Palynological Study of Ora and the Upper Part of Kaista Formation in Zakho area, Iraqi Kurdistan Region

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Abstract

Palynological investigations of Ora Formation and the upper part of Kaista Formation (Late Devonian – Early Carboniferous) in the Northern Thrust Zone were conducted in Kaista exposures about 2km away to the north west of Kaista village Zakho District, Northern Iraq. The upper part of Kaista Formation is mainly composed of dolomitic limestone interbedded in the lower part with black shale, fine sandstone, and sometimes with lime mudstone, but in the upper part the facies is dominantly fossiliferous limestone. Ora Formation is composed of black shale and silty shales interbedded with siltstones and thin fossiliferous limestone. Based on available organic matter, (phytoclasts, amorphous organic matters, and palynomorphs). Kaista section divided into five different palynofacies (PF1, PF2, PF3, PF4 and PF5). The detailed palynological study in Kaista section, having both Ora and Kaista Formations, enabled their division into five palynozones (P.Z1, P.Z2, P.Z3, P.Z4 and P.Z5). The basic index for this division is the miospores studied in the sum of 15 samples. The palynological analysis has confirmed the previously determined age of the studied formations, as (Late Devonian – Early Carboniferous) for the Kaista Formation and Early (Strunian-Late Tournaisian) for Ora Formation. The palynomorphs and the organic matters indicate that the depositional environment of Ora Formation is shallow marine to near shore. However, the depositional environment of the Kaista Formation was not established owing to scarcity of diagnostic palynomorphs.

Introduction

The studied formations are the upper part of Kaista Formation and all Ora Formation. Both formations crop out in the Northern Thrust Zone, very close to the Iraqi – Turkish boarder. The Kaista Formation was first introduced by Wetzel and Morton (1952) in Bellen et. al., (1959) in the Northern Thrust Zone region of Iraq to be of Late Devonian (Famennian) age, whereas the Ora Formation was first introduced by Wetzel (1952) in Bellen et. al. (1959) from the same area to be of Early Carboniferous or Late Devonian – Early Carboniferous. There are only few studies on the
Paleozoic sequence in this area. The most important studies are Hasson, (1999), Al-Lami (1998) and Baban (1996). Al-Lami (1998) conducted a palynology study of the interval 1295-1394 m. in Akkas-1 borehole which is nearly coincident with the entire Ora Formation. He gave late Devonian age to the studied section in his study. Al-Hasson (1999) studied the palynomorphs of the Late Devonian – Early carboniferous in Khleisia well1. She gave Late Devonian-Early Carboniferous age for the studied section Fig.1. The Kaista section is about 2 kilometers northwest of Kaista village (Latitude 37° 17' 45" and Longitude 43° 10' 00"), in the core of Chia Zinnar fold where Paleozoic formations are successively well exposed. The area of the Kaista section(studied area) Fig.1 is affected by several faults which led to some distortion of the stratigraphic section to some interruption and repetition of strata. However, impact of faulting is much greater.

**Aim of the study**

The main aims are to check the content of different types of palynomorphs and organic matters, then making use for dating and comparison with their equivalent units in other places in the world in order to determine the palynofacies, the real age, and environment of deposition of the studied formations.

**Geological setting**

The studied area is part of the Northern Thrust Zone of Buday (1980) which corresponds to the Zone of Imbrications of the foreland basin of Numan (2000). The structural pattern of the Thrust Zone is characterized by relatively long east – west trending anticlinorium with three dome shaped culminations, where the oldest Paleozoic rocks are cropping out. The southern limbs of the anticlinorium are the steeper ones; the northern flanks are less disrupted by faults. The main movement that took place at that time is Caledonian – Hercynian movement (Buday, 1980). The age proposed by the original authors for the Kaista Formation was Late Devonian (Famennian). Other researchers favored Late Devonian – Early Carboniferous (Gaddo & Parker, 1959; Ditmar, 1971).

The age of the Ora Formation was proposed by the original author as Early Carboniferous or Late Devonian – Early Carboniferous (Wetzel, 1952, in Bellen et al., 1959). This was later disputed by Hasson (1999) on the basis of palynological evidence and Late Devonian – Early Carboniferous age was proposed. The Kaista Formation overlies the
Pirispiki Formation with disconformable contact and underlies the Ora Formation with conformable and gradational contact (Bellen et al., 1959). Near the latter contact, the carbonate rock decrease with increase of clastic rock toward the Ora Formation, with few interbedding of limestone with shale near the contact. The Ora Formation is overlain by Harur Formation with conformable and gradational contact. Near this contact the thickness of carbonate rock increases with decrease of shale towards the contact with Harur Formation.

**Methodology**

Palynological analysis was carried out on 15 samples taken from kiasta section Fig.2. The usual procedure of the preparation of sample was followed (Traverse, 1988).

**Palynostratigraphy**

Fifteen samples were studied palynologically for both formation, one sample for Kaista Formation, and fourteen for Ora Formations, this is due to rareness of palynomorphs in Kaista Formation if compared with Ora Formation, and only two species were observed in Kaista Formation during this study. A total of 88 miospore species belongs to 40 genera and some acritarch species were identified. The distribution of spores was established by making the range of stratigraphic important species as given in the range chart Fig.2.

Fig.1: Location map of the study area.
Zonation:

The range chart shows the following miospore assemblage palynozones Fig.2:

-Palynozone 1 (P.Z1): This assemblage palynozone is represented in the present study by samples (Kk6, Kk-Or, KkOr1). This palynozone is equivalent to the (LL) palynozone of Higgs et al. (1988) (Fig. 3). This palynozone is characterized by an association species in the bottom of this palynozone such as, Retispora lepidophyta, Apiculiretusispora multiseta, A. plicata, Archaeozonotriletes vermiciforms, Auroaspora speciosa, Cyclogranisporites minitus, Cymbosporites boafeticus, Camarazonotriletes sextantii, Densosporites cf. regalis, D. cf. spinosus, D. intemedius, D. rarispinosus, Grandispora cornuta, Hymenozonotriletes pusillites, Leavigatisporites sp., Leiotriletes glaber, L. incompatus, L. minutissimus, L. pagius, L. parvulus, Lophotriletes magnius, Leiozonotriletes insignatus, Punctatisporites irasss, P. resolutus, Retusotriletes sp., R.septalis, R.crassus, R.cf.crassus, R.distinctus, R.communis, Rhabdaspores langii, Spelaeotriletes resolutus, S.microspinus, Teichertspora torquata, Trachytriletes medius, Verrucosisporites irregularis, in addition to the presence of species restricted to North Africa and Middle East such as Aratisporites saharaensis, other distinctive taxa which characterized the younger palynozone also ranged down in the present study into (P.Z1), such as, Verrucosisporites nitidus, Vallastisporites verrucosus, Umbonotisporites cf. abstrusus, Spelaeotriletes balteatus, Hymenozonotriletes explanatus, Cyrtosporites cristifer, Prolycospora rugulosa, Densosporites spitbergensis, Raistrickia variableis. This palynozone ends with the first appearanceof (Auroraspora cf.asperella,Dictyotriletes reticosus, Leiotriletes platyrugosus).

Age of this zone - The presence of first appearance of the Retispora lepidophyta indicates Late Devonian, Lower Strunian age, Martel et al., (1993).

-Palynozone 2 (P.Z2): This assemblage palynozone is represented in the present study by samples (KOr2, KOr4, KOr6, KOr7). This palynozone is equivalent to the (LE) sub-palynozone of the (PL) palynozone of Clayton et al. (1978), and to the (LE) palynozone of Higgs et al. (1988) Fig.3. The base of the palynozone is characterized in the bottom by Hymenozonotriletes explanatus, with several taxa that make their first appearance within this palynozone such as, Ancyrospora furcula, Auroaspora cf. asperella, Azonomonoletes sp., Cymbosporites cyathus,
Cymbosporites sp. cf. magnificus, Dictyotriletes reticosus, Endoculespora setacea, Leiotriletes platyrugosus, Lophozontriletes proscurrus, Spelaeotriletes gigantus. Species such as Cymbosporites magnificus, Retusotriletes crassus, ranged down in this study from younger palynozone into the PZ2, together with the most of the diagnosis species of the preceding P.Z1 palynozone, (Fig 2). This palynozone is ends with the first appearance of (Corbulispora vimineus, Dictyotriletes sp., Raistrickia corynoges, Retusotriletes planus, Umbonatisporites cf. distinctus), and final appearance of Spelaeotriletes resolutus.

**Age of this zone** - The age of this zone is Upper Devonian, Middle Strunian age.

-Palynozone 3 (P.Z3): This assemblage palynozone is represented in this study by samples (KOr8, KOr10, and KOr12). This palynozone is equivalent to the (LN) palynozone of Streel et al. (1987) and Maziane et al. (1999). This zone is characterized by first appearance of Lophozontriletes malevkensis, Densosporites sp., Dictyotriletes sp., Corbulispora vimineus, Cristatisporites colliculus, Gemenspora decora, Acanthotriletes multisetus, Auroraspora sp., Auroraspora solisortus, Grandispora douglasianus, Hymeaozontriletes genuinus, Lophotriletes magnus, L. uncatus, Radiizonate geniinus, Retusotriletes minutus, R. planus, Spelaeotriletes traingulatus, Trachytriletes nigratus, Umbonatisporites cf. distinctus, Vallatisporites ciliaris, V. communis, Raistrickia densa, R. golatensis, Brochotriletes diversifoviatus. Another distinctive species which characterized the younger Tournaisian palynozone are ranged down in the present study into the (P. Z3) assemblage zone such as, Raistrickia corynoges, Vallatisporites vallatus, V. agadesi, Spelaeotriletes obstrusus, S. owensii, in addition to the most diagnosis species of the preceding palynozones. This palynozone is ends with the final appearance of (Brochotriletes diversifoviatus, Corbulispora vimineus, Radiizonate geniinus, Verrucosisporites irregularis, Camarazonotriletes sextanti

**Age of (P.Z3)** – The age of this zone is Upper Strunian to Upper – Lower Tournaisian.

-Palynozone 4 (P.Z4): This palynozone is represented in this study by the samples (KOr14s1, KOr15s1). This palynozone is equivalent to the VI, HD and BP Palynozone of Higgs et al. (1988), (Fig. 3). This zone is characterized by disappearance of Retispora lepidophyta a world wide marker species for latest Devonian (Upper Strunian), which is extending in LL to LN palynozone of Higgs et al. (1988).
McGregor and McCutcheon (1988) stated that *Retispora lepidophyta* is a worldwide marker species for the latest Devonian (Strunian). This zone is characterized along most palynozones some of those species are diagnostic species for the (P. Z₄) zone such as *Vallatisporites vallatus, Densosporites variomarginatus*, *Spelaeotriletes obstrusus*.

Higgs et al. (1988), placed the first occurrence of *Vallatisporites vallatus* at the base of the BP zone, or ranged below (VI) palynozone after Higgs et al. (1988).

This zone is characterized by the disappearance of species in the base of this zone, such as, *Verrucasisporites irregularis, Corbulisporites vimineus, Camarazonotritiletes sextantii, Brochotritiletes diversifoventus, Radizone geninunus*. The top of this zone is characterized by the disappearance of *Lophotriletes lebediansis, Spelaeotriletes triangulatus*, with continue of ranges of many species in the preceding and younger zone.

**Age of (P.Z₄) -** The age of this palynozone extends from Devonian – Carboniferous boundary (Upper – Lower Tournaian) to Middle Tournaian, within the Courceyan stage.

**Palynozone 5 (P.Z₅):** The P.Z₅ assemblage palynozone is represented in this study by the samples, (KOr15s₂, KOr16s₁, & Or-Hr.contact). This palynozone is equivalent to (PC) palynozone after Higgs et al. (1988),(Fig. 3). Many of the taxa from the preceding palynozones are common element of this zone (P.Z₅); these taxa are ranged along this palynozone, which is the final palynozone of the present study. These taxa are, *Vallatisporites vallatus, V. verrucosus, Densosporites spitibergensis, Retusotriletes minitus, Spelaeotriletes owensii, Prolycospora rugulosa, Aratrisporites saharaensis, Spelaeotriletes balteatus, Aurorospora solisortus, Vallatisporites agadesi*. (Fig.2).

**Age of (P. Z₅) -** The age of this zone is Upper– Middle Tournaian – Upper Tournaian.

**Palynofacies**

The term palynofacies was first introduced by Combaz (1964), to indicate the total assemblage of particulate organic matter contained in the sediment after the removal of the sediment matrix, by the standard techniques of palynological separation. Palynofacies used as a good tools for concluding paleoenvironment, sea level fluctuations and palaeoclimate in Naqishbandi (1999). The main studied components are spores, acritarchs and sedimentary organic matters. Acritarchs was not used in establishing the palynofacies, due to their scarcity, whilst spores and sedimentary
organic matters are common enough to be used as good indicators for this purpose. The main organic matters in the present study are the followings. Fig. 4.

1-Palynomorphs - This type of organic matter, include phytoplankton group, freshwater algal colonies and some types of bacteria. Commonly palynomorphs are spores, pollen grains, dinoflagellates and acritarchs

2-Phytoclasts - Those particles are originally fragments of plants, sometimes called "phytoclasts", or they are biostructures of Gymnosperm trachieds. Marsan and Pocock (1981) devised a classification for phytoclasts based largely on botanical and coal petrologic of particulate palynodebris. Increasing of these particles is a good indicator for non–marine environment. The particles are of different forms (Vascular plant remains, woody and membranous, plant cuticles, root cortex tissues, gymnosperm xylem).

3-Amorphous organic matter:

They are structureless and dark matters. This type of particles likely to be associated with hydrocarbon generation (Traverse, 1988).
<table>
<thead>
<tr>
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**STRATIGRAPHY**

Current study

- **CARBONIFEROUS**
  - P.Z5
  - P.Z4
  - P.Z3
  - P.Z2
  - P.Z1

- **DEVONIAN**
  - LN
  - PL
  - LE
  - LL
Palynofacies description:

Depending on the data we got from the current study Table 1, the following palynofacies were recognized Fig.4:

**Palynofacies 1 (PF1):** It is located in Kaista Formation and lower part of Ora Formation, limited between sample Kk6, and Kor.1. The amount of organic matters is different in the upper part of Kaista Formation, the spores is between 1.5%, while other organic components are different in amount. In the sample Kk6 the amount of amorphous organic matter is 46.9%; but spores are increased observably into 50% in the lower part of Ora Formation, which is of silty facies mainly, in this facies palynomorphs are 19%, amorphous 17.4%, and phytoclasts 18.9%, with no or rare acritarchs.

**Palynofacies 2 (PF2):** This facies is appeared in the lower part of Ora Formation limited between sample (Kor.2, Kor.4, ….Kor.7), which is mainly shale interbedded thin bedded fossiliferous limestone in the upper part of the facies. The range of the spores is between 7.8-41.8%, while palynomorphs and amorphous organic matter decrease, with increasing of

![Correlation of the present study miospor zonation scheme with previous zonation schemes for the Tournaisian of Britain and Ireland, after Higgs et al. (1988).](image-url)
spores are more abundant 56.6-66.4%. The lithology is shale, with abundant brachiopods of few mm. sizes. The amount of palynomorphs in this facies ranged between 14.76%-20%, amorphous 6.6%-3.75% and phytoclasts is 8.3%-25%. The acritarchs are relatively abundant 8% if compared with other palynofacies.

**Palynofacies 4 (PF4):** This facies represents the middle to upper part of Ora Formation, in sample Kor.13s2, the spores are abundant 51.1%, while the palynomorphs is 37.63%, amorphous is 5.76% and phytoclasts are 5.49%.

**Palynofacies 5 (PF5):** This facies appeared near the contact of Ora with Harur Formation, in samples Kor.15s2, Kor.16s1. In this facies spores are relatively abundant 40.6-52.2%, with 9.1-31.2% amorphous, and palynomorphs is 11.2-24.5%, while phytoclasts is 5.4-25.5%. The common lithology is silty marls interbedded with fossiliferous limestone and become shale interbedded with fossiliferous limestone toward the contact between Ora and Harur Formations. The fossiliferous limestone is rich in brachiopods and crinoids packed to each other.

**Table 1: Organic matter percentages in thirteen samples choose from the Kaista section for both Kaista and Ora Formations.**

<table>
<thead>
<tr>
<th>Samples numbers</th>
<th>Spores %</th>
<th>Palynomorphs %</th>
<th>Amorphous %</th>
<th>Phytoclasts %</th>
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<tr>
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<td>37.63</td>
<td>5.76</td>
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<td>14.76</td>
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<td>46.9</td>
<td>33.5</td>
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</table>

Kor= Ora Formation in Kaista section. Number of samples = (1...16). S = sample
Fig. (4) : Organic matter percentages point-counted in samples taken from Kaista section for both Kaista and Ora Formations.

References


- Al-Naqishbandi, Srood; Stratigraphy and Palynofacies of Upper Jurassic and Lower Cretaceous Formations for selected wells in Tameem and Salahaddin- Iraq; Baghdad University, unpublished Ph.D thesis.


A- *Apiculiretusisporites multiseta* (Luber) Butterworth and Spiner 1967, KK-or – 63.5/27.9, size 48 μm
B- *Hymenozonotriletes explanatus* (Luber) Kedo 1963, KK-or. 65/36.2, size 60 μm
C- *Hymenozonotriletes explanatus* (Luber) Kedo 1963, Kor12 – 70.5/34.5, size 60 μm.
D- *Lophotrilletes magnus* (Naum.) Kedo 1963, Kor1 – 71.2/35, size 60 μm.
F- *Vallatisporites verrucosus* Hacquebard 1957, Loboziak eta al., 1992 ,KK-or.70.8/28.6, size 52 μm.
G- *Cyrtospora cristifer* (Luber) emend Vanderzwan 1979, Kor12 – 61.5/27.5, size 55μm.
H- *Cyrtospora cristifer* (Luber) emend Vanderzwan 1979, KK –or. – 73.5/18.2, size 43μm.
I- *Auroraspora cf. asperella* (Kedo) Vanderzwan 1988a, Kor4 – 67.2/11.8, size 40μm.
J- *Camarazonotriletes sextantii* McGregor and counfield, 1976, Kor1, size 44μm.
K- *Ancyrospora furcula* (Owens) Richardson and McGreger, 1986, Kor8 – 66.4/15.8, size 52μm.
L- *Auroraspora cf. asperella* (Kedo) Vanderzwan 1988a, Kor16s1 – 69.5/23.3, size 41μm.
A. *Verrucosisporites irregularis* Phillips and Clayton 1980, KK-or - 63.2/35.8, size 33μm.

B. *Lophotriletes uncutas* (Naum.) Kedo 1963, Kor10 – 64/28.5, size 30μm.

C. *Leiozontriletes insignitus* Haquebard, Nohdeh, Kor12 – 68.7/29, size 72μm.

D. *Azonomonoletes sp.*, Kor10 - 63.2/27.5, size 39μm.


F. *Cyclogranisporites minutus* Bhardwaj 1957, KK-or. - 62/37, size 23 μm.

G. *Densosporites cf. spinosus* Dybova et Jachowicz, Coquet et al., 1995, KK or. – 58.8/13.8, size 41μm.

H. *Gemnospora decora* (Naumova) Arkhangelskaya, Turnan and Racki, 1999, Kor10 – 68.7/27.8, size 25μm.

I. *Lophotrilites magnus* (Naum.) Kedo 1963, Kor1 – 62/44.2, size 45μm.

J. *Dictyotrilites sp.*, Kor15s1 – 60.2/27.5, size 30μm.

K. *Leiotriletes incomptus* (Flex and Burbridge) Higgs, Clayton and Keegan 1988a, Kor1 – 58.5/24.3, size 30μm.

L. *Densosporites cf. spinosus* Dybova et Jachowicz, Coquel et al., 1995, Kor12 – 63.5/40, size 45μm.

M. *Densosporites cf. regalis* (Bharadwaj et Venkatachala) Smith et Butterworth, Coquel et al., 1995, Kor12 – 60.8/39, size 42μm.
N- *Densosporites* cf. *regalis* (Bharadwaj et Venkata chala) smith et Butterworth, Coquel et al., 1995, KKor – 65.8/34.5, size 41μm.

B- *Leiotriletes parvulus* Kedo 1963, KK – or. – 73.2/29.2, 30μm.
C- *Brochotrilletes diversifovius* Playford and Satterthwait, 1985, Kor16s1 – 65.2/32.2, size 52μm.
D- *Brochotrilletes diversifovius* Playford and Sutterhwait 1985, Kor2 – 66.3/34.2, size 52μm.
E- *Spelaeotrilletes triangulus* Neves and Owens, 1966, Kor12 – 62.5/24.8, size 44μm.
F- *Spelaeotrilletes triangulus* Neves and Owens, 1966, Kor10 –, size 41μm.
G- *Spelaeotrilletes owensii* Loboziak and Aperl, 1978, Kor10 – 64.2/16.8, size 41μm.
H- *Retusotrilletes communis* Naumova 1953, Kor1 – 60.5/37.5, size 55μm.
J- *Densosporites variomarginatus* Playford 1963, Kor12– 64.4/25.4, size 35μm.
L- *Vallatisporites agadesi* Loboziak and Alpern, 1978, Kor 12, 64.2/21.2, size 53μm.
N- *Retusotriletes septalis* Jush, Kedo 1963, KK or 67.8/32.2, size 40μm.
O- *Rasitrickia variabilis* Dobly and Neves, Richardson and McGregor 1986, KK or 66.5/23, size 35μm.

A- *Dictyotriletes reticosus* (Naum.) Kedo 1963, Kor 2 – 66.2/27.8, size 45μm.
B- *Dictyotriletes reticosus* (Naum.) Kedo 1963, Kor 12 – 69.8/26.5, size 45μm.
C- *Cymbosporites sp. cf. c. magnificus* Playford 1992, Kor 12 – 61.2/31.8, size 45μm.
D- *Raistrickia variabilis* Dobly and Neves, Richardson and McGregor 1986, Kor 7s 2 – 70.2/33.6, size 25μm.
F- *Punctatisporites irrasus* Hacquebard 1957, Kor 1 – 69.8/34.9, 30μm.
H- *Cymbosporites boaeticus* (Tchib.) Obukh. Latvija. Dobele, Arkhimovirtch et al., 1993, KK or 67./30, size 54μm.
I- *Retusotriletes distinctus* Richardson 1965, Kor 1 – 52/20.6, size 60μm.
J- *Auroraspora speciosa* (Naumova) Obukh, Avkhimovitch et al., 1993, Kor 8 – 61.5/18.5, size 50μm.
K- *Auroraspora speciosa* (Naumova) Obukh, Avkhimovitch et al., Kor 1 – 70.3/25.2, size 48μm.
L- *Retusotriletes sp.*, Kor 1 – 70.5/30.5, size 40μm.
M- *Rhabdasporites langii* (Eisenack) Richardson, 1960, Kor1 – 59.5/33.1, size 70μm.
O- *Punctatisporites irrasus* Hacquebard 1957, Kor1 – 65/18.2, size 30μm.
P- *Retusotriletes distinctus* Richardson 1965, Kor 12 – 66.2/23.8, size 41μm.

A- *Densosporites intermedius* Butterworth and Williams 1958, Kor 10, size 50μm.
B- *Teichertospora torquata* (Higgs) McGregor and Playford 1990, Kor1 – 60.4/33.8, size 40μm.
D- *Densosporites intermedius* Butterworth and Williams 1958, Kor 10 – 64.8/31.5, size 50μm.
E- *Densosporites sp.*, Kor 10 – 65.7/21.2, size 50μm.
F- *Retispora lepidophyta* (Kedo) Playford 1976, KK – or.- 63.7/19, size 58μm.
G- *Verrucosisporites irregularis* Phillips and Clayton 1980, Kor 12 – 60.6/32.8, size 46μm.
J- Cymbosporites cyathus, Allen 1965, Kor 6s₂ – 62.2/32.2, size 22µm.
K- Speleaeotriletes microspinus Neves and Ioannides 1974, Kor 10 – 71.8/29.7, size 45µm.
L- Spelaeotriletes microspinus Neves and Ioannides 1974, KK – or. – 72.5/26, size 68µm.
M- Raistrickia densa Urban 1971, Kor 12 – 59.5/38.8, size 47µm.
N- Spelaeotriletes resolutus Higgs, 1975, KK – or. – 71.3/43, size 44µm.
O- Retusotriletes communis Naumova 1953, KK – or. – 72.6/29.2, size 40µm.

A- Radiizonates genuinus (Jushko) Loboziak and Alpen 1978, Kor 14s₂ – 60.5/25.5, size 60µm.
B- Leiotriletes pagius (Allen) Avkhimovitch et al., 1993, KK – or. – 63/15.3, size 44µm.
C- Hymenozonotriletes pusillites Kedo 1963, Kor 10 – 58.2/40.2, size 50µm.
D- Vallatisporites ciliaris (Luber) Sullivan 1964b, Kor 10 – 64/20.3, size 60µm.
E- Vallatisporites vallatus Hacquard 1957, Kor 10 – 65.8/33.8, size 43µm.
F- Lophozonotriletes proscurrus, Kedo 1963, Kor 4 – 67.2/17, size 40µm.
G- Leiotriletes minutissmus (Naum.) Kedo 1963, Kor 1 – 75/37, size 34µm.
H- Punctatisporites resolutus Playford 1971, Kor 10 – 72.2/18, size 42µm.
I- \textit{Trachytriletes medius} (Naum) Kedo 1963, KK – or. – 63/17, size 28\textmu m.

J- \textit{Aratrisporites saharaensis sp.} Loboziak, Clayton and Owens 1986, Kor15s1–65/37.5, size 40\textmu m.

K- \textit{Lophozonotriletes proscurrus}, Kedo 1963, Kor16s1–117/0.5, size 50\textmu m.

L- \textit{Hymenozonotriletes genuinus} (Jaschko) Byrshera, Coquel et al., 1977, Kor16s1–122.5/8.2, size 44\textmu m.

M- \textit{Punctatisporites resolutus} Playford 1971, KK –or. –66/37.2, size 42\textmu m.

N- \textit{Retusotriletes minutus} Butterworth and Mahdi 1982, Kor16s1 – 116.2/1.3, size 37\textmu m.

O- \textit{Retusotriletes planus} Dobly et Neves, Loboziak and Streel 1981, Kor16s1–130.5/16.5, size 47\textmu m.

P- \textit{Lophotrilites magnus} (Naum.) Kedo 1963, Kor12–124.2/10.4 size 65\textmu m.

\begin{center}
\textbf{Plate (7)}
\end{center}

A. \textit{Retusotriletes communis} Naumova 1953, Kor16s1 – 131.2/11.4, size 50\textmu m.

B. \textit{Spelaeotriletes obtusus} Higgs 1975, Kor16s1 – 125/4.2, size 45\textmu m.

C. \textit{Auroraspora solisortus} Hoffmeister, Staplin and Malloy 1955, Kor16s1 – 120.2/4.2, size 36\textmu m.

D. \textit{Leiotrilites glaber} (Waltz) Ischenko, Kedo 1963, Kor16s1 – 114.5/5.8, size 35\textmu m.

E. \textit{Spelaeotriletes gigantus} Loboziak and Clayton 1988, Kor16s1 – 113.5/6.5, size 83\textmu m.
F. *Spelaeotriletes gigantus* Loboziak and Clayton 1988, Kor15s1 – 126.2/15.5, size 103μm.
G. *Aratrisporites saharanesis sp.* Loboziak, Clayton and Owens 1986, Kor16s1 – 123/6.1, size 47μm.

H. *Densosporites cf. regalis* (Bharadwaj et Venkatachala) Smith et Butterworth, Coquet et al., 1995, Kor16s1 – 131.2/7.3, size 50μm.
I. *Retusotriletes crassus* Clayton, Johnson, Sevastopulo and Smith 1980, Kor16s1 – 110.8/8.2, size 40μm.
J. *Retustotriletes septalis* (Jush.) Kedo 1963, Kor16s1 – 108/7.1, size 48μm.
M. *Punctatisporites resolutus* Playford 1971, Kor16s1 – 126/9.2, size 45μm.
N. *Leiotriletes parvulus* Kedo 1963, Kor16s1 – 130/11.1, size 30μm.
O. *Rasitrickia corynoges* (Sullivan), Richardson and McGregor 1986, Kor16s1 – 130.3/11.4, size 43μm.

A. *Dictyotriletes sp.* Kor16s1 – 126.1/13, size 53μm.
B. *Densosporites variomarginatus* Playford 1963, Kor16s1 – 128.8/12.8, size 43μm.
C. *Acanthotriletes multisetus* (Luber) Kedo 1963, Kor16s1 – 122.7/16.4, size 45μm.
D. *Leiotriletes glaber* (Waltz) Ischenko, Kedo 1963 Kor12 – 110.2/3.5, size 38μm.
E. *Leavigatisporites sp.* Kor16s1 – 126.8/17.8, size 37μm.
F. *Hymenozonotriletes genuinus* (Juchko) Byvsheva, Coquel et al., 1977, Kor15s2 – 124.4/0.2, size 43μm.
G. *Cristatisporites colliculus* Playford 1971, Kor12 – 110.7/3.5, size 60μm.
H. *Densosporites spitsbergensis* Playford 1963, KK – or. – 70.5/37.2, size 53μm.
I. *Stenozonotriletes stenozonalis* (Waltz) Ishchenko 1958, Kor10 – 71.6/23.8, size 27μm.
K. *Lophozonotriletes lebediansis* (Naumova), Richardson and McGregor 1986, Kor12 – 110.5/5.9, size 40μm.
L. *Auroraspora cf. asperella* (Kedo) VanDerZwan 1980a, Kor10 – 116/4.8, size 45μm.
M. *Vallatisporites communis* (Sullivan), Coquel et al., 1995, Kor12 – 115.5/9.2, size 43μm.
O. *Trachytriletes nigratus* (Naum.) Kedo 1963, Kor15s2 – 128.7/0.1, size 42μm.
P. *Raistrickia golatensis* Staplin 1960, Kor10 – 123.2/8.2, size 40μm.

B. *Endoculespora setacea* (Kedo) Avkh. and Higgs, Avkh. et al., 1993, Kor10 – 60.5/28.8, size 23μm.
C. *Umbonatisporites cf. abstrusus* (Playford) Clayton 1971, KK–or. 66.5/37.8, size 50μm.

D. *Aneurospora sp.* Kor10 – 63.5/27.5, size 23μm.

E. *Aneurospora sp.* Kor10 – 58.5/44.8, size 28μm.

F. *Cymbosporites magnificus* (McGregor) McGregor and Comfield 1982, Kor10 – 65.5/36.8, size 40μm.


H. *Densosporites cf. spinosus* Dybova et Jachowicz, Coquel et al., 1995, KK–or. – 58.8/13.8, size 41μm.

I. *Verrucosisporites nitidus* (Naumova) Playford 1964, KK–or.- 63/20, size 42μm.


K. *Diezalophasia remota* (Deunff) Playford 1977, Kor10 – 64.5/27, size 17μm.

L. *Protoleiosphaeridium sorediforme* (Tim.), Nadle, 1973, Kor16s1 – 129.7/10.8, size 31μm.

M. *Leiosphaeridea sp.* KK–or. – 65.8/30.5, size 22μm.

N. *Protosphaeridium petiginosus* Kor7s2 – 69.5/20.5, size 27μm.


P. Scolecodont, Kor16s1 – 121.2/8.5, size 110μm.

A. *Unellium piriforme* ,Kor2 – 58/43.5, size 25μm.

B. *Micrhystridium stellatum* Deflandre 1945 Kor10 – 64.5/24.5, size 12μm.

D. *Stellinium octoaster* (Staplin) Javdine, Coquel et al., 1977, Kor15s2 – 122.2/0.8, size 23μm.

E. *Michrystridium sp.* Kor10 – 110.8/10.1, size 10μm.

F. *Veryhachium trispinosum* (Eisenack) Dennff 1956, Kor16s1 – 112.8/4.3, size 10μm.

G. Palynomorphs, Kor1 – 121.5/12.2, 250X.

H. Phytoclasts, Kor16s1 – 111.2/3.5, 250X.

I. Large plant cuticles, Kor15s2 – 107.5/5.8, 250X.

J. Phytoclasts, Kor16s1 – 115.5/5.5, 250X.

**Summary**

This study aimed to investigate the composition of the A-Ra and upper part of the Kiesta Formation in the Zakh region in the Kurdish region of Iraq, 8 km north of Kiesta village towards the north-west of the village.
وجد بأن الجزء العلوي من تكوين كيستا يتكون بصورة رئيسية من صخور جيرية متدلية ومتناحرة خاصة في الجزء السفلي مع الطفح الأسود وصخور رملية ناعمة اضافة إلى الاطيان الجيرية احيانا.
أما في الجزء العلوي وجد بأن السحنات السائدة هي صخور جيرية ذات نسبة عالية من المتحجرات، في حين أن تكوين اورا يتكون من طفح أسود وطفح غريني متداخل مع صخور غرينية وطبقات رقيقة من الصخور الجيرية ذات نسبة عالية من المتحجرات.

بالاعتماد على المواد العضوية المتوفرة، تم تقسيم تكوين كيستا إلى خمسة سحات بالينولوجي مختلفة.

( PF 1 - PF 5 )

تم دراسة تكوين اورا تفصيليا من الناحية بالينولوجي مع الجزء العلوي من تكوين كيستا مؤدياً إلى تقسيم المقطع إلى خمسة سحات بالينولوجية (P.Z 1 – P.Z 5).

الاندماج الدالة لهذا التقسيم في البوسومات المتوفرة ظنين 15 نموذج مدروس. ونتيجة لذلك فأن عمر تكوين كيستا هو الديفوني المتاخر والكاربوني المبكر. أما عمر تكوين اورا فقد وجد بأنه السترونيان المتاخر إلى التورنيسين المتاخر. حددت البالينولات والمواد العضوية المتوفرة بيئة الترسب لتكوين اورا على أنها بيئة بحرية ضحلة إلى قرب ساحلية. ولندرة البالينولات في تكوين كيستا لم يتم تحديد بيئته الترسبية.