Research Article

GEOLOGY

Utilizing Remote Sensing and Lithostratigraphy for Iron and Clay Minerals Mapping in the North of Aswan Area, Egypt

Samir Kamh[1], Hamza Khalil[1], Gamal Mousa[1], Mamdouh Abdeen[2], Ola Ghobara[1]

[1]Geology Department, Faculty of Science, Tanta University, Tanta 31527, Egypt
[2]National Authority of Remote Sensing and Space Sciences, Cairo, Egypt

Corresponding author: *Samir Kamh*   **e-mail:** *skamh@science.tanta.edu.eg*

KEY WORDS	ABSTRACT
	Araba, Gilf and Abu Ballas formations contain clay and iron sediments are detected by the processing techniques to the remote sensing data of Landsat-8 OLI/TIRS. The false color composite, band ratio and principal component analysis techniques are adopted as the image analysis algorithms. The stratigraphic detailed studies are performed, and an improvement geologic map is produced. The Araba Formation is represented by about 20 m thick, the thickness of the Gilf Formation ranging from 10 to 35 m where Abu Ballas Formation has 25 m thickness in the study area. Three clay-beds are recorded in Gilf Formation. Thesis clay beds are a character of the so-called ball-clay shale, currently of economic use in ceramics industry. More than 108 samples from clay and iron sediments are collected and spectrophotometry study was performed. A high content of clay minerals and iron oxides are reported in the spectral curves which helped to map the clay and iron minerals in a satisfactory scale in the study area.

1. Introduction

Clay and iron deposits can be found in a variety of geological formations dating from the Cambrian to Quaternary. These deposits can be found in many locations throughout Egypt, including the Nile Valley and Delta, as well as the Eastern and Western Deserts. East of Aswan area mostly compose of non-marine to marginal and shallow marine siliciclastics sedimentary rocks. The Nubian sandstone and other formations in this area are encompassed clay and iron deposits. **Hussein (1990)** suggested that the iron ores in these formations are deposited under lacustrine conditions during the Senonian age. **Khedr et al. (2010a)** mentioned that the sedimentary rocks at Aswan area represent about 170 m thickness and consists mainly of sandstone intercalated with six clay beds. Aswan clay is known commercially as ball clay. The highly plastic clay minerals which rolling into balls are known commercially as ball clay. This type of clay is used essentially in the ceramic industry. The ball clay is composed mainly of poorly crystalline kaolinite and illite and/or smectite in a small percent **(Baioumy and Ismael, 2014)**. The main color of the ball clay is white, but ranges of brown to pink and of grey to black are also observed .

Remotely sensed images are an important source of the iron and clay deposits maps. They give a quantitative, geographically contiguous estimate of the surface reflectance of these mineral characteristics **(Scull et al., 2003)**. This technique is decreasing the field survey coast and facilitate mapping of the remote areas **(Dogan and Kilic, 2013)**. It also aids in the production of more accurate and up-to-date iron and clay minerals maps through large-scale automatic survey and verified by the field **(Cohen et al., 2003)**. The spectral reflectance of some physical properties (such as particle size and surface roughness) and components (such as surface mineralogy) of these deposits can be the targets which detected by the remote sensing sensors. The present work used the remotely sensed data to produce mineral composite maps of the iron oxide and clay minerals to the study area.

2. Study area description

The study area is located at the north of Aswan city, south of Egypt. it extends between latitudes 24° 3' 45" – 24° 16' 12" N and longitudes 32° 51' 11" – 33° 8' 52" E, which covering about 685.52 km^2 (Fig. 1). Where the ball clays in the study area have relatively large reserves of about ten million metric tons for sure **(Baioumy and Ismael, 2014)**. A lot of companies produced the ball clay for local ceramic and tile manufactures mainly from Wadis Abu Subeira and Abu Aggag at the north of Aswan area. Therefore, the objective of the current work is to explore and map the clay and iron ore deposits in the study area using integrated study between field observation, lithostratigraphy and remote sensing data.
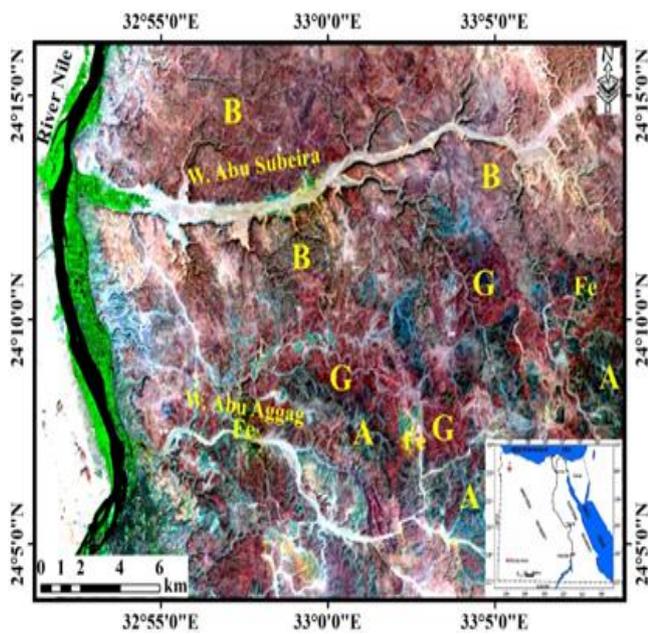
Fig. 1: Landsat-8 RGB-753 for the study area. inset map showing the location map of the study area. Note: A: Araba Formation, G: Gilf Formation, B: Abu Ballas Formation, and Fe: rich iron areas.

The study area is characterized by geomorphological and geological properties can create a favourable depositional environment for clay and iron accumulations. These conditions encouraging for exploration to the clay and iron ore deposits. **El Bastawesy et al., (2013)** stated that the geomorphology of the area around the River Nile has high impact in the hydrological system development as well as the ores accumulation. The area is drained by many wadis namely Abu Subeira, Abu Aggag, Um shah, al-Hudi, al-Haytah and Um Udah (Fig. 2).

The topography is described as relatively low to moderate elevations ranging from 75 m to 546 m as shown in the Digital Elevation Model (SRTM DEM 30 m) of the target area (Fig. 2). The high elevated plateau is recorded at the south east of the study area and the elevations are decreased towards the east. The sedimentary plateau is highly dissected with the relatively E-W direction wadis of Abu Subeira and Abu Aggag take a nearly right angle with the River Nile, where their tributaries oriented NW-SE .
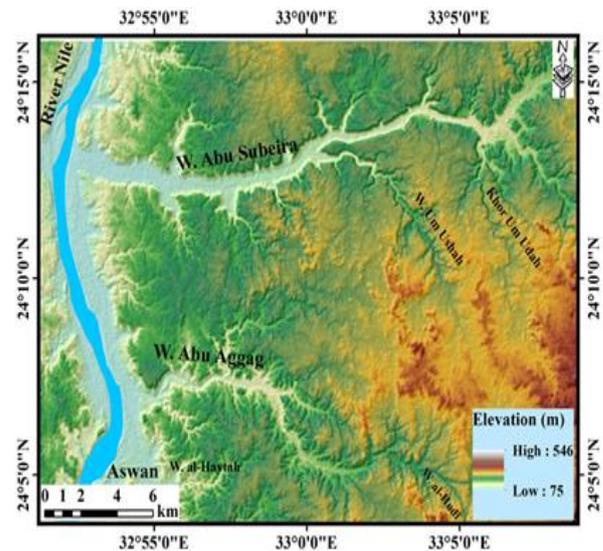

Fig. 2: The Digital Elevation Model SRTM DEM with 30 m spatial resolution of the study area.

Geologically, the sedimentary successions are unconformably overlying Precambrian basement rocks in the area. These rocks are represented as small hills at the south of the area. Basement rocks are represented by gneisses and highly fractured hills of granite. The granitic intrusions are composed mainly of sheared tonalite and granodiorite intruded into the surrounding rock units (Fig. 3). The age of the sedimentary successions of the study area are ranged from Cambrian to upper Cretaceous. The constitute units of the Nubia sandstone succession such as sandstones, siltstones and shale are considered a favourable depositional environment for clay and iron ores. Three main formations are investigated in the study area; they known as Araba Fm. (Cambrian-Ordovician in age), Gilf

Fm. (Carboniferous) and Abu Ballas Fm. (upper Jurassic to upper Cretaceous) overlained by Quaternary deposits. These rock units area recorded in the field as horizontal beds. **Salem and El Gammal (2015)** reported that the stratigraphic section in the north Aswan area is composed mainly of fluvial deposits containing cross-bedded ferruginous sandstones, ripple-laminated sandstone, and lens-shaped sands. Moreover, the rocks are dissected mostly by NW-SE and NE-SW structural sets of faults, sometimes give fault-block shapes at the fault intersection relationships.
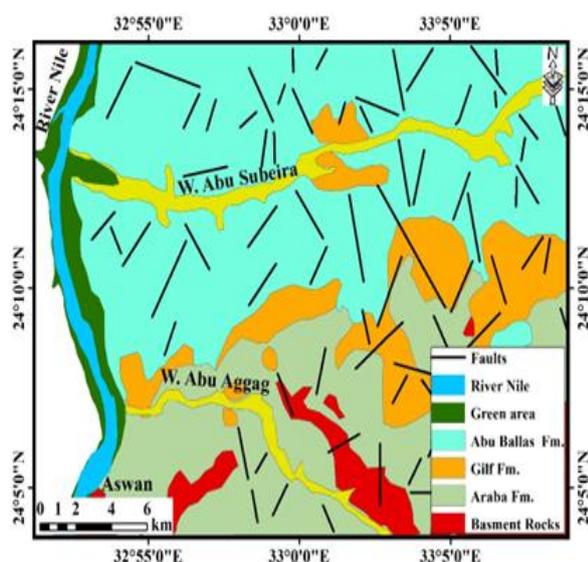

Fig. 3: Geologic map of the study area (modified after Khedr et al., 2010a).

3 .Data and Methods

Landsat-8 OLI/TIRS, taken on 19 March 2020 (path/row: 174/43) is used in the image processing, to produce updated geologic map and to explore the rich areas of clay and iron minerals. Landsat-8 has nine spectral bands in the VNIR and SWIR spectral ranges with a spatial resolution of 30 m, as well as two TIR bands with a spatial resolution of 90 m. The Landsat-8 image is corrected geometrically to Universal Transverse Mercator (UTM), with WGS-84 datum.

The image is radiometrically and atmospherically corrected using ENVI v. 5.3 software package and the processed image results are exported to ArcGIS v. 10.5 package to produce the final geologic map. The field visits are performed to lithostratigraphy description, collect rock samples, measurements and detect clay and iron quarries for maps validation. The mineral content of the collected samples were investigated by Spectrophotometer at the National Authority of Remote Sensing and Space Sciences (NARSS), Egypt. One hundred and eight samples representing different clay and iron beds occurring from the study area are analyzed to elucidate lithostratigraphy and depositional environments. Among these number 42 of clay, 46 of sandstone and 15 shale samples. The remaining 5 samples are varied and include conglomerate, marl and iron oxides. Moreover, the ball clay beds at Wadies of Abu Subeira and Abu Aggag are represented by thirteen samples.

4. Results and Discussion

4.1. Remote Sensing based Geological Mapping

Remote sensing approaches provide detailed mineralogical data and help in mineral identifications and lithological discrimination (**Pour and Hashim 2012**). Different image processing techniques have been used for geological mapping as well as clay and iron deposits detection in the studied area. The image processing of the Landsat-8 data are adopted and many algorithms are applied. To enhance the geological contacts and minerals of clay and iron the following techniques are performed; (**1**) False Color Composite

(FCC) as a straightforward algorithm for enhancing the lithological differentiation and structural features and/or lineaments. **(2)** Principal Component Analysis (PCA) which reduce the dimensionality of data sets and use the uncorrelated bands to detect the clay and iron ores distribution, and **(3)** band ratio method which considered as one of the most effective algorithms to detect mineralization such as clay **(e.g. Gilles et al., 2019; Hegab, 2021)** and iron ore deposits **(e.g. Salem and El Gammal, 2015)**. Moreover, the spectral data for rocks and minerals of the representative samples was used to detect the mineralogical composition of the rock units especially which rich in clay and iron ores.

4.1.1 False Color Composite (FCC)

The composite of the Landsat-8 RGB-753 highlighted the geological contacts and discriminates lithological discrimination between the three sedimentary formations in the study area. Where the Araba fm. is appeared as dark bluish brown pixels in the south of the area (Fig. 1). Where the Gilf fm. is enhanced as bright pixels of reddish-purple dismembered localities at the central parts of the area. The Abu Ballas fm. exhibit yellowish brown signature at the north of the area. the iron rich areas appear as dark green signatures.

4.1.2 Band ratios

By identifying the distinctive absorption features and high reflectance values of the specific minerals, the band ratio technique can produce a good differentiated image **(Hassaan et al., 2018)**. Among sets of bands ration we offered here the band ratio of RGB-4/2-5/7-5/4 which helped to differentiating

between the three geological formations and iron ores areas (Fig. 4). Araba fm. exhibits by a pale greenish violet, Gilf fm. Which containing the clay minerals, takes a dark violet color where the Abu Ballas fm. highlighted by the bluish violet color at the north of the area. the rich iron ore pixels attain a bright green color.

4.1.3 Principal Component Analyses (PCA)

From the constructing PCs of bands 1 to 7 to the landsat-8 and their eigenvectors values, it clear that the first three component is the more informative ones. Figure (5) shows the PCA-123 which explore the Araba fm. in yellowish red colors, the Gilf fm. in the bright red pixels and Abu Ballas fm. as yellowish greenish red signature. The iron rich areas reflected as bright cyan pixels.

The aforementioned image enhances the structure fractures and faults which dissected the rock units and control also the distribution of the mineralization in the area (Fig. 3). An improved geologic map of the study area (Fig. 3) was produced as the interpretation results of the remote sensing results and verified by the field investigation.
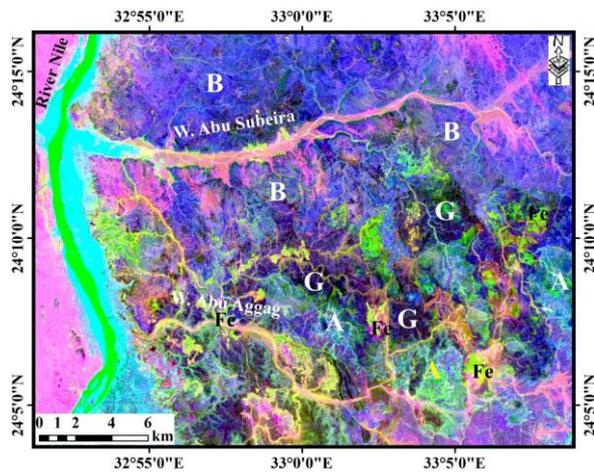
Fig. 4: Landsat-8 band ratio RGB-4/2-5/7-5/4 discriminates effectively between the three sedimentary formations and enhance the iron rich areas with bright green color. For abbreviations, see Fig. 1.
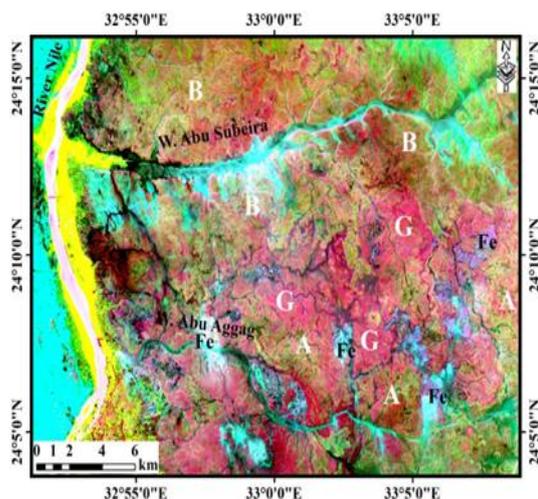

Fig. 5: Landsat-8 PCA-123 explores contacts between the three sedimentary formations and enhance the iron rich areas with bright cyan color. For abbreviations, see Fig. 1.

4.2 Lithostratigraphy

More than nineteen stratigraphic sections with 108 samples were collected and described during the fieldwork. The measured sections are described and correlated with other sections provided by previous authors in Aswan area and southern Egypt. During the field investigation, the vertical and lateral variations of each of the units over the basement rocks were studied and described (Fig. 6a, b, and c). The recorded sections are correlated with the lithostratigraphic classifications suggested by different authors. A short description of recognized rock units and their relative age is given below:

4.2.1 Araba Formation (Cambrian-Ordovician)

Author and type section: The name Araba Formation was introduced by **Hassan (1967)** to define the clastic unit directly overlies disconformably the basement rocks at Wadi Araba-Sinai.

Stratigraphic boundaries and description: The Araba Formation represents the oldest sedimentary unit in Wadi Abu Aggag. This unit overlays disconformably the basement rocks in Aswan area. It is overlaid by an unconformable contact with the Carboniferous Gilf Formation (Fig. 7a). In Wadi Abu Aggag, the Araba Formation is represented by about 20 m thickness of fining upward clastic sequence as the base is unexposed. The lower part of the sequence is made up of conglomerate and arenaceous sandstone. These sandstones are coarse grained, kaolinitic, trough cross bedded with many paleosole horizons. The base of the sequence followed by sandstone bed has violet to yellow colors and sandy claystone and/or siltstone changed sometimes to mudstone which exhibit badly protected roots of unidentified flora. The sandstones are ripple marked and cross bedded generally of the planner and trough types. The Araba Formation is devoid of economic clay beds.

Equivalent units: Araba Formation is equivalent to the Abu Aggag Formation, which recorded by **Klitzsch (1974-1987)** for the basal bed of sandstone in Wadi Abu Aggag section. **El-Naggar (1970) and Hendriks et al., (1984a)** demonstrated the Abu Aggag Sandstone as the basal bed of the Nubian sandstone sequence which reported by **Khedr (1978)**, in Aswan Fm. offered by **Klitzsch (1984)**, and facies-1 described by **Van Houten et al., (1984)** and to Araba Fm. explained by **Khedr et al., (2010a)** in Aswan area. **Osman et al., (2002 and 2005)** introduced three formations of Araba, Gabgaba, and Naquse which equivalent to Araba Formation.

Remarks: The Araba Formation represents the oldest exposed rock unit in Wadi Abu Aggag. **Khedr et al., (2010a)** mentioned that different authors have been denominated different names to the lower sedimentary bed of the Infra Nubia Group in Aswan environs, e.g. Abu Aggag Formation by **El-Naggar (1970)**, Abu Aggag Sandstone by **Hendriks et al., (1984a)**, lower part of the Nubian sandstone sequence by **Khedr (1978)**, Aswan Fm. by **Klitzsch (1984)**, and facies-1 unit by **Van Houten et al., (1984)**. However, they dated this stratigraphic unit as Cambrian-Ordovician age due to its fossil record and consequently, changed all previous formational names to Araba Formation.

Age assignment: **Issawi and Jux, (1982)** assigned the age of Araba Formation as Cambrian. According to **Khozym (2006)**, the upper surface of the Araba Formation is characterized by the presence of a wavy unconformity surface covered by a bioturbated sandy siltstone sheet, which contains Calamites suckowi.

Brongniart (announces the beginning of the Gilf Formation sedimentation in the Carboniferous. **Khedr et al., (2010a)** dated Araba Formation as Cambrian-Ordovician age due to the presence of Skolithos and Archaeocyatre in the sandstone bed near the upper part of the formation. They also recorded the *Archaeocalamites* sp. With the lower Carboniferous age in the iron ore bands Wadi Abu Aggag. But in the entrance of Wadi Abu Aggag, they discovered the Visean/Lower Namurian Lepidod-endropsis devogedi and Tomiodendron Trogianum.

In the present work, Araba Formation is represented by about 0.5 m thick. A few badly preserved approximately vertical cylindrical burrows (most probably *Skolithos* sp.) are recorded from the upper part of Araba Formation. Skolithos is a frequent trace fossil ichnogenus that appears as lineated structures in sedimentary rocks and is formed by a range of organisms rather than having a floral origin in shallow marine habitats around the world. Based on the previous studies and field observations of the present study, the Araba Formation assigned a Cambrian-Ordovician age .

4.2.2 Gilf Formation (Carboniferous)

Author and type section: Issawi and Jux, (1982), the Plateau of Gilf Kebir – southwestern Desert.

Stratigraphic boundaries and description: The Gilf Formation is defined with two unconformable surfaces which overlies the Araba Formation and underlain the Abu Ballas Formation. The initial emergence of iron-ore bed is the marker to define the base of this unit in the iron mines area

around Aswan. Gilf Formation begins with thin bioturbated sandy siltstone bed at its base which characterized by black color due to the weathering. This unit is covered by an economic shale bed that changed laterally into oolitic ironstone bands in Wadi Abu Aggag area. The thickness of the Gilf Formation (previously Timsah Formation) is ranged between 10 to 35 m and consists mainly of laminated sandstone, oolitic ironstone, silty-clay (economic ball clay beds) and shale. The lower part of the formation (Fig. 7a) is dominated by ferruginous shale horizon best developed attaining few meters thick in Wadi Abu-Aggag .

In Wadi Abu Subeira the Gilf Formation includes three clay-beds. The clay beds are a character of the so called Ball-clay shale, currently of economic use in ceramics industry. Aswan ball clays have variety of colors such as grey, yellowish grey, reddish to brownish grey and textures such as massive to faint laminated and moderately hard clays.

The term "ball clay" is known from clay mines to the highly plastic clay which rolled to balls. Ball clay is made up of kaolinite that is weakly crystalline and contains tiny amounts of illite and/or smectite. The best-grade ball clays are lacking quartz sand or silt, as well as iron oxide minerals, however carbonaceous material may be present. Mostly, ball clay is practically white in appearance, however it comes in a variety of colours ranging from pink to brown, grey to black but it is frequently almost white after fire .

The three clay beds of the Gilf Formation are separated by sandstone beds. The ball-clay beds of the Carboniferous Gilf Formation in Wadi Abu Subeira attains a thickness between 1 to 4 meters, includes oolitic iron bands and concretions, gradually changes upward into thin iron-oxide band (Fig.7b) and usually covered by 20-40 cm thick horizon of very hard siliceous
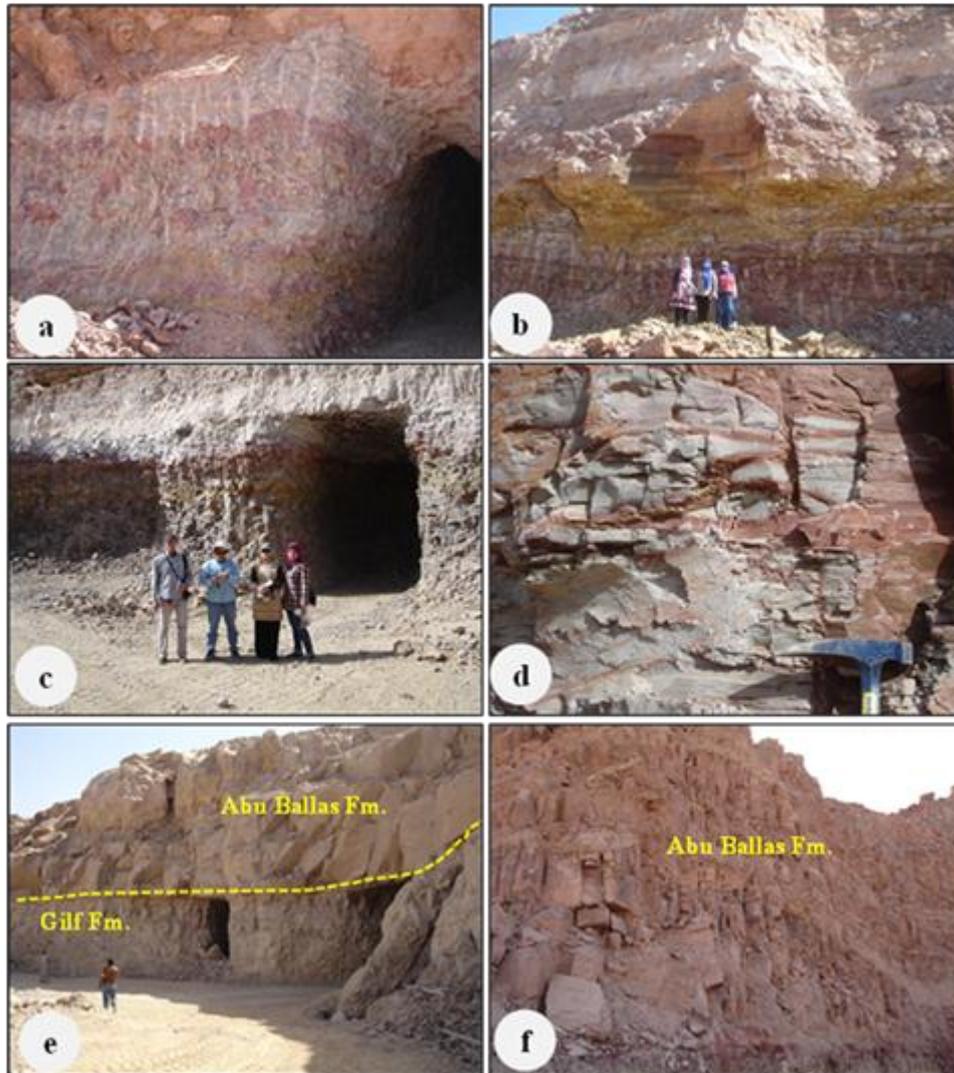
Fig. 6: Field photograph showing a, b and c) Lithological characteristics of the Aswan ball clays. Yellowish to brownish gray faint laminated clays. Gray massive clays with fractures filled with Fe-rich brownish clays, d) Aswan ball clays bearing banded iron oxides, e) The contact between Gilf Formation and Abu Ballas Formation, and f) Abu Ballas sandstone

shale and sandy shale forming the floor of the ball-clay quarries in Wadi Abu Subeira (Fig. 7b). The base of the silica bands forming the sealing of the Ball-clay mines in Abu Subeira valley is marked by iron bands (Fig. 6d)

The silty claystone beds (ball-clay) show vertical and lateral variations in lithology, thickness, and number of along and in both ides of Wadi Abu Subeira. Laterally the Ball-clay beds show decrease in number and increase in iron oxides and shale content. There is a general upward increase in the clay fraction accompanying with decreasing in silt and sand fractions. Laterally the shale ratio increases either in the west or in the southwest direction, whereas the silt and sand percent increases northeasterly **(Khedr et al., 2010b)**. They recorded a general upward decrease of the clay fraction in the columnar sections accompanying by a general upward increase in both the silt and the sand fractions in Aswan area and a general increase in the clay ratio in both the east and the northeast directions

accompanied by eastward decrease in the silt-sized fraction.

Equivalent units: The Gilf Formation is coeval to the same unit which represent the Upper unit of the Infra Nubia Group of **Khedr et al., (2010a)** in Aswan area. This formation overlies the Araba Formation with unconformable contact and equivalent to the Timsah Formation defined by **El Naggar (1970)**.

Age assignment: The fossils of Calamites and Strotocrinus are discovered by **Khedr et al., (2010a)** at the lower part of the Gilf Formation which give it the Carboniferous age. **Zaghloul (1983)** one of different authors assigned different ages to the Gilf formation. They identified Paleozoic ichnofossils (Bifungites) in the beds above the iron ore bands. Where **Khedr (1978)** recorded ichnofossils (Bifungites) in the beds under the iron ore beds in the vicinity of Aswan area. The term "Umm Baramil Formation" is not used in this study; instead, it is regarded as a complementing section of the Gilf Formation with a thickness of 30 m. This formation is defined by the first appearance of an iron-ore bed at the base and a deeply scoured unconformity surface at the top .

4.2.3 Abu Ballas Formation (Upper Jurassic-Early Cretaceous)

The Abu Ballas Formation is composed primarily of friable and white cross-bedded sandstone which includes silicified rootlets (Fig. 6e and f). The occurrence of the microspores Classopollistorosus, Glcicheniidites and Serpulasulcata J. de C Sowerby species are recorded by **Khedr (2002)** in the thin beds at the top of the Bajocian-Oxfordian Kalabsha kaolin section. He stated that Abu Ballas Formation covered the economic kaolin deposit of Kalabsha, SW of Aswan and dated to late Jurassic-early Cretaceous age. Commonly, lateritization process in the late Jurassic-early Cretaceous period produced this weathering profile over the Precambrian granitic rocks.

5. Clay and Iron Ores Mapping and Evaluation

Ball clays are found in quite considerable deposits in Egypt with at least 10 million metric tons reserve in the area around Aswan City. This clay is quarrying from Abu Subeira and Wadi Abu Agag districts by a lot number of ceramic and tile companies for domestic and industrial uses. As previously stated, the ball clay in the Abu Subeira and Abu Aggag districts is primarily made up of grey, yellowish grey, reddish grey, and brownish grey clays .

The mineral exploration for the clay and iron ores can performed by the remote sensing data which can map these minerals on a regional scale with appropriate spatial and spectral detail. Landsat-8 data are successfully to detect and evaluate the clay minerals and iron oxides in the study area. There are economic values of clay and iron minerals with different grades are recorded. Also, a lot of ball clay quarries were visited and evaluated .

The clay minerals were detected and examined by their spectral signatures which detected the presence of Hematite, Kaolinite, Palygorskite, Goethite, Ferrihydrite. Also the image processing techniques and minerals indices were performed to Landsat 8. Figure 8 (a and b) shows the spectral signature of two kaolinite and iron oxides samples from Wadi Abu Subeira and Wadi Abu Aggag,
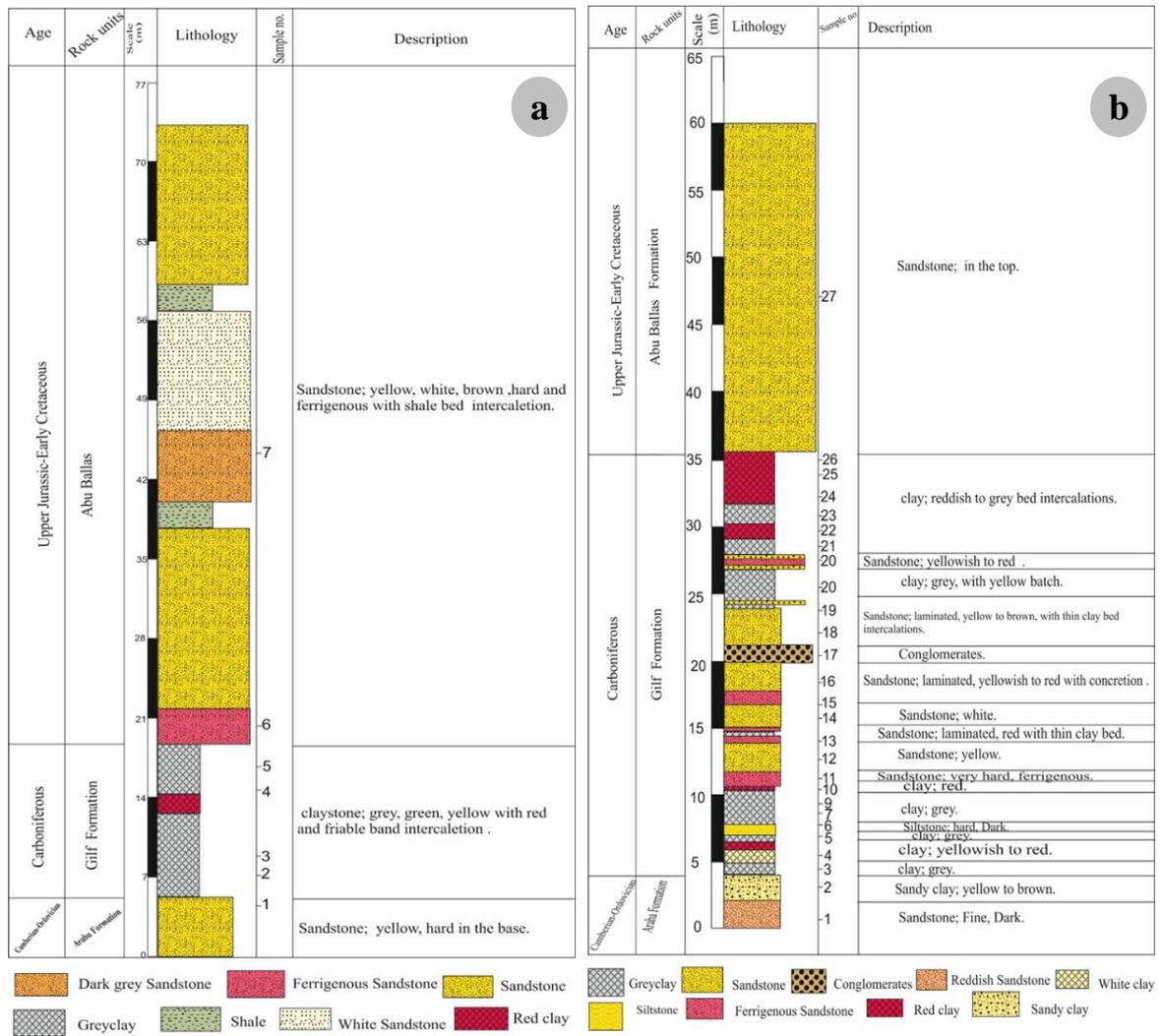
Fig. 7: Stratigraphic column showing the stratigraphic position of the Aswan ball clays and iron beds in different units at studied section in Wadi Abu Aggag (a) and Wadi Abu Subiera (b).
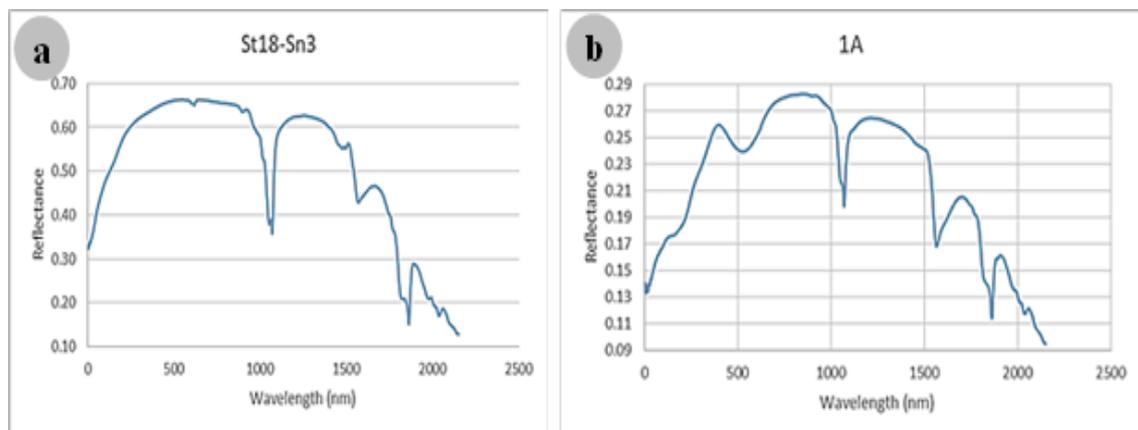

Fig. 8: Spectral signature curves of two representative samples of a) kaolinite from Wadi Abu Subeira and b) iron oxides from Wadi Abu Aggag.

respectively. In respect to the presence of OH−1 and Al-OH groups the kaolinite shows absorption peaks at 1.4 and 1.9 μm, respectively (Fig. 8a). in accordance to the spectral ranges of Landsat-8, the band 7 offers a lower reflectance than band 6 for the kaolinite group minerals. Consequently, the band ratio 6/7 can helps to identify kaolinite group minerals as shades of grey pixels (Fig. 9a). Where the iron oxides show absorption peak at 0.5 and 1.6 μm (Fig. 8b), therefore the Landsat-8 band ratio 4/2 can detect the rich areas with iron oxides as bright white pixels (Fig. 9b). The threshold values which can be extracted from the band ratio histograms, the clay and iron minerals can be explore using the following formula :

Threshold = the ratio mean + 3 x the standard deviation (with a confidence of 98%) (**Fatima et al., 2017**).

Figure (10) shows the mapping and the distribution of clay minerals and iron oxides detected by the Landsat-8 band ratios to the study area. The data from the field investigation are used to confirm the results of the two band ratio images. Moreover, the presence of the iron working quarries around Wadi Abu Aggag supports the accuracy of the produced map.

6. Conclusion

As a consequence of integrated study of remotely sensed data and lithostratigraphy, as well as field examination, the sedimentary formations and associated clay and iron mineralization have been identified in the Aswan, Egypt area. The remote sensing techniques were succeeded in better discriminating lithologies and structural elements. Araba, Gilf and Abu Ballas formations were described and measured in the field and detailed stratigraphic successions are drawn. The clay minerals and iron oxides in the study area were successfully mapped using Landsat-8 band ratio indices. Remote sensing and stratigraphy were successfully detected significant amounts of clay minerals and iron oxides Abu Subeira and Abu Aggag districts north of Aswan. As a result, band ratio indices are considered as one of the most effective tools for the mineral prospecting. The present study recommend that this methodology can helps enhances lithologies and mineral deposits at the surface especially, in remote and inaccessible areas. Where the working quarries of the ball clay and iron ores around Wadis of Abu Subeira and Abu Aggag are support the results of the present study with a high confidence level.
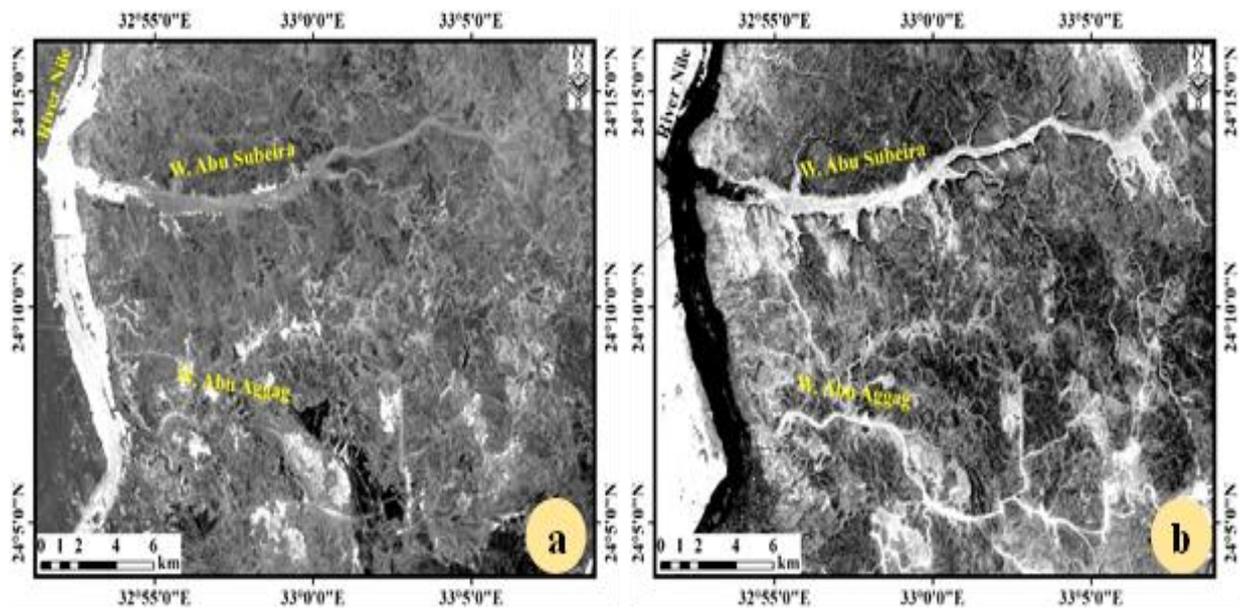
Fig. 9: a) Landsat-8 band ratio 6/7 to enhance the clay minerals and b) the band ratio 4/2 to detect the iron oxides in bright pixels.
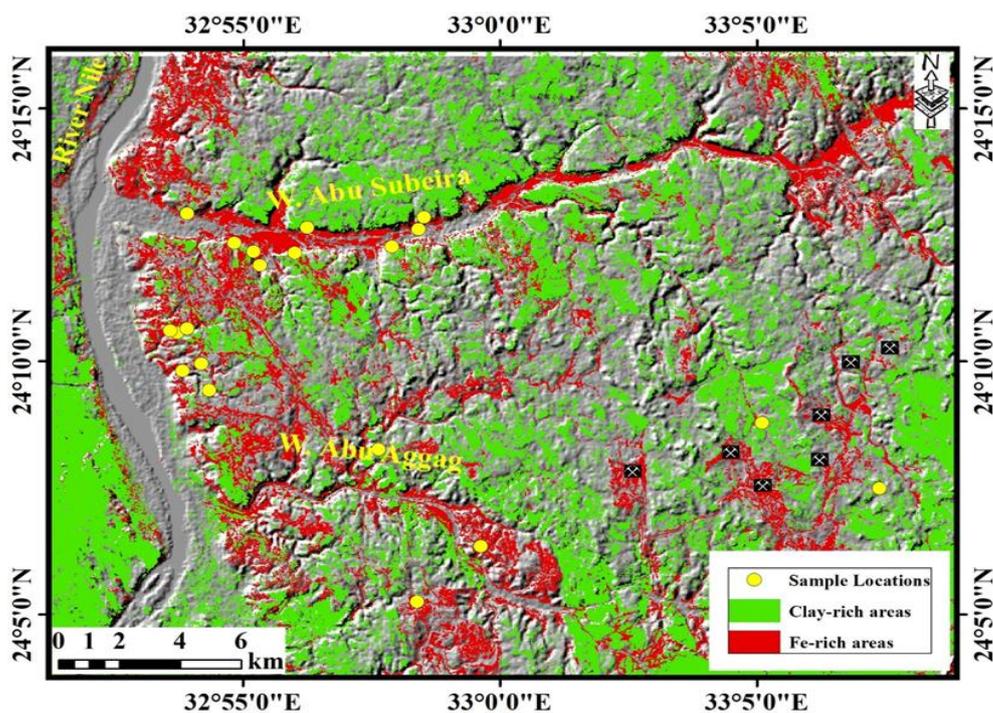

Fig. 10: The distribution map of the clay- and iron rich localities drapped over the hillshade map of the study area. This map is derived from the remote sensing data and verified by the field and stratigraphic studies. Note: the presence of the iron working quarries (black boxes) around wadi Abu Aggag at the extracted iron rich areas.

REFERENCES

Baioumy, H. and Ismael, I. (2014): Composition, origin and industrial suitability of the Aswan ball clays Egypt. *Applied Clay Science*, 102: 202–212.

Cohen, W.B., Maiersperger, T.K., Gower, S.T., and Turner, D.P. (2003): An improved strategy for regression of biophysical variables and landsat ETM+ data. Remote Sens. *Environ.*, 84: 561–571.

Dogan, H.M., and Kilic, (2013): O.M. Modelling and mapping some soil surface properties of central Kelkit basin in Turkey by using Landsat-7 ETM+ images. *Int. J. Remote Sens*. 34: 5623–5640 .

El Bastawesy, M., Gabr, S., and White, K., (2013): Hydrology and geomorphology of the upper White Nile lakes and their relevance for water resources management in the Nile basin. Hydrological Processes, 27(2): 196–205.

El-Naggar, Z. R., (1970): On a proposed lithostratigraphic subdivision of the late Cretaceous- Early Paleogene succession in the Nile Valley, Egypt, U.A.R 7th Arab Petrol. Congr., Kuwait 64 (B-3): 1-50.

Fatima, K., Khattak, M., Kausar, A., Toqeer, M., Haider, N. and Rehmand, A. (2017): Minerals identification and mapping using ASTER satellite image. J. of Applied Remote Sensing, 11(4): 1-18.

Gilles G., Xavier B., Karine A., Anne B., and Audrey H., (2019): Clay Minerals Mapping from Imaging Spectroscopy. Earth Observation and Geospatial Analyses, 1-14.

Hassaan, M. M., El Dosoky, H. M., Salem, S. M., El Afendy, A. A., and Soliman, Omar A., (2018): Genesis of Iron Deposits in Bir Um Hibal area, Southeast Aswan, Egypt: Remote sensing - Structural-Lithological-Ore Mineralogical Contributions. Middle East Journal of Applied Sciences, 8(1):19-36.

Hassan A.A. (1967): A New Carboniferous Occurrence in Abu Durba, Sinai, Egypt. Proceedings of the 6th Arab Petroleum Con., Baghdad, 2: 8.

Hegab, M. A. (2021): Remote Sensing and Gamma-Ray Spectrometry Based Gold Related Alteration Zones Detection: Case Study (Um Balad area), North Eastern Desert, Egypt. *Pure Appl. Geophys*. 178: 3909–3931.

Hendriks, F., (1985): Upper Cretaceous to Lower Tertiary sedimentary environments and clay mineral associations in the Kharga Oasis area (Egypt). N.Jb. Geol. Palaont. Mh. (Stuttgart) 10: 579-591.

Hendriks, F., Luger, P., Bowitz, J., and Kallenbach, H., (1987): Evolution of the depositional environments of SE- Egypt during the Cretaceous and Lower Tertiary. Berliner geowiss. Abh. (A), 75(1): 49-82.

Hendriks, F., Luger, P., Bowitz, J., Kallenbach, H., and Schroeder, J. H., (1984): Stratigraphy and sedimentological framework of the Kharga- Sinn- El Kaddab stretch (western and southern part of the upper Nile Basin), western desert, Egypt. Erliner geowiss. Abh., (A), 50: 117-151.

Hussein, A.A., (1990): Mineral deposits of Egypt. In: Said, R. (Ed.), Geology of Egypt. Bakema Publ. Co, Amsterdam.

Issawi, B. and Jux, U., (1982): Contribution to the stratigraphy of the Paleozoic Rocks in Egypt. Geol. Surv. of Egypt. Cairo, No. 64:24 .

Khedr, E. S., (1978): Some Geological Studies in the Unconformity Zone between the Basement and the Nubian Sandstone in Aswan Area, Egypt: Ph.D. Thesis, Assiout University.

Khedr, E. S., (2002): Lateritic Kaolinite and the evolution of ferruginous Kaolinite pisoids on the Late Jurassic surface of the African shield: (1)

Kalabsha. Egypt. 6th Int. Conf. Geol. Arab World Cairo University 2: 695-726.

Khedr, E. S., Youssef, A.A., Abu Elmagd, K. and Khozyem, H. M. (2010a): Tectono-Stratigraphic Subdivision of The Clastic Sequence of Aswan Area, Southern Egypt. 5th Int. Conf. Geol. of the Tethys Realm, South Valley University, 197-216.

Khedr, E. S., Youssef, A.A., Refaat, A.A., Abu Elmagd, K. and Khozyem, H. M. (2010b): Mineralogy and Geochemistry of the Economic clay beds of Aswan area, Southern Egypt. 5th Int. Conf. Geol.of the Tethys Realm, South Valley University, 179-196.

Khozyem, H. M. (2006): Stratigraphy and sedimentology of the claystone and shale beds in Aswan area and their implication in ceramic industry. M.Sc Thesis, Aswan's Faculty of Science, South Valley University, Egypt, 247.

Klitzsch, E., (1978): Geologische Bearbeitiung der Sudwest Agypten. Geol.Rundschau 67(2): 509-520.

Klitzsch, E., (1980): Neue stratigraphische und paläogeographische Ergebnisse aus dem Nordwest-Sudan.- Berl.geowiss.

Klitzsch, E., (1983a): Paleozoic formations and a Carboniferous glaciation from the Gilf Kebir-Abu Ras Area in southwestern Egypt. - *J. Afri. Earth Sci.*, 1(1): 17-19.

Klitzsch, E., (1983b): Geological Research in and Around Nubia-Episodes, Ottawa, Ontario.3: 15-19 .

Klitzsch, E., (1984): Northwestern Sudan and bordering areas: geological development since Cambrian time. - Berl. Geowiss. Sudan). Geol. Runschau., 75: 755-768 .

Osman, R. A., Ahmed, S. M., and Khater, T. M., (2002): The stratigraphy and facies associations of Wadi Gabgaba and its surroundings with an emphasis on the lower Paleozoic glaciations. 6th Int. Conf.

Geol. Arab World Cairo Univeristy 2: 469-482.

Osman, R. A., Ahmed, S. M., and Khater, T. M., (2005): The Geological development of Wadi Gabgaba, Eastern Desert, Egypt. 1st Int. Conf. on the Geol. of Tethys, Cairo University, 465-476.

Pour, B.A. and Hashim, M., (2012): Identifying areas of high economic potential copper mineralization using ASTER data in Urumieh-Dokhtar Volcanic Belt, Iran. Adv. Space Res. 49: 753-769

Salem, S and El Gammal, E. (2015): Iron ore prospection East Aswan, Egypt, using remote sensing techniques. The Egyptian Journal of Remote Sensing and Space Sciences 18: 195-206.

Scull, P., Franklin, J., Chadwick, O.A., and McArthur, D. (2003): Predictive soil mapping: A review. Progr. Phys. Geogr., 27: 171–197 .

Van Houten, F. B., Bhattacharyya, D. P., and Mansour, S. El., (1984): Cretaceous Nubia formation and correlative deposits, eastern Egypt: Major regressive-transgressive complex. Geol. Soc. Am. Bull., 95: 397-405.

Zaghloul, Z. M., (1983): On the discovery of Paleozoic trace fossils Bifungites, in the Nubian sandstone facies of Aswan, Egypt, *J. Geol.*, 27(1-3): 65-72.

الاستفادة من الاستشعار عن بعد والطباقية الصخرية في تخريط معادن الطين والحديد في منطقة شمال أسوان، مصر

سمير قمح[1]، حمزة خليل[1]، جمال موسى[1]، ممدوح عابدين[2]، علا غباره[1]

[1] قسم الجيولوجيا ـ كلية العلوم ـ جامعة طنطا
[2] الهيئة القومية للاستشعار عن بعد وعلوم الفضاء ـ القاهرة

تعتبر التكوينات الرسوبية في منطقة شمال أسوان بمصر من التكوينات المهمة حيث تحتوي على تمعدنات الطين واكاسيد الحديد. وفى هذه الدراسة تم عمل دراسة تكاملية بين تقنية الاستشعار عن بعد والطباقة الصخرية والبصمات الطيفية بالإضافة الى التحقق الحقلي وذلك في تحسين الخريطة الجيولوجية **السابقة** لمنطقة الدراسة والكشف عن المناطق الغنية بمعادن الطين والحديد واضافة الى استخراج التراكيب الجيولوجية بالمنطقة. ولذلك فقد استخدمت الدراسة المرئيات الفضائية من نوع لاندسات ٨ بدقة تفريقية ٣٠ متر ونموذج الارتفاعات الأرضية من نوع SRTM بدقة تفريقية ٣٠ متر أيضا وتم تطبيق مجموعة من الخوارزميات على هذه البيانات لرصد الحدود الفاصلة بين الصخور وكذلك ما تحويه من تمعدنات. كما تم عمل دراسة استراتيجرافية تفصيلية ورسم أكثر من ١٠ قطاعات استراتيجرافية في المنطقة مع التركيز على الطبقات الغنية بمعادن الطين والحديد. وقد بينت هذه الدراسة بأن المنطقة تحتوي على تكوين عربة وهو ممثل بحوالي ٢٠ متر وتكوين الجلف والذي يتراوح سمكه ما بين ١٠ الى ٣٥ متر ثم يعلوه تكوين أبو بلاص بسمك حوالي ٢٥ متر. وقد تبين ان تكوين الجلف هو التكوين الذي يحتوي على معظم تمعدنات الطين واكاسيد الحديد بالمنطقة. وتم فصل المناطق الغنية بتمعدنات الطين والحديد باستخدام خوارزميات نسب الحزم وتم عمل تخريط لهذه المناطق الغنيه بتمعدنات الطين والحديد، حيث تبين غنى المنطقة بالفعل بهذه التمعدنات وقد تم التحقق من هذه الخريطة بدرجة دقة وثقة تصل الى ٩٥% من العمل الحقلي وجود الأماكن الفعلية لمحاجر الطين والحديد المنتشرة في شمال اسوان حيث تبين ان مواقع هذه المحاجر وقعت كلها في المناطق الغنية بمعادن الطين والحديد التي تم فصلها عن طريق بيانات الاستشعار عن بعد، مما يؤكد نجاح هذه التقنية ووضع توصية لاستخدامها لاستكشاف معادن في مناطق أخرى مشابهة للظروف الجيولوجية لمنطقة الدراسة.