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PALYNOSTRATIGRAPHICAL STUDY OF SOME CRETACEOUS ROCKS (APTIAN–LOWER CENOMANIAN) OF NABIL-1 WELL, NORTH WESTERN DESERT, EGYPT

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ABSTRACT

A palynological analysis has been carried out on the Lower–Middle Cretaceous (Aptian-lower Cenomanian) rock units encountered in the subsurface section of the Nabil-1 well, north Western Desert of Egypt. Twenty four ditch cutting samples have been analyzed palynologically and produced 40 species, which allow recognizing six informal palynomorphs zones restricted to northern Western Desert ranging from early Aptian to Cenomanian age. The identified zones are CE.1 *Elaterosporites klaszii* Acme zone, CE.2 *Trilobosporites laevigatus* interval zone, AL.1 *Araucariacites australis* Acme zone, AL.2 *Concavissimisporites punctatus* interval zone, AL.3 *Concavissimisporites* sp. sensu Deaf 2009 interval zone, AP.1 *Murospora florida* Acme zone and AP.2 *Afropollis operculatus* Acme zone. The erected palynozones are not only applicable to the western part of the Western Desert, but valid to the north Western Desert as well. They are correlated with well-documented zonations established for the same interval from other sites in the north Western Desert of Egypt and outside in North Africa. The palaeoenvironmental settings ranged between arid to semi arid in the lower Cenomanian to humid in the Albian and Aptian with marine conditions that varied between near shore to open marine environment.

***Keywords*:** Cretaceous, Aptian–early Cenomanian, Palynostratigraphy, Palynomorphs Alamain, Dahab, Kharita, Bahariya, Western Desert, Egypt.

INTRODUCTION

The Western Desert is considered as the main sedimentary basin in Egypt since the Paleozoic Era (Hantar, 1990). Practically, many papers have been issued on the palynological characteristics of the Cretaceous stages in north Western Desert (e.g., Aboul Ela and Tahoun 2010;ElBeialy et al.2010, 2011;Tahoun2012; Tahoun et al. 2012, 2013; Tahoun and Mohamed 2013; Makled and Baioumi 2013; Makled et al. 2013; Zobaa et al. 2013; Deaf et al.2014). Owing to the considerable abundance, diversity, and fair to good preservation of the palynomorphs in Cretaceous deposits, they are previously and extensively used for dating the Cretaceous sediments and differentiating between their stages. In the same stratigraphic horizons, a remarkable variation in the horizontal extension of some recovered taxa is reported. This may be attributed to the minor ecologic changes within the Western Desert basins and also to the lateral sedimentological variation characterizing the area (Hantar 1990; Kerdany and Cherif 1990). Facies control may have influenced the dinoflagellate cyst assemblages, making them inter-regionally variable in composition (Poulsen and Riding 2003).

Although there are many publications dealing with the Cretaceous palynology of the Western Desert, none of them is concerned with the extreme western part of the Western Desert basin close to the Egyptian–Libyan boundary except further south at Foram-1 well (Srivastava 1984). Hence, this work aims to present a new valuable information about the characteristic Cretaceous (Aptian–lower Cenomanian) palynomorphs the western part of the Western Desert basin that have not been investigated before. It also aims to erecting and establishing an Early–Middle Cretaceous palynostratigraphic zonation scheme for this part of the Western Desert and to correlate such proposed palynozones herein with those previously suggested by many authors inside and outside Egypt.

GEOLOGICAL SETTINGS

Twenty four ditch cutting samples from the Nabil-1 well (Lat. 30° 34' 03.1" N, Long. 26° 51' 23.4" E, Fig. 1) were palynologically investigated. The samples span the stratigraphic time interval from the Aptian to the early Cenomanian and cover Alamain, Dahab, Kharita, and Bahariya formations (Figs. 2). The Alamein Formation was described as white to light brown, hard, microcrystalline dolomite with some limestone, which conformably overlies the Alam El-Bueib Formation and represents the early Aptian age. The Dahab Formation consists of greenish, gray shale with interbedded siltstone, sandstone, and limestone. It represents the late Aptian age (Schlumberger, 1995). The Kharita Formation (early–late Albian) is mainly composed of sandstone and shale with thin limestone streaks. It conformably overlies the Dahab Formation. The Bahariya Formation (late Albian–early Cenomanian) is dominated by near shore marine fine-grained sandstone interbedded with shale and siltstone. It conformably overlies the Kharita Formation (Schlumberger, 1995).

MATERIAL AND METHODS

Palynomorphs were extracted from around 10 g of each ditch cutting sample by the standard palynological preparation technique. Carbonates and silicates were dissolved by treatment with hydrochloric and hydrofluoric acids, respectively. The fine inorganic residues were removed by sieving through 15 µm nylon mesh. After preparation of some test slides, it was noted that the palynomorphs are highly diluted and masked by the dominating amorphous organic matter. Thus, the organic residues need to be oxidized to concentrate the palynomorph content. Such step is accomplished using nitric acid (10 %) for 2 min to remove such amorphous organic matter. The residue was finally treated with ammonia solution (5 %) for <1 min to remove the formed humic acid. The organic residues were mounted in a permanent medium (Canada Balsam). Two hundred specimens were counted for few samples, but the majority of the samples have <200 counts from two slides. The slides are stored in the Palynological Laboratory in the Exploration Department of Egyptian Petroleum Research Institute, Cairo.

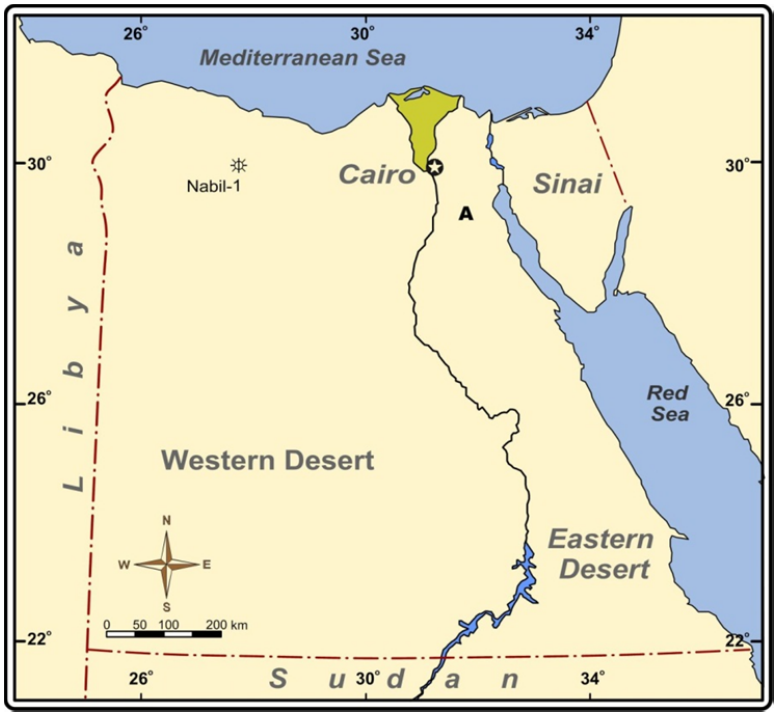

Fig. 1: A. Location map of Egypt showing the studied in the Nabil-1X well.

PALYNOLOGICAL SCHEME

Palynomorph assemblage (40 species belonging) was recovered from the investigated 24 samples. The zonation represents an idealized succession of bioevents, which takes into account factors such as palaeoenvironmental/facies control on sediment distribution and ranges of taxa, natural variability, and

sampling spacing. The variation in abundance and diversity of the palynomorph assemblages recovered fro7m the studied Cretaceous succession reflects a number of correlatable events of local and regional stratigraphic importance.

These events help to construct a number of local successive palynological zones that could be traced regionally. Ten informal sporomorph zones have been established. These proposed zones are named by prefix of two capital letters indicating the stages (CE for Cenomanian, AL for Albian, AP for Aptian, BA for Barremian) followed by simple alpha-numeric scheme 1, 2, etc. The well-preserved taxa as well as the stratigraphically important ones are photographed and illustrated in Plate 1. Most of the identified palynomorph taxa are presented in Figs. 2. They are organized based on their highest occurrence in a stratigraphical order. Owing to the large size of the range chart (Figs. 2), few well-preserved taxa present in one or two samples are not listed in the range chart, but they are photographed and depicted in the plate. They are organized principally based on their first downhole appearances (last appearance data) and/or first downhole influxes. The erected palynomorphs zones are correlated with independently dated zones from different locations within the Western Desert and outside Egypt. These zones are discussed from top to bottom.

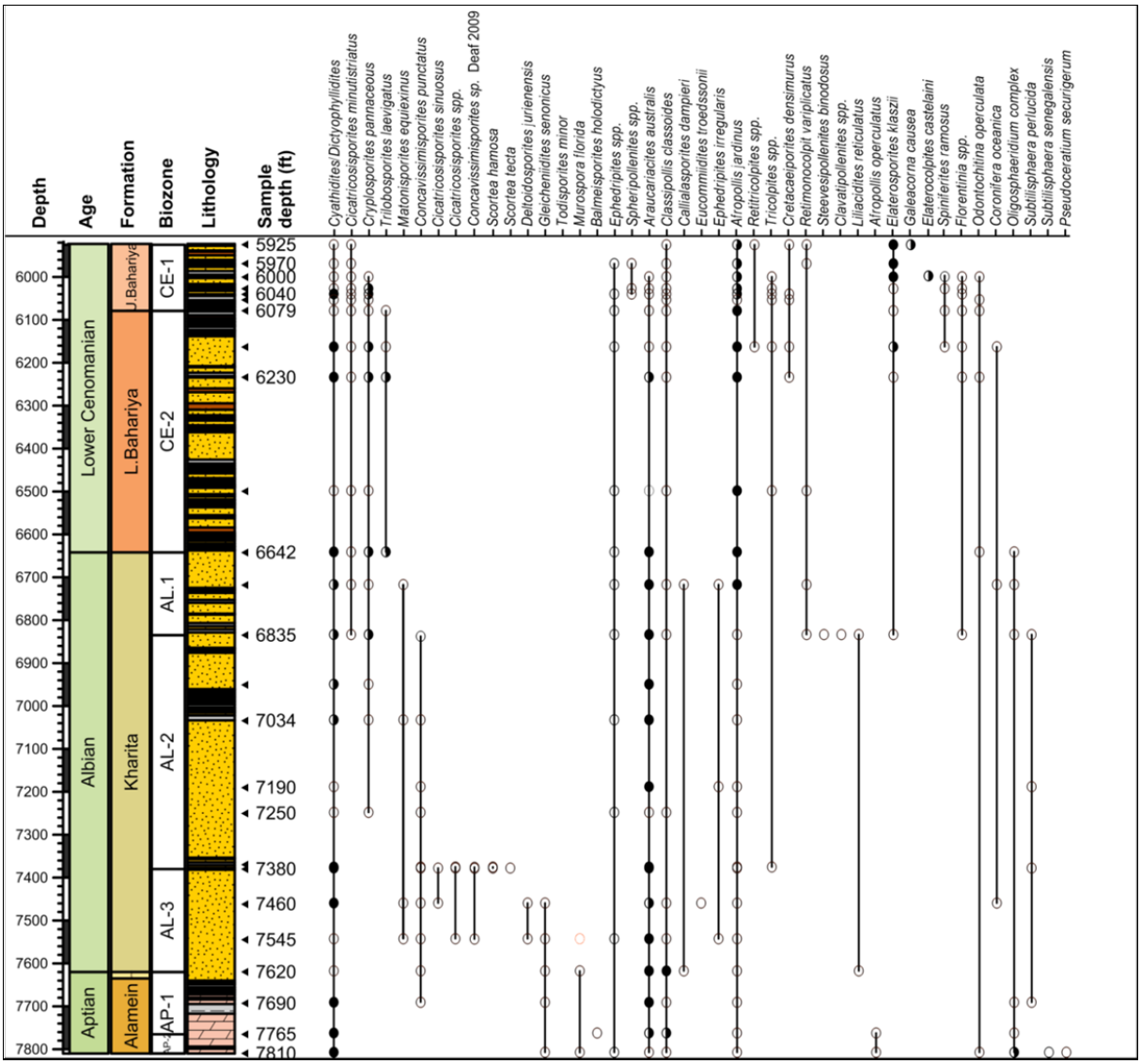

Fig. 2: Semi-quantitative vertical distribution chart palynomorphs chart from the Nabil-1X well. 1-Dahab Formation.

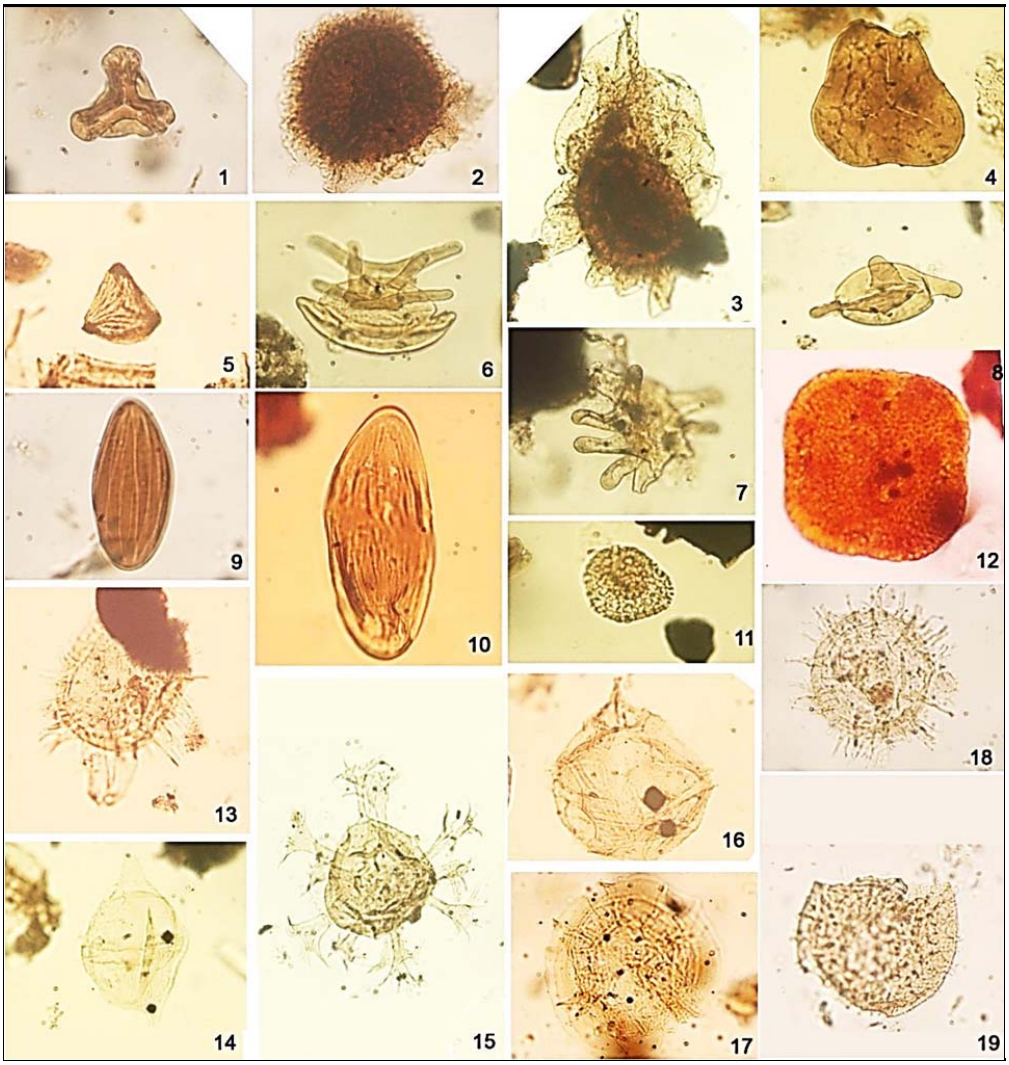

Plate 1: *1- Gleicheniidites* sp. A, depth 7460 ft, diameter 47 µm. 2-*Crybelosporites pannuceus*, depth 6040 ft, diameter73 µm. 3- *Crypelosporites pannuceus*, depth 7765 ft, diameter 60 µm. 4-*Scortea hamoza*, depth 7380 ft, diameter 70 µm. 5-*Appendicisporites sp.*, depth 7575 ft, diameter 23 µm. 6-*Elaterosporites klaszii*, depth 6000 ft, diameter 40 µm. 7- *Elaterocolpites castelaini*, depth 6040 ft, diameter 37. 8-*Sofrepites legouxae*, depth 6000 ft, diameter 30 µm. 9- *Ephedripites* sp. B, depth 6079 ft, diameter 70 µm. 10-*Steevesipollenites binodosus*, depth 6835 ft, diameter 83 µm. 11- *Afropollis jardinus*, depth 6079 ft, diameter 40 µm. 12-*Cretacaeiporites densimurus*, depth 6040 ft, diameter 52 µm. 13- *Florentinia* sp. A, depth 6079 ft, diameter 45 µm. 14-*Subtilisphaera senegalensis*, depth 6835 ft, diameter 30 µm. 15- *Oligosphaeridium complex*, depth 6642 ft, diameter 53 µm. 16- *Cribroperidinium* sp. depth 7622 ft, diameter 45 µm. 17-*Dinogymnium acuminatum*, depth 6230 feet, diameter 51 µm. 18-*Coronifera oceanica*, depth 7460 ft, diameter 32 µm. 19-*Peseudoceratium securigerum*, depth 7810 feet, diameter 35 µm.

PALYNOMORPHS BIOZONES

Early Cenomanian

Two palynomorphs biozones were recognized through the early Cenomanian time from top to bottom as follows:

CE.1 *Elaterosporites klaszii* Acme zone

Definition: An influx of *E. klaszii* is a remarkable event that characterizes this zone.

Occurrence, depth, and thickness: From 5925 to 6079 ft (154 ft thick), the Bahariya Fm.

Diagnosis Other: important taxa in this zone are *Crybelosporites pannuceus*, *Cicatricosisporites minutaestriatus*, and other spores with a simple trilete mark related mostly to genera *Cyathidites*/*Dictyophyllidites*. *Elaterocolpites castelainii*, *Elateroplicites africaensis*, and *Galeacornea causea* were recorded only in the first sample (5940ft). Angiosperm pollen grains are represented mainly by *Afropollis jardinus*, *Tricolpites* spp., *Retimonocolpites* spp. (large forms), and *Cretacaeiporites densimurus* (rare). Gymnosperm pollen grains in the described zone occur sporadically and represented mainly by species related to *Araucariacites*, *Ephedripites*, and *Classopollis*. No dinoflagellate cysts have been recorded until the depth of 6000 ft.

Below the 6000 m depth, the marine dinoflagellate cysts increase in diversity, although they are still less frequent than the terrestrial palynomorphs. Genera are mainly represented by *Florentinia* spp., *Spiniferites* spp., *Odontochitina operculata*, and *Coronifera oceanica*. Marine dinoflagellate cysts regularly occur and increase in its number especially where limestone streaks are present.

Suggested age: Early Cenomanian.

Dating of the early Cenomanian microfloras is based upon correlation with the previously described sections in Egypt as well as on other localities in Africa and Southern America (ASA).

The highest occurrence of *A. jardinus* indicates an age not younger than early Cenomanian (Doyle et al. 1982). Recently, Deaf et al. (2014) raise its top range to mid-Cenomanian. *Elaterosporites klaszii* first appeared in Brazil in middle Albian time (Jardiné 1967; Muller 1968) and at the same interval in Egypt (EL Shamma 1988, 1991; Omran et al. 1990; Schrank and Ibrahim 1995) and continues to be present in the mid-Cenomanian (Deaf et al. 2014). Other elater-bearing pollen *E. castelainii* and *G. causea* are mentioned from the late Albian–early Cenomanian of Brazil together with *Classopollis brasiliensis* (Herngreen 1974, 1975). *C. brasiliensis* and *C. densimurus* are recorded in Egypt from early Cenomanian (EL Shamma 1991; Bassiouni et al. 1992; Schrank and Ibrahim 1995) and mid-Cenomanian (Deaf et al. 2014). The presence of high percentage of angiosperms assigned to genera Afropollis, *Tricolpites*, and *Retitricolpites* indicates an early Cenomanian age (Schrank 1987).

Correlation: The present CE.1 Acme zone is correlated to the zone CE-3 (El Shamma et al., 1999) and zone 2 (Tahoun and Mohamed 2013) based on the same taxon (*E. klaszii*).

Paleoevironmental settings: The miospore assemblage indicates an arid to semi arid warm climate according to the abundant occurrences of the Elaters bearing pollen and *Afropollis jardinus* (Tahoun et al., 2015). The diversity and abundance of dinoflagellates point to near shore to open marine environment (Makled et al., 2013).

CE.2 *Trilobosporites laevigatus* interval Zone

Definition: The top of this zone is defined by the first downhole appearance of *T. laevigatus*.

Occurrence, depth, and thickness: From 6079 to 6642 ft (563 ft thick), the Bahariya Fm.

Diagnosis: This zone is characterized by a sharp decline in the frequency of *E. klaszii* and predominance of *A. jardinus* with a sporadic occurrence of *C. densimurus*. Most of the other palynomorph components of the upper CE.1 sporomorph biozone are still represented in the present zone in terms of spores, gymnosperm, and angiosperm pollen grains. The zone shows a gradual downward increase in the number of *Araucariacites australis* and *A. jardinus* with a decrease in *Tricolpites* spp.

Suggested age: Early Cenomanian.

Correlation: The CE-1 interval zone (El Shamma et al. 1999) and zone 4 (Tahoun and Mohamed 2013) based on the *Trilobosporites laevigatus* species could be correlated with the present CE.2 zone.

Paleoevironmental settings: in general the appearance of *Araucariacites australis* and *A. jardinus* indicate to fluctuated humid and arid climate (Makled et al., 2013).

Albian

The general palynological characteristics of this time interval can be summarized in the predominance of terrestrial land-derived microfloras of *Cyathidites*/*Dictyophyllidites* beside the regular occurrence of *C. pannuceus* and *Concavissimisporites punctatus* and the sporadic occurrence of *C. minutaestriatus*. A marked in-crease in percentage of gymnosperm pollen grains particularly *A. australis* as well as a marked decrease in percentage of *A. jardinus*, and other angiosperm pollen grains can be noticed. The marine dinoflagellate cysts are rare.

From the successive occurrence of the different species and their frequency within the studied samples, three palynomorphs biozones are recognized from top to base.

AL.1 *Araucariacites australis* Acme zone

Definition: The first downhole influx of *A. australis* is a remarkable event indicative for this zone.

Occurrence, depth, and thickness: From 6642 to 6835 ft (193 ft thick), the basal part of the Bahariya Fm.

Diagnosis: The common miospores represented in this zone are *C. pannuceus*, *C. minutaestriatus* and *Cyathidites*/*Dictyophyllidites*. Angiospermous pollen grains are represented mainly by *A. jardinus*, *Retimonocolpites* sp., *Liliacidites reticulates*, and *Stellatopollis* spp. Gymnosperm pollen grains are represented mainly by *A. australis* with *Ephedripites irregularis*, *Classopollis classoides*, and *Callialasporites dampieri*.

Suggested age: Late Albian.

Correlation: The present AL.1 Acme zone could be correlated with the upper part of zone VI in the Eastern Desert, Egypt (Ibrahim et al. 2001) and correlates with zone 3 of the Western Desert (Obeid et al. 2006) based on the notable influx of *A. australis*.

Paleoevironmental settings: the appearance of *C. minutaestriatus* and *Cyathidites*/*Dictyophyllidites*. Indicate to fluctuated humid (Makled et al., 2013).

AL.2 *Concavissimisporites punctatus* interval zone

Definition: The top of this zone is defined by the first downhole appearance (highest occurrence) of *C. punctatus*. The lower limit is defined by the highest occurrence of *Concavissimisporites* sp. sensu Deaf 2009 spores.

Occurrence, depth, and thickness: From 6835 to 7380 ft (545 ft thick), the upper part of the Kharita Fm.

Diagnosis: The present zone has a palynomorph assemblage similar to the one described above. Marine dinoflagellate cysts are few; they are dominated by few cysts of *Oligosphaeridium complex*, *Florentinia* spp., *C. oceanica*, and *O. operculata*. The most noteworthy feature of the Albian miospores in Egypt is the first downhole appearance of *C. punctatus* and *E. irregularis* (Ibrahim et al. 1995;El Shamma et al. 1999). Dinoflagellate cysts association of *C. oceanica*, O. *complex*, *and Cyclonephelium vannophorum* characterize the Vraconian age in the Tethyan Realm (Williams and Bujak 1985; Uwins and Batten 1988). A similar association has been attributed to early–middle Albian by Uwins and Batten (1988) from northeast Libya.

O. complex has been recorded from the late Albian of Canada (Singh 1971). The same species is reported from the Albian–early Cenomanian of France (Davey and Verdier 1973), from the Albian of northeast Libya (Thusu et al. 1988) and northeastern Egypt (Ibrahim et al. 2002). According to Uwins and Batten (1988), the last appearance datum of *O. complex* is in the late Albian.

Suggested age: Middle–late Albian.

Correlation: The present AL.2 *C. punctatus* interval zone could be correlated with the upper part of zone I in the Western Desert (Sultan and Aly 1986) and corresponds with Al 2–1 zone of the Western Desert, Egypt (El Shamma et al. 1999) based upon the first downhole appearance of the index taxon *C. punctatus*.

Paleoevironmental settings: The diverse assemblage of the dinoflagellates indicates the open marine environment (Makled et al., 2013).

AL.3 *Concavissimisporites* sp. sensu Deaf 2009 Interval Zone

Definition: The upper boundary of this palynozone is based upon the first downhole appearance of *Concavissimisporites* sp. sensu Deaf 2009, while the lower limit is defined upon the first downhole influx of *Murospora florida*.

Occurrence, depth, and thickness: From 7380 to 7620ft (240 ft thick), the basal part of the Kharita Fm.

Diagnosis: This zone still has the main characteristic features of the above described Albian zones; meanwhile, a reduction in the percentage of *A. jardinus* and *A. australis* is noticed. Spores are dominated by smooth trilete forms related to gen-era *Cyathidites*/*Dictyophyllidites*, *Todisporites*, *Gleicheniidites*, *Matonisporites*, *and Murospora* spp. (rare). Common spores are *C. punctatus*, *Concavissimisporites* spp., and *Cicatricosisporites* sinuosus. Associated angiosper-mous pollen grains are *Tricolpites* spp. and *Clavatipollenites* spp. Gymnospermous pollen grains are common and comprise A. *australis*, *C. classoides*, *Ephedripites* spp., and *C. dampieri*.

Marine dinoflagellate cysts are still scarce. They are dominated by *Subtilisphaera perlucida*, *O. complex*, *C. oceanica*, and *O. operculata*. Deaf (2009) recorded the last appearance data of the *Concavissimisporites* spp. in the early Albian. Bassiouni et al. (1992) and El Shamma et al. (1999) referred the same association recorded herein with *Scortea hamosa* and *S. tecta* (identified here as *Concavissimisporites* sp. sensu Deaf 2009 and *Concavissimisporites* sp., respectively) to the early Albian in the Western Desert. Chlonova (1976, 1979)dated early Albian age for Russian sections based upon similar assemblage including *Scortea hamosa* and *S. tecta*. In Alberta, Canada, Banerjee and Davies (1988) use the same *Scortea* species for dating the Manville Group a late Aptian to early Albian age. Ravn and Witzke (1995) give the Dakota Formation, USA, an Albian age based on *S. tecta* and others. *S. perlucida* was recorded from early Albian (Duxbury 1983, southern England; Ibrahim et al. 2002, Northeastern Egypt). Habib and Drugg (1987) considered the Early Albian boundary to be marked by the last appearance datum of this taxon.

Suggested age: Early Albian.

Correlation: The present AL.3 interval zone could be correlated with the lower part of zones III and 4 in Western Desert (EL Shamma 1988) and (Obeid et al. 2006), respectively, based on the same palynological event (the first downhole appearance of *Concavissimisporites* sp. sensu Deaf 2009).

Aptian

The general palynological characteristic of this stratigraphic interval can be considered as a natural extension of the pre-ceding early Albian palynomorphs in terms of predominance of *Cyathidites*/*Dictyophyllidites* and *C. punctatus*. Angiospermous pollen grains are mainly representing by rare *Afropollis* aff. *jardinus*; meanwhile, a reduction in the number of gymnosperms pollen *Araucariacites* is recorded. Marine dinoflagellate cysts comprise few cysts of *Subtilisphaera* spp., *Cyclonephelium* spp., and *O. complex*. The few samples investigated from the Alamein dolomites are relatively poor in their palynomorphs content. The stratigraphic interval below the Kharita Formation represented by Alamein and Dahab formations has some significant palynological events. Such events could be summarized in the highest persistent occurrence of *Afropollis operculatus*, the remarkable influx of *M. florida*, beside the persistent occurrence of the dinoflagellate cysts *Subtilisphaera* senegalensis and the first downhole appearance of *Pseudoceratium securigerum*.

According to these events, the Aptian age could be subdivided into two palynological palynomorphs biozones having more common sharing taxa and slightly differentiated in their distribution.

AP.1 *Murospora florida* Acme Zone

Definition: The upper most limit of this biozone is defined by the first abundant downhole occurrence of *M. florida*. The lower limit of this zone is based upon the first abundant downhole occurrence of A. operculatus combined with a sud-den reduction in the number of the *M. florida* specimens.

Occurrence, depth, and thickness: From 7620 to 7765 ft (145 ft thick), the Dahab and Alamein formations.

Diagnosis: The palynological assemblage recorded from this interval is dominated by palynomorphs taxa *Cyathidites*/*Dictyophyllidites* and *C. classoides*. *Concavissimisporities punctatus* is one of the other significant recorded taxa within this interval. Gymnospermous pollen grains are common and comprise *A. australis*, *C. classoides, Ephedripites* spp., *Spheripollenites psilatus*, *Spheripollenites* spp., *Steevesipollenites* spp., and *C. dampieri*. *M. florida* is extensively represented in the local record of the Aptian. It was reported from the Western Desert, Egypt (EL Shamma 1988; El Shamma and Arafa1988; Omran et al. 1990; Bassiouni et al. 1992; El Shamma et al. 1999; Mahmoud and Moawad 2002); from the Aptian of the Nile Delta, Egypt (El Beialy et al. 1990); and from the Aptian of northeastern Egypt (Ibrahim et al. 2001).

Suggested age: Late Aptian

Correlation: The present AP.1 Acme zone could be correlated with zone I (Aptian) of El Shamma and Arafa (1988) based on the coexistence of the most characteristic taxon *M. florida*. In the same way, the proposed zone could be equated with the upper part of AP-1 Zone (El Shamma et al. 1999) in the common presence of *M. florida*.

Paleoevironmental settings: in general the appearance of highly ornamented and heavy spores like *Cyathidites*/*Dictyophyllidites* and *Concavissimisporities punctatus* indicate in addition to *Ephedripites* spp indicate a fluctuated humid to arid climate (Makled et al., 2013).

AP.2 *Afropollis operculatus* Acme Zone

Definition: The top limit of this zone is defined by the first downhole common occurrence of A. operculatus and characterized also by the remarked reduction in number of *M. florida*. This zone ends at the last downhole (lowermost) occurrence of *A. operculatus*.

Occurrence, depth, and thickness: From 7765to7810m (45 ft thick), Alamein

Diagnosis: The last downhole (lowermost) occurrence of *A.* aff. *jardinus, A. operculatus*, and the dinoflagellate cysts *P. securigerum*, beside the persistent occurrence of *M. florida* and *Balmeisporites holodictyus*, in addition to the first downhole appearance (highest occurrence) of *Pilosisporites* spp. (fine spines) are important palyevents palynologically characterizing this zone.

Other associated spores are Cyathidites/ *Dictyophllidites*, *Gleicheniidites senonicus*, and *Verrucosisporities* spp. *M. florida* is one of the common spores, while *C. punctatus* is among the rare ones. *Cupressacites oxycedroides* are among the gymnospermous pollen grains recorded herein. Almost the same gymnospermous association recovered in the previous zone is still recorded.

This zone is characterized by important palynological event represented by the first downhole occurrence of *P. securigerum*. Marine dinoflagellate cysts vary in their frequency. An increase in species diversity of the dinoflagellate cyst assemblage is recorded, comprising *O. complex*, *Cribroperidinium orthoceras*, *C. edwardsii*, and *C. vannophorum*. An association of *P. securigerum*, S. *senegalensis*, and *Cyclonephelium* spp. is also recorded. In Egypt, *A. operculatus* has been recognized from early Aptian and/or slightly younger (El Shamma and Baiumi 1993; Schrank and Ibrahim 1995; El Shamma etal.1999). Doyle et al. (1977) recoded A. operculatus from the early Aptian of West Africa and the equatorial region. Some Early Cretaceous forms such as *Pilosisporities* spp. and *Appendicisporites* spp. are also documented as well.

Davey and Verdier (1974) documented P. *securigerum* from the Aptian of France. This species is accounted from the late Aptian of England (Duxbury 1983; Lister and Batten 1988), northeast of Libya (Uwins and Batten 1988), and Egypt (Omran et al. 1990; Schrank and Ibrahim 1995; Ibrahim e t al. 1995, 2002). The occurrence of *P. securigerum* supports the early–middle Aptian age as approved by Thusu and Van Der Eem (1985) and Thusu et al. (1988) in northeast Libya and the Western Desert of Egypt (El Shamma and Baioumi 1993).

Suggested age: Early Aptian.

Correlation: The proposed AP.2 Acme zone could be equated with zone I (EL Shamma 1988) and correlated with AP-1 zone (El Shamma et al. 1999) where they were erected on the same palynoevent represented by the first downhole common occurrence of *A. operculatus*.

Paleoevironmental settings: in general the appearance of Cyathidites/ *Dictyophllidites*, *Gleicheniidites senonicus*, and *Verrucosisporities* spp. *M. florida* with *A. operculatus* indicate to fluctuated humid and arid climate (Makled et al., 2013).

CONCLUSION

Twenty four samples have been palynologically analyzed for their palynomorph content. The investigated samples cover the Lower–Middle Cretaceous rock units encountered in the succession of the Nabil-1 well, north Western Desert of Egypt. Ten informal palynomorphs zones ranging from early Cenomanian to Hauterivian have been established. These palynozones illustrating Early–Middle Cretaceous scheme could be utilized and applied overall the north Western Desert territory. The sporomorph biozones CE.1 and CE.2 are of early Cenomanian age and are recognized from the Bahariya Formation. The biozones AL.1, AL.2, and AL.3 are Albian in age. Only the AL.1 is of late Albian age and is known from the basal part of the Bahariya Formation. The other zone AL.2 is of middle–late Albian age. AL.3 is of early Albian age. They are documented from the Kharita Formation. The biozone AP.1 is late Aptian in age, and the zone AP.2 is of early Aptian age. The latter AP.1 and AP.2 zones are distinguished through the Dahab, Alamein. A correlation task for the established palynozones in the present study with those previously well documented, erected in north Western Desert and outside Egypt in the Tethyan Realm, has been carried out. The palaeoenvironmental settings ranged between arid to semi arid in the lower Cenomanian to humid in the Albian and Aptian with marine conditions that varied between near shore to open marine environment.

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Palynostratigraphical study of some Cretaceous rocks

دراسة بالينوستراتجرافية لبعض صخور العصر الطباشير (الابتي –السينوماني السفلي) لبئر نبيل-١ بشمال الصحراء الغربية مصر

طارق فؤاد مصطفى و مصطفى محمود أمين

الخلاصة

تم إجراء تحليلات في الباليولوجية (حفريات نباتية) على الوحدات الصخرية في العصر الطباشيري السفلي في الجزء تحت سطح الأرض من بئر نبيل -١ ، شمال الصحراء الغربية لمصر . وقد تم تحليل أربع وعشرين عينة فتاتية وأنتجت ٤٠ نوعا من الحفريات النباتية (الباليولوجية) ، والتي سمحت بالتعرف على ستة نطاقات تقتصر على شمال الصحراء الغربية بدءا من العصر الأبتي المبكر إلى عصر السينوماني ، المناطق التي تم تحديدها هي Acme *Elaterosporites klaszii* CE.1 ، *Trilobosporites laevigatus* CE.2، AL.1 Sensu Deaf 2009 interval zone، *Murospora florida* AP.1 Acme ومنطقة .*Afropollis operculatus* AP.2 لا تنطبق بالينوزونات المقامة على الجزء الغربي من الصحراء الغربية فحسب ، بل تنطبق أيضًا على الصحراء الغربية الشمالية أيضًا . و قد قورنت مع المناطق الموثقة توثيقا جيدا والتي أنشئت لنفس المنطقة من مواقع أخرى في شمال الصحراء الغربية في مصر وخارجها في شمال أفريقيا . تراوحت البيئة القديمة بين المناطق القاحلة وشبه القاحلة في العصر السينوماني السفلي إلى الرطبة في الألبي والأبتي مع الظروف البحرية التي تراوحت بين الشاطئ القريب الى بيئة بحرية مفتوحة .