JURASSIC/CRETACEOUS BOUNDARY
IN
WEST-CENTRAL ALBERTA

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EXECUTIVE SUMMARY

The Jurassic/Cretaceous boundary in a well is important to both industry and government because it determines the stratigraphic limit of a company’s oil and natural gas rights. In west-central Alberta this boundary is elusive because the only definitive way to locate it, is by the use of paleontology. This report, a cooperative effort between industry and government organizations, presents regional cross sections in which the location of the boundary has been defined using palynology, core studies and detailed correlations. The cross sections represent a grid of control wells that can be used to further detailed studies in local areas, such as that presented in the companion volume to this report, ARC Open File Report 1992-23.

The report discusses Jurassic stratigraphy, the nature of the Jurassic/Cretaceous boundary and includes nine regional cross sections, as well as the results of all 268 palynological analyses that were performed for this study. Because paleontological analysis is the only definitive method to locate this important boundary, this study recommends that in future, whenever possible, core is taken and palynological analyses performed to establish the exact location of the boundary. This will help both industry and government in defining the stratigraphic limit of oil and gas leases.
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INTRODUCTION

This report on the Jurassic/Cretaceous boundary in west-central Alberta is a follow-up on a request by the Alberta Department of Energy for the Alberta Geological Survey to help solve the definition of this important boundary in several wells in the Niton area, as well as in the Medicine River Field. The boundary between these geological systems is important in defining oil and gas leases. The objective of this study was to establish a bridge between the Niton area and the Gilby/Medicine River/Sylvan Lake fields area by means of regional cross sections and to make the palynological data used in this study available to both industry and government. Studies in the Niton area (Losert, 1986, 1990) have shown that age dating using palynology is the only sure way to differentiate Jurassic and Cretaceous strata.

The study area is shown in Figure 1 and encompasses Townships 33 to 55, west of the fifth meridian between the Jurassic subcrop in the east, and the edge of the disturbed belt in the west. By sampling cores that cross the Jurassic/Cretaceous boundary along a series of NW to SE and NE to SW cross sections, a grid of wells containing the paleontologically defined boundary has been established. These wells (Table 1) can then be used for further detailed correlations or studies in local areas. Cross section B* - B' includes the tie well (7-22-37-4W5) between this regional study and the local study focussed on the Medicine River and Sylvan Lake areas by Strobl et a. (1993b). The present report is made up of three sections. An introductory text section outlines the regional stratigraphic framework and discusses the Jurassic/Cretaceous boundary; an appendix with the results of all the palynological analyses on a well by well basis; and a folder containing the regional cross sections that show the Jurassic stratigraphy and palynological results. G. Dolby and Associates provided the palynological interpretations. The senior author takes the responsibility for the interpretations expressed in this report and the correlations on the cross sections.

PREVIOUS WORK

The location and nature of the Jurassic/Cretaceous boundary has been the subject of a number of previous stratigraphic studies. In the northern part of the present study area Losert (1986, 1990) and Marion (1982, 1984) have defined the relationships
Figure 1. Location map showing the study area and the location of the nine regional cross sections used in this study.
Table 1. Wells logged and sampled for palynological analysis.

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between stratigraphic units (e.g. Fernie, Niton B, Rock Creek, Poker Chip, versus Cretaceous-aged sands and shales) and mapped the boundary between the Jurassic and Cretaceous systems. To the north of the present study area, Poulton et al. (1990) have defined the boundary in a number of wells. In the southeastern corner of the study area (Twp 35 - 40, Rg 1 - 5 W5) a series of authors (Ter Berg; 1966, Watkins, 1966a, 1966b; Deere and Bayliss, 1969; Rall, 1980; Hopkins, 1981, 1982; Collar, 1990; Handcock et al., 1993; and Strobl et al., 1993a, 1993b) have delineated the stratigraphic relationships of a large number of Jurassic and Lower Cretaceous units (Nordegg, Poker Chip Shale, Rock Creek sandstones, Fernie Shale, J1, J2, J3 sandstones, etc.). Young (1992), Kramers et al. (1992), and Putnam and Moore (1993) have looked at the regional nature of the Jurassic units and their relationships with overlying Cretaceous strata. The interested reader is referred to these studies for more details.

REGIONAL STRATIGRAPHIC RELATIONSHIPS

In addition to delineating the Jurassic/Cretaceous boundary, the present study also has sampled the cored Jurassic section to the top of the Nordegg. Figure 2 shows the stratigraphic and age relationships of the regional Jurassic units in the study area, based on palynological zonations. The results of the palynological analyses (268 samples from 95 wells examined) are given in Appendix 1 and shown on the grid of nine regional cross sections (Figure 1 and pocket). These cross sections also show the relationships of the major Jurassic unit from the Nordegg to the sub-Cretaceous unconformity. Because of the extreme complexity of the Lower Cretaceous units, no Cretaceous correlations, other than the Ostracod marker datum are shown. For a detailed description of the Jurassic units, the interested reader is referred to Losert (1986, 1990), Marion (1982, 1984), Collar (1990), Rall (1980), Putnam and Moore (1993) and Strobl et al. (1993b). Springer et al. (1963), Hall (1984), Poulton (1988), Poulton (1989), and Poulton et al. (in press), provide a more regional stratigraphic analysis of the Jurassic in the Western Canada Sedimentary Basin.

Poker Chip to Rock Creek transition

Previous to this study the Poker Chip - Rock Creek contact had been assumed to be unconformable. However, in the majority of cores examined, this appears to be a transitional contact, either in age (from palynology) or lithology. The typical Poker
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Figure 2. Jurassic palynological zonations and stratigraphy (modified from Poulton et al., 1990).
Chip palynoflora continues on into the shales between the basal Rock Creek sands. Typical Rock Creek sands are also found in stratigraphic positions that are laterally equivalent to Poker Chip shales (wells 6-13-55-13W5 and 4-30-54-12W5, cross section B - B*). Vice versa, Poker Chip shales laterally grade into unquestionable Rock Creek sands (wells 8-11-42-8W5 and 6-1-43-7W5, cross section N - N*). In the extreme southeast of the study area an unconformable relationship can be shown between the Poker Chip shale and the overlying Rock Creek sands (Strobl et al., 1993b). To the north of the study area, Poulton et al. (1990) found several cores where there also appears to be an unconformable relationship. Young (1992) in his sequence stratigraphic analysis of the Jurassic sediments in west-central Alberta has suggested that a major sequence boundary exists between the Poker Chip shales and the Rock Creek sands and that lateral equivalents of Rock Creek and Poker Chip lithologies are the result of Rock Creek channels cutting down into the Poker Chip shales. The palynological evidence from this study shows that sedimentation must have been continuous. Locally the Rock Creek may have cut into underlying shales. Sedimentologically, the transition from the Poker Chip shale to the Rock Creek sands probably is one of energy levels in the depositional environment, probably documenting wave base. Thus the Poker Chip shales are the deeper water lithofacies and the Rock Creek sands the shallower lithofacies, within reach of storm wave base. In the north-west portion of the study area (Niton area), a shale conformably overlies the Rock Creek sands, suggesting a similar transition at the top of the Rock Creek.

**Other Jurassic units.**

Locally the Rock Creek is overlain by the lower Oxfordian Niton B sands or mid to upper Oxfordian Fernie Shales (Figure 2, cross sections B - B* and K - K*). The Niton B sands are only found in the northwestern portion of the study area, and unconformably overlie the Rock Creek sands or shales. In some wells in this area, a thin capping of the more regionally widespread Fernie shale is found (Losert, 1990). Over the remainder of the study area the Fernie Shale is the youngest Jurassic unit. The Bathonian - Callovian shale shown on figure 2 was not found in this study. However, Strobl et al. (1993b) have found this shale in the Medicine River/Sylvan Lake area.
JURASSIC/CRETACEOUS BOUNDARY

The Jurassic/Cretaceous boundary is an unconformable surface. It records the shifting of sediment sources from a mature, easterly source terrain on the Canadian shield, to the rising Cordillera with a mixture of sediment sources, predominantly immature (Figure 3). Thus one would expect Jurassic sediments to be mature, with sands being quartzose and containing no grains such as feldspars and detrital micas. On the other hand, sediments from the rising Cordillera would have come from a mixed source area containing sedimentary, igneous, metamorphic and volcanic rocks. Therefore, one would expect complex mineralogies in the Lower Cretaceous sands. However, as shown by Hopkins (1982) quartzose sands do occur in the Lower Cretaceous Ellerslie Member, especially in channel sands that rework Jurassic strata. In addition, most researchers agree that the Jurassic sediments were deposited under dominantly nearshore to offshore, marine conditions and the Cretaceous sediments were deposited under a mix of depositional conditions, ranging from nearshore marine to continental. Consequently, the presence of coal, abundant carbonaceous debris, chert, feldspar, and other fragile grains would indicate a Cretaceous age, whereas the presence of marine borrowing traces, calcareous shell debris or coquinas, and an absence of fragile grains would point towards a Jurassic age. If no palynologic data is available, then the above considerations would allow for some distinction between Jurassic and Cretaceous lithologies.

The strata on either side of the Jurassic / Cretaceous boundary can be of any lithology. In this study, a variety of combinations and lithologic contacts were found. In some cases an apparently uniform succession of shales consisted of Oxfordian Fernie shales overlain by Lower Cretaceous shales (e.g. 16-34-41-5W5), or a thin pebble bed in a shale records the boundary (11-10-46-9W5). Sometimes the unconformity separates two sands, the upper a typical Lower Cretaceous, carbonaceous, salt and pepper sandstone, and the lower a quartzose, argillaceous Rock Creek sandstone (8-14-51-11W5). In a large number of cases, Lower Cretaceous shales directly overlie Jurassic Rock Creek (2-16-43-6W5, 14-25-51-8W5) or Niton B sands (10-14-54-13W5). Another common occurrence is a Lower Cretaceous sandstone lying on top of either Poker Chip shale (7-28-51-15W5) or the late Jurassic Fernie shale (7-17-45-9W5).
Figure 3. Schematic a) early to mid Jurassic paleogeography and b), early Cretaceous paleogeography. (after Marion, 1982 and Jackson, 1984)
To definitively locate the Jurassic/Cretaceous boundary, a sequence of samples for palynological analysis is needed, because one isolated sample may give the wrong answer. In the 7-35-52-9W5 well, detrital Jurassic shale material overlies Cretaceous age shales. In this case the Jurassic shales came from an eroded valley wall and were deposited into a Cretaceous valley-fill. Lithologically it was not possible to identify the Jurassic-age shale as detrital. Cretaceous-age material can also be found infilling karst caverns or pipes in either Nordegg or Mississippian limestones. When palynological analysis is not conclusive (no recovery) or available, then lithological attributes may allow for a probable determination.

CONCLUSIONS

The Jurassic/Cretaceous boundary can be difficult to delineate because it separates similar lithologies of different ages. However, using core studies, detailed local correlations and paleontological results, the boundary can be defined with certainty. Jurassic sediments were deposited under predominantly marine conditions and were derived from a mature source area. In contrast, Cretaceous strata consist of sediments derived from the rising Cordillera to the west or reworked siliciclastics from underlying strata, and were deposited in a wide variety of depositional environments. Thus the presence of coal, carbonaceous debris, chert, feldspar and other fragile grains indicates a Cretaceous age, whereas the presence of marine borrowing traces, calcareous shell debris or coquinas, and an absence of fragile grains would point towards a Jurassic age. Because paleontological analysis is the only definitive method to locate this important boundary, this study recommends that in future when wells are drilled that are projected to penetrate the Jurassic/Cretaceous contact, core is taken and palynological analyses performed to establish the exact location of the boundary. This will help both industry and government in defining oil and gas leases and will help to solve problems with deeper rights reversion.

ACKNOWLEDGEMENTS

The authors would like to thank the following organizations for their support of this study: Amoco Canada Petroleum Company for financially supporting this study; the Alberta Energy Resources Conservation Board for granting us free use of the ERCB
Core Research Centre facilities; and Chevron Canada Resources for supplying some paleontological data. We would also like to thank the following people that helped with various stages of the study. Ed Niewinski of the Energy Resources Conservation Board helped in reviewing wells, pointing out problem areas and assisted with logging some of the cores. Sheila Stewart and Dennis Nikols of the Alberta Geological Survey helped with establishing and building of the cross sections, which were then transferred to and drafted on a Macintosh workstation by Campbell Kidston. Lastly, we would like to thank Rudy Strobi who gave constructive input on the correlations from his point of view in dealing with the Jurassic/Cretaceous boundary in the Medicine River and Sylvan Lake areas in the southeast corner of the study area. This study has also benefitted from constructive comments by the geological staff of the Alberta Department of Energy and the Alberta Energy Resources Conservation Board.

REFERENCES CITED


APPENDIX 1

PALYNOLOGICAL ANALYSES

G. Dolby
G. Dolby and Associates
Calgary, Alberta
PALYNOLOGICAL ANALYSIS OF CRETACEOUS AND JURASSIC CORE SAMPLES FROM CENTRAL ALBERTA

by
G. Dolby

Project 92.01

November 1993

Prepared for:
Alberta Research Council
7th Floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta T6H 5R7

Prepared by:
G. Dolby, P. Geol.
6719 Leaside Drive S.W.
Calgary, Alberta T3E 6H6
SECTION 4

RESULTS (continued)

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9-32-55-11W5 .......................... 91-13 .......................... 108
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SECTION 5

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DOLBY & ASSOCIATES
Two hundred and sixty-eight core samples from seventy-two wells were prepared for palynological analysis. The principal aim of the project was to provide palynological data which would help in distinguishing Cretaceous and Jurassic strata in central Alberta. These data might also be expected to provide additional information on the sequence of Jurassic palynological assemblages which would help in the correlation of individual wells and in the definition of the relationships between the various formations.

The Scientific Authority for the project was Dr. J.W. Kramers of the Alberta Geological Survey.

The samples were prepared by Amoco Canada Petroleum Ltd. and by Global Geolab Ltd. The results are summarised in Section 2 and described on a sample by sample basis in Section 4.
### SECTION 2

#### SUMMARY OF RESULTS

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DOLBY & ASSOCIATES
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The principal aim of this study was to use palynological data to aid in identifying and correlating the relatively thin Jurassic sequence of central Alberta and also to confirm the age of the overlying Cretaceous strata. In the study area, cores rarely penetrate more than part of the Jurassic section. The program could be considered to have been based on spot-samples and establishing the sequence of palynological events is therefore difficult. The assemblages consist of a mixture of species the stratigraphic ranges of which are well known from the European standards. However, a number of species found in the Jurassic of the Western Canada Basin have not been described in the literature and their ranges are, as yet, imperfectly known.

The sequence of palynological assemblages described below is based partly on the occasional occurrences of known species with the unpublished forms and partly on the affinity of the assemblage when these markers are absent. It is obviously tentative and will be refined as more data become available. Where possible the zonal scheme outlined in the text-figure on page 22 has been used for the Jurassic. This is based on the European stratotypes. It is clear from this work, and from previous studies (Dolby, 1990, 1991) that some of the sub-zones may be divided further.

Late Pliensbachian - Middle Toarcian Assemblages

These are characterised by an abundance of sapropelic kerogen and large clumps of small sphaeromorphs. In north-west Europe they are abundant to the top of the bifrons Ammonite Zone (J14C) but may still be significant to the top of the Middle Toarcian, variabilis Ammonite Zone (lower J14B). This feature was almost certainly a response to specific environmental conditions but is widespread in north-west Europe and the Arctic, including the Sverdrup Basin. The kerogen often obscures or dilutes the palynomorph assemblages.
Typical dinocyst species from this zone include:

*Nannoceratopsis gracilis*
*Mancodinium semitubulatum*
*Scriniocassis weberii*
*Dinocyst PC-1*

*N. senex*
*Maturodinium inornatum*
*S. priscus*
*Lithodinia serrulata*

*N. senex* tends to be more numerous than *N. gracilis* and the converse applies to overlying zones although both may be abundant. Acritarchs are occasionally numerous and rare specimens of prasinophytes may occur.

Apart from the sphaeromorphs, which are often termed *Spharipollenites* in the literature, the pollen and spore flora is poorly developed. Small numbers of the following species may be present:

*Distalannulisporites incertus*
*Corrugatisporites anagammensis*
*Classopolis spp.*

*Mathesporites tumulosus*
*C. amplextaeformis*

**Late Toarcian Assemblages**

These are not always well defined and it is generally difficult to distinguish them from early Aalenian assemblages if certain markers are absent. The distinctive gymnosperm pollen *Callialasporites dampieri* appears at the base of the Late Toarcian and its presence therefore provides a lower age-limit to these associations.

The dinocyst species listed for the underlying zone persist here and *Lithodinia serrulata* and Dinocyst PC-1 may be abundant. Species such as *Evansia evittii* and *Phallocysta* spp. may also occur sporadically and the first *Fromea* spp. may also occur toward the top of the zone.

*Spharipollenites* spp. are rare but the remainder of the spore-pollen association from the underlying zone is often abundant.
Aalenian Assemblages

The species encountered in the Late Tertiary continue into the early Aalenian in similar numbers. The base of the Aalenian is defined by the appearance of Jansonia jurassica and Fromea senilis. The first appearance of Nannoceratopsis dicrtyamobonis also occurs, for all practical purposes, at this level.

The Lithodinia serrulata - Dinocyst PC-1 association dies out in the early Aalenian, probably close to the opalinum - murchisonae Ammonite Zone boundary. Most of the Parvocysta group such as ?P. cracens also die out at this point.

Although Dinocyst PC-1 dies out in the early Aalenian, a variety (Dinocyst cf. PC-1) persists into later strata. Few of these have been found as yet and so the complete range has not been determined. It may go as high as the top of the murchisonae Zone but similar forms reach the top of the Aalenian in north-west Europe.

The most distinctive feature of the Aalenian samples in this study is the presence of Fromea 83/1 and F. senilis which can form as much as 15% of the total assemblage. Nannoceratopsis senex and N. gracilis are numerous to abundant elsewhere but in this study they are rare. The Escharisphaeridida - Batiacasphaera complex becomes significant, but not abundant, towards the top of the Aalenian. Valensiella ovula appears in the late Aalenian concavum Ammonite Zone and can be significant in the overlying Bajocian. Evansia granulata also appears in the Aalenian - Bajocian transition.

In the terrestrial fraction, the association of D. incertus, M. tumulosus, C. anagrammensis and C. amplexctaetiformis is abundant in the early Aalenian but diminishes in importance thereafter. It is typical of many Poker Chip samples and the reduction in numbers may be in response to the changing conditions which gave rise to the deposition of the Rock Creek Formation.
Bajocian Assemblages

The Aalenian - Bajocian boundary is marked, under ideal circumstances, by the abrupt decline in *N. gracilis* and *N. senex* as well as the disappearance of *Scrinioaennis weberii*. In this study, these three species are usually rare and different criteria have been used.

The transition into the Bajocian is marked by a significant reduction in the numbers of *Forneua* spp. Whether these are confined to the Aalenian is difficult to determine given the fact that these came from spot samples. The base of the Bajocian appears to be marked by the abundance of *Escharisphaeridia - Batiacasphaera* spp. (especially large forms of the former) *Dissiliodinium* spp. and by the appearance of *Evansia tripartita* and *Meiourogonyaulax decapitata*. *Nannoceras* *dictyamazonis* probably dies out in the Early Bajocian (*discites* Ammonite Zone) and *Phalnocysta minuta* probably dies out slightly later. The mid- to late Early Bajocian is distinguished by the disappearance of *Scrinioaennis priscus* more or less concomitant with the appearance of *Acanthaulax crispa* and *Escharisphaeridia asymmetra*. *N. senex* dies out at the top of the Early Bajocian as does *N. gracilis* for all practical purposes.

There is a marked change in the terrestrial microfloras which begins in the Aalenian but develops in the Early Bajocian. The small spore flora of the Poker Chip is replaced by assemblages rich in the following species.

*C. turbatus*  
*Lycopodiumsporites*  
*Corollina* spp.

The latter two are often abundant in the underlying strata but larger, "heavier" forms predominate here.

During the Late Bajocian, dinocyst species appear which go on to characterise the remainder of the Middle Jurassic and, in some cases, the Late Jurassic. They were not recorded in this study and the youngest early Middle Jurassic floras recovered may have come from the early Late Bajocian.
Oxfordian - Kimmeridgian Assemblages

No evidence for Bathonian or Callovian strata was seen in this study. The earliest Oxfordian palynofloras can be found in the latest Callovian but no Callovian index species were recovered.

Early Oxfordian assemblages in this study are characterised by Sentusidinium spp., especially S. rioulitii and S. villersense, Escharisphaeridia rudis and Ellipsoidicyum gochtii. Acanthaulax spp. and Gonyaulacysta jurassica are usually present and can be abundant. Other species present include Valensiella ovula, E. cinctum, Aldorla dictyota, Scriniodinium crystallinum and Leptodinium eumorphum.

The early Middle Oxfordian is often characterised by Acanthaulax spp. in great abundance. Also appearing at this point are such species as Scriniodinium luridum and Leptodinium mirabile.

The late Middle Oxfordian to earliest Kimmeridgian contains abundant specimens of Gonyaulacysta spp., Leptodinium spp. and Scriniodinium spp. The presence of S. crystallinum in this assemblage indicates an age no younger than earliest Kimmeridgian, baylei Ammonite Zone.

The terrestrial assemblages consist generally of long-ranging species. In contrast to the Middle and Early Jurassic, bisaccate pollen can be abundant.

Cretaceous Assemblages

There was no unequivocal evidence for younger Jurassic strata in this study although it is present elsewhere (Dolby, 1990). Some of the samples which were tentatively assigned a Cretaceous age did not contain species restricted to the Cretaceous. They were assigned partly on sedimentological grounds. These assemblages are often characterised by spore species such as Convacissimisporites exquisitus and C. apiverrucatus which are known to range down to the latest Kimmeridgian (rotunda Ammonite Zone, J2).
Most of the Cretaceous assemblages are dominated by bisaccate pollen which usually comprise a greater proportion of the assemblages than in the Late Jurassic. The spore flora is dominated by the following:

- **Cicatricosisporites** spp.
- **Concavissimisorites** spp.
- **C. trioreticulatus**
- **C. tabulatus**
- **Taxodiaceaeopollenites hiatus**

- **Appendicisporites** spp.
- **C. tribotrys**
- **Foraminisporis wonthaggiensis**
- **Aequitriradites spinulosus**
- **Januaspores spiniferus**

Most of the samples yielded terrestrial assemblages but a small number are rich in dinocysts. The most distinctive of these are usually dominated by **Balmula tripenta**, **Vesperopsis** spp. and **Atopodinium** sp. It is a strongly environmentally controlled assemblage, probably of brackish-water origin which Singh (pers. comm.) has found in the Ostracod Zone (late Aptian - early Albian). The only published record of this group is from the Late Albian of the U.S.

The only other marine assemblage found is of Middle Albian age and contains the following:

- **Psuedoceratium pelliferum**
- **Palaeoperidinium cretaceum**
- **Aptee polymorpha**
- **Circulodinium brevispinosum**

- **P. gochti**
- **Odontochitina operculata**
- **Apteodinium indicosum**
- **Batioladinium jaegerii**
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WELL: 11-19-33-4W5
Samples: JWK92-54-1, 54-2
Depth: 2733.9m, 2734.9m
Age: Bajocian, J13

Remarks
These samples strongly resemble 92-53-2 but are of much poorer quality. Palynomorphs are rare.

Significant species
Escharisphaeridae spp. 
Evansia evitti

Sample: JWK92-54-3
Depth: 2736.5m
Age: Early Bajocian - Aalenian, ?J13B-J14A

Remarks
This extremely poor sample contains Dictyotidium eastendensis and abundant Cymatosphaera spp. similar to 92-53-4. A transitional Rock Creek - Poker Chip age is suggested.

Sample: JWK92-54-4
Depth: 2738.1m
Age: Late Pliensbachian, J14

Remarks
Palynomorphs are rare and thermally altered. The few species present are typical of the Poker Chip.

Significant species
Mathesporites tumulosus
Nannoceratopsis senex
Distalannulisporites incertus

DOLBY & ASSOCIATES
WELL: 11-33-34-4W5
Samples: JWK92-51-1, 51-2
Depths: 8497.5', 8521.8'
Age: Cretaceous

Remarks
These are poorly-preserved, thermally altered samples in which many of the palynomorphs are unidentifiable. However, *Cicatricosisporites* spp. are present in both indicating a Cretaceous age.
WELL: 10-31-35-4W5
Sample: JWK92-49-1
Depth: 8584.5’
Age: Late Aptian - Early Albian

Remarks
This rich Cretaceous sample contains specimens of *Balmula tripenta* indicating a probable Ostracod Zone age.

Significant species
*Balmula tripenta*  
*Appendicisporites* spp.

Sample: JWK92-49-2
Depth: 8587.5’
Age: Cretaceous

Remarks
The yield from this sample was extremely low but the *Cicatricosisporites* group is prominent suggesting a possible riverbank environment.

Significant species
*Cicatricosisporites* spp.  
*Appendicisporites* spp.

Sample: JWK92-49-3
Depth: 8609’
Age: Cretaceous

Remarks
A low yielding sample from a high energy environment. The presence of several *Cicatricosisporites* specimens indicates a Cretaceous age.
WELL: 10-33-35-4W5
Samples: JWK92-50-1, 50-2, 50-3
Depths: 8035', 8044', 8052'
Age: Late Aptian - Early Albian

Remarks
These samples contain rich Cretaceous assemblages. The composition of 50-1 resembles those from lowland floodplain swamp environments. Samples 50-2 and 50-3 also contain rare dinocysts indicating possible lagoonal environments. Jurassic reworking is prominent in 50-2. The presence of Balmula tripenta indicates a possible correlation with the Ostracod Zone.

Significant species
Cicatricosisporites spp.  Taxodiaceae pollenites hiatus
Appendicisporites spp.  Januasporites sp.
Balmula tripenta  Pseudoceratium sp.
**WELL:** 8-23-35-5W5

**Sample:** JWK92-52-1

**Depth:** 2708.2m

**Age:** Cretaceous

**Remarks**

*Cicatricosisporites* spp. predominate in this low-yielding sample suggesting a possible riverbank environment.

**Significant species**

*Cicatricosisporites* spp.

*Microreticulatisporites uniformis*

*Appendicisporites* spp.

*Januasporites spiniferus*

---

**Sample:** JWK92-52-2

**Depth:** 2714.7m

**Age:** Indeterminable

**Remarks**

A barren sample.
### WELL:

**Sample:** JWK92-53-1  
**Depth:** 3021.5m  
**Age:** Middle to Early Oxfordian, J8-J9B

**Remarks**
Pollen and spores are abundant but the dinocyst assemblage is somewhat limited. Specimens of *Gonyaulacysta jurassica*, *G. cladophora* and *Ellipsoidictyum gochtii* suggest a Middle to Early Oxfordian age.

**Significant species**

*Gonyaulacysta jurassica*  
*Ellipsoidictyum gochtii*  
*G. cladophora*

---

**Samples:** JWK92-53-2, 53-3  
**Depths:** 3022.5m, 3034m  
**Age:** Bajocian, J13

**Remarks**
Specimens of *Escharisphaeridia - Batiacasphaera* spp. are abundant in 53-2 with smaller numbers of *Evansia evittii*. The situation is reversed in 53-3. No Aalenian influence is present and an undifferentiated Bajocian age is assigned.

**Significant species**

*Escharisphaeridia* spp.  
*Evansia evittii*  
*C. aff. asymmetra*  
*Batiacasphaera* spp.

---

**Sample:** JWK92-53-4  
**Depth:** 3038.2m  
**Age:** ?Early Bajocian - Aalenian, ?J13B-J14A

**Remarks**
Acritarchs are abundant in this sample, especially *Cymatosphaera* spp. and *Dictyotidium* spp. suggesting a highly restricted environment. Small numbers of
spores typical of the Poker Chip are also present. The sample may come from the
Poker Chip - Rock Creek transition. See 92-54-3.

**Significant species**

*Cymatosphaera (A)*

*Mathesporites tumulosus*

*Distalannulispores incertus*

*Dictyotidium eastendensis*

*Corrugatisporites anagammensis*

*C. amplectaeformis*
WELL: 14-22-36-3W5
Samples: JWK92-57-1, 57-2, 57-3
Depths: 2270.2m, 2280.4m, 2282.4m
Age: Cretaceous

Remarks
All three samples contain very abundant bisaccate pollen as well as typically Cretaceous spores. Many of the spores and pollen in 57-3 are fragmented similar to 55-2 and 56-1.

Significant species
Cicatricosisporites spp.  
Concaavisimisporites trioreticulosus  
Appendicisporites erdtmannii  
Januasporites spiniferus  
C. tribotrys  
Microreticulatisporites uniformis
WELL: 11-23-36-4W5
Samples: JWK92-48-1, 48-2
Depths: 7780.2', 7795.5'
Age: Late Aptian - Early Albian

Remarks
In addition to rich and varied Cretaceous spore-pollen assemblages, numerous specimens of Balmula tripenta indicate a Late Aptian - Early Albian age equivalent to the Ostracod Zone.

Significant species
Balmula tripenta
Appendicisporites spp.
Januasporites sp.
Cicatricosisporites spp.
Concavissimisporites trioreticulosus
C. tribotrys

Sample: JWK92-48-3
Depth: 7818.5'
Age: Cretaceous

Remarks
No dinocysts were recovered in this Cretaceous sample.

Significant species
Cicatricosisporites spp.
Foraminisporis wonthaggiensis
Appendicisporites spp.
Microraticulatisporites uniformis
WELL: 6-12-37-2W5
Sample: JWK92-59-1
Depth: 2212.25m
Age: Indeterminable

Remarks
A barren sample.
<table>
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<td>Samples:</td>
<td>JWK92-58-1, 58-2</td>
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<tr>
<td>Depths:</td>
<td>7025.6', 7044.9'</td>
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<tr>
<td>Age:</td>
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</tbody>
</table>

**Remarks**

Barren samples.
WELL: 7-22-37-4W5
Sample: JWK92-64-1
Depth: 7618.75'
Age: ?Cretaceous

Remarks
This poor sample contains a specimen of Foraminisporis cf. wonthaggiensis and a highly questionable specimen of Lecaniella foveata which suggest a Cretaceous age. There are no really convincing Cretaceous markers present however and no Jurassic species were recorded.

The age assigned must remain very tentative.

Significant species
Biassicate pollen
Foraminisporis cf. wonthaggiensis
Neoraistrickia truncata
?Lecaniella foveata

Samples: JWK92-47-1, 47-2
Depths: 7621.5', 7626.5'
Age: Probably Oxfordian

Remarks
These poor samples contain rare Jurassic dinocysts such as Gonyaulacysta jurassica, Sentusidinium spp. and Ellipsoidicythum sp. They range from Bathonian to Oxfordian strata, but, given the age of similar samples in this study, an Oxfordian age is more likely.

Sample: JWK92-47-3
Depth: 7659'
Age: Indeterminable

Remarks
The kerogen consists of highly altered, inertinic debris. No age can be assigned.
WELL: 11-22-38-4W5

Samples: JWK92-46-1, 46-2, 46-3, 46-4, 46-5, 46-6
Depths: 7445.5', 7451.5', 7458.5', 7461.5', 7466.5', 7491'
Age: Cretaceous

Remarks
Samples 46-1 to 46-5 yielded good Cretaceous (probably Albian) assemblages. Sample 46-6 is poor but contains a number of Cretaceous species.

Significant species
Cicatricosisporites australiensis
C. imbricatus
Microreticulatisporites uniformis
Concavissimisporites trioreticulosus
Appendicisporites cf. bilateralis
Tigrisporites reticulatus
Couperisporites tabulatus
C. hallei
C. augustus
Pilosisporites trichopapillosus
C. tribotrys
A. problematicus
T. scurrandus
Aequitriradites spinulosus

Samples: JWK92-46-7, 46-8
Depths: 7508', 7520'
Age: Indeterminable

Remarks
Kerogen is abundant but all the palynomorphs appear to have been winnowed out and an age cannot be assigned.

Samples: JWK92-46-9, 46-10
Depths: 7531', 7536.8'
Age: Probably Toarcian - late Pliensbachian, J14B-D

Remarks
The spore assemblages are typical of the Poker Chip but the most obvious feature here are the great abundances of Nannoceratopsis senex in both samples. N. gracilis is present in 46-9 (one specimen) and there are no other dinocysts. The dominance of N. senex is more typical of the Toarcian - late Pliensbachian and there are no signs of an Aalenian influence. See 55-3 and 55-4.
Significant species

*Nannoceratopsis senex* (A)
*Distalannulispores incertus*
*Mathesproites tumulosus*

*N. gracilis*
*Corrugatisporites anagammensis*
*C. amplectaeformis*
WELL: 14-21-38-7W5
Sample: JWK92-30-1
Depth: 2748m
Age: Jurassic

Remarks
There are no marker species with limited ranges in this sample but the abundance of *Classopolis* spp. indicates a Jurassic age.

Sample: JWK92-30-2
Depth: 2751.5m
Age: Early Bajocian to Aalenian, J13B-J14A

Remarks
There is a strong resemblance between this sample and 92-18-2 in that the terrestrial component has a similarly distinctive composition. Dinocysts are relatively rare but include large species of *Escharisphaeridina* spp. *Scriniocassidium* cf. *priscus*, *Caddasphaera halosa* and *Jansonia* sp. As in 18-2, the Bajocian influence is stronger.

Significant species
*Araucariacites australis* (A)                      *Lycopodiumsporites* spp. (A)
*Jansonia* sp.                                      *Scriniocassidium* cf. *priscus*
*Escharisphaeridina* spp.

Sample: JWK92-30-3
Depth: 2760m
Age: Early Bajocian to Toarcian (undifferentiated)

Remarks
The yield from this sample was too low to provide a precise age.
Sample: JWK92-30-4
Depth: 2763.5m
Age: Aalenian - Toarcian (undifferentiated)

Remarks
The yield was low but a significant number of small spores and pollen typical of the Poker Chip are present. No dinocysts were recorded.

Significant species
Mathesporites tumulosus
Distalannulisporites incertus
Corrugatisporites anagrammensis
C. amplexaformis
WELL: 16-15-38-8W5
Samples: JWK92-29-1, 29-2
Depths: 2869.8m, 2871.5m
Age: Cretaceous

Remarks
Although the kerogen yield was high for both samples, spores and pollen are rare. Judging by the sorting, the energy level was relatively high. A fragment of Cicatricosisporites sp., which appears to be in situ in 29-2, indicates a Cretaceous age.

Sample: JWK92-29-3
Depth: 2880.7m
Age: Indeterminable

Remarks
The residue is similar to 29-1 and 29-2 with very few palynomorphs. The overall composition tends to favor a Jurassic age over a Cretaceous age but this is pushing the data beyond acceptable limits.
WELL: 8-24-39-4W5
Samples: JWK92-55-1, 55-2
Depths: 2212m, 2213m
Age: Cretaceous

Remarks
These rich assemblages contain abundant Cretaceous markers. The palynomorphs in the lower one are mostly broken, a feature also seen in 56-1 and 57-3.

Significant species
Cicatricosisporites spp.  Appendicisporites erdtmannii
Concacavissimisporites trioreticulosis  C. tribotrys
Foraminisporis wonthaggiensis  Tigrisporites reticulatus

Samples: JWK92-55-3, 55-4
Depths: 2216m, 2221.5m
Age: Early Toarcian - late Pliensbachian, J14C-D

Remarks
Both samples are rich in Nannoceratopsis senex and Spherialpollenites spp. Assemblages such as this are typical of mid-Toarcian to late Pliensbachian in the Sverdrup Basin and north-west Europe. Samples 46-9 and 46-10 are similar except that the Spherialpollenites spp. are not so prominent.

Significant species
Nannoceratopsis senex (A)  Spherialpollenites spp. (A)
Distalannullisporites incertus  Mathesporites tumulosus
Corrugatisporites anagrammensis  C. amplectaeformis
<table>
<thead>
<tr>
<th>WELL:</th>
<th>10-21-39-5W5</th>
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<tr>
<td>Sample:</td>
<td>JWK92-45-1</td>
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<tr>
<td>Depth:</td>
<td>2334.3m</td>
</tr>
<tr>
<td>Age:</td>
<td>Indeterminable</td>
</tr>
</tbody>
</table>

**Remarks**

Despite a fair kerogen yield, palynomorphs are extremely rare and an age cannot be assigned.
WELL: 14-19-40-4W5
Sample: JWK92-31-1
Depth: 2345.1m
Age: Indeterminable

Remarks
A virtually barren sample.

Samples: JWK92-31-2, 31-3
Depths: 2345.35m, 2354.7m
Age: Probably Jurassic

Remarks
Both samples yielded small numbers of identifiable palynomorphs. The higher one contains Distalannulisporites incertus and Mathesporites tumulosus suggesting equivalence with the Poker Chip or Poker Chip - Rock Creek transition.
WELL: 4-4-40-5W5
Sample: JWK92-15-1
Depth: 2345.5m
Age: ?Cretaceous

Remarks
Spores and pollen are generally fragmented. Bisaccate pollen are abundant, however, and a Cretaceous age is very tentatively assigned. No marker species are present.
WELL: 4-9-41-2W5
Sample: JWK92-56-1
Depth: 6555.2'
Age: Cretaceous

Remarks
Many of the palynomorphs are broken as in 55-2 and 57-3. Cretaceous spores are numerous.

Significant species
Cicatricosisporites spp. Appendicisporites erdmannii
Januasporites spiniferus Foraminisporis wonthaggiensis
WELL: 12-5-41-3W5
Samples: JWKO-32-1, 32-2, 32-3
Depths: 7039.5', 7066.5', 7082.4'
Age: Indeterminable

Remarks
Apart from rare small, unidentifiable spores and pollen in 32-1 and 32-2, these samples are essentially barren.

Samples: JWKO-70-1, 70-2, 70-3
Depths: 7043', 7051.5', 7064.5'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
These three samples yielded organic residues typical of the lower part of the Poker Chip shale. Sapropelic debris is abundant and often obscures the palynomorphs. The abundance of small Spheripollenites spp., often in clumps or tetrads along with numerous to abundant Nannoceratopsis senex is typical of the Early Toarcian-Late Pliensbachian.

Significant species
Spheripollenites spp. (A)  
Distalannulissporites incertus  
Corrugatisporites amplexaformis  
Lycoptocladites spinatus/baculatus  
Nannoceratopsis senex (A)  
Classopollis spp.  
Mathesporites tumulosus  
C. anagaramensis  
Ischyosporites crateris  
Micrhystridium spp.
WELL:
10-24-41-3W5

Samples:
JWK92-12-1, 12-2

Depths:
6580.5', 6615'

Age:
Aalenian to late Pliensbachian, J13B-J14

Remarks
Amorphous kerogen dominates both samples and palynomorphs are relatively rare. The spore-pollen association is typical of the Poker Chip and rare specimens of *Nannoceratopsis senex* are present. The marine fraction is insufficiently rich and diverse to assign a more precise age.

Significant species

*Distalannulisporites incertus*  
*Corrugatisporites anagrannensis*  
*Mathesporites tumulosus*  
*Nannoceratopsis senex*
**WELL:** 16-34-41-5W5

**Samples:** JWK92-14-1, 14-2

**Deeps:** 2248.8m, 2250.2m

**Age:** Cretaceous

**Remarks**

Bisaccate pollen are abundant in both samples (61% and 63%). A Cretaceous age is indicated by the presence of *Cicatricosisporites* spp. and *Concavissimusporites tribotrys* in 14-1 and by *Tigrisporites scurrandus* and *Taxodiaceaeapollenites hiatus* in 14-2.

**Significant species**

*Cicatricosisporites hughesii*  
*Concavissimusporites tribotrys*  
*Taxodiaceaeapollenites hiatus*

---

**Samples:** JWK92-14-3, 14-4

**Deeps:** 2250.5m, 2250.58m

**Age:** Late to late Middle Oxfordian, J6B-J7

**Remarks**

Sample 14-3 contains abundant *Gonyaulacysta jurassica* and *Aldorfa dictyota* with significant numbers of *Valensiella ovula* and specimens of *Scriniodinium luridum* and *S. crystallinum*. The lower sample has abundant *G. jurassica* and *V. ovula* but few other dinocysts. Assemblages such as this are typical of the Late to late Middle Oxfordian.

**Significant species**

*Gonyaulacysta jurassica* (A)  
*Valensiella ovula*  
*S. luridum*

---

* Aldorfa dictyota  
* Scriniodinium crystallinum
WELL: 9-4-42-5W5

Samples: JWK92-63-1, 63-2
Depth: 2330.8m, 2331.2m
Age: ?Jurassic

Remarks
These samples have been thermally altered and indeterminate spores and pollen are abundant. Bisaccate pollen comprise approximately 23% of the assemblages, which is somewhat higher than is usually found in Oxfordian and older samples. No Cretaceous markers are present.

A specimen of *Escharisphaeridia* cf. *rudis* in 63-1 and *Gonyaulacysta jurassica* in 63-2 suggest a Jurassic possibly Oxfordian age but there is evidence of reworking of Jurassic forms such as *Scriniocassis priscus*.

A Jurassic age is assigned but this must remain very tentative since the data are inconclusive.

Significant species
Bisaccate pollen (A)

*Ischyosporites crateris*
*Callialasporites dampierii*

*Gonyaulacysta jurassica*
*Escharisphaeridia* cf. *rudis*

*Neoraistrickia truncata*  
*Cerebropollenites mesozoicus*  
*C. turbatus*  

*Scriniocassis priscus* (RW)

Sample: JWK92-26-1
Depth: 2331.3m
Age: ?Late Jurassic

Remarks
Bisaccate pollen are extremely abundant in this sample forming a higher proportion of the assemblage than is usual in Late Jurassic samples in this study. However, the presence of *Gonyaulacysta jurassica* and *Lycopodiacidites spinulosus* suggest a Jurassic age and there are no obvious Cretaceous markers present to contradict this.

Significant species

*Gonyaulacysta jurassica*  
*Lycopodiacidites spinulosus*
### Sample: JWK92-28-2
- **Depth:** 2335.3m
- **Age:** Probably Early Bajocian, J13B

**Remarks**
This sample is similar in composition to 92-25-3 except that the Fromea spp. are absent. *Escharisphaeridia* spp. are also more prominent. An Early Bajocian age is tentatively assigned. The total kerogen resembles that from delta-front or basal distributary mouth bars.

**Significant species**
- *Evansia granulata*
- *Escharisphaeridia* spp.
- *Batiacasphaeridia* sp.

### Sample: JWK92-28-3
- **Depth:** 2339.3m
- **Age:** Aalenian, J14A

**Remarks**
This sample contains *Fromea* spp. and resembles 92-25-3.

**Significant species**
- *Fromea 83/1*
- *Scriniocassia cf. priscus*
- *Fromea senilis*
- *Evansia granulata*

### Sample: JWK92-28-4
- **Depth:** 2346.6m
- **Age:** Aalenian - Late Toarcian, J14A-B

**Remarks**
The yield from this sample was extremely low. The small number of spores and pollen are typical of the Poker Chip but the higher energy conditions which resulted in a poor yield may place the sample in the Poker Chip - Rock Creek transition.

**Significant species**
- *Callialasporites dampiereii*
- *Distalannulisporites incertus*
- *Corrugatisporites anagrammensis*
- *Leptolepidites/Mathesporites* sp.
WELL: 16-15-42-5W5
Sample: JWK92-27-1
Depth: 2198m
Age: Aalenian, J14A

Remarks
This sample is similar to 92-26-3 and 92-25-3. In addition, a specimen of *Scriniocassis weberi* indicates an age no younger than earliest Bajocian, *discites* Ammonite Zone.

Significant species
- *Fromea 83/1*
- *Evansia granulata*
- *S. weberi*
- *F. seniils (A)*
- *Scriniocassis priscus*

Sample: JWK92-27-2
Depth: 2200.3m
Age: Aalenian to Late Toarcian, J14A-B

Remarks
The kerogen indicates a relatively high energy environment of deposition where most of the palynomorphs have been winnowed out. A precise age determination is impossible but a specimen of *Callalasporites dampierii* places a lower age limit of Late Toarcian.
WELL: 8-11-42-8W5  
Sample: JWK92-44-1  
Depth: 2490.45m  
Age: ?Cretaceous  
Remarks  
This sample is dominated by inertinitic debris. The assemblage is extremely limited in composition being dominated by bisaccate pollen (70%). There are no marker species present and a Cretaceous age is tentatively assigned.  

Samples: JWK92-44-2, 44-3, 44-4, 44-5  
Depths: 2495.73m, 2496.7m, 2498m, 2504.4m  
Age: Early Bajocian, J13B  
Remarks  
Dinocysts are present in all these samples and include specimens of Escharisphaeridia spp. and Scriniocassis priscus which means that they are no younger than Early Bajocian. There are no obvious Aalenian influences such as specimens of Fromea spp. and an Early Bajocian age is assigned.  

Significant species  
Scriniocassis priscus  
Escharisphaeridia spp.  

Sample: JWK92-44-6  
Depth: 2507.9m  
Age: Aalenian, J14A  
Remarks  
The spore assemblage is typical of Poker Chip samples and specimens of Dinocyst cf. PC-1 resemble those found in 92-19-2 which is also Aalenian.  

Significant species  
Dinocyst cf. PC-1  
Mathesporites tumulosus  
Corrugatisporites anagammensis  
Fromea 83/1  
Distalannulisporites incertus  
C. amplectaeformis
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<td>JWK92-43-1</td>
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<tr>
<td>Depth:</td>
<td>2315.79m</td>
</tr>
<tr>
<td>Age:</td>
<td>Indeterminable</td>
</tr>
</tbody>
</table>

Remarks
An essentially barren sample.
WELL: 2-16-43-6W5
Sample: JWK92-28-1
Depth: 2280.7m
Age: Probably Cretaceous

Remarks
Bisaccate pollen comprise 68% of the assemblage. This factor, with a specimen of *Kluviosporites* cf. *areolatus* favors a Cretaceous rather than a Jurassic age.

Sample: JWK92-28-2
Depth: 2297.5m
Age: Early Bajocian to latest Aalenian, J13B-J14A

Remarks
Specimens of *Scrinocassis priscus* indicate an age no younger than late Early Bajocian whereas *Valensiella ovula* places a lower age limit of latest Aalenian, *concavum* Ammonite Zone on the sample. *Fromea* spp. are present but rare.

Significant species
*Scrinocassis priscus*  
*Valensiella ovula*  
*Fromea senilis*
WELL: 6-1-43-7W5
Sample: JWK92-13-1
Depth: 2396.5m
Age: Cretaceous

Remarks
Bisaccate pollen are abundant in this poorly preserved sample. Specimens of Cicatricosisporites spp. and a dinocyst resembling Muderongia sp. indicate a Cretaceous age.

Significant species
Cicatricosisporites sp.  C. hughesii
cf. Muderongia sp.

Sample: JWK92-13-2
Depth: 2410m
Age: Cretaceous

Remarks
Bisaccate pollen comprise 80% of the assemblage which is typical for Cretaceous samples in this study. However, apart from rare Taxodiaceae pollenites hiatus, there are no Cretaceous markers present.

Sample: JWK92-13-3
Depth: 2413.5m
Age: Possibly Early Cretaceous

Remarks
Long-ranging pollen dominate the sample (83%) which is typical of the Early Cretaceous but there are no marker species present. There are specimens of Concavissimisporites cf. exquisitus which ranges down to the latest Kimmeridgian. JWK91-13-1 is grossly similar.

An early Cretaceous age is tentatively assigned but a latest Jurassic age cannot be ruled out.
WELL: 6-26-43-11W5

Samples: JWK92-5-1, 5-2

Depths: 9478.8', 9485.5'

Age: Indeterminable

Remarks

Virtually barren samples.

Samples: JWK92-38-1, 38-2

Depths: 9486.3', 9492'

Age: Probably Jurassic

Remarks

The recoveries were low from these coarse lithologies and the preservation is poor
due to carbonisation. The small number of spores and pollen recovered tend to
favor a Jurassic rather than Cretaceous age.

Sample: JWK92-5-3

Depth: 9508'

Age: Early Bajocian to Toarcian (undiff.)

Remarks

The organic material has been severely thermally altered and only the more
distinctive species are identifiable. Classopolis spp. are abundant and a
specimen of Corrugatisporites anagramensis favors a Poker Chip or lower Rock
Creek age. The total residue appears to be well-sorted, indicated a high energy
environment typical of the Rock Creek, but this could have been exaggerated by
the maturation process.
WELL: 10-17-44-3W5
Sample: JWK92-33-1
Depth: 6472'
Age: Cretaceous

Remarks
Bisaccate pollen comprise 81% of the assemblage and the Cicatricosisporites group is abundant in this Cretaceous sample.

Significant species
Cicatricosisporites exilioides  
Appendicisorites spp.
Concavissimisorites tribotrys  
C. hallei
A. erdtmanii
C. trioreticulosus
WELL: 16-21-44-4W5
Samples: JWK92-34-1, 34-2
Depths: 2071.4m, 2073.1m
Age: Cretaceous

Remarks
Bisaccate pollen are abundant and numerous Cretaceous markers are present in both samples.

Significant species
- Cicatricosisporites australis
- Concaviissimisporites tribotrys
- Foraminisporis wonthaggiensis
- C. exilioides
- C. trioreticulosus
- Januasporites spinulosus
WELL: 8-14-44-8W5
Sample: JWK92-11-1
Depth: 2405.75m
Age: Indeterminable

Remarks
The organic residue consists almost entirely of inertinite debris. No useful, indubitably in situ palynomorphs were recorded.

Sample: JWK92-11-2
Depth: 2406.2m
Age: Probably Cretaceous

Remarks
Most of the palynomorphs are poorly preserved and fragmented. A specimen of Cicatricosispore sp. suggests that a Cretaceous age is most likely.

Samples: JWK92-11-3, 11-4
Depths: 2406.7m, 2407.2m
Age: Jurassic

Remarks
Palynomorphs are rare and poorly preserved due to the high level of thermal maturity. Specimens of Escharisphaeridia spp., Sentusidinium spp. and ?Ellipsoidicyum sp. indicate a Jurassic age. There are insufficient data to be more precise.
**WELL:** 7-17-45-9W5  
**Sample:** JWK91-19-1  
**Depth:** 2416.75m  
**Age:** Cretaceous  

**Remarks**  
The palynomorphs in this sample are highly degraded and pyritized such that few are identifiable. A small number of *Cicatricosisporites* spp. indicates a Cretaceous age.

<table>
<thead>
<tr>
<th>Samples:</th>
<th>JWK91-19-2, 19-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depths:</strong></td>
<td>2417.4m, 2418.1m</td>
</tr>
<tr>
<td><strong>Age:</strong></td>
<td>Late Jurassic, earliest Kimmeridgian to late Middle Oxfordian, J6-J7</td>
</tr>
</tbody>
</table>

**Remarks**  
The upper sample yielded specimens of *Leptodinium aff. mirabile* and other indeterminate cysts of Jurassic aspect. Sample 19-3 yielded abundant dinocysts, many of them unidentifiable due to the high level of thermal maturation. *Leptodinium mirabile* is abundant with specimens of *L. subtile, Scriniodinium luridum, S. crystallinum, Valensiella ovula, Ellipsoidictyum cf. cinctum* and *Gonyaulacysta jurassica.*

*S. crystallinum* indicates a J6 or older age whereas the *Leptodinium* spp. do not range below J8. The lack of J8 markers, which are abundant in some samples in this study, suggest that a J6-J7 age is more likely.

**Significant species**  
*Leptodinium subtile*  
*Scriniodinium crystallinum*  
*L. mirabile*  
*S. luridum*
Samples: JWK92-37-1, 91-19-4
Depth: 2418.4m
Age: Bajocian, J13

Remarks
Acritarchs are abundant in this sample as are specimens of Classopolis spp. A small number of simple dinocysts belonging to the genera Escharisphaeridla Dissiliodinium and Batlacasphaera is typical of the Bajocian, Rock Creek Formation.

Samples: JWK92-37-2, 91-19-5
Depth: 2426.3m
Age: ?Early Bajocian to Aalenian, ?J13B-J14A

Remarks
This sample resembles others from the Early Bajocian - Aalenian transition in this study such as 92-25-3, 92-26-3 and 92-27-1. Dinocysts are rare but include Scriniocassis priscus, Nannoceratopsis senex, Fromea cf. senilis and Escharisphaeridla spp.

Significant species
Scriniocassis priscus
Nannoceratopsis senex
Fromea cf. senilis
Escharisphaeridla spp.

Sample: JWK91-19-6
Depth: 2434.3m
Age: Indeterminable

Remarks
An essentially barren sample.
WELL: 1-11-45-10W5
Samples: JWK92-6-1, 92-39-1
Depths: 2481.1m, 2481.5m
Age: Indeterminable

Remarks
Palynomorphs are extremely rare in these kerogen rich samples. Ages cannot be assigned.

Samples: JWK92-39-2, 39-3
Depths: 2482.2m, 2482.9m
Age: Most probably early Middle Oxfordian, J8

Remarks
These samples are rich in organic debris but palynomorphs are rare, especially in 39-3. Sample 39-2 contains a significant number of Acanthaulax spp. which is typical of other J8 samples in this study. A specimen of Escharisphaeridia cf. rudis in 39-3 indicates that this sample is not significantly older than 39-2.

Significant species
Acanthaulax spp. Escharisphaeridia cf. rudis

Sample: JWK92-6-2
Depth: 2484.3
Age: Possibly Middle Jurassic

Remarks
The yield from this sample was low but the preponderance of small spores and pollen suggest a Middle rather than Late Jurassic age.
Sample: JWK92-6-3
Depth: 2485.2m
Age: Bajocian, probably early, J13B

Remarks
The palynomorphs have been severely affected by thermal maturation processes.

Specimens of Evansia evittii, Escharisphaeridia spp. together with a lack of "Poker Chip" spore types, indicate a probable Bajocian age. A questionable specimen of Scrinicassis priscus suggests that an Early Bajocian age is more likely.

Sample: JWK92-6-4
Depth: 2501.5m
Age: Early Bajocian - Aalenian, J13B-J14A

Remarks
Few palynomorphs are present. The total kerogen is well-sorted indicating high energies more typical of the Rock Creek than the Poker Chip.

Sample: JWK92-6-5
Depth: 2507.7m
Age: Aalenian - Toarcian undifferentiated

Remarks
The yield from this sample was small but the total kerogen is rich in small pollen. Numerous specimens of spores typical of the Poker Chip indicate an Aalenian - Toarcian age but there are no dinocysts to provide a more precise age.

Significant species
Distalannulisporites incertus
C. amplectaeformis

Corrugatisporites anagammensis
WELL:

6-2-46-8W5

Sample:

JWK92-7-1

Depth:

2189.2m

Age:

Cretaceous

Remarks

This poorly preserved assemblage contains several specimens of Cicatricosisporites spp. indicating a Cretaceous age.

Sample:

JWK92-7-2

Depth:

2193.1m

Age:

Bajocian, J13

Remarks

Terrestrial taxa such as Classopollis spp. and Corollina spp. are abundant in this sample whereas dinocysts are rare. The presence of specimens of Sestrosporites pseudoalveolatus, Dissiliodinium spp. and Escharisphaeridia spp. is typical of the essentially Bajocian Rock Creek.

Significant species

Dissiliodinium spp. 
Sestrosporites pseudoalveolatus 
Escharisphaeridia spp. 
Classopollis spp. (A)

Samples:

JWK92-7-3, 7-4

Depths:

2194.5m, 2201.6m

Age:

Early Bajocian to Aalenian, J13B-J14A

Remarks

Identifiable dinocysts are present in small numbers in these samples and include Scrinocassis priscus which indicates an age no younger than Early Bajocian (sauzei Ammonite Zone). Also present are Nannoceratopsis gracilis, N. senex, Phallocysta minuta, P. cf. eumeke and, in the higher sample, Fromea aff. senilis. The overall composition and appearance of the assemblages do not resemble
those from typical Poker Chip samples. It is possible that these are slightly younger although the age-range is similar.

**Significant species**

*Scriniocassis priscus*  
*Nannocaratospis gracilis*  
*Phalicylnysta cf. eumeke*

*Fromea aff. senilis*  
*N. senex*  
*P. minuta*
WELL: 11-10-46-9W5
Sample: JWK92-35-1
Depth: 2075.66m
Age: probably Cretaceous

Remarks
Bisaccate pollen comprise 82% of this assemblage and although they can be abundant in the Late Jurassic of this area, abundances such as this are more typical of the Cretaceous. However, the lack of Cretaceous markers means that a Jurassic age cannot be ruled out.

Samples: JWK92-35-2, 91-18-1, 91-18-2
Depths: 2075.91m, 2077.6m, 2077.98m
Age: Early Middle Oxfordian, J8

Remarks
All three samples contain abundant dinocysts but the composition of the assemblage is varied. Sample 92-35-2 contains abundant Acanthaulax spp. which is typical of the J8 Zone. The presence of Leptodinium subtile in 91-18-1 and of L. cf. mirabile in 91-18-2 indicate that the samples are no older than J8. The lowermost sample also contains abundant Ellipsoidictyum gochtii which is also typical of Middle Oxfordian and older sediments elsewhere.

Significant species
Acanthaulax spp.  Ellipsoidictyum gochtii
Leptodinium cf. mirabile  L. subtile
L. eumorphum  Scriniiodinium luridum
WELL:

Sample:  JWK91-20-1
Depth:  10271.5'
Age:  Cretaceous

Remarks
Although this sample is rich in kerogen, palynomorphs are relatively rare, possibly due to a high energy level in the environment. *Cicatricosisporites* spp. are numerous, more so than pollen, and with specimens of *Foraminisporis wonthaggiensis* and *Klukisporites areolatus* present, a Cretaceous age is indicated.

Significant species
*Cicatricosisporites* spp.  
*Klukisporites* cf. *areolatus*  
*Foraminisporis wonthaggiensis*

Sample:  JWK91-20-2
Depth:  10285.4'
Age:  Indeterminable

Remarks
The yield from this sample was extremely small and limited to a few long-ranging bisaccate pollen and indeterminable spores. An age cannot be assigned.

Samples:  JWK91-20-3, 20-4, 20-5
Depths:  10287.4', 10287.8', 10290.8'
Age:  Jurassic

Remarks
Palynomorphs are rare in 20-3, possibly due to high energy levels in the environment of deposition. A dinocyst of Jurassic aspect along with rare specimens of *Escharisphaeridia* sp. favor a Jurassic age. This must remain tentative given the poor quality of the assemblages.

Samples 20-4 and 20-5 are richer but are of essentially similar composition.
Sample: JWK91-20-6
Depth: 10291.3'
Age: ?Oxfordian

Remarks
This sample is obviously Jurassic and resembles many of the Rock Creek Bajocian samples in this study. The age is based on the presence of numerous specimens of Escharisphaeridia sp., some of which resemble E. rudis, a form which characterises the Oxfordian in this study, along with a Jurassic spore-pollen assemblage. The sample is too poor to assign a precise age.

Significant species
Escharisphaeridia cf. rudis
Matonisporites crassiangularus
Couperisporites jurassicus
Converrucosisporites congregatus

Sample: JWK91-20-7
Depth: 10293.4'
Age: Jurassic

Remarks
This sample yielded a very small assemblage of long-ranging palynomorphs, none of which can be used to date the sample with any degree of precision.
<table>
<thead>
<tr>
<th>WELL:</th>
<th>11-11-47-9W5</th>
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<tr>
<td>Sample:</td>
<td>JWK91-17-1</td>
</tr>
<tr>
<td>Depth:</td>
<td>2086m</td>
</tr>
<tr>
<td>Age:</td>
<td>Cretaceous</td>
</tr>
</tbody>
</table>

**Remarks**

As in some other Cretaceous samples in this study, bisaccate pollen are overwhelmingly abundant comprising 88% of the assemblage. Specimens of *Cicatriciosporites* sp. and *Foraminisporis wonthaggiensis* confirm the Cretaceous age.

**Significant species**

*Cicatriciosporites* sp.  
*Foraminisporis wonthaggiensis*

<table>
<thead>
<tr>
<th>Sample:</th>
<th>JWK91-17-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth:</td>
<td>2087.95m</td>
</tr>
<tr>
<td>Age:</td>
<td>Late Aptian - Early Albian</td>
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</tbody>
</table>

**Remarks**

This sample is similar in composition to 91-16-1. The association of abundant *Balmula tripenta* and *Pseudoceratium* spp. with rare *Vesperopsis mayi* is typical of the Ostracod Zone at some localities. Bisaccate pollen comprise 75% of the assemblage with dinocysts comprising 6%.

**Significant species**

*Balmula tripenta* (A)  
*Pseudoceratium* spp. (A)  
*Vesperopsis mayi*  
*P. cf. pelliferum*

<table>
<thead>
<tr>
<th>Samples:</th>
<th>JWK91-17-3, 17-4, 17-5, 17-6, 17-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depths:</td>
<td>2091.6m, 2094.5m, 2099.5m, 2102.6m, 2103.9m</td>
</tr>
<tr>
<td>Age:</td>
<td>Early Cretaceous</td>
</tr>
</tbody>
</table>

**Remarks**

The preservation of the palynomorphs in these samples varies but is generally poor, probably due to diagenetic rather than thermal degradation. Bisaccate pollen are abundant forming at least 75% of each assemblage. *Cicatriciosporites* species and the related *Appendicisporites* are numerous to abundant indicating a Cretaceous age. Dinocysts are rare, present only in 17-3
and 17-4, and are of Early Cretaceous age. Other Cretaceous markers are listed below.

**Significant species**

_Cicatricosisporites_ spp.  
_Concavissimisporites_ tribotrys  
_Couperisporites_ tabulatus  
_Tigrisporites_ scurrandus

_Appendicisporites_ spp.  
_Aequitriradites_ spinulosus  
_Foraminisporites_ wonthaggiensis

_Pseudoceratium_ sp.  
_Atopodinium_ sp.
### WELL: 6-15-48-9W5

**Sample:** JWK91-16-1  
**Depth:** 2119m  
**Age:** Late Aptian - Early Albian

#### Remarks
This sample contains a high proportion of bisaccate pollen (73%) but dinocysts are abundant and *Cicatricosisporites* spp. are quite numerous. The dinocyst association is dominated by *Baimula tripenta* with small numbers of *Vesperopsis* sp. and *Atopodinium* sp. This unusual assemblage is probably of brackish water origin and may be found in the Ostracod Zone of the Late Aptian - Early Albian.

### Significant species

- *Baimula tripenta* (A)  
- *Atopodinium* sp.  
- *Vesperopsis* sp.  
- *Cicatricosisporites* spp.

### WELL: 6-15-48-9W5

**Sample:** JWK91-16-2  
**Depth:** 2119.6m  
**Age:** Possibly Cretaceous

#### Remarks
This sample yielded an assemblage similar to 91-14-1, 14-2 and 91-13-1 and is dominated by bisaccate pollen (76%) with specimens of *Ischyosporites pseudoreticulatus* and *Concavissimisporites* cf. *equisetus* which indicate an age no older than latest Kimmeridgian J2. Rare, recycled Jurassic dinocysts are also present.

### WELL: 6-15-48-9W5

**Sample:** JWK91-16-3  
**Depth:** 2120.8m  
**Age:** Oxfordian, ?J6B-J7

#### Remarks
Although there are distinct similarities in the terrestrial fraction with the overlying sample, bisaccates comprise 85% for example, a number of well-preserved dinocysts indicate a Jurassic age. The presence of *Gonyaulacysta jurassica*,
Adnatosphaeridium filamentosum, Valensiella ovula and Scrinitodinium luridum without older markers suggest an Oxfordian, possibly late Oxfordian age.

**Significant species**

Gonyaulacysta jurassica  
Valensiella ovula  

JWK91-16-4

Depth: 2121.8m  
Age: Bajocian, J13

**Remarks**

Although this sample yielded a small amount of organic material, dinocysts are numerous. The age is based on the presence of *Evansia tripartita* (Bajocian - Middle Callovian) with a specimen of *Meiourogonyaulax decapitata* (Bajocian - Bathonian). The prevalence of simple forms belonging to *Escharisphaeridia* and *Dissiliiodinium* is also typical of the Bajocian.

**Significant species**

Meiourogonyaulax decapitata  
Escharisphaeridia spp.  

Evansia tripartita  
Dissiliiodinium spp.

Sample: JWK91-16-5

Depth: 2140.6m  
Age: Probably Aalenian - Late Toarcian, J14A-B

**Remarks**

The yield from this sample was extremely low. Specimens of *Callialasporites dampieri*, *Corrugatisporites amplexicaeformis*, *Distalannulisporites incertus* and *Mathesporites tumulosus* suggest an Aalenian - Late Toarcian age. The low yield may reflect Rock Creek - Poker Chip transition facies.
WELL: 5-34-48-12W5
Sample: JWK91-21-1
Depth: 2497.1m
Age: Cretaceous

Remarks
This sample yielded an assemblage of poorly preserved palynomorphs. A questionable specimen of Cicatricosisporites sp. and several specimens of Taxodiaceaeapollenites sp. indicate a Cretaceous age. Recycled Jurassic dinocysts are quite numerous.

Samples: JWK91-21-2, 21-3, 21-4
Depths: 2498.4m, 2499.4m, 2502.3m
Age: Jurassic

Remarks
These three samples contained very poor assemblages of palynomorphs and little organic debris. Small numbers of Escharisphaeridia spp. in each sample favor a Jurassic age.

Sample: JWK91-21-5
Depth: 2517.8m
Age: Jurassic, Early Bajocian - Aalenian, J13B-J14A

Remarks
The effects of high thermal maturation are obvious here and very few palynomorphs can be identified to species-level. The Classopollis group is abundant and rare specimens of Escharisphaeridia sp. and Mathesporites cf. tumulosus point to an Early Bajocian or older age. A precise age determination is not possible.
Sample: JWK91-21-6
Depth: 2522.5m
Age: Aalenian - Late Toarcian, J14A-B

Remarks
This sample is richer than any of the overlying samples. The presence of Nannoceratopsis gracilis, Fromea spp., Mathesporites tumulosus and a complex of Leptolepidites - Uvaesporites spp. is typical of the Poker Chip.

Significant species
Nannoceratopsis gracilis
Mathesporites tumulosus
Fromea spp.
Leptolepidites - Uvaesporites spp.
WELL: 16-28-49-5W5
Sample: JWK92-21-1
Depth: 1726.8m
Age: Cretaceous

Remarks
Bisaccate pollen comprise 96% of the assemblage. The remainder contains a diverse assemblage of typically Cretaceous spores.

Significant species
Cicatricosisporites hallei
Concavissimisporites tribotrys
Januasporites cf. spiniferus
C. exilioides
Appendicisporites sp.
Pilosisporites trichopapillosus
WELL: 12-30-49-5W5
Sample: JWK92-8-1
Depth: 1757.3m
Age: Cretaceous

Remarks
The organic matter in this sample is dark-colored, presumably due to primary oxidation. Numerous specimens of the Cicatricosisporites group along with specimens of Concavissimisporites tribotrys, Aequitriradites spinulosus and Foraminisporis wonthaggiensis indicate a Cretaceous age.

Significant species
Cicatricosisporites spp. C. exiloides
C. australiensis Appendicisporites bilateralis
Concavissimisporites tribotrys Foraminisporis wonthaggiensis

Sample: JWK92-8-2
Depth: 1763m
Age: Early Toarcian to Late Pliensbachian, J14C-D

Remarks
Amorphous debris predominates in this sample although palynomorphs are abundant. Indeterminate dinocysts are extremely rare but the spore-pollen association typical of the Poker Chip is present in reasonable numbers. The presence of clumps of Spheripollenites sp. in abundance could be due to local environmental conditions, however, this feature characterises the mid-Toarcian to Late Pliensbachian in the Arctic and in north-west Europe.

Significant species
Spheripollenites spp. (A) Methesporites tumulosus
Distalannulisporites incertus Corrugatisporites anagramidensis

Sample: JWK92-8-3
Depth: 1764m
Age: Indeterminable

Remarks
A virtually barren sample.
WELL: 8-32-49-10W5
Samples: JWK91-15-1, 15-2
Depths: 2175.15m, 2177.84m
Age: Early Cretaceous

Remarks
Bisaccate pollen dominate both samples, 78% and 75% respectively. Both samples contain spores which range down to the latest Kimmeridgian (J2) but the presence of Klukisporites areolatus in the lower sample indicates a Cretaceous age.

Recycled Jurassic dinocysts are present in both samples but are especially numerous in the higher one.

Significant species
Klukisporites areolatus
WELL: 11-20-49-11W5
Sample: JWK92-41-1
Depth: 2315.79m
Age: Probably Middle to Early Oxfordian, J8-J9B

Remarks
Dinocysts are rare which is dominated by spores and pollen. Specimens of Escharisphaeridia rudis, Sentusidinium spp. and Gonyaulacysta cf. cladophora suggest a Middle to Early Oxfordian age. The lack of diversity prevents a more precise assignment.

Significant species
Escharisphaeridia rudis  Sentusidinium spp.

Samples: JWK91-23-1, 23-2
Depths: 2316.3m, 2316.5m
Age: Early Oxfordian, J9B

Remarks
These samples are very similar in composition to 91-22-1 and 91-22-2. Escharisphaeridia rudis is abundant in 23-1 and there are a few specimens of Sentusidinium villersense and S. rioultii present in both samples.

Significant species
Escharisphaeridia rudis (A)  Sentusidinium villersense
S. rioultii  Bisaccate pollen (A)

Sample: JWK91-23-3
Depth: 2317.1m
Age: ?Early Oxfordian, J9B

Remarks
Dinocysts are fairly numerous but are difficult to identify. Some specimens resemble Acanthaulax sp., similar to Oxfordian - latest Callovian forms present in other Oxfordian samples in this study. Bisaccate pollen are also abundant. A clear age determination cannot be made but the overall composition suggests a Late Jurassic age.
WELL: 12-35-50-4W5
Sample: JWK92-10-1
Depth: 1533.5m
Age: Cretaceous

Remarks
This is a rich and diverse Cretaceous assemblage in which the Cicatricosisporites group is prominent.

Significant species
Cicatricosisporites spp. (A)
C. exilioides
Appendicisporites bilateralis
Aequitriradites spinulosus

C. halei
C. imbricatus
Tigrisporites reticulatus
WELL: 6-1-50-5W5
Sample: JWK92-9-1
Depth: 1701.45m
Age: Cretaceous

Remarks
A typical Cretaceous sample dominated by bisaccate pollen (90%) with Cicatricosisporites spp., Taxodiaceae pollenites hiatus, Aequitriradites spinulosus and Couperisporites tabulatus.

Significant species
Cicatricosisporites spp.  Taxodiaceae pollenites hiatus
Aequitriradites spinulosus  Couperisporites tabulatus
WELL: 8-15-50-11W5
Samples: JWK92-40-1, 40-2, 40-3
Depths: 2210.65m, 2211.7m, 2211.95m
Age: Early Oxfordian, J9A-B

Remarks
Dinocysts are rare in these spore/pollen rich samples but the assemblages are consistent with an Early Oxfordian age.

Significant species
Escharisphaeridia rudis
Valensiella ovula
Santusidinium villersense
Acanthaulax spp.

DOLBY & ASSOCIATES
Sample: JWK91-22-3
Depth: 2218m
Age: Middle Jurassic, probably Bajocian, J13

Remarks
Classopolis spp. are extremely abundant (56%) in this sample and there is very little marine influence. Spores such as Concavissimisporites cf. southeiensis and Mathesporites tumultosus suggest a Bajocian age but a precise age is not possible due to the lack of marine markers.
WELL: 14-25-51-8W5
Sample: JWK92-20-1
Depth: 1770.5m
Age: Cretaceous, probably Middle Albian

Remarks
This sample yielded a rich assemblage of Cretaceous dinocysts, probably of Middle Albian age. Spores and pollen are relatively rare.

Significant species
Pseudoceratium pelliferum
P. gochii
Palaeoperidinium cretaceum
Apteodinium indicosum
Circulodinium brevispinosum
P. cf. retusum
Odontochnia operculata
Batioladinium jaegerii
Aptea polymorpha

Sample JWK92-20-2
Depth: 1778.75m
Age: Possibly Aalenian - Late Toarcian, ?J14A-B

Remarks
The organic yield from this sample was extremely low. Rare specimens of Distulannulisporites incertus, Uvaesporites sp., Exesipollenites spp. and Callialaspoides dampierii suggest a possible Poker Chip origin. The yield is unusually low however, and this correlation must remain tentative.
WELL: 6-33-51-9W5
Sample: JWK92-19-1
Depth: 6022.5'
Age: ?Cretaceous - Late Jurassic

Remarks
This assemblage contains abundant bisaccate pollen which is more typical of the Late Jurassic and Cretaceous. However, the only species present with limited ranges appear to have a Poker Chip origin. The latter were probably recycled.

Significant species
Scrinioeassis priscus
Mathesporites tumulosus
Leptolepidites sp.
Bisaccate pollen (A)

Sample: JWK92-19-2
Depth: 6039'
Age: Aalenian, J14A

Remarks
This is a rich assemblage typical of the Poker Chip. The presence of Jansonia cf. jurassica indicates an age no older than Aalenian.

Significant species
Fromea 83/1
Dinocyst cf. PC-1
Scrinioeassis priscus
Nannoceratopsis gracilis
Fromea senilis
Jansonia cf. jurassica
Phallochysta minuta
WELL: 15-11-51-9W5

Samples: JWK91-24-1, 24-2
Depths: 1948.1m, 1956.05m
Age: Cretaceous

Remarks
Both samples yielded large numbers of bisaccate pollen with a few specimens of Cicatricosisporites spp. This composition is typical of Cretaceous samples in this study.

Sample: JWK91-24-3
Depth: 1960.75m
Age: Aalenian to Late Toarcian, J14A-B

Remarks
Sapropelic debris obscures many of the palynomorphs. The association of numerous Fromea 83/1 and Dinocyst PC-1 is often found in the Poker Chip.

Significant species
Dinocyst PC-1  Fromea 83/1
Classopolis spp. (A)  Uvaesporites sp.
WELL: 8-10-51-10W5
Sample: JWK92-25-1
Depth: 2050.2m
Age: Late Aptian - Early Albian

Remarks
Bisaccate pollen comprise 97% of the assemblage. The presence of a small number of Balmula triphenta is indicative of a possible Ostracod Zone origin, i.e., of late Aptian - Early Albian age.

Significant species
Balmula triphenta Cicatricosisporites hallei

Sample: JWK92-25-2
Depth: 2051.8m
Age: Indeterminable

Remarks
This sample contained highly oxidized, inertinitic debris only.

Sample: JWK92-25-3
Depth: 2055.1m
Age: Aalenian, J14A

Remarks
This is a rich assemblage in which Fromea 83/1 is abundant. There are also several specimens of Evansia granulata which suggest a Bajocian influence. The kerogen is more typical of the Poker Chip but the small spores and dinocysts, which are often characteristic, are absent. An Aalenian age is assigned but a Bajocian (?earliest) cannot be ruled out.

Significant species
Fromea 83/1 (A) Evansia granulata
Nannoceratopsis gracilis
WELL: 8-14-51-11W5
Samples: JWK92-24-1, 24-2
Depths: 2158.7m, 2162.05
Age: Cretaceous

Remarks
Both samples appear to have been deposited in an oxidizing environment and the assemblages are of limited composition. *Cicatricosisporites* spp. are present in both samples indicating a Cretaceous age.

Significant species
*Cicatricosisporites hughesi*
*C. imbricatus*

Sample: JWK92-24-3
Depth: 2168.5m
Age: Cretaceous

Remarks
This is a richer and more varied assemblage of Cretaceous age.

Significant species
*Cicatricosisporites exiliioides*
*C. halei*

Concavissimisporites tribotrys

Sample: JWK92-24-4, 24-5, 24-6
Depths: 2171.05m, 2172.9m, 2179.8m
Age: Aalenian, J14A

Remarks
The composition of these assemblages resembles some from the Poker Chip but the small dinocysts and spores which characterise this formation are absent or rare. The yields are also low. It is possible that they come from the Poker Chip - Rock Creek transition. The presence of *Scriniocassis priscus* indicates an age no younger than late Early Bajocian but numerous *Fromea* spp. are more typical of the Aalenian samples in this study.

Significant species
*Fromea 83/1*
*F. senilis*
WELL: 7-28-51-15W5
Samples: JWK92-60-1, 60-2, 60-3
Depths: 2600.5m, 2601.5m, 2607.4m
Age: Aalenian-Late Toarcian, J14A-B

Remarks
The assemblages from these samples have been subjected to significant thermal alteration. There is little sign of marine influence apart from rare acritarchs and many of the specimens are unidentifiable. The spore-pollen association is typical of the Poker Chip and Poker Chip-Rock Creek transition and the presence of Callialasporites dampieri indicates an age no older than Late Toarcian.

Significant species
Classopolis spp. (A)  
Uvaesporites sp.  
Callialasporites dampieri  
Microhystridium spp.

Mathesporites tumulosus  
Distalanulisporites incertus  
C. turbatus
WELL: 15-9-52-6W5
Samples: JWK92-18-1, 18-2, 18-3
Depths: 1818.5m, 1821.6m, 1822.75m
Age: Early Bajocian to ?Aalenian, J13B-?J14A

Remarks
Yields were low from these samples, particularly 18-3. Dinocysts are rare but include Scriniocassis priscus and Evansiia spp. The terrestrial fraction is quite varied but Classopollis spp. predominate. Other prominent species include Lycopodiumsporites spp. and Converrucosisporites congregatus. An Early Bajocian to Aalenian age is indicated but judging by the composition of the terrestrial fraction, it is doubtful whether the section extends significantly into the Aalenian.

Significant species
Scriniocassis priscus  Lycopodiumsporites spp.  Evansiia spp.  Converrucosisporites congregatus
WELL: 1-17-52-8W5
Sample: JWK91-62-1
Depth: 1822.35m
Age: Probably Cretaceous

Remarks
This sample yielded a rich assemblage of long-ranging spores and pollen. Specimens of Concavissimisporites montuosus, Contignisporites glebuletus and Concavissimisporites spp. are more typical of the Cretaceous but the first two species have been recorded in the Kimmeridgian.

Significant species
Bisaccate pollen (A)  Contignisporites glebuletus
Concavissimisporites spp.  C. montuosus
Cerebropollenites mesozoicus  Callialasporites trilobatus

Samples: JWK92-62-2, 62-3
Depths: 1824.2m, 1824.7m
Age: Early Bajocian, J13B

Remarks
Both assemblages represent a highly restricted marine environment where specimens of Caddasphaera halosa and Evansia tripartita are abundant. The latter appears in the Bajocian and there are no specifically Late Bajocian elements present. The spore-pollen association is similar to other Bajocian samples in this study.

Significant species
Classopolis spp. (A)  Corollina spp. (A)
Callialasporites turbatus  C. dampieri
Cerebropollenites mesozoicus  Ischyosporites crateris
Escharisphaeridia spp.  Evansia tripartita (A)
Caddasphaera halosa (A)  Micrhystridium spp.
Sample: JWK92-62-4
Depth: 1829.9m
Age: Early Bajocian-Late Aalenian, J13B-A

Remarks
Spores and pollen are less numerous in this sample and dinocysts are rare. A specimen of *Nannoceratopsis senex* suggests an Aalenian influence although it does range into the early Bajocian. Rare specimens of *Corrugatisporites* spp. and *Uvaesporites* sp. are infrequent above the Aalenian samples in this study.

Significant species
Classopolis spp. (A)  
*Callialasporites turbatus*  
*Corrugatisporites anagramensis*  
*Batiacasphaera* sp.  
*Corollina* spp. (A)  
*C. dampieri*  
*Uvaesporites* sp.  
*Nannoceratopsis senex*

Sample: JWK92-62-5
Depth: 1833m
Age: Early Aalenian, J14A

Remarks
Small indeterminate dinocysts are abundant in this sample. The presence of Dinocyst PC-1 with *Jansonia jurassica* indicates an early Aalenian age.

Significant species
Classopolis spp. (A)  
*Callialasporites dampieri*  
*C. trilobatus*  
*Scriniocestus priscus*  
*Jansonia jurassica*  
*Fromea* cf. *senilis*  
*Nannoceratopsis senex*  
*Ischyosporites crateris*  
*C. turbatus*  
*Distalannulisporites incertus*  
*S. weberi*  
*Dinocyst PC-1*  
*Phallocysta minuta*
**WELL:**

4-29-52-8W5

**Samples:**

JWK92-1-1, 1-2

**Depths:**

1815.5m, 1820.1m

**Cretaceous**

**Remarks**

Both samples yielded small residues although the lower one is somewhat richer. The Cretaceous age is based on the presence of *Cicatricosisporites* spp., *Taxodiaceae pollenites hiatus* and *Tigrisporites scurrandus*.

**Significant species**

*Cicatricosisporites cf. minor*  
*C. haliei*  
*Taxodiaceae pollenites hiatus*  
*Tigrisporites scurrandus*

**Sample:**

JWK92-1-3

**Depth:**

1821.8m

**Age:**

Indeterminable

**Remarks**

The extremely small residue contains rare, long-ranging spores and pollen and one questionable dinocyst.
**WELL:** 7-35-52-9W5  
**Sample:** JWK92-16-1  
**Depth:** 6273.5'  
**Age:** Probably Toarcian debris  

**Remarks**  
The sparse kerogen is dominated by sapropelic debris. Rare *Sphaeripollenites* sp., *Distalannulisporites incertus*, *Corrugatisporites anagammensis* and *Calliasporites turbatus* suggest a Toarcian age. However, given the nature of the underlying samples, this is probably a reworked assemblage.

### Samples  
**JWK92-15-2, 16-3**  
** Depths:** 6320', 6363'  
** Age:** ?Cretaceous  

**Remarks**  
Both samples are highly oxidized and dominated by inertinitic debris which contrasts with 16-1. Spores and pollen are relatively rare, especially in 16-2, but bisaccate pollen are abundant in 16-3, a feature more typical of Cretaceous samples in this study. A precise age cannot be assigned to these two samples.
WELL:

3-14-52-14W5

Samples:

JWK91-14-1, 14-2

Depths:

2334.3m, 2335.9m

Age:

Possibly Early Cretaceous

Remarks

These samples are similar to 91-13-1 in that they are typical of the Early Cretaceous but do not contain any marker species to confirm the age-range. The lower sample contains specimens of *Ischyosporites pseudoreticulatus* and *Conavissimisporites apiverrucatus* which indicates that the sample is no older than latest Kimmeridgian, J2. The preservation is poor due to thermal maturation.

Samples:

JWK91-14-3, 14-4, 14-5, 14-6, 14-7, 14-8

Depths:

2336.4m, 2339.9m, 2345.2m, 2348.5m, 2359.9m, 2362.6m

Age:

Middle to ?Early Oxfordian, J8-?J9A-B

Remarks

The yields and overall compositions of these samples vary considerably. Sample 14-3 is rich in spores and pollen with few dinocysts; 14-4 is rich in dinocysts (85%); samples 14-5, 14-6 and 14-7 are poor and dominated by terrestrial microfloras; sample 14-8 is slightly richer with numerous dinocysts.

*Acanthaulax* spp. are present in most samples and are especially abundant in 14-4 and 14-8. This is typical of early Middle Oxfordian (J8) to latest Callovian strata (J9C). The presence of *Leptodinium cf. subtile* in 14-4 indicates that this sample is no older than Middle Oxfordian (J8). Although some species typical of the Early Oxfordian in this study are present (e.g., *Escharisphaeridia rudis*, *Sentusidinium cf. rioutii*), the overall character of the assemblages appears to be younger than 91-11-2, 22-1, 22-2, 23-1 and 23-2.

Significant species

*Acanthaulax* spp.  
*Leptodinium cf. subtile*
**WELL:** 16-3-53-8W5
**Samples:** JWK92-2-1, 2-2
**Depths:** 1768m, 1768.1m
**Age:** Early Bajocian to Aalenian, J13B-J14A

**Remarks**
These extremely rich samples are typical of the Poker Chip. The presence of *Phallocysta minuta*, *Nannoceratopsis dictyambonis* and *Jansonia aff. jurassica* indicate a basal Early Bajocian (*discites* Ammonite Zone) to Aalenian age. No representatives of the *Lithodinia serrulata* - Dinocyst PC-1 complex are present.

**Significant species**
- *Phallocysta minuta*
- *Nannoceratopsis dictyambonis*
- *Jansonia cf. jurassica*
- *Fromea spp.*

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**Sample:** JWK92-2-3
**Depth:** 1768.3m
**Age:** Aalenian - Late Toarcian, J14A-J14B

**Remarks**
The terrestrial fraction is more noticeable in this sample. *Distalannulisporites incertus* is abundant and there are numerous specimens of *Mathesporites tumultosus* and *Corrugatispores anagrammensis*. *Phallocysta minuta* is as numerous as in the overlying samples but the other marker species are absent. *Lithodinia aff. serrulata* is present here. Obviously, this sample is not significantly older than 2-1 and 2-2 but a slightly broader age range is assigned due to the lack of Aalenian and younger marker species.

**Significant species**
- *Phallocysta minuta*
- *Lithodinia aff. serrulata*
WELL: 7-31-53-10W5
Samples: JWK92-17-1, 17-2, 17-3
Depths: 6002', 6008', 6023.5'
Age: late Early Bajocian, J13B

Remarks

_Scriniocassis priscus_ is present in all three samples indicating an age no younger than Early Bajocian, _sauzei_ Ammonite Zone. Samples 17-1 and 17-2 also contain specimens of _Acanthaulax cf. crispa_, _sensu stricto_ specimens of which do not range below the late Early Bajocian. These two samples also contain several specimens of _Jansonia jurassica_ which does not range below the Aalenian. _Pareodinia_ spp. predominate in 17-3. The samples in some ways resemble 92-7-3 and 7-4 but are closer in composition to 92-23-1 and 23-2 which are of late Early Bajocian age.

Significant species

_Scriniocassis priscus_  
_Fromea serilis_  
_Evansia evitti_  
_Acanthaulax cf. crispa_  
_Phallocysta minuta_  
_Jansonia jurassica_
WELL: 7-36-53-14W5
Samples: JWK92-61-1, 61-2
Depths: 2175.85m, 2178m
Age: Early Bajocian, J13B

Remarks
Both samples yielded spore-pollen assemblages typical of the Bajocian with numerous specimens of very robust forms of Corollina sp. Dinocysts are abundant in 61-1, mainly specimens of Escharisphaeridia spp., but the presence of Scriniocassis priscus in both samples indicates an age no younger than Early Bajocian.

Significant species
Classopollis spp. (A)
Ischyosporites crateris
Callialasporites dampieri
Ovalipollis anigmatic

Escharisphaeridia spp. (A)
Scriniocassis priscus
Micrhystridium spp.

Corollina spp. (A)
Mathesporites tumulosus (R)
C. turbatus
Cerebropollenites mesozoicus

Baticasphaera sp.
Jansonia jurassica
Cymatosphaera sp.
WELL: 6-12-54-6W5
Sample: JWK92-4-1
Depth: 4954.5’
Age: Late Aptian - Early Albian

Remarks
This Cretaceous assemblage contains abundant Balmula tripenta with specimens of Atopodinium sp. and Vesperopsis sp. Similar assemblages are present in 91-16-1 and 91-17-2. They probably indicate a brackish environment within the Ostracod Zone

Significant species
Balmula tripenta
Vesperopsis sp.
Atopodinium sp.
Cicatricosisporites spp.

Samples: JWK92-4-2, 4-3
Depths: 4959.5’, 4963’
Age: Cretaceous

Remarks
In addition to abundant bisaccate pollen, both samples contain numerous specimens of Cicatricosisporites spp. typical of the Cretaceous.

Significant species
Cicatricosisporites spp.
Appendicisporites jansonii

Sample: JWK92-4-4
Depth: 4967’
Age: Indeterminable

Remarks
A virtually barren sample.
Samples: JWK92-4-5, 4-6
Depths: 4974.7', 4976.5'
Age: Aalenian - Late Toarcian, J14A-B

Remarks
These samples are rich in spores and pollen typical of the Poker Chip and closely resemble samples 92-3-2 and 3-3. Dinocysts are extremely rare and include Nannoceratopsis senex. A restricted, possibly lagoonal environment is indicated.

Significant species
Mathesporites tumulosus
Corrugatisporites anagammensis
Distalunnissporites incertus (A)
Nannoceratopsis senex
**WELL:**
6-18-54-7W5

**Sample:**
JWK92-3-1

**Depth:**
1625m

**Age:**
Cretaceous

**Remarks**
Although spores and pollen are abundant, most are broken. Numerous representatives of the *Cicatricosisporites* group indicate a Cretaceous age.

**Significant species**

<table>
<thead>
<tr>
<th>C. exilidioides</th>
<th>C. hallei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigrisporites scurrandus</td>
<td>Appendicissporites erdtmanii</td>
</tr>
<tr>
<td></td>
<td>Taxodiaceaeopollenites hiatus</td>
</tr>
</tbody>
</table>

**Samples:**
JWK92-3-2, 3-3

**Depths:**
1634.2m, 1637m

**Age:**
Aalenian - Late Toarcian, J14A-B

**Remarks**
The spore-pollen association often found in Poker Chip samples is present in abundance here but dinocysts are extremely rare and include *Nannoceratopsis senex*, *Wallodinium* sp. and *Caddasphaera halosa*. A highly restricted, possibly lagoonal environment is envisaged.

**Significant species**

<table>
<thead>
<tr>
<th>Mathesporites tumulosus (A)</th>
<th>Distalannulisporites incertus (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugatisporites anagrammensis (A)</td>
<td>Nannoceratopsis senex</td>
</tr>
</tbody>
</table>

**Sample:**
JWK92-3-4

**Depth:**
1646.3m

**Age:**
?Aalenian - ?Toarcian

**Remarks**
Only five palynomorphs were recorded from this low-yielding sample. They include *Mathesporites tumulosus* and *Distalannulisporites incertus* which are typical of the Poker Chip. A precise age cannot be assigned.
WELL: 4-13-54-11W5
Samples: JWK92-23-1, 23-2
Depths: 1940.78m, 1945.1m
Age: Late Early Bajocian, J13B

Remarks
These samples are rich in dinocysts and the presence of Sentusidinium asymmetrum with Scriniocassis priscus indicates a late Early Bajocian age for the samples. Pareodinia spp. predominate in 23-1 and Caddasphaera halosa is abundant in 23-2. The samples bare a striking resemblance to 92-17-3.

Significant species
Scriniocassis priscus
Evansia evittii
Caddasphaera halosa (A)

Sample: JWK92-23-3
Depth: 1851.7m
Age: probably Aalenian, J14A

Remarks
This rich sample has a rather limited composition which in some ways resembles a Poker Chip assemblage. For example, Mathesporites tumulus is numerous and there are a few specimens of Leptolepites/Uvaesporites spp. Araucariacites australis is unusually abundant however which, in this area, is more typical of post-Poker chip samples. Small dinocysts are absent but Fromea 83/1 is abundant. An Aalenian age is tentatively proposed.

Significant species
Fromea 83/1 (A)
Leptolepites/Uvaesporites spp.

Mathesporites tumulosus
Araucariacites australis (A)
WELL: 10-34-54-11W5
Samples: JWK92-22-1, 22-2
Depths: 1815.35m, 1815.9m
Age: Indeterminable

Remarks
These samples are rich in highly oxidized, inertinitic debris. No identifiable palynomorphs are present.

Samples: JWK92-22-3, 22-4
Depths: 1819.5m, 1820.5m
Age: Earliest Aalenian to Late Toarcian, J14A-B

Remarks
These are typical Poker Chip assemblages. The presence of *Parvocysta cracens* in 22-3 means that the sample is no younger than the earliest Aalenian, *opalimum* Ammonite Zone. There are also several specimens of *Fromea 83/1* in both samples and *Callialasporites dampieri* is numerous in 22-3. *Nannoceratopsis senex* is abundant in 22-4.

Significant species
*Parvocysta cracens*  
*Lithodinia serrulata*  
*Nannoceratopsis gracilis*  
*Callialasporites dampieri*  
*Fromea 81/1*  
*Phallocysta minuta*  
*N. senex (A)*
WELL: 13-21-55-11W5
Samples: JWK91-6-1, 6-2, 6-3
Depths: 1859m, 1861.5m, 1864.3m
Age: Probably Cretaceous

Remarks
The preservation of the spores and pollen in these three samples is extremely poor and most specimens are unidentifiable. The overall appearance is similar to sample 5-1 and the presence of cf. Taxodiaceaeapollenites hiatus suggest a Cretaceous age. A specimen of Cicatricosisporites sp. also tends to favor a Cretaceous age, although this taxon is found, albeit relatively rarely, in rocks as old as Late Kimmertidgian. A spore resembling Ischyosporites disjunctus is present in 6-3. Undoubted specimens would indicate a Cretaceous age.

Significant species
- cf. Taxodiaceaeapollenites hiatus
- Clasopollis spp.
- Cicatricosisporites sp.
- Callialasporites turbatus
- C. trilobatus
- Lycopodiumsporites reticulumsporites
- Bisaccate pollen (A)
- Cerebropollenites mesozoicus
- Baculatisporites cf. comaumensis
- C. damperii
- Ischyosporites cf. disjunctus
- L. spp.

Samples: JWK91-6-4, 6-5
Depths: 1864.55m, 1865.6m
Age: Indeterminable

Remarks
Sample 6-4 yielded a small residue containing a few indeterminable spores. Sample 6-5 yielded abundant amorphous inertinitic kerogen similar to many of the samples in 4-30-37-3W5.
Sample: JWK91-5-6
Depth: 1868.5m
Age: Aalenian - late Toarcian, J14A-B

Remarks
This assemblage is grossly similar to samples 5-3 to 5-5 and is typical of the Poker Chip and contiguous strata.

Significant species

Lithodinia cf. serrulata
Fromea sp.

Classopolis spp. (A)
Exesipollenites spp. (A)
Leptolepidites spp.
Callialasporites turbatus
C. trilobatus
Araucariacites sp.

Dinocyst PC-1
Scriniocassid cf. weberii

Corollina spp. (A)
Mathesporites tumulosus (A)
Uvaesporites spp.
C. dampieri
Corrugatisporites amplexaetiformis
Perinopollenites elatioides
WELL: 13-27-55-11W5
Sample: JWK91-3-1
Depth: 1871.9m
Age: Indeterminable

Remarks
This sample consists of amorphous kerogen similar to samples 2-3 to 2-9. An age cannot be assigned.

Sample: JWK91-3-2
Depth: 1873.4m
Age: late Middle Bajocian, J13

Remarks
This sample is rich in well-preserved palynomorphs. Abundant Sentusidinium asymmetricum with a specimen of Phallocysta eumeke indicates a late Middle Bajocian age, J13B, humphriesianum Ammonite Zone.

Significant species
Sentusidinium asymmetricum (A)  Phallocysta eumeke
Clasopolis spp. (A)  Caddasphaera halosa (A)
Callilasporites turbatus  Bisaccate pollen (A)
Perinopollenites cf. elatoide  C. dampieri
Exesipollenites sp. (A)  Uvaesporites sp.
Cerebropollenites mesozoicus  Leptolepidites sp.
Sestosporites pseudalveolatus

Sample: JWK91-3-3
Depth: 1874.2m
Age: Indeterminable

Remarks
This sample yielded a small residue of inertinitic grains only.
Samples: JWK91-3-4, 3-5
Depths: 1878.15m, 1884.2m
Age: Aalenian-late Toarcian, J14 A-B

Remarks
These samples yielded rich assemblages dominated by spores and pollen. They closely resemble samples 4-2 to 4-5 in the 4-34 well.

The age is based on a distinctive dinocyst association which is often found in the shales assigned to the Poker Chip Formation. The marker species include Evansia evittii, Lithodinia cf. serrulata, Dinocyst PC-1, Fromea sp. and Caddasphaera halosa.

The abundance of spores resembling Mathesporites tumulosus suggests a position relatively close to a shoreline.

Significant species
Evansia evittii
Dinocyst PC-1
Caddasphaera halosa
Mathesporites tumulosus (A)
Classopolis spp. (A)
Exesipollenites spp. (A)
Perinopollenites cf. elatioides
Cerebropollenites mesozoicus
Ischyosporites crateris
Lycopodiumsporites austroclavatidites

Leptodinia cf. serrulata
Fromea sp.
Leptolepidites sp.
Corollina spp. (A)
Callialasporites turbatus
C. dampierii
Corrugatisporites amplexaetaeformis
I. cf. punctatus
Uvaesporites spp.
WELL: 10-29-55-11W5
Samples: JWK91-5-1
Depths: 1864.5m
Age: Probably Cretaceous

Remarks
This sample is rich in largely unidentifiable small spores and pollen. Bisaccate pollen is also abundant and a single long-ranging dinocyst is present.

Most of the recognisable spores and pollen have long stratigraphic ranges through much of the Jurassic and Cretaceous. However, the presence of some grains which resemble Taxodiaceaeopollenites hiatus indicates a Cretaceous age for the sample. The overall character of the spores and pollen is also more typical of the Cretaceous than the Jurassic when compared with other samples in this and previous studies.

Significant species

cf. Taxodiaceaeopollenites hiatus
Cerebropollenites mesozoicus
Callialasporites turbatus
Bisaccate pollen (A)

Lycopodiumsporites spp.
Concavissimisporites spp.
Neoastrickia truncata

Pareodinia ceratophora

Sample: JWK91-5-2
Depth: 1869.3m
Age: Indeterminable

Remarks
The kerogen consists of inertinite and semi-fusinite grains with extremely rare palynomorphs. If the species listed below were present in large numbers the sample would probably be assigned a Jurassic age, however, because of the poor recovery, an age cannot be assigned with any confidence. A similar situation occurred in JWK91-2-2 (4-30-37-3W5) where it was interpreted as being due to reworking.

Significant species
Corollina sp.
Exesispollenites sp.

Classopollis sp.
Leptolepidites sp.

Dinocyst indet.
Samples: JWK91-5-3, 5-4, 5-5
Depths: 1873.3m, 1873.9m, 1874.3m
Age: Aalenian - late Toarcian, J14 A-B

Remarks
These three samples yielded rich assemblages which closely resemble those in samples 3-4, 3-5 and 4-2 to 4-5. Marker species include Lithodinia cf. serrulata, Dinocyst PC-1, Caddasphaera halosa, Nannoceratopsis gracilis, Fromea sp. and an array of spore species assignable to Mathesporites tumulosus, Leptolepidites spp. and Uvaesporeites spp.

The presence in 5-4 and 5-5 of dinocyst fragments which closely resemble Parvocysta cracens suggest that these samples are no younger than earliest Aalitan in age (opalinum Ammonite Zone).

Significant species
Lithodinia cf. serrulata
Caddasphaera halosa
Fromea sp.
Classopollis spp. (A)
Exesipollenites spp. (A)
Leptolepidites spp.
Callialasporites turbatus
Perinopollenites elatoides
Corrugatisporites amplexaeformis

Dinocyst PC-1
Nannoceratopsis gracilis
Parvocysta cf. cracens
Corollina spp. (A)
Mathesporites tumulosus (A)
Uvaesporeites spp.
C. dampieri
Ischyosporites spp.
Araucariacites sp.
WELL: 9-32-55-11W5
Sample: JWK91-13-1
Depth: 1962m
Age: Possibly Early Cretaceous

Remarks
This sample is dominated by long-ranging bisaccate pollen which comprise 88% of the assemblage. This feature is typical of other Early Cretaceous samples in this study although there are no Cretaceous markers present. There are species present which range down into the Kimmeridgian such as Concavissimisporites exquisitus, C. montucus and Ischyosporites pseudoreticulatus. The latter does not range below the latest Kimmeridgian, J2, in western Canada.

An Early Cretaceous age is tentatively assigned but a latest Jurassic age cannot be ruled out.

Sample: JWK91-13-2
Depth: 1962.4m
Age: Early Middle Jurassic

Remarks
Small, mostly indeterminate spores and pollen (41%) and Classopolis spp. (28%) species dominate this assemblage. Bisaccate pollen are relatively rare at 4%. Identifiable dinocysts are extremely rare and limited to small specimens of Escharisphaeridia sp. Small, simple Leiospheres are abundant suggesting a highly restricted environment such as a lagoon.

The overall character of the assemblage is typical of the early Middle and Early Jurassic of western Canada but the lack of any marker species prevents a more accurate age assignment.
Samples: JWK91-13-3, 13-4
Depths: 1966m, 1967.8m
Age: Aalenian, J14A

Remarks
Dinocysts, especially very small species, typical of the Poker Chip Shale are abundant in both samples. The presence of Fromea 83/1 and F. senilis at 1967.8m suggests that these samples are more likely Aalenian than Toarcian in age.

Significant species
Fromea 83/1 (A)  F. senilis
Nannoceratopsis gracilis  Evansia evittii
Lithodinaia serrulata (A)  Dinocyst PC-1 (A)
WELL: 4-34-55-11W5
Sample: JWK91-4-1
Depth: 1872m
Age: Indeterminable

Remarks
This sample contains amorphous kerogen similar to sample 3-1. An age cannot be assigned.

Samples: JWK91-4-2 to 4-5
Depths: 1875.7m, 1876.3m, 1879.1m, 1880.1m
Age: Aalenian-late Toarcian, J14 A-B

Remarks
The rich, well-preserved assemblages from these samples are virtually indistinguishable from samples 3-4 and 3-5. They are typical of the Poker Chip and an undifferentiated Aalenian-late Toarcian age is assigned.

Significant species
Evansia evittii
Dinocyst PC-1
Caddasphaera halosa
Phallocysta eunekes
Mathesporites tumulosus (A)
Classopollis spp. (A)
Exesipollenites spp. (A)
Perinopollenites cf. elatioides
Cerebrospollenites mesozoicus
Corrugatisporites amplexaformis
Lycopodiumspores reticulumsporites
Uvaeasporites spp.

Lithodinia cf. serrulata
Fromea sp.
Nannoceratopsis gracilis
Scriniocassid cf. weberi
Leptolepidites sp.
Corollina spp. (A)
Callialasporites turbarus
C. dampieri
Araucariacites cf. australis
Ischysporites crateris
L. austroclavatidites
cf. Couperisporites sp.
WELL: 6-10-55-12W5
Samples: JWK91-12-1, 92-36-1
Depths: 6228’, 6229’
Age: Cretaceous

Remarks
Bisaccate pollen are abundant in both samples but undoubted Cretaceous markers are rare. Specimens of Appendicisporites bilateralis, Aequitriradites spinulosus and Foraminisporis cf. wonthaggiensis in 92-36-1 indicate a Cretaceous age. Recycled Jurassic palynomorphs are present, especially in 91-12-1 where it is difficult to assign a Cretaceous age based on that assemblage alone.

Significant species
Appendicisporites bilateralis  Aequitriradites spinulosus
Foraminisporis cf. wonthaggiensis

Sample: JWK91-12-2
Depth: 6229.7’
Age: ?Jurassic

Remarks
This sample is not dissimilar to 91-12-1 in that bisaccate pollen are abundant (75%) but there are no Cretaceous markers. Specimens of Escharisphaeridia rudis, Acanthaulax sp. and Gonyaulacysta cf. jurassica suggest a Middle Oxfordian age but, given the high level of reworking in the higher samples, a Cretaceous age cannot be ruled out.

Significant species
Bisaccate pollen (A)  Escharisphaeridia rudis
Gonyaulacysta cf. jurassica  Acanthaulax sp.
Sample: JWK91-12-3
Depth: 6241.5'
Age: Early Middle Oxfordian, J8

Remarks

Dinocysts are abundant in this sample especially *Gonyaulacysta jurassica* and *Liesbergia cf. scarburghensis*. The abundance of the latter species and the lack of older markers is typical of the early Middle Oxfordian, zone J8. Also present are specimens of *Ellipsoidicyum cf. cinctum* and *Valensiella ovula*.

Many of the dinocyst specimens are poorly preserved due to bacterial attack and are difficult to identify to species level.

Significant species

*Liesbergia cf. scarburghensis* (A)
*Gonyaulacysta jurassica* (A)
*Acanthaulax spp.* (A)
*Escharisphaeridula rudis*
WELL: 7-35-55-14W5
Sample: JWK91-11-1
Depth: 2029.7m
Age: Early Cretaceous

Remarks
This rich sample is dominated by non-age diagnostic bisaccate pollen which comprise 75% of the assemblage. Most of the spore and pollen species have long stratigraphic ranges but species such as Foraminisporis dailyi and Taxodiaceaeapollenites sp. indicate an Early Cretaceous age.

A small number of dinocysts is present but appear to be largely reworked. A specimen of cf. Atoapodinum sp. which resembles forms found with Balmula tripenta in 91-16-1 and 91-17-2 also confirms the age.

Significant species
Foraminisporis dailyi
Taxodiaceaeapollenites sp.

Sample: JWK91-11-2
Depth: 2030.1m
Age: Early Oxfordian J9A-B

Remarks
This relatively rich sample contains abundant dinocysts of Jurassic aspect, especially Escharisphaeridia rudis which is abundant in 91-22-1, 22-2, 23-1 and 23-2. Other significant species include Sentusidinium villersense, Ellipsoidicyum gochtii and Gonyaulacysta jurassica. Bisaccate pollen are also abundant as they are in the other two wells. Specimens of Lithodinia sp. and Meiourogonyaulax cf. callomonii may indicate a Callovian influence but there is a stronger resemblance with the Oxfordian samples in wells 91-22, 91-23 and 92-40.

Significant species
Escharisphaeridia rudis (A)
Sentusidinium villersense
Samples: JWK91-11-3, 11-4
Depths: 2035.7m, 2043.45m
Age: Aalenian, J14A

Remarks
These two rich samples yielded similar assemblages in which dinocysts are quite numerous. The presence of *Scriniocassis priscus* indicates that the sample is no younger than Early Bajocian (*sauzei* Zone). However, numerous specimens of *Fromea senilis* suggest an Aalenian age.

Significant species
*Scriniocassis priscus*  
*Nannoceratopsis gracilis*  
*Fromea senilis*


