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BIOSTRATIGRAPHIC ZONATION

SHELL UNAK B-11

68° 40' 10" N. LAT.; 135° 18' 40" W. LONG.

NORTHWEST TERRITORIES

AUSTIN & CUMMING EXPLORATION CONSULTANTS

CALGARY, ALBERTA

FEBRUARY, 1977

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SUMMARY & CONCLUSIONS

BY

L. W. CUMMING, P. GEOL.

SUMMARY AND CONCLUSIONS

Biostratigraphic analysis of the Shell Unak B-11 well consists of a palynostratigraphic study carried out by Dr. Glenn E. Rouse and a micropaleontological analysis by Drs. W. Braun and M. Brooke.

One hundred seventeen (117) palynomorph slides prepared from 111 sidewall core samples plus 5 conventional core samples were analyzed for microfloral content (Fig. 1). Slides used for this portion of the study were prepared by the operator and supplied to Austin & Cumming by the Institute of Sedimentary and Petroleum Geology. Unwashed samples proved incomplete and generally inadequate, necessitating the use of operator's slides.

Palynological examination identifies two Cenozoic zones (U-1 and U-2) plus nine Mesozoic zones (U-3 to U-11). The Cenozoic is represented by an undifferentiated Neogene zone and one Paleocene zone. The Mesozoic zones range in age from Maestrichtian-Campanian at the top (2074 feet) through Middle Albian, Lower Albian-Aptian, Hauterivian, Barremian, Valanginian, Berriasian-Tithonian to Triassic-Early Jurassic at the base of the well. Table 1 of the palynological report illustrates characteristic palynomorphs, environment, probable age and organic maturation for each zone.

One hundred twentyfive (125) micropaleontological slides, disintegrated and picked by the Institute of Sedimentary and Petroleum Geology, were examined for microfaunal content. Microfossil analysis identifies the probable presence of the Neogene I assemblage (100-190') commonly found near the surface in other wells examined in the area. Underlying the Neogene is the Cyclammina 71 fauna, which is commonly indicative of Paleocene age beds. The Mesozoic sequence (2050-10,320') is represented faunally by one Upper Cretaceous unit (Maestrichtian-Campanian, Rouse) and four Lower Cretaceous to Jurassic assemblages. The uppermost Cretaceous Haplophragmoides 267-268 fauna has not previously been recognized in the area. This assemblage coincides with palynological zone U-3 indicated by Rouse as Maestrichtian to Campanian age. The Lower Cretaceous to Jurassic is divided micropaleontologically into four assemblages. Assemblage I and II span beds palynologically dated as Middle Albian to Barremian-Hauterivian age. Assemblage III may span the Jurassic-Lower Cretaceous boundary, whereas Assemblage IV is tentatively considered Jurassic. Continuing studies in the area, hopefully, will provide a distinct microfaunal zonation for this Lower Cretaceous-Jurassic succession of beds. Correlation of the micropaleontological analysis with palynological results is illustrated in Table 1 of the Micropaleontology report.

Operator data (well history report) indicates a possible Paleozoic unit below 8200 feet. These studies failed to confirm the presence of pre-Mesozoic beds in this interval and lithological data tends to support the Triassic-Early Jurassic designation presented by Rouse.

PALYNOSTRATIGRAPHIC STUDY

BY

GLENN E. ROUSE, PH.D.

TABLE 1

UNAK B-11
PALYNOLOGICAL ZONATION

DEPTH	ZONE	DEFINITIVE PALYNOMORPHS	ENVIRONMENT	AGE	ORG. MAT.
1000	U-1 1117'	SPRUCE - PINE - <u>SCHIZOSPORIS</u> ZONE	TERRESTRIAL & AQUATIC	NEOGENE	1
2000	U-2 2074'	PARAALNI- CASUARINIDITES ZONE	TERRESTRIAL & MARINE	PALEOCENE	1-2
	U-3 2296'	WODEHOUSEA - AQUILA - DICONODIN.	TERR. & MARINE	MAASTR. - CAMPAN.	2
	U-4 2550'	ARAUCARICITES - CYCLONEPHELIUM	TERR. & MARINE	MID - ALBIAN	2-3
3000	U-5 3863'	CYCLONEPHELIUM - cf. COMPACTUM	TERRESTRIAL & MARINE	APTIAN - LR. ALBIAN	2-3
4000			STRONG MARINE		
5000	U-6 5435'	CLEISTOSPHAERIDIUM - OLIGOSPHAERIDIUM	TERRESTRIAL STRONG MARINE MAINLY TERRESTRIAL	HAUTERIVIAN - BARREMIAN	3-4
6000	U-7 6576'	IMBATODINIUM - CANNINGIA - 2	MAINLY TERRESTRIAL	VALANGINIAN - L. HAUTERIVIAN	4
7000	U-8 7754'	PALEOPERIDIUM NUDUM LYCOPodium AUSTRORCLAV.	TERRESTRIAL & MARINE	BERRIASIAN - TITHONIAN	4-5
8000	U-9 9050'	PAEODINIA CERATOPHORA CLAVATIPOLL. COUPERI PFLUGIPOLL. DAMPIERI	TERRESTRIAL & MARINE	UPPER JURASSIC	5-6
9000	U-10 9495'	PODOCARPIDITES ZONE	MAINLY TERRESTRIAL	JURASSIC cf. MID - EARLY UPPER	5-6
10,000	U-11 10,320'	ALISPORITES - CEDRIPITES cf. PICEITES	MAINLY TERRESTRIAL	MESOZOIC, cf TRIAS. - E. JURASSIC	6
11,000					

SUMMARY

Seventy-four terrestrial and fifty aquatic palynomorphs were obtained from 111 samples (106 sidewall cores plus 5 conventional cores), distributed to a depth of 10,320 feet.

Eleven palynomorph zones have been established, ranging through Neogene, Paleocene, Maastrichtian-Campanian, mid-Albian, Aptian-Albian, Hauterivian-Barremian, Valanginian-Lower Hauterivian, Berriasian-Tithonian, Jurassic, and early Mesozoic. (Table 1). The younger and older zones are based mainly on terrestrial palynomorphs, whereas those of the late Jurassic and Lower Cretaceous correlate with dinoflagellate zones of Brideaux from the Mackenzie Delta region. Several strong marine and terrestrial zones have been identified.

ZONATION

Zone U-1 0-1117 feet. Neogene

Characteristic palynomorphs:

Pinus-1

Picea-2

Corylus/Carpinus

Taxodiaceapollenites hiatus

Schizosporis spp.

Although the number of palynomorphs is small, they correlate well with those in Neogene zones of outcrop and other wells.

Zone U-2 1117-2074 feet. Paleocene

Key palynomorphs:

Paraalnipollenites-1

Casuarinidites-1

Myricipites dubius

These are characteristic of the lower Paleocene from outcrop and other well sections of the region.

Zone U-3 2074-2296 feet. Maastrichtian-Campanian

Key palynomorphs:

Wodehousea spinata
Aquilapollenites polaris
Cranwellia striata
Diconodinium-5 and -6
Alterbia cf. minor

In this thin interval, the Maastrichtian terrestrial species occur near the top, followed immediately below by the Campanian dino-flagellates.

Zone U-4 2296-2550 feet. Mid-Albian

Key palynomorphs:

Araucaricites-2
Appendicisporites cristatus
Classopollis-1
Cyclonephelium cf. attadellicum
Cyclonephelium-2
Pseudoceratium cf. regium

Although this zone cannot be correlated directly with dated mid-Albian assemblages, 4 of the 5 occur in mid-Albian rocks. (The 5th may be a previously unrecorded species).

Zone U-5 2550-3863 feet. Aptian-Lower Albian

Key palynomorphs:

Araucaricites-2 and -3
Cirratrriadites teter (Known: Lower Albian)
Cyclonephelium cf. compactum (Known: Aptian-Cenomanian)
Cyclonephelium-2 (Known: Aptian-Cenomanian)
Cyclonephelium-3
Canningia cf. minor (Known: Lower Albian-Campanian)

Although not correlative to any other dated zone, the ranges of key species indicate an interval of Aptian-Lower Albian.

Zone U-6 3863-5435 feet. Hauterivian-Barremian

Key palynomorphs:

Cleistosphaeridium disjunctum
Cleistosphaeridium cf. heteracantha
Oligosphaeridium cf. anthophorum
Oligosphaeridium cf. complex
Perinopollenites elatoides
Phyllocladidites microreticulatus

The dating of this interval is based on a general correlation with part of Brideaux's Divisions IV-D and IV-E, particularly the occurrence of Oligosphaeridium cf. complex in IV-E.

Zone U-7 5435-6576 feet. Valanginian-Lower Hauterivian

Key palynomorphs:

Imbatodinium villosum
Canningia-2
Gonyaulacysta cf. hyalodermopsis
Podocarpidites multesimus

The age of U-7 is based mainly on the occurrence of Canningia-2 and Gonyaulacysta cf. hyalodermopsis which appear to correlate with Brideaux's IV-E Parsons Well, and Imbatodinium villosum, quoted by Brideaux (p. 246) as occurring in Valanginian-Lower Hauterivian rocks in Northern Canada.

Zone U-8 6576-7754 feet. Berriasian-Tithonian (cf. Husky Formation)

Key palynomorphs:

Paleoperidinium nudum
Ovoidinium cf. waltoni
Gonyaulacysta cf. cladophora
cf. Concavissimisporites punctatus
Podocarpidites langii
Lycopodiumsporites austroclavidites
Pilosisorites cf. trichopapillosus
Cerebropollenites mesozoicus

This is an assemblage containing a mixture of early Cretaceous (Pilosisorites cf. trichopapillosus; cf. Concavissimisporites punctatus); late Jurassic (Paleoperidinium nudum; Ovoidinium cf. waltoni), and some that straddle the boundary (Perinopollenites elatoides; Lycopodiumsporites austroclavidites). It appears to represent the interval of the Husky Formation, correlative with Kugpik palynozone KP-5A.

Zone U-9 7754-8172 feet. Upper Jurassic

Key palynomorphs:

Pareodinia ceratophora
Clavatipollenites couperi
Pflugipollenites dampieri

This zone is represented by only 3 sidewall core samples, and is relatively depauperate in species.

Zone U-10 9050-9450 feet. Jurassic, cf. mid-early Upper.

Key palynomorphs:

Podocarpidites cf. biformis
Podocarpidites cf. decorus
Sestrosisporites irregulatus

This is essentially a terrestrial interval, with relatively poorly preserved conifer and fern palynomorphs.

Zone U-11 9450-10,320 feet. Mesozoic, cf. Triassic-early Jurassic

Palynomorphs:

cf. Piceites sp.
Alisporites cf. rotundus
Cedripites cf. cretaceus
Pilosisporites sp.
Cycadopites sp.

Preservation is poor and palynomorphs few, but those identified appear to represent post-Permian forms, likely Triassic-early Jurassic.

A summary of Unak palynozones, depositional environments, and age designations is outlined in Table 1.

CORRELATIONS

Many of the Unak palynozones can be correlated with those given by Brideaux (1976) for Gulf Mobil Parsons N-10 well. Some of these correlations are based on rather limited evidence, but in general the ages and sequences parallel one another between the Gulf Parsons N-10, Shell Kipnik 0-20 and the subject well.

MICROPALEONTOLOGICAL STUDY

BY

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UNAK B-II

PALYNOLOGY Rouse, 1976			MICROPALAEONTOLOGY Braun & Brooke, 1976	
Zones	Environment	Age		
1000 - U-1 1117'	terrestrial and aquatic	NEOGENE	NEOGENE ASSEMBLAGE I ? not diagnostic 850'	
2000 - U-2 2074'	terrestrial and marine	PALEOCENE	CYCLAMMINA 71 FAUNA 1700' not diagnostic 2050'	restricted marine
U-3 2296'	"	MAEST. & CAMPANIAN	HAPLO. 267-268 FAUNA 2250'	
U-4 2550'	"	M. ALBIAN	L. CRETACEOUS ASSEMBLAGE I 2500'	
3000 - U-5 3500 3863'	" strong marine	L. ALBIAN - APTIAN	LOWER CRETACEOUS ASSEMBLAGE II	marine
4000 - U-6 4200 4400 5435'	terrestrial strong marine mainly terrestrial	BARREMIAN - HAUTERIVIAN	4,500' not diagnostic	
6000 - U-7 6576'	"	L. HAUTERIVIAN - VALANGINIAN	6165'	
7000 - U-8 7754'	terrestrial and marine	BERRIASIAN - TITHONIAN	L. CRETACEOUS ASSEMBLAGE III 6,700' JURASSIC (?) ASSEMBLAGE IV 7,400'	shallow-water boreal fauna
8000 - U-9 9050'	"	UPPER JURASSIC	not diagnostic	
9000 - U-10 9495'	mainly terrestrial	JURASSIC cf. MID- EARLY LATE		
10,000 - U-11 10,320'	"	MESOZOIC cf. TRIASSIC - EARLY JURASSIC	Ammobaculites 273	

SHELL UNAK B-11

SUMMARY OF MICROPALAEONTOLOGICAL STUDY

General Remarks

One hundred and twenty-five (125) micropaleontological slides were submitted for study. The Tertiary sequences analyzed contained only a few foraminiferal species, but a moderately diverse Lower Cretaceous to Jurassic microfauna of more open-marine, shallow-water origin was encountered between 2,500 feet and about 7,500 feet of the borehole.

All microfossils that could be identified, including certain characteristic fragments were provided with species numbers, and their sequence and relative abundance is shown on the accompanying chart. Whenever possible, the fossils were identified to generic rank, or as close as possible, but no attempt has been made to search the literature for identical or closely related forms.

The micropaleontological data are plotted from top to bottom, a standard procedure in subsurface micropaleontological studies. First occurrences are used to delineate the upper boundary of a faunal unit or assemblage although, in reality, these are last occurrences. The lower boundary of any given assemblage is more difficult to define without the results from cored sections, and the base of the faunal unit is usually drawn where a drop in occurrence of many forms is evident, or where a distinct faunal break occurs immediately below.

Microfaunal Assemblages

Neogene Assemblage I ?

The presence of one valve of a fresh-water ostracode in sample 100-190 feet may indicate the presence of the Neogene unit I. However, this interval is only tentatively recognized in the Unak B-11 borehole as the one valve found is insufficient evidence; it may even be a contaminant! However, according to palynological evidence, the U-1 sequence is interpreted to be of "terrestrial and aquatic" origin, thus obviously missing a marine component. This readily explains the absence of the fossils of Assemblage I which are abundantly present in other boreholes. Even the fresh-water ostracodes of the same assemblage are practically missing at Unak. For these reasons, and taking also into consideration the more "southerly" geographic position, it is assumed that the Neogene sequences are mainly of terrestrial origin at Unak.

No characteristic microfossils were found between sample interval 100-190 feet and 850 feet.

Cyclammina 71 - Fauna

Starting with sample 850 feet, the characteristic Cyclammina 71 appears in conspicuous abundance, continuing to about the 1700 foot level, and with isolated specimens and fragments trailing down to about 2050 feet. The fauna is of low diversity and the few specimens of the other species associated may well be all contaminants. The lower boundary of the faunal unit is drawn tentatively at 1700 feet, the disappearance of the majority of 71-specimens.

The lower boundary of the Cyclammina 71-Fauna falls within the lower part of the Paleocene palynological Zone U-2, and its upper boundary occurs within the lower part of the Neogene Zone U-1. It is suggested, however, that the palynological boundary be adjusted, from 1117 to 850 feet to conform to the micropaleontological one. It is most unlikely that species 71 ranges into the Neogene, or that all its occurrences in these stratigraphically highest samples would be the result of re-working.

The Cyclammina 71-Fauna is relatively widespread in the Mackenzie Delta region, and it is known in literature as the arctica-borealis complex. Staplin and co-workers trace this fauna from the base of the Taglu C-42 borehole to about the 9,000 foot level in Reindeer D-27 from where Chamney and Petracca report the same species. This faunal unit, therefore, seems to be equivalent to Chamney's 11 B unit of Reindeer, or his "Middle Cyclammina (vitreous)" horizon.

Chamney considers the Cyclammina faunas to represent a Danian age, "inferring more indicators of Maestrichtian than Paleocene age". Staplin, however, considers the arctica-borealis complex to be of "probable Eocene" age, a placement more compatible with our experience. Petracca too argues for a Tertiary age of these faunas.

Cyclammina 71 was found to date in our studies in the following borehole sequences dated on palynological evidence to be of Paleocene age: Ikhill I-37, Kugpiik O-13, Taglu C-42, and Titalik K-26. It was found within sequences dated to be of Middle to Lower Eocene age at Ikattok J-17, but a re-evaluation of the palynological results is under way to confirm or correct this age placement. However, the 71-species was found also in quite an unusual combination with the younger "Cyclammina" 7 (Haplophragmoides 504 of Staplin et al.) at Pullen E-17, Umiak J-37, and Ya Ya A-28, and in sequences supposedly of Middle to Upper Eocene age - one half to one full stage higher than its "normal" occurrence.

For the time being and until more is known about the overall range of this characteristic species, the following "rule of thumb" may be applied: the Cyclammina 71-Fauna seems to occur foremost in Paleocene sequences but may extend into Middle Eocene ones. In some cases where it is associated with "Cyclammina" 7 or other diagnostic species of Upper Eocene or younger age, the possibility should be considered that the 71-specimens (and possibly others) are re-worked. Thus the age assignment should not be based on the occurrence of Cyclammina 71 but rather on the other diagnostic species associated, such as "Cyclammina" 7. In other cases, however, the reverse situation may have to be considered - that "Cyclammina" 7 or other species are up-hole contaminants! Affirmation of the age, therefore, by palynological means is essential.

Haplophragmoides 267 and 268 - Fauna

From about 1700 to 2,050 feet of the section penetrated, only fragments or undiagnostic forms were found. With sample 2050 feet, many specimens of Haplophragmoides 267 and 268 appear aside of a few other agglutinated Foraminifera. This fauna has not been recognized to date in our studies; it is of low diversity, indicating restricted conditions similar to those that prevailed also during deposition of the Cyclammina 71 - Fauna.

The faunal break at 2050 feet coincides with the upper boundary of the palynological Zone U-3 of Maestrichtian to Campanian age, but both Haplophragmoides species seem to continue into the underlying sequences, unless all specimens in these lower horizons can be proven to be contaminants. The base of the microfaunal unit is drawn at 2,250 feet and along the top of a conspicuous faunal break where many Lower Cretaceous Foraminifera appear.

Lower Cretaceous Assemblages

Pending the outcome of comprehensive studies of the Jurassic to Lower Cretaceous microfaunas of western Canada presently undertaken in our laboratory, and pending the integration of the results obtained with published data, the Lower Cretaceous to Upper Jurassic microfaunal succession is tentatively divided into informal faunal units: Assemblages I to IV in descending order. Assemblage III may span the Cretaceous-Jurassic boundary, and Assemblage IV may be wholly Jurassic in age. In order not to confuse these faunal units with Assemblages I and II of Late Tertiary - Neogene age, the prefix Lower Cretaceous and Jurassic is used.

Lower Cretaceous Assemblage I

A number of "new" foraminiferal species appear in sample 2250-2300 feet, among them the diagnostic Ammodiscus 55, Glomospira 38-83, Lenticulina 92, and others. The distinct faunal break coincides also with the boundary between the Upper Cretaceous palynological Zone U-3 and the Middle Albian Zone U-4. The same faunal break was recognized at Roland Bay L-41, although there the microfauna is distinctly more varied, more abundant and persistent in occurrence, indicating that more open-marine conditions prevailed in these northwesterly regions at the time of deposition.

The lower boundary of Assemblage I is drawn at the 2,500 foot level to coincide with the lower boundary of the Middle Albian palynological Zone U-4, where a shift in the microfaunal spectrum takes place, and in accordance with the same break in the Roland Bay borehole. In both wells, this faunal unit is only about 300 feet thick and thinly developed.

Lower Cretaceous Assemblage II

Starting at about 2500 feet and continuing to the 4500 foot level approximately species of Assemblage II appear among up-hole contaminants and forms extending downwards from the overlying assemblages. The Assemblage II-species do not occur as abundantly and consistently as do certain species of the overlying faunal units, and the shift in the microfaunal spectrum is gradual without any sudden and sharp breaks.

Assemblage II is relatively diversified and composed of about an equal mixture of calcareous and agglutinated foraminiferal species. Among the calcareous forms are species of such characteristic genera as Marginulinopsis and Lenticulina, and the agglutinated element is mainly represented by species of Haplophragmoides, Ammodiscus, and Trochammina.

Unlike at Roland Bay where Assemblage II is richer in both species and abundance and where the faunal unit could be divided into 2 sub-assemblages, the Unak microfaunal succession does not lend itself as readily to such a division. There are indications, however, that the lower sub-assemblage is more prominently represented at Unak B-11 as is the upper one. A case in point is the appearance of such forms as Recurvoides? 199, Haplophragmoides 118, polymorphinid 114 and Reophax 115 relatively "high" in the Unak succession. These forms characterize the lower sub-assemblage at Roland Bay, aside of Ammodiscus 134, Trochammina 122-131, and Genus ind. 119.

The Lower Cretaceous Assemblage II spans the full extent of the palynological Zone U-5 of Lower Albian to Aptian age and continues into the upper part of Zone U-6 of Barremian-Hauterivian age. Its lower boundary is drawn at the 4500 foot level above a barren interval.

Undiagnostic Interval

From 4500 to 6,165 feet, only undiagnostic forms or fragments were found which all may be contaminants. On palynological evidence, the same interval is considered to be essentially composed of terrestrial sequences - a fact that readily explains the absence of marine faunas.

Lower Cretaceous Assemblage III

With sample 6,165-6,180 feet, a few "new" forms appear, among them Ammobaculites 130 and Haplophragmoides 141 which were used at Roland Bay to mark the upper boundary of Assemblage III. However, the presence of such diagnostic species as ostracode 20, Astacolus 213, Nodosaria 207 and Saracenaria 144, all present in the lower half of the Roland Bay succession, point to the possibility that the upper half of Assemblage III is not represented at Unak, possibly due to terrestrial conditions prevailing there (see undiagnostic interval above) in contrast to the Roland Bay region.

Faunal unit III extends to about 6700 feet, from about 6,165 feet, and thus is thinly developed. It starts within the lowermost part of the palynological Zone U-7 of Lower Hauterivian-Valanginian age and ends within the Berriasian-Tithonian Zone U-8, thus representing in part the Cretaceous-Jurassic boundary sequences.

Jurassic(?) Assemblage IV

There are a few indicators, however weak, of the presence of Assemblage IV. Ostracode 20 and Ammobaculites 139, or the main occurrence of Ammobaculites 147 and Arenoturrispirillina 245 are considered to be typical of late Jurassic sequences; however, the fauna is of low diversity in contrast to the much richer Assemblage IV at Roland Bay or other Jurassic microfaunas such as the one contained in the Husky Formation of the northern Richardson Mountains.

This fossiliferous interval spans the 6700 foot to about 7400 foot level and is about equivalent to the palynological Zone U-8 of Berriasian-Tithonian age.

Ammobaculites 273

The last fossiliferous sample encountered in the Unak borehole from a cored section between 9495-9525 feet contained a specimen of Ammobaculites 273. The interval above, from 7400 feet downward is practically devoid of any diagnostic forms and the section seems to be of terrestrial origin, according to palynological evidence. No mention would be made ordinarily of the occurrence of one specimen only, practically isolated and without a diagnostic fauna associated, but the same species was also discovered in the lowermost sample of the Ikhil I-37 borehole. It thus may prove useful in future studies.

This specimen occurs in the uppermost part of the palynological Zone U-11 of undifferentiated Mesozoic age (Triassic-Early Jurassic).

References Cited

- Chameny, T.P., 1973: Tuktoyaktuk Peninsula Tertiary and Mesozoic Biostratigraphy Correlations; Geol. Surv. Can., Paper 73-1, part B, p. 171-179, 3 figs., 1 table.
- Petracca, A.N., 1972: Tertiary microfauna, Mackenzie Delta area, Arctic Canada; Micropaleontology, v. 18, no. 3, p. 355-368.
- Staplin, F.L. et al.: Tertiary Biostratigraphy, Mackenzie Delta Region, Canada; copy of manuscript of a joint oral presentation to C.S.P.G. by paleontological staffs of Gulf-Imperial and Mobil Oil Canada.
- _____: Bull. Canadian Petrol. Geology, Vol. 24, no. 1, p. 117-136, 6 figs., 2 plates.

PALYNOMORPH PHOTOGRAPHIC PLATES

SHELL UNAK B-11

SHELL UNAK B-11

Magnification X1000 except where indicated.

PLATE 33

1. *Paraalnipollenites confusus*
2. *Laevigatosporites anomalus**
3. *Callistopollenites-1*
4. *Ailanthipites-1*
5. *Cicatricosisporites-1*
6. *Cicatricosisporites-2*
7. *Araucaricites-2*
- 8.-9. *Araucaricites-3*
10. *Velosporites-1*
11. *Alisporites bilateralis*
12. *Alisporites rotundus*
13. *Alisporites thomasi*
14. *Alisporites minutus*
15. *Phyllocladidites minimus*

*N.B.: Those names with an asterisk have not been published in the literature. They are used here in a provisional capacity only.

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Magnification X1000 except where indicated.

PLATE 34

16. *Phyllocladidites microreticulatus*
17. *Parvisaccites radiatus*
18. *Deltoidospora diaphana*
19. *Pilosisporites* cf. *trichopapillosus*
20. *Pflugipollenites dampieri*
21. *Cycadopites*-1
22. *Polysphaeridium*-1 (X500)
23. *Oligosphaeridium complex* (X500)
24. *Oligosphaeridium*-2
25. "*Broomea*"-1
26. *Pareodinia ceratophora*
27. *Paleoperidinium nudum*
28. *Gonyaulacysta*-4
29. *Cyclonephelium*-2

SHELL UNAK B-11

Magnification X1000 except where indicated.

PLATE 35

- 30. *Gonyaulacysta*-2
- 31. *Gonyaulacysta* cf. *jurassica*
- 32. *Ovodinium* cf. *waltoni*
- 33. cf. *Endoscrinium* *campanula*
- 34. *Pseudoceratium* cf. *regium*
- 35. *Canningia*-1
- 36. *Cyclonephelium* *compactum*
- 37. *Cleistosphaeridium* cf. *disjunctum*
- 38. *Imbatodinium* *rillosum*