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BIOSTRATIGRAPHIC ZONATION

ELF CAPE NOREM A-80
ARCTIC ISLANDS

by

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CONTENTS

BIOSTRATIGRAPHIC ZONATION

ELF CAPE NOREM A-80

SUMMARY AND CONCLUSIONS

Elf Cape Norem A-80 contains sediments varying in age from Middle Albian to Middle Norian for the interval 90-5550'. These subdivisions, along with the sample control used, are shown on a biostratigraphic log. A curve indicating the generalized environment of deposition, and pertinent remarks on correlation, complete the log.

Approximately 97 terrestrial species of palynomorphs and 52 species of marine phytoplankton were present. Their distributions are shown on Tables II and III, and the more diagnostic species are illustrated on Plates V-XIV. In the microfossil assemblages, 162 species of foraminifera belonging to 45 genera were observed, in addition to minor numbers of ostracoda and radiolaria. Fragmentary remains of scolecodonts, crinoids, echinoids, etc., as well as plant materials, were present. Their qualitative and quantitative distributions are shown on Table IV.

The environment of deposition varies from terrestrial in the Albian through a series of transgressive-regressive phases to neritic in the lower section of the Jurassic. Two of these transgressive phases appear to be related to gas shows at 2530' and 4350'.

The fossils indicate a high degree of metamorphism which increases imperceptibly throughout the Jurassic and probably produced fairly mature hydrocarbons, such as are present in predominantly gas facies.

Biostratigraphic analysis suggests the following zonation:

Palynomorphs

Middle - Lower Albian	90- 690'
Aptian-Barremian	720- 810'
Barremian or older	840-1080'
Berriasian? - Upper Jurassic	1110-2100'
Middle Kimmeridgian	2190-2490'
Oxfordian	2610-3000'
Callovian?	3000-3300'
Middle Jurassic	3300-5550'

Microfossils

Middle Albian	690'
Neocomian (Barremian)	720'
Late Tithonian - Oxfordian	1050'
Callovian?	1830'
Bathonian	2580'
Toarcian	2700'
Toarcian-Pliensbachian	2760'
Upper Pliensbachian	4740'

Note: GSC Papers 72-38, p.18 and 74-11, p.15-17 deal with the lower half of the well

INTRODUCTION AND METHOD OF STUDY

Sample material from the Elf Cape Norem A-80 well was obtained from government unwashed samples and conventional core, and processed by standard laboratory techniques. Technicians spent a minimum time of one hour per sample in picking a representative collection of microfossils from the matrix. Similarly, the paleontologists spent at least the same amount of time counting and identifying the fossil forms. The well was sampled throughout to provide maximum microfossil coverage, and at from 30' to 100' intervals for palynomorph studies. The footages (expressed also in metres where space allows) are shown on the Biostratigraphic Log (I), as well as on the distribution charts (II-IV). Also shown on I are the ages in standard European terminology for both palynomorphs and microfossils, the microfossil zonation and generalized environments of deposition, and any comments on suggested correlation or distribution.

The environment of deposition is shown as a single curve ranging through terrestrial (nonmarine), brackish (fresh and marine), littoral (shoreline), sublittoral, neritic and open marine. Each of these habitats is based on the total fossil population present, the associated fauna and flora, whether mixing has occurred, condition of the material (water-worn, weathered, iron-stained) and so on. Such an interpretation cannot be as comprehensive as those based on detailed population analysis, water depth, rate of deposition, turbidity, salinity, richness and other factors that require specialized paleoecological techniques. However, a single-line curve is adequate for a generalized interpretation of depositional habitats in this area and can provide the basis for paleobathymetric mapping.

Environments in the locality of the Elf Cape Norem A-80 well vary from predominantly terrestrial in the Middle Albian to neritic in the Lower Jurassic. Numerous small transgressive-regressive phases occur, suggesting a somewhat unstable area. The beginnings of two of these transgressive phases coincide with gas shows recorded at 2530' and 4350'. The high degree of metamorphism evident throughout the Jurassic suggests that hydrocarbons must have been profoundly affected, possibly enough to place them within a predominantly gas-bearing facies.

Dr. Geoffrey Norris did the palynology and photographed diagnostic terrestrial and marine palynomorphs. Javed Iqbal is responsible for most of the microfossil identifications. The report has been prepared by Dr. D.M. Loranger.

BIOSTRATIGRAPHIC SUMMARY

The Biostratigraphic Log (I) has been prepared at the mechanical log scale of 1" = 100', to facilitate comparison with distribution charts. The conclusions of palynomorphological and micropaleontological studies with regard to age determination are placed within the first two columns. Since there are some wide divergences of opinion, both sets of determinations have been recorded.

Another column shows the sample control for the microfossil and palynological samples examined. This column is scaled in feet and in metres, as are other tables in this report whenever space would permit.

Microfossil zonation as it appeared in this well is given, as well as the published name of the zone. Where published names are not available, a key fossil has been selected to indicate the distribution of the zone and facilitate correlation.

Environments of deposition in this well show, after a predominantly terrestrial Albian section, a series of transgressive and regressive phases due to minor sea-level changes that brought neritic forms into the area. This series continued throughout the Jurassic and terminates abruptly in a littoral zone which is close to the top of the Norian in this area.

Remarks on correlation or related faunas and their distributions have been included to enhance the value of this summary.

PALYNOLOGY

SUMMARY

The distribution of 97 species of terrestrial palynomorphs and 52 species of marine microplankton in 87 cuttings samples indicates nonmarine Lower or Middle Albian in the top 690' of the subject well. Marine Aptian and Neocomian occur from 720' to 1080'. Between 1110' and 2100' a well-developed Upper Jurassic and in part Berriasian section is present. Marine Kimmeridgian, Oxfordian, and possible Callovian occur from 2190' to 3210'. Below 3300' marine Middle Jurassic occurs to 5550', with a regressive interval at 4410-4710'.

MATERIALS AND METHODS

Samples from the subject well provided by Paleo Services Limited through Canadian Rock Surgery Ltd. were prepared by standard palynologic techniques. Results of the palynologic analyses are plotted on the accompanying Tables II and III, which show distribution of terrestrial miospores and marine palynoplankton, the species being indicated by standard code numbers.

SUMMARY OF AGE AND ENVIRONMENT

Lower and Middle Albian	90- 690'	Nonmarine
Barremian-Aptian	720- 810'	Marine
Barremian or older Lower Cretaceous	840-1080'	Marine
Upper Jurassic (possibly Berriasian in part)	1110-2100'	Marine
Middle Kimmeridgian	2190-2490'	Marine
Oxfordian (probably Callovian below 3000')	2610-3210'	Marine
Middle Jurassic (regressive interval 4410-4710')	3300-5400'	Marine
Middle Jurassic	5490-5550'	Marine

DISCUSSION OF ASSEMBLAGES

Nonmarine Lower and Middle Albian: 90-690'

Forty-eight terrestrial species characterize this interval, of which about three quarters are long-ranging and occur in lower horizons.

The following miospores occur in this interval and are restricted to the Lower Cretaceous in western Canada and Europe:

Pilosisporites verus
Cicatricosisporites cf. *ludbrooki*
C. australis
Foraminisporis daileyi

Foraminisporis wonthaggiensis
Trilobosporites marylandensis
Triporoletes *reticulatus*
Acanthotriletes varispinosus
Densoisporites microrugulatus
Aequitriradites spinulosus
Cedripites cretaceous
Retitriletes singhii
Rogalskaiporites cicatricosus
Couperisporites complexus

Tigrisporites scurrandus at 390' and the total lack of angiosperm pollen indicates a Middle Albian age, at least for the upper part of this interval. The presence of *Lycopodiumsporites marginatus* at 690' suggests an age no older than Aptian for the base of this interval. This species, however, ranges into the Albian, allowing the possibility that the entire interval is Albian.

The absence of dinoflagellates in this interval indicates nonmarine conditions of deposition.

Marine Barremian-Aptian: 720-810'

The following dinoflagellates in this interval have restricted Lower Cretaceous ranges; the tops of their ranges elsewhere are indicated:

Tenua hystrix (Aptian)
Doidyx anaphryssa (Lower Barremian)
Muderongia mcwhaei (Aptian)

Among the spores, *Appendicisporites jansonii* has a Barremian-Albian range but *Januasporites spiniferus* is restricted to the Middle Albian in western Canada. The latter is perhaps the result of cavings from higher horizons, but this species has not been found above 780'. The balance of evidence favours a Barremian-Aptian assignment.

Marine Barremian or older Early Cretaceous: 840-1080'

The following spores suggest an Early Cretaceous age:

Concavissimisporites punctatus
Taurocusporites segmentatus
Coronatispora valdensis
Appendicisporites potomacensis

The dinoflagellates terminating in this interval have more restricted ranges:

Imbatosphaeridium villosum (Upper Jurassic to Hauterivian)
Pareodinia albertii (Jurassic to Valanginian)
Sirmiodinium grossi (Jurassic to Barremian; Hauterivian in California)
Dingodinium albertii (Lower to Middle Barremian)
Muderongia cf. *simplex* (Valanginian-Barremian)

Thus, this interval is no younger than Barremian and may be somewhat older. The presence of *Tanyosphaeridium* sp. in the higher part of the interval is curious: this species has a middle and upper Albian range

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in western Canada and has also been found associated with Albian species in arctic Canada. Caving from above is unlikely, since the Albian identified in this well is entirely nonmarine, unless a very thin marine Albian horizon is present which was missed in sampling.

Marine Upper Jurassic and possibly Berriasian in part: 1110-2100'

Dinoflagellates with restricted ranges indicate a late Jurassic age:

Kalyptea monoceras (Tithonian)
Prolixosphaeridium dierense (Lower Kimmeridgian to Lower Cretaceous)
Tubotuberella rhombiformis (Upper Tithonian to Berriasian)
Pareodinia ceratophora (Middle and Upper Jurassic)

Terrestrial palynomorphs, however, are represented by several species with scattered occurrences in this interval and lowest Cretaceous ranges elsewhere as indicated:

Cicatricosisporites purbeckensis (Berriasian)
Trilobosporites minor (Aptian-Albian)
Trilobosporites apiverrucatus (Lower Cretaceous)
Cicatricosisporites hallei (Lower Cretaceous)
Foraminisporis asymmetricus (Barremian-Aptian)
Trilobosporites cf. *hannonicus* (Lower Cretaceous)
Cicatricosisporites angicanalis (Berriasian)
Trilobosporites cf. *obsitus* (Berriasian)

One spore (*Podocarpidites* cf. *rousei*) has a Jurassic range while one dinoflagellate (*Gonyaulacysta hyalodermopsis*) has a Lower Cretaceous distribution elsewhere.

Evidently, these assemblages are from horizons close to the Jurassic-Cretaceous boundary.

Marine Lower or Middle Kimmeridgian: 2190-2490'

Two dinoflagellates with restricted ranges in this interval have overlapping ranges as indicated:

Scriniodinium crystallinum (Callovian - Middle Kimmeridgian)
Endoscrinium cf. *campanula* (Kimmeridgian-Cretaceous)

The spores are not diagnostic. *Podocarpidites arcticus* characterizes this interval, but the original author (Pocock, 1970) did not mention its range.

Marine Oxfordian, probably Callovian or older below 3000': 2610-3210'

The following dinoflagellates in this interval have Oxfordian ranges:

Gonyaulacysta cf. *granuligera* (Oxfordian-Kimmeridgian)
G. cf. *jurassica* (= *G. jurassica* var. *longicornis*) (Oxfordian)
G. nealei (Oxfordian)
Ctenidodinium ornatum (Callovian-Oxfordian)
G. cf. *cladophora* (Oxfordian - Lower Kimmeridgian)

Others have longer ranges as indicated:

> *Gonyaulacysta jurassica* (Bathonian-Kimmeridgian)
> *Hystrichosphaeridium pattei* (Middle Jurassic - Kimmeridgian)

G. jurassica var. *longicornis* characterizes the Oxfordian in the Sverdrup Basin, according to Johnson (1973).

Thus the majority of species favours an Oxfordian age. Below 3000' the occurrence of *Nannoceratopsis pellucida*, which in the Sverdrup Basin is confined to the Upper Bajocian and Callovian (Johnson, 1973), indicates these ages for the lower part of the interval.

Spores are not diagnostic.

<u>Marine Middle Jurassic, with a regressive interval at 4410-4710'</u>: 3300-5400'

This interval is characterized by *Nannoceratopsis gracilis*, which ranges from Lower Jurassic to Bajocian in the Sverdrup Basin and Europe, and is dominated by the miospore *Spheripollenites scabratus*. It is associated with several miospore species and one acritarch with putative Bajocian-Callovian ranges in western Canada and elsewhere:

> *Distalanulispora incerta*
> *Corrugatisporites amplectiformis*
> *Staplinisporites jurassicus*
> *Classopollis minor*
> *Concentrisporites pseudosulcatus*
> *Podocarpidites* cf. *rousei*
> *Leiofusa deunffi*

A Middle Jurassic age is indicated for this interval by all these species.

The regressive interval at 4410-4710' is marked by a drop in dinoflagellate diversity.

<u>Marine Middle Jurassic:</u> 5490-5550'

This interval contains the following distinctive dinoflagellates and spores:

> *Pareodinia* 1
> *Diconodinium* 2
> *Wanaea digitata* (Oxfordian in western Australia; Callovian in Greenland - Sarjeant, 1972)
> *Cirratriradites* cf. *Leiotriletes incertus*

This association occurs in Panarctic Drake Point L-67, between 3600' and 4650' below Oxfordian (Loranger, 1972), where a Middle or early Late Jurassic age was favoured. In view of the superadjacent definite Middle Jurassic in Elf Cape Norem A-80, it is unlikely that this interval is younger than Middle Jurassic. However, the eometamorphic rank of the phytoclasts at the top of the interval is greater than that of those above 5490', indicating a possible unconformable or fault contact. Several Middle Jurassic species of high metamorphic rank occur in the interval, and the occurrence of *Cirratriradites* cf. *L. incertus* at 5190' in the overlying interval makes an extensive hiatus unlikely. No definite Lower Jurassic species were encountered, which suggests a probable Middle Jurassic age for the interval.

The only recycled Permo-Triassic pollen in this well occurs in this interval.

IDENTIFICATIONS

Species names and numbers as in Tables II & III, and photographs(X625).

Terrestrial Palynomorphs

1. *Stereisporites antiquasporites* (Wilson and Webster) Dettmann
2. *Taxodiaceaepollenites hiatus* (Potonié) Kremp
3. *Classopollis torosus* (Reissinger) Balme
4. *Alisporites bilateralis* Rouse
5. *Gleicheniidites senonicus* Ross
6. *Alisporites grandis* (Cookson) Dettmann
7. *Deltoidospora hallei* Miner
8. *Osmundacidites wellmanii* Couper
*9. *Cyathidites australis* Couper
10. *Laevigatosporites ovatus* Wilson and Webster
11. *Alisporites* cf. *parvus* de Jersey
*12. *Deltoidospora psilostoma* Rouse
13. *Cerebropollenites mesozoicus* (Couper) Nilsson
14. *Vitreisporites pallidus* (Reissinger) Potonié
15. *Pilosisporites verus* Delcourt and Sprumont
16. *Cicatricosisporites* cf. *ludbrooki* Dettmann
17. *C. australis* (Cookson) Potonié
18. *Podocarpidites multesimus* (Bolchovitina) Pocock
19. *Lycopodiumsporites austroclavatidites* (Cookson) Potonié
20. *Foraminisporis daileyi* (Cookson and Dettmann) Dettmann
21. *Foraminisporis wonthaggiensis* (Cookson and Dettmann) Dettmann
22. *Exesipollenites tumulus* Balme
23. *Cingutriletes clavus* (Balme) Dettmann
*24. *Todisporites minor* Couper
25. *Trilobosporites marylandensis* Brenner
26. *Klukisporites pseudoreticulatus* Couper
27. *Perinopollenites elatoides* Couper
28. *Dictyophyllidites harrisii* Couper
29. *Ginkgocycadophytus nitidus* (Balme) de Jersey
30. Triporoletes *reticulatus* (Pocock) Playford
*31. *Baculatisporites comaumensis* (Cookson) Potonié
32. *Acanthotriletes varispinosus* Pocock
33. *Appendicisporites* cf. *jansonii* Pocock
34. *Taurocusporites* cf. *segmentatus* Stover
35. *Tigrisporites scurrandus* Norris
36. *Lycopodiumsporites reticulumsporites* (Rouse) Dettmann
37. *Densoisporites microrugulatus* Brenner
38. *Neoraistrickia truncata* (Cookson) Potonié
*39. Recycled Carboniferous-Devonian spores
40. *Aequitriradites spinulosus* (Cookson and Dettmann) Cookson and Dettmann
41. *Cedripites cretaceus* Pocock
42. *Stereisporites regius* (Drozhastchich)
43. *Perotrilites* 1
44. *Eucommiidites minor* Groot and Penny
45. *Rogalskaisporites cicatricosus* (Rogalska) Danse, Corsin and Levin
46. Retitriletes singhii Srivastava

*species that did not photograph well

47. *Ephedripites multicostatus* Brenner
48. *Couperisporites complexus* (Couper) Pocock
49. *Cicatricosisporites hughesi* Dettmann
50. *Phyllocadidites* 1
51. *Marattisporites scabratus* Couper
52. *Januasporites spiniferus* Singh
53. *Callialasporites dampieri* (Balme) Sukh Dev
54. *Eucommiidites troedssonii* Erdtman
55. *Dictyophyllidites harrisii* Couper
56. *Appendicisporites jansonii* Pocock
57. *Circulina parva* Brenner
58. *Concavissimisporites punctatus* (Delcourt and Sprumont) Brenner
59. *Converrucosisporites variverrucatus* (Couper) Norris
*60. *Taurocusporites segmentatus* Stover
61. *Coronatispora valdensis* (Couper) Dettmann
62. *Trilobosporites* cf. *minor* Pocock
*63. *Appendicisporites potomacensis* Brenner
64. *Hymenozonotriletes* 2
65. *Deltoidospora juncta* (Kara Murza) Singh
66. *Cicatricosisporites purbeckensis* Norris
*67. *Trilobosporites minor* Couper
68. *Cicatricosisporites annulatus* Archangelsky and Gammero
69. *Trilobosporites apiverrucatus* Couper
70. *Cicatricosisporites hallei* Delcourt and Sprumont
71. *Podocarpidites* cf. *rousei* Pocock
72. *Foraminisporis asymmetricus* (Cookson and Dettmann) Dettmann
73. *Sestrosporites pseudoalveolatus* (Couper) Dettmann
74. *Trilobosporites* cf. *hannonicus* Delcourt and Sprumont
75. *Cicatricosisporites angicanalis* Doring
76. *Trilobosporites* cf. *obsitus* Norris
77. *Distalanulisporites verrucosus* Pocock
78. *Contignisporites dorsostriatus* (Bolchovitina) Dettmann
79. *Podocarpidites arcticus* Pocock
80. *Pteruchipollenites microsaccus* Couper
81. *Trilobosporites* cf. *T. apiverrucatus* Couper
82. *Perinopollenites* 1
83. *Ceratosporites varispinosus* Pocock
84. *Circulina* 1
85. *Distalanulisporites incertus* (Bolchovitina) Pocock
86. *Corrugatisporites amplectiformis* (Kara Murza) Pocock
87. *Matthesisporites tumulosus* Doring
88. *Staplinisporites jurassicus* Pocock
89. *Corrugatisporites anagrammensis* (Kara Murza) Pocock
90. *Classopollis minor* Pocock
91. *Concentrisporites pseudosulcatus* (Briche, Danse, Corsin and Levin) Pocock
92. *Spheripollenites scabratus* Couper
93. *Apiculatisporis variabilis* Pocock
94. *Antulisporites* 1
95. *Cirratriradites* cf. *leiotriletes incertus* Bolchovitina
96. *Callialasporites trilobatus* (Balme)
*97. Recycled Permo-Triassic pollen

Marine Phytoplankton

1. *Oligosphaeridium complex* (White) Davey and Williams
2. *Gonyaulacysta* cf. *kostromiensis* Vozzhenikova
3. *Gardodinium* 1
4. *Tenua hystrix* Eisenack
5. *Doidyx anaphrissa* Sarjeant
6. *Muderongia mcwhaei* Cookson and Eisenack
7. *Cantulodinium* 1 → Muderongia sp. A [illegible]
8. *Imbatosphaeridium villosum* Vozzhenikova
9. *Pareodinia albertii* Warren MS.
10. *Chtroesphaeridia pococki* Sarjeant
11. *Tanyosphaeridium* sp. Singh
12. *Sirmiodinium grossi* Alberti
13. *Dingodinium albertii* Davey, Downie, Sarjeant and Williams
14. *Pterospermopsis australiensis* Deflandre and Cookson
15. *Veryhachium reductum* (Deunff) de Jeckowsky
*16. Unidentified cavings?
17. *Muderongia* cf. *simplex* Alberti
*18. *Baltisphaeridium multispinosum* Singh
19. *Kalyptea monoceras* Cookson and Eisenack
*20. *Gonyaulacysta hyalodermopsis* Cookson and Eisenack
21. *Prolixosphaeridium deirense* Davey, Downie, Sarjeant and Williams
22. *Tubotuberella rhombiformis* Vozzhenikova
23. *Leiofusa jurassica* Cookson and Eisenack
24. *Pareodinia ceratophora* Deflandre
25. *Sirmiodinium* 2
26. *Veryhachium europaeum* Stockmans and Willière
27. *Micrhystridium* cf. *inconspicuum* (Deflandre) Deflandre
28. *Valensiella* 1
29. *Scriniodinium crystallinum* (Deflandre) Klement
30. *Micrhystridium* cf. *piliferum* Deflandre
31. *Endoscrinium* cf. *campanula* (Gocht)
32. *Gonyaulacysta* cf. *granuligera* (Klement)
33. *Chytroesphaeridia* 2
34. *Gonyaulacysta* cf. *jurassica* (Deflandre)
35. *Gonyaulacysta jurassica* (Deflandre) Deflandre
36. *Nannoceratopsis pellucida* Deflandre
37. *Gonyaulacysta nealei* Sarjeant
38. *Ellipsoidictyum* 1
39. *Hystrichosphaeridium pattei* Valensi
40. *Ctenidodinium ornatum* (Deflandre) Sarjeant
41. *Kalyptea* cf. *diceras* Cookson and Eisenack
42. *Gonyaulacysta* cf. *cladophora* (Deflandre) Sarjeant
43. *Nannoceratopsis gracilis* Alberti
44. *Palaeohystrichophora* 1
45. *Micrhystridium stellatum* Deflandre
46. *Nannoceratopsis* cf. *gracilis* Alberti
47. *Crassosphaera* 1
48. *Leiofusa deunffi* Pocock
49. *Diconodinium* 2
50. *Wanaea digitata* Cookson and Eisenack
51. *Spinidinium* 1
52. *Pareodinia* 1

MICROPALEONTOLOGY

SUMMARY

Microfossil study of the complete sampled interval in the Elf Cape Norem A-80 well yielded good results. The microfaunas recovered were abundant in number and showed much variation in species. Preservation was good in the Cretaceous but throughout the Jurassic became increasingly poor as a result of alteration. Many calcareous foraminifera were present, but were badly altered, so that precise identifications could not always be attempted.

Several foraminiferal zones were identified which range in age from Middle Albian to Late Pliensbachian. The majority can be correlated to the Alaska, Arctic Islands and Richardson Mountains sections. The distribution of some species suggests relationships to the northern Alberta plains and to the occurrences in the United Kingdom, France and Germany.

MATERIALS AND METHODS

Government samples of unwashed cuttings were prepared at composite 20' or 30' intervals to provide complete coverage of the well. Core for the interval 5505-5540' was also examined. Standard laboratory procedures were used throughout, and technicians devoted a minimum of one hour's time per sample to separating representative fossil materials from disintegrates and mounting them on slides. Paleontologists spent at least an equal amount of time in counting the individual specimens. With the abundance of forms recovered and the inherent difficulties of working with altered material, further time could have been used to pursue the more academic taxonomic aspects. However, we believe such an effort would have yielded little additional information of a purely applied nature.

The results of counting and identifying the foraminifera and associated microfossils are plotted on Table IV, with the same standard symbols as used on Tables II and III. Fossil identifications are represented by numbers, the key to which appears on pages 20 to 23.

Table IV shows the distribution of 162 species of foraminifera belonging to 45 genera, 2 genera of radiolaria, and miscellaneous fragmentary remains of ostracods, scolecodonts and plants. Other less abundant groups (crinoids, echinoids, gastropods, pelecypods, etc.) are also indicated. Two oolite horizons were evident which, as they appear to be of stratigraphic value, have been included.

Zonation and age dating where possible have been based on calcareous forms, although their preservation left much to be desired. While arenaceous foraminifera made up the larger percentage of recovered specimens, many of them represent facies-controlled faunas and their ranges are therefore suspect. The zones recognized from comparison with published literature are indicated on the Biostratigraphic Log (I); where these zones have not been given a specific identification name in the literature, to save space one of the more distinctive forams has been used to indicate the complete fauna. Since this study is based on cuttings, and cavings are common throughout the hole, the tops of zones given are based on the first occurrence of diagnostic species; emphasis therefore is usually placed on the upper limits of the ranges rather than the total ranges indicated. Two good examples of contamination are present in the genera *Budashevaella* and *Tiphotrocha*, which are generally considered Miocene foraminifera and presumably were derived from the drilling mud.

SUMMARY OF AGE DETERMINATIONS

Middle Albian	(*Verneuilinoides borealis*) (*Gaudryina tailleuri*)	690'
Neocomian (Barremian)	*Glomospira subarctica*	720'
Late Tithonian - Oxfordian	(*Haplophragmoides canui* (*Arenoturrispirillina* spp.	1050' 1350'
Callovian?	*Astacolus ectypus*	1830'
Bathonian	*Lenticulina turgida*	2580'
Toarcian	*Rectoglandulina turbinata*	2700'
Toarcian-Pliensbachian		2760'
Upper Pliensbachian	*Nodosaria radiata*	4740'

DISCUSSION OF ZONATION

Albian

The presence of the following species indicates sediments of Albian age:

Ammobaculites fragmentarius
Uvigerinammina manitobensis
U. athabascensis
Ammodiscus cf. *rotalarius*
A. mangusi
Gaudryinella irregularis
Reophax cf. *minuta*
Verneuilinoides fischeri
Miliammina awunensis
Trochammina cf. *umiatensis*
Bathysiphon brosgei
Globulina lacrima var. *canadensis*
Gaudryina cf. *irensis*
Haplophragmoides rota
Psamminopelta bowsheri
Ammodiscus rotalarius
Lenticulina bayrocki

Bergquist (1966) cites the following forms as occurring within the widespread *Verneuilinoides borealis* zone of Alaska:

Gaudryinella irregularis
Ammodiscus rotalarius
Miliammina awunensis

Bathysiphon brosgei
Psamminopelta bowsheri
Uvigerinammina manitobensis
Ammodiscus mangusi
Textularia
Globulina lacrima var. *canadensis*
Ammobaculites fragmentarius

He also indicates that *M. awunensis*, *U. manitobensis* and *A. mangusi* are restricted to the *V. borealis* zone, which is considered by both him and Tappan (1962) to represent Late Albian to Middle Albian time. However, Chamney (1973) has found *A. mangusi* in cuttings from the Sinclair Wolverine Creek D-61 well at 2720' in a Middle to Early Albian assemblage. This occurrence may be due to cavings, or the species may have a longer range than previously recognized. This species cannot therefore be used to designate the *V. borealis* zone until its range is better known. It appears likely, however, that the *V. borealis* zone is represented in the well, as *M. awunensis* and *V. manitobensis* are found near the contact of the Tuktu and Torok formations approximately in the middle of the zone in 781 outcrop sections.

Bergquist (1966) shows that these species of foraminifer continue into the Early Albian *Gaudryina tailleuri* zone:

Gaudryinella irregularis
Ammodiscus rotalarius
Bathysiphon brosgei
Globulina lacrima canadensis
Ammobaculites fragmentarius

The occurrence of *G. tailleuri* and *U. athabascensis*, which are normally restricted to the *G. tailleuri* zone, indicates that some portion of this Early Albian zone is present.

Species, apparently indicative of the middle portion of the *V. borealis* zone and some portion of the *G. tailleuri* zone, occur within the interval 690-720' in the Elf Cape Norem A-80 well, suggesting an age of Middle to Early Albian. Furthermore, *U. athabascensis*, *L. bayrocki* and *G. lacrima canadensis* are common to the Clearwater and Loon River formations, which are generally considered Middle to Early Albian in age. If reworked material is discounted, it appears likely that this section from 690' to 720' represents Middle to Early Albian sediments. If reworked material is present, the section could have been deposited in Middle Albian time. Until additional evidence is available, this section is therefore provisionally assigned to the Middle-Lower Albian.

Neocomian

Barremian textulariina present in this well include:

Haplophragmoides cf. *inflatigrandis*
H. cf. *latidorsalis*
H. duoflatis
Ammobaculites reophacoides
H. aff. *goodenoughensis*

Trochammina squamata
Haplophragmoides cf. *coronis*
Glomospirella elongata
Glomospira subarctica
Glomospirella arctica
Psamminopelta bowsheri
Haplophragmoides coronis
Glomospira antarctica var. *saturna*
Gaudryinella sherlocki

Except *G. sherlocki*, these forms have been described by Chamney (1969) from Unit 1 of the Mount Goodenough section in the Richardson Mountains. Unit 1 represents the basal 110' of Barremian section in that locality and is approximately equivalent to the lower part of Jeletsky's Zone B (1961) underlying the *Crioceras (Crioceras)* cf. *emerici* subzone of the Barremian. Chamney considers this microfauna is related to *Verneuilinoides sublithiformis* of northwestern Germany, which is Barremian in age.

Two specimens of *Lituotuba gallowayi* were present near the top of this fauna and apparently extend downwards to 1140'--which could represent caved material. They may represent an extension of the known range of the species from the *Buchia okensis* zone of the Berriasian (Chamney, 1971), or they might indicate stratigraphic condensation of the *G. subarctica* and *L. gallupi* zones in a direction northeast of the Richardson Mountains section, or a facies-controlled species. The bulk of evidence, however, is indicative of Barremian age in the section 720-1050' in the Elf Cape Norem A-80 well.

<u>Late Tithonian - Oxfordian</u>

Foraminifera from this well that have been published as Upper Jurassic include:

Haplophragmoides canui
Gaudryina topogarukensis
Lagena liassica
Trochammina topogarukensis
Involutina cheradospira
Glomospira pattoni
Eoguttulina liassica
Arenoturrispirellina jeletskyi
A. intermedia
A. waltoni
A. sp.
Bigenerina nodosaria
Lenticulina audax
Dentalina cf. *guembeli*
Globulina cf. *topagorukensis*
Ammobaculites vetusta
Lenticulina muensteri
Nodosaria hortensis
Gaudryina milleri
Trochammina gryci

Rectoglandulina cf. *brandi*
Ammobaculites alaskensis
Bathysiphon anomalocoelia

Tappan (1955) records *H. canui* from outcrop and subsurface of the Arctic Coastal Plain of northern Alaska. Two localities on the Canning River in that region containing this foraminifer were assigned to the *Amoeboceras* zone (Upper Oxfordian) of the Kingak Formation. This is a widely distributed form which was originally described by Cushman from localities in France, and occurs in the Arctic Islands, Alaska, and a large part of the Northwest Territories. In the Elf Cape Norem A-80 well this form is well developed from 1050' to at least 1530', and less abundant down to 3150', which may be due to cavings.

Involutina cheradospira and *Glomospira pattoni* are present at 1200-1230' and suggest a relationship to the *Aucella bronni* zone in Alaska (Tappan, 1955).

Below this depth a well-defined *Arenoturrispirellina* zone is present from 1350' to 1550'. Chamney (1973) associates it with the *Buchia piochii* (sensu lato), *Buchia mosquensis* (sensu lato) and *Buchia concentrica* (sensu lato) zones suggested by Jeletsky (1961, 1967). Collectively the *Arenoturrispirellina* range in age from Late Tithonian through Oxfordian, which would suggest at least the interval 1050-1550' can be considered Upper Jurassic in age.

Callovian?

Elsewhere the following forms have been recorded from the Callovian:

Ammobaculites agglutinans
Eoguttulina liassica
Astacolus ectypus
Lenticulina muensteri
Saracenaria phaedra
Lenticulina quenstedti
Dentalina cf. *guembeli*
Ammodiscus thomsi

Of these forms, *A. agglutinans*, *E. liassica* and *L. muensteri* have long ranges and hence are not definitive for stratigraphic purposes. Tappan (1955) records *S. phaedra* from the Oxfordian or lower Kimmeridgian of Alaska, and Gordon (1967) finds this species in the Callovian of Brora, Scotland. Chamney (1971) records *A. thomsi* from Callovian localities in the Savik and upper Wilkie Point formations from Ellesmere, Axel Heiberg and Amund Ringnes islands. This species is related to Jeletsky's *Cardioceras* spp. zonation. An *A. ectypus* was found at 1830-1860' which is considered characteristic of the Callovian in the Sundance and Rierdon formations in Montana, Wyoming and North Dakota (Loeblich and Tappan, 1950). Lower in the well, at 2750', a solitary *L. audax* was present but is thought to represent cavings, as it is usually associated with the Oxfordian *Cardioceras cardiforme* zone in South Dakota (Loeblich and Tappan, 1950). It appears, then, that evidence for Callovian-age sediments in this well is not as conclusive as one would like, since *A. thomsi* is not represented by the characteristically large forms that are usually found. Their absence, of course, may represent a local condition. This section from 1830' to 2580' is provisionally assigned to the Callovian, but with some reservations due to the inadequate fauna present in this well

Bathonian

Published Bathonian foraminifera common to the Elf Cape Norem A-80 well are:

Planularia beierana
Lenticulina varians
Marginulina terquemi
Lenticulina muensteri
Rectoglandulina brandi
Lenticulina galeata
L. quenstedti
Nodosaria setulosa
Lenticulina turgida
Reophax multilocularis
Nodosaria hortensis
Dentalina communis
D. propinqua
Pseudonodosaria sowerbyi
Ammobaculites agglutinans

With the exceptions of *L. muensteri*, *L. quenstedti* and *A. agglutinans*, these forms appear to be restricted to the Bathonian and include species recorded from Upper, Middle and Lower Bathonian in several counties in England (Cifelli, 1959). This fauna occurs within the interval 2580-2700' in the Elf Cape Norem A-80 well.

Toarcian

Foraminifera recorded from sediments of this age and present in the Cape Norem A-80 well are:

Ammobaculites vetusta
Textularia areoplecta
Lituotuba irregularis
Eoguttulina liassica
Marginulina demissa
Haplophragmoides barrowensis
Reophax suevica
Trochammina canningensis
T. sablei
Ammobaculites barrowensis
Rectoglandulina turbinata
Astacolus pediacus
Lenticulina cf. *toarcensa*
L. prima
Reophax densa
Nodosaria pachistika

Lenticulina varians
Nodosaria setulosa
Lenticulina subalata
Lingulina polita
Marginulina psila
Gaudryina kelleri
Lingulina lanceolata
Gaudryina dyscrita
Nodosaria radiata
Dentalina subtenuicollis
Nodosaria phobytica
N. vermicularis
Reophax metensis
Nodosaria regularis
Citharina fallax
Marginulina utricula
M. interrupta
M. prima

Examination of the ranges of these forms shows that the arenaceous *A. vetusta, T. areoplecta, L. irregularis, R. suevica, T. canningensis* and *A. barrowensis* are probably facies-controlled, as they occur in association with what appear to be good Oxfordian index fossils. Calcareous foraminifers such as *Rectoglandulina turbinata, Lenticulina* cf. *toarcensa, L. prima, L. varians, Lingulina polita, L. lanceolata, Marginulina psila, Nodosaria setulosa, N. radiata, N. phobytica, N. regularis, N. vermicularis* and *Citharina fallax* are considered to be more reliable in approximating the age of the interval below 2250'. In the South Barrow Test No. 3 well, Tappan (1955) indicates that *N. setulosa* occurs low in the Toarcian just above the Pliensbachian boundary. This species occurred at 2760-2790' in the Elf Cape Norem A-80 well, where its associated forms show close similarity to the Lower Toarcian range chart of the South Barrow No. 3 well.

Toarcian-Pliensbachian

Previously recorded from and apparently restricted to the Late Pliensbachian are the following:

Trochammina sablei
Lingulina polita
L. lanceolata
Nodosaria radiata
N. phobytica
N. vermicularis
N. regularis

These Late Pliensbachian forms occur within the interval 4740-5490' in the Elf Cape Norem A-80 well, and are associated with *Gaudryina kelleri* that may be Hettangian? in age. The general appearance of the range chart for these species is similar to the distribution chart prepared for the South Barrow Test No. 3 well (Tappan, 1955). The possibility exists that a shallow brackish-to-littoral fauna represents the uppermost Toarcian in the Elf Cape Norem A-80 well; this grades into a calcareous fauna of Toarcian age. Below 4740' another calcareous fauna of Late Pliensbachian age can be identified. The boundary between the two stages can perhaps be approximated by comparison with the South Barrow No. 3 well chart. These occurrences would suggest a possible boundary between the Lower Toarcian - Upper Pliensbachian at 2760'. Although this is indeed slim evidence for a division between the stages, it appears to be the only data available in this well.

Middle Norian

Microfossil evidence was not sufficient to determine a definite top for the Triassic. However, a few forms at 5490' associated with a distinctive oolite zone have been found at the top of the Triassic in outcrop on Melville Island, suggesting a parallel situation here. The top of the Triassic based on lithology was 5505', which is confirmed by the recovery of *Monotis scutiformis typica* Kiparisova. Tozer (1973) places this form within the *Columbianus* zone of the Middle Norian.

IDENTIFICATIONS

1. *Haplophragmoides* indet.
2. *H. inflatigrandis* Chamney
3. *Ammobaculites fragmentarius* Cushman
4. *Ammobaculites* sp.
5. *Uvigerinammina manitobensis* (Wickenden)
6. *Ammodiscus* sp.
7. *Textularia agglutinans* d'Orbigny
8. *Uvigerinammina athabascensis* (Mellon and Wall)
9. *Gaudryina* sp.
10. *Ammodiscus* cf. *rotalarius* Loeblich and Tappan
11. *Trochammina* sp.
12. *Ammodiscus mangusi* (Tappan)
13. *Haplophragmoides* cf. *latidorsalis* Chamney
14. *H. duoflatis* Chamney
15. *H. topagorukensis* Tappan
16. *H. bonanzaensis* Stelck and Wall
17. *Gaudryinella irregularis* Tappan
18. *Ammobaculites reophacoides* Bartenstein
19. *Haplophragmoides* aff. *goodenoughensis* Chamney
20. *Reophax* cf. *minuta* Tappan
21. *Bathysiphon* sp.
22. *Verneuilinoides fischeri* Tappan?
23. *Miliammina awunensis* Tappan
24. *Miliammina* sp.
25. *Trochammina* cf. *umiatensis* Tappan
26. *T. squamata* Chamney
27. *Haplophragmoides* cf. *coronis* Chamney
28. *Glomospirella elongata* Chamney
29. *Lituotuba gallowayi* Chamney
30. *Gaudryinella sherlocki* Bettenstaedt
31. *Glomospira subarctica* Chamney
32. *Lenticulina bayrocki* Mellon and Wall
33. *Verneuilinoides* sp.
34. *Glomospira subarctica saturna* Chamney
35. *Glomospirella arctica* Chamney
36. *Bathysiphon brosgei* Tappan
37. *Psamminopelta bowsheri* Chamney
38. *Globulina lacrima* var. *canadensis* Mellon and Wall
39. *Saccammina?* sp.
40. *Reophax* cf. *clavulina* (Reuss) Frizzell
41. *R. dentalinoides* (Reuss) Cushman
42. *Gaudryina irenensis* Stelck and Wall
43. *Gaudryina tailleuri* Tappan
44. *Haplophragmoides* cf. *rota* Nauss
45. *Dorothia glabrella* Cushman and Cushman
46. *Haplophragmoides coronis* Chamney
47. *Ammodiscus* cf. *thomsi* Chamney
48. *A. rotalarius* Loeblich and Tappan
49. *Haplophragmoides* cf. *topagorukensis* Tappan
50. *Involutina aspera* Terquem

51. *Haplophragmoides canui* Tappan
52. *Gaudryina topagorukensis* Tappan
53. *Lagena liassica?* (Kubler and Zasingli)
54. *Nodosaria* sp.
55. *Haplophragmoides* cf. *canui* Tappan
56. *Ammobaculites* cf. *alaskensis* Tappan
57. *Trochammina* cf. *sablei* Tappan
58. *Lagena aphela?* Tappan
59. *Turrispirellina* sp.
60. *Ammobaculites* cf. *vetusta* (Terquem and Berthelin)
61. *Trochammina topagorukensis* Tappan
62. *Textularia areoplecta* Tappan
63. Ostracod
64. *Reophax* spp.
65. *Marssonella?* sp.
66. *Lituotuba irregularis* Tappan
67. *Lagena?* sp.
68. *Involutina* cf. *cheradospira* (Loeblich and Tappan)
69. *Glomospira pattoni* Tappan
70. *Ammobaculites agglutinans* (d'Orbigny)
71. *Lagena* cf. *aphela* Tappan
72. *Ammobaculites* cf. *barrowensis* Tappan
73. *Dorothia* sp.?
74. *Budashevaella* sp.
75. *Trochammina* cf. *gryci* Tappan
76. *Bolivina??* sp.
77. *Globulina topagorukensis* Tappan
78. *Lenticulina* cf. *bayrocki* Mellon and Wall
79. *Bathysiphon anomalocoelia* Tappan
80. *Eoguttulina?* sp.
81. *E. liassica* (Strickland)
82. *Trochammina* spp.
83. *Marginulina* cf. *demissa?* (Terquem and Berthelin)
84. *Gaudryina* aff. *nanushukensis* Tappan
85. *Haplophragmoides barrowensis* Tappan
86. *Reophax suevica* Franke Tappan
87. *R.* cf. *multilocularis* Harusler-Gooder
88. *Bigenerina* cf. *nodosaria* d'Orbigny
89. *Spiroplectammina* sp.
90. *Arenoturrispirellina jeletskyi* Chamney
91. *A. intermedia* Chamney?
92. *Trochammina canningensis* Tappan
93. *Globulina* cf. *topagorukensis* Tappan
94. *Arenoturrispirellina waltoni* Chamney
95. *A.* sp. Chamney
96. *Trochammina sablei* Tappan
97. *Lenticulina* sp.
98. *Tritaxia* sp.?
99. *Ammobaculites vetusta* (Terquem and Berthelin)
100. *Arenoturrispirellina intermedia* Chamney
101. *Tritaxia??* sp.
102. *Ophthalmidium* sp.

103. *Ammobaculites cobbani* Loeblich and Tappan
104. *A.* aff. *wenonahae* Tappan?
105. *Verneuilina?* sp.
106. *Tiphotrocha* sp.?
107. *Astacolus ectypus* Loeblich and Tappan
108. *Marginulina* sp.
109. *Ammobaculites barrowensis* Tappan
110. *Proteonina?* sp.
111. *Gaudryina milleri*
112. *Trochammina gryci* Tappan
113. *Astacolus* sp.
114. *Saccamina lathrami* Tappan
115. *Rectoglandulina turbinata* (Terquem and Berthelin)
116. *Lenticulina audax* Loeblich and Tappan
117. *L. muensteri* (Roemer)
118. *Astacolus pediacus* Tappan
119. *Lingulina* sp.
120. *Lenticulina* cf. *toarcensa* Payard and Tappan
121. *Saracenaria phaedra* Tappan and Gordon
122. *Rectoglandulina* cf. *brandi* Tappan
123. *Pseudonodosaria sowerybi* (Schwager)
124. *Lenticulina* cf. *prima* (d'Orbigny)
125. *Ammobaculites alaskensis* Tappan
126. *Reophax* cf. *densa* Tappan
127. *Planularia* cf. *beierana* (Gümbel)
128. *Nodosaria* cf. *pachistika* Tappan
129. *Lenticulina galeata* (Terquem)
130. *L. quenstedti* (Gümbel)
131. *L. varians* (Borneman)
132. *Eoguttulina oolithica* (Terquem)
133. *Nodosaria* cf. *setulosa* Tappan
134. *Lenticulina subelata* (Reuss)
135. *Lingulina polita* Tappan
136. *Marginulina* cf. *psila* Tappan
137. *Gaudryina kelleri* Tappan
138. *Bigenerina* sp. n. sp.??
139. *Lenticulina turgida* (Schwager)
140. *Lingulina* cf. *lanceolata* (Haügler)
141. *Gaudryina dyscrita* Tappan
142. *Eoguttulina* cf. *inovroclaviensis* (Bielecka and Pozeryski)
143. *Textularia* cf. *areoplecta* Tappan
144. *Nodosaria radiata* (Terquem)
145. *Dentalina* cf. *subtenuicollis* Franke
146. *D.* cf. *guembeli* Schwager and Gordon
147. *Nodosaria phobytica* Tappan
148. *N. vermicularis* (Terquem)
149. *Reophax metensis* Franke
150. *Nodosaria hortensis* Terquem
151. *Trochammina squamosa* (Jones and Parker)
152. *Dentalina communis* d'Orbigny
153. *Nodosaria regularis* Terquem
154. *N. liassica* (Barnard)

155. *Dentalina propinqua* Terquem
156. *Citharina fallax* (Payard)
157. *Marginulina terquemi* d'Orbigny
158. *M. utricula* Terquem and Berthelin
159. *Marginulina* cf. *interrupta* Tappan
160. *M. prima* d'Orbigny
161. *M. prima* var. *burgundiae* Terquem
162. *Saccammina* sp.
163. *Globulina?* sp.
164. Plant remains, megaspores
165. Cartilage
166. Oolites
167. Spines (and echinoid fragments)
168. Crinoids
169. Gastropod
170. Pelecypod
171. Scolecodont (fragment)
172. Radiolaria
173. *Dictyomitra?* sp.
174. Ammonite (pyritized fragment)

APPENDIX

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Micropaleontology

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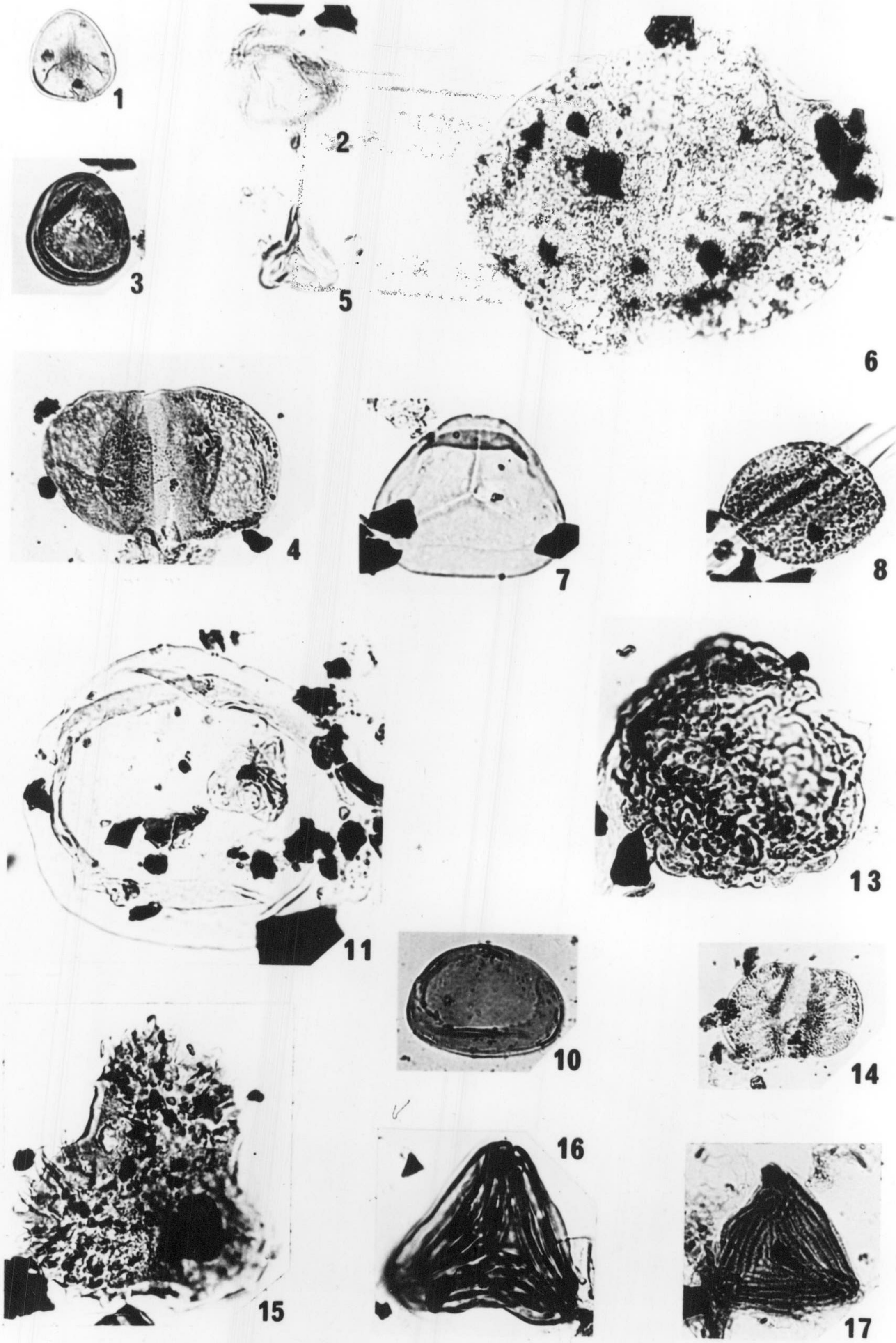

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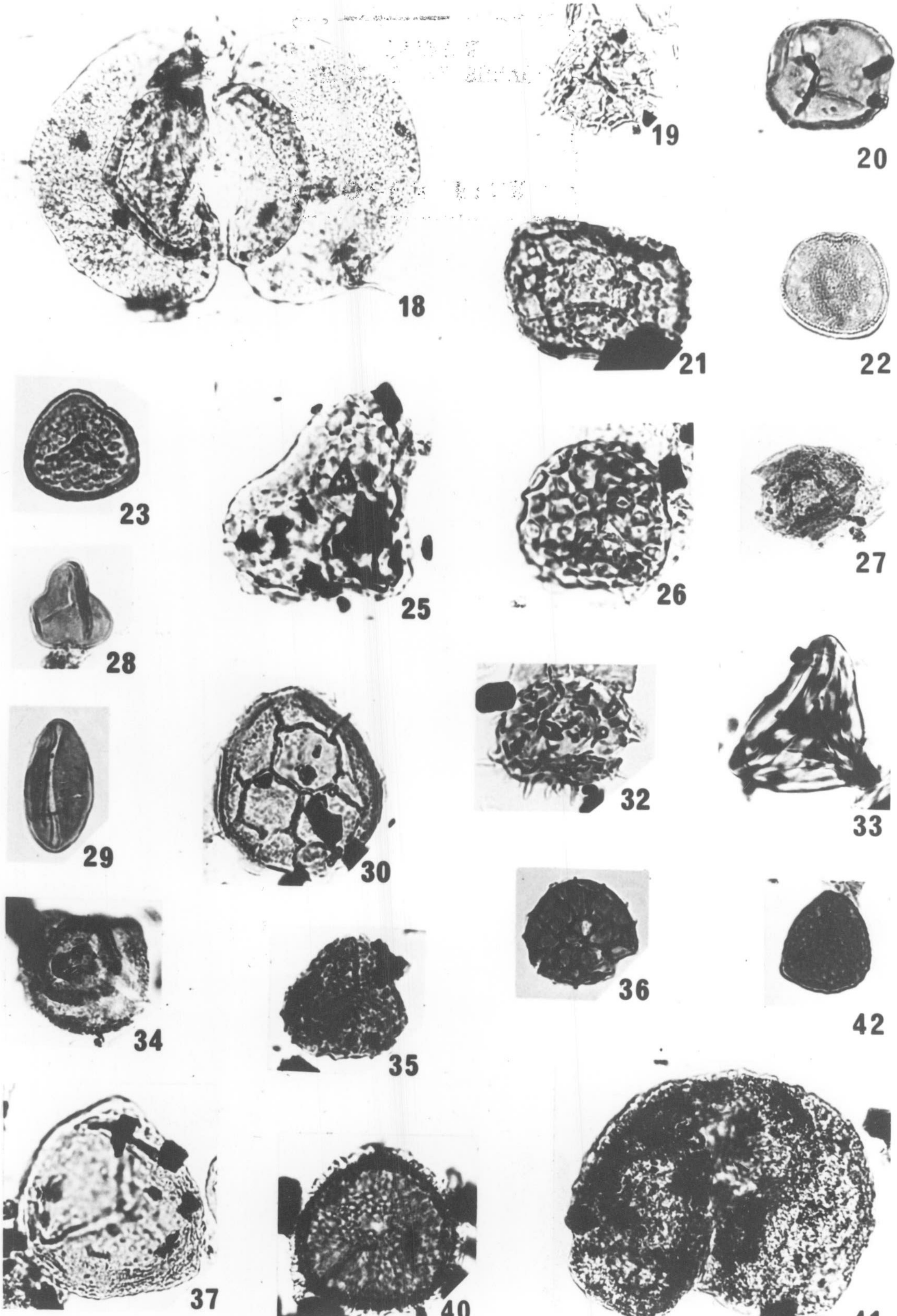

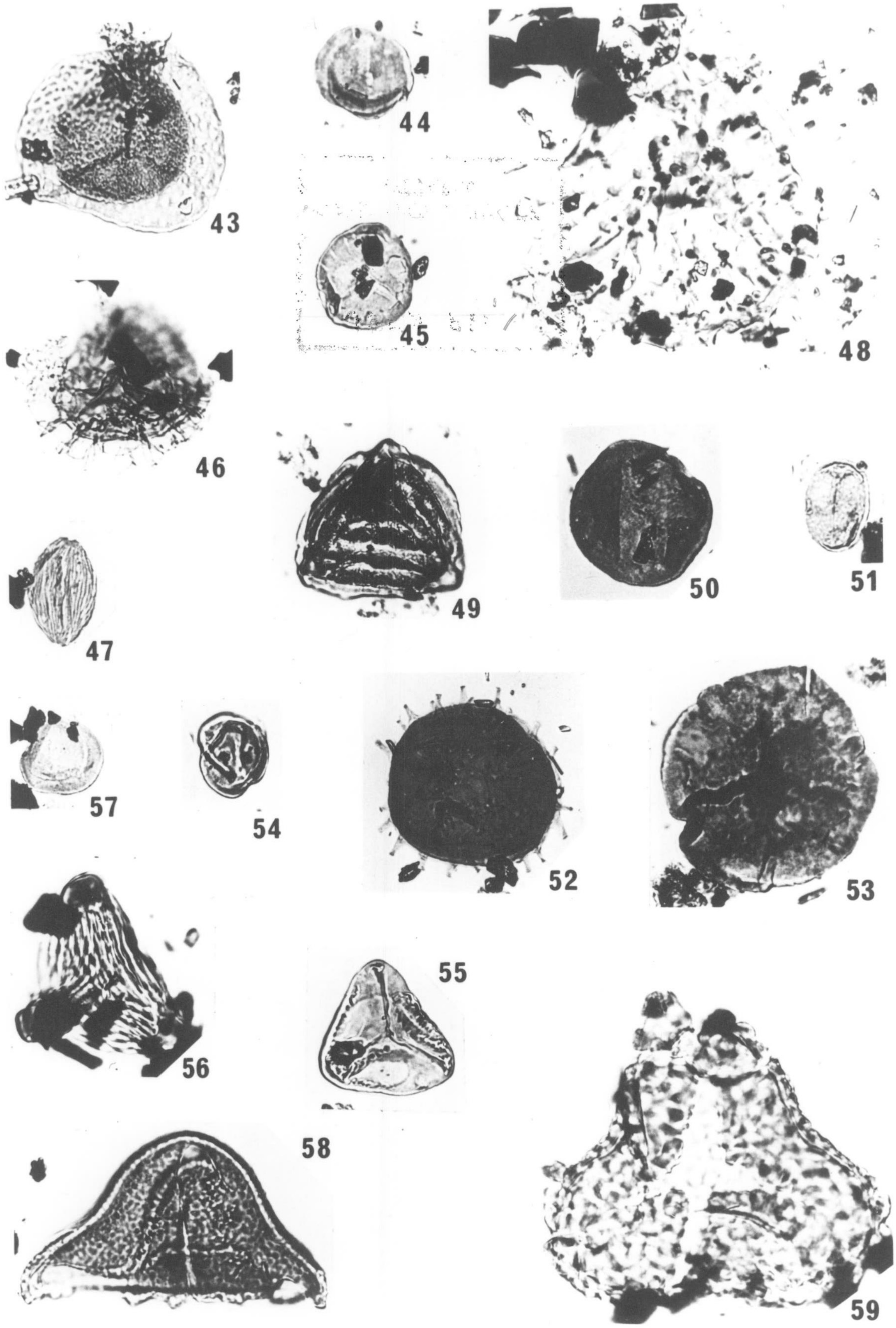
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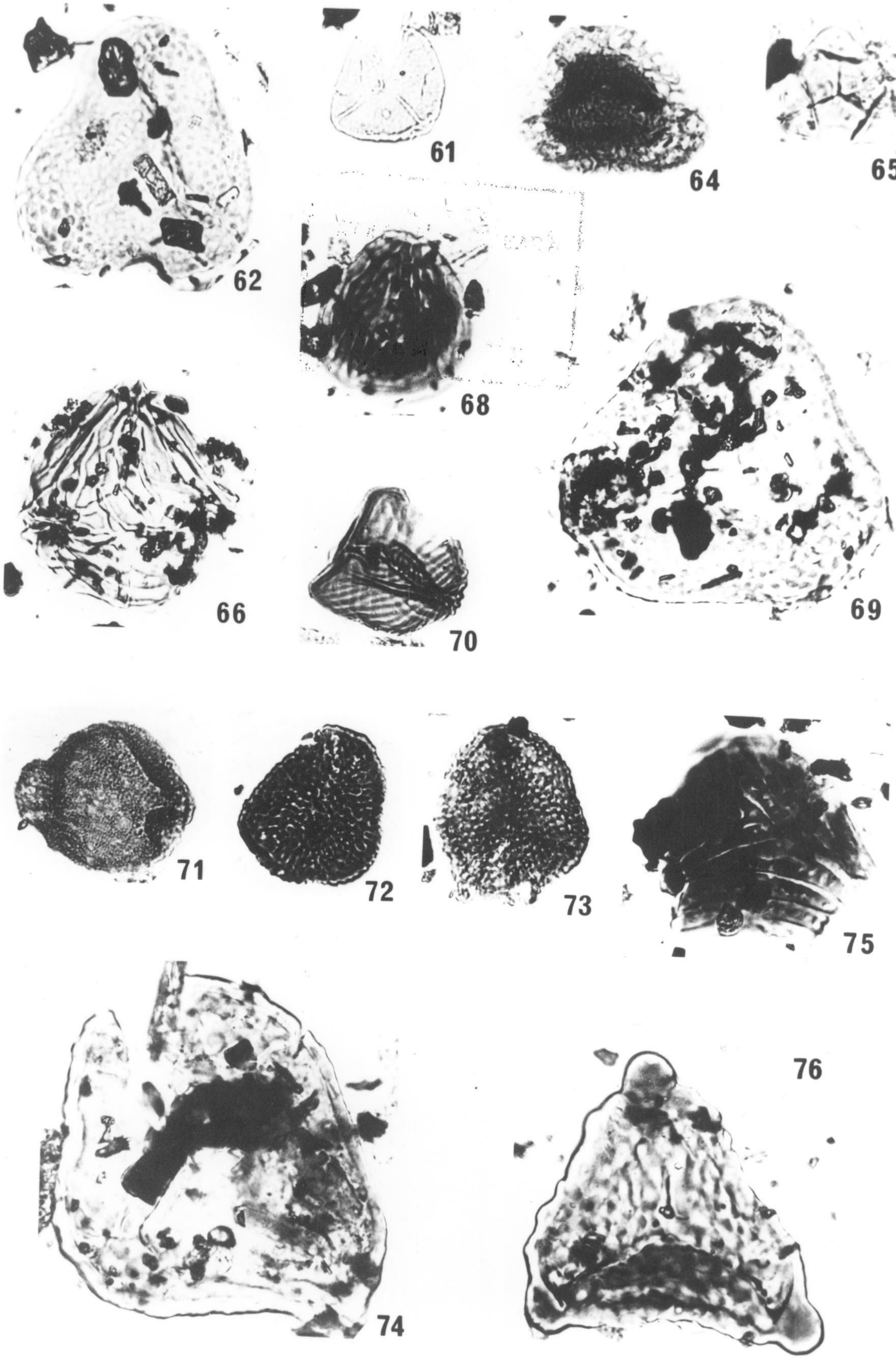

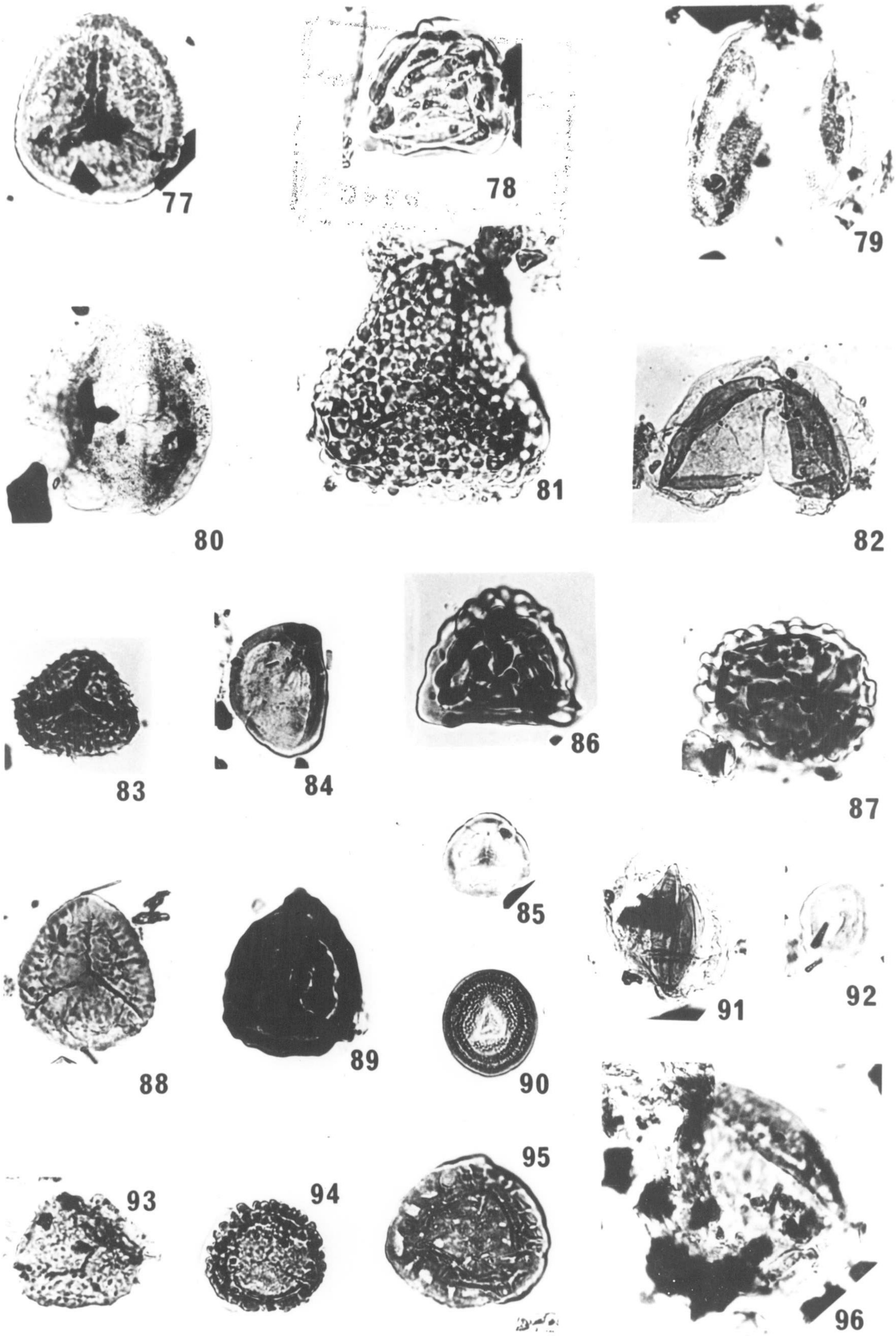
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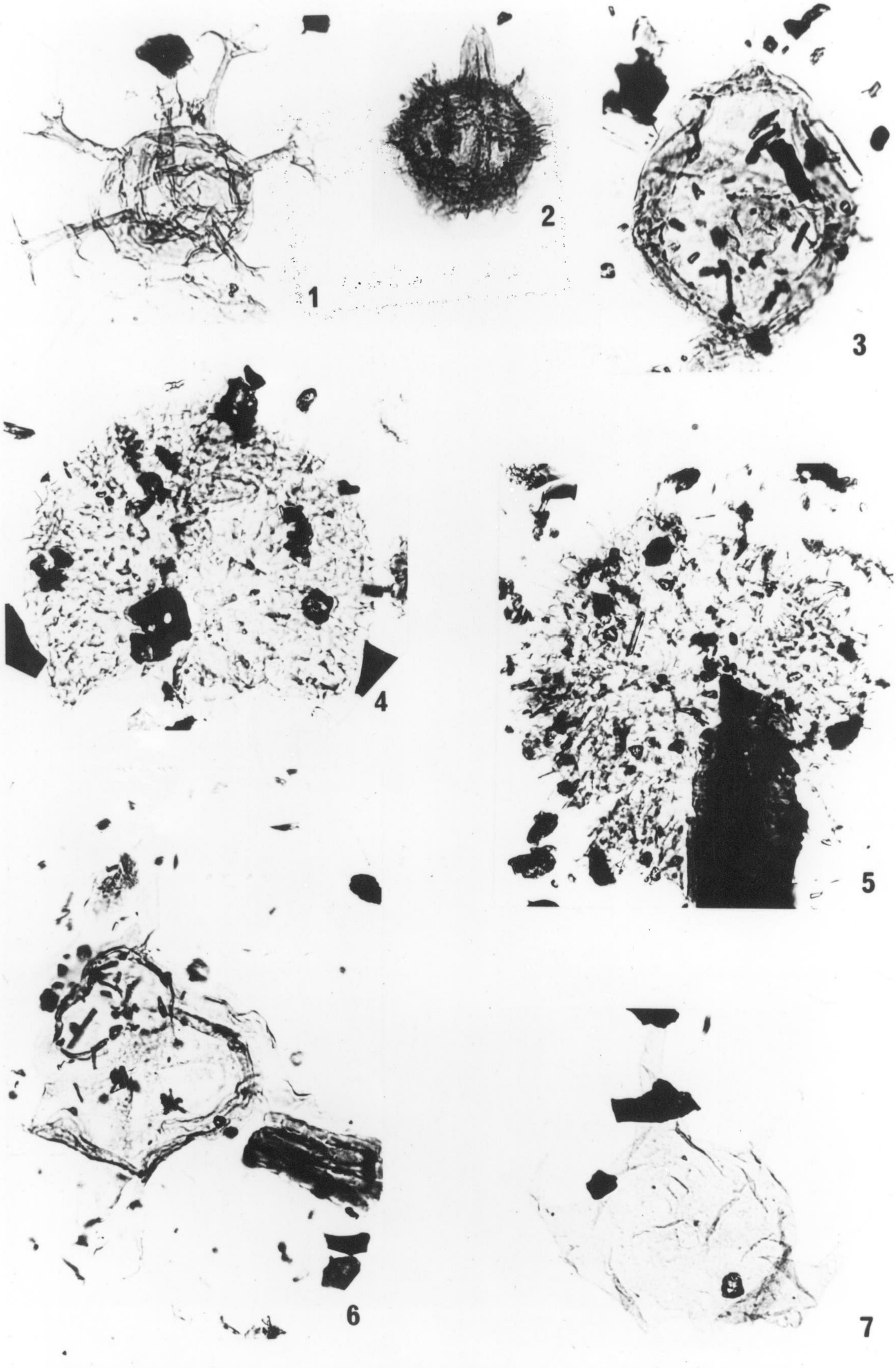

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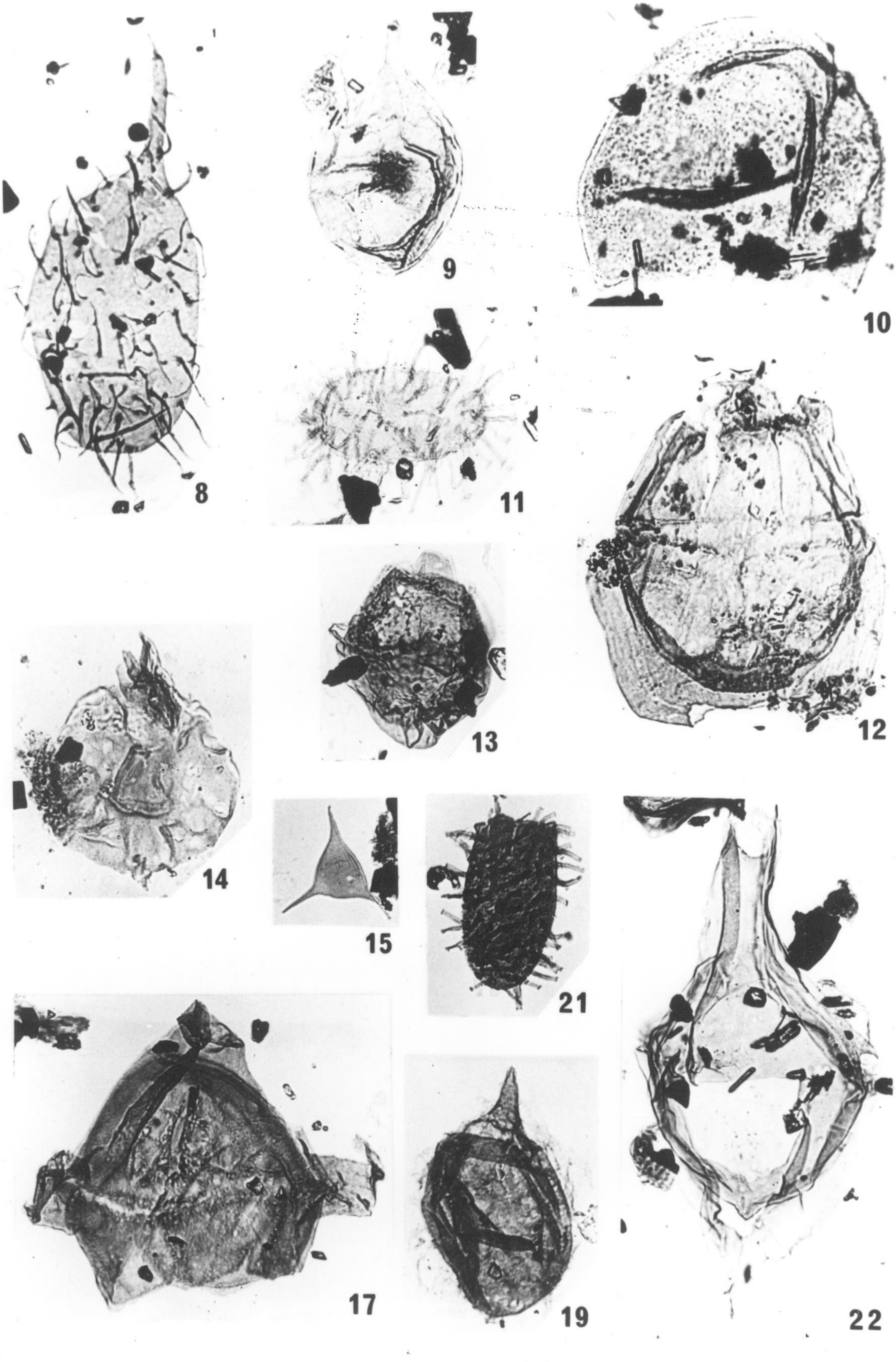


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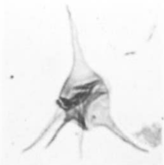
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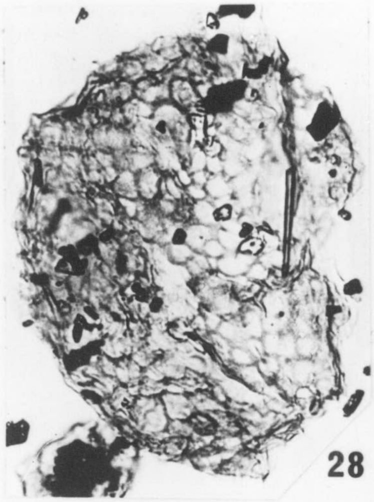
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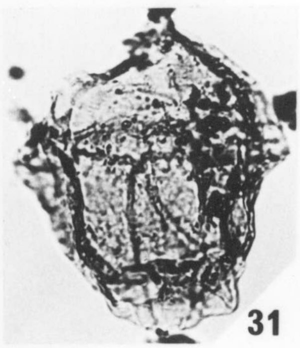
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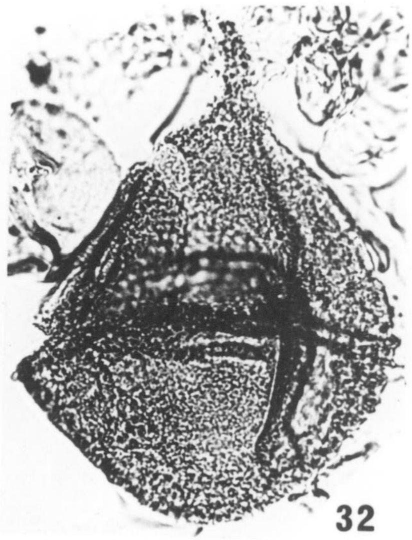
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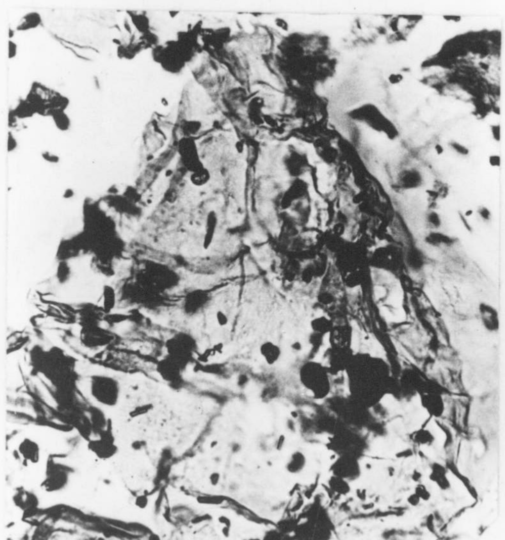
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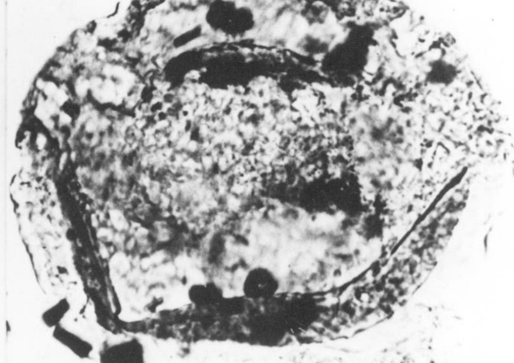
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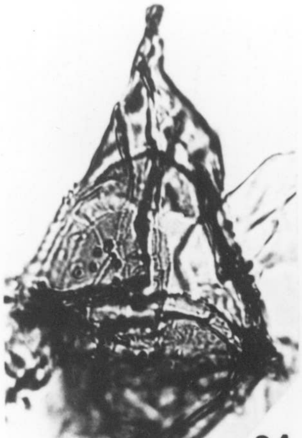
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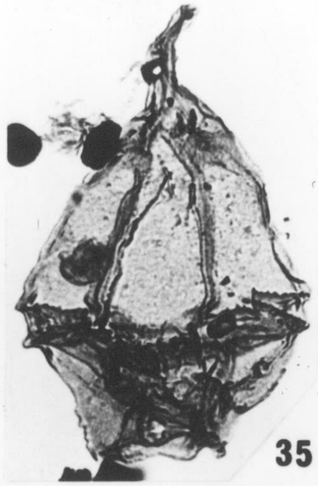
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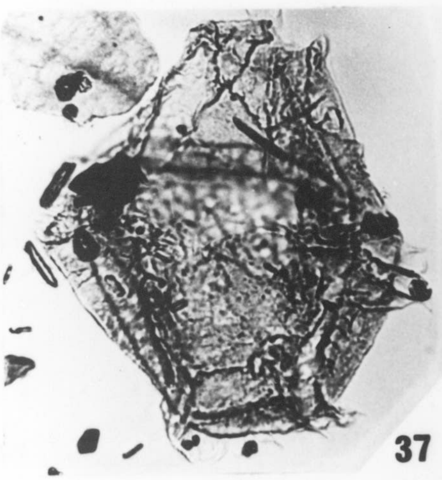
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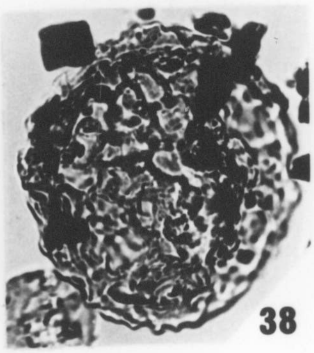
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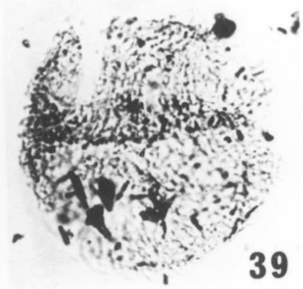
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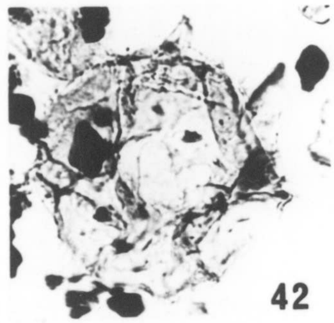
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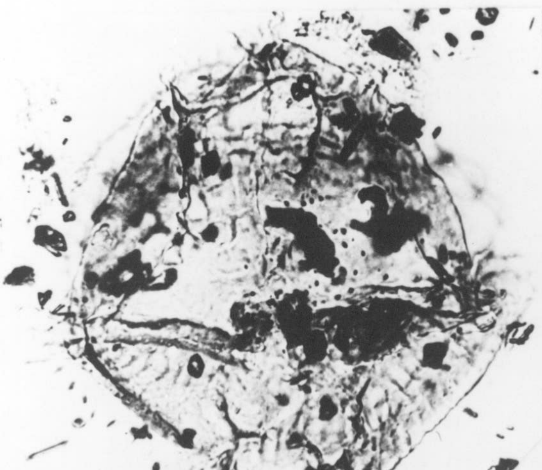
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