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## Mineralogy of the radioactive pegmatites of Humrat Ghannam alkali feldspar granite, Central Eastern Desert, Egypt

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### ABSTRACT

Radioactive anomalies are recorded in the pegmatite pockets hosted in the marginal zone of Gabal Humrat Ghannam alkali feldspar granitic pluton with older rocks, Central Eastern Desert of Egypt. These pegmatite bodies are the most important due to their higher radioactivity level. Generally, they are pink to red in color, elongated in the NE- SW and N-S relatively trends. They found as small bodies and pockets with dimensions ranging from 0.5 to 5 m in width and 10 to 50 m in length.

Detailed microscopic examinations, environmental scanning electron microscope (ESEM) and Electron microprobe analysis revealed the presence of several economic minerals in the pegmatite pockets. These minerals include zircon, thorite, uranophane, kasolite, xenotime, cassiterite and fluorite. Accordingly, the mineralized Humrat Ghannam pegmatites can be considered as a promising target for several economic metal values such as Zr, Th, U, Yb and Y. © 2015 Trade Science Inc. - INDIA

### INTRODUCTION

Rare-metal mineralization is particularly and genetically associated with post-orogenic, geochemically distinctive granitoids<sup>[25]</sup>. Several rare metal mineralization occurrences including Nb-Ta, U-Th and Zr-Hf minerals have been recorded in different localities of the Eastern Desert namely; El Naga, Abu Khurg, Abu Dabbab, Noweibi Abu Rushied and Sibai localities. These mineralizations are however mainly restricted to the granite pegmatite bodies associated with the younger granite that are widely distributed in the Eastern Desert<sup>[10, 15, 1, 11, 13, 3, 4, 2, 21, 7, 5]</sup>.

Gabal Humrat Ghannam granite was described by Asran, 1993 as a zoned-pluton distinguished into an earlier phase of porphyritic granite and a later phase of alkali-feldspar granite. Ali (2001) consid-

ered that, the field, petrographic and geochemical results indicate that the homogeneous Gabal Humerat Ghanam together with Gabal El Sibai are composed of alkali-feldspar and A1-type granite.

The aim of the present study is to identify the mineralogical characteristics of the radioactive and economic minerals of Humrat Ghannam pegmatites.

### Geological outline

The area of study is located near by the Red Sea at about 50 km southwest Quseir town. It is bounded by latitudes 25° 45' and 25° 49' N and longitudes 34° 11' and 34° 20' E (Figure 1).

The alkali feldspar of Gabal Humrat Ghannam is gradational, characterized by the formation of pegmatitic bodies which contain radioactive anomalies. They intrude the older surrounding rocks e.g. the metavolcanics and the older granitoids carrying sev-

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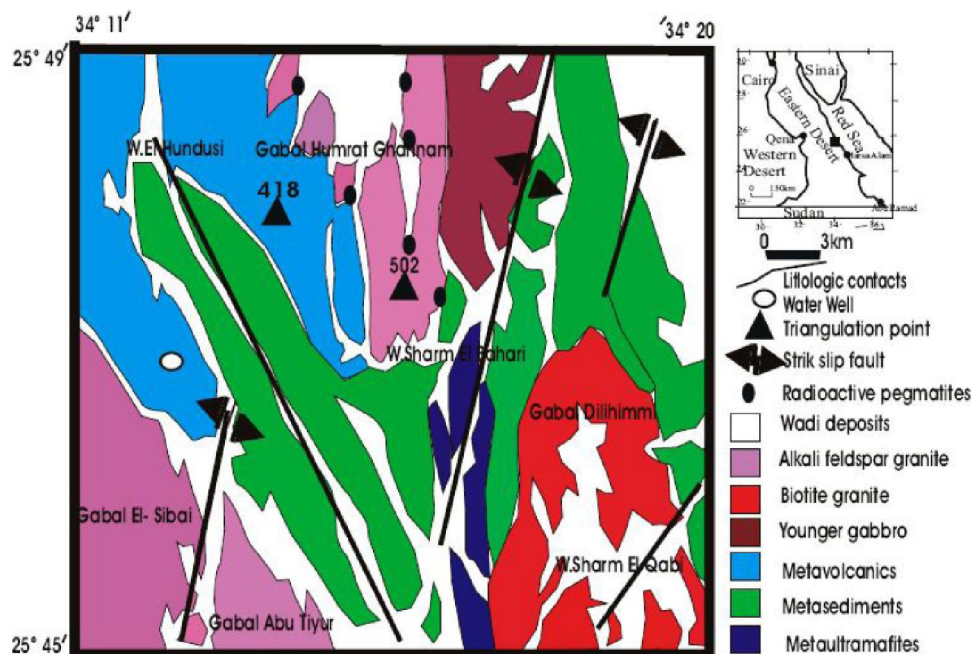


Figure 1 : Geological map of Gabal Humrat Ghannam area, Modified after<sup>[6]</sup>

eral xenoliths from these older granitoids of different sizes and shapes. They intrude also, the younger gabbro carrying them as roof pendants and sending offshoots in them.

The alkali feldspar granites are pink, medium to coarse grained and are characterized by exfoliation and cavernous weathering. All these granites becomes darker in colour adjacent to the mafic older gabbro and metavolcanics. This is most probably attributed to the assimilation of the enclaved fragments derived from these basic rocks in the marginal zone<sup>[6]</sup>.

The studied pegmatite bodies are the most important due to their relatively large sizes and higher radioactivity level. They are pale pink to white in color and elongated in the NNE-SSW and ENE-WSW trends. They are composed mainly of feldspars and quartz with scattered very small lenses of micas enclosing radioactive minerals. Their sizes range from 0.5 to 5 meters in width and 10 to 50 meters in length (Figure 2).

### Sampling and techniques

A bulk composite sample (~10 Kg) was collected from the highest field recorded radioactive anomalies. Concentrates of heavy minerals were obtained from various representative samples

through applying crushing, desliming and sizing. This was followed by heavy liquid separation using bromoform (sp.gr.2.85 gm/cm<sup>3</sup>) to estimate the heavy mineral content of each size fraction. Several grains of the latter were handpicked from all the obtained sink fractions for quantitative elemental analysis by the Environmental Scanning Electron Microscope (ESEM) which is a Philips Model XL 30 and is supported by an energy dispersive X-ray unit (EDAX). Also, polished thin-sections of some mineral grain varieties were analyzed using Back scattered electron images were collected with the scanning electron microscope energy dispersive spectrometry (BSE), (model Jeol 1400SEM) at the Microscopy and Microanalyses Faculty, university of New Brunswick (UNB) Canada. Mineral composition were determined on the JEOL JXA-733 Super probe; operating conditions were 15 kV, with a beam current of 50 nA and peak counting times 30 second for all elements. Standards used in this study were, as follows: jadeite, kaersutite, quartz, and apatite (for Na, Al, Si, P, and Ca, respectively), SrTiO<sub>3</sub> (for Ti), CaF<sub>2</sub> (for F), Fe, Nb, Hf, Ta, Sn, Th, and U metals (for Fe, Nb, Hf, Ta, Sn, Th, and U, respectively), YAG (for Y), cubic zirconia (for Zr), La-, Ce-, Nd-, Sm-, Pr-, Er-, Gd-, Eu-, Tb-, Dy-, and Yb- Al; Si-bearing glass, for (La-, Ce-, Nd-, Sm-, Pr-, Er-, Gd-

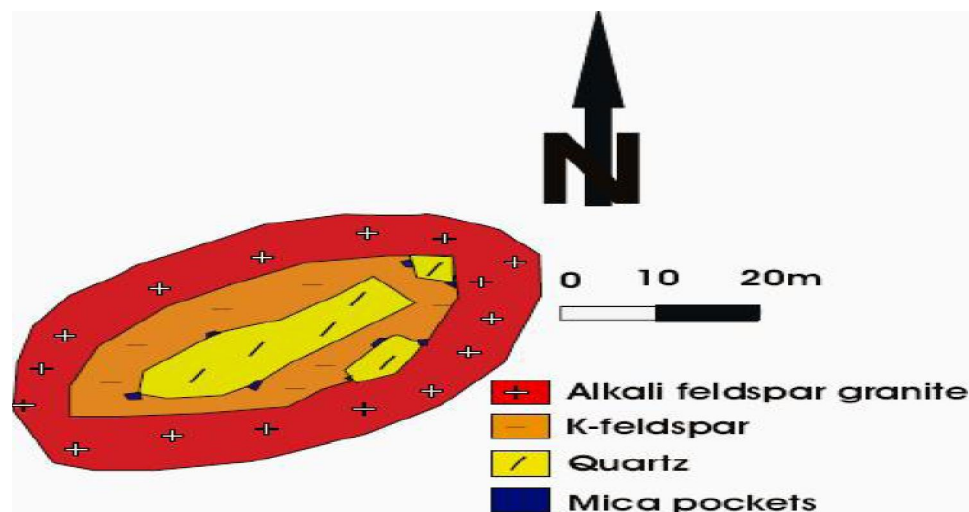


Figure 2 : Sketch showing the studied zoned pegmatite in Gabal Humrat Ghannam granite

, Eu-, Tb-, Dy-, and Yb-) and crocoite (for Pb).

## RESULTS AND DISCUSSION

### Radioactivity

Field radiometric measurements indicated that the radioactivity of pegmatites is more than twice that of their enclosing country rocks of the alkali feldspar granites of Gabal Humarat Ghannam granite. Radioactive anomalies are recorded in the pegmatites hosted in the alkali feldspar granites of Gabal Humarat Ghannam especially nearly contacts with the older rocks<sup>[6]</sup>. The spectrometric investigation in the pegmatite bodies revealed that, the chemical U contents in the pegmatite ranges from 600.8 to 1010.2 ppm, while the Th contents vary between 437.1 and 854.3 ppm. The Th/U ratios range from 0.73 to 0.84<sup>[6]</sup>.

### Mineralogical Investigations

Microscopic examination of the heavy fractions of the three size classes (-0.600 + 0.400 mm), (-0.400 + 0.200mm) and (-0.200 + 0.072mm) revealed that the content of the heavy accessory minerals in the studied Humrat Ghannam pegmatite samples amounts to about 3 %. Zircon and xenotime represent about 60% of the obtained heavy fractions. The contents of heavy and accessory minerals have been determined using the counting technique. These data indicate that zircon is the predominant mineral followed by xenotime in all size fractions (-0.600 to

0.072 mm). Beside these minerals, thorite, uranophane, and kasolite were recorded in appreciable amounts. Scattered cassiterite and fluorite grains occur in much lower amount.

The detailed mineralogical characteristics of the separated minerals showed the following.

### Zircon: $ZrSiO_4$

It is clearly evident that zircon crystals of the studied radioactive pegmatites are generally characterized by their coarse size and distinctive habit. Under a binocular microscope, they are mostly pale to deep brown in colour and generally sub-translucent to opaque with dull luster (Figure 3A). The most common habit is the bipyramidal form with various pyramidal faces and outgrowths (Figs.3 B, C and D). Some zircon crystals are however characterized by extremely short prisms and are more or less equidimensional and exhibiting square cross section. It is referred to the pyramidal combination with extremely short prisms as mud zircon and to the prismatic type with no tendency to be elongated as murky zircon<sup>[26]</sup>.

Several zircon crystals occur as euhedral to subhedral prismatic crystals (six or eight sided) found as being 30 to 100  $\mu\text{m}$  in size and occur as distinctive habits. They were handpicked and subjected to elemental analysis using the Environmental Scanning Electron Microscope (ESEM) at 15-25Kv accelerating voltage and a counting time of 60-100 second. The SEM microphotographs (Fig-



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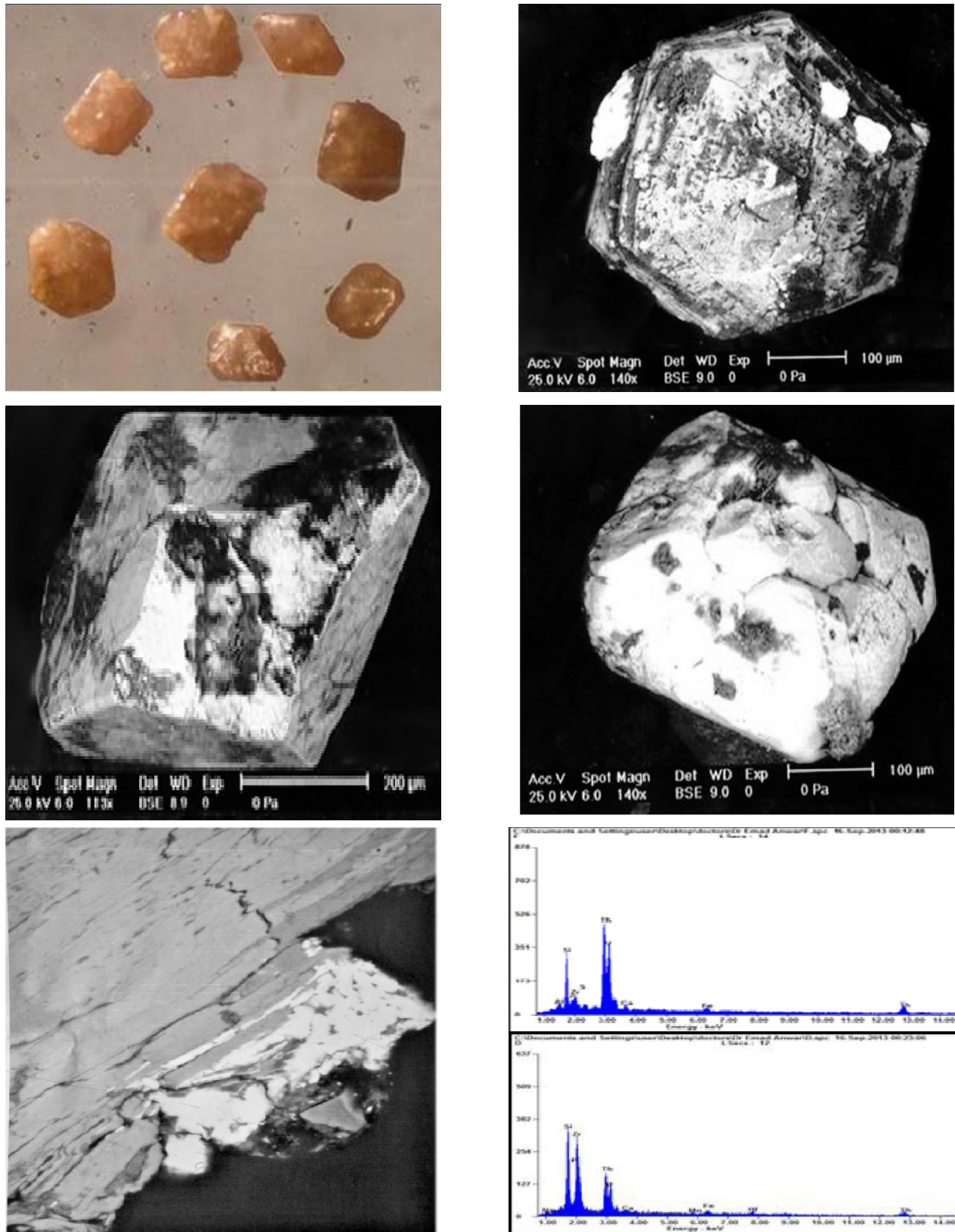


Figure 3 : A - Course pale to deep brown zircon crystals. Binocular microscope; B - C - & D : SEM images for the studied zircon exhibiting bipyramidal form, with various pyramidal faces and outgrowths; E - SEM images of the zircon crystals; F&G: EDAX spectrum for zircon and thorite inclusions

ures 3B-D- and C) reflected various morphological features of zircon. The EDAX analysis (Figures 3 F and G) reflects the chemical composition of zircon with its thorite inclusions. The latter indicates that the major elements in zircon are Zr (47.83%), Si (25.39%) and Fe (9.17%). Almost the majority of the investigated zircon crystals are characteristically contains several black inclusions of thorite (Figure 3G). The thorite inclusions are present as randomly distributed inclusions of varying sizes. The EDAX analysis of these inclusions revealed the presence of Th (47.46), U (11.96), Si (17.74) and Y (5.16). It is actually noteworthy that Ali et al. (2005), Abdel Warith et al. (2007), and Raslan (2009 a and 2010) reported the presence of thorite inclusions in rare metal mineralization and accessory heavy minerals (zircon, spessartine garnet and samarskite-Y.

The obtained microprobe analyses (EMPA) in the core of zircon is as follow: ZrO<sub>2</sub> (58.23 to 60.68) with an average 59.46; SiO<sub>2</sub> (33.10 to 32.92) with an average, 33.01; HfO<sub>2</sub> (2.19 to 2.78) with an average, 3.84; UO<sub>2</sub>, (0.87 to 0.93) with an average 0.90; ThO<sub>2</sub>, (0.16 to 0.25) with an average 0.21; Y<sub>2</sub>O<sub>3</sub>, (0.42 to 0.79) with an average 0.61; FeO, (0.39 to

0.40) with an average 0.40 and a total REE of 0.92 with an average sum of 99.05 wt%. The rim of zircon contains mainly ZrO<sub>2</sub> (55.177 to 58.10) Av. 56.64, SiO<sub>2</sub> (31.18 to 31.25) Av. 31.22, HfO<sub>2</sub> (4.90 to 5.16) with an average. 5. 03, UO<sub>2</sub> (1.43 to 1.75) with an average.1.59, ThO<sub>2</sub> (0.28 to 0.38) with an average. 0.33, Y<sub>2</sub>O<sub>3</sub> (0.22 to 0.23) with an average. 0.22, FeO (0.26 to 0.28) with an average. 0.27 and total REE of 0.92 with an average sum of 97.99 Wt % (TABLE 1).

The microprobe data confirm that the Hf, U, Y, Pb and some REE (Dy) content in the studied zircon is generally increased from the core to the rim of crystals.

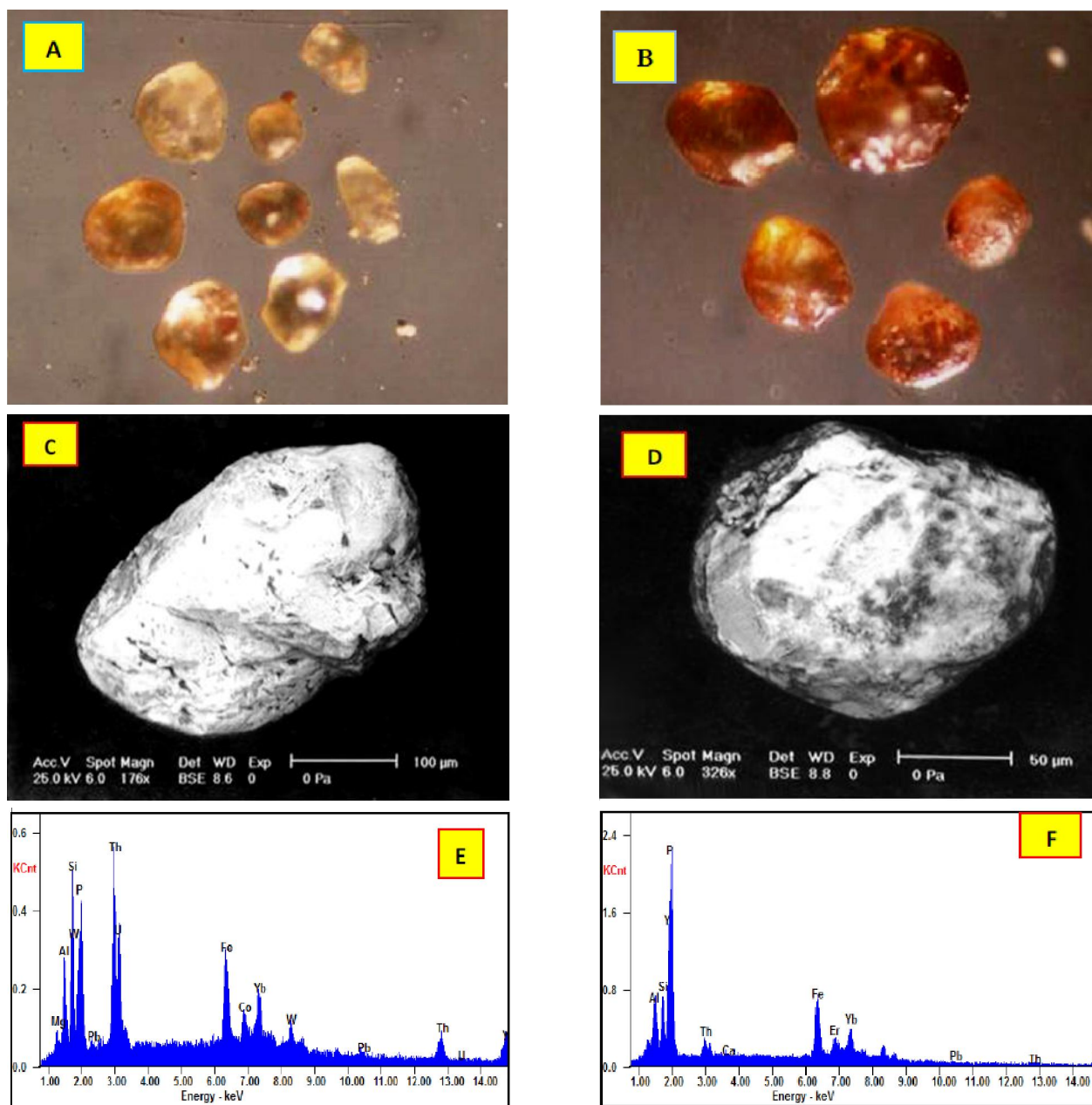
#### Xenotime: Y(PO<sub>4</sub>)

Under a binocular microscope, xenotime-(Yb) is transparent rounded to subrounded crystals, characterized by colorless to pale yellowish or reddish brownish colour (Figure 4A and B). It has a white streak, vitreous luster. ESEM photomicrographs reflect various morphological features of xenotime (Figure 4 C - D). Semi quantitative analyses show that the chemical composition of xenotime together

**TABLE 1 : Electron microprobe (EMPA) analyses of zircon from Humrat hannam pegmatites, Central Eastern Desert, Egypt**

Oxides	Core 1	Rim 1	Core 2	Rim 2	Ave.Core N=2	Ave.Rim N=2
SiO <sub>2</sub>	33.10	31.25	32.92	31.18	33.01	31.22
ZrO <sub>2</sub>	58.23	55.17	60.68	58.10	59.46	56.64
HfO <sub>2</sub>	2.78	4.90	2.19	5.16	2.49	5.03
Al <sub>2</sub> O <sub>3</sub>	0.24	0.47	0.11	0.20	0.18	0.34
P <sub>2</sub> O <sub>5</sub>	0.61	0.35	0.48	0.27	0.55	0.31
CaO	0.11	0.29	0.08	0.14	0.10	0.22
FeO	0.39	0.28	0.40	0.26	0.40	0.27
MnO	0.02	0.15	0.07	0.12	0.05	0.14
TiO <sub>2</sub>	0.10	0.06	0.09	0.10	0.10	0.08
Y <sub>2</sub> O <sub>3</sub>	0.23	0.49	0.78	1.23	0.51	0.86
Ce <sub>2</sub> O <sub>3</sub>	0.18	0.05	0.30	0.24	0.24	0.15
Tb <sub>2</sub> O <sub>3</sub>	0.07	0.03	0.13	0.09	0.10	0.06
Dy <sub>2</sub> O <sub>3</sub>	0.11	0.33	0.08	0.40	0.10	0.37
Yb <sub>2</sub> O <sub>3</sub>	0.79	0.24	0.42	0.22	0.61	0.23
PbO	0.12	0.27	0.10	0.34	0.11	0.31
ThO <sub>2</sub>	0.25	0.38	0.16	0.28	0.21	0.33
UO <sub>2</sub>	0.87	1.75	0.93	1.43	0.90	1.59
Total	98.20	96.31	99.90	99.66	99.05	97.99

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**Figure 4 :** A&B- transparent, and colorless to pale yellowish or brownish reddish xenotime crystals, Binocular microscope; C-D - Scanning images of rounded to subrounded xenotime crystals; E&F- EDAX analysis for thorite bearing xenotime and xenotime respectively

with high (Yb) content, a matter which will be classifies it as Yb-rich xenotime. The latter indicates that the major elements are Y (17.81%), P (10.29%) with appreciable amounts of Yb (11.69%) and Th (2.07%). The studied xenotime species crystals are characteristically contain numerous inclusions of thorite (Figure 4E and F).

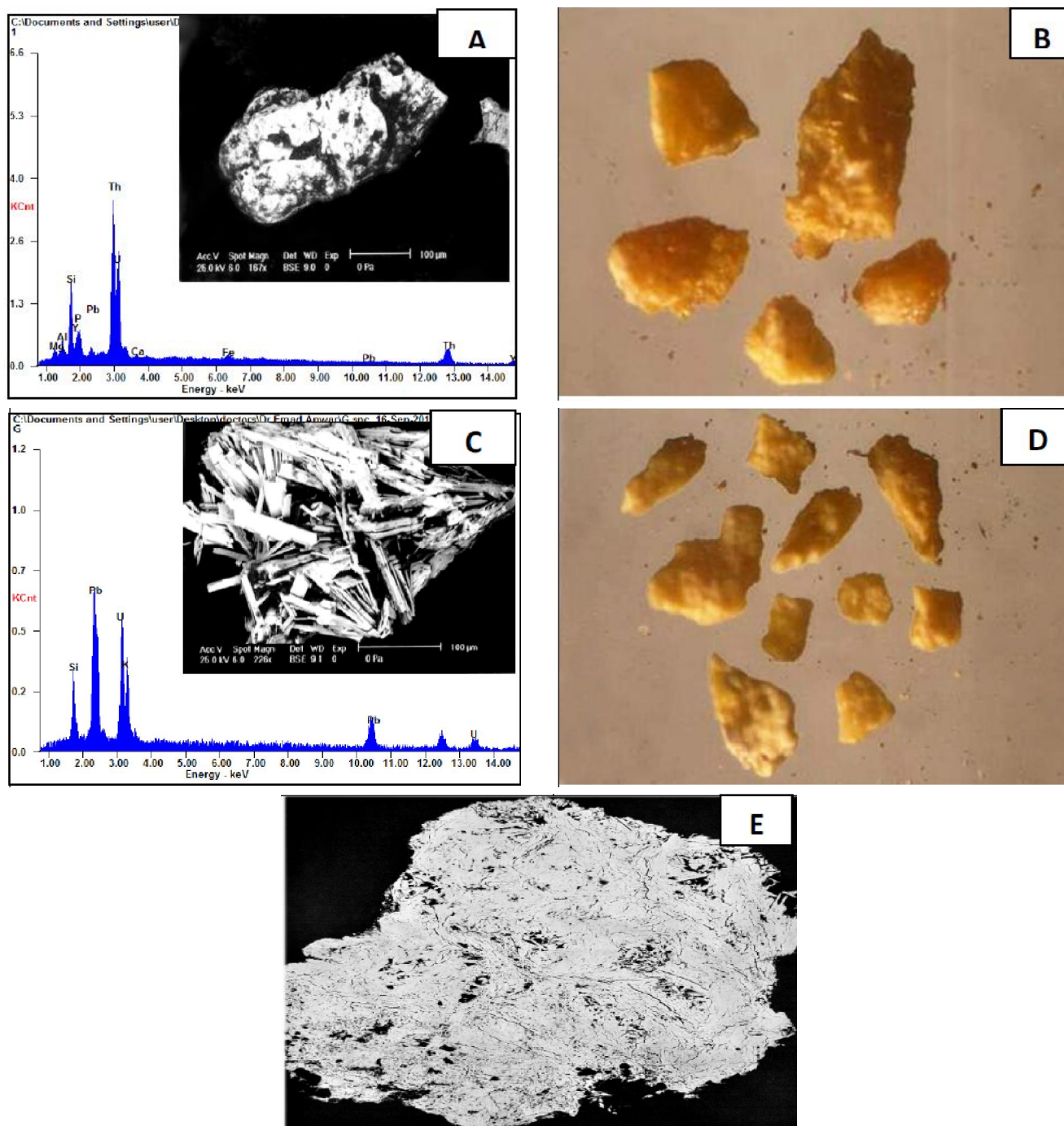
Buck et al. (1999) identified Yb-dominant xenotime in the Shatford Lake pegmatite group, south-eastern Manitoba, Canada. The ratio Y/Yb (atomic)

varies between 0.39 and 0.68 for Yb rich xenotime. The authors mentioned that variation in the concentrations of complexing agents such as fluorine in the magma may have played a role in determining the Y/Yb values.

### Thorite : $\text{Th}(\text{SiO}_4)$

Angular to subangular black massive thorite grains were actually detected in the studied bulk samples of radioactive pegmatite. Thorite was found





**Figure 5 :** A-SEM image and EDAX analysis of thorite crystal; B-Canary to lemon yellow kasolite grains, binocular microscope; C-SEM image and EDAX analysis of kasolite crystal; D- Massive yellow crystals of uranophane, Binocular microscope; E- SEM images of the uranophane crystals

as numerous inclusions of variable sizes in zircon and xenotime (Figure 3F and G and Figure 4 E and F)). The obtained ESEM data (Figure 5A) reflect the morphological features of thorite and its semi quantitative chemical composition, respectively. The major elements of the thorite are included Th (42.14%), Si (7.81%), U (8.41%), Y (5.81%) and

Fe (1.01%). Also, minor amounts of REE was reported as substituents for Th.

#### Uranyl silicate minerals

Uranyl silicates are the most abundant group of uranium minerals. The uranyl silicate minerals can be divided into several categories on the basis of

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their uranium and silicon ratios<sup>[24]</sup>. Three categories, with uranium to silicon ratios of 1:1, 1:3, and 2:1, are well defined and reported by Stohl (1974); Stohl & Smith (1974). Kasolite and uranophane are the members of the first group with uranium to silicon ratio 1:1.

### Kasolite: $Pb(UO_2)SiO_4 \cdot 2H_2O$

Kasolite is distinguished by its bright colors (canary lemon, yellow and brown of different intensities), (Figure 5B). These minerals are close in their physical properties and morphological features and characterized by their softness to crushing. However, kasolite grains, compared to other uranium secondary minerals are relatively harder<sup>[16]</sup>.

Kasolite is generally distinguished from the other uranium silicates by its crystal habit and luster. It is a hydrated silicate of lead and hexavalent uranium and is the only uranyl silicate with lead as major cation. These grains usually occur as massive granular forms composed of druses of rod like crystals. They are characterized by their waxy or greasy lus-

ter under binocular microscope (Figure 5B). ESEM data of the kasolite (Figure 5C) reflect the major elements in the Kasolite mineral; U (44.20%), Pb (44.64%) and Si (9.42%).

### Uranophane : $(CaO \cdot 2UO_3 \cdot 2SiO_2 \cdot 6H_2O)$

Under binocular microscope, uranophane grains are generally massive with granular form (Figure 5D). Their luster is dull and greasy. These grains are distinguished by their bright colors (canary to lemon yellow) with pale yellow streak and found in the form of fissures and fracture fillings (Figure 5D). Raslan (2009 b) identified dark colored iron aniferous grains in some radioactive granite plutons in the Eastern Desert of Egypt. These grains are mainly composed of uranophane and beta-uranophane, coated and stained with limonite. Raslan (2004) remarked that the presence of both uranophane and beta-uranophane as a mixture in some samples is attributed to the presence of both habits (massive granular and fibrous acicular crystals) as intergrown mixtures. The EPMA analyses of the crystals (TABLE 2) reflect the chemical composition of uranophane; these results indicate that the major elements are  $UO_2$  (69.10 %),  $SiO_2$  (15.93%), and  $CaO$  (5.19 %). Also, minor amounts of REE, and Y were reported as substituents for U (TABLE 2). The core of uranophane is characterized of  $UO_2$  (69.10),  $SiO_2$

**TABLE 2 : Electron microprobe (EMPA) analyses of uranophane from Humrat Ghannam pegmatites, Central Eastern Desert, Egypt**

Oxides	Core	Rim
SiO <sub>2</sub>	15.93	14.80
Al <sub>2</sub> O <sub>3</sub>	0.00	0.00
ZrO <sub>2</sub>	0.00	0.00
HfO <sub>2</sub>	0.00	0.00
P <sub>2</sub> O <sub>5</sub>	0.10	0.18
CaO	5.19	4.76
FeO	0.05	0.41
TiO <sub>2</sub>	0.06	0.03
MnO	0.00	0.00
Y <sub>2</sub> O <sub>3</sub>	0.03	0.10
Ce <sub>2</sub> O <sub>3</sub>	0.02	0.16
Tb <sub>2</sub> O <sub>3</sub>	0.00	0.00
Dy <sub>2</sub> O <sub>3</sub>	0.06	0.04
Yb <sub>2</sub> O <sub>3</sub>	0.03	0.01
PbO	0.15	0.18
Nb <sub>2</sub> O <sub>3</sub>	0.00	0.00
Ta <sub>2</sub> O <sub>3</sub>	0.00	0.00
ThO <sub>2</sub>	0.14	0.09
UO <sub>2</sub>	69.10	66.96
Total	91.06	87.25

**TABLE 3 : Electron microprobe (EMPA) analyses of fluorite from Humrat Ghannam pegmatites, Central Eastern Desert, Egypt**

Oxides	Core	Rim
F	46.34	24.80
SiO <sub>2</sub>	0.55	0.23
Al <sub>2</sub> O <sub>3</sub>	0.48	0.18
ZrO <sub>2</sub>	0.00	0.00
HfO <sub>2</sub>	0.00	0.00
P <sub>2</sub> O <sub>5</sub>	0.00	0.00
CaO	78.45	76.10
FeO	0.13	0.46
TiO <sub>2</sub>	0.00	0.00
MnO	0.00	0.00
Y <sub>2</sub> O <sub>3</sub>	0.01	0.18
ThO <sub>2</sub>	0.10	0.28
UO <sub>2</sub>	0.06	0.11
Total	126.23	120.29



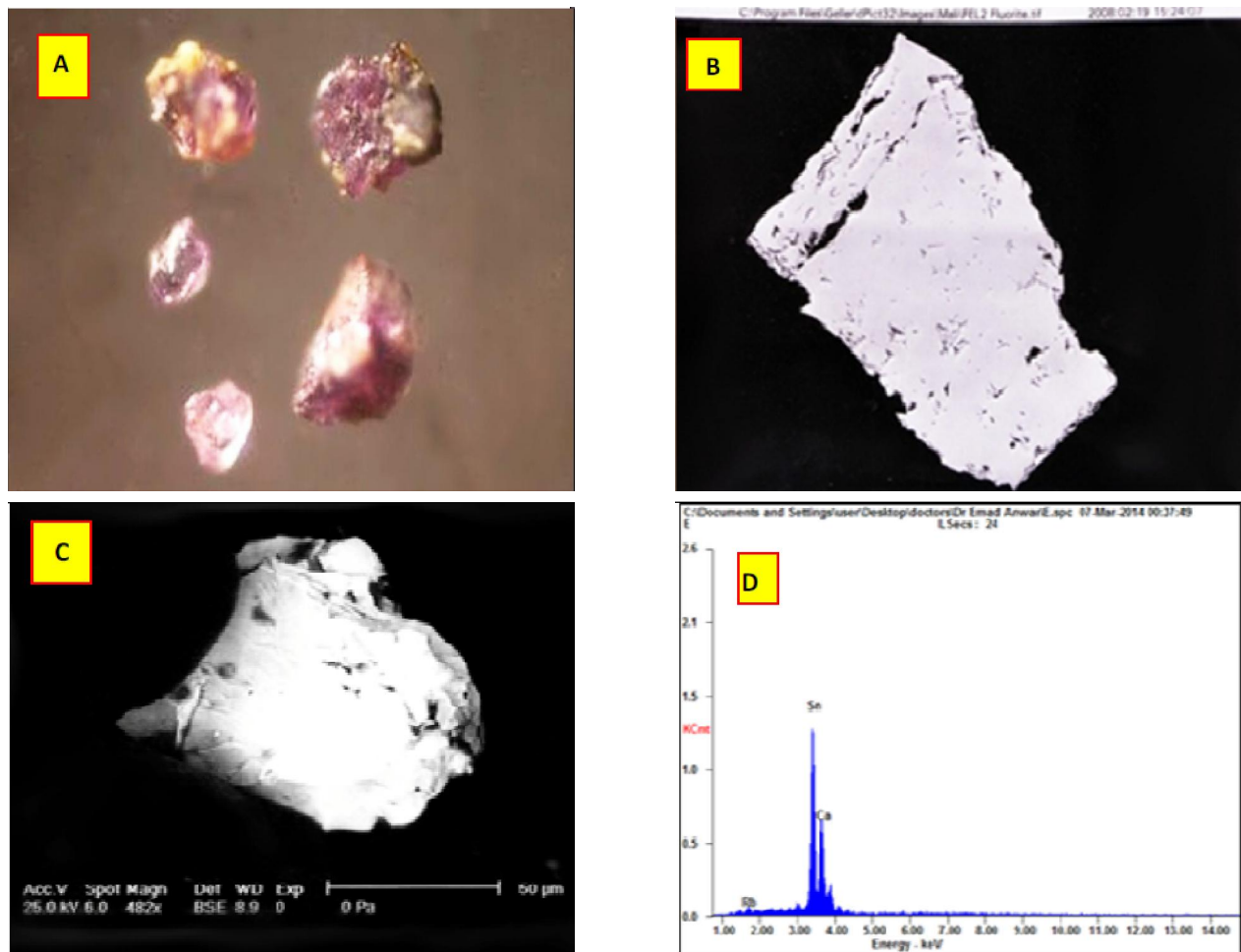


Figure 6 : A-Blue to violet fluorite crystals, Binocular microscope; B- SEM images of the fluorite crystals; C- Anhedral crystal of cassiterite; D- SEM image and EDAX analysis of cassiterite crystal

(15.93), CaO (5.19), FeO (0.05), PbO (0.15) and ThO<sub>2</sub> (0.14), while the rim of uranophane is characterized by UO<sub>2</sub> (66.96), SiO<sub>2</sub> (14.80), CaO (4.76), FeO (0.14), PbO (0.18) and ThO<sub>2</sub> (0.09). The analyses show that there is increase in the elements P<sub>2</sub>O<sub>5</sub>, FeO, Y<sub>2</sub>O<sub>3</sub>, Ce<sub>2</sub>O<sub>3</sub>, PbO and decrease in SiO<sub>2</sub>, CaO, TiO<sub>2</sub>, Dy<sub>2</sub>O<sub>3</sub>, Yb<sub>2</sub>O<sub>3</sub>, UO<sub>2</sub> and ThO<sub>2</sub> from core to rim (TABLE 2).

#### Fluorite: CaF<sub>2</sub>

Fluorite shows large blue to violet euhedral to subhedral crystals with a size range of 200-400 μm (Figure 6A and B). The EPMA (TABLE 3) indicates that the major elements in the core and rim of fluorite are CaO (78.45 – 76.10wt %) and F (46.34-24.80 wt %), with significant amounts of Y<sub>2</sub>O<sub>3</sub> (0.01-0.18 wt%), UO<sub>2</sub> (0.06-0.11 wt%) and ThO<sub>2</sub> (0.10-0.28 wt%). Yttrium partially substitutes Ca. El-Kammar et al. (1997) concluded that the change in

colour of fluorite is mainly controlled by the Y content. The presence of fluorite accompanying the mineralization indicates that the hydrothermal alteration processes were involved during shearing.

#### Cassiterite : SnO<sub>2</sub>

Cassiterite occurs as large anhedral crystals (200 μm) and the obtained ESEM data (Figure 6 C and D) indicate that Sn is the most predominant element (92.39%) together with minor amounts of Ca and Rb.

## CONCLUSIONS

The pegmatite bodies in the marginal zone of alkali feldspar granites and older rocks are the most important due to their higher radioactivity level. Generally, they are pink to red in color, elongated in the NE- SW and N-S relatively trends. They are and

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found as small bodies and pockets with dimensions ranging from 0.5 to 5 m in width and 10 to 50 m in length.

ESEM and microprobe analyses confirm the presence of zircon, thorite, Yb-rich xenotime, uranophane, kasolite, cassiterite and fluorite. The mineralized Humrat Ghannam pegmatites is considered to be a promising ore materials for its rare-metals mineralization that include mainly Zr, U, Th, Yb, Y and REE.

The microprobe data discuss the Hf, U, Y, Pb and some REE especially  $Dy_2O_3$  contents in the studied zircon is generally increased from core to rim of the crystal.

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### REFERENCES

- [1] H.M.Abd alla, A.H.El Afandy; Contrasting mineralogical and geochemical characteristics of two A-type pegmatite fields, Eastern Desert, Egypt, *Egyptian Mineralogists*, **20**, 287-328 (2003).
- [2] Abd El A.A.Wahed, Abd El A.A.Mottalib, A.A.Sadek; Mineralogical and radiometrical characteristics of rare-metal pegmatite at southern Humr Waggat Pluton, Central Eastern Desert, Egypt, *Journal of Middle East Research Center, Ain Shams University, Cairo*, **19**, 105-116 (2006).
- [3] Abd El A.A.Wahed, M.F.Raslan, El M.O.Husseiny; Radioactive pegmatites of Um Lassifa granitic pluton, Central Eastern Desert, Egypt: Mineralogical investigation, The 9<sup>th</sup> International Mining, Petroleum and Metallurgical Engineering Conference, 12 (2005).
- [4] Abd El A. Warith, M.F.Raslan, M.A.Ali; Mineralogy and radioactivity of pegmatite bodies from the granitic pluton of Gabal Um Tager El-Tahtani area, Central Eastern Desert, Egypt The 10<sup>th</sup> International Mining, Petroleum, and Metallurgical Engineering Conference March 6-8 2007, Mining, Code No. M3, Faculty of Engineering - Cairo University, (2007).
- [5] M.A.Ali; Mineral chemistry and genesis of Zr, Th, U, Nb, Pb, P, Ce and F enriched peralkaline granites of El Sibai shear zone, Central Eastern desert, *Egypt Geology*, **56(1)**, 107-128 (2013).
- [6] M.A.Ali; Geology, petrology and radioactivity of Gabal El-Sibai area, Central Eastern Desert, Egypt, Ph.D.Thesis, Cairo University, 300 (2001).
- [7] M.A.Ali, D.R.lentz, D.C.Hall; Mineralogy and geochemistry of Nb, Ta, Sn, U, Th and Zr bearing granitic rocks from Abu Rushied shear zone, South Eastern desert, Egypt, *Chinese journal Geochemistry*, **30**, 226-247 (2011).
- [8] M.A.Ali, M.F.Raslan, M.G.El-Feky; Radioactivity and mineralogy of some pegmatite bodies from Gabal Al-Farayid granites, South Eastern Desert, Egypt, The 9<sup>th</sup> International Mining, Petroleum, and Metallurgical Engineering Conference February 21-24, 2005, Faculty of Engineering- Cairo University, (2005).
- [9] F.A.Amm ar; Mineralogical and radiometric studies on the uraniferous pegmatites of Abu- Dob area, *Journal of Environmental Research*, **4**, 52-84 (2001).
- [10] M.A.Asran; Contribution to the petrography, Petrochemistry and petrogenesis of Humrat Ghannam and Um Naggat granitoids, Eastern Desert, Egypt, *Egyptian Mineralogist*, **5**, 57-79 (1993).
- [11] M.Y.Attawiya, A.A.Zalata, M.E.Ibrahim, M.E.Mostafa, N.A.Dawood; Geology, Geochemistry and mineralogy of uraniferous pegmatites at Gabal Abu Dob, central Eastern Desert, Egypt, - Fifth Arab conference on the peaceful uses of Atomic Energy, Beirut, 26-45 (2000).
- [12] H.M.Buck, M.A.Cooper, P.Cerny, F.C.Hawthorne, J.D.Grice; Xenotime- (Yb) a new mineral from the Shatford Lake pegmatite group, southeastern Manitoba, *Canadian Mineralogist*, **37**, 1303-1306 (1999).
- [13] EL A.M.Kammar, EL N.T.Hazik, M.Mahdi, N.Ali; Geochemistry of accessory minerals associated with radioactive mineralization in the Central Eastern Desert, Egypt, *Journal of African Earth Sciences*, **25/2**, 237-252 (1997).
- [14] H.S.S.Meky; Geological, Petrographical and geochemical studies on granitic rocks of Abu-Tiyur and Humrat Ghannam plutons, Eastern Desert, Egypt, Ph.D.Thesis, Al-Azhar Univ., 306, (1997).
- [15] S.A.Omar; Geology and geochemical features of the radioactive occurrences of Um-Anab granitic masses, Eastern Desert, Egypt, M.Sc.Thesis, Cairo University, 195 (1995).

---

*Current Research Paper*

- [16] M.F.Raslan; Mineralogical and beneficiation studies for some radioactive granites along Wadi Balih, North Easter Desert, Egypt (MSc Thesis), Faculty of Science, Cairo University, Cairo, Egypt, (1996).
- [17] M.F.Raslan; On the distinction between uranophane and beta-uranophane from some uraniferous granitoids in the Eastern Desert
- [18] of Egypt, In Seventh International Conference on the Geology of the Arab World, Feb 2004, Cairo University, 45-52 (2004).
- [19] M.F.Raslan; Mineralogical and Minerallurgical characteristics of samarskite-Y, columbite and zircon from stream sediments of the Ras Baroud area, Central Eastern Desert, Egypt, The scientific papers of the institute of mining of the wroclaw university of technology, Wroclaw, Poland, Mining and Geology, XII, 126, 179-195 (2009 A).
- [20] M.F.Raslan; Occurrence of uraniferous iron grains at Gabal Gattar, El Missikat and El Erediya Granites in Eastern Desert of Egypt, Resource Geology, 59(1), 99-105 (2009 B).
- [21] M.F.Raslan, El H.E.Shall, S.A.Omar, A.M.Daher; "Mineralogy of polymetallic mineralized pegmatite of Ras Baroud granite, Central Eastern Desert, Egypt", Journal of Mineralogical and Petrological Sciences, 105, 123-134 (2010).
- [22] F.V.Stohl; The crystal Chemistry of the Uranyl Silicate Minerals, Ph.D.Thesis, The pennsylvania state university, University Park, (1974).
- [23] F.V.Stohl, D.K.Smith; The crystal chemistry of the uranyl silicate minerals, (abstr.) American Crystallographic Association Meeting, Program and Abstracts, 2, 271 (1974).
- [24] F.V.Stohl, D.K.Smith; The crystal chemistry of the uranyl silicate minerals, Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania, (1981).
- [25] G.Tischendorf; Geochemical and petrographic characteristics of silicic magmatic rocks associated with rare-element mineralization. In: Stemp M.rok, L.Burnol, G.Tischendorf, (Eds.): Metallization associated with acid magmatism: Prague, Czech.Geol.Surv., 41-98 (1977).
- [26] F.A.Williams, J.A.Meehan, K.L.Paulo, T.U.John, H.G.Rushton; Economic geology of the decomposed columbite- bearing granite, Jos Plateau, Nigeria.Econ.Geol., 51, 303-32 (1956).