Palynological Analysis of cutting samples from Well: A1-177/01, Murzuq Basin

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Abstract: Playonological study have been utilized in order to define age and depositional environments of the penetrated sections of the well A1-177/01, which belongs to Chevron Libya Limited, located in the South Eastern Margin of Murzuq Basin. The study based on selected one hundred and four cutting samples, and despite of difficulties caused by heavy caving and reworked palynomorphs, palynological recoveries in general was good in the upper half of the studied section.

Microscope investigations revealed moderately rich to poor assemblages consisting mainly of miospores, few marine acritarches and chitinozoans, recovered from the studied samples enabled to erect six distinctive palynological assemblages. These assemblages range from Early Silurian to Early Carboniferous in age. The ages assigned to these assemblages have been determined by comparing the palynomorphs assemblages with similar assemblages recorded from Paleozoic sequences in other nearby wells in Murzuq Basin, Ghadamis Basin, North East Libya region, South east Libya (Al Kufrah Basin) and also from other parts of old Gondwana region. Paleoenvironmental interpretation is based on interpreted lithological and palynological criteria.

Keywords: Triassic, Cretaceous, Palynomorphs, Offshore Sirt Embayment.

INTRODUCTION

The studied well A1-177/01, which belongs to Chevron Libya Limited, located in the South Eastern Margin of Murzuq Basin (Fig. 1).

One hundred and four cutting samples (Table 1) were selected by Libyan Petroleum Institute (LPI) geologists for this palynological study, and despite of difficulties caused by heavy caving and reworked palynomorphs, palynological recoveries in general was good in the upper half of the studied section.

The lithostratigraphic units referred to in this report (Table 2), are based upon schemes used by Bellini and Massa (1980) and Klitzsch (1981). Reference has also been made to the Libyan Volume of the Lexicon of Stratigraphy by Burollet (1960). Paleoenvironmental interpretation is based on interpreted lithological and palynological criteria, (Table 3).

MATERIAL AND METHODS

Samples: One hundred and four cutting samples from well A1-177/01 were selected by LPI geologists.

Laboratory techniques: The samples were prepared in the laboratory of the L.P.I. according to standard palynological procedures. The preparation stages can be summarized as following:

Cleaning sample: Samples were washed using tap water and 150 µm mesh sieve to remove drilling mud.

Picking: All selected samples were sieved in 2 mm mesh sieve to eliminate any possible caved material (material larger than 2mm assumed to be caved)

Demineralization:

- Carbonate removal using hydrochloric acid (HCI 18%).
- Silicate removal using hydrofluoric acid (HF 40%).
- Sieving using 10, 18, 22 and 64 micron sieve as appropriate
- Oxidation to remove unwanted organic matter using nitric acid (HNO3 65%) for about 3-5 minutes (applied for the majority of samples)
- Removal of minerals (separation the inorganic mineral from the organic matter by using zinc chloride (ZnCl) with specific gravity 2.00.

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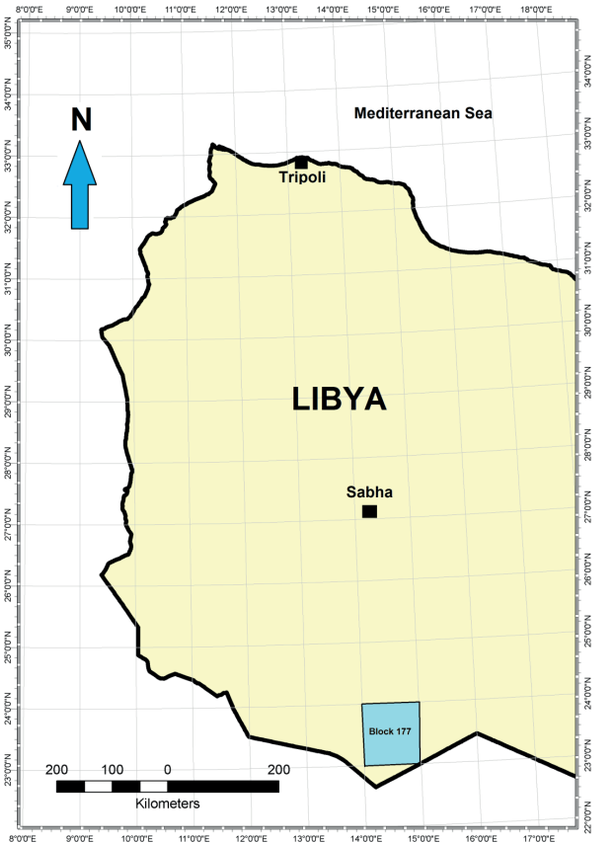


Fig. 1. Location Map of the Study Area.

The cleaned and neutralized residue is mixed with few drops of the dispersing solution (PVA) to prevent coagulation of the organic residue on the slide. This mixture spread on two 24X30mm cover slips using pipettes and allowed to dry on hot plate (25˚C). Mounting was achieved by placing one or two drops of the resin on to a clean microscope slide (76 X 26mm).

PALYNOLOGICAL RESULTS

Six palynological assemblages were identified among the studied sequences. The distribution of the common and stratigraphically significant palynomorphs is listed in the well stratigraphic chart (Fig. 2) and the identified assemblages can be described below as follows:

***Interval (ft.):* 420–1180.**

Samples analyzed: 16 Cutting samples.

Age: Lower Carboniferous, (Late Visean).

Remarks: Rich and diverse land derived organic matter, dominated by spores and herbaceous debris was recovered from this interval. Age of this interval based on the highly abundance of *Aratrispors sahariensis* and presence of *Diatomozonotriletes fragilis* Reworked Devonian and Tournasian Spores are abundant.

The above assemblage similar to what have been recorded by Clayton & Loboziak (1985) and Loboziak & Clayton (1988) from Carboniferous sediments of North East Libya, and can be assigned to the Late Visean (Clayton, 1995). The base of this assemblage is marked by first appearance down hole (last occurrence) of species *Spelaeotriletes proteau,* however the top of this assemblages cannot be seen in this well. Late Visean palynomorphs, also reported by El-Harbi (2000), from upper part sediments of Mrar Formation, Ghadamis Basin.

Palaeoenvironment: The predominance of land derived organic matter in which spores and herbaceous debris were the most common, absent of marine palynomorphs (no acritarches were observed), and the presence of butrroccocus (fresh water algae) in this intervals, suggest deposition in a non marine environment.

Interval (ft.): 1240–1690.

Samples analyzed: 12Cutting samples.

Age: Lower Carboniferous, (? Early Tournasian).

Remarks: Rich and diverse land derived organic matter, dominated by spores and herbaceous debris was recovered from this interval. The first down hole appearance (last occurrence) of *Idnotriletes explanatus*, *Cyrtospors cristifer* and *Umbonatispora baculatus* indicate an age no younger than Mid-Tournaisisn. The presence of upper most Fammenien spore *Retispora lepidophyta* and Givetian–Frasnian spores *Grandispora libyansis* & *Grandispora inculta* in the lower most part of this interval, regarded as reworked due to nature of their preservation.

The above assemblage is considered to be Tournaisian (probably Early Tournaisian) in age and almost similar in composition to palynozone 12 of Grignani *et al* (1991). Reworked Devonian and caved Visean spores are abundant.

Palaeoenvironment: The predominance of land derived material in which spores and herbaceous debris were the most common, few marine palynomorphs 1-2% (acritarches), and the presence of butrroccocus (fresh water algae) in this intervals, suggest deposition in marginal marine environment.

Interval (ft.): 1750–1910.

Samples analyzed: 4 Cutting samples.

Age: Middle Devonian &? Latest Devonian undifferentiated (Early Givetian &? Strunian).

Table 1: Samples selected for plalynological investigation

S/N	Depth/feet	S/N	Depth/feet	S/N	Depth/feet
1	420	39	2210	77	3920
2	460	40	2240	78	3980
3	510	41	2250	79	4040
4	570	42	2300	80	4100
5	630	43	2360	81	4160
6	690	44	2380	82	4220
7	760	45	2390	83	4280
8	820	46	2420	84	4340
9	880	47	2480	85	4400
10	910	48	2490	86	4460
11	920	49	2540	87	4520
12	940	50	2600	88	4580
13	1000	51	2630	89	4640
14	1060	52	2640	90	4700
15	1110	53	2650	91	4760
16	1180	54	2660	92	4820
17	1240	55	2670	93	4880
18	1300	56	2690	94	4900
19	1310	57	2720	95	4930
20	1330	58	2780	96	4960
21	1360	59	2840	97	4990
22	1410	60	2900	98	5020
23	1470	61	2960	99	5050
24	1530	62	3020	100	5080
25	1590	63	3080	102	5110
26	1630	64	3140	103	5140
27	1650	65	3200	104	5160
28	1690	66	3260		
29	1710	67	3320		
30	1730	68	3380		
31	1750	69	3440		
32	1790	70	3500		
33	1850	71	3560		
34	1910	72	3620		
35	1970	73	3680		
36	2030	74	3740		
37	2090	75	3800		
38	2150	76	3860		

Table 2: **Summary of the Stratigraphy**
The following summary tables are based on data obtained from the analyses of ditch cuttings samples. The boundaries quoted are either the bottom depths of sampled intervals or have been adjusted to suitable wire line log break (marked by the suffix (log).

Top Depth/feet	Series	Stage	Formation
420 - 1180	Lower Carboniferous	Visean	Mrar
1240 - 1690	Lower Carboniferous	Tournasian	
	Unconformity		Mrar
1700(log) - 1960	Middle Devonian ?Latest Famennian	Givetian & ?Strunian	Awaynat Wanin II & ?Tahara
	Unconformity		
1970 - 2380	Lower Devonian	?Siegenian -Emsian	Quan Kasa & ?Tadrart
	Unconformity		
2390 - 2690	Silurian	Llandovery-Wenlock	Akakus
	Unconformity		
2750 (log) - 5071	Barren Samples	indeterminate	

Table 3: Summary of the Paleoenvironments

Top Depth/feet		Paleoenvironment
420 – 1180		Non – marine
1240 – 1690		Marginal marine
	Unconformity	
1700(log) - 1960		Marginal marine
	Unconformity	
1970 – 2380		Non – marine
	Unconformity	
2390 – 2690		Outer neritic
	Unconformity	
2750 (log) - 5071	Barren Samples	indeterminate
	Unconformity	
5072 Basement (log) – 5160 T.D		

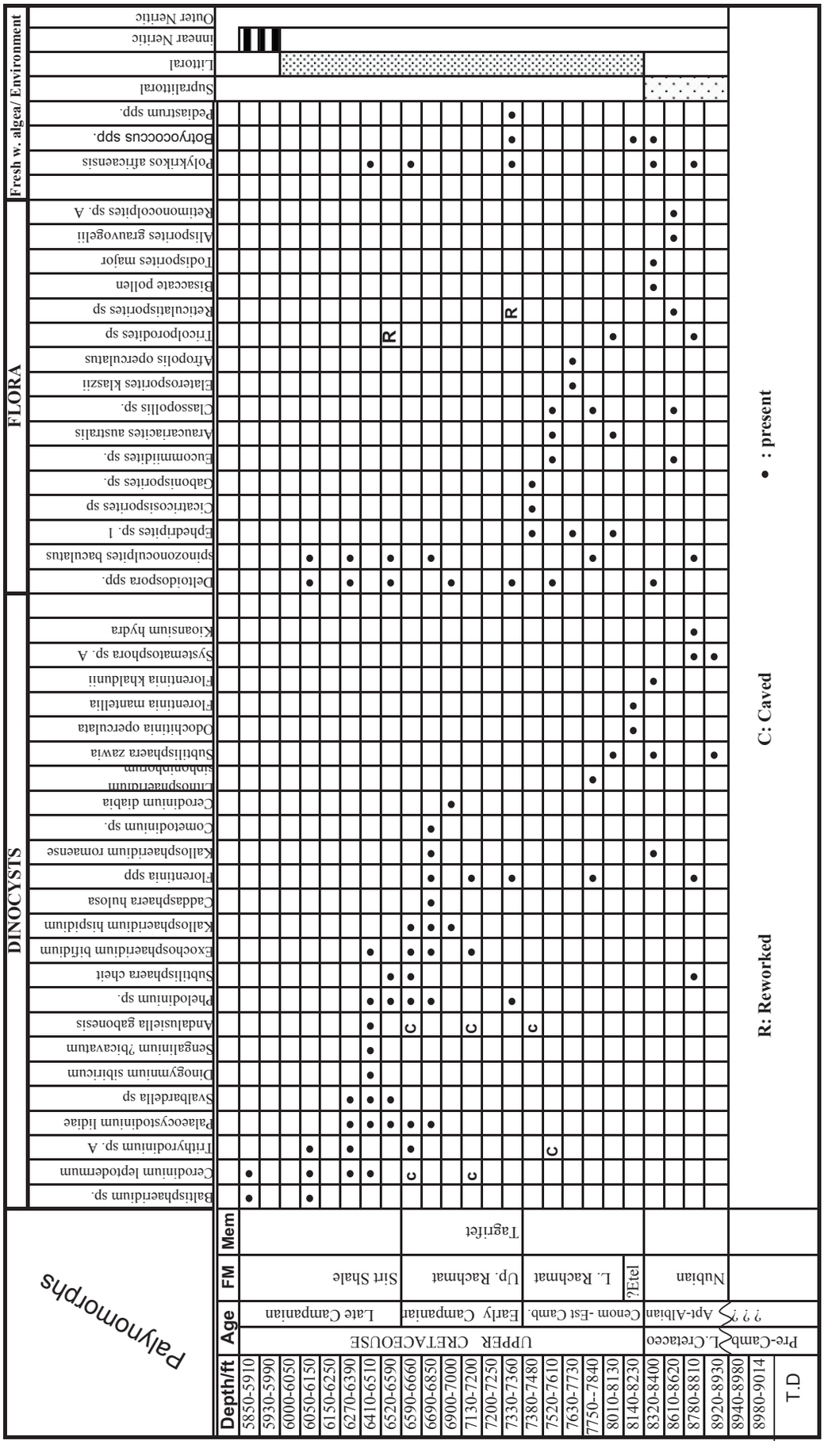


Fig. 2. Stratigraphic Chart of Well A1-177/01.

Remarks: The rare presence of Retispora lepidophyta in the intervals (1750-1850) indicates an age of latest Famennian (Strunian), but the sparsely presence of diagnostic palynomorphs such as *Acinosporites acanthomammillatus* & *A. macrospinspinosus* and the common presence of *Grandispora* inculta, *Acanthotriletes horides*, *Grandispora nauomova*, *Grandispora libyaensis & Geminospora lemuratus,* along with other spores, strongly indicate a Givetian age for this interval. However, it is hard to regard them as being reworked spores. Therefore, this interval was regarded as condensed middle and upper most Devonian deposits. Frasnian and most of the Upper Famennian index palynomorphs were not recorded from this interval, therefore, sediments of these ages might be either eroded or not deposited, thus an unconformity surface can be set between Early Givetian and Latest Devonian times.

The above assemblages is correlate very well with (AD) Oppel Zone- Interval *lem* of Streel *et al* (1987). Streel *et. al*., (1988), reported similar assemblages from Givetian sediments of North East Libya and also from the revised zonation and age of the Aouinet Ouenine III Formation, in the Ghadamis Basin western part of Libya.

Palaeoenvironment: The predominance of land derived material in which spores and herbaceous debris were the most common, few marine palynomorphs 1-2% (Acritarches), suggest deposition in a marginal marine environment**.**

Interval (ft.): 1970–2380.

Samples analyzed: 10 Cutting samples.

Age: Lower Devonian, (? Siegenian - Emsian).

Remarks: The first down hole appearance (last occurrence) of *Dictyotriletes emsensis*, *Brochotriletes macgregri* ,*Camptozonotriletes caperatus* and *Emphanisporites micronatus* indicate age of no younger than Emsian as have been dated in (McGregor, 1979). The barren sandy sequence (2100-2380) which stratigraphicaly lies between mid Silurian and Emsian times, questionably considered to be part of Tadrart Formation, and questionably assigned to a Siegenian time. The presences of Silurian spores such as *Archeozonotriletes* cf. *chulus* and *Archeozonotriletes chulus* in this interval, regarded as being reworked.

Palaeoenvironment: The predominance of land derived material in which spores and herbaceous debris were the most common, and the absence of marine palynomorphs, suggest deposition in non marine environment**.**

Interval (ft.): 2390–2690.

Samples analyzed: 14 Cutting samples.

Age: Silurian, (Late LLandovery-Wenlock).

Remarks: The analyzed samples from the above interval reveled rich chitinozoans assemblages and some acritarches species. Age of this interval based on the presence of the following Acritarchs species: *Arpylorus antiquus*, *Diexallophasis remota*, *Helosphaeridium malvernensis*, *Hoegklintia Cylindrica, Villosacapsula & Leiofusa bernesga* together with chitinozoans species such as: *Spherochitina* spp, *Angochitinia* spp, and *Ancyrochitina ancyrea*. The above assemblages can be well correlated with the LLandovery assemblages which have been reported by Hill *et al* (1985), from three wells (E1-81, A1-46 and D1-31) from North East Libya.

Palaeoenvironment: The presence of abundant marine palynomorphs, dominated by chitinozoans and acritarchs suggest an open marine environment of deposition**,** most likely outer neritic zone.

Interval (ft.): 2780–5160 T.D.

Samples analyzed: 46 Cutting samples.

Age: Indeterminate.

Remarks: All samples analyzed from the above interval prove to be barren of palynomorphs.

CONCLUSIONS

A review of miospores and acritarchs faunas of the interval 1240–1690 feet of the studied well A1-177/01 suggest precisely Early Carboniferous (? Early Tournasian) age. This interval was previously regarded as a Silurian sediments by Chevron Geologists (2009).

This conclusion is based on the highest occurrence downhole of the following characteristic species: *Idnotriletes explanatus*, *Cyrtospors cristifer* and *Umbonatispora baculatus*. Six palynological zones have been established from the Silurian and Carboniferous sediments of the well A1-177/01, on the basis of miospores, acritarchs and chitinozoans, ranging in age from Early Silurian to Early Carboniferous in age. These zones are assemblage zones and are corelatable with other assemblages reported by other authors from the Murzuq Basin, Ghadamis Basin, North East Libya region, South east Libya (Al Kufrah Basin) and also from other parts of old Gondwana region.

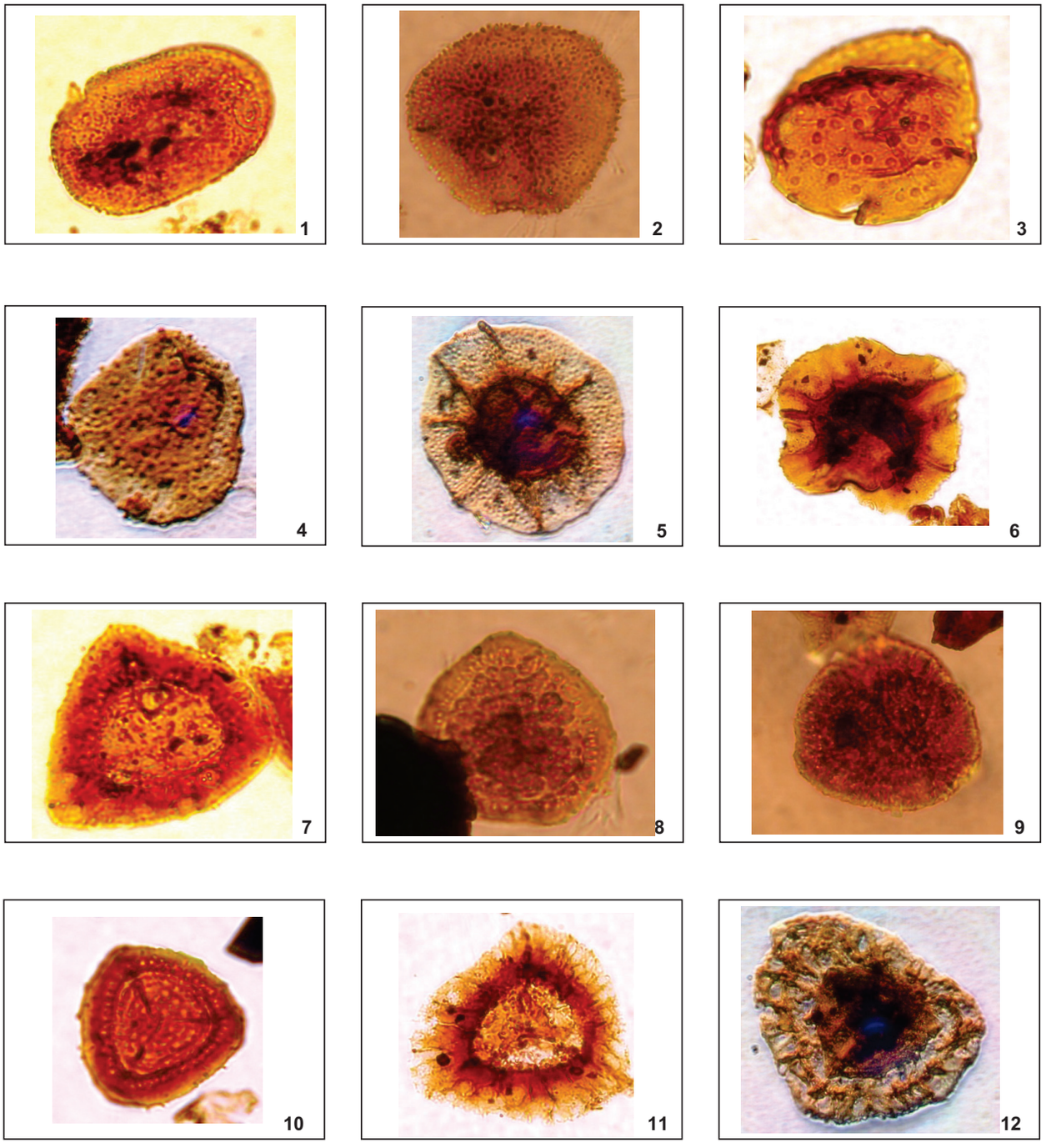


PLATE I

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate I - 1	Aratrisporites saharnsis, S4/570 ft
Plate I - 2.	Spelaeotriletes triangulus, S8/820 ft
Plate I - 3	Spelaeotriletes pretosus, S21/1360 ft
Plate I - 4	Spelaeotriletes pretosus, S22/1410 ft
Plate I - 5	Comptozonotriletes cyrenaicus, S8/820 ft
Plate I - 6	Comptozonotriletes cyrenaicus, S21/1360 ft
Plate I - 7	Vallatisporites vallatus, S27/1690 ft
Plate I - 8	Vallatisporites verrucosus, S8/820 ft
Plate I - 9	Vallatisporites agadesi, S1/420 ft
Plate I - 10	Vallatisporites sp, S7/760 ft, X1000
Plate I - 11	Radiizonates sp, S7/760 ft
Plate I - 12	Radiizonates genuinus, S25/1590 ft

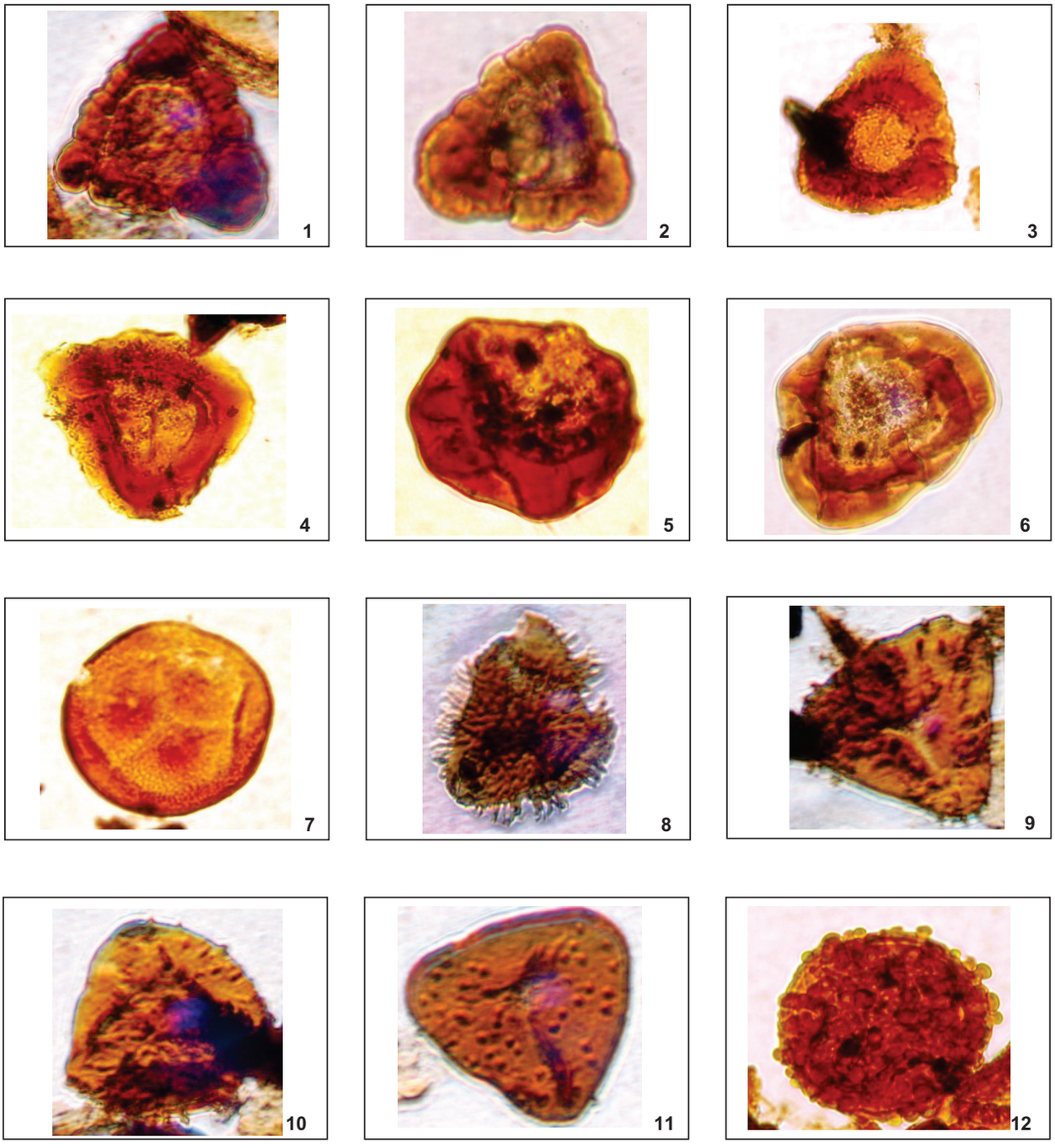


PLATE 11

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate II - 1	Densosporites variomarginatus, S23/1470 ft
Plate II - 2	Densosporites variomarginatus, S23/1470 ft
Plate II - 3	Cingulizonate bialatus, S25/1590 ft
Plate II - 4	Cingulizonate bialatus, S18/1300 ft
Plate II - 5	Knoxisporites pristinus, S6/690 ft
Plate II - 6	Knoxisporites pristinus, S6/690 ft
Plate II - 7	Retusotriletes crassus, S27/1690 ft
Plate II - 8	Ditomozonotriles fragilis, S27/1690 ft
Plate II - 9	Umbonatisporites baculatus, S27/1690 ft
Plate II - 10	Umbonatisporites baculatus, S27/1690 ft
Plate II - 11	Umbonatisporites sp, S26/1630 ft, X1000
Plate II - 12	Raistrickia clavata, S26/1630 ft

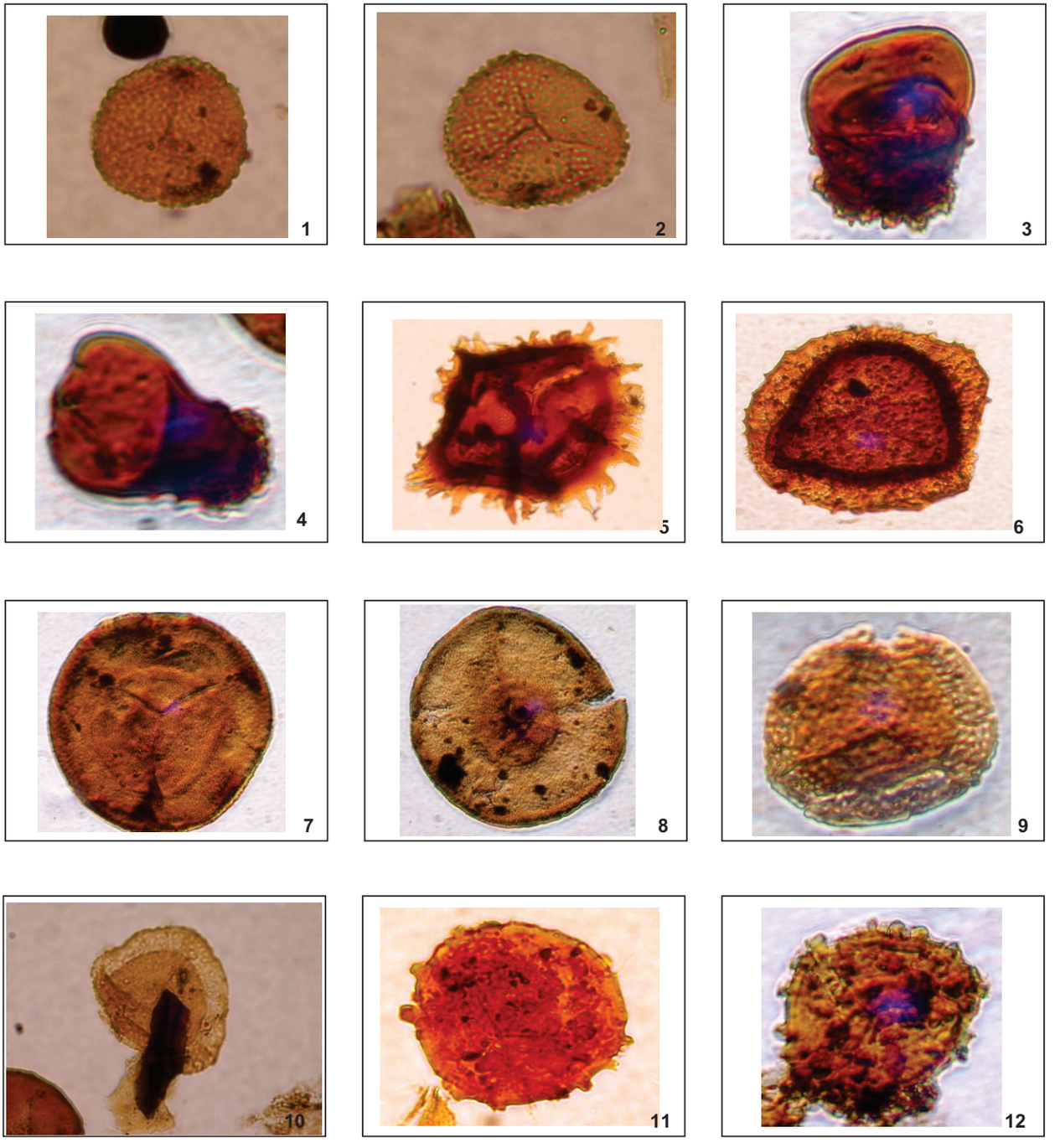


PLATE 111

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate III - 1	verrucosisporites fammenensis, S29/1790 ft, X1000
Plate III - 2	verrucosisporites fammenensis, S29/1790 ft, X1000
Plate III - 3	Cyrtospora cristifer, S27/1690 ft
Plate III - 4	Cyrtospora cristifer, S27/1690 ft
Plate III - 5	Dictyotiletes fimbriatus, S27/1690 ft
Plate III - 6	Indotriradites explanatus, S27/1690 ft
Plate III - 7	Spelaeotriletes giganteus, S8/820 ft
Plate III - 8	Spelaeotriletes giganteus, S8/820 ft
Plate III - 9	Retispora lepidophyta, S30/1850 ft
Plate III - 10	Retispora lepidophyta, S28/1750 ft
Plate III - 11	Pustulatisporites dolbii, S23/1470 ft, X900
Plate III - 12	Pustulatisporites dolbii, S23/1470 ft, X900

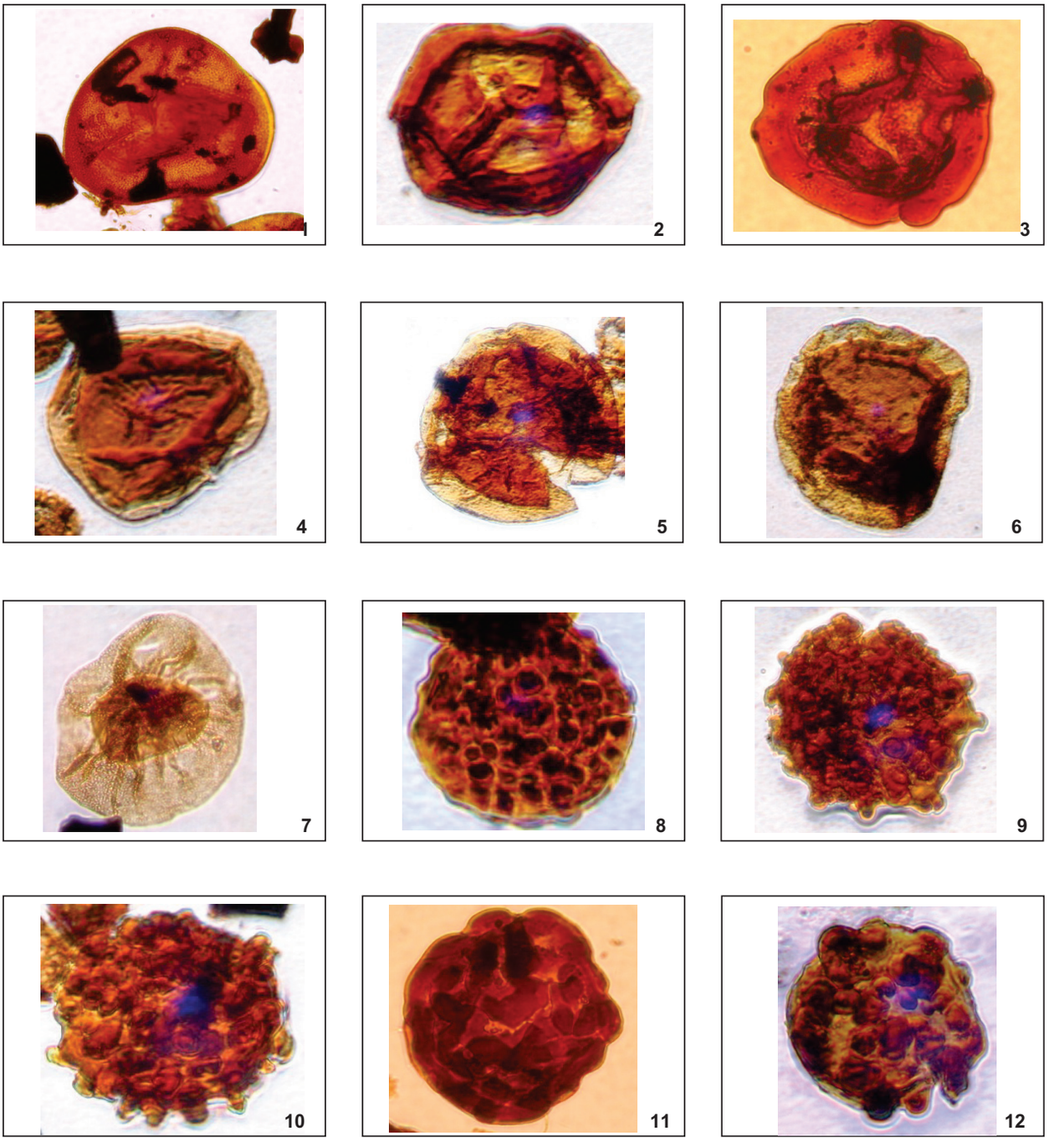


PLATE IV

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate IV - 1	Retusotriletes sp, S20/1470 ft
Plate IV - 2	Knoxisporites litratus, S22/1410 ft
Plate IV - 3	Lophozonotriletes rarituberculatus, S27/1690 ft
Plate IV - 4	Aurospora asperella, S18/1300 ft
Plate IV - 5	Aurospora sp, S8/820 ft
Plate IV - 6	Aurospora sp, S24/1530 ft
Plate IV - 7	Aurospora solisortus, S3/510 ft
Plate IV - 8	Verrucosisporites nitidus, S20/1470 ft
Plate IV - 9	Pustulatisporites gibberosus, S27/1690 ft
Plate IV - 10	Pustulatisporites gibberosus, S12/940 ft
Plate IV - 11	Convolutispora vermiformis, S15/1110 ft
Plate IV - 12	Verrucosisporites cf premnus, S31/1910 ft

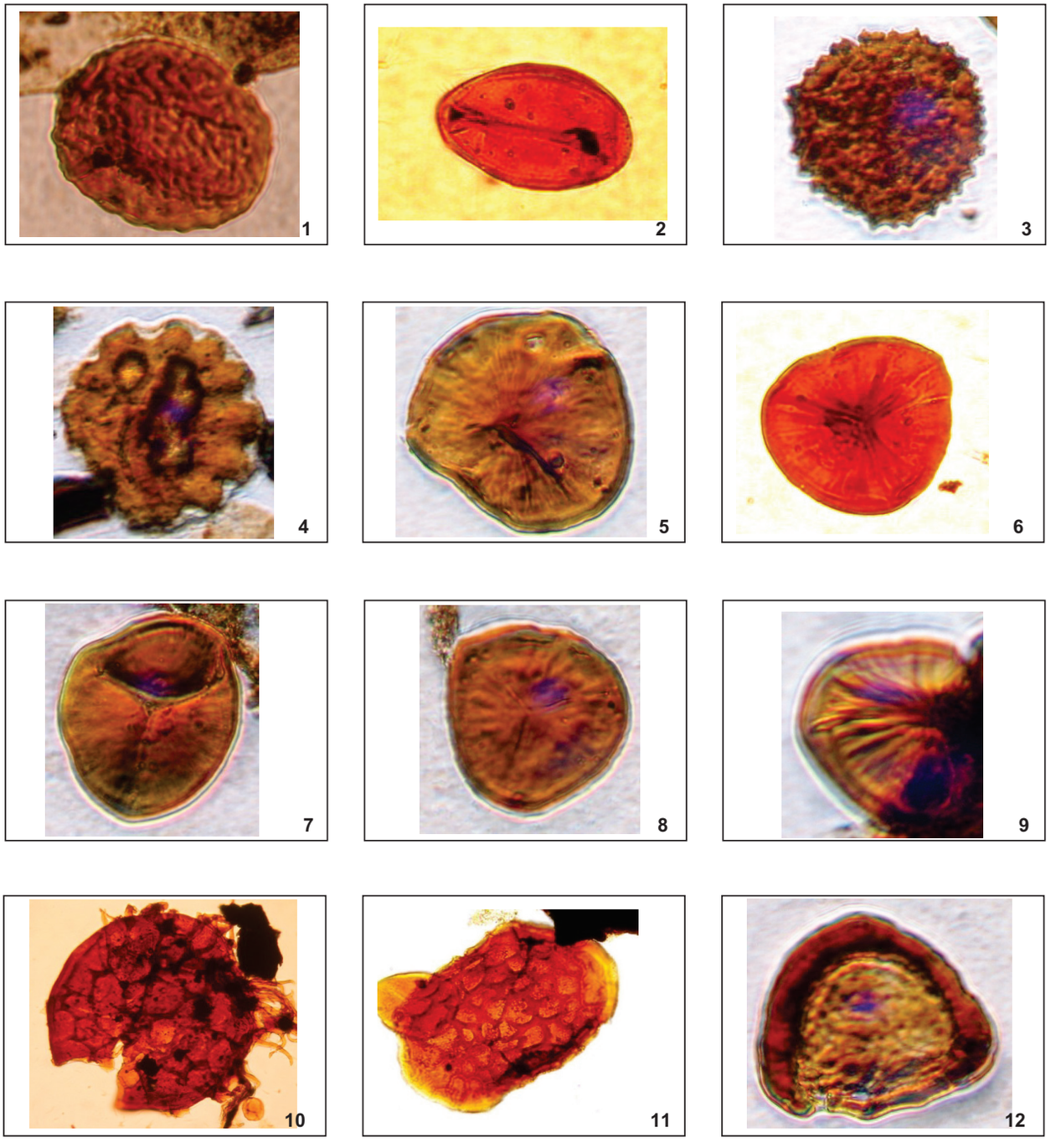


PLATE V

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate V - 1 Rugospora sp, S27/1690 ft, X1000
Plate V - 2 Monoletes spore, S20/1470 ft, X1000
Plate V - 3 Cristatisporites sp, S20/1470 ft
Plate V - 4 Marnhites brasiliensis, S28/1750 ft
Plate V - 5 Emphanisporites sp, S30/1850 ft
Plate V - 6 Emphanisporites rotatus, S33/2030 ft
Plate V - 7 Emphanisporiteso abscurus, S34/2090 ft, X1000
Plate V - 8 Emphanisporites cf annulatus, S30/1850 ft
Plate V - 9 Emphanisporites sp, S30/1850 ft, X1000
Plate V - 10 Courbolispora cancellata, S24/1530
Plate V - 11 Dictyotiletes trivialis, S33/2030 ft
Plate V - 12 Archeozonotriletes sp, S30/1850 ft

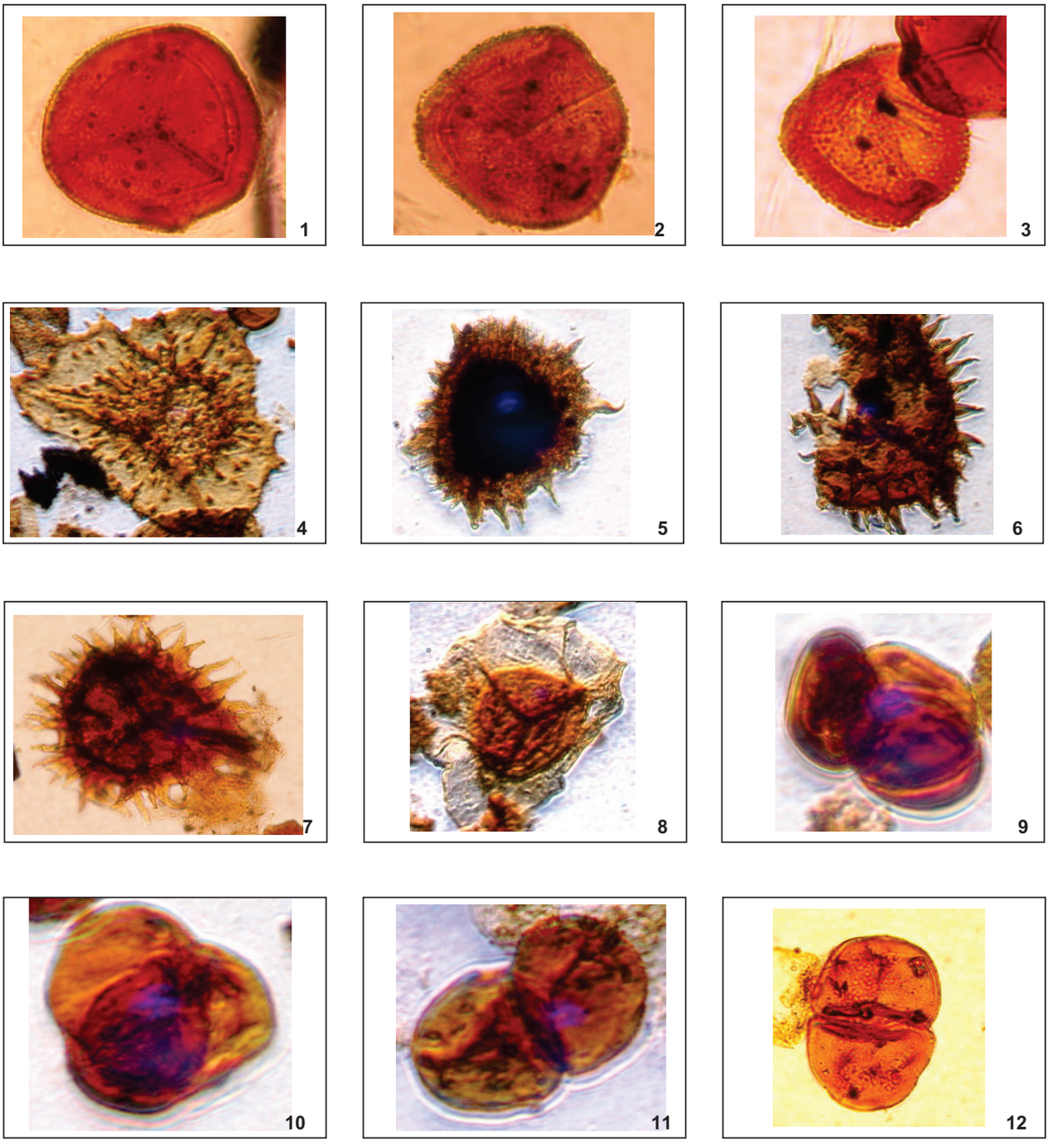


PLATE VI

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate VI - 1	Geminospora lemurata, S31/1910 ft, X900
Plate VI - 2	Geminospora lemurata, S31/1910 ft, X900
Plate VI - 3	Cymbosporites cyathus, S33/2030 ft
Plate VI - 4	Grandispora libyensis, S28/1750 ft
Plate VI - 5	Grandispora naumovae, S30/1850 ft
Plate VI - 6	Acanthotriletes horids, S28/1750 ft
Plate VI - 7	Ancyrosporites cf langii, S29/1790 ft
Plate VI - 8	Camptozonotiletes caperatus. S32/1970 ft
Plate VI - 9	Tetrahedraletes medinensis, S33/2030 ft
Plate VI - 10	Tetrahedraletes medinensis, S33/2030 ft
Plate VI - 11	Dyad spore, S33/2030 ft, X1000
Plate VI - 12	Dyad spore, S33/2030 ft, X900

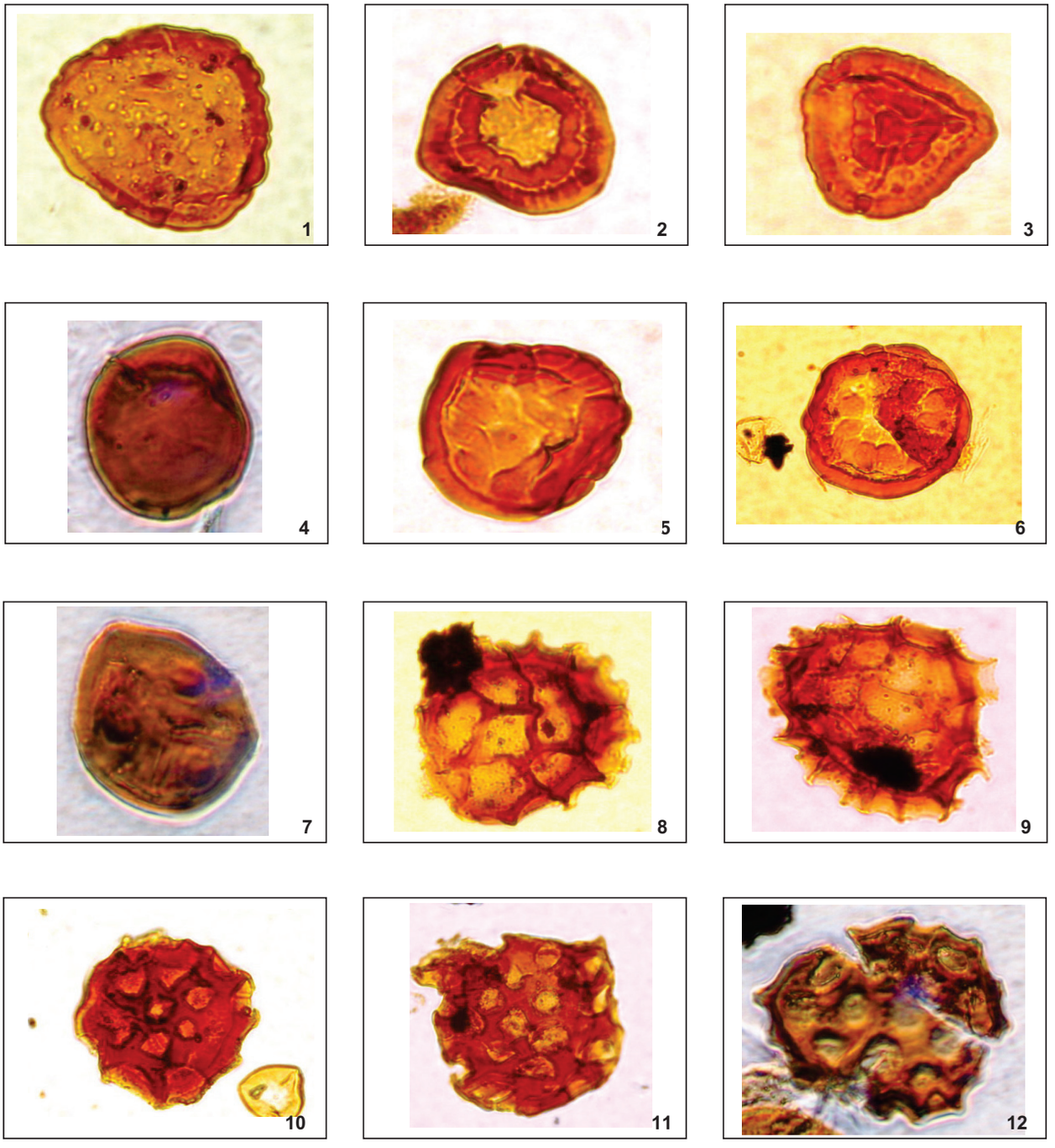
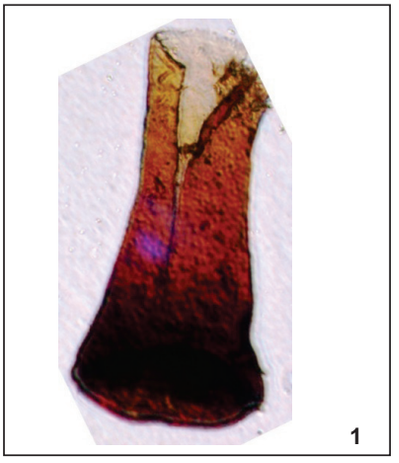
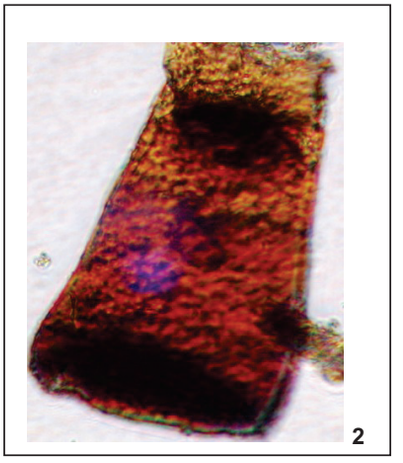


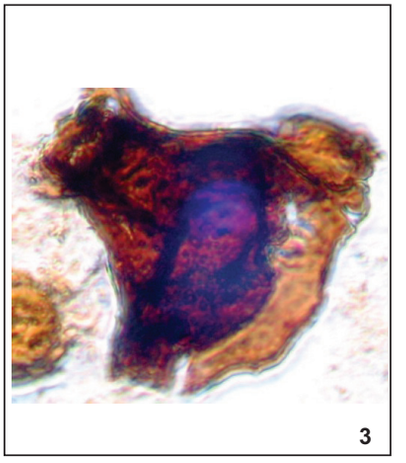
PLATE VII

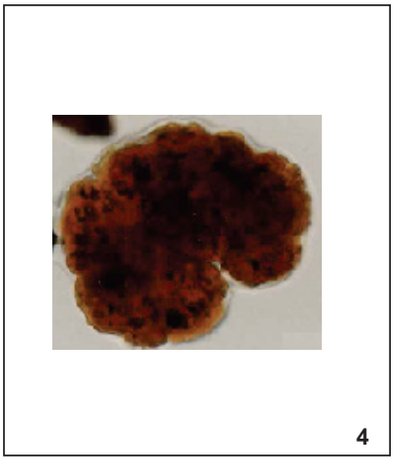
The species name is followed by the sample number and depth.
All figures are X1000 unless otherwise indicated

Plate VII - 1	Brochotriletes foveolatus, S33/2030 ft
Plate VII - 2	Synorisporites libycus, S33/2030 ft
Plate VII - 3	Synorisorites libycus, S34/2090 ft
Plate VII - 4	Archeozonotriletes sp, S33/2090 ft
Plate VII - 5	Archeozonotriletes cf chulus, S33/2030 ft
Plate VII - 6	Archeozonotriletes cf chulus, S33/2030 ft
Plate VII - 7	Synorisporites tripapillatus, S33/2030 ft
Plate VII - 8	Dictyotiletes emsiansis, S34/2090 ft, X800
Plate VII - 9	Dictyotiletes emsiansis, S33/2030 ft, X800
Plate VII - 10	Brochotriletes sp, S34/2090 ft, X800
Plate VII - 11	Brochotriletes sp, S33/2030 ft, X800
Plate VII - 12	Brochotriletes sp, S33/2030 ft, X800

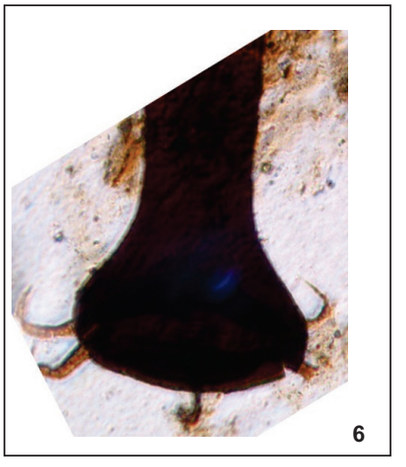


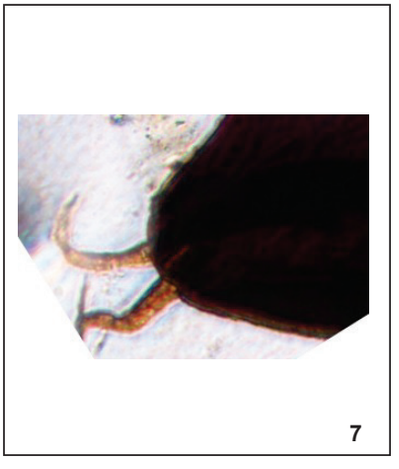












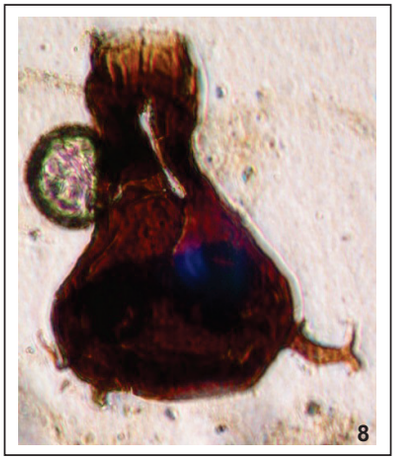
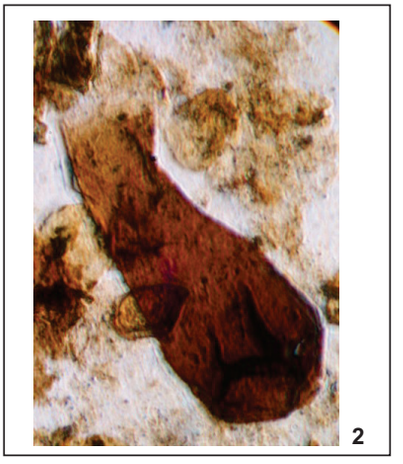


PLATE VIII

The species name is followed by the sample number and depth.
All figures are X400 unless otherwise indicated

Plate VIII - 1 Conochitina sp, S46D/2650 ft
Plate VIII - 2 Conochitina sp, S46D/2650 ft
Plate VIII - 3 Cyathochitina kuckersiana, S45C/2640 ft
Plate VIII - 4 Botryococus sp, S11/920, X800
Plate VIII - 5 Ancyrochitina ancyrea, S46C/2640 ft
Plate VIII - 6 Ancyrochitina ancyrea, S46C/2640 ft
Plate VIII - 7 Ancyrochitina ancyrea, S46C/2640 ft
Plate VIII - 8 Ancyrochitina ancyrea, S46C/2640 ft

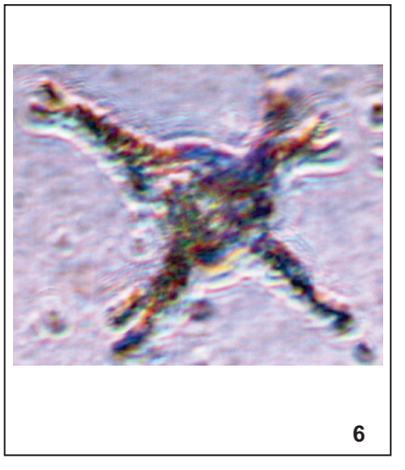

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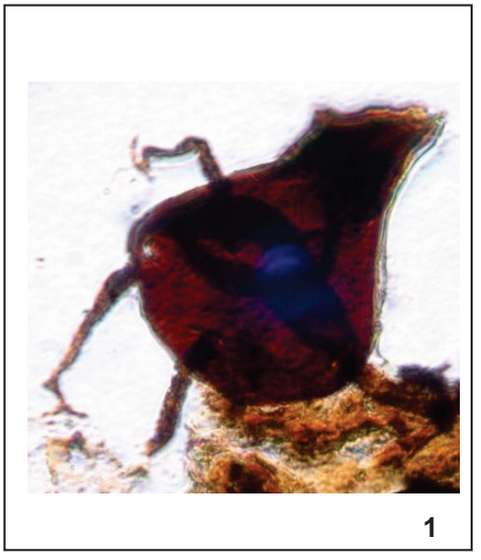

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PLATE IX

The species name is followed by the sample number and depth.
All figures are X800 unless otherwise indicated

Plate IX - 1	Angochitina sp, S46C/2690 ft, X400
Plate IX - 2	Angochitina sp, S46C/2690 ft, X400
Plate IX - 3	Leiofusa bernesga, S46C/2690 ft
Plate IX - 4	Veryhachium cf oklahomenses, S45C/2640 ft
Plate IX - 5	Hoegklintia cylindrica, S46C/2690 ft
Plate IX - 6	Diexallophasis remota, S45D/2650 ft
Plate IX - 7	Helosphaeridium malvernensis, S46C/2690 ft
Plate IX - 8	Helosphaeridium malvernensis, S46C/2690 ft





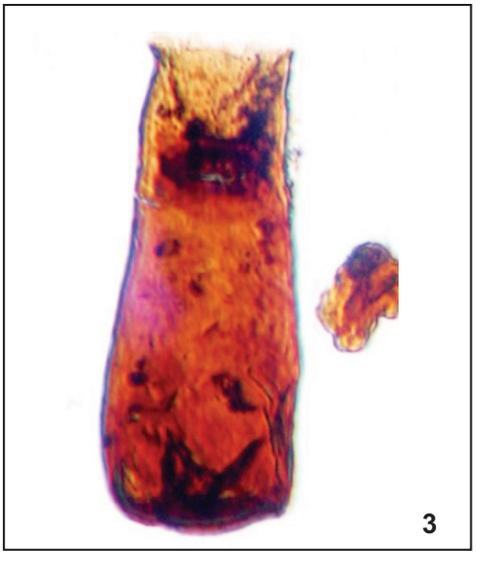




PLATE X

The species name is followed by the sample number and depth.
All figures are X400 unless otherwise indicated

Plate X - 1	Ancyrochitina ancyrea, S46C/2690 ft
Plate X - 2	Ancyrochitina ancyrea, S46C/2690 ft
Plate X - 3	Angochitina sp, S45D/2690 ft
Plate X - 4	Conochitina sp, S46D/2690 ft

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