# Reviewing on the sedimentological and vertebrate paleontological aspects of the Upper Cretaceous exposures in Kharga Oasis, Egypt

**Mohsen, Sara[1], Abdel Gawad M. K.[2], Tantawy A.[1], Mousa M. K.[1] & Abu El-Kheir G. A.[1*]**

[1] Department of Geology, Faculty of Science, New Valley University, Al-Kharga, New Valley, 72511 Egypt.

[2] Department of Geology, Faculty of Science, Cairo university, Giza 12613, Egypt.

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## Abstract

The Late Cretaceous in Egypt attracts great attention from paleontologists since its end coincides with the mass extinction of several vertebrate groups from which reptiles such as dinosaurs and non-avian dinosaurs and plesiosaurs. The Cretaceous sequences of the Southwestern Desert of Egypt contain assemblages of terrestrial and marine fossils. The Qauseir Formation composed mainly of variegated shale of Campanian age. This formation is exposed at the Darb El Arbien located between Kharga and Beris and to the south of Beris. These strata contain many fragments of Sauropods dinosaurs, crocodyliforms and turtles. The Campanian succession of Kharga Oasis is witnessed the main transgression of the Tethyan sea to the Western Desert of Egypt. This study focusses on reviewing the Late Cretaceous deposits of Kharga Oasis along the extension of Darb El Arbien, containing the high diversity and abundance of terrestrial vertebrate fossils and petrified wood.

**Keywords:** Upper Cretaceous, Campanian, Kharga, Western Desert, Egypt

## Introduction

The vertebrate bearing horizons in the Upper Cretaceous strata in Egypt are concentrated in the Western Desert, [1, 2]. There are three main vertebrate bearing horizons [3]: the first and oldest is the Cenomanian horizon which is concentrated in Baharyia Oasis, which is famous for dinosaur remains in Egypt and other vertebrates such as fishes, crocodiles, turtles [4] and Squamata [5], the second is the Campanian horizon in Kharga and Dakhla Oases which contain dinosaurs [6], fishes, and marine lizard remains [1], the third and youngest is the Maastrichtian horizon in Dakhla and Farafra Oases which contains fishes and marine lizard remains [7, 8, 2].

The Middle Campanian main transgression of the Tethyan Sea in Egypt formed broad, shallow, and semi-restricted embayments [10]. These transgressive deposits are exposed in Dakhla Basin of the Western Desert and represented by the intertidal and supratidal, alternating with marsh and estuarine sediments of the variegated shale of the Quseir Formation [11]. The sequence of the Quseir Formation hosted many terrestrial fossils such as Dinosaur bones, [6, 3], crocodyliforms [12] and turtle clusters. The Tethyan sea transgression continued its inundation to the Maastrichtian influenced by the oceanic anoxic condition, forming shallow marine phosphatic layers, represented by the Duwi Formation and inner to outer neritic dark shale, with thin layers of sandstone interrelations, represented by the lower part of Dakhla Formation [13].

Kharga depression extends along a north–south axis for about 200 km with bounding escarpments to the northwest, north and east, varying in width from 40 to 85 km. The depression is approximately 50 m above sea level. The northern and eastern boundaries of the basin are sharply defined by the high cliffs of the western Plateau. In contrast, the south and west, the basin gradually merges into the Western Desert.

The stratigraphic sequences in the south Western Desert are represented by fluvial and fluvio-marine successions, summarized from the base to the top as follows:

**Six Hill Formation [14]:** It is composed of cross bedded sandstone, of about 50 m. thick of Late Jurassic-Early Cretaceous age [15], [16].

**Abu Balls Formation [14]:** It overlies Six Hills Formation, and it is widely exposed in the Abu Balls region, which is located south of Kharga Oasis. It attains about 25 m thick consists of fluvio-marine sandstone and shale deposits of Aptian age [17, 18].

**Sabaya Formation [14]:** It overlies Abu Ballas Formation, it is formed at the type locality at Gebel El Sabaya, from about 170 m thick of fluvial cross bedded sandstone intercalated with thin layers of



* Corresponding authors: gebely2006@sci.nvu.edu.eg

mudstone, containing fragmented petrified wood trunks and rootlets and some columnar tubes of ferruginous sandstone of Albian to Early Cenomanian age.

**Maghrabi Formation [19]:** It is probable Cenomanian age. It documents the second transgression of the sea during the cretaceous. It is well exposed at Kharga Oasis; it conformably overlies the Sabaya Formation and underlies the Taref Formation. It is attributed to a mixed estuarine and delta flat environment. Maghrabi Formation measuring thickness of about 60 m and formed of coarse grained and conglomeratic sandstone with a large-scale trough cross bedding which are unconformably overlain by marine claystone in the uppermost part of the Taref Formation [15, 20, 21].

**Taref Formation [22]:** According to [22], Taref Formation is composed of fluviatile cross-bedded sandstone with thin layers of clay and shale intercalation, containing some fragments of petrified wood and leaf impressions that might suggest near-shore marine impacts [21, 23-26]. Taref Formation attains about 100 m in Gebel Taref (north Kharga) with an unexposed base [22]. Taref Formation unconformably overlies Maghrabi Formation and unconformably underlies Quseir Formation and of Turonian age.

**Quseir Formation [11]:** It regards well distinct evidence of the real transgression of the Tethyan Sea to the south of Egypt, forming swampy, intertidal to supratidal deposits during Campanian age. Quseir Formation has wide distribution in Kharga and Dakhla south Western Desert and Quseir region in Eastern Desert of Egypt [11]. It extends from the northeast to the southwest between Kharga-Dakhla and gradually disappears to the west of Dakhla.

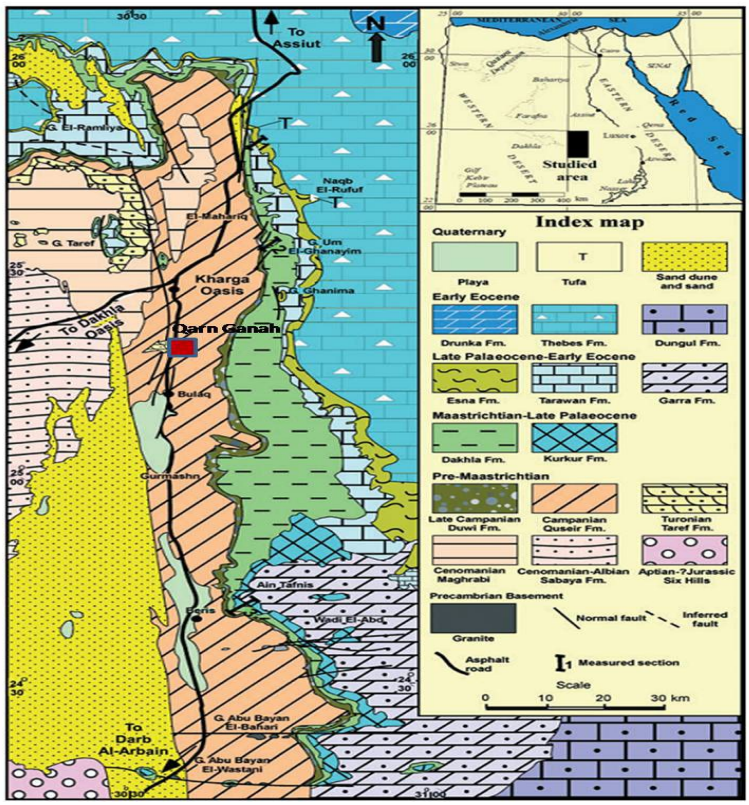


**Figure 1**. Geological map of the Kharga Oasis, (modified after EL Azabi 2011 and Mohsen *et al*. 2024).

Quseir Formation is equivalent to Wadi Hennis Formation and El Hefhuf Formation in Farafra depression in the north [15]. It is additionally extending from the east to the south along Darb Al Arbain between Kharga and Beris Oases and it is equivalent to the lower part of Kiseiba Formation in the south [27]. The type of section of the Quseir Formation is at Gebel Atshan in Quseir area, Red Sea coast [11]. It is composed of variegated shale, siltstone and sandstone intercalations. Quseir Formation is characterized by the presence of fragmentary bones and partially skeletons of the vertebrate fossil remain as lungfishes, sawfishes, turtle shells, crocodile bones and some separated partial skeletons of dinosaurs [1].

These sequences are related to the shallow marine environment. Sallam *et al*. [1] reported that no yielded nanoplankton assemblages from the chosen rock samples of the stratigraphic section represented the Quseir Formation near Teneida village, Dakhla. However, they identified significant 23 nanoplankton taxa from the middle and upper Duwi Formation comparable to zone CC23 (Qadrum trifidum). of lower Campanian age. The palynlogical study gave an optimized indicator for the relative age dating of Quseir Formation based of the marginal and continental paleoenvironment of the present facies. Therefore, the exposed layers of the base of the Quseir Formation close to Bulaq village, east of Kharga are examined by [28], depending on a certain marker angiosperm range such as proteacidites sp. and Syncolporites schrankii, he referred Quseir Formation to the Campanian age. The Santonian age for the studied formation is typically represented by the palm and other proteaccean and Syncolporate pollens [28]. Therefore, the age of Quseir Formation may be referring to Santonian to lower Campanian age. Quseir Formation attains 80 m thickness at Dakhla [15, 20, 29, 30, 31] and divides into two members, Mut at the base and Hindaw at the top. Mut Member is composed of about 20 m thick of reddish laminated shale, containing some traces of plant leaves and roots with very little recording of vertebrate fossils. Hindaw Member is formed of about 25 m thick of grayish green laminated shales and compacted mudstone with occasional intertidal channels, Mut and Hindaw members contain high variety and abundance of terrestrial reptiles such as Sauropod and Theropod dinosaurs [1], crocodiles [12] and turtle and fish [1, 3, 28, 32] studied the palynofloras of the lower part of Quseir Formation, between Kharga and Beris, near Bullaq area. He recorded abundance of water ferns and freshwater algae, supporting the occurrence of moist in warm-humid paleoclimate. From the nannoplankton analysis, the Quseir Formation is dated as the late Campanian age. According to research on polymorphs and palynofacies, it is thought to have been deposited under fluvio-lacustrine and restricted shallow marine environments.

**Duwi Formation** [11]**:** It unconformably overlies the Quseir Formation and underlies the Dakhla Formation. It reaches about 50 m. and is composed of high economic valuable phosphate layers and thick layers of dark shale deposits. The phosphate layers contain abundance of different taxa of shark teeth, turtle, crocodiles, and some marine reptile fragments. The phosphate beds of Dakhla basin were deposited in marine transgression of late Campanian age, invading the northern fringe of Africa plate, which were a shallow seas bioproductivity was high, producing the restricted environment suitable for organic matter preservation. The phosphate strata are characterized by the presence of various species of shark teeth and fish bone fragments, marine reptiles such as Mosasaurs, Plesiosaurs and Turtles (Abu El-Kheir personal observations). Duwi Formation is well extended between Kharga and Beris Oases and along the northern escarpment between Kharga and Dakhla, forming of about 50 m of variegated shale, and sandstone and siltstone thin layers intercalations [11, 15, 20]. Duwi Formation indicates a littoral environment of deposition, oscillating with the inner to outer sublittoral conditions. It is Late Campanian to Lower Maastrichtian age [31].

**Dakhla Formation** [33]**:** It exhibits about 200 m thick of intertidal to subtidal dark gray laminated shale interbedded with thin layers of fossiliferous sandstone and siltstones at the type of section (Gebel Gifata, 12 km west of the town of Mut; [34]. Dakhla Formation is subdivided into three distinct members as follow: Mawhoob Member is the lower part of Dakhla Formation, formed of gray to dark gray laminated shale, containing abundance of weathered and well-preserved marine reptiles such as Mosasaurs and Turtle, shark teeth and fish bones; Beris Member is the middle part of Dakhla Formation and it is characterized by the dark laminated shale and calcareous, fossiliferous sandstone intercalations marked by the occurrence of *Oxygyra overweigi* bivalves. Beris Member is the most important part of Dakhla Formation that contain varieties of vertebrate fossils such as Mosasaurs [35 ,36], and Plesiosaurs (marine reptiles), Turtle skeleton (side neck turtles, fish bones such as Pychodonts [2, 8, 37] Sward fish; The upper part of Dakhla Formation is subdivided into lower Kharga and upper Kharga members which are consists of dark gray laminated shale, separated by the erosion surface represents the K/T boundary. Dakhla Formation gave well evidence for the deposition during the OAEs (Oceanic Anoxic Events), where notably high productivity which formed the black shale, which attracted many marine reptiles to these areas such

as Mosasaur, Plesiosaurs, Turtles, and fish for these high nutrients in shallow restricted sea in the middle and south Egypt during the Maastrichtian age [2, 8].

**Tarawan Formation** [33]**:** It is the upper part of the scarp face of the plateaus bounded the Dakhla Depression from the north. It conformably overlies the Dakhla Formation. It is composed mainly of 10–55 m. of snow white to yellowish white hard, thickly bedded chalk and chalky limestone with few marl and shale intercalations and forming a wall. The formation is well developed and extended between Teneida in the East and Abu Minqar in the West. The sediments indicate deep facies display gradual lateral and vertical changes in lithology [33], it is of Paleocene of Paleocene age.

## Lithostratigraphy of Kharga-Beris extension

The stratigraphic succession of Kharga Oasis and the surrounding areas, extending along Darb El Abrien (between Kharga and Beris) composed from the base to the top of about 30 m thick of fluvial cross bedded, fine to medium grained, ferruginous sandstone of the Taref Formation, containing rootlets(rhizoliths) and some vertical burrows. The strata are tectonically highly northeast inclined. Taref Formation is represented as isolated hills along Darb El Arbien. The base of the Taref Formation is often covered with sand sheets and sand dunes. The basal succession is overlain by variegated shales of the Quseir Formation. The area between Qarn Ganah and Bulaq is morphologically formed of folded isolated consecutive hills along the extension of Darb Al Arbain between Kharga and Beris Oases. These hills are formed of sandstones intercalated with thin layers of shales belonging to Taref Formation which overlain by the variegated shales of the Quseir Formation in the floor around these hills. These hills are separated by a group of inferred faults, forming two horsts separated by graben [38]. The structural setting of Qarn Ganah area represents doubly plunging domal structure around north-south trending axis [15].

Hendriks *et al*. [20] divided Quseir Formation between Kharga and Beris Oases into two consecutive main facies, the lower facies consist of tidal flat deposits of about 25 to 45 m thick, which is subdivided into six sub-facies, formed of varicolored gray claystones and bioturbated sandstones. The first sub-facies forms the basal part of Quseir Formation which is composed of gray to violet mottled claystones of supratidal to intertidal facies alternating with supratidal marsh and estuarine deposits, yielding freshwater gastropods and vertebrate fossils such as dinosaurs, turtles, crocodiles, and fishes, it represents the exposed deposits of Qarn Ganah. The upper facies composed of inner shelf deposits of about 20 m thick.

Quseir Formation expose low angle northeast inclined beds of about 25 m thick of variegated shales and gray glauconitic mudstones and siltstones interrelated with thin layers of ferruginous conglomeratic sandstone, containing fragments vertebrate bones and coprolites. It is subdivided into two members; Mut Member at the base and Hindaw Member at the top, The lower member is composed of about 15 m thick of reddish colored laminated shale, containing rootlets (rhizoliths) and some vertical burrows. These successions are intercalated with thin layers of siltstone. The upper member is formed of about 10 m thick of gray to pale green glauconitic, compacted shale, intercalated with thin layers of sandstone and intertidal channels. Hindaw Member contains high variety and abundance of terrestrial vertebrate fossils such as Turtle shells, Crocodile bones and Dinosaur scattered elements in different mod of preservation.

According to [3], these terrestrial vertebrate fossils are distributed into three successive horizons, namely HI, HII and HIII in Hindaw Member. The First Horizon (HI) is recognized at the base of Hindaw Member, it has little exposure and mostly covered by the above sequences. It contains Turtle bone fragments and petrified. The second horizon (HII) found above the first horizon by 8 m, composed of grayish green, cemented mudstone. It contains fractured and incomplete components of Dinosaurs, Turtles, and some scattered elements of Crocodile bones. It has well exposure surface than the previous horizon but is still influenced by the strata`s over all inclination. The bones are slightly eroded, fragmented, and scattered. The third horizon (HIII) is the main vertebrate bearing horizon of the study area which contains more than 50 clusters of Turtle shells in moderately preserved states and some weathered and still embedded elements of Dinosaurs and Crocodiles. Some tiny grazing trace fossils are observed on the surfaces of the Turtle shells [3].

Quseir Formation herein is topped by weathered phosphate layer forming the base of the Duwi Formation, containing varieties of shark teeth, turtle bones and fishbones in the outer borders of the area.

Hindaw Member is unfortunately covered with the sand sheet and the agriculture works which covered the highly significant Late Cretaceous vertebrate locality.

**Vertebrate paleontological setting of Kharga Oasis**

Few vertebrate bearing localities were recorded along the Kharga-Beris Road extension and south Beris Oasis. These are represented by Qarn Ganah, Gaga and south Beris areas.

Qarn Ganah area is located about 10 km southeast of Kharga Oasis, close to Kharga- Beris main road. Qarn Ganah area is a broad, flat, slightly northeast inclined. The area is bordered at the western side by highlands Taref Formation which are highly tectonically influenced. Qarn Ganah area is formed of Campanian variegated shale beds of the Quseir Formation. It contains many partial skeletons of Turtles, some scattered Dinosaur bones, and Crocodile elements, [8, 39].

Gaga area is located about 10 km north of Beris. The area exhibits well exposure of the Campanian Quseir Formation, containing many fragments of Turtles, some Dinosaur fragments and crocodyliforms elements [40].

South Beris area contains an abundance of Late Cretaceous reptile remnants, containing turtle, crocodyliforms and dinosaur remains (personal observations).

Few attempts for the vertebrate fossil's discovery of Kharga Oasis are summarized as follows:

**Lamanna *et al.*** [40] re-described the known specimen of humerus which was previously referred to Ornithischian [22] and they referred it to crocodyliformes instead of Ornithischian.

**Sallam *et al.*** [6] discovered a Late Cretaceous dinosaur *Mansourasaurus shahinae* from the variegated shale deposits of Qusier Formation nearby Teneda village, Dakhla.

**Saber *et al.*** [12] described a new genus of crocodyliform *Wahasaucus egyptensis* from Quseir Formation of Dakhla Oasis, north Tenida.

**Abu El-Kheir** [3] studied the stratigraphy and the taphonomic conditions of the vertebrate bearing horizons of the Western Desert of Egypt. He recorded many separated dinosaur elements, crocodile, and turtle shells in four detective vertebrate bearing horizons in the upper part of the Quseir Formation. The turtle bones are well preserved articulated and not abraded shells. These preserved states may give some indication that the turtles were deposited in their places or transported for short distances by currents. The sauropod dinosaur's scattered elements, especially the fore and hind limbs are not well preserved, highly abraded, and also highly affected by the gypsum alteration of the hosted mudstone layers. These conditions may give some indication for the long-distance transportation of the dinosaur elements by high currents into the restricted ponds, where the accumulation of the turtle clusters. He also detected three successive vertebrate bearing horizons HI, HII and HIII. These horizons have well exposed surfaces exhibit high abundance of well-preserved complete and partial shells, scattered long bone of fore and hind limbs of sauropod dinosaurs. Some crocodyliforms elements such as vertebrae and fragmented skulls are observed in these horizons.

**AbdelGawad *et al.*** **[32]** identify turtle shell, from the Quseir Formation of Qarn Ganah, Kharga Oasis represents the first record of Bothremydidae (Pleurodira) from the Campanian age in Egypt and in Africa. The specimen is attributed to a new genus and species of Bothremydini, *Khargachelys caironensis*. This specimen brings new data to the poorly known diversity of turtles from the Late Cretaceous of Egypt.

**El Hedeny *et al.*** [41] reported a significant bioerosional structures on the turtle skeletal remains, indicating that they were commonly utilized by predators and scavengers. A common sign of insect feeding reflects an increase in insect activity and a slightly prolonged time of exposure prior to final sedimentation. Nine ichnogenera (*Nihilichnus, Karethraichnus, Cubiculum, Osteocallis, Radulichnus, Osteichnus, Osedacoides, Sulculites,* and *Machichnus*), representing ichnospecies, were identified. Eight of these ichnotaxa are recorded for the first time in Egypt. The recognized bioerosional structures appeared as borings, shallow chambers, grooves and punctures produced by ticks, beetles, polychaete worms, fishes/crocodile and radula of gastropods. Such bioerosion traces were likely caused by relatively long exposure time before the final deposition or burial. In some cases, borings may be produced during the host's lifetime.

**Wahba *et al.*** [42] recorded new evidence of saltasurid sauropod dinosaurs, represented by complete and preserved humerus bone north Gaga village.

## References


[1] Sallam, H. M., O'Connor, P. M., Kora, M., Sertich, J. J., Seiffert, E. R., Faris, M., El- Sayed, S. (2016). Vertebrate paleontological exploration of the Upper Cretaceous succession in the Dakhla and Kharga Oases, Western Desert, Egypt. *Journal of African Earth Sciences*, 117, 223-234.

[2] Capasso, L., Abdel Aziz, T., Mohamed Kamel, M., Gamal Ahmed, W. D., & Gebely Abdelmaksoud, A. E.-K. (2021). Anomoeodus aegypticus n. sp. (Pisces,† Pycnodontiformes) from the late Cretaceous of the Dakhla Formation, Western Desert, Egypt. *Thalassia Salentina*, 43, 89-104.

[3] Abu El-Kheir, G.-M. (2020). Taphonomic conditions and assessment of the late cretaceous vertebrates bearing sites in the western desert, egypt. *Egyptian Journal of Geology*, 64, 471-484

[4] Mohsen, A., Hirayama, R., AbdelGawad, M., Sileem, A., & Aly, M. (2020). New Record of Testudines and Aves Fossils from Bahariya Formation (Cenomanian), Bahariya Depression, Egypt. *J. Vertebr. Paleontol*, 249, Abstract.

[5] Salem, B. S., Lamanna, M. C., O'Connor, P. M., El-Qot, G. M., Shaker, F., Thabet, W., A., El-Sayed, S., & Sallam, H. M. (2022). First definitive record of Abelisauridae (Theropoda: Ceratosauria) from the Cretaceous Bahariya Formation, Bahariya Oasis, Western Desert of Egypt. *Royal Society Open Science*, 9, 220106.

[6] Sallam, H. M., Gorscak, E., O'Connor, P. M., El-Dawoudi, I. A., El-Sayed, S., Saber, S. Lamanna, M. C. (2018). New Egyptian sauropod reveals Late Cretaceous dinosaur dispersal between Europe and Africa. *Nature Ecology & Evolution*, 2(3), 445-451.

[7] AbdelGawad, M. K., El-Kheir, G. A. A., & Kassab, W. G. (2021). The youngest records of mosasaurid reptiles from the Upper Cretaceous of the South-Western Desert in Egypt. *Proceedings of the Geologists' Association*, 132(5), 556-562.

[8] Abu El-Kheir, G.-M., Abdelgawad, M. K., & Kassab, W. G. (2021). First known gigantic sea turtle from the Maastrichtian deposits in Egypt. *Acta Palaeontologica Polonica*, 66(2).

[9] AbdelGawad, M., Kassab, W., & Abu El-Kheir, G. (2019). Reviewing of the Testudines occurrence in the Late Cretaceous from South Western Desert, Egypt. *EGUGA 2019*, 21, 1671.

[10] El Hawat, A. S. (1997). Sedimentary basins of Egypt: an overview of dynamic stratigraphy. *African basins*, 39-85.

[11] Youssef, M. (1957). Upper Cretaceous rocks in Quesir area. *Bulletin de L'Institute de Egypt*, 7, 35-63.

[12] Saber, S., Sertich, J. J., Sallam, H. M., Ouda, K. A., O'Connor, P. M., & Seiffert, E. R. (2018). An enigmatic crocodyliform from the Upper Cretaceous Quseir Formation, central Egypt. *Cretaceous research*, 90, 174-184.

[13] Tantawy, A., Keller, G., Adatte, T., Stinnesbeck, W., Kassab, A., & Schulte, P. (2001). Maastrichtian to Paleocene depositional environment of the Dakhla Formation, Western Desert, Egypt: sedimentology, mineralogy, and integrated micro-and macrofossil biostratigraphies. *Cretaceous research*, 22(6), 795-827.

[14] Barthel, K. W., & Boettcher, R. (1978). Abu Ballas Formation: A significant lithostratigraphic unit of the former "Nubian Series." *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie*, 18, 155–166.

[15] Hermina, M. H. (1990). The surroundings of Kharga, Dakhla, and Farafra Oases. In Said, R. (ed.), the Geology of Egypt. AA Balkema, Rotterdam, 259–292.

[16] Soliman HA (1977) Foraminfereset microfossiles végétauxprovenant du " Nubia sandatone de subsurface de L'Oasis El Kharga, Désert de L'Quest. *Egypte Revue De Micropaléontologie* 20(2):114–124

[17] Böttcher, R. 1982. Die Abu Ballas Formation (Lingula Shale) (Apt?) der Nubischen Gruppe Südwest-Ägyptens. *Berliner Geowissenschaftliche Abhandlungen, Reihe A* 39, 1–145.

[18] Schrank, E. (1987) "Palaeozoic and Mesozoic palynomorphs from northeast Africa (Egypt and Sudan) with special reference to Late Cretaceous pollen and dinoflagellates.", *Berliner Geowissenschaftliche Abhandlungen, Reihe A, Geologie und Pal¤ontologie* Vol. 75 # 1 P. 249- 310

[19] Barthel, K. W. and Herrmann-Degen, W. 1981. Late Cretaceous and Early Tertiary stratigraphy in the Great Sand Sea and its SE margins (Farafra and Dakhla Oases),SW Desert, Egypt. Mitt. Bayer. *Staatsslg. Paliont. hist. Geol*. 21,141-182.

[20] Hendriks, F., Luger, P., Kallenbach, H. & Schroeder, J.H. (1984) Stratigraphical and sedimentological framework of the Kharga-Sinn El-Kaddab stretch (western and southern part of the Nile Basin), Western Desert, Egypt. *Berliner geowiss. Abh*. (A), 50. 117–15.

[21] Dominik, W. (1985). Stratigraphie und Sedimentologie (Geochemie Schwmineralanavse) der Oberkreide von Bahariya aund ihre Korrelation zum Dakhla Becken (Western Desert, Ägyptten). *Berliner Geowissenschaftliche Abhandlungen*, 62(A), 1–173.

[22] Awad GH, Ghobrial MG (1965) Zonal stratigraphy of the Kharga oasis. Ministry of Industry, general Egyptian Organization for Geological Research and Mining, *Geolological survey. Cairo* 34:1–77.

[23] Hermina, M.H. (1967) Geology of the northwest approaches of Kharga. *Geol. Surv. Egypt, Cairo*, Paper No. 44, 87 pp.

[24] Mansour, H.H. & Khallaf, A.F. (1979) Application of textural characteristics for depositional environment interpretation of the Upper Cretaceous-Paleocene east of Idfu-Sibaiya, Nile Valley. *Ann. geol. Surv. Egypt*, 9, 498–522.

[25] Zaghloul, E. A. (2021). Geology of Dakhla Oasis, Western Desert, Egypt. Sustainable Water Solutions in the Western Desert, Egypt: Dakhla Oasis, 29-44.

[26] Ouda, K. A., 2021. The Nubia Sandstone (Nubia Group), Western Desert, Egypt: An Overview. *International Journal of Trend in Scientific Research and Development (IJTSRD)*, 5: 2456–6470.

[27] Klitzsch, E., & Lejal-Nicol, A. (1984). Flora and fauna from strata in Southern Egypt and Northern Sudan (Nubia and surrounding areas). " (1984): 47-79.

[28] Mahmoud, M. S. (2003). Palynology and palaeoenvironment of the Quseir Formation (Campanian) from central Egypt. *Journal of African Earth Sciences*, 36(3), 135- 148.

[29] Awad, G. H. and Abed, M. (1969): Biostratigraphical zoning of the lower Tertiary in the Dakhla Oasis. *Geological Survey, UAR* 47, 63 pp.

[30] Said, R. (1990). The geology of Egypt: balkema. *Rotterdam, Brookfield*, 734.

[31] Issawi, B., Francis, M.H., Youssef, E.A., & Osman, R.A. (Ed). (2009). The phanerozoic geology of Egypt: a geodynamic approach. *Ministry of Petroleum and the Egyptian Mineral Resources Authority Special Publication*, (vol. 81, p. 571)

[32] AbdelGawad, M., Pérez-García, A., Hirayama, R., Mohesn, S., Tantawy, A.-A., & Abu El- Kheir, G. (2023). The First Side-Necked Turtle (Pleurodira, Bothremydidae) from the Campanian (Late Cretaceous) of Egypt. *Diversity*, 15(2), 284.

[33] Said, R. (1962). The geology of Egypt: *Elsevier Sci. Pub. Co., Amsterdam*, 377.

[34] Said, R., (1961). Tectonic framework of Egypt and its influence on distribution of foraminifera. *AAPG Bulletin*, 45(2), pp.198-218.

[35] Shaker, A.A., Longrich, N.R., Strougo, A., Asan, A., Bardet, N., Mousa, M.K., Tantawy, A.A. and El-Kheir, G.A.A., 2024. A new species of Halisaurus (Mosasauridae: Halisaurinae) from the lower Maastrichtian (Upper Cretaceous) of the Western Desert, Egypt. *Cretaceous Research*, *154*, p.105719.

[36] Abu El-Kheir, G., Shaker, A. A., Street, H. P., Longrich, N. R., Strougo, A., Asan, A., & AbdelGawad, M. (2023). A Prognathodontin Mosasaur from the Maastrichtian of the Dakhla Oasis, Western Desert, Egypt. *Fossils*, 1(1), 60-75.

[37] Ghobrial, M. G. (1967). The structural geology of the Kharga Oasis: General Egyptian organization for geological research and mining. *Geological survey*. Paper no. 43. 39 pp.

[38] Mohsen, S., AbdelGawad M.K, Tantawy A. Mousa M. K and Abu El-Kheir G. A. (2024) . A new upper

Cretaceous reptiles bearing locality: Qarn Ganah, Kharga Oasis, Western Desert, Egypt. *New Valley University of Basic and Applied Science*, 2(1): 1-7.

[39] Lamanna, M. C., Smith, J. B., Attia, Y. S., & Dodson, P. (2004). From dinosaurs to dyrosaurids (Crocodyliformes): removal of the post-Cenomanian (Late Cretaceous) record of Ornithischia from Africa. *Journal of Vertebrate Paleontology*, 24(3), 764- 768.

[40] El Hedeny, M., Mohesn, S., Tantawy, A.-a., El-Sabbagh, A., AbdelGawad, M., & El-Kheir, G. A. (2023). Bioerosion traces on the Campanian turtle remains: New data from the lagoonal deposits of the Quseir Formation, Kharga Oasis, Egypt. *Palaeontologia Electronica*, 26(3), 1-21.

[41] Wahba, D.G.A., Abu El-Kheir, G.A., Tantawy, A.A. and AbdelGawad, M., 2023. A new record of saltasaurids in Africa; new evidence from the Middle Campanian, Western Desert, Egypt. *Historical Biology*, pp.1-5.