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# PETROGRAPHICAL, MINERALOGICAL AND GEOCHEMICAL STUDIES OF CRETACEOUS-PALEOCENE CLASTIC ROCKS IN WADI QWIEH – WADI ABU HAMRA AREA, CENTRAL EASTERN DESERT, EGYPT

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## ABSTRACT

*Integrated petrographical, mineralogical and geochemical studies were carried out on the sandstone and shale bedsof Tarif, Qusier, Duwi, Dakhla and Esna formations exposed at Wadi Qwieh – Wadi Abu Hamra area, which located between Latitudes 26° 16′ and 26° 20′ N and Longitudes 34° 05′ and 34° 08′ E*

*Petrographically, the studied sandstone samples in Tarif Formation is quartz arenite with iron oxides and silica cement, generally monocrystaline, moderately sorted, sub-rounded to sub-angular with normal and wavy extinction. The main mineralogical constituent of the studied sandstone is quartz with hematite, gypsum and microcline as minor constituent. The clay minerals are montmorillonite and kaolinite, where montmorillonite is more abundant that pointed to presence of ultramafic-mafic rocks in the source area.*

*Geochemical studies reflect that the sandstones of the Tarif Formation were probably deposited under relatively warm and slightly alkaline conditions.*

***Keywords:*** Clastic Rocks, Petrography, Mineralogy, Geochemistry, Depositional Environment, Wadi Qwieh, Wadi Abu Hamra.

## 1. INTRODUCTION

The study area is exposed at the central part of the Eastern Desert, along Red Sea Coast, Egypt. It lies between Latitudes 26° 16′ and 26° 20′ N and Longitudes 34° 05′ and 34° 08′ E (Fig.1).The study area is bounded by basement rocks in the northern and western sides, bounded by quaternary deposits in the eastern side to the coastal boundary. The area has attracted the attention of many authors whom studied the lithostratigraphy, biostratigraphy and depositional environment **(Word et al.,1979**, **Howaidy 1979, El Badry et al., 1983**, **El-Kammar 2015**, **Hassaan et al., 2016,Abou El-Anwar 2017, Abou El-Anwar et al., 2018)**. This work aims to investigate the petrography, mineralogy, geochemistry and interpretation of depositional environment of the clastic sedimentary rocks in the Wadi Qwieh – Wadi Abu Hamra area.

## 1- METHODOLOGY

A total of 23samples were collected from thestudied clastic sedimentary rocks in the study area to throw some light on petrography, mineralogy, geochemistry and interpretation of the environment of deposition of the Tarif Formation, Qusier Variegated Shale, Duwi Formation, Dakhla Shale and Esna Shale. Description of the stratigraphic position of the studied rock units by using the field observation, identify the mineralogical composition, petrographical description to identify the different lithofacies and the chemical distribution of the major and trace elements and their studied rock units.

Petrographic microscope issued to investigate the mineral composition and texture of the studied samples. Also, the mineralogical analysis of (14 samples)of the studied sandstones and shales samples were carried out by the X-ray diffraction analysis (XRD). The

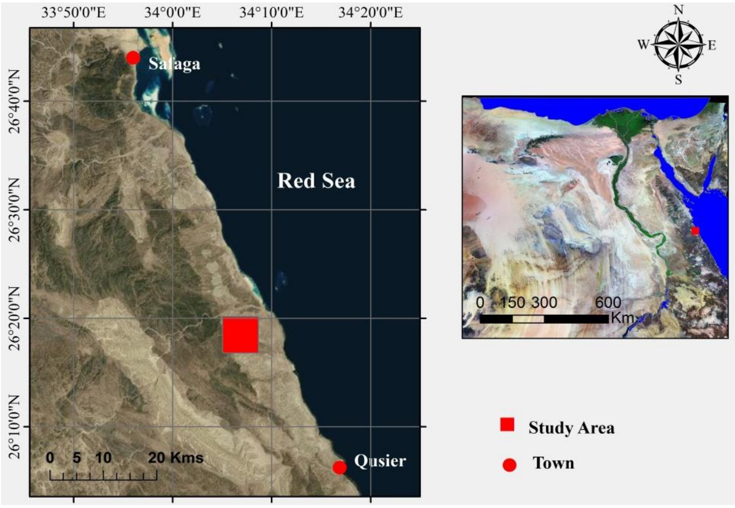



**Fig.(1): Landsat image showing the study area.**

analysis was carried out in the laboratories of Central Metallurgical Research Institute (CMRDI). The obtained X-ray data using interpreted using **ASTM (1960)** cards together with the published cards of **(Brown, 1961** and **Deer et al., 1963)**.

Seventeen representative samples of four sandstones and thirteen shales have been subjected to chemical analysis to estimate their contents. The analysis was carried out in the laboratories of National Research Center, using Axios Sequential WD-XRF, PANalytical (2016).

## 2- GEOLOGIC SETTING

Figures 2 and 3 showsthe geologic map of the study area and the composed stratigraphic succession of the study area, the stratigraphy of the study area is represented as a part of the central Eastern Desert.

Figurers(4 a – e) show the stratigraphic columnar section of the studied Tarif, Qusier Variegated, Duwi, Dakhla and Esna shale formations.

Structurally, the sedimentary rocks of study area are separable into two main divisions: the pre-rift Cretaceous-Eocene succession (more than 1500 m. thick) and the syn-rift Oligocene and younger sediments **(Khalil and McClay, 2002)**.The sedimentary sequence of the study area can be summarized as following from (top to base):

- Thebes Formation (Lower Eocene)
- Esna Shale (Upper Paleocene)
- Tarawan Chalk (Paleocene)
- Dakhla Shale (Maastrichtian to Danian)
- Duwi Formation (Campanian to Maastrichtian)
- Quseir Variegated Shale (Turonian)
- Tarif Formation (Cenomanian).

## 4. PETROGRAPHY

### 4.1. Quartz Arenite:

Quartz arenite was reported in the lower and middle part of the Tarif Formation and in the upper part of the Qusier Variegated Shale, in this rock, the iron oxides is the common cement of the quartz grains of the Tarif Formation samples.The quartz grains are subanguler to subrounded, moderately sorted, clay content less than 5%, so it is submature sample, have monocrystaline with oblique extinction, so it`s origin is plutonic quartz grains > 95%, with contact normal (no compaction).(Fig.5 a, b).The quartz grains of the upper part of the Qusier Variegated Shale are monocrystaline with oblique extinction and many other with wavy extinction, also have polycrystalline quartz grains almost 2 units / grain are recorded (Figures 5 c, d), while in the middle part of the Tarif Formation the quartz arenite is cemented by silica (Fig.5 e).

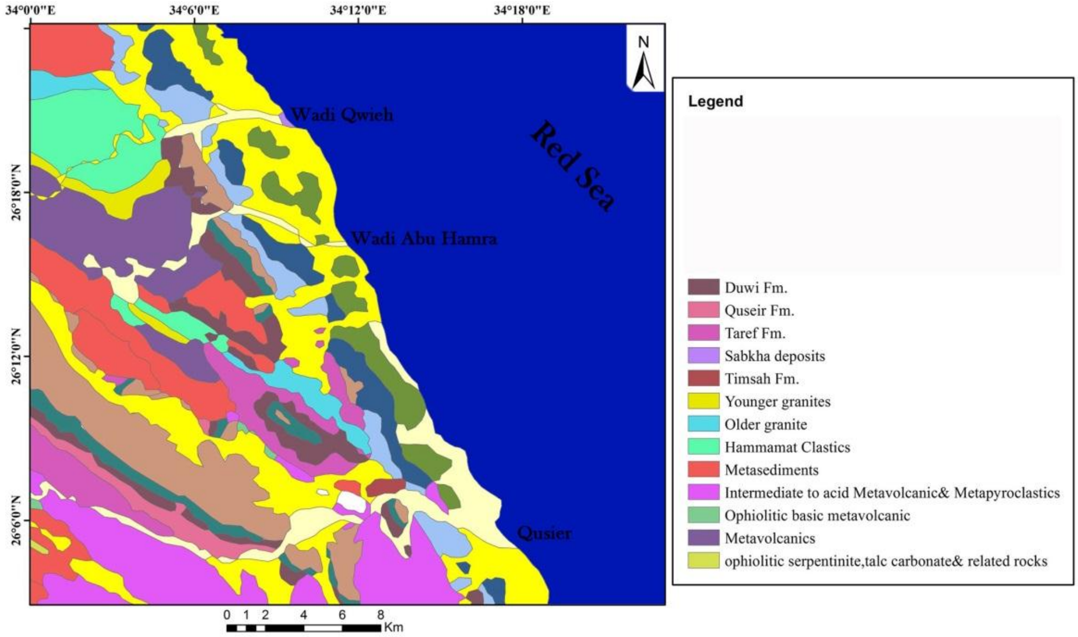



**Fig. (2): Geologic map showing the location of the study area (after Conoco 1987)**

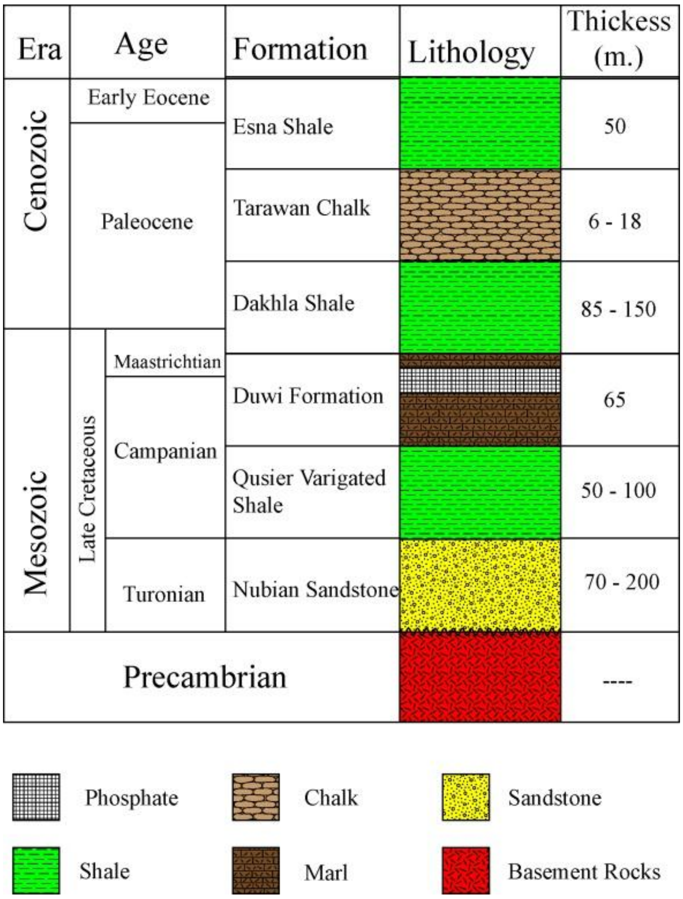
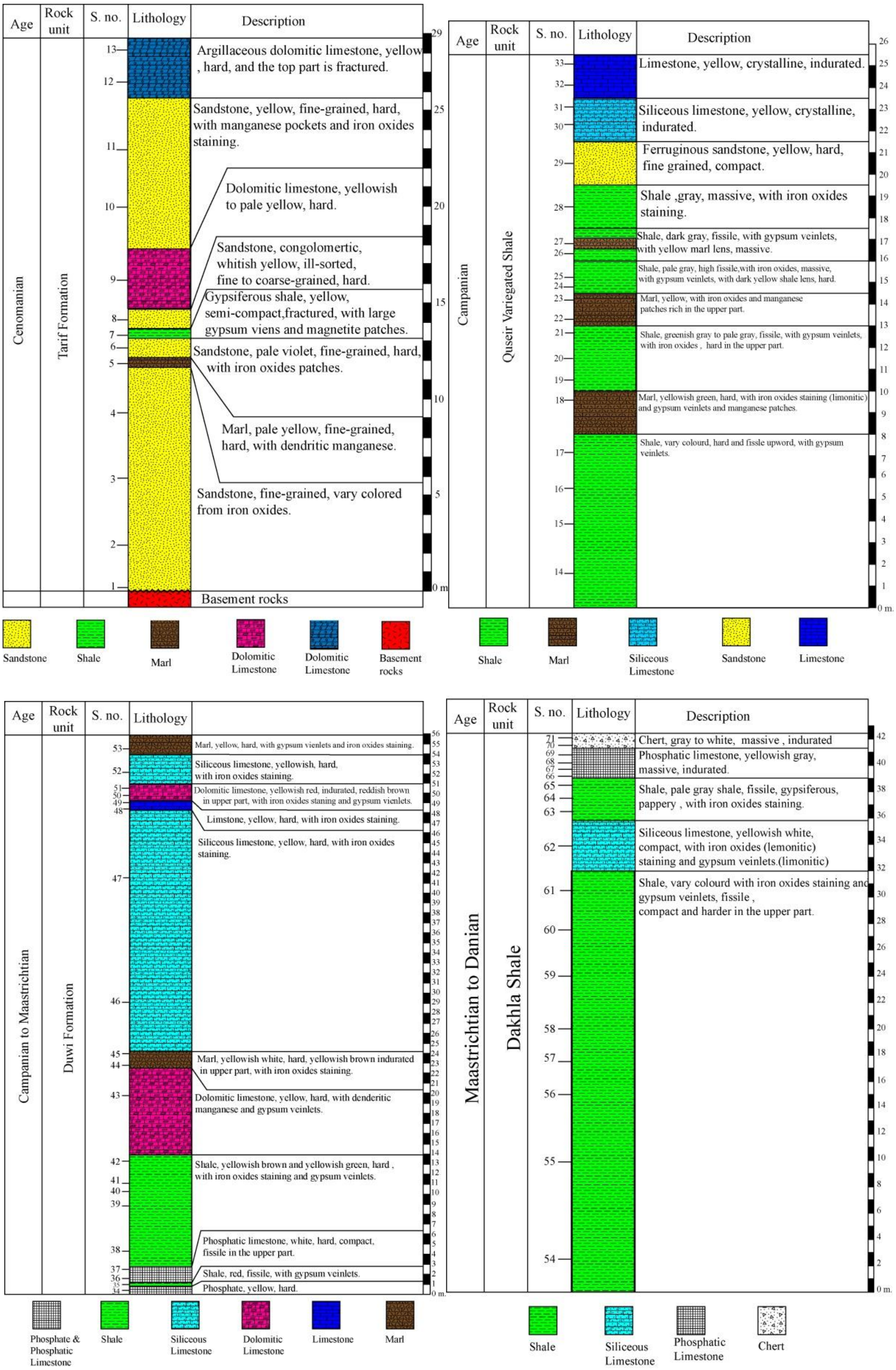



**Fig. (3): Composite stratigraphic succession of the study area, Modified after (Said, 1990 andPurser and Bosence, 1998).**


Age
Rock unit
S. no.
Lithology
Description
Cenomanian
Tarif Formation
Argillaceous dolomitic limestone, yellow, hard, and the top part is fractured.
Sandstone, yellow, fine-grained, hard, with manganese pockets and iron oxides staining.
Dolomitic limestone, yellowish to pale yellow, hard.
Sandstone, congolomertic, whitish yellow, ill-sorted, fine to coarse-grained, hard.
Gypsiferous shale, yellow, semi-compact,fractured, with large gypsum viens and magnetite patches.
Sandstone, pale violet, fine-grained, hard, with iron oxides patches.
Marl, pale yellow, fine-grained, hard, with dendritic manganese.
Sandstone, fine-grained, vary colored from iron oxides.
Basement rocks
Sandstone
Shale
Marl
Dolomitic Limestone
Dolomitic Limestone
Basement rocks
Campanian
Quseir Variegated Shale
Limestone, yellow, crystalline, indurated.
Siliceous limestone, yellow, crystalline, indurated.
Ferruginous sandstone, yellow, hard, fine grained, compact.
Shale ,gray, massive, with iron oxides staining.
Shale, dark gray, fissile, with gypsum veinlets, with yellow marl lens, massive.
Shale, pale gray, high fissile,with iron oxides, massive, with gypsum veinlets, with dark yellow shale lens, hard.
Marl, yellow, with iron oxides and manganese patches rich in the upper part.
Shale, greenish gray to pale gray, fissile, with gypsum veinlets, with iron oxides , hard in the upper part.
Marl, yellowish green, hard, with iron oxides staining (limonitic) and gypsum veinlets and manganese patches.
Shale, vary colour, hard and fissle upword, with gypsum veinlets.
Shale
Marl
Siliceous Limestone
Sandstone
Limestone
Campanian to Maastrichtian
Duwi Formation
Marl, yellow, hard, with gypsum vienlets and iron oxides staining.
Siliceous limestone, yellowish, hard, with iron oxides staining.
Dolomitic limestone, yellowish red, indurated, reddish brown in upper part, with iron oxides staning and gypsum vienlets.
Limstone, yellow, hard, with iron oxides staining.
Siliceous limestone, yellow, hard, with iron oxides staining.
Marl, yellowish white, hard, yellowish brown indurated in upper part, with iron oxides staining.
Dolomitic limestone, yellow, hard, with denderitic manganese and gypsum veinlets.
Shale, yellowish brown and yellowish green, hard , with iron oxides staining and gypsum veinlets.
Phosphatic limestone, white, hard, compact, fissile in the upper part.
Shale, red, fissile, with gypsum veinlets.
Phosphate, yellow, hard.
Phosphate & Phosphatic Limestone
Shale
Siliceous Limestone
Dolomitic Limestone
Limestone
Marl
Maastrichtian to Danian
Dakhla Shale
Chert, gray to white, massive , indurated
Phosphatic limestone, yellowish gray, massive, indurated.
Shale, pale gray shale, fissile, gypsiferous, pappery , with iron oxides staining.
Siliceous limestone, yellowish white, compact, with iron oxides (lemonitic) staining and gypsum veinlets.(limonitic)
Shale, vary colour with iron oxides staining and gypsum veinlets, fissile , compact and harder in the upper part.
Shale
Siliceous Limestone
Phosphatic Limestone
Chert

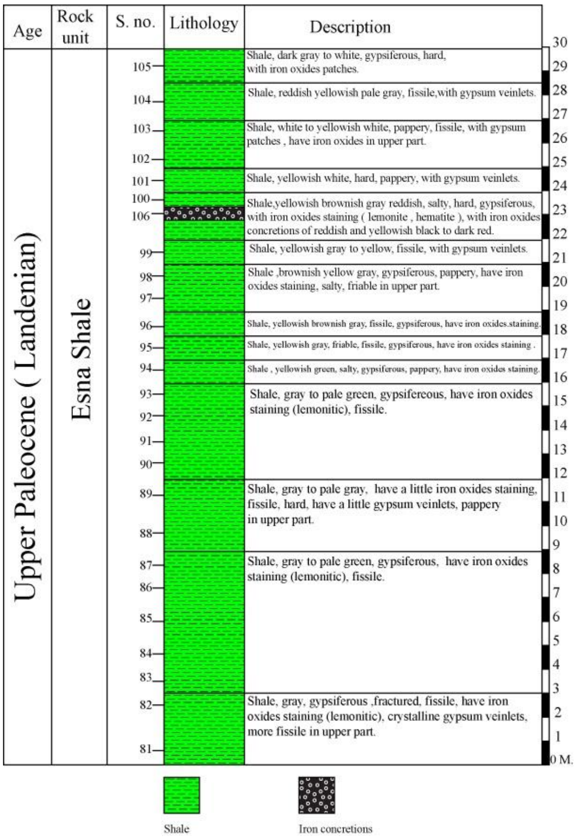
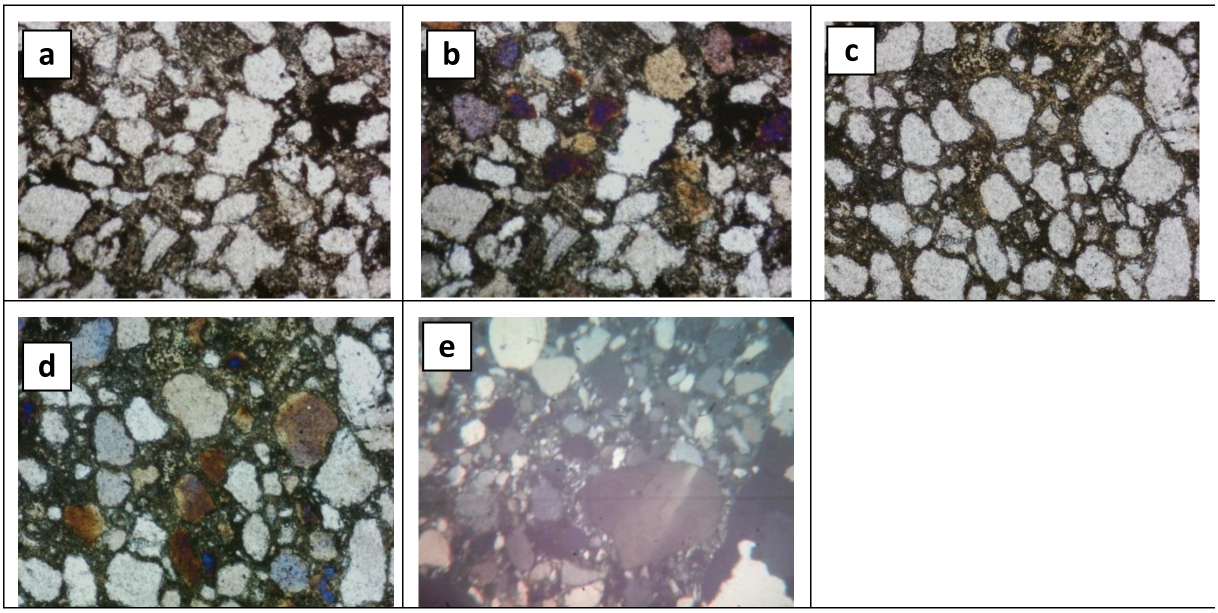



**Fig. (4): Stratigraphic columnar section of the studied sections**




**Figures 5; a and b:*Quartz Arenite:* Photomicrograph showing Quart Arenite cemented by iron oxides, composed of subanguler to subrounded, moderately sorted quartz grains with oblique extinction (a, Plane Polarized Light, X40, b, Crossed Nicols, X40), c and d: *Quartz Arenite*Photomicrograph showing Quartz Arenite, cemented by silica, composed of subrounded and ill-sorted quartz grains, have monocrystaline type with oblique extinction and many other with wavy extinction, also have polycrystalline quartz grains, (c, Plane Polarized Light, X40, d, Crossed Nicols, X40), e: *Quartz Arenite*Photomicrograph showing Quartz Arenite cemented by silica, composed of subanguler to subrounded quartz grains, Ill-sorted conglomerates grains, with monocrystaline(wavy extinction)(Crossed Nicols, X40).**

## 5. MINERALOGY

### 5.1.Mineralogical composition of the bulk samples:

The identification of minerals of the bulk samples of the lower and middle parts of the Tarif Formation and of the upper part of the Qusier Variegated Shale illustrated in (Fig.5),show the presence of the non-carbonatemineral quartz as a major and minor contents of hematite,gypsum and microclineoccasionally, (Table 1).

**Table 1: Minerals detected in XRD analysis of bulk samples**

| Mineral | Main lines in A° | ASTM card | Sample no |
|---|---|---|---|
| Quartz | 4.26A° 3.34A°, and 1.82A° | 5- 0490 | 3,6,25 |
| Hematite | 2.69A°, 1.69A° and 2.51A° | 13-534 | 3 |
| Gypsum | 7.65A°, 3.06A°, and 4.27A° | 6-0046 | 6 |
| Microcline | 3.40A°, 2.77A° and 1.72A° | 13-1 | 25 |

Quartz is the most abundant non-carbonate mineral in the bulk samples, the microscopic of samples revealed that the detrital quartz grains arethe most abundant.

Gypsum is recorded only in sample no. 6 in the Tarif Formation; the presence of gypsum in the sample reflects the increase of sulfate in solution either during the deposition or during the cementation processes.

### 5.2. Oriented-particle:

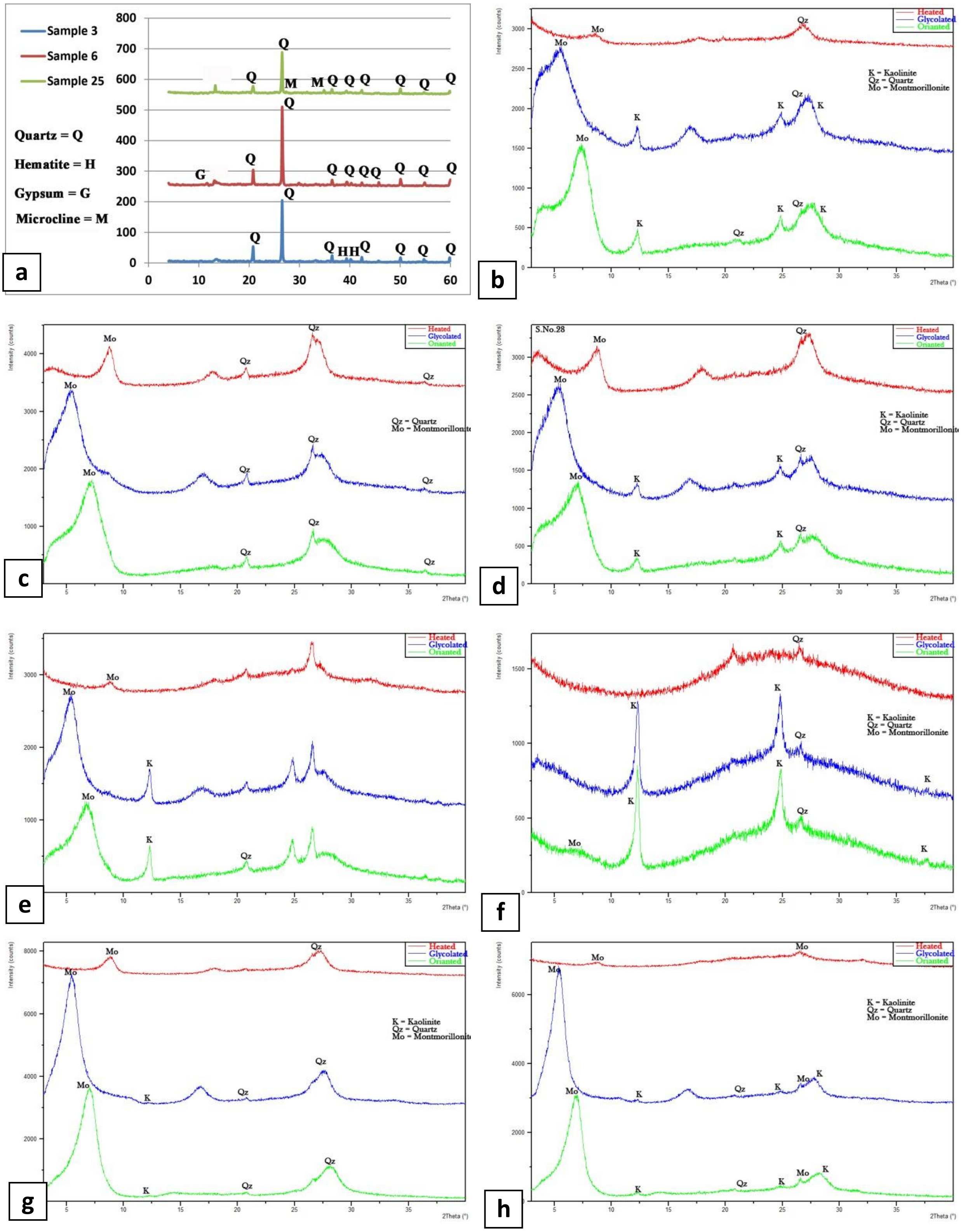
Samples were subjected to each study: 3 from lower, middle and upper part of the Qusier Variegated Shale, 2 from lower and middle part of Duwi, 3 from the middle part of Dakhla, 3 from the middle and upper part of Esna formations.

The clay minerals are montmorillonite and kaolinite. The charts of X-ray diffraction patterns of untreated, glycolated and heated of the oriented samples shown in Figures (5 a - k).

**Droste et al., (1962)** stated that the montmorillonite can be derived from weathering of chlorite in alkaline environment rather than from illite.

**Mohr et al., (1971)** reported that the montmorillonite originates from soils with relative high pH, rich in $Ca^{+2}$ and $Mg^{+2}$ and under impeded drainage. The increase in kaolinite content in the lower part of the Duwi Formation (Fig.5 e) and in the lower part of the Esna Shale (Fig. 5 i) points to seasonal change of climate and chemical weathering.The occurrence of kaolinite indicates a source area which experienced intense weathering possibly during prevalence of tropical conditions **(Biscaye 1965)**.

Where increasing rainfall favour ionic transfer and pedogenic development **(Leung and Lai 1965, Millot 1970, Wang and Chen 1988)**.Meanwhile the increasing concentration of kaolinite indicates the high water–rock ratio in the source area along with a humid-subtropical to tropical climate **(Raucsik and Varga 2008**.



Sample 3
Sample 6
Sample 25
Quartz = Q
Hematite = H
Gypsum = G
Microcline = M
a
b
c
d
e
f
g
h
Heated
Glycolated
Oriented
K = Kaolinite
Qz = Quartz
Mo = Montmorillonite
S.No.28
Intensity (counts)
2Theta (°)

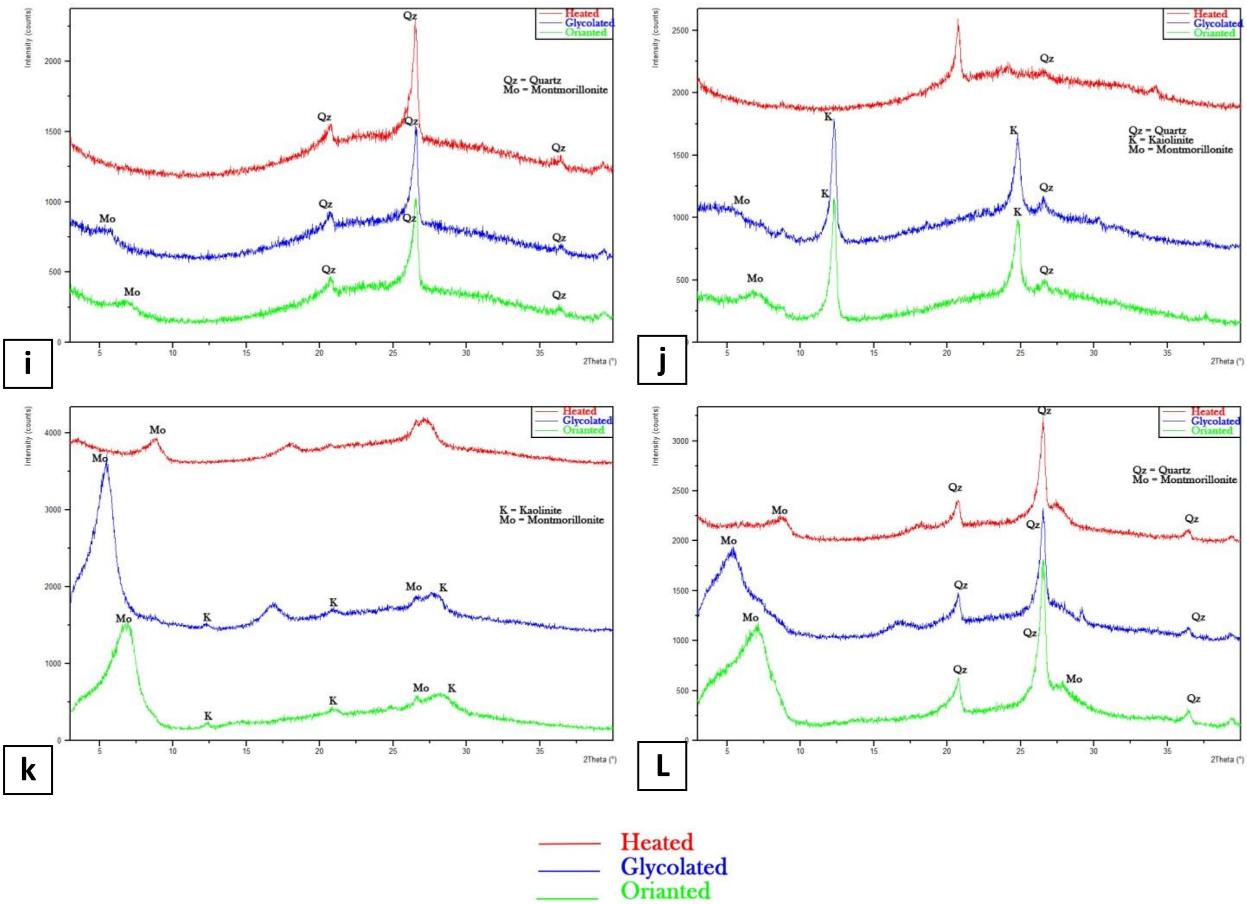



**Fig.5:Representative profiles of X-Ray diffraction patterns for three bulk sandstone samplesof Tarif Formation (samples 3 and 6) and Qusier Variegated Shale (sample 25) in (a), eleven shale samples; b: (sample no. 16), c: (sample no. 24), d: (sample no. 28), e: (sample no. 35), f: (sample no. 41), g: (sample no. 58), h: (sample no. 60), i: (sample no. 60), j: (sample no. 83), k: (sample no. 94), L: (sample no. 105),**

## 6. GEOCHEMICAL CHARACTERIZATION

Table 2 shows the concentrations of the major constituents (in %) and trace elements (in ppm) in the studied rock units.

The major oxides and trace elements, shown in table 2 indicate the following geochemical characteristics:-

In Tarif sandstone samples, the CaO, MgO, $K_2O$, $SiO_2$, $P_2O_5$, $Na_2O$, Cl, $TiO_2$, L.O.I., Ni, Cu, Sr, Zr, Cr and Mn show genital vertical increasevariation, while $Al_2O_3$, $Fe_2O_3$, $SO_3$, Co and Zn characterized by high fluctuation in vertical distribution in the studied sandstone samples.

In the shale samples, MgO, $K_2O$, $SiO_2$, $P_2O_5$, $Fe_2O_3$, $TiO_2$, $SO_3$, Ni, Cu and Zn are characterized by genital vertical variation, while CaO, $Na_2O$, Cl, L.O.I., Co, Sr, Zr, Cr and Mn are characterized by high fluctuation in vertical distribution in the studied shale samples.

Both CaO and L.O.I. show general decrease towards the center, while MgO show general increase from base to top. Where the Cl increase upward Tarif sandstone bed (7.14 %) the base of the shale and decrease in upper part in the shales, this may be pointed to arid evaporational environment. This may show change of a very shallow marine environment. The Qusier Variegated Shale is ferruginous (max.= 10.92), while the upper sandstone beds of the Tarif Formation is highly ferruginous (max. = 20.61).

Table 2: concentrations of the major constituents (in %) and trace elements (in ppm) in the Upper Cretaceous clastic rocks

| | | | Major Constituents (in %) | | | | | | | | | | | | Trace elements (in ppm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S. No. | CaO | MgO | $K_2O$ | $SiO_2$ | $Al_2O_3$ | $P_2O_5$ | $Na_2O$ | Cl | $Fe_2O_3$ | $TiO_2$ | $SO_3$ | L.O.I. | Co | Ni | Cu | Zn | Sr | Zr | Cr | Mn |
| Tarif Formation | Sandstone | 1 | 5.03 | 0.9 | 0.31 | 65.9 | 2.61 | 0.38 | 0.5 | 0.23 | 14.7 | 0.98 | 4.1 | 4.2 | 189 | 43 | 45 | 41 | 163 | 375 | 84 | 78 |
| | | 3 | 1.07 | 0.51 | 0.11 | 71 | 1.07 | 0.1 | 0.4 | 0.23 | 20.61 | 1.83 | 0.93 | 1.99 | 78 | ND | 30 | 71 | 100 | 348 | 154 | 53 |
| | | 6 | 4.88 | 0.27 | 1.32 | 55.7 | 12.3 | 0.18 | 0.89 | 0.08 | 3.7 | 1.17 | 13 | 6.4 | 47 | 32 | 21 | 19 | 140 | 155 | ND | 59 |
| | Average of S.S. samples | | **3.66** | **0.56** | **0.58** | **64.20** | **5.33** | **0.22** | **0.60** | **0.18** | **13.00** | **1.33** | **6.01** | **4.20** | **104.6** | **37.50** | **32.00** | **43.67** | **134.3** | **292.6** | **119** | **63.33** |
| | Shale | 7 | 9.11 | 2.57 | 0.55 | 27 | 12.85 | 0.59 | 5.78 | 7.17 | 3.82 | 0.03 | 14.8 | 15.2 | ND | 77 | 57 | 109 | 208 | 58 | 213 | 161 |
| Qusier Variegated Shale | | 19 | 0.42 | 2.8 | 2.65 | 53 | 14.81 | 0.1 | 1.27 | 1.74 | 10.35 | 1.08 | 0.14 | 11.5 | 119 | 104 | 47 | 49 | 68 | 245 | 179 | 101 |
| | | 20 | 1.1 | 2.9 | 3.37 | 44.7 | 13.62 | 0.51 | 2.41 | 3.97 | 10.92 | 0.84 | 0.45 | 15 | ND | 110 | 35 | 117 | 165 | 189 | 110 | 150 |
| | | 24 | 0.51 | 3.31 | 2.65 | 48 | 13.96 | 0.2 | 2.92 | 3.84 | 8.67 | 0.7 | 0.06 | 15.1 | 128 | 70 | 40 | 74 | 53 | 137 | 120 | 76 |
| | | 26 | 1.09 | 3.11 | 2.23 | 47.6 | 14.54 | 0.54 | 3.82 | 3.72 | 9.61 | 0.81 | 0.1 | 12.53 | 151 | 99 | 53 | 171 | 90 | 150 | 143 | 127 |
| Duwi Format-ion | | 35 | 13.8 | 1.24 | 0.87 | 34.9 | 17.43 | 1.01 | 0.49 | 0.31 | 7.07 | 0.52 | 2.16 | 22.02 | ND | 138 | 63 | 184 | 121 | 91 | 422 | 351 |
| | | 41 | 11.5 | 1.65 | 0.95 | 38 | 16.12 | 0.74 | 1.02 | 0.23 | 7.69 | 0.72 | 2.05 | 19.06 | ND | 95 | 52 | 191 | 109 | 118 | 235 | 276 |
| Dakhla Shale | | 58 | 0.57 | 3.49 | 1.76 | 49.8 | 14.97 | 0.55 | 1 | 1.28 | 8.61 | 0.94 | 0.94 | 15.9 | 123 | 117 | 55 | 131 | 50 | 220 | 148 | 125 |
| | | 60 | 0.32 | 3.12 | 1.09 | 52.1 | 15.23 | 0.68 | 1.14 | 1.52 | 7.63 | 1.13 | 1.57 | 14 | 161 | 50 | 75 | 91 | 779 | 383 | 185 | 54 |
| Esna Shale | | 83 | 5.75 | 1.92 | 1.23 | 35.4 | 17.34 | 0.24 | 3.37 | 2.9 | 5.95 | 0.67 | 3.6 | 21.5 | ND | 109 | 69 | 125 | 175 | 100 | 263 | 80 |
| | | 88 | 14.7 | 1.98 | 1.05 | 31.6 | 16.51 | 0.2 | 3.32 | 3.44 | 5.13 | 0.53 | 0.79 | 20.45 | ND | 97 | 54 | 124 | 750 | 216 | 285 | 79 |
| | | 94 | 7.72 | 3.1 | 0.88 | 18.7 | 6.82 | 0.13 | 18.65 | 14 | 2.15 | 0.17 | 14.9 | 12.5 | ND | 34 | ND | 85 | 118 | 29 | 121 | 83 |
| | | 97 | 14.4 | 6.49 | 1.02 | 22.6 | 8.38 | 0.2 | 10.08 | 8.11 | 3.45 | 0.25 | 3.23 | 21.45 | ND | 49 | 24 | 73 | 404 | ND | 187 | 165 |
| | | 105 | 7.27 | 7.41 | 0.58 | 41.5 | 7.7 | 0.77 | 1.87 | 3.24 | 3.99 | 0.25 | 0.18 | 25 | 70 | 87 | 35 | 149 | 18 | 60 | 287 | 46 |
| Average of shale samples | | | **6.30** | **3.22** | **1.49** | **38.92** | **13.59** | **0.46** | **4.08** | **3.96** | **6.79** | **0.62** | **3.21** | **17.23** | **125.3** | **88.29** | **50.69** | **119.5** | **222** | **153.5** | **207.** | **133.8** |

The trace element distribution show higher contents of Co, Ni, Cu, Zn, Zr and Mn in the upper sandstone beds of Tarif Formation show increase upward in the Tarif sandstone beds. The highly ultramafic elements Ni, Cu and Cr in the sandstone and shale samples (Dakhla Shale and Qusier Variegated Shale) is duo to their ultramafic source, while they are belong limited detection of the applied technique analysis.

**Pettijohn (1975)** mentioned that the $SiO_2/Al_2O_3$ ratio of the shale reflect the grains size, where the higher the coarser the grain size and vice versa. The shale samples both of Tarif and Duwi formationsare the finest, while the shale of the Qusier Variegated Shale and Dakhla Shale are of larger size (Table 3).

**Pettijohn et al., (1973)** reported that the calcium and magnesium elements originate as chemical precipitates in sandstones primarily as carbonates and much may be diagenetic.The ratio of CaO/MgO in the sandstone samples in s. no. 1, 3 and 6 are 5.58, 2.09 and 18.07 respectively, so the CaO/MgO ratio of the studied sandstone doesn't show any particular trend for distribution and this variation can be attributed to the relative position of Upper Cretaceous sandstone rock units form shore line. **Trask (1939)** stated that the higher the salinity, the greater the content of $CaCO_3$.

**Millot (1970)** stated that clays contain $K_2O/Na_2O$ ratio equals 2.94. As well, **Weaver (1967)** the K/Na and K/Mg ratios are equally important, where low ratios favour the formation of montmorillonite (which is recorded in XRD) and chlorite materials, while high ratios favour the formation of illite. Also high values are more likely to occur in continental than marine environments. In the studied shale samples, the $K_2O/Na_2O$ ratio is always lies less than the published ratio as it shown in table 4 and low ratios maybe due to that the montmorillonite is the main clay mineral and the absence of illite as it resulted in XRD.

Table 3: The average of $SiO_2/Al_2O_3$and $K_2O/Na_2O$ratios in the shale samples

| **Formation** | **$SiO_2/Al_2O_3$** | **$K_2O/Na_2O$** |
|---|---|---|
| Tarif Formation | 2.10 | 0.10 |
| Qusier Variegated Shale | 3.39 | 1.05 |
| Duwi Formation | 2.17 | 1.21 |
| Dakhla Shale | 3.38 | 1.33 |
| Esna Shale | 2.64 | 0.13 |

### 4- Tectonic setting

Figure 6illustrates the ternary plot of $SiO_2$-$Al_2O_3$-$Fe_2O_3$of sandstone samplespointing to that the Cenomanian Tarif Formation sandstones mainly are subgreywacke**(Moore and Dennen 1970)**

**Pettijohn et al., (1973)** proposed a classification for the sandstones based on the relationship between Log ($SiO_2$ / $A1_2O_3$) and Log ($Na_2O$ / $K_2O$). The relationship between Log ($SiO_2$ / $A1_2O_3$) and Log ($Na_2O$ / $K_2O$)for Tarif sandstone samples shown in Fig.7 revealed that; the samples ranged from sublithic-arenite to lithic-arenite.

**Blatt et al., (1980)** proposed another classification for the sandstones based on their chemical composition in relation to tectonic setting. He added that a plot of $Fe_2O_3$, MgO, $Na_2O$ and $K_2O$ on a ternary diagram Fig.8 makes a fairly effective separation, with some overlap, among eugeosynclinal sandstones (mostly greywacke) taphrogeosynclinal sandstones (mostly arkoses) and exogeosynclinal sandstones (mostly lithic sandstones). The relationships suggested by **Blatt et al., (1980)**, it seems that the Tarif Formation sandstone samples eu-geosyncline sediments.

Figure 9 shows a log-log plot of ($SiO_2/Al_2O_3$) vs. ($Fe_2O_3/K_2O$) after **Herron (1988)**, which reflect that the sandstone and shale samples of the Tarif Formation are Fe-sand and Fe-shale, due to the recorded of high iron oxides content, and most of the shales of Qusier Variegated, Duwi, Dakhla and Esna formations of the Wadi Qwieh-Wadi Abu Hamra area are plot in the shale field.

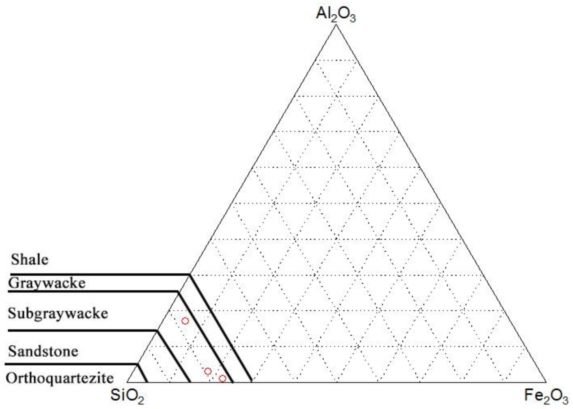



Fig.6: Ternary plot of Si -Al -Fe of the studied sandstone samples **(after Moor and Dennen, 1970)**

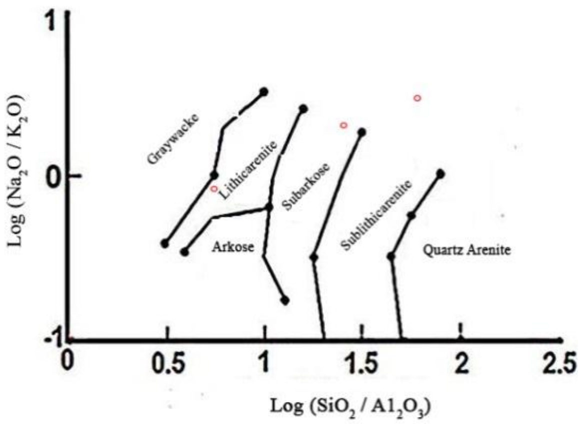



Fig.7: Chemical classification of the sandstone samples of the Tarif Formation based on the log ($SiO_2/Al_2O_3$) vs. log ($Na_2O/K_2O$) of **(Pettijohn et al., 1973)**

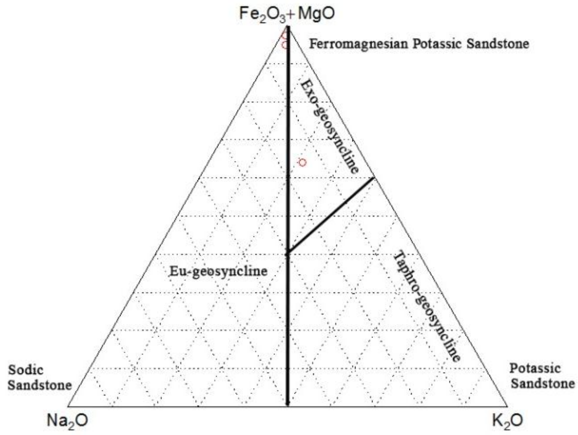



Fig.8: Chemical composition of the studied sandstone samples of the Tarif sandstone in relation to tectonic setting (after **Blatt et al., 1980)**

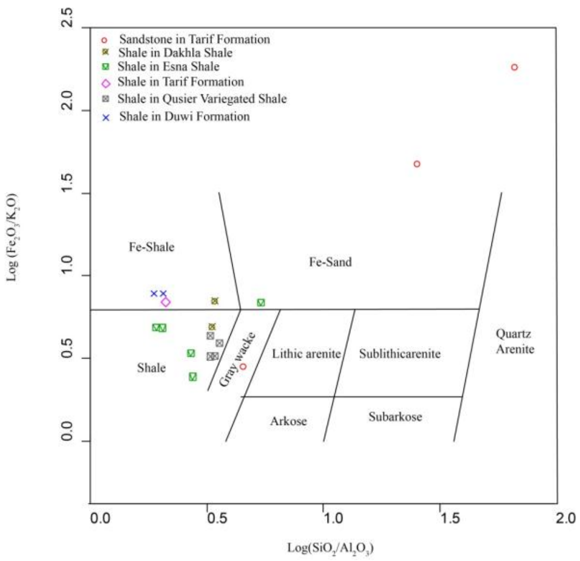



Fig. 9: shows a log-log plot of ($SiO_2/Al_2O_3$) vs. ($Fe_2O_3/K_2O$) after **Herron (1988)**,

## CONCLUSIONS

The clastic sedimentary rocks of the Upper Cretaceous inWadi Qwieh – Wadi Abu Hamra area, shows that the following results: 1- the lithofacies type of the sandstone samples in Tarif Formation are quartz arenite quartz arenite cemented by iron oxides and silica. 2- The X-ray diffraction analysis of the clastic rocksrecorded that the main mineral constituents is quartz, while hematite, gypsum and microcline are less abundant, 3- The oriented shale samples show that the most chief clay minerals detected are montmorillonite (smectite) and kaolinite.4- Geochemically, the environment of deposition of Upper Cretaceous sandstones was not deep, also indicate occasionallyevaporational of studied shale is deposited in semi-restricted environment.

## REFERENCES

**ABOU EL-ANWAR, E. A. (2017):** "Mineralogical, petrographical, geochemical, diagenesis and provenance of the Cretaceous Black Shales, Duwi Formation at Quseir-Safaga, Red Sea, Egypt Egyptian." Jour. of Petroleum No. 26, pp. 915–926.

**ABOU EL-ANWAR, E. A., MEKKY, H. S., & ABDEL WAHAB, W. (2018):** "Mineralogy and depositional environment of black shales of the Duwi Formation, Quseir area, Red Sea coast, Egypt." Carbonates and Evaporites, 10p.

**AMERICAN SOCIETY OF TESTING MATERIAL (A. S. T. M.)(1960**): "Index to the powder diffraction file." A. S. T. M., special technical pub.,

**BISCAYE, B. E. (1965):** "Mineralogy and sedimentation of recent deep sea clay in the Atlantic Ocean and adjacent seas and oceans." Geol. Soc. America Bull. V. 76, pp. 803-832.

**BLATT, H., MIDDLETON, G. & MURRAY, R. (1980):** "Origin of sedimentary rocks." Printed Hall Inc. Englewood Cliffs. New Jersey, 781p.

**BROWN, C. (1961):** "The X-Ray identification and crystal structure of clay minerals." A symposium, the Mineralogical Soc., London, 544p.

**CONOCO, C. (1987):** "Geological map of Egypt." NG 36 NE Qseir.

**DEER, E. A., HOWIE, A. A. & ZISSMAN, J. (1963):** "Rock- forming minerals." V. 1, John Wiley and Sons, 528p.

**DROSTE, J. B. J, BHATTACHARYA, H. & SUNDERMAN, J.A., (1962):** "Clay mineral alteration in some Indiana soils" clays and clay minerals ($9^{th}$ Nat. Conf. 1960), pp. 329-343.

**ELBADRY, O., HASSAAN, M., & ABU EL-ENEIN, F. (1983**): "Sedimentology and Chemistry of the sandstone of Nubia facies." Fac. Sci. Zagazig Univ., Bull., No 5.

**ELKAMMAR, M. M., (2015):** "Source-rock evaluation of the Dakhla Formation black shale in Gebel Duwi, Quseir area, Egypt." Jour. of African Earth Sciences V. 104, pp. 19-26.

**HASSAAN, M. M., SAKR, S. M., ABDEL GAWAD, E., & EL-NAGGAR, I.M., (2016):** "Reconnaissance lithological-geochemical exploration for organic matter and total organic carbon in the Late Campanian-Paleocene black shale belt, Upper Egypt." IJISET – International Jour. of Innovative Science, Engineering and Technology, V. 3 Issue 2, pp. 699-709.

**HERRON, M. M. (1988):** "Geochemical classification of terrigenous sands and shales from core or log data." Jour. of Sedimentary Petrology 58, V.5, pp.820-829.

**HOWAIDY, A. A. (1979**): "Stratigraphy of the Cretaceous and Lower Tertiary rocks in Wasif area, Eastern Desert, Egypt." Fac. Sci., Al-Azhar Univ., Cairo.

**KHALIL & MCCLAY (2002):** "Extensional fault-related folding, northwestern Red Sea, Egypt". Jour. of Structural Geology V. 24, pp.743-762.

**LEUNG, K. W., & LAI, C. Y. (1965):** "A synthesis of the genesis of reddish brown latosols in Taiwan." Jour. of the Agricultural Association of China, New Series, V. 52, pp. 81-102.

**MILLOT, T. G. (1970):** "Geology of clays." Springer. Verlag, New York, 429p.

**MOHR, E. C. J., VAN BAREN, F. A. & VAN SCHUYLENBORGH, J. (1971):** "Tropical soils, The Hague, the Netherland: In: Seghal et. al. (1974), Genesis, transformation and classification of clay minerals in soil." Bull. Indian Soc. Soil Sc., V. 9, pp. 1- 21.

**MOORE, B. R., & DENNEN, W. H. (1970**): "A geochemical trend in silica-aluminum-iron ratios and the classification of clastic sediments." Jour. Sed. Petro. V. 40, 1147p.

**PETTIJOHN, F. J. (1975):** "Sedimentary rocks." Harper & Brothers "New York, 718p.

**PETTIJOHN, F. J., FETTER, P. E., & SIEVER, R. (1973):** "Sand and sandstones." New York: Springer Verlag, Berlin 618p.

**PURSER, B. H., & BOSENCE, D. W. J., (EDS), (1998):** "Sedimentation and tectonics in Rift Basins: Red Sea- Gulf of Aden" 663p. London

**RAUCSIK, B., & VARGA, A. (2008):** "Climate-environmental controls on clay mineralogy of the Hettangian-Bajocian successions of the Mecsek Mountains, Hungary: An evidence for extreme continental weathering during the early Toarcian oceanic anoxic event." Paleogeography Paleoclimatology Paleoecology, V. 265, pp. 1-13.

**SAID, R. (1990):** "The Geology of Egypt."A.A. Balkema, Rotterdam/Brookfield, 734p.

**TRASK, P. D. (1939):** "Organic content of recent marine sediments." In Recent marine Sediments, symposium Soc. Eco. Paleontologists Mineralogists, spec. publ, No. 4. Tulsa pp. 428-453.

**WANG, H. M., & CHEN, S. H. (1988):** "Mineralogical and chemical studies of gravel weathering and its relation to lateritic soil formation in the Linkou terrace." Tih-Chih, V. 8, pp. 27-47.

**WARD, W. C., MCDONALD, K. C. & MANSOUR, S. E. I. (1979):** "The Nubia Formation of the Quseir – Safaga area, Egypt, Geol. Surv. Egypt, V. 9, pp. 420-431.

**WEAVER, C. E. (1967):** "Potassium, illite and the ocean: Geochem." Et. Cosmochim Acta, V. 31, pp. 2181- 2196.