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BIOSTRATIGRAPHIC ZONATION

IOE SPRING RIVER YT N-58
YUKON TERRITORY

by

D.M. Loranger, P. Geol.

69-10-138-30

June 1974
(Revised May 1975)

Calgary, Alberta

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SUMMARY AND CONCLUSIONS

The IOE Spring River YT N-58 well contains paleontological material ranging in age from Upper Cretaceous to Upper Jurassic, Upper-Middle? Jurassic and into Paleozoic of indeterminate age. Fossil recovery from both palynomorphs and microfossils was generally poor in numbers and species.

Palynomorph slides taken at 100' intervals on the whole yielded poor results because of the absence of index forms. The distribution of 8 species of terrestrial and 8 species of marine palynomorphs is shown on Tables II and III, together with a graph indicating the geothermal index. The 41 microfossil species identified are predominantly arenaceous and benthonic in habitat; their distribution and abundance is indicated, along with associated fossil material, on Table IV.

The environment of deposition is generally within the littoral zone, with some variation toward terrestrial and sublittoral deposition: the Upper Cretaceous varies from a littoral to a terrestrial environment; the Albian is predominantly terrestrial; the Jurassic is within the littoral or terrestrial milieu, and the Paleozoic appears to have been entirely within the littoral habitat. As these particular habitats seldom produce well-preserved fossils in abundance, and the amount of metamorphism and geothermal activity present was very great, it is remarkable that any zonation could be accomplished. This high degree of alteration could only have a destructive effect on hydrocarbons that might have been present, although the total productivity of organic matter appears to have been very low.

INTRODUCTION AND METHOD OF STUDY

Sample material for the IOE Spring River YT N-58 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. Paleontologists spent at least the same amount of time in counting and identifying the fossil forms. The well was sampled in continuous 50' intervals from 650' to total depth to provide maximum microfossil coverage, and at 100' intervals for palynomorphs. The footages are shown on Plate I, along with standard European terminology when the evidence appeared to validate the determinations.

BIOSTRATIGRAPHIC ZONATION

The Biostratigraphic Log (I) has been prepared at the mechanical-log scale of 1" = 100', to facilitate comparison with various types of mechanical logs. The age determinations arrived at from palynological and micropaleontological studies are placed within the first two columns. Commonly the palynomorphs precede, by one stage or portion thereof, the ages determined by the microfossils. However, in this well the high degree of metamorphism or geothermal activity appears to have destroyed much of the original microflora, so that the age determinations have been made principally on the evidence furnished by the microfossils and ancillary forms.

Another column, scaled in both feet and metres, shows the control for the microfossil and palynological samples examined.

Microfossil zonation as it appeared in the well is given, along with 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 to facilitate correlation. Generalized environments of deposition and preservation are indicated, with comments on correlation.

The environment of deposition is shown as a single curve ranging through terrestrial (nonmarine) (1), brackish (fresh and marine) (2), littoral (shallow) (3), sublittoral (4), neritic (5) and open marine (6). 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, and so on.

Environments in the locality of the IOE Spring River YT N-58 well show considerable fluctuation within the limits of the terrestrial to sublittoral habitats in the Lower Cretaceous. A reworked zone of *Verneuilinoides borealis* has some brackish-water forms present in a predominantly littoral environment, which becomes terrestrial in the interval 800-1100'. There is an apparently littoral/sublittoral interval between 1100' and 1400', which continues down to the base of the *Gaudryina taillleuri* zone, where terrestrial material predominates, to 3400' and then grades into a more littoral milieu. Marine palynomorphs are associated with a zone of littoral microfossils in the interval 4200-4900'. Below 5050' some slight terrestrial evidence is observed which continues to the top of the Paleozoic. The spines and shell fragments from the Paleozoic suggest a return to littoral conditions.

The environment of preservation gives some indication of the amount of alteration the rocks have undergone subsequent to deposition. The amount of alteration is controlled by factors other than depth of burial — metamorphism, faulting, or geothermal activity. The scale indicates a relative progression from normal (1) through slight alteration (2), moderate alteration (3), partial carbonization of spores (4) and of other materials (5). It is believed to represent the effects of pressure, compaction and faulting and shows some variation from the interpretation of colour changes in palynomorphs, which are used as a geothermal index (Plates II and III).

Moderate alteration was observed in the Upper Cretaceous and Albian, increasing to a more severe degree in the *Gaudryina tailleuri* zone. This high degree of alteration continued throughout the remainder of the borehole and increased in the Paleozoic section. The geothermal index varied from 2 to 5 and showed maximum values in the intervals indicated on Tables II and III.

PALYNOLOGY

SUMMARY

Sixty slides were examined covering the interval 100-7000' in the subject well. The palynomorphs are poorly preserved, their colour ranging from medium-brown to black. The total assemblage is very sparse, yielding only eight terrestrial and eight marine taxa, most of which could be identified only to the generic level.

From 100' to 1400' the section is almost barren and of indeterminable age. The sparse assemblage from 1500' to 4900' suggests an Upper Cretaceous - Albian age. Several of the genera present indicate that the age may be Cenomanian-Albian. From 5000' to 7000' the section is barren and the age is therefore indeterminate.

MATERIALS AND METHODS

Slides of the subject well were supplied by Paleo Services Limited. Tables II and III show the respective results for terrestrial and marine taxa. The data are plotted in order of appearance of new taxa, proceeding down the section. An "X" following a taxon number indicates assignment to that genus, but not to the species level. Taxon numbers correspond to those of previous reports.

SUMMARY OF AGE AND ENVIRONMENT

Indeterminable		100-1400'
Upper Cretaceous - Albian	Nonmarine (except base)	1500-4900'
Indeterminable		5000-7000'

DISCUSSION OF ZONATION

Indeterminable: 100-1400'

Only two terrestrial palynomorphs were identified from this interval. The age is therefore indeterminable — especially since the two fauna are long-ranging.

Upper Cretaceous - Albian: 1500-4900'

From 1500' to 4100' marine taxa are exceedingly rare, whereas from 4200' to 4900' they suggest marine conditions. Marine taxa may well have been present in the interval 1500-4100' and subsequently destroyed by metamorphism.

Of the three taxa identified to species level, *Odontochitina striatoperforata* (M4) has the most restricted range, namely Senonian-Albian. *Astrocysta cretacea* (M2) ranges from the Barremian to the Campanian, and *Alisporites bilateralis* (5) from the Upper Jurassic to the Maestrichtian. The following three genera are indicative of, though not restricted to, the Cenomanian-Albian:

Diconodinium sp.
Chlamydophorella sp.
Cyclonephelium sp.

Indeterminable: 5000-7000'

This interval is entirely barren and therefore of indeterminable age.

PALYNOMORPH COLOUR AND CONDITION

Increasing carbonization (eometamorphism) of plant material results in alteration and colour change from translucent yellow to opaque brown (McIntyre, 1972). This report subdivides this progression into five types of palynomorph colour and condition, coded simply as 1 to 5 (Table A). Each sample is then assigned a position on this scale which can subsequently be recorded on the palynomorph distribution charts.

Terrestrial and marine palynomorphs and plant tissue each react differently to carbonization. Marine palynomorphs are often 1/2 to 1 unit lighter than terrestrial palynomorphs, and terrestrial palynomorphs are often 1/2 to 1 unit lighter than plant tissue. This fact has been noted previously by others (e.g., McIntyre, 1972, p. 113).

The colour and condition number assigned to each sample is that of the terrestrial palynomorphs when present and otherwise of the marine palynomorphs or of the plant tissue if totally barren. In samples that are stained the code number refers to condition and colour intensity rather than actual colour, relating the pink-red series to the yellow-brown series.

The code number given is only for colour and its effect on palynomorph identification. It does not in any way reflect palynomorph condition with respect to mechanical, chemical or biochemical corrosion.

Staplin (1969) proposed a thermal-alteration index (1 to 5) but it was not related to particular temperatures. His thermal index from 1 to 3 corresponds closely to the palynomorph code numbers 1 to 3 used here. Palynomorph codes 4 and 5 correspond approximately to the change in Staplin's thermal index from 3 to 4. McIntyre's (1972) experimental work has shown that the primary factor causing carbonization of palynomorphs is temperature in excess of 200°C. A pronounced change occurs between 200°C and 270°C as the pollen colour deepens. The orange-brown pollen colour of samples subjected to 270°C is therefore approximately equivalent to Code No. 3. As in McIntyre's results, it has been observed that as pollen colour becomes darker still (Codes 4 and 5), palynomorph abundance is sharply reduced and many samples are barren.

McIntyre (1972) and others therein noted that spores from coal with less than 60 per cent fixed carbon show little carbonization. In the range 60-65 per cent fixed carbon, where pollen becomes dark brown, commercial oil pools are uncommon. This zone (60-65 per cent fixed carbon) appears to correspond to Staplin's index change from 3 to 4, where associated hydrocarbons change from wet or dry to dry only.

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TABLE A

CHART OF PALYNOMORPH COLOUR AND CONDITION

Code Number	Palynomorph Colour	Palynomorph Condition	Remarks
1	Yellow to light yellow-brown	Good to excellent	Palynomorphs translucent; no loss of detail
2	Dark yellow-brown to medium brown	Good	Palynomorphs translucent; fine detail lost
3	Medium to dark brown	Fair	Becoming opaque; fine sculpture obscure; specific assignment becoming uncertain if based on fine sculpture
4	Dark brown-black	Poor	Considerably opaque; only coarse sculpture visible; specific and even generic assignment can be uncertain
5	Black	Poor	Palynomorphs opaque; only outlines discernible; generic assignment usually difficult

IDENTIFICATIONS

Terrestrial Taxa

1006 Coniferales indet.
22X *Cyathidites* sp.
31X *Lycopodiumsporites* sp.
1012 *Verrucosisporites* sp.
57X *Trilobosporites* sp.
49X *Converrucosisporites* sp.
5 *Alisporites bilateralis* Rouse
111X *Stereisporites* sp.

Marine Taxa

71X *Diconodinium* sp.
1003 Dinoflagellates indet.
4X *Odontochitina* sp.
18X *Cyclonephelium* sp.
16X *Chlamydophorella* sp.
2 *Astrocysta cretacea* (Pocock) Davey
137X *Deflandrea* sp.
4 *Odontochitina striatoperforata* Cookson and Eisenack

MICROPALEONTOLOGY

SUMMARY

Microfossil study of the complete sampled interval 650-7009' in the IOE Spring River YT N-58 well yielded modest results. The microfauna recovered were sparse in numbers and badly metamorphosed, so that identifications could be made only with some reservation, even at the generic level. The intervals yielding micropaleontological information indicated the presence of Albian, Upper Jurassic, probably Upper-Middle? Jurassic and undifferentiated Paleozoic sediments.

MATERIALS AND METHODS

Government samples of unwashed cuttings were prepared at composite 50' intervals to provide complete coverage of the well. 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 whatever time was necessary in attempting to identify the badly indurated material.

The results of counting and identifying the foraminifera and associated fossils or fragmentary remains are plotted on Table IV with the same standard symbols as used in Tables II and III. Fossil identifications are represented by numbers, the key to which appears on page 12. Table IV shows the distribution of 41 species of foraminifera identified to generic or specific levels, and 10 types or genera of associated fossil remains, in addition to occurrences of unidentifiable foraminifera.

The faunas are essentially arenaceous except for a Jurassic assemblage at 5350'. The arenaceous forms have been common in the Mackenzie delta area, but many of them represent facies-controlled faunas and their ranges and implied ages are therefore suspect. The zones recognized from comparison with published literature and other wells examined in the previous project are indicated on the Biostratigraphic Log (I). Where any of these zones has 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 facies. Since this study is essentially based on cuttings, and cavings are present in the borehole, the tops of zones given are based on the first occurrence of diagnostic species; the emphasis therefore is usually placed on the upper limits of the ranges rather than optimum development of key species or the total range.

SUMMARY OF AGE DETERMINATIONS

Lower Cretaceous	(*Verneuilinoides borealis* (reworked) (*Gaudryina tailleuri*	650' 1750'
Upper Jurassic	*Arenoturrispirillina* sp.	3900'
Upper-Middle? Jurassic	*Astacolus pediacus*	5350'
Paleozoic	Spines and shell fragments	6670'

DISCUSSION OF ZONATION

Verneuilinoides borealis: 650' (Reworked)

The index fossil was accompanied by a poorly represented assemblage of

Haplophragmoides sp.
Gaudryina sp.
Bathysiphon sp.
Ammobaculites sp.
Verneuilina porta
Gaudryina barrowensis
Ammodiscus mangusi

The horizon is common in the Mackenzie delta, the Arctic Islands and Alaska, and extends as far south as northern Alberta.

Bone Beds and Radiolaria: 1450'

A very poorly developed bone bed and radiolaria zone occurs in this well beginning at 1450' and extending downward to 2000'. Upper Cretaceous microflora are present above 1750' and *G. tailleuri* below that footage — suggesting perhaps that this marks the break between the Upper and Lower Cretaceous.

Gaudryina tailleuri: 1750'

The index fossil, together with associated

Saccammina cf. *lathrami*
Reophax troyeri
Pelosina sp.
Miliammina manitobensis
Ammodiscus sp.

marks the occurrence of this widespread Albian horizon found throughout the Mackenzie delta, Arctic Islands and Alaska.

Arenoturrispirillina sp.: 3900'

One poorly preserved index fossil, together with

Involutina cheradospira
Glomospira pattoni
Haplophragmoides cf. *kingakensis*
Lituotuba irregularis
Involutina orbis

appears to indicate the presence of Upper Jurassic sediments. *Arenoturrispirillina* sp. also occurs in the Neocomian and is found in association with *Haplophragmoides* cf. *goodenoughensis*, *Thuramminoides* sp. and a caved *Gaudryina tappanae*. The possibility exists, therefore, that some very early Lower Cretaceous is present, but it is quite possible that this represents reworked material as some *Trochammina sablei* appear higher than their normally associated forms.

Arenoturrispirillina sp. and its associates suggest an age of Upper Jurassic, possibly encompassing the Late Tithonian to Oxfordian stages.

Astacolus pediacus: 5350'

A few calcareous foraminifera representative of *Astacolus pediacus* and *Lenticulina muensteri* were present in a dominantly arenaceous assemblage at 5350'. This species is considered Lower Jurassic in Alaska, but no substantiating evidence for that age was present in the palynomorphs found in the same interval. Furthermore, in the Arctic Islands *A. pediacus* is present in sediments of Middle to Upper Jurassic age, which suggests that in the Spring River well the zone containing this fossil probably represents something younger than Lower Jurassic. *Lenticulina muensteri* is a long-ranging form occurring in Upper and Middle Jurassic, but it has not been recorded from the Lower Jurassic in the areas we have examined.

Failing, therefore, any evidence for Lower Jurassic, and with the presence of at least slight evidence for Oxfordian-Callovian? for *A. pediacus*, this section is provisionally considered as Upper-Middle? Jurassic in age.

Spines and shell fragments: 6670'

Broken spines of unknown affinities and shell fragments are present in reasonable numbers below 6670', suggesting Paleozoic sediments of indeterminate age.

IDENTIFICATIONS

318 *Miliammina sproulei* Nauss
53 *Haplophragmoides* sp.
157 *Gaudryina* sp.
51 *Bathysiphon* sp.
85 *Ammobaculites* sp.
66 *Verneuilinoides borealis* Tappan
172 *Spiroplectammina* cf. *webberi* Tappan
99 *Gaudryina barrowensis?* Tappan
271 *Verneuilina porta* Stelck and Wall
224 Foraminifera indet.
242 *Ammodiscus* sp.
54 *Trochammina* sp.
285? *Gaudryina tailleuri?* Tappan
279 *Saccammina* cf. *lathrami* Tappan
97 *Reophax troyeri?* Tappan
248 *Cyclammina* sp.?
211 *Pelosina* sp.
285 *Gaudryina tailleuri* Tappan
166 *Miliammina manitobensis* Wickenden
242? *Ammodiscus* sp.
184 *Globulina* sp.
190 *Trochammina sablei* Tappan
250 *Trochamminoides* sp.
193 *Trochammina gryci* Tappan
101 *Verneuilinoides* sp.
268 *Thuramminoides* sp.
131 *Involutina cheradospira* (Loeblich and Tappan)?
265 *Haplophragmoides* cf. *kingakensis* Tappan
197 *Glomospira pattoni* Tappan
109 *Arenoturrispirillina* sp.
198 *Lituotuba irregularis* Tappan
126? *Ammobaculites alaskensis?* Tappan
157? *Gaudryina* sp.
229 *Uvigerinammina* sp.
227 *Involutina orbis?* (Lalicker)
53? *Haplophragmoides* sp.?
265? *Haplophragmoides* cf. *kingakensis* Tappan
56 *Gaudryina tappanae* Chamney
226 *Lenticulina muensteri?* (Roemer)
146 *Astacolus pediacus* Tappan
371 *Haplophragmoides* cf. *canui* Cushman
365 *Haplophragmoides* cf. *goodenoughensis* Chamney
225 *Trochammina canningensis* Tappan
5 Carbonaceous plant fragments
6 Cartilage
9 *Dictyomitra* spp.
1 Pelecypod
19 Radiolarians
12 Spines indet.
16 Aragonite
4 Ostracods
25 *Paracypris?* sp.
11 Shell fragments indet.

APPENDIX

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APPENDIX

IOE SPRING RIVER N-58

SUMMARY

Study of the cores from this well, from both microfossil and palynological aspects, proved most disappointing. Not only was little recovered, but due to metamorphism the preservation was so poor that speciation could not be attempted.

The microfossil list that is attached is of value only when compared with the original distribution table (IV) of the report. It is evident that some of the distributions based on cuttings are due to cavings, and that these cores can contribute little to a redefinition of the original interpretation.

The palynological report on these cores by L. Wilkins is also attached.

PALYNOLOGY

SUMMARY

Cores throughout the IOE Spring River N-58 well were examined for palynomorphs. The interval from 1970' to 4907.2' yielded palynomorph remnant structures with a thermal-alteration index of 4. Generic identifications of the isolated taxa was not possible except for one dinoflagellate, *Pareodinia ceratophora*, of Albian to Bajocian age. From 5405' to 7009' the samples were barren of palynomorphs, and the residues on the slides was black with a probable thermal-alteration index of 5.

MATERIALS AND METHODS

Slides of the subject well were supplied by Paleo Services Limited, Calgary. Examination was made by L. Wilkins.

SUMMARY OF AGE AND ENVIRONMENT

Lower Cretaceous - Jurassic	Marine	1970-4907.2'
Indeterminable		5405-7009'

DISCUSSION

Lower Cretaceous - Jurassic: 1970-4907.2'

Palynomorphs isolated in this interval were mainly remnant structures with a thermal-alteration index of 4. The dominant taxa identifiable were Coniferales indeterminate and one dinoflagellate, *Pareodinia ceratophora* Deflandre, which ranges from Albian to Bajocian. Associated hydrocarbons related to the thermal-alteration index of 4 from this zone would be dry gas only.

Indeterminable: 5405-7009'

No recognizable palynomorphs were isolated from this interval. Residue on slides was black, probably indicating a thermal-alteration index of 5. This zone would correspondingly be barren of hydrocarbons, or would yield only dry gas.

REFERENCES

Singh, C., 1971, Lower Cretaceous microfloras of the Peace River area, northwestern Alberta: Res. Coun. Alberta, Bull. 28 (vs.1-2-App.), 560 p.

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MICROPALEONTOLOGY

IDENTIFICATIONS

1970.0-1977.8	*Haplophragmoides* sp.
1977.8-1981.0	*Haplophragmoides* sp. *Ammodiscus* sp.
3557.0- 3584.5-3588.0	Foraminifera?
4400.0-4406.8	Foraminifera?
4406.8-4414.0	"
4414.0-4420.0	"
4900.0-4907.2	
5405.0	Foraminifera?
5411.3-5418.7	
5418.7-5420.0	
5939.0-5946.0	Foraminifera?
5946.0-5949.5	"
6245.0-6252.5	Aragonite prisms
6252.5-6260.0	" "
6260.0-6263.5	
6459.0-6460.0	
6465.8-6472.8	
6472.8-6480.0	
6760.0-6767.0	Foraminifera?
6998.0-7003.8	
7003.8-7009.0	