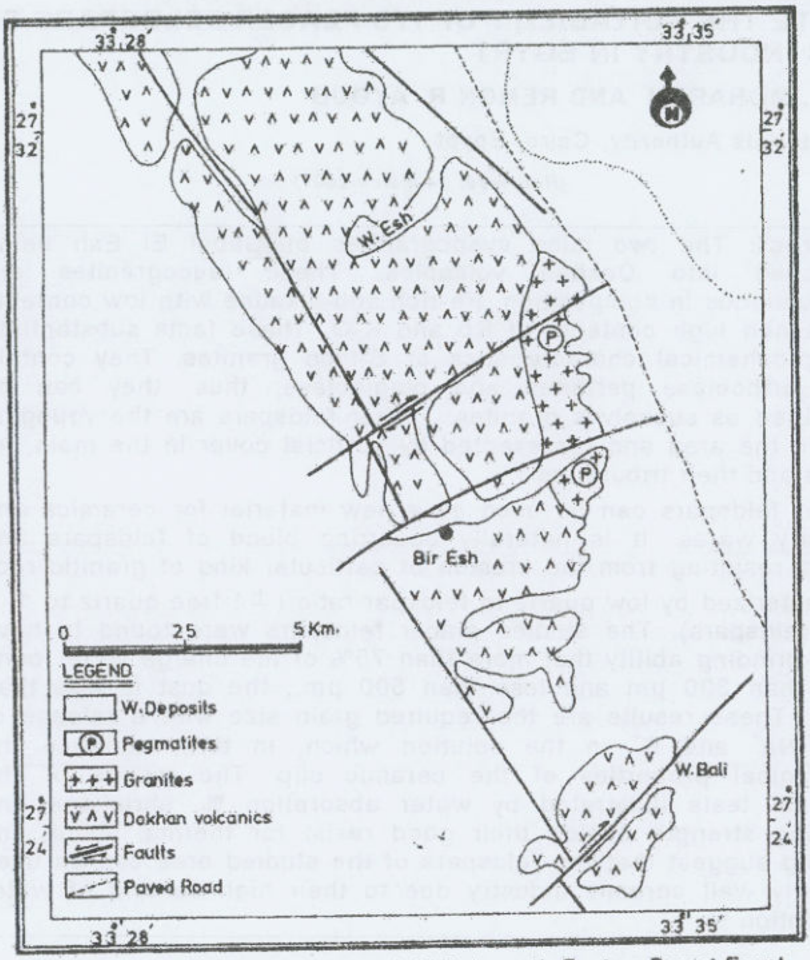


Fig.(1): Geoloical map of Gabal El Esh, north Eastern Desert, Egypt.

in the studied area include: (1) Dokhan volcanics (oldest) and (2) younger granites (youngest). These rocks are mostly invaded by numerous dyke swarms of various shape and composition. Pegmatites are very rare. Few patches of Miocene sediments plastered on some parts of the eastern flank of the area. The gamma radioactivity of different rock units in the studied area are of specific normal type. The area under investigation is highly tectonized and dissected by fractures and faults. The majority of these faults are accompanied by shear zones representing areas of localized deformation. The main fault sets recorded in the area are of strike separation and are trending NNW-SSE, NW-SE and NE-SW (Fig. 2a). El-Kholy (1996) concluded that the NW-SE is the oldest, while NNW-SSE fault set is the youngest one. Normal faults are mainly recorded in the Miocene sedimentary rocks.

Dokhan volcanics in the study area are mainly represented by andesites. They crop-out as hills possessing moderate peaks at the west and northern parts of the area. Generally, the colour of the Dokhan volcanics is grey of different shades. Some of the porphyritic andesite shows primary flow structure due to liner orientation of plagioclase phenocrysts. The Dokhan volcanics are intruded by younger granites that are represented by large apophyses and several offshoots. The Dokhan volcanics are jointed in various strike directions. The most common directions of these joints are, in decreasing order of predominance, NNW-SSE, NE-SW and WNW-ESE (Fig. 2b). The main exposures of younger granitic rocks in the El-Esh area are located in the eastern bank of the area as small elevated masses. The granites along the contact with Dokhan volcanics are strongly hematitized and silicified. They are invaded by basic dykes striking NE-SW directions. Younger granites are jointed in various trends. The main trends are, in decreasing order of predominance, NW-SE, NNE-SSW and ENE-WSW (Fig. 2c).

Placer feldspars are the youngest unit in the area and represented by surficial cover in the main dry wadis and their tributaries. They composed of loose sands, gravels, pebbles, cobbles and boulders. The finer fragments occupy the central course of the wadis and their lower reaches, while the coarser ones are found at the foot-hills and at the heads of the wadis. Placer feldspars are also represented in the study area by small scattered patches of sands, gravels and pebbles covering small part of the studied granites exposed in the extreme southeastern border of the mapped area. They extend for many hundred meters away from the mountain front. They are thickest at the point of origin and thin in a down stream direction.

Methodology

The mineralogical and chemical analyses were carried out in the laboratories of Analyses Department in Nuclear Materials Authority of Egypt (N.M.A). The rapid method of silicate analysis as reported by Shapiro and Brannock (1962) was used for the analysis of the major oxides. The trace elements were determined by using the X-ray fluorescence technique (XRF). The mechanical and physical tests for placer feldspars were carried out in the laboratories of Ceramica Cleopatra Group Company.

Petrography

The studied younger granite could be texturally classified as perthitic leucogranite. It is medium- to coarse-grained, hypidiomorphic, possessing subhedral to euhedral crystal faces. It is mainly composed of perthites, quartz, plagioclase, biotite and muscovite as essential minerals, while zircon, sphene and apatite are the accessory minerals. Iron oxides, fluorite, epidote and muscovite are found as secondary minerals. Accordingly, the studied younger granites is considered as two mica granite (biotite and muscovite). The cracks and fractures are usually filled with quartz, muscovite, iron oxides and epidote. Figure (2 d) shows the modal analyses according to modal classification of Streckeisen (1976).

The studied younger granites were plotted within the syenogranite field. Feldspars represent more than 63% of the mineral composition of the studied granites. Batres (2006) suggested that the suitability of granitoid rocks for ceramic industries depend on the mineralogical composition, the feldspars must be more than 60% of mineral composition.

Perthites are commonly represented by orthoclase perthite (Fig. 3a), while microcline perthite is less dominant. Quartz is found as medium to coarse subhedral to anhedral crystals showing distinct undulatory extinction. Quartz usually contains inclusions of feldspars, apatite, epidote, zircon, muscovite and iron oxides associated with colourless small irregular crystals of fluorite (Fig. 3b). Plagioclase occurs as subhedral to euhedral tabular crystals. It is sometimes cracked and sometimes shows glide twinning, reflecting strain effects. Plagioclase are enclosed and/or corroded by perthite and quartz (Figs. 3c and d). It usually encloses muscovite, zircon, apatite and iron oxides (Figs. 3e and f). Biotite forms medium to large irregular flakes; some of their cleavage planes are kinked. Muscovite occurs as small to medium irregular flakes and /or filling the cracks or replacing feldspars and biotite. Both biotite and muscovite flakes are corroded by quartz and feldspars (Figs. 3 g and h). Several biotite and muscovite flakes show faint to dark pleochroic halos due to radiogenic effect of zircon inclusions.

Geochemistry

Twelve representative samples of fresh younger granites were chemically analyzed for major oxides and trace elements (Table 1). The studied younger granites are characterized by their relatively high silica contents with an average value of 74.89 %. They are considered as low calcium granites with an average CaO equal to 0.51%. They have high contents of Zr, Rb, Y and Nb and low contents of Ba and Sr. In general, they show wide variation in their trace elements content and narrow variation in their major oxides content. The total alkalis content (K_2O+Na_2O) is more than 7.5% suggesting a good ability for ceramic industry (Singer, 2001).

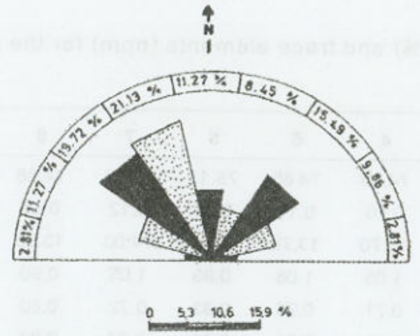


Fig. (2a): Rose diagram showing the main directional trends of faults according to their number, Gabal El-Esh area.

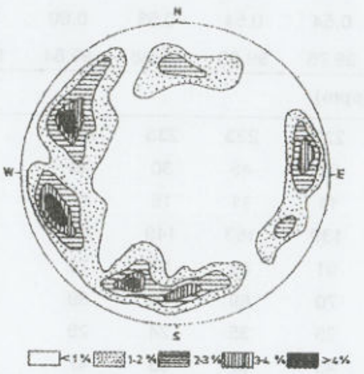


Fig. (2b): Countor diagram of joints in Dokhan volcanics, Gabal El-Esh area.

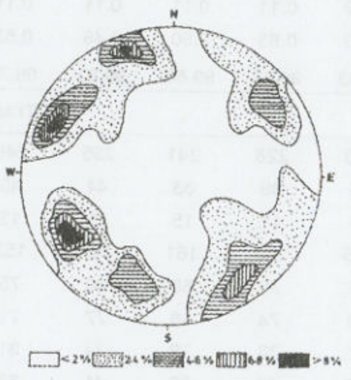
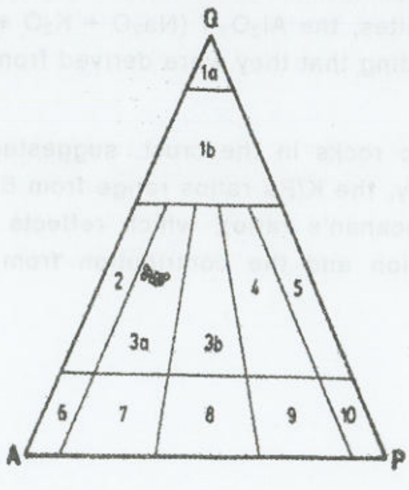


Fig. (2c): Countor diagram of joints in younger granites, Gabal El-Esh area.



(1a) Quartz rocks,
(1b) Quartz rich granitoids,
(2) Alkali granite,
(3a) Syenogranite,
(3b) Monzogranite,
(4) Granodiorite,
(5) Tonalite,
(6) Alkali syenite,
(7) Syenite,
(8) Monzonite,
(9) Monzodiorite,
(10) Diorite or Gabbro

Fig. (2d): Q - A – P ternary diagram (Streckeisen, 1976)

Table (1): Major oxides (wt%) and trace elements (ppm) for the studied younger granites of Gabal El-Esh.

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	75.00	74.68	74.80	74.85	74.65	75.12	75.09	74.88	75.00	74.86	74.78	74.91
TiO_2	0.10	0.10	0.10	0.10	0.11	0.08	0.12	0.11	0.10	0.11	0.10	0.08
Al_2O_3	14.00	14.00	14.01	13.70	13.70	14.40	14.00	13.53	14.11	14.33	13.75	13.82
Fe_2O_3	1.14	1.03	1.10	1.05	1.08	0.99	1.05	0.90	1.02	0.92	1.20	1.15
FeO	0.62	0.64	0.60	0.71	0.76	0.82	0.72	0.80	0.63	0.83	0.66	0.70
MnO	0.03	0.04	0.02	0.03	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.03
MgO	0.31	0.30	0.30	0.29	0.26	0.32	0.29	0.28	0.24	0.30	0.34	0.28
CaO	0.51	0.50	0.48	0.51	0.60	0.60	0.53	0.49	0.49	0.44	0.50	0.46
Na_2O	3.82	3.96	3.89	4.04	3.91	3.52	3.74	3.95	3.72	3.70	3.92	4.00
K_2O	3.71	3.83	3.89	3.97	4.01	3.24	3.55	4.26	3.90	3.61	3.83	3.81
P_2O_5	0.09	0.11	0.11	0.11	0.11	0.07	0.08	0.12	0.10	0.11	0.09	0.10
L.O.I.	0.50	0.63	0.50	0.46	0.53	0.61	0.54	0.54	0.53	0.60	0.67	0.56
Total	99.83	99.82	99.80	99.82	99.75	99.81	99.75	99.89	99.88	99.84	99.87	99.90
Trace elements (ppm)												
Rb	230	228	241	235	246	231	222	233	233	217	215	242
Ba	35	39	33	44	40	29	32	45	30	46	41	38
Sr	10	11	15	11	13	12	11	11	15	12	12	17
Zr	135	159	161	155	159	127	130	163	149	153	139	144
Y	95	70	80	80	75	92	91	82	82	78	80	88
Nb	80	74	66	77	71	81	70	69	75	69	77	85
Ga	27	33	29	24	31	29	25	35	24	29	30	30
Pb	30	42	36	41	36	42	45	32	33	47	43	40

Petrogenesis of the studied younger granites

Didier *et al.* (1982) take the Al_2O_3 / (Na_2O + K_2O + CaO) ratio to discriminate between crustal type granitoids (C-type) and mantle type granitoids (M-type). They suggested that C-type has ratio more than 1.1 but M-type has ratio less than 1.1. In the studied granites, the Al_2O_3 / (Na_2O + K_2O + CaO) ratio is ranging between 1.6 and 2 indicating that they were derived from crustal sialic materials.

The K/Ba ratio of granitic rocks in the crust, suggested by Bucanan (1982), is 65. In the present study, the K/Ba ratios range from 651 to 1078 for younger granites (more than Bucanan's ratio); which reflects the advanced degree of magmatic differentiation and the contribution from sialic crustal materials.

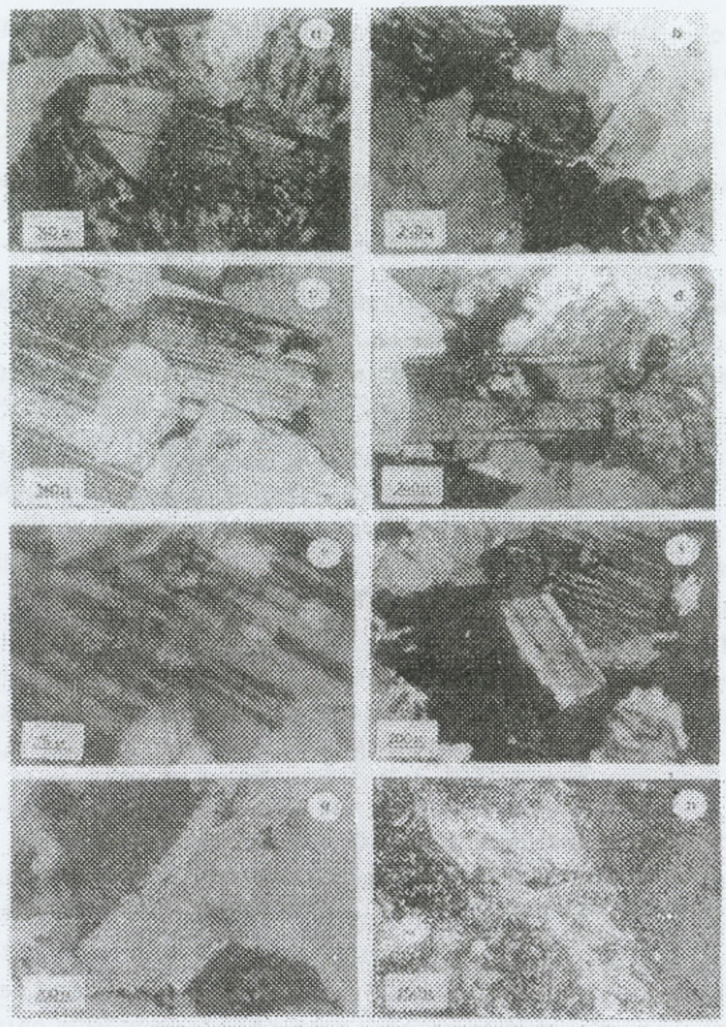


Fig. (3)

(a): Subhedral to eubhedral large tabular crystal of plagioclase corroded by quartz and perthite, the cracks are filled with iron oxides. C.N.

(b): Euhedral plagioclase crystal shows lamellar and simple twinning. It encloses poikilitically in quartz, the cracks are filled with iron oxides. C.N.

(c): Plagioclase crystals intergrowth each other and are corroded by quartz, the cracks are empty. C.N.

(d): Euhedral plagioclase crystal enclosed in orthoclase perthite, it shows selective alteration (the cores are more altered than the outer rims). C. N.

(e): Large euhedral crystals of zircon and quartz are found as inclusions in plagioclase. C. N.

(f): Iron oxides and apatite are found as inclusions in plagioclase encloses poikilitically in orthoclase perthite. C. N

(g): Large elongated flakes of muscovite corroded by cracked quartz, the cracks are filled with epidote and muscovite. C. N.

(h): Muscovite is corroded by feldspars and quartz to different degrees until some islets are completely separated and surrounded by the other silicate minerals. C.N.

Geochemical classification

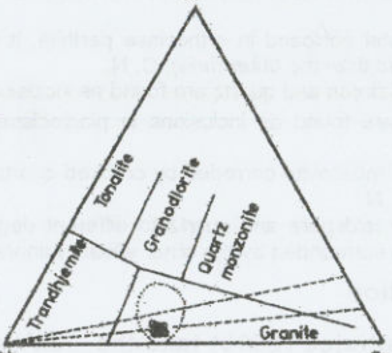
Recently, Dostal and Chatterjee (2000) take the Ga/Al ratio as a good guide for measuring the degree of differentiation in peraluminous and peralkaline granites. They suggested that the Ga/Al ratio increase from monzogranites (Ga/Al less than 0.0001) to syenogranites (0.0001<Ga/Al<0.0005) to alkali feldspars granite (0.0005<Ga/Al). The increase of the Ga/Al ratio, from monzogranites to

syenogranites to alkali feldspars granites, is due to an increase of Ga. The range of Ga/Al ratio values in the studied granites is ranging from 0.00017 to 0.00045 classifying this granite as syenogranites. On the Or - Ab - An ternary diagram (Barker, 1979), the younger granites plot in the granite field (Fig. 4a). Streckeisen (1976) used the same diagram for classification of plutonic rocks. The younger granites plot in the alkali feldspars granite and syenogranite field

Magma type

Granitoid rocks are described using Maniar and Piccoli, index in (1989) as: peraluminous (A/CNK >1), metaluminous (A/NK >1 and A/CNK <1) and peralkaline (A/NK <1) using molar ratios (A = Al_2O_3, C = CaO, N = Na_2O and K = K_2O). In the present study, all the granitic samples under study have A/CNK more than one, Then, they are classified as peraluminous granite. The molar Al2O3/ (CaO + Na_2O + K_2O) versus Rb/Sr diagram (White and Chappell, 1983) discriminates between I-type and S-type granites as well as between metaluminous and peraluminous affinities. The studied samples plot in the field of the S-type granites with peraluminous affinities (Fig. 4b). Chapman and Hall (1997) suggested that the S-type granites is characterized by the following: 1) peraluminous leucogranite, 2) collision granite (syn-collision or post collision), 3) crustal type granite (C-type), and 4) crystalized at low pressure (less than 2.5 kb). All these criteria are in complete harmony with the data of the studied granites.

On the (Al_2O_3 + CaO)/(FeOt + Na_2O + K_2O) versus 100 (MgO + FeOt + TiO_2)/ SiO_2 (Sylvester, 1989), the all samples plot in the highly fractionated calc-alkaline granite field (Fig. 4c). Sylvester (1989) suggested that, the highly fractionated calc-alkaline granite has chemical composition similar to a great extent to the alkali granites due to the high total alkali contents and depletion in the CaO content. Then, the studied granites have been formed from peraluminous calc-alkaline magma with some alkaline affinity due to decreasing of CaO% and MgO% and have reached a high degree of differentiation.



*The straight dashed line (after Streckeisen, 1976) to differentiate between monzogranite, syenogranite and alkali feldspar granite.

*The curved dashed line (after Ragab and El-Gharabawi, 1989), which represents late orogenic alkali feldspar granite field

(Fig. 4a): An - Ab – Or ternary diagram (Barker, 1979)

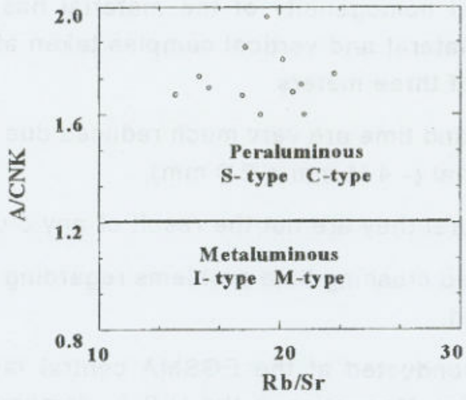
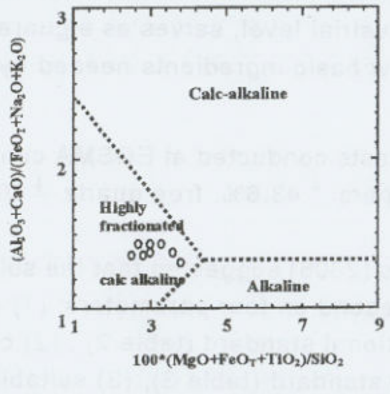


Fig. (4b): Al_2O_3/ ($CaO + Na_2O + K_2O$) versus Rb/Sr diagram (White and Chappell, 1983).



(Fig. 4c): ($Al_2O_3 + CaO$)/($FeO_t + Na_2O + K_2O$) versus 100 ($MgO + FeO_t + TiO_2$)/ SiO_2 (Sylvester, 1989).

PLACER FELDSPARS

Placer feldspars are naturally occurring from the erosion of particular kind of granitic rocks that are an important glaze raw material in ceramic industries and sanitary wares (Singer, 2001). Mobile Petroleum Service Company has recorded the occurrence of the placer feldspars and Ceramica Cleopatra Company has used these placer feldspars as a new raw material for ceramics and sanitary wares (Gouda, 2003 and 2007).

Merits of placer deposits as a new row material

In addition to the results published by the Egyptian Geological survey and Mining Authority [EGSMA] Mobile conducted its own research and evaluation of new material which confirmed EGSMA's report and proved the following results:-

1) Tests conducted at the National Research center confirmed and recommended the use of placer feldspars as a suitable replacement to or in line with conventional rock feldspars in the manufacture of ceramic tiles and sanitary wares.

2) Quality stability and homogeneity of the material has been established by across comparison of lateral and vertical samples taken at half- meter intervals from six pits to depth of three meters.

3) Crushing expenses and time are very much reduced due to the relatively small grain size of the material (- 4 ¼ mm + 2.0 mm).

4) Grain sizes are natural they are not the result of any crushing processes.

5) As a result of reduced crushing time problems regarding increased iron fillings are very much lessened.

6) Purification tests conducted at the EGSMA central laboratories and at the technical center of Eriez Magnetics in the U.S.A. demonstrated that ferric and magnetic impurities can be reduced to 0.5% lower contamination rates can also be achieved at lower flow rates.

7)The abundance of this new material in nature and Mobile's technical ability to produce it on a semi-industrial level, serves as a guarantee for a continuous and dependable supply of tow basic ingredients needed by the ceramic and sanitary wares industry.

8) Flotation separation tests conducted at EGSMA central laboratories produced high qualities free feldspars ±43.6%. free quartz ±30.9% and pure fine clay ± 19.5%.

Singer (2001) and Batres (2006) suggested that the suitability of placer feldspars for ceramic industries depend on four parameters: (1) mineralogical composition must be obey to international standard (table 2) , (2) chemical composition must be obey to international standard (table 3), (3) suitability of placers for physical parameters (water absorption less than 17 %, shrinkage less than 6.5% and bending strength over 17 nuten/cm^2), and (4) resistance to thermal shocks and crazing.

EXPERIMENTAL WORK FOR THE STUDIED PLACER FELDSPAR SAMPLES

Ten samples from placer feldspars were tested by physical and chemical tests for feldspars to report their suitability for ceramic industry. More than 50 samples were collected; from which 10 samples were chosen for chemical and physical tests. The sample weight is about 5 g. Generally, sampling is taken across five meters interval.

1-Grindability and particle size analysis

Grinding is reducing the dimensions of materials. Grinding is classified into two main types, continues and discontinues grinding. In the present work the discontinues grinding type is applied. The working cycle is divided into three steps:

A- Add about 18000 – 20000 kg of raw materials into the mill with 600 liter water in presence of silica or alubit as grinding media..

B- Grinding for about 8 hours.

C- Drying and sieving analysis

The studied feldspars were found to have good grinding ability that more than 75% of the charges were found over than 300 μ m and less than 500 μ m The dust is less than 0.5%. These results are the needed grain size with a release of both Na^+ and K^+ in the solution which, in turn, enhance the rheological properties of the ceramic slip.

2- Mineralogical test

Placer feldspars is naturally occurring blend of feldspars and quartz resulting from the erosion of particular kind of granitic rock which is characterized by low quartz to feldspars ratio ($\pm$1 free quartz to 1- 4 free feldspars). Table (2) shows the standard international mineral composition of placer deposits that was reported by Singer (2001) and the average of mineral composition for 20 placer feldspars samples from Eastern Desert of Egypt (Gouda, 2007) that were used in ceramic industry by Ceramica Cleopatra Company. The importance of this natural blend as has been proven by tests lies in it's suitability for use as replacement to or in parallel with conventional feldspars in the manufacturing of ceramic and sanitary wares. Placer feldspars exist in very large quantities locally, its abundance can easily satisfy total demand and allow for export. The comparison between the average of mineral composition of the studied placer feldspars and the mineral analyses of the international and Egyptian placer feldspars is given in table (2). These results reveal the very good suitability of the studied placer feldspars for ceramic industry due to their high content of free feldspars (more than international standard).

3-Tests for quality for placer feldspars (chemical test)

The flotation test was conducted to establish the mineralogical composition and assist in the economic feasibility of producing free high quality materials. No magnetic separation of impurities was applied in this floatation test.

Feldspars analysis differ due to technical flotation methods. According to the chemical analysis for the studied placer feldspars (Table 3), the average composition of the 10 placer feldspar samples, containing the total alkali about 8.66%, Al_2O_3 13% and SiO_2 = 75.91%. Total Fe_2O_3 about 1.04%, which indicate to a good new raw material in ceramic industry according to Singer's (2001).

4- Mechanical tests

There many tests were carried out for feldspars to adapt the quality of feldspars for ceramic industry. These tests include resistance for thermal shocks and crazing as well as physical tests (shrinkage, water absorption and bending strength). These tests were applied in biscuit sample (5x7.5 cm or 7.5x10 cm) that prepared as follow:-

1- Weight 250 g grind feldspars

2- Add 5% (12.5 g) Spanish kaolin to increasing the plasticity and not change of ceramic body.

3- Take the mixture for grinding 80 minutes and put the slap in the drier about 90 minutes at 100o C.

4- Make hand grinding with little amount of spray water.

5- Pressing the sample at 300 bar and passed to the glaze line.

6-Firing of sample at 1200-1220o C for 47 minutes.

Determination of the resistance to thermal shocks

The test is made on 25 biscuit samples for 10 cycles from 105o to 110oC at 15 – 20° C. The biscuit samples are kept in a stove for about 20 minutes at 105° to 110° C and then rapidly put in cold water (15-20° C), keep them for 15 minutes and start the cycle up again — after 10 tests examine the biscuit sample with the naked eye, identifying the defects which have arisen. The studied biscuit samples show high resistance for thermal shock.

Table (2): The average of the mineralogical composition for the studied placer feldspars compared with international standard value of placer feldspars as well as the average of 20 placer feldspar samples from Eastern Desert of Egypt.

Mineral / Placer type	Free feldspars	Free quartz	Mafics	Fine clays
Average % of 10 samples from the studied placer feldspars	45.24	29.36	7.15	18.25
Average % of international standard reported by Singer (2001)	43.60	30.30	6.64	19.46
Average % of 20 samples from Eastern Desert of Egypt (Gouda, 2007)	44.52	30.00	7.10	18.38

Table (3): The chemical analysis of the studied placer feldspars compared with data of international standard reported by Singer (2001).

Sample No.	1	2	3	4	5	6	7	8	9	10	Aver age	Range of internationa l standard
SiO_2	76.63	75.36	76.00	75.29	75.79	76.47	75.48	75.71	76.25	76.10	75.91	68 - 78
TiO_2	0.11	0.18	0.10	0.18	0.16	0.13	0.15	0.14	0.10	0.11	0.13	0 - 0.2
Al_2O_3	12.96	13.11	13.05	13.00	12.63	13.09	13.15	13.12	12.84	13.00	13.00	11 – 16
Fe_2O_3	1.02	1.15	0.99	1.16	1.17	1.00	1.11	0.95	0.88	0.99	1.04	0 – 2
MgO	0.11	0.19	0.21	0.19	0.19	0.11	0.20	0.17	0.22	0.23	0.18	0 – 1
CaO	0.75	0.83	0.87	0.83	0.83	0.61	0.83	0.92	0.79	0.90	0.81	0 – 1.5
Na_2O	3.68	4.00	3.78	4.13	4.04	3.71	3.88	3.75	3.76	3.78	3.85	2 – 5
K_2O	4.52	4.98	4.66	4.95	4.88	4.63	4.88	5.12	4.87	4.66	4.81	4 –10
L.O.I.	0.06	0.10	0.05	0.07	0.07	0.07	0.11	0.04	0.07	0.07	0.07	0 – 0.3
Total	99.84	99.90	99.71	99.80	99.76	99.82	99.80	99.92	99.78	99.84		
Trace elements (ppm)												
U	3.3	3.1	2.9	3.0	3.0	2.7	2.8	2.7	2.5	2.6	2.66	0 – 4
Th	9.8	8.8	9.0	9.2	9.1	9.0	9.0	9.0	9.0	9.1	9.10	0 - 11

Determination of the resistance to crazing

The test is subjected to exposing of biscuit samples to pressure of 5 atm (500 KPa – 159° C). The value of maximum pressure must be reached in one hour, kept for one hour and the discharged as quick as possible. After that the biscuit samples must be let to cool down for half an hour in autoclave. A colouring solution is then applied to the surface (for instance methylene blue) and let to rest for one minute. Clean with a wet cloth and check the biscuit samples surface. The studied biscuit samples show very high resistance for crazing.

Physical tests

These tests include shrinkage, water absorption and bending strength according to international standard limits (table 4). After the preparation of biscuit sample the physical tests were started by determination of water absorption over their determination of the bending strength and finally the determination of shrinkage.

I- Water absorption determination (E):

Water absorption can be determined according to the following formula

$E = (M_2 - M_1)/100M1$

Where, M_1 is the weight of the dry tile, and

M_2 is the weight of the humid tile.

II- Determination of the bending strength (B.S.):

Bending strength can be determined after the result that expressed by the formula:

$B.S = 3\ FL\ /\ 2BH^2$

Where, F is the applied bending strength (in newton).,

L is the distance between the supporting rollers (inter-axis) (in mm). ,

B is the tile width., and

H is the minimum thickness of the measured long the breaking edge (in mm).

III- Determination of shrinkage (Shr.):

Shrinkage is the rate of change in length and width for inspected sample. Shrinkage is directly proportional to the total alkali content and inversely proportional to water absorption and bending strength. It expressed by the formula:

$Shr. = (L_2 - L_{1)}\ /\ L_1$

Where, L1 is the length after ignition, and

L_2 is the length before ignition

The results of the physical tests for the studied placer feldspars illustrated by water absorption %, shrinkage and bending strength were given in table (5). Accordingly, from these results, the feldspars of the studied area can be used for wall ceramic industry. Although, the value of bending strength is very high but can not be used in floor ceramic industry due to their high values in water absorption %.

Table (4): International standard limits for shrinkage, water absorption and bending strength (Konta, 1979).

Characters	Ceramic wall	Ceramic floor
Shrinkage (Shr.)	0 - 0.3 %	5 - 6.5 %
Water absorption (E)	14 –17 %	Less than 3 %
Bending strength (B.S.)	Over 17 nuten/cm^2	Over 27.5 nuten/cm^2

Table (5): Water absorption %, shrinkage and bending strength for placer feldspars of G. El-Esh.

Sample No.	Water absorption %	Shrinkage	Bending strength
1	14.5	0.22	33.5
2	15.1	0.19	50.4
3	16.2	0.23	21.5
4	16.2	0.25	41.3
5	15.2	0.30	33.6
6	14.8	0.28	39.8
7	15.0	0.24	40.2
8	14.8	0.22	50.2
9	15.1	0.15	35.6
10	16.5	0.26	40.2

CONCLUSIONS

Gabal El Esh area lies between latitudes 27° 26` and 27° 34` N and longitudes 33° 30` and 33° 36` E covering about 107 km^2 (Fig. 1). The area lies 37 km to the north of Hurghada city. The basement rocks, of Pre-cambrian age, cropping out in the studied area include:- (1) Dokhan volcanics (oldest) and (2) younger granites (youngest). Placer feldspars are the youngest unit in the area and represented by surficial cover in the main dry wadis and their tributaries.

Petrographically, the studied younger granites were identified as syenogranite. These granites could be texturally classified as perthitic leucogranite. They are mainly composed of perthites, quartz, plagioclase, biotite and muscovite as essential minerals while zircon, sphene, epidote and apatite are the accessory minerals. Iron oxides, fluorite and muscovite are found as secondary minerals. They are considered as two mica granites.

The studied younger granites are considered as S-type granites originated from a peraluminous calc-alkaline highly fractionated magma. This magma is also rich in Rb but depleted in Ba and Sr indicating that this granite has originated under low pressure extensional conditions.

Placer feldspars can be used as a new material for ceramics and sanitary wares. It is naturally occurring blend of feldspars and quartz resulting from the erosion of particular kind of granitic rock which is characterized by low quartz to feldspars ratio (±1 free quartz to 1- 4 free feldspars). The studied placer feldspars were found to have good grinding ability that more than 75% of the charge was found over than 300 μm and less than 500 μm. The dust is less than 0.5%. These results are the needed grain size with a release of both Na^+ and K^+ in the solution which, in turn, enhance the rheological properties of the ceramic slip.

The mineral composition and geochemical data reveals that the placer feldspars of the studied area are good flux in ceramic industries. The results of the physical tests illustrated by water absorption %, shrinkage and bending strength beside their good resist for thermal shock and crazing suggest that the feldspars of the studied area can be used for wall ceramic industry, but not used in floor due to high value of water absorption (more than 14%).

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جيولوجية الصخور الجرانيتية وملائمة فلسبار الوديان بمنطقة جبل العش فى صناعة السيراميك فى مصر

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الجرانيت الوردى ثنائى الميكا فى منطقة جبل العش يخترق صخور الدخان البركانية. ومن خلال الدراسات البتروجرافية والجيوكيميائية أمكن تقسيم الجرانيت الوردى قيد الدراسة إلى سيانوجرانيت . ومن خلال الدراسات الجيوكميائية لصخور الجرانيت وجد أنه غني بالسيلكا والحديد وقد نشأ عن صهير ألومنيومى كلسى مائل إلى القلوى بدرجه كبيره غني بالروبيديوم وفقير في الباريوم والأسترونشيوم . تعتبر فلسبارات الوديان الناتجة من فعل التجوية للصخور الجرانيتية من أهم وأحدث المواد المستخدمة فى صناعة السيراميك والأدوات الصحية. وفلسبار الوديان فى منطقة الدراسة يعتبر مميز من خلال معامل الطحن حيث أن مايزيد عن 75% منة يتواجد بين 300 و 500 ميكرون. كما أن الاختبارات الميكانيكية تأكد قدرة فلسبار الوديان فى منطقة الدراسة على تحمل التصدع وفعل الحرارة العالية. وقد أثبتت باقى الدراسات الفيزيقية على إمكانية استخدامه فى صناعة سيراميك الحوائط فقط ولايسمح بصناعة سيراميك الأرضيات لارتفاع معامل امتصاصية المياه.