Petrographical and mineralogical studies of Hammamat sediments and Gattarian granite along Wadi Belih, north Eastern Desert, Egypt.

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Abstract
The Hammamat sediments at Wadi Belih area are represented by greywacke and siltstones. The greywackes are immature and are fine to coarse grained and composed of quartz, feldspar and hematite. The younger granites (The Gattar granites) are composed mainly of quartz and feldspars as essential minerals and biotite, hornblende, zircon, and apatite as accessory minerals. Some secondary minerals as epidote, chlorite and sericite are found. The radioactive minerals are identified by using the Quanta FEG-250 ESEM instrument which is an environmental Scanning Electron Microscope (ESEM) attached by Energy Dispersive X-ray(EDX) in the national central research (NCR). The younger granites and Hammamat rocks at Wadi Belih area contain primary uranium mineral as Coffinite, secondary minerals as Uranophane, Kasolite, Schroekingerite and uranium bearing minerals like Columbite.

Keywords
Radioactivity mineralogy: hamamamate sediments and granites W.Balih

Introduction

The present study deals with the Petrographical, mineralogical and radioactive minerals studies of Hammamat sediments and Gattarian granite along W. Belihby using The Quanta FEG-250.

General Geology
Gabal Gattar and Wadi Belih areas are located in the north eastern desert (NED) of Egypt between latitudes 26° 52’ to 27° 08’ N and longitudes 33° 13’ to 33° 26’ E Figure 1. It comprises the Gattar granite pluton which forms a mountainous terrain with G. Gattar (1963m), G. Umm Disi (1556 m), G. Abu El Hassan, G. Abu El Hassan El-Ahmar, G. Reddah, G. Theima and G. Abu Samyu. The main wadis are W. Balli (Fig. 1). The Gattar plouton is oval in shape striking NE-SW direction with the same direction of G. El Eglab (Stern and Gottfried, 1986 and Ayoub 2003), and G. Uqab El Nugum south Eastern Desert Egypt (Samaan, 2000). G. Gattar covers an area of about 455km2 with about 30km length and 20km wide. It is dissected by various faults trending mainly ENE-WSW, NNW-SS, NW-SE and NNE-SSW (Waheeb and EL Sundoly 2016). The basement rocks in the studied area are classified according to Takla classification (2002), into:

- Intra-plate Magmatism and Sediments:
  - Felsic and mafic dykes (Younger)
  - Younger granites (G. Gattar granites)
  - Hammamat sediments
- Dokhan volcanics
- Subduction-related granitoids (Arc granites):
  - Granodiorites (Older)
Subduction-Related Granitoids (Arc Granitoids)

The Subduction-Related Granitoids in the studied area are represented by granodiorites, Intra-plate Magmatism and Sediments, Dokhan volcanics and Hammamat sediments.

Granodiorites

The granodiorite crops out at the north east part of the studied area (Figure 1). Waheeb and EL Sundoly (2016) mentioned that the granodiorites are characterized by low to moderate relief, exfoliation and boulder weathering with characteristic monumental shapes. The older granitoids are intruded by the younger granites which took xenoliths of various shapes and sizes from them.

Intra-plate Magmatism and Sediments

The Intra-plate Magmatism and Sediments in the studied area represented by Dokhan volcanic, Hammamat sediments and younger granites (Gattar granites).

Dokhan volcanics

The Dokhan volcanics are crop out as large area in the northern and central part of the area of study (Fig. 1). It is represented by a successive sequence of lava flows ranging in composition from intermediate to acidic varieties with their related pyroclastics. The Dokhan volcanics are intruded by the younger granites. The contact between Dokhan volcanic and younger granites are structural contact (Roz 1994).

Hammamat sediments

The Hammamat sediments crop in the central part of the study area. They are unconformably overly all the pre-existing older rocks (Mahdy, et al., 1990). The succession of these well-stratified molasses type sediments, in the study area, attains a thickness of about 250 meter of well-defined clastic sediments and generally forms moderate to high relief mountainous terrains with gentle slopes (Shalaby 1990).

The Hammamat sediments were studied microscopically and it is shown that they are composed mainly of two rock types: greywacke and siltstone.

Petrography

Greywacke

The greywackes in the studied Hammamat sediments are immature and are fine to coarse grained. They are dark to gray in color and consist mainly of subangular to subrounded quartz, altered feldspar, rock fragments and a matrix (20-40%) rich in sericite, chlorite, fine grained quartz and iron oxide. Some varieties are rich in calcite.

Quartz

occurs as subangular to subrounded grains up to 2 mm in diameter and mainly occurs as polycrystalline fragments Figure 2, sometimes showing mosaic texture. Monocrystalline quartz is minimal or absent.

Feldspar

Are commonly plagioclase and are mainly sussritized Figure 3, subhedral to anhedral grains

Rock fragments

Are frequent in samples. They are dominated by granitic fragments as well as other rock units such as acidic volcanic and quartzite.

Siltstones

Siltstones microscopically, consist of wide varieties of fine angular to subrounded grains of quartz, in silt size Figure 4, feldspar, microcrystalline chlorite, sericite, detrital mica Figure 5 and epidote; all are densely packed in a dark hematitic matrix. Feldspars are rounded to subrounded, Rock
fragments are relatively uncommon. Carbonate
veinlets and patches are absent.

Figure 2 Polycrystalline fragments quartz (Qz) in
graywake C. N.

Figure 3 Saussuritized plagioclase in graywake.

Figure 4 Angular to sub-rounded quartz grains (Qz) in
siltstone C. N.

Figure 5 Detrital mica (M) in Siltstones C. N.
**Younger granites (G. Gattar granites)**

Gabal Gattar granites are light pink in color, hard, generally forms high relief mountainous. Holocrystalline and coarse grained, pink to red in color (Ghobrial and Lotfi 1967). Microscopically, it is composed mainly of quartz, potash feldspars and plagioclase as essential minerals, biotite, hornblende, zircon, apatite, opaque and sphene as accessory minerals, epidote, chlorite and sericite are secondary minerals.

**Quartz**

Occurs as the predominant minerals constituting about 40% of the rock. It forms coarse anhedral crystals, showing wavy extinction Figure 6 and enclosing zircon, perthite, plagioclase and biotite.

**Feldspars**

Occurs as perthite, microcline and plagioclase, the perthite occur as orthoclase perthite, it build simply twinned, flame type Figure 7. Microcline occurs as euhedral crystals cross hatching Figure 8. Plagioclases are subhedral to anhedral crystal, lamellar twining Figure 9. Some plagioclases show saussuritization Figure 10 and others are zoned. The plagioclase crystals enclose zircon Figure 11.

**Biotite**

Occurs as euhedral flaky crystals, pleochroic from dark brown to yellow, and partially altered to chlorite Figure 12. Some biotite crystals enclosed zircon.

Hornblende occurs as coarse prismatic crystals, green in color, pleochroic from dark green to light green. Some hornblende crystals enclose opaque Figure 13 and zircon, it partially altered to chlorite.

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**Figure 6** Wavy extinction in quartz (Qz), Biotite (Bi) C.N.

**Figure 7** Flame perthit in orthoclase perthit C.N.

**Figure 8** Cross hatching in microcline C.N.

**Figure 9** Lamellar twinning in plagioclase C.N.

**Figure 10** Saussuritization (S) plagioclase C.N.

**Figure 11** Plagioclase crystals enclose zircon (Zr) C.N.

**Figure 12** Biotite altered to chlorite PPL.
Radioactive minerals of Hammamat

Sediments and Gattarian granite

The minerals detected by using Olympus microscope in Nuclear Materials Authority (NMA) Cairo, Egypt and Quanta FEG-250 ESEM attached by Energy Dispersive X-ray(EDX) in the national central research (NCR), Geza, Egypt.

The FEG column in Quanta 250 allows beam deceleration, which permits to achieve a resolution of 1.4 nm even at 1 kV electron landing voltage. The Quanta equipment can work under three different pressure ranges, the maximum pressure being 2600 Pa. This permits observation of life-sciences samples without previous metallic coating, i.e., studies in environmental conditions (ESEM).

This microscope allows the use of a Wet-STEM, which permits to analyze samples with controlled humidity and temperature, which is crucial in life-science samples. The SEM-Quanta can also use a heater to perform observations on samples heated up to 1000 ºC and detect changes in the morphology of the material. In addition, with this microscope deceleration of the electron beam over non-conductive samples can be performed leading to 1.4 nm resolution even at 1 kV.

The mineralogy and radioactive minerals of Hammamat sediments and Gattarian granite are:

**Hammamate Sediments**

**Uranophane:** (calcium uranium silicate hydrated), Ca(UO$_2$)$_2$(SiO$_3$)H$_2$O, yellow color Figure 16, showing radial crystal under FEG microscope Figure 17. The uranophane contains 53.25% SiO$_2$, 38.15% UO$_2$ and 6.8% CaO.

**Kasolite:** Pb(UO$_2$)$_2$(SiO$_4$)·H$_2$O, it contains 3.03 PbO, 18.23 SiO$_2$, 9.96 CaO and 34.06 UO$_2$ Figure 19, it is monoclinic system Figure 20.

**Schroeckingerite:** NaCa$_3$(UO$_2$)(CO$_3$)$_3$(SO$_4$)F•10(H$_2$O), the EDX Figure 18 shows that the schroeckingerite contains 5.54% Na$_2$O, 7.18% SiO$_2$ and 49.11% UO$_2$.

**Gattar Granite**

**Coffinite:** Uranium bearing silicate U(SiO$_4$)$_{0.9}$(OH)$_{0.4}$ dark brown in color Figure 14, Coffinite contains 53% UO$_2$ and 27% SiO$_2$. Figure 15 shows ESEM image for coffinite and there EDX.

**Columbite:** (Fe,Mn)(Nb,Ta)$_2$O$_6$ Figure 21, it contain 6.59% SiO$_2$, 12.89% Nb$_2$O$_5$, 49.23% UO$_2$, 7.07% CaO and 5.9% TiO$_2$. Samaan (200--) mentioned that the columbite of high niobium is high in carrying uranium while the columbite of high tantalum is very low in carrying uranium.
Conclusions

- The Hammamat sediments crop in the central part of the study area. They are unconformably overlying all the pre-existing older rocks.
- It is composed mainly of two rock types: greywacke and siltstone. The greywackes consist mainly of quartz, feldspar and rock fragments. In greywackes the Ca-feldspars are altered to saussurite (saussuritization). Saussurite is not however recognized as a true mineral because it is a microscopic mixture of several other minerals. The complete or partial alteration of calcium-rich plagioclase to a fine-grained aggregate of secondary, sodic-rich plagioclase, epidote, muscovite, calcite, scapolite, and zeolites. The process commonly takes place during the low-grade regional metamorphism). Siltstones consist of quartz, feldspar, microcrystalline chlorite, sericite, mica and epidote. The Hammamat sediments contain Uranophane, Kasolite and Schroekingerhierite. The Uranophane also known as uranotile, is a rare mineral that forms from the oxidation of uranium-bearing minerals. It is closely related to the two other uranium bearing minerals. The major constituents of kasolite are; uranium, lead and silicon. Lead does not exist as a radiogenic
product and not even as a substitute for uranium in the mineral structure. Alternatively, galena mineralization could be considered as a source for lead. Schrockingerite is one of the few uranyl carbonate minerals that is found on the mineral markets. Other uranyl carbonates include and eronite, rutherfordinite, sharpite, liebigite, zwartite and bayleyite. Schrockingerite, in addition to having a uranyl (UO₂) group in its chemistry, has a sulfate ion.

- The younger granites form high mountainous relief. The Gattar granite is holocrystalline and coarse grained, pink to red in color. Microscopically, it is composed mainly of quartz which characterized by undulos extinction due to oriented pressure (Dynamic effect), potash feldspars and plagioclase as essential minerals, biotite which partially chloritized due to chemical alteration (thermal effect), hornblende, zircon, apatite, and opaque as accessory minerals, epidote, chloride and sericite are secondary minerals.

- The younger granites contain Coffinite and Columbite. Coffinite, USiO₄, is the second most abundant U(IV) mineral on Earth, and its formation is by the alteration of the UO₂. Columbite forms a series with the mineral tantalite. In fact the two are often grouped together as a semi-singular mineral called columbite-tantalite in many mineral guides, where they are compose a series of two or more elements which occupy the same places within a crystal structure and their respective percentages can then vary. Columbite is the more niobium than tantalite rich in uranium content.

References


