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 Kiasta 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 wel1. 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^{o} 17' 45" and Longitude 43^{o} 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.

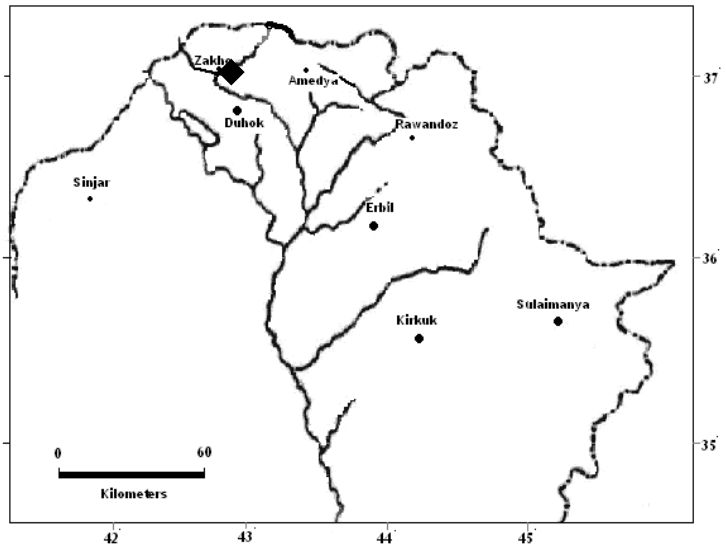


Fig.1: Location map of the study area.

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.

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 vermiforms, Auroaspora speciosa, Cyclogranisporites minutus, 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. parvilus , Lophotriletes magnus, Leiozonotriletes insignatus, Punctatisporites irasss, P. resolutus ,Retusotriletes sp., R.septalis,* R.*crassus, R.cf.crassus, R.distinctus,R.communis,Rhabdasporites langii, Spelaeotriletes resolutus, S.microspinosus, Teichertospora torguata, 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, Aurospora 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 PZ_2, 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, Gemensopora decora, Acanthotriletes multisetus, Auroraspora sp., Auroraspora solisortus, Grandispora douglastowensis, Hymeaozonotriletes genuinus, Lophotriletes magnus, L. uncatus, Radiizonate geniunus, 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 geniunus,Verrucosisporites irregularis,Camarazonotriletes sextantii*

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 ($KOr14s_1$, $KOr15s_1$). 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 McCutheon (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. Z_4) 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 irrgularis, Corbulisporites vimineus, Camarazonotriletes sextantii, Brochotriletes diversifoventus, Radiizonate geniunus.* 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 Tournaisian) to Middle Tournaisian, within the Courceyan stage.

-Palynozone 5 (P.Z5): The $P.Z_5$ assemblage palynozone is represented in this study by the samples, ($KOr15s_2$, $KOr16s_1$, & 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 sptibergensis, Retusotriletes minutus, 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 Tournaisian – Upper Tournaisian.

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

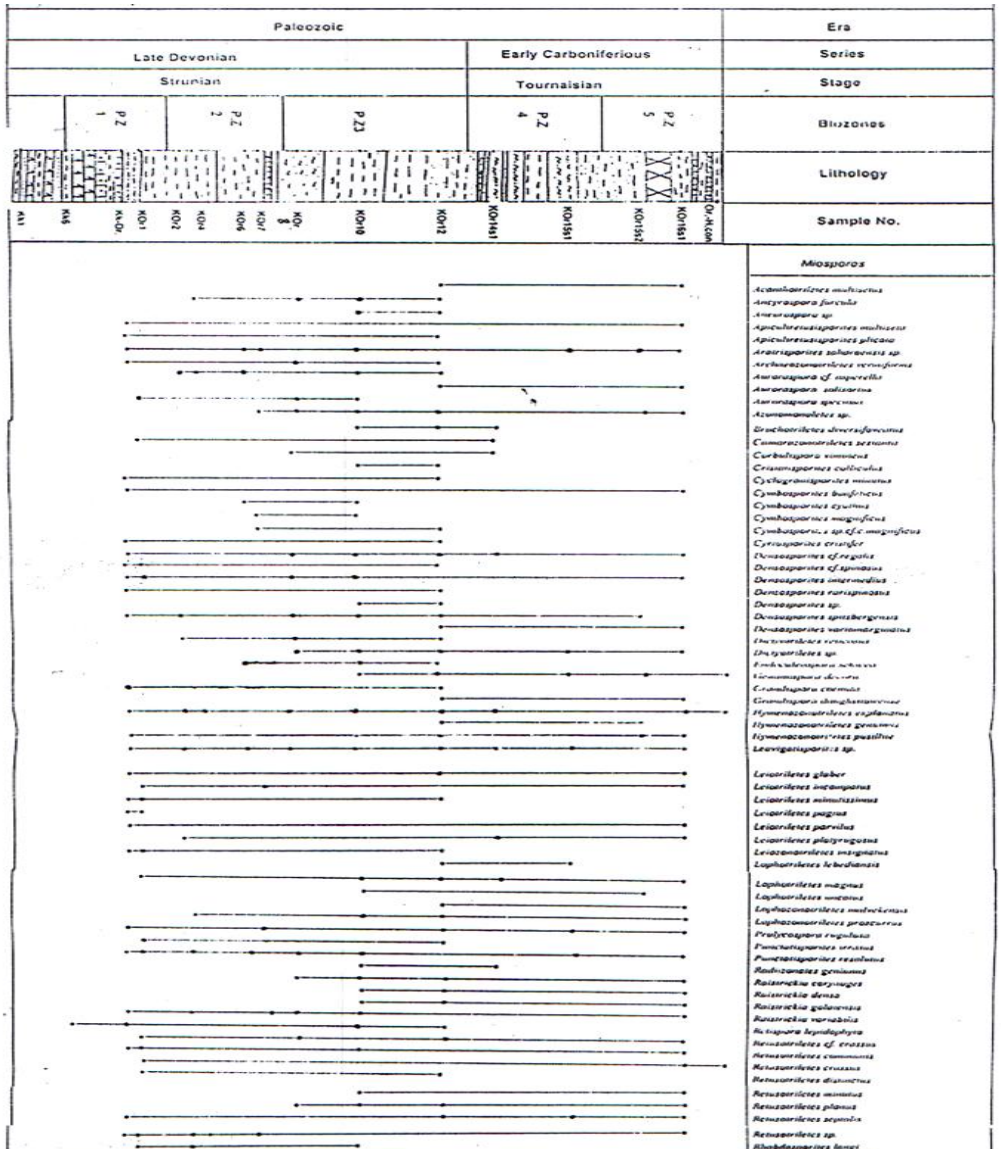
organic matters are common enough to be used as good indicators for this purpose. The main organic matters in the present study are the followings. Fig. 4.

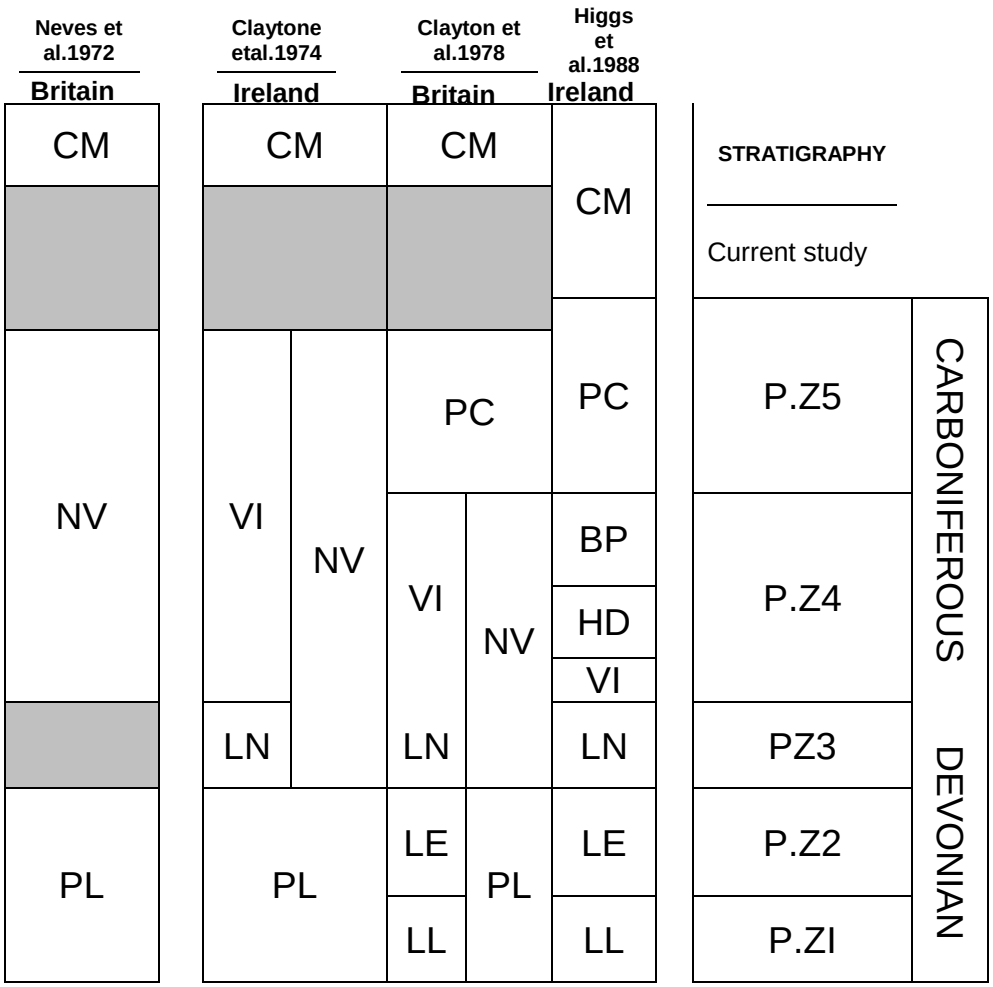
1-Palynomorphs - This type of organic matter, include phytoplankton group, freshwater algal colonies and some types of bacteria. Commonly palynomorphs are spores, pollen grains, dinoflagellates and acritarchs

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 structurless and dark matters. This type of particles likely to be associated with hydrocarbon generation (Traverse, 1988).




Neves et al.1972
Britain
CM
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Higgs et al.1988
Ireland
CM
PC
BP
HD
VI
LN
LE
LL
STRATIGRAPHY
Current study
P.Z5
P.Z4
PZ3
P.Z2
P.ZI
CARBONIFEROUS
DEVONIAN

P.Z=palynozone
numbers=1,2,3,4,5

Fig.(3) **Correlation of the present study miospor zonation scheme with previous zonation schemes for the Tournaisian of Britain and Irland, after Higgs et al. (1988).**

Palynofacie 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

Fig.3: Correlation of the present study miospor zonation scheme with previous zonation schemes for the Tounaisian of Britain and Irland, after Higgs et al. (1988).

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.13$s_{2, the}$ 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.15s_2, 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.

Samples numbers	Spores %	Palynomorphs %	Amorphous %	Phytoclasts %
Kor16s_1	40.6	24.5	9.1	25.5
Kor15s_2	52.2	11.2	31.2	5.4
Kor13s_2	51.1	37.63	5.76	5.49
Kor12	56.6	14.76	3.57	25
Kor10	66.4	19	5.9	8.7
Kor8	65	20	6.6	8.3
Kor7s_2	41.8	19.48	31.8	6.8
Kor6	11.6	42.6	43.4	2.3
Kor5	7.8	43.1	47	1.96
Kor4	8.9	44	44	2.9
Kor2	21.9	27.8	45.27	4.9
Kor1	44.6	19	17.4	18.9
Kk6	1.5	18	46.9	33.5

Kor=Ora Formation in Kaista section. Number of samples=(1.....16)
Kk= Kaista Formation in Kaista section. s=sample

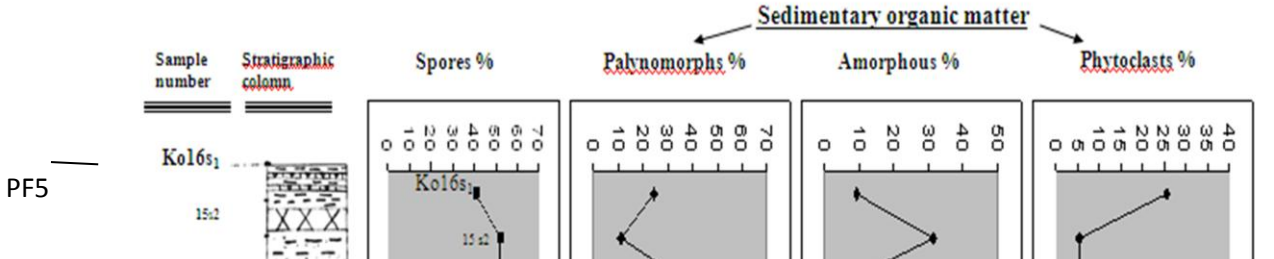

Fig. (4) :Organic matter percentages point-counted in samples taken from Kaista section for both Kaista and Ora Formations.

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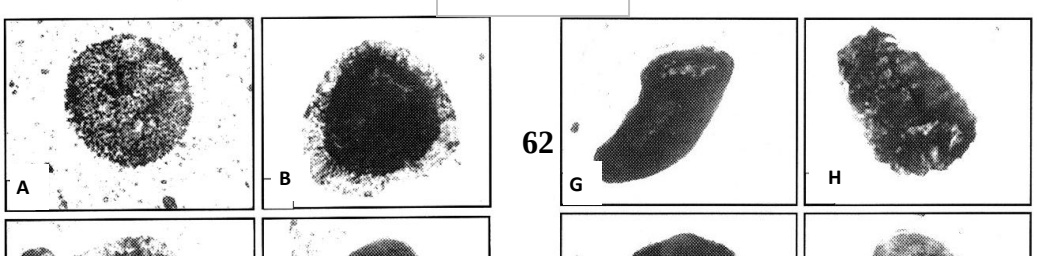
Plate (1)



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- *Lophotriletes magnus* (Naum.) Kedo 1963, Kor1 – 71.2/35, size 60 µm.

E- *Archaeozonotriletes vermiforms* (Tschibr.) Andreeva, 1965, KK-or – 67.7/36, size 51µm.

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.

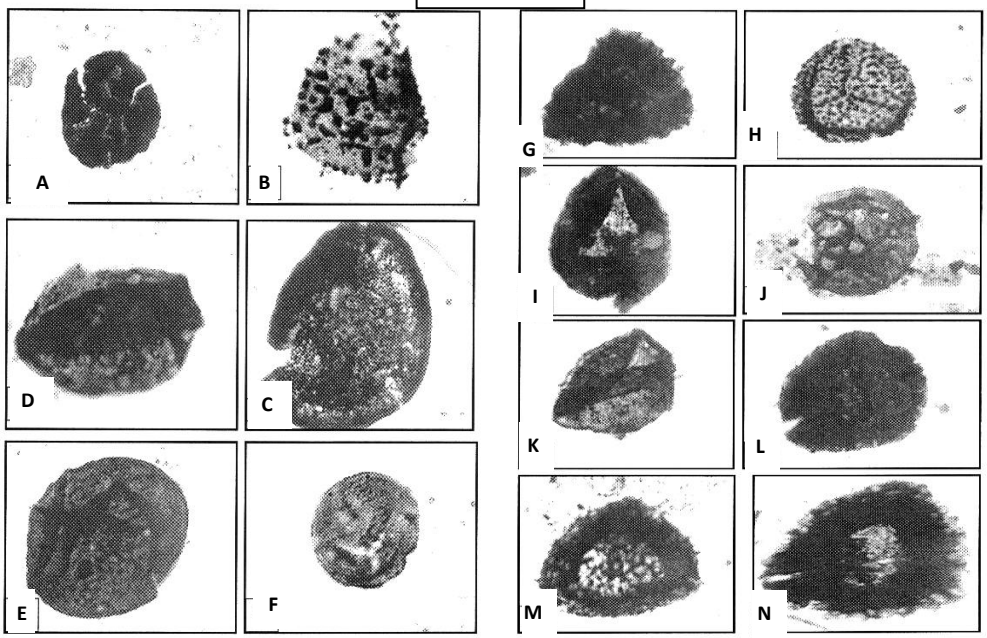
I-*Auroraspora cf. asperella* (Kedo) Vanderzwan 1988a, Kor4 – 67.2/11.8, size 40µm.

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, Kor16s_1 – 69.5/23.3, size 41µm.

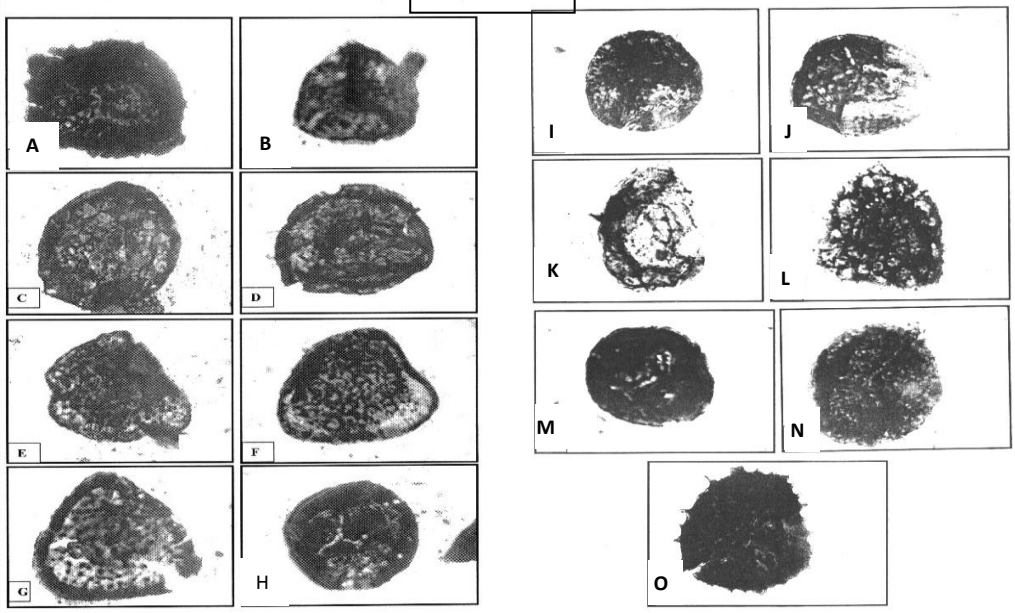
Plate (2)



A-*Verrucosisporites irregularis* Phillips and Clayton 1980, KK-or - 63.2/35.8, size 33µm.
B-*Lophotriletes uncatus* (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.
E- *Leiotriletes platyrugosus* (Waltz) Naum, Kedo 1963, KK-or – 69.5/18.2, size 38µm.
F- *Cyclogranisporites minutus* Bhardwaj 1957, KK-or.- 62/37,size 23 µm.
G -*Densosporites cf. spinosus* Dybova et Jachowicz, Coqut 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-*Lophotriletes magnus* (Naum.) Kedo 1963, Kor1 – 62/44.2, size 45µm.
J-*Dictyotriletes 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-*Densosporties cf. regalis* (Bharadwaj et Venkata chala) smith et Butterworth, Coquel et al., 1995, KKor – 65.8/34.5, size 41µm.

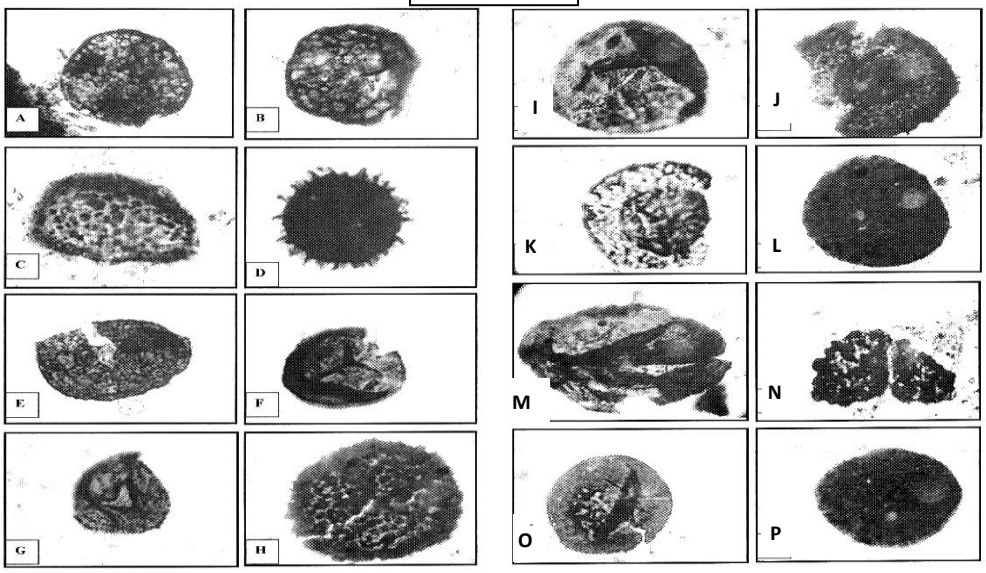
Plate (3)



A-*Densosporites rarispinosus*, Playford 1963, KK – or – 66.5/32.5, size 44µm.
B-*Leiotriletes parvilus* Kedo 1963, KK – or. – 73.2/29.2, 30µm.
C-*Brochotriletes diversifoviatus* Playford and Satterthwait, 1985,Kor16s_1 – 65.2/32.2, size 52µm.
D-*Brochotriletes diversifoviatus* Playford and Sutterhwait 1985, Kor2 – 66.3/34.2, size 52µm.
E- *Spelaeotriletes triangulus* Neves and Owens, 1966, Kor12 – 62.5/24.8, size 44µm.
F- *Spelaeotriletes triangulus* Neves and Owens, 1966, Kor10 –, size 41µm.
G- *Spelaeotriletes owensii* Lobozaki and Aplern, 1978, Kor10 – 64.2/16.8, size 41µm.
H- *Retusotriletes communis* Naumova 1953, Kor1 – 60.5/37.5, size 55µm.
I- *Retusotriletes communis* Nanmova 1953, Kor12 – 62.5/25.2, size 45µm.
J- *Densosporites variomarginatus* Playford 1963, Kor 12– 64.4/25.4, size 35uµm.
K- *Prolycospora rugulosa* (Butterworth and Spinner) Turnan, 1978, KK-or., size 24µu. 63.5/20.8.
L- *Vallatisporites agadesi* Loboziak and Alpern, 1978, Kor 12, 64.2/21.2, size 53µm.

M- *Retusotriletes cf. crassus* Clayton, Johnson, Sevastopulo and Smith 1980, Kor 1 – 65.3/26, size 27µm.
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.

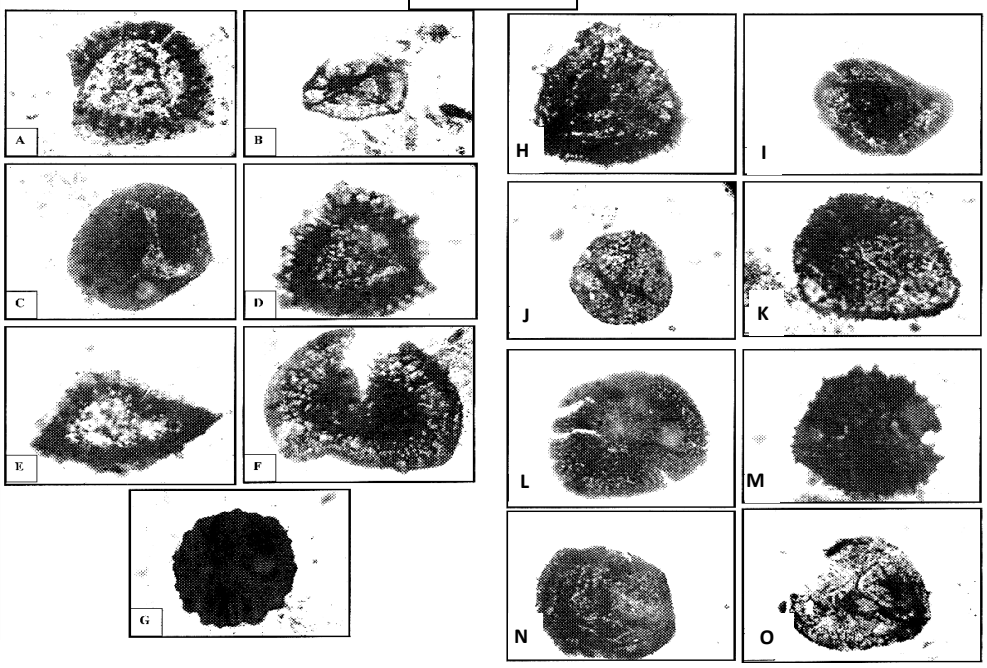
Plate (4)



A- *Dictyotriletes reticosus* (Naum.) Kedo 1963, Kor2–66.2/27.8,size 45µm.
B- *Dictyotriletes reticosus* (Naum.) Kedo 1963,Kor12–69.8/26.5,size 45µm.
C- *Cymbosporites sp. cf. c. magnificus*, Playford 1992, Kor12 – 61.2/31.8, size 45µm.
D- *Raistrickia variabilis* Dobly and Neves, Richardson and McGregor 1986, Kor7s2 – 70.2/33.6, size 25µm.
E- *Aratrisporites saharaensis sp.* Loboziak. Clayton and Owens 1986, KK – or.– 28.6/19.5, size 37µm.
F- *Punctatisporites irrasus* Hacquebard 1957, Kor 1 – 69.8/34.9, 30µm.
G- *Prolycospora rugulosa* (Butterworth and Spinner) Turnan, 1978, Kor $7s_2$ – 66.3/29.3, size 21µm.
H- *Cymbosporites boafeticus* (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) Cbukh, Avkhimovitch et al., 1993, Kor 8 – 61.5/18.5, size 50µm.
K- *Aurorapora 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.
N- *Corbulispora vimineus* (Nekr.) Obukh. And Nekr. Avkhimevitch et al., 1993, Kor 8 – 63.5/28.2, size 40µm.
O- *Punctatisporites irrasus* Hacquebard 1957, Kor1 – 65/18.2, size 30µm.
P- *Retusotriletes distinctus* Richardson 1965, Kor 12 – 66.2/23.8, size 41µm.

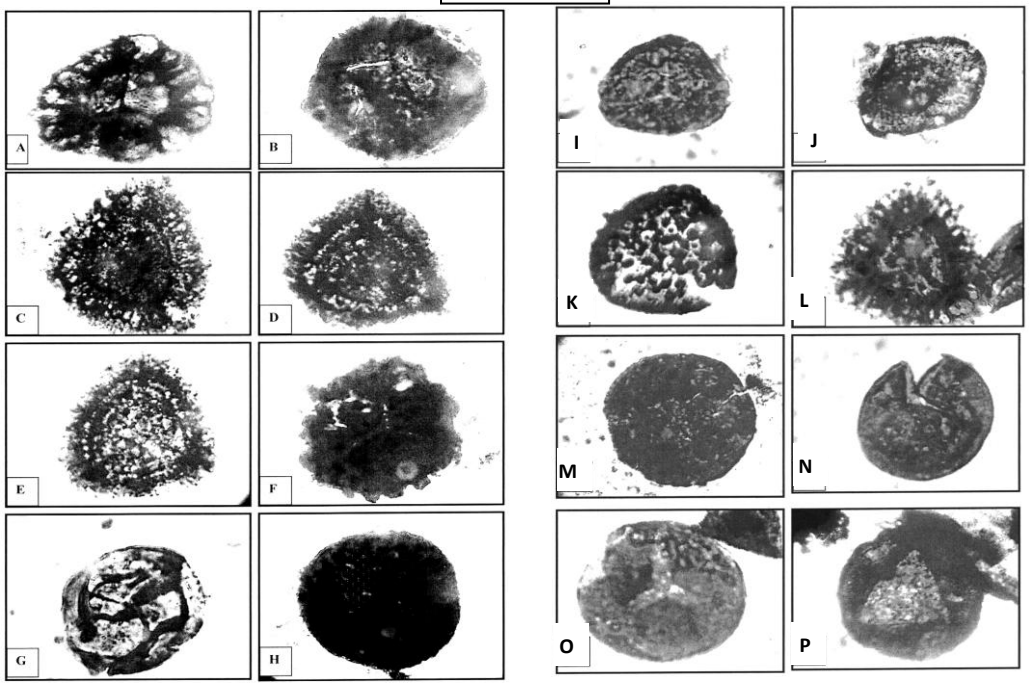
Plate (5)



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.
C- *Apiculiretusispora plicata* (Allen) Streel, Richardson and Rasul, 1978, KK – or. – 68.8/17. size 35µm.
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.
H- *Grandispora cornuta* (Higgs) Richardson and McGregor 1986, KK – or. - 65.2/19.5, size 62µm.
I- *Spelaeotriletes balteatus* (Playford) Higgs 1975,KK–or.Size 40µm,59.3/17.8.

J- *Cymbosporites cyathus*, Allen 1965, Kor $6s_2$ – 62.2/32.2, size 22µm.
K- *Speleaeotriletes microspinosus* Neves and Ioannides 1974, Kor10 – 71.8/29.7, size 45µm.
L- *Spelaeotriletes microspinosus* 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.

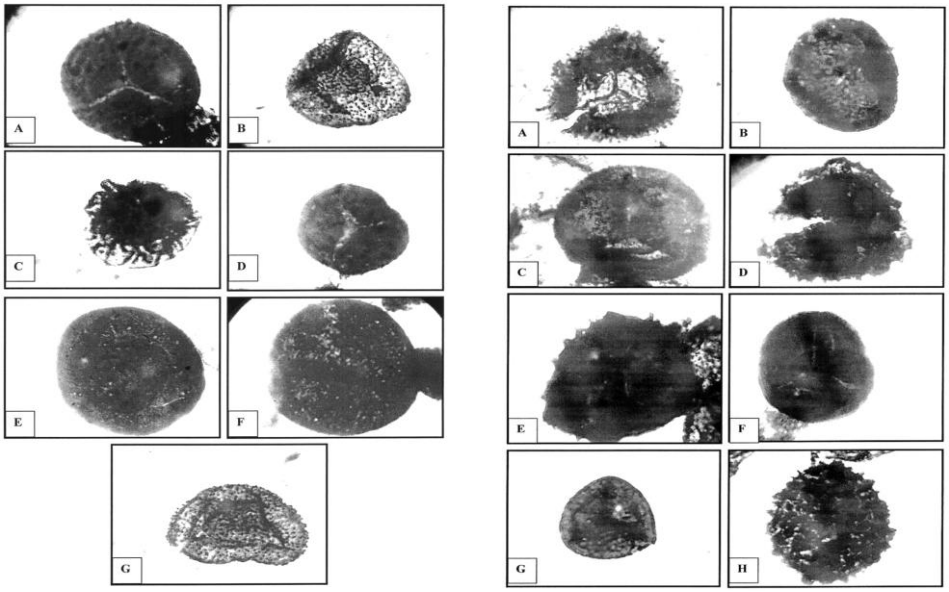
Plate (6)



A- *Radiizonates genuinus* (Jushko) Loboziak and Alpen 1978, Kor $14s_1$ – 60.5/25.5, size 60µm.
B- *Leiotriletes pagius* (Allen) Avkhimovitch et al.,1993,KK–or.– 63/15.3,size 44µm.
C- *Hymenozontriletes pusillites* Kedo 1963, Kor10 – 58.2/40.2, size 50µm.
D- *Vallatisporites ciliaris* (Luber) Sullivan 1964b,Kor10–64/20.3,size 60µm.
E- *Vallatisporites vallatus* Hacqubard 1957, Kor10 – 65.8/33.8, size 43µm.
F- *Lophozonotriletes proscurrus*, Kedo 1963, Kor4 – 67.2/17, size 40µm.
G- *Leiotriletes minutissmus* (Naum.) Kedo 1963, Kor1 – 75/37, size 34µm.
H-*Punctatisporites resolutus* Playford 1971, Kor10 – 72.2/18, size 42µm.

I- *Trachytriletes medius* (Naum) Kedo 1963, KK – or.- 63/17, size 28µm.
J- *Aratrisporites saharaensis sp*. Loboziak, Clayton and Owens 1986,Kor15s_1–65/37.5,size 40µm.
K- *Lophozonotriletes proscurrus*, Kedo 1963, Kor16s_1–117/0.5,size 50µm.
L-*Hymenozonotriletes genuinus* (Jaschko) Byrshera, Coquel et al., 1977, Kor16s_1-122.5/8.2, size 44µm.
M- *Punctatisporites resolutus* Playford 1971, KK –or. –66/37.2,size 42µm.
N- *Retusotriletes minutus* Butterworth and Mahdi 1982, Kor16s1 – 116.2/1.3, size 37µm.
O-*Retusotriletes planus* Dobly et Neves, Loboziak and Streel 1981,Kor16s1–130.5/16.5,size 47µm.
P-*Lophotriletes magnus* (Naum.) Kedo 1963, Kor12–124.2/10.4 size 65µm.

Plate (7)



A. *Retusotriletes communis* Naumova 1953, Kor16s1 – 131.2/11.4, size 50µm.
B. *Spelaeotriletes obtusus* Higgs 1975, Kor16s1 – 125/4.2, size 45µm.
C. *Auroraspora solisortus* Hoffmeister, Staplin and Malloy 1955, Kor16s1 – 120.2/4.2, size 36µm.
D. *Leiotriletes glaber* (Waltz) Ischenko, Kedo 1963, Kor16s1 – 114.5/5.8, size 35µm.
E. *Spelaeotriletes gigantus* Loboziak and Clayton 1988, Kor16s1 – 113.5/6.5, size 83µm.

F. *Spelaeotriletes gigantus* Loboziak and Clayton 1988, Kor15s1 – 126.2/15.5, size 103µm.

G. *Aratrisporites saharanesis sp.* Loboziak, Clayton and Owens 1986, K or16s1 – 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.

K. *Grandispora douglstownense* McGregor 1973, Kor16s1 – 116.2/8.4, size 70µm.

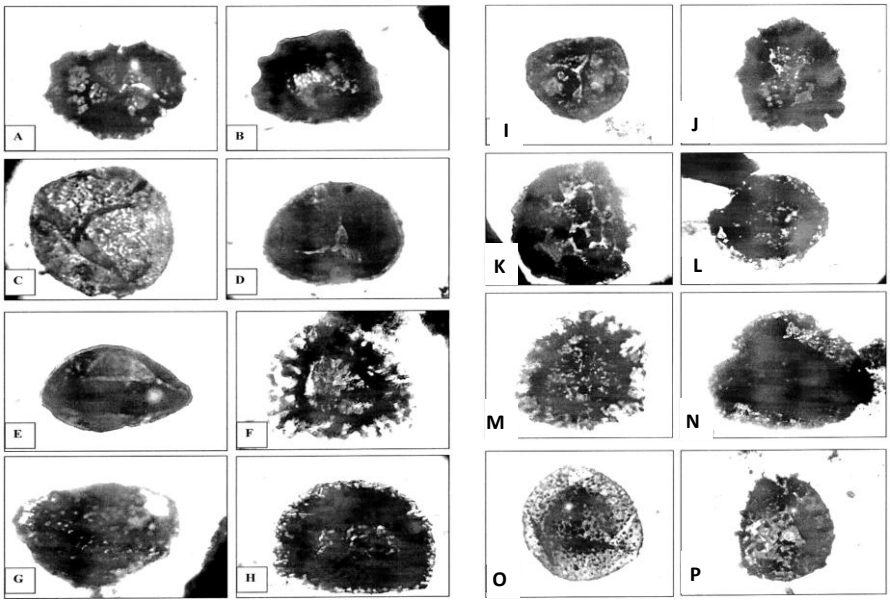
L.*Rasitrickia densa* Urban 1971, Kor16s1 – 127.5/9.3, size 42µm.

M. *Punctatisporites resolutus* Playford 1971, Kor16s1 – 126/9.2, size 45µm.

N. *Leiotriletes parvilus* Kedo 1963, Kor16s1 – 130/11.1, size 30µm.

O. *Rasitrickia corynoges* (Sullivan), Richardson and McGregor 1986, Kor16s1 – 130.3/11.4, size 43µm.

Plate (8)



A. *Dictyotriletes sp*. Kor16s1 – 126.1/13, size 53µm.

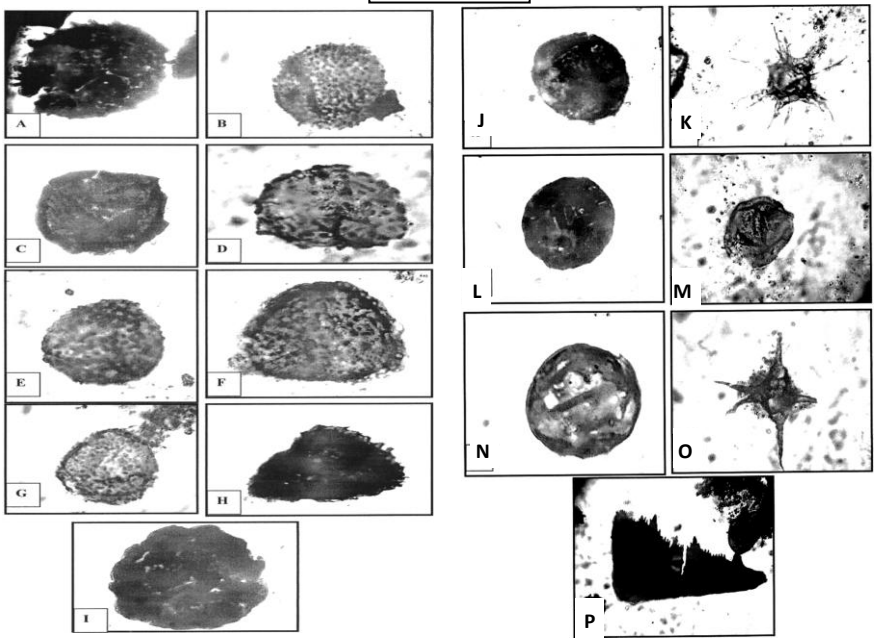
B. *Densosporites variomarginatus* Playford 1963, Kor16s1 – 128.8/12.8, size 43µm.

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) Byvshera, 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.
J. *Lophozonotriletes malevkensis* (Naum.) Kedo 1963, Kor16s1 – 124.2/9.2, size 30µm.
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.
N. *Umbonatisporites cf. distinctus* Clayton, 1970, Kor15s2 – 117.9/8.3, size 93µm.
O. *Trachytriletes nigratus*(Naum.)Kedo 1963, Kor15s2–128.7/0.1,size 42µm.
P. *Rasitrickia golatensis* Staplin 1960, Kor10 – 123.2/8.2, size 40µm.

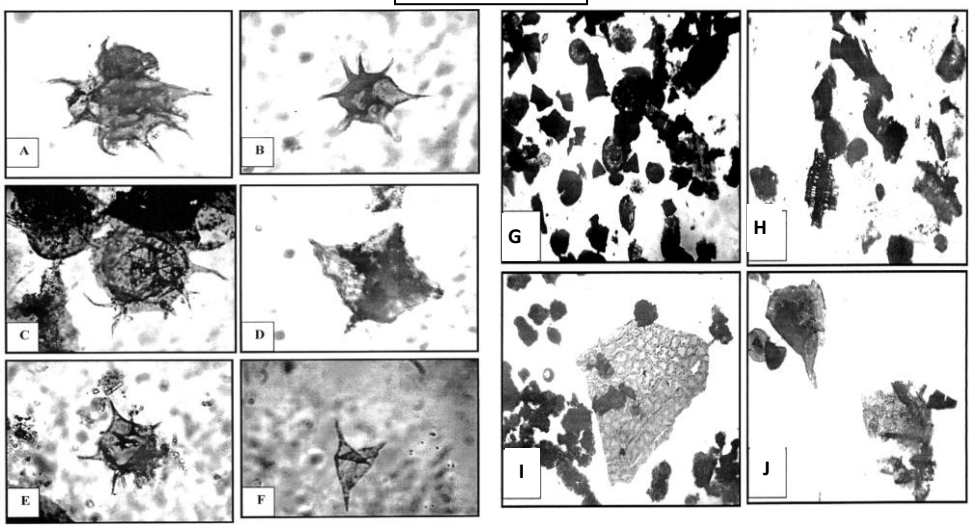
Plate (9)



A. *Raistrickia densa* Urban 1971, Kor10 – 114.2/8.3, size 41µm.
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.
G. *Umbonatisporites cf. abstrusus* (Playford) Clayton 1971, KK–or. – 62.2/13.8, size 44µm.
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.
J. *Protoleiosphaeridium planum*, Nadler, 1973, KK–or. – 67.5/24.2, size 24µm.
K. *Diexalophasis 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.
O. *Diaxallophasis pachymora* (Hill) 1978, Doring 1981, Kor8 – 65.8/25, size 15µm.
P. Scolecodont , Kor16s1 – 121.2/8.5, size 110µm.

Plate (10)



A. *Unellium piriforme* ,Kor2 – 58/43.5, size 25µm.
B. *Micrhystridium stellatum* Deflandre 1945 Kor10 – 64.5/24.5, size 12µm.

C. *Multiplicisphaeridium brazusdesnudum* (Cramer) Lister 1970, Kor16s1 – 115.8/15.2, size 30µm.
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.

دراسة بالينولوجية لتكويني اورا والجزء العلوى من تكوين كيستا فى منطقة زاخو اقليم كوردستان العراق

سرود فاروق نقشبندي كوفند حسين شيروانى دانا نوري رضا

كلية العلوم – جامعة صلاح الدين

تاريخ الاستلام:٢٠٠٧/٥/٢٨، تاريخ القبول:٢٠٠٧/١٢/١٠

الخلاصة

تضمنت هذة الدراسة بالينولوجية تكوين اورا والجزء العلوي لتكوين كيستا(الديفوني المتأخر – الكربـــوني المبكر)، شمال منطقة الفوالق الزاحفة في مقطع كيستا (قرب قرية كيستا–قضاء زاخو محافظة دهوك) يبعد ٢كم عن قرية كيستا باتجاه شمال غرب القرية.

وجد بأن الجزء العلوي من تكوين كيستا يتكون بصورة رئيسية من صخور جيرية متدلمتة و متداخلة خاصة في الجزء السفلي مع الطفح الاسود و صخور رملية ناعمة اضافة الى 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 اسود وطفح غريني متتداخل مع صخور غرينية وطبقات رقيقة من الصخور الجيرية ذات نسبة عالية من المتحجرات.
بألاعتماد على المواد العضوية المتوفرة ، تم تقسيم تكوين كيستا الى خمسة سحنات بالينولوجية مختلفة (PF 1- PF 5).

تم دراسة تكوين اورا تفصيليا من الناحية البالينولوجية مع الجزء العلوي من تكوين كيستا مؤدياً الى تقسيم المقطع الى خمسة انطقة بالينولوجية (P.Z 1 – P.Z 5) والاداة الدالة لهذا التقسيم هي الما يوسبورات المتوفرة ظمن ١٥ نموذج مدروس. ونتيجة لذلك فأن عمر تكوين كيستا هو االديفونى المتأخر والكاربوني المبكر. أما عمر تكوين اورا فقد وجد بأنه السترونيان المبكر الى التورنيسين المتأخر. حددت البالينولات والمواد العضوية المتوفرة بيئة الترسيب لتكوين اورا على انها بيئة بحرية ضحلة الى قرب ساحلية. ولندرة البالينولات في تكوين كيستا لم يتم تحديد بيئته الترسبية.