Jurassic Boundary Study

Medicine River/Sylvan Lake

(Twp. 37 - 40, Rg. 3 - 5W5)

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1Dolby and Associates
Executive Summary

The Medicine River/Sylvan Lake area (Townships 37-40, Ranges 3-5 W5) is one of the most prolific oil and gas areas in the Western Canada Sedimentary Basin. This area is intensely drilled and contains an abundance of subsurface data, yet in terms of correlation of the Lower Cretaceous, Jurassic and Mississippian productive intervals, it is one of the most problematic. The Jurassic units are unconformity bounded and the distinction between the Cretaceous and Jurassic strata generally cannot be made using geophysical well logs alone. Similar challenges may also be encountered in differentiating Jurassic from Mississippian strata.

The emphasis of this report is on working scale cross sections, providing a consistent set of correlations. The correlations have been reviewed by government and industry geologists with extensive experience in the area. Representative cored wells, palynology and where appropriate, petrography form the basis for correlations. The aim of this report is to provide a reference framework from which more detailed correlations and studies of the Jurassic boundary can be made. Previously, comprehensive data for this stratigraphic interval, particularly the palynology and reference sections were not publicly available to the private sector.

This report contains descriptions of key lithofacies, 21 interlocking cross sections, 102 core descriptions (with the associated core gamma or equivalent geophysical log curves), and analysis of over 200 palynology samples. Five distinct successions are investigated: the Ellerslie Formation, J-Valley units (J1 to J3), Rock Creek Member, Nordegg Member, and the Mississippian (Banff Formation, Pekisko Formation, Shunda Formation and Elkton Member).
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Introduction

Considerable confusion over the age of productive intervals and the legal ramifications associated with "best guess" correlations of Jurassic and Cretaceous units in west-central Alberta led to the initiation of two stratigraphic/palynological studies. This report provides a consistent set of correlations for the Jurassic boundary in the Medicine River/Sylvan Lake area, Townships 37-40, Ranges 3-5 W5 (Figure 1). The complementary study by Kramers and Dolby (1993) provides a regional assessment for Townships 33-55, Ranges 1-15W5. A common well, 7-22-37-4W5, links the two studies.

Within the Medicine River/Sylvan Lake area, hydrocarbon recovery is obtained from numerous stratigraphic levels including the Cardium, Viking, Glaucanitic, Ostracod and Ellerslie units of Cretaceous age; Rock Creek and Nordegg in the Jurassic; J1 to J3 valley fills, the Elkton, Pekisko and Shunda units in the Mississippian; and the deeper Leduc reef trend in the Devonian. Although much of this area is intensely drilled, considerable hydrocarbon potential remains and the area is a favoured exploration target for oil and gas companies operating in this portion of the Western Canada Basin.

The Jurassic units are unconformity bounded, highly variable in terms of lithofacies and challenging to correlate. The distinction between Cretaceous and Jurassic sandstones is commonly unclear, particularly for valley fill quartzose units in Townships 39, 40 and 41, Range 3W5 (TerBerg, 1966; Hopkins, 1981); Township 38, Range 3W5 and the recently discovered valley fill successions in Twp 37, Ranges 3 and 4W5 (Figure 2).

Extreme topography associated with the Mississippian and Jurassic surfaces, numerous post-Jurassic incisions, erosional outliers, karst intervals, and variations in well log quality (ie. 1950's compared to modern logs) produce a significant amount of subjectivity in some picks. For these reasons, representative cored wells form the basis for correlation. The cross sections contained in this report have been reviewed by government and industry geologists working this area, resulting in general agreement on the picks presented. Dolby and Associates provided the palynological interpretation. The senior author takes responsibility for the interpretations and picks in the report noting, however, that reinterpretation of some wells is expected as new drilling and associated 3-d seismic data redefines the local stratigraphy. Accurate maps of the valley fill successions and the Jurassic erosional edges would have to be updated yearly, requiring an evaluation of every available core and well log, and seismic data on an LSD by LSD basis. The maps, cross sections, core descriptions, palynology results, and thin section data presented in this report, provide a reference framework from which more detailed correlations and studies can be made.

This study includes 102 core descriptions (with the associated core gamma or equivalent geophysical log curves), palynological analysis of approximately 200 samples and a series of 21 interlocking cross sections.

Five distinct successions are investigated:

1. Ellerslie successions (Cretaceous)
2. Valley fill units (J1 to J3)
3. Rock Creek Member (including the Poker Chip Shale)
4. Nordegg Member
5. Mississippian units (Banff Formation, Pekisko Formation, Shunda Formation and Elkton Member)

In the back of this report are:

- Appendix 1 (Interpreted Core Descriptions)
- Appendix 2 (Palynological Analysis - Introduction and Summary)
- Appendix 3 (Palynological Analysis - Sample Descriptions)
Figure 1. Location of the detailed study area with respect to regional trends (modified after Springer et al., 1963 and Carlson, 1968).
Figure 2.
Rock Creek and Nordegg erosional edges and location of major Jurassic valley fill successions
Mississippian Units

The cross sections in this report extend down to the Banff Formation because correlation of the Jurassic requires a firm understanding of the Mississippian units. Mississippian "highlands" in Townships 38 to 40, Range 3W5 for example, are often overlain by productive or potentially productive Nordegg and Rock Creek successions of the Jurassic. In addition, Mississippian units themselves are commonly productive, particularly in association with subcrop edges or karsting. Just as importantly, J-valley and Cretaceous valley fills, 30 to 150 m deep, 2 to 4 km wide and tens of kilometres long are well delineated by Mississippian isopach maps (Figure 3). Careful study and mapping of valley trends and preserved "highlands" offer critical data for interpreting the lateral extent of Jurassic/Cretaceous strata.

The basic Mississippian stratigraphy and large scale isopach maps are provided by Penner (1958) and Martin (1967). A more in-depth look at the paleogeography and lithofacies associations are provided by Richards et al. (1993) and Speranza (1993). Numerous Mississippian oil and gas pools appear to be associated with dolomitized units and/or structure. Further studies examining lithofacies, structural controls and karst processes in the Mississippian are highly recommended for both scientific and economic reasons. In this report, only brief informal descriptions of the subcropping units are discussed for application to Jurassic boundary correlations. These units are, in ascending order: Banff Formation, Pekisko Formation, Shunda Formation and Elkton Member of the Turner Valley Formation.

Banff Formation

The Banff Formation subcrops at the base of valley fill successions and east of the northwest oriented Pekisko Formation erosional edge (Figure 3). In the cores examined, only the uppermost Banff is described. This unit has a distinctive buff to grey colour and consists of silty dolostone. Green, pyritic, non calcareous mudstone interbeds may also be present in variable amounts. The informally named "Clark's Member" near the Banff/Pekisko contact appears to be most prone to karsting (and the associated collapse or breccia pipes) which is observed most commonly at the base of J Valley fill (Cross section 5-5').

With the exception of severely karsted intervals and valley fill areas, the uppermost Banff Formation is recognized on geophysical well logs by the sharp shift to the right of the gamma ray curve, shift to the left on the porosity curves and low resistivity compared to the overlying Pekisko carbonates (Figures 4 and 5).
Figure 3. Isopach map of Pekisko Formation. Note the orientation of post-Mississippian incised valleys (from Martin, 1967).
Figure 4. Type log 12-11-39-5W5, Poker Chip shale absent.
Figure 5. Type log 6-23-39-5W5, partial erosion of Shunda Formation.
Pekisko Formation

The Pekisko Formation is one of the most common Mississippian units cored in the study area. This succession is a clean bioclastic limestone, consisting of assorted crinoidal ossicles and plates, bryozoan fragments and spirifer shell remains. Minor green mudstone interbeds are also found but are less common. According to Martin (1967), the Pekisko undergoes secondary dolomitization within the valley areas; here, the unit is described as a fine sucrosic to medium crystalline dolostone.

On logs, the Pekisko Formation displays a characteristic blocky gamma ray signature, high resistivity, and relatively tight porosity log responses (Figures 4 and 5). Typically, the Pekisko ranges in thickness from 30 m to 36 m, with the exception of eroded or faulted units associated with valley incision (Cross section 11-11').

Shunda Formation

The Shunda Formation consists of green dolomitic mudstones and silty dolostones, which overlie the relatively clean Pekisko carbonates. The green to greenish grey colour and dolomitic composition appears to be characteristic and distinctive. Karst breccias associated with the Shunda/Jurassic unconformity contact are prominent features. A similar observation is noted by Martin (1967) who cites a 43 m thick breccia within the Shunda at 12-28-36-7W5 and suggests that similar breccias are found throughout the study area at this stratigraphic level.

On geophysical well logs the Shunda Formation is recognized as a series of up to four cleaning upward or shallowing upward successions overlying the Pekisko Formation (Figure 4). Each shallowing upward succession has a distinctive signature, which can be used for regional correlation. Throughout much of the detailed study area, the upper portions of the Shunda Formation are partially eroded. Lower preserved portions can be correlated, however, based on these signatures (compare Figures 4, 5 and 6). In the extreme west, where the Shunda Formation is not eroded by post-Mississippian incision, all four shallowing upward successions can be recognized, with a cumulative thickness of up to 45 m (Figure 7, cross sections 1B-1B' and 11-11').
Figure 6. Type log 8-2-38-4W5, Cretaceous capping Mississippian.
Figure 7. Isopach map of the Shunda Formation illustrating erosional outliers and post-Mississippian valley systems (from Martin, 1967).
Elkton Member

The Elkton Member of the Turner Valley Formation, consists dominantly of dolostone, commonly characterized by vuggy porosity and bitumen staining. The Elkton may be silicified or cherty, particularly along the Jurassic unconformity contact. Crinoids, spirifers, corals and bryozoan fragments are selectively preserved in some cores. Euhedral calcite and quartz mineralization infilling fractures and voids is common.

On geophysical logs, the Elkton Member is recognized by its clean, blocky gamma ray signature and relatively high porosity (Figure 8). In this study, the Elkton is identified only where the complete succession of the Shunda Formation (ie. all four cycles) are present, providing consistency in the picks. Capping the Shunda, the Elkton is situated high in the stratigraphic column and is a prime target for post-Mississippian erosion. Generally the Elkton is found in the southwestern portion of the study (Townships 37-38, Ranges 4-5W5) and within isolated erosional outliers in Townships 37-38, Range 3W5 (Figure 9, cross sections 1B-1B' and 3E-3E').

Karst Features

Correlating the Mississippian/Jurassic or Mississippian/Cretaceous unconformity is challenging in many instances. In the cored well, 1-28-36-3W5, for example, Martin (1967) has identified a large block of Pekisko strata 30 m thick, which has slumped into a post-Mississippian valley. In this well, the Pekisko Formation is intersected at 2319 m and a detrital or karst zone consisting of sandstones, siltstones and green (oxidized) mudstones is found from 2349 m to 2393 m.

Some of the more identifiable examples of karst features in the immediate study area include breccias consisting of cobble sized, angular carbonate clasts with a green argillaceous matrix (12-10-39-3W5, Appendix One). Breccias with bedding angles of up to 30° to the core axis are interpreted as pipe or cavern deposits (10-28-40-3W5M, Appendix One). Myers (1988) describes similar paleokarst features exposed in Mississippian outcrops in New Mexico (Figures 10 and 11). Concentrations of pyrite, calcite filled fractures, oxidized intervals, slickensided mudstones, cutans (Hopkins, pers. comm.), and thin paleosols are features observed for these karsted successions.

On geophysical logs, karsted successions display anomalous gamma ray and sonic porosity or density porosity responses. The successions, which are pyrite rich and oxidized display "unconformity-type" kicks in which the gamma ray, resistivity and porosity logs go off-scale by an order of magnitude. Other intervals where the karsted interval contains sandstones and siltstones, however, may be difficult to differentiate from the Nordegg or J1 sediments (Cross section 3D-3D').
Figure 9. Isopach map of the Elkton Member illustrating prominent Mississippian highlands (from Martin, 1967).
Figure 10. Karst features of New Mexico Mississippian carbonates - possible analogues for the Mississippian strata in the Sylvan Lake/Medicine River area (from Meyers, 1988).
Figure 11. Variations in karsting effects associated with carbonate lithofacies (from Meyers, 1988).
**Nordegg Member**

The Nordegg Member is identified on the basis of stratigraphic position, between the Mississippian unconformity and the Poker Chip shale. From a regional context, lithologies in the Nordegg vary from black bituminous chert, to finely crystalline limestone (often dolomitic), to bioclastic limestone to a fine grained dolomitic sandstone (Deere and Bayliss, 1969; Poulton et al., 1990). Generalized stratigraphic relationships are shown in Figures 12 and 13.

Within the detailed study area the Nordegg is made up of thin breccias (marking the lower Jurassic/Mississippian erosional unconformity), calcareous sandstones, sandy limestones and coquinas, from the base to the top of the succession, respectively. Generally, the Nordegg Member is absent in Townships 37-38, Ranges 3-4W5 (Figure 2). Incision by numerous Cretaceous valley systems or erosion associated with the base of Rock Creek/Poker Chip succession have created a series of erosional outliers. Differences between the 1990’s and 1950’s geophysical log types and quality make correlation particularly challenging. Provided that adequate core control is available and knowing lithofacies trends, however, correlations can be made with reasonable confidence. Note that the erosional edge proposed in Figure 2 is generalized, and is subject to change when mapping on a more detailed scale, or new data is added.

**Nordegg Breccias (detrital)**

Nordegg breccias are extremely variable in composition, representing the detritus infilling lows, deposited at the base of Nordegg marine sediments. Rall (1980) differentiates this unit from Mississippian breccias (likely karst derived) on a local pool scale. For practical purposes, in this report, Nordegg breccias are lumped in with the Mississippian karst intervals due to difficulties in differentiating the lithologies of these two units at a similar stratigraphic level (Cross sections 5-5’ and 6-6’).

**Nordegg sandstones**

Nordegg sandstones are generally very fine grained to fine grained, and are comprised of quartz, chert, and rounded detrital dolomite grains. Accessories include fragmented pelecypod shells, crinoid stems, and rare gastropods (Rall, 1980). In the cores examined, the sandstones are massive, commonly calcareous, some with dissolution porosity, and many contain stylolite features (eg. 4-31-38-3W5; 14-18-39-3W5, Appendix 1). In Townships 39 and 40, Range 3W5, Nordegg sandstones of the Gilby Jurassic B and Medicine River Jurassic A pools, form high quality reservoirs capped by relatively impermeable Poker Chip Shale and these reservoirs are trapped updip by the western edge of the J Valley (Cross sections 3A-3A’ and 3B-3B’).
Further west these dolomitic sandstones become increasingly fossiliferous and calcareous. Termed the "Medicine River member", Collar (1990) outlines a lithofacies transition from dolomitic sandstones to calcareous sandstones and bioclastic limestones to the west. One transitional cored well described in the current study is 6-25-40-4W5 (Appendix 1), which consists of interbedded limestone and calcareous sandstone.

On geophysical logs, Nordegg sandstones have an irregular to blocky gamma ray and high resistivity signature (Figure 14) positioned between the distinctive Poker Chip Shale at the upper contact and Mississippian carbonates or dolomitic mudstones at the base.

**Bioclastic limestones**

Bioclastic limestones are medium grey, containing abundant pelecypod detritus and a finely crystalline calcite matrix. An example from the cores examined includes 12-11-39-5W5M (Appendix 1). Both Deere and Bayless (1969) and Collar (1990) show interbedded siltstones and sandstones marking the transition between the two lithofacies from west to east.

On geophysical logs, these limestones cap the Mississippian carbonates, with the Mississippian-Jurassic contact marked by subtle differences (Figure 4 @7866’). Correlation based on core description and recognition of distinctive lithofacies such as the coquina are essential to differentiate these contacts (Cross section 1B-1B’).

**Nordegg coquinas**

Nordegg coquinas or highly fossiliferous limestones are selectively preserved along paleo-highlands. These successions consist of large articulated or broken oyster shells, identified as *Ostrea*, 10 cm or more in diameter. This unit caps both the Medicine River member sandstones (4-13-40-4W5) and the bioclastic limestones (12-11-39-5W5M, Appendix 1). The Nordegg coquina makes an excellent core and geophysical log marker in the study area.

On geophysical logs, coquinas characteristically show a very clean, relatively tight limestone lithology response, high resistivity, and can be identified by its position capping Nordegg sandstones or bioclastic limestones (Figure 4, cross sections 2A-2A’ and 7-7’).
Figure 12. Generalized lithofacies and isopach map of the Nordegg Member (from Poulton et al., 1990).
Figure 13. Schematic cross section illustrating lithofacies transitions and stratigraphic relationships associated with the Nordegg Member (from Poulton et al., 1990).
Figure 14. Type log 16-20-35-3W5, Nordegg dolomitic sandstone named "Medicine River member" by Collar (1990).
**Fernie Formation**

The Poker Chip Shale, which underlies and in some instances is interbedded with the Rock Creek Member, is used to identify this middle Jurassic succession. The Poker Chip Shale ranges from Pliensbachian to Aalenian in age. The Rock Creek Member ranges from Aalenian to Bajocian. Within the study area, younger shales are selectively preserved capping the Rock Creek Member; typically these yield Bathonian to Oxfordian ages (Figure 15).

In the Rock Creek Member there is a complete range of lithofacies, from non-calcareous quartzose sandstones in the east, to calcareous sandstones and limestones in the west. Towards the west, quartzose sandstones interdigitate with fossiliferous sandstones and limestones (11-28-38-5W5, Appendix 1). In addition to lithofacies changes, widespread erosion by Ellerslie channel successions, has resulted in Rock Creek Member outliers.

**Poker Chip Shale**

The Poker Chip Shale is generally greenish grey, non-calcareous, silty and very platey (resulting in a series of centimetre thick discs). Thin interbeds of fine grained to very fine grained quartz arenite sandstones are rare, but have been observed. Typically, the Poker Chip Shale contains pyrite and minor glauconite. Characteristically, no coaly fragments or carbonaceous detritus have been observed. *Terebellina* and *Helminthopsis* trace fossils identified north of Township 50 (Putnam and Moore, 1993) suggest slow sedimentation rates and quiet water deposition, possibly in an inner shelf environment.

A very distinct olive green mudstone or siltstone, commonly slickensided or waxy in appearance, rip up clasts or conglomerate marks the base of the Poker Chip. At 10-32-39-6W5, Deere and Bayliss (1969) observed sub-rounded grains of quartz, chert and phosphatic material in a calcite matrix. The presence of phosphatic minerals and/or pyrite may account for distinct “unconformity” spikes observed on gamma ray and porosity logs typically marking the lower contact. This appears to be a regional unconformity surface (Cross section 2C-2C').
Rock Creek Member regional sandstones

Non-calcareous Rock Creek sandstones make up the major reservoir in the Sylvan Lake gas field and a portion of the oil production in the Gilby and Medicine River fields. These reservoirs consist of fine grained to very fine grained quartz arenites (97 to 100% quartz), typically churned to highly bioturbated, may contain stylolites and generally appear massive. Trace fossils identified include Asterosoma, Rhizocorallium, Terebellina, Thalassinoides, Diplocraterion, and Palaeophycus (See 12-10-39-3W5, Appendix 1).

On geophysical logs, these relatively thick, clean quartzose sandstones commonly appear blocky, with sharp upper and lower contacts (Figure 5). An unconformity spike may be recognized at the upper contact with Ellerslie sandstones or shales. Differentiating the highly quartzose sandstones of the Ellerslie from the Rock Creek quartz arenites based on geophysical logs alone, is a problem continually faced by workers in this area. In most instances, correlations based on cored wells are essential, where palynology, mineralogical differences, trace fossil interpretation and structures are used to differentiate these units (Cross sections 2A-2A' and 2B-2B').

Rock Creek Member calcareous sandstones and limestones

Rock Creek calcareous sandstones and limestones are typically found in the western portion of the study area. The limestones are generally dominated by pelecypod and echinoid fragments and cemented by calcite spar. A petrographic study of the Rock Creek limestones by Collar (1990) indicates that the quartz content can reach 17% to 36.5%, suggesting that these limestones are transitional with the siliceous sandstones to the east.

Geophysical logs show a similar blocky gamma ray response as the non-calcareous sandstones, particularly for the carbonate equivalents (Figure 4, cross section 1B-1B').

Fernie Shales

Fernie shales are dark grey and silty, but not as platey as the Poker Chip unit. Unlike the Poker Chip, the Fernie shales may contain carbonaceous detritus and commonly contain silty laminations. In some portions of the study area, Fernie shales are preserved capping the Rock Creek Member, typically yielding an Oxfordian age (Cross section 3B-3B').
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Figure 15. Jurassic palynological zonation and lithostratigraphy, (modified after Poulton et al., 1990).
Valley Fill Units (J1 to J3)

Hydrocarbon production is obtained from a deeply incised valley systems in Townships 39 - 41, Range 3W5, Township 38 Range 3W5, and the recently discovered oil pools in Twp 37, Range 3W5 (Figure 2). The J-valley trend in Townships 39 - 41 consists of 3 major sandstone successions, the J1, J2 and J3, initially described by Ter Berg (1966) and followed up in more detail by Rall (1980) and Hopkins (1981) (Figure 16, cross sections 5-5', 6-6', 8-8', 10-10', 11-11').

The J1 succession varies from relatively immature kaolinitic, cherty sandstones and chert breccias to relatively clean, quartzose, high porosity sandstones. It is interpreted as a detrital unit which may contain reworked Mississippian and Nordegg carbonates and sandstones, associated with initial valley fill. Locally, J1 sandstones are known to have porosities of 20%, and the overlying Poker Chip Shales and the J Valley edge provide the trap in petroleum reservoirs.

The J2 succession consisting of highly porous, fine grained quartz arenites is mineralogically mature. With the exception of a minor increase in chert content, this mineralogy is similar to that of the regional Rock Creek sandstones (Hopkins, 1981). The clean, blocky gamma ray response is commonly used to map this reservoir unit. Other features noted in cores from Township 40 Rge 3W5, include a waxy green mudstone marking the base and laminated rhythmic drape features (14-21-40-3W5, Appendix 1). Combined, the J1 and J2 sandstones are favoured exploration targets in the study area.

The J3 succession consists of moderately sorted, medium to fine grained sandstones, kaolinitic sandstones and sandy mudstones (Hopkins, 1981). The relatively high proportion of chert and angularity of quartz grains distinguish J3 and J2 sandstones in petrographic studies. In addition, the relatively high kaolinite content which is commonly present in J3 sandstones, can be interpreted from the wide separation between the CNL porosity and Density porosity curves (Hopkins, pers. comm.).

Age Determinations

In the lower reaches of the J-Valley, the Poker Chip Shale commonly drapes J1 sandstones establishing a Jurassic age for the J1 (Toarcian to Pliensbachian, Rall, 1980). In Township 40, Range 3W5 (this report) the base of the J2 unit is interpreted to be as young as Aalenian (7-29-40-3W5, Appendix 1), suggesting that the J2 is also Jurassic in age. Based on results of the current study, however no cored intervals containing capping mudstones have been available for dating J2 or J3 successions. The 10-10-41-3W5 well which is just outside of the study area contains a bedded mudstone capping the J2 unit, with palynology indicating a probable Bajocian age (Handcock et al., 1993). No age for the J3 successions has been established due to poor recovery of palynomorphs in this interval.
Ellerslie Formation

Cretaceous sandstone successions can be challenging to differentiate from Jurassic Rock Creek sandstone units in core, and commonly are impossible to differentiate if only geophysical logs are available. Careful description of core and thin sections combined with palynological interpretation, however, can lead to correlations with a relatively high degree of geologic confidence, particularly in areas where the depositional trends or preserved erosional edge of the Rock Creek is known.

Distinctive features that Ellerslie sandstones may display in core, include a salt and pepper appearance, coaly or carbonaceous detritus, and rootlets (6-21-39-3W5, 8-13-39-4W5 and 11-22-38-4W5, Appendix 1). The salt and pepper appearance is likely associated with the change in source area from the Canadian Shield to the east (during the early to middle Jurassic) to the westerly source (during the latest Jurassic and early Cretaceous). Black, bluish and white chert fragments derived dominantly from uplifted Paleozoic units produce the salt and pepper effect (Marion, 1984). The presence of high angle cross beds, ripple lamination and/or rip up clasts found in Cretaceous aged channel successions is also distinctive.

Jurassic sandstones are highly reworked and very quartzose. Where palynology is not applicable for a given well, the quartz arenite mineralogy of the Jurassic successions has been commonly used to differentiate the regional Rock Creek Member from Ellerslie sandstones (Cross sections 2B-2B' and 3E-3E'). This method is problematic in that Ellerslie sandstones may also be quartz arenites in some cases. The presence of feldspar (usually microcline) and biotite observed in thin section, however, has been used in this study to interpret a Cretaceous age. In published studies to date, no Rock Creek or Bajocian aged sandstones are known to contain feldspar grains, biotite or feldspar derived cements.

In terms of geophysical log character, Cretaceous sandstones may display fining-upward signatures. In addition, the contact between the Jurassic and Cretaceous may be marked by a concentration of pyrite, oxidized zone or clasts, resulting in an unconformity spike on logs. In core, the Cretaceous/Jurassic and Cretaceous/Mississippian contact may be marked by a green waxy mudstone (4-13-39-3W5, Appendix One). In some instances, interpreted sand on sand contacts of the Cretaceous/Jurassic are marked only by a slight change in grain size and the presence of a pyritic horizon (14-9-37-3W5, Appendix 1).

For most correlations, unless obvious woody detritus, rootlets or fining upward sandstones are observed, palynological dating of interbedded mudstones and thin section analyses are critical.
Conclusions

1. Within the Medicine River/Sylvan Lake area, considerable hydrocarbon potential remains and is a favoured exploration target for oil and gas companies operating in this portion of the Western Canada Sedimentary Basin.

2. Extreme topography associated with the Mississippian and Jurassic surfaces, numerous post-Jurassic incisions, erosional outliers, karst intervals, and variations in well log quality (i.e. 1950's compared to modern logs) make correlations challenging in the study area. This study provides a set of interlocking cross sections, representative core descriptions and palynological data to serve as a reference framework for detailed correlations.

3. Nordegg Member lithofacies include dolomitic sandstones, calcareous sandstones, sandy limestones and coquinas. The coquina lithofacies appears to be a reliable and diagnostic marker capping the Nordegg succession.

4. The Poker Chip Shale is one of the main units used for correlation. Its distinctive greenish grey colour and platey appearance together with characteristic log response, make the Poker Chip easily recognizable throughout the study area.

5. The Rock Creek Member exhibits a complete range of lithofacies, from quartz arenite sandstones to calcareous sandstones and limestones. In many cases, Rock Creek Member sandstones are difficult to distinguish from similar lithologies of the Cretaceous Ellerslie Formation.

6. The J1 and J2 valley fill successions appear to be Jurassic in age. The J1 succession varies from relatively immature kaolinitic, cherty sandstones and chert breccias to relatively clean, quartzose, high porosity sandstones. The J2 succession consists of highly porous, fine grained quartz arenites. Both the J1 and J2 successions are favoured exploration targets in the study area. The J3 succession is generally tight, consisting of kaolinitic sandstones and sandy mudstones. Dating of the J3 has not been possible, due to poor recovery of palynomorphs.

7. Distinctive features that Ellerslie sandstones may display in core, include a salt and pepper appearance, coaly or carbonaceous detritus, and rootlets, however, quartz arenites of the Ellerslie can be difficult to differentiate from quartz arenites of the Rock Creek Member. Careful description of core and thin sections combined with palynological interpretation are required to differentiate Ellerslie from Jurassic units.
Acknowledgements

A study of this type with its complex stratigraphy and need for extensive sample data, cannot be done in isolation. This work is the result of collaborative efforts between government and industry. We wish to acknowledge Amoco Canada Ltd. for financially supporting this study, the Alberta Department of Energy and the Alberta Research Council for covering the costs of staffing and travel, and the Energy Resources Conservation Board for providing support through technical services and access to the ERCB Core Research Centre.

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References Cited


Appendix 1
(Core Descriptions)

Medicine River/Sylvan Area
(Twps 37,38,39 and 40
Rges 3,4 and 5W5)
<table>
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<th>List of Cores</th>
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6-12-40-4W5
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14-19-
6-25-
10-26-
4-36-

14- 4 - 40-5W5
Symbols used in the core study:

Lithology

- Sandstone
- Silty Sandstone
- Silty Mudstone
- Mudstone
- Dolomitic Mudstone
- Limestone
- Dolostone
- Breccia
- Coquina

Contacts

- Erosional (scoured)
- Sharp
Samples

- JWK91-7.3 @ 7361.6' (P2-T2)
  - Sample number
  - Depth
  - Age determined by palynology

Structures

- Planar tabular bedding
- Low angle tabular bedding
- Flaser bedding
- High angle cross bedding

Accessories

- Rip up clasts
- Breccia horizon
- Calcareous
- Dolomitic
- Pyrite
- Woody material
- Paleosol horizon

- Coal lamina
- Coal fragments
- Siltstone lamina
- Mudstone lamina
- Organic mudstone lamina
- Pebbles/ granules
Ichnofossils

Rootlets
Diplocraterion
Planolites
Palaeophycus
Teichichnus
Asterosoma
Zoophycus
Escape trace

Fossils

Plant remains
Pelecypods
Crinoids
Corals
Molluscs
Shell fragments
Date logged: October 23, 1992
Logged by: Rudy Strobl

**Core Gamma**

- Finely interlaminated, wavy bedding, siltstone, vfg sandstone and minor shales (double mud drapes thoughout)
- Very pyritic, selective replacement of clasts by pyrite?
- Rock Creek sandstone, highly bioturbated, buff coloured, stylolites, massive.
- White fossiliferous limestone, Rock Creek?
- Green to greenish grey dolomites and dolomitic shales, massive, minor pyrite
Date logged: October 22, 1992
Logged by: Rudy Strobl
Remarks: Rock Creek over Mississippian High

[Diagram showing grain size and core gamma with labels for Rock Creek sandstone, dark grey shale with abnt pyrite, green to white Dolomitic shale (Shunda? Fm), rip ups common, green slickensided shale marking transition with Mississippian at base.]
Gulf et al Sylvan Lake
14-19-37-3w5

Date logged: July 15, 1993
Logged by: John Kramers

Geophysical log gamma curve

- Sandstone, fine grained, kaolinitic, argillaceous in part, massively bioturbated, no apparent sedimentary structures. Appears to grade into the unit below.
- Interbedded v.f. sandstone, siltstone, with brown laminated shale, laminations vary from subhorizontal to wavy scattered x' laminae. Grades into the unit below. No apparent bioturbation.
- Looks like the interval from 7431-7482 in the 4-30-37-3W5 well.

JWK93-2-1 @2266.65 Cretaceous
JWK93-2-2 @2267.3 Indeterminate
JWK93-2-3 @2268.43 Cretaceous
JWK93-2-4 @2270.5 Indeterminate
- Black shale with some interbedded silt sand laminae, shows as a radioactive kick on gamma log.

JWK93-2-5 @2272.0 Early Oxfordian
JWK93-2-6 @2272.75 Early Oxfordian
- Siltstone, argillaceous with interbedded shale laminae, abundant pyrite in nodules and laminae, gets sandy towards base and grades into sand below.

JWK93-2-7 @2279.2 Indeterminate
JWK93-2-8 @2284.2 Indeterminate
JWK93-2-9 @2285.75 Indeterminate
- Sandstone, fine grained, argillaceous in part, bioturbated with some clear trace fossils showing up in parts of the core, gets more argillaceous towards the base, some horizontal laminae @2280. Could be Jurassic J2 sand.
- Sandstone to shaly sand, abundant pyrite
- Sandstone, v.f to f grained, pyrite, scattered shale laminae
- Sandy shale to shaly sand, pyrite
- Sandstone, argillaceous, scattered shaly laminae, may have minor bioturbation
- Carbonate breccia, with minor sand between clasts
Sun Sylvan Lake
12-20-37-3w5

Date logged: October 22, 1992
Logged by: Rudy Strobl
Remarks: Rock Creek erosional outlier

---

Core gamma
Rock Creek
Reworked? Poker Chip

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

FEET

(Indet) RS 92-59-1 @7415.2
(Indet) RS 92-59-2 @7419.2

Green, waxy mudstone
Chert, dolomite, green mudstone breccia
Glenora Shelter
4-27-37-3w5

Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Well defined Rock Creek at this location, capped by Fernie mudstones.

Geophysical log gamma

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Cretaceous (possibly fluvial) sandstones
Dark grey shales with scattered pyrite throughout. Not as black or as massive as typical Poker Chip
(Bathonian) RS 92-24-1 @2180.35
(Bathonian) RS 92-24-2 @2180.90
Black carbonaceous remains interpreted as plant fragments.
Finer grained dark stained sandstone above vs upper fine grained, white, highly bioturbated sandstones of Rock Creek below.

Green shale, slickensided
(Bajocian?) RS 92-24-3 @2194.25
(P2-T2) RS 92-24-4@2194.75
(P2-T2) RS 92-24-5@2195.00
Black massive mudstones typical of Poker Chip
Date logged: October 22, 1992  
Logged by: Rudy Strobl  
Remarks: Rock Creek and thin Poker Chip preserved on Mississippian High  
(Note the complete Shunda and thick Elkton, on logs)

---

**Geophysical log gamma curve**

**Rock Creek**

**Lower Fernie** (Poker Chip)

**GRAIN SIZE**
- cobble
- pebble
- granule
- sand
- silt
- clay

**BIOTURB**

**FEET**
- 7300
- 7310
- 7320

---

Rock Creek Sandstone, with minor shale laminae and mudstone drapes, highly bioturbated throughout

Green waxy silty shale marking transition to Rock Creek sandstone

(Indet) RS 92-60-1 @7320.0
(P2-T2) RS 92-60-2 @7323.0
(P2-T2) RS 92-60-3 @7324.8

Dark grey, platey Pocker Chip shale
Date logged: May 13, 1993
Logged by: Rudy Strobl
Remarks: To determine Rock Creek VS Ellerslie.

Geophysical log gamma

Thin section @7217
Quartzose sandstone with organic laminae. Bleached appearance. Likely Rock Creek. 15 cm friable sandstone, kaolinite? rich, pyritic Organic rich laminae

Thin section @7229.5
Dolomitic mudstone typical of Shunda Formation, breccias associated with Karst surface. Light grey dolostone, brecciated with green mudstone matrix. Vertical karst pipe infilled by secondary calcite and green mudstone.

Thin section @7217
Well sorted, clean, quartzose sandstone, subrounded to subangular, rare chert, mica inclusions, quartz overgrowths common.

Thin section @7229.5
Well sorted, quartzose sandstone, subrounded to subangular, minor heavy minerals, quartz overgrowths common.
Core gamma

**GRAIN SIZE**
- cobble
- pebble
- granule
- sand
- silt
- clay

**Shale, black, minor siltstone beds, some bioturbation**
- JWK91-10-1 @7354.0' (Cretaceous)
- JWK91-10-2 @7363.0' (Cretaceous)

**Salt and pepper sandstone, massive, fining upward channel deposit**
- JWK91-10-3 @7377.5' (Indet)
- Pebby sandstone
- JWK91-10-4 @7386.0' (Poss Cretaceous)

**Salt and pepper sandstone, generally massive, some high angle cross bedding**

**Several v. large (up to 6'-10") limestone boulders in the sand marking base of channel succession.**
- JWK91-10-5 @7419.0' (Indet)

**Quartzose sandstone, minor shaly laminae (micaceous), some high angle cross beds**
- JWK91-10-6 @7445.0' (Indet)

**Erosional surface with pebbles and v. coarse sand, high angle bedding**
- JWK92-68-1 @7465.2' (Indet)
- JWK91-10-7 @7467.0' (Indet)
- JWK92-68-2 @7468.0' (Indet)
- Shale, black with interlaminated siltstone
Kewanee Sylvan Lake 4-30
04-30-37-03w5

Date logged: August 13, 1991 / July 7, 1992
Logged by: John Kramers
Remarks: Valley Fill

---

Core Gamma

Grain Size
- cobble
- pebble
- granule
- sand
- silt
- clay

---

Ellerslie

Cretaceous Valley Fill

---

Sandstone, silty with shaly laminae, vertical burrows
Shale, black, sandstone interbeds

JWK91-2-1 @7391.0' (Cretaceous)
Sandstone, fg, with Skolithos and Palaeophycus

JWK91-2-2 @7406.0' (Indet)
Sandstone, medium grained to coarse grained at base
Typical fining upward salt and pepper Lower Cretaceous sand

JWK91-2-3 @7428.0' (Indet)
JWK91-2-4 @7431.0' (Indet)

JWK92-67-1 @7445.0' (Indet)

JWK91-2-5 @7454.0' (Indet)
Interbedded fg to mg sandstone, quartzose, shale and siltstone laminations

Sandstone, mg, quartzose, high angle cross beds

JWK91-2-6 @7476.0' (Indet)
JWK91-2-7 @7478.0' (Indet)

JWK92-67-2 @7489.0' (Indet)
JWK91-2-8 @7494.0' (Indet)
JWK91-2-9 @7498.0' (Indet)
Rock Creek Mbr? or J2?

Poker Chip?

Sandstone, fg to mg, quartzose, scattered shale laminae

Black shale grading down into pyritic mudstone

JWK91-2-10 @7525' (latest Bathonian)

Sandstone, fg to mg, quartzose, fairly well sorted, shaly partings and shale wisps

Sandstone, fg to mg, quartzose, argillaceous at base

JWK91-2-11 @7566.0' (Bath- Bajo undiff)

JWK91-2-12 @7569' (Indet)

JWK91-2-13 @7573' (no younger than Baj)

Shale, dk green to greenish grey, some chert fragments, silty in part

JWK91-2-14 @7579.0' (Jurassic)
Sandstone, fine to med. grained, quartzose, fairly well sorted, pyrite disseminated throughout, bedding appears to be at high angle to core, scattered oil staining, erosional surfaces within sand clearly visible.

50 cm of finer sand with high angle lenticular laminae

JWK91-1-1 @ 2247.2 m (Indet)

Soft sediment deformation

JWK92-69-1 @ 2257.0 m (Indet)
Shale, light grey, abnt silt/sides, pyritic
JWK91-1-2 @ 2258.2 m (Indet)
Sandstone as above
JWK91-1-3 @ 2261.2 m (Indet)
JWK92-69-2 @ 2261.5 m (Indet)
Salt and pepper sandstone with interbedded shale wisps
JWK91-7-1 @7342.2' (Indet)
JWK92-65-1 @7349.0'(Indet)
JWK91-7-2 @7352.5' (prob Cret)
Flaser bedded shales, rippled in part
JWK92-65-2 @7359.0' (Indet)
JWK91-7-3 @7361.6' (Indet)
JWK91-7-4 @7364.0' (Indet)

Quartzose sandstone, rare shale laminations

Oil stained at base
Date logged: August 13, 1991, July 7, 1992
Logged by: John Kramers
Remarks: Along Mississippian high, west of valley

- Cretaceous
  - Oxfordian Shale
  - Bathonian Shale

- Rock Creek

- Poker Chip?
  - Elkton?

- Core gamma

- GRAIN SIZE
  - cobble
  - pebble
  - granule
  - sand
  - silt
  - clay

- Sandstone, vfg to fg, massive
  - JWK91-9-1 @7385.0' (Indet)
  - JWK92-66-1 @7387.0' (Indet)
  - JWK91-9-2 @7390.4' (prob Cret)
  - Shale, brown, with interlam siltstone and vfg ss
  - JWK92-66-2 @7393.7 (Indet)
  - JWK92-66-3 @7394.2' (?Oxfordian)
  - Black shale grading down into sandstone below
  - JWK91-9-3 @7395.5' (Bathonian)

- Sandstone, quartzose, oil stained
  - JWK91-9-4 @7415.5' (Indet)
  - Shale, brownish green, some slickensides

- JWK91-9-5 @7440.5' (Indet)
  - Shale, green, pyritic

- JWK91-9-6 @7457.5' (Indet)
  - Shale, green, slickensided
  - Carbonate rubble
HB Texaco Sylvan Lake
4-32-37-3w5

Date logged: October 22, 1992
Logged by: Rudy Strobl
Remarks: Thin Rock Creek - east side of valley

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Salt and pepper sandstone, fine grained, high angle beds
High angle beds, striping may be double sand drapes

Core gamma

Cretaceous

J/C Boundary @7418
From Logs

Quartzose, f.g., very well sorted sandstone, buff coloured, bioturbated to churned in upper part.

Green, slickensided shale

Shunda (Oxidized)
Date logged: October 22, 1992
Logged by: Rudy Strobl
Remarks: Erosion down to Banff, west of Rock Creek outlier

Mottled appearance of f.g. sandstone due to bioturbation

Highly deformed breccia with dolomitic and green shale clasts

Grey to greenish grey dolomitic shale (Shunda or Banff?)
Date logged: October 21, 1992
Logged by: Rudy Strobl
Remarks: Along Mississippian high, appears to have significant reworking along the base of the Rock Creek.

Finely interlaminated green silt with sandstone, highly bioturbated with marine forms including Terebellina sp. and Asterosoma sp.

(mid to late Aalenian) RS 92-54-1 @2302.5

Very calcareous sandstone, oil stained throughout

Ripped up fossil debris including crinoids
Chert clast supported conglomerate, pyrite at base marks contact with Mississippian

Green calcareous shale with abundant pyrite
Green dolomitic shale, possible Mississippian detrital?
Chert breccia with limestone matrix, clasts angular up to 10 cm diameter
Green highly deformed shale, possible clast
Massive dolomite/dolomitic shale
HB Baysel Sylake 7-22
7-22-37-4w5

Date logged: February 27, 1992
Logged by: J. Kramers

Core gamma

Glaucenic

Ellerslie

Oxfordian Shale

Rock Creek

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

FEET

Wispy shales and shale clasts

Black shale with sandy interlaminations (up to 3 cm)

Shale, black with occasional sand interbeds up to 2-3 cm

Argillaceous sandstone, highly burrowed

Sandstone, fg to mg, ripple laminated, salt and pepper appearance

(\textit{?}Cretaceous) JWK 92-64-1 @7618.75

Laminated sandstone at base

(Prob Oxfordian) JWK 92-47-1 @7621.5

(Prob Oxfordian) JWK 92-47-2 @7626.5

Sandstone, very argillaceous, green, abnt pyrite, highly oxidized

Sandstone, fg, quartzose, some wavy shale laminae in upper 7-10 ft., colour varies from buff to brown.

Indet) JWK 92-47-3@7659.0
H.B. Texaco Sylvan Lake
2-36-37-4w5

Date logged: May 12, 1993
Logged by: Rudy Strobl

Core gamma

**Cobble**
**Pebble**
**Granule**
**Sand**
**Silt**
**Clay**

**GRAIN SIZE**

**FEET**

Dense, black mudstone with minor sandy laminae (salt and pepper?) and minor pyrite.

*(Cret)* RS 93-105 @ 7375'

Bioturbated, carbonaceous debris? at contact.

Highly bioturbated sandstone, abundant rock fragments, minor chert? Pyritized mudstone.

Highly pyritized, glauconitic, micaceous sandstone, friable, churned.

Friable to bentonitic mudstone marking the contact with Rock Creek sandstone.

Highly quartzose with bitumen infilling pores, highly bioturbated to churned.

Dense, pyritic mudstone and interlaminated sandstone, distinctive green colour, churned.

*(Late Aal-Early Baj)* RS 93-106 @7424'
*(Late Aal-Early Baj)* RS 93-107 @7426'

Green, pyritized mudstone, oxidized?

Greenish grey to black mudstone, minor pyrite, typical Poker Chip.

Pyritized shell material

*(Indet)* RS 93-108 @7441'

Green pyritic mudstone, high oxidized, marking the Mississippian unconformity.

Highly brecciated dolostone, abundant vertical fractures, pin point vugs. Appears to be Elkton capping Shunda.

Elkton/Shunda contact highly brecciated.

Dolomitic mudstones of the Shunda indicate approximate depth of contact.

Grey dolomitic mudstone typical of the Shunda Fm

Pin point and large vuggy porosity throughout.

2 cm wide breccia pipe, karst feature.
Date logged: October 21, 1992
Logged by: Rudy Strobl
Remarks: Along Mississippian High, thin Rock Creek and Poker Chip preserved over Elkton and complete Shunda interval.

*Correlation of Rock Creek - compare Sp, deep resistivity and gamma ray logs of 10-36 and 2-36-37-4W5*
H.B. Texaco Sylvan Lake
12-36-37-4w5

Date logged: October 22, 1992
Logged by: Rudy Strobl

Remarks: 12-36 appears to be made up entirely of thick Cretaceous valley fill; adjacent to Mississippian and Rk Creek outlier (see 10-36).

GRAIN SIZE

Core gamma

FEET

Salt and pepper sandstone, high angle cross bedding
Highly bioturbated to churned
Silty laminations and selective pyrite replacement throughout
Finely disseminated woody detritus, possible rooting also
Dark grey to black shale/siltstone, abundant thin walled shell material, mostly pelecypods
Large wood fragment and pyritized clasts at base, erosion surface shows up as gamma/porosity spike.
High angle bedding throughout, with soft sed deformation, interbedded sands contain large, angular siltstone clasts
**Cretaceous Valley Fill**

- Highly disturbed bedding, pyritic, slump structures, scattered rip up clasts
- Interlaminated silts, highly bioturbated to churned
- Chert, green shale and carbonate angular clasts marking base of Cretaceous valley fill.
- Green pyritic shale marking unconformity transition
- Dolomitie shale
Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Within thick Cretaceous valley fill (75 m) of clean sandstones.

Coaly fragments near base of shale
(Cretaceous) RS 92-23-1 @2167.1
(Cretaceous) RS 92-23-2 @2169.0
Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Well located on Mississippian High

Gulf et al Sylvan Lake
10-18-38-3w5

Quartzose, highly bioturbated very fine grained sandstone
(Cretaceous) RS 92-19-1 @2251.2m

Clean quartzose very fine grained sandstone, highly bioturbated to churned.

Quartzose, medium grained, cross bedded sandstone, salt and pepper appearance. no bioturbation,
Argillaceous limestone, fractured throughout, highly bioturbated.
(Indet) RS 92-19-2 @2260.8m
(Indet) RS 92-19-3 @2261.7m
(Indet) RS 92-19-4 @2264.6m

Highly brecciated limestone with green shale lenses or beds throughout.
Gulf Maxus Sylvan Lake
1-20-38-3w5

Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Located on Mississippian high, east and south of regional Rock Creek erosional edge.

GRAN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay

Very fine grained sandstone, with abundant shell material, massive, bioturbated throughout.

(Cretaceous) RS 92-22-1 @2217.0

Dark grey, massive shale, interbedded silty lenses.
(Cretaceous) RS 92-22-2 @2220.3

Clean, well sorted, highly bioturbated fine grained sandstone
(Cretaceous) RS 92-22-3 @2229.9

Coaly fragments at base indicate Cretaceous reworking
Green shale, highly deformed, with abundant pyrite.
(Cretaceous) RS 92-63-1 @2180.5

Cretaceous, channel sandstone with abundant organic debris, coal fragments high angle cross bedding selectively preserved; bioturbation indicates estuarine?

Large chert boulder at base, high pyrite content, greenish grey siltstone throughout.
Date logged: October 23, 1992
Logged by: Rudy Strobl
Remarks: Thick Mississippian - weathered succession - appears to be severely karsted

- Green and greenish grey dolomitic shale, large infilled fracture at base
- Brecciated limestone and green shales with limey matrix
- Base of weathered interval
- White to light grey massive limestone
- Calcareous salt and pepper sandstone, Limestone rip ups, green shale infills fractures.
- Pyritic siltstone along fracture marking contact with Pekisko.
- Crystalline limestone, oil stained, massive
Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Along Mississippian High, east of Rock Creek erosion edge.

Fine grained salt and pepper sandstone, abundant coaly fragments and rip ups, bedding disturbed by bioturbation.

Laminated siltstone, mudstone and minor sandstone similar to above

Crinoidal limestone, fractured and partly dolomitized at upper contact.

Dolomitic limestone, minor shell material.
Date logged: October 21, 1992
Logged by: Rudy Strobl
Remarks: Near erosional edge of Jurassic? Valley

Granulometry:
- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma:

Reworked Cretaceous?

- Highly brecciated, calcareous in places, clasts include dolomite, sandstone and chert
- Green, siltstone, high angle contorted bedding, numerous clasts
Date logged: July 22, 1992
Logged by: Rudy Strobl
Remarks: Poker Chip over Nordegg

- Poker Chip, Greenish grey shale, massive throughout.
- (P2-T2) RS-4-1 @7242
- (P2-T2) RS-4-2 @7246

- Calcite recrystallization in vugs
- Dissolution along vugs and fractures

GRAN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

Poker Chip

Nordegg
Salt and pepper sandstone, mod well sorted, probably Cretaceous
Rip up clasts consisting of underlying green siltstone
Green siltstone, silty shale, slickensided, abnt pyrite
Dolostone contains green siltstone clasts, possible detrital assoc with upper unit
Angular green siltstone clasts
Dolostone, abundant vugs and bitumen staining
Date logged: October 16, 1992
Logged by: Craig Siemens and Rudy Strobi
Remarks: Poker Chip slump block? May be part of larger Cretaceous valley system.

Finely laminated sandstone, salt and pepper appearance

Black shale with sandy laminations

Cretaceous channel sandstones
Light grey to green shale associated with contact

Dark grey shale, pyrite throughout.

Highly brecciated limestone, fractures filled with green pyritic shales
Sandstone, very calcareous, brecciated and deformed
Dolostone and dolomitic shales
Date logged: July 30, 1992
Logged by: Rudy Strobl
Remarks: Located east of proposed Rock Creek erosional edge. Need detailed cross section to confirm Ellerslie vs Rock Creek.

Very fine grained to argillaceous sandstone, abundant shell debris and calcareous throughout.

(P2-T2) RS 92-20-1 @2324.4m
- Dark grey massive shales,
(P2-T2) RS 92-20-2@2326.3m
(P2-T2) RS 92-20-3@2328.8m

Fossiliferous limestone, dissolution porosity throughout, oil stained, corals and bryozoans present.
Midwest et al. Sylake 11-22
11-22-38-4w5

Date logged: February 27, 1992
Logged by: J. Kramers

GAIN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

Glaucnitic Sandstone

Shale, black, scattered silty laminae and flaser bedding
Interbedded 1 to 3 cm sandstone beds
Carbonaceous material at base
Sandstone, fgg to fng, salt and pepper, scattered shaley laminae at base
Shale, black, sandy at upper contact, shell debris scattered from 7424-7426'
Shale with silty sand interbeds
Sandstone, shaley, bioturbated grading down to black shale shells 3-4 cm in size

(Cretaceous) JK 92-46-1@7445.5
(Cretaceous) JK 92-46-2@7451.5
Sandstone, fgg to fng, quartzose
(Cretaceous) JK 92-46-3@7456.5
(Cretaceous) JK 92-46-4@7461.5
(Cretaceous) JK 92-46-5@7466.5
Massive to faintly laminated

(Cretaceous) JK 92-46-6@7491.0
Lower portion of core gamma missing

(Indet) JK 92-46-7 @7508.0
- Brocken wispy shale laminations intermixed with shale clasts
(Indet) JK 92-46-8 @7520.0
- Greenish wispy shale at angle to core
(Toarcian) JK 92-46-9 @7531.0
- Shale, olive green
(Toarcian) JK 92-46-10 @7536.8

Mississippian unconformity @7546 (from logs)
Date logged: October 7, 1992
Logged by: Rudy Strobl

**Grain Size**
- cobble
- pebble
- granule
- sand
- silt
- clay

**Geophysical Logs**
- Gamma curve

**Elkton**
- Dolomitic limestone, with bitumen staining
- Dolostone, with bitumen staining
- Clean, dolostone and dolomitic limestones, It grey, minor dissolution cavities, bitumen staining common
- (Indet) RS 92-28-1 @7641.5
- (Indet) RS 92-28-2 @7647.5

**Shunda**
- Greenish shales, massive and waxy
- Fractured with abundant calcite fill
Date logged: October 7, 1992
Logged by: Rudy Strobl
Remarks: Well developed Poker Chip, Appears to have a limey Rock Creek, brecciated Nordegg (need detailed cross section to confirm)
Date logged: July 24, 1992
Logged by: Rudy Strobl

Apache Condor
4-32-38-4w5

GRAN SIZE

Massive, black to dark grey shales, minor pyrite
(P2-T2) RS 92-12-1 @7645.5'
(P2-T2) RS 92-12-2 @7647.6'
(Indet) RS 92-12-3 @7648.0'

Green, oxidized mudstone, reworking at base of Poker Chip?
Nordegg Coquina, sharp upper and lower contacts
Highly brecciated, abundant pyrite and green mudstones infilling cracks
Nordegg Member
Elkton? or Shunda?
4th cycle of Shunda on logs - see cross section 9A-9A'

Upper 40 cm possibly Nordegg coquina
Limestone, finely crystalline, laminated with disrupted bedding at base

Calcite filled fractures, dissolution porosity throughout
Pyrobitumen infilling large dissolution cavity

Predominantly vuggy dolomitic limestone

Brecciated, bitumen stained, vuggy porosity, calcite infilling fractures

Buff to lt grey dolomite, dissolution porosity noted

Pelecypods selectively preserved or dissolved

Greenish grey shale, mudstone fragments marking contact
Date logged: May 14, 1993
Logged by: Rudy Strobl
Remarks: Core interval to differentiate Rock Creek vs Ellerslie Section 9A. Ties in with 4-34Ek-38-4W5 well.

**Brink et al Evergreen**

**6-33-38-4W5**

**GRAIN SIZE**
- cobble
- pebble
- granule
- sand
- silt
- clay

**Core gamma**

**Ellerslie Mbr**
- Black carbonaceous mudstone, plant fragments.
- Salt and pepper sandstone.
- Rooting? structures

**NordeggCoquina**
- Abundant shell material.
- 15 cm argillaceous coal

**Poker Chip**
- Very clean, massive, quartzose sandstone
- Green mudstone, typical Poker Chip contact
- Greenish grey, Poker Chip
- Nordegg Coquina.

**Shunda, Fm**
- Dolostones, greenish grey to light grey, typical of the Shunda Formation.
Date logged: July 23, 1992
Logged by: Rudy Strobl

Cretaceous (Ehlersie?) Fine grained sandstone, salt and pepper appearance minor bioturbation throughout.

Light greenish grey, silty shale
(Barren) RS 92-6-1@2287
(P2-T2) RS 92-6-2@2288
(Indet) RS 92-6-3@2289.7
Dark grey shale, more dense (likely Jurassic Poker Chip)
Green shaly siltstone,

Dolomite, grainstone with abundant fractures, highly oil saturated at top

Dolomitic Sandstone Breccia, highly fractured.

(Indet) RS 92-6-4@2305.6

Thin Section @2285.5 m Quartzose, fine grained with abundant altered feldspars, clay in pore space, highly altered and cemented.
Dome Butte
11-28-38-5w5

Date logged: July 23, 1992
Logged by: Rudy Strobl

Gamma curve
Geophysical log

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0

Limy mudstone, abundant bivalves, sandy at base.
Sandstone, very calcareous, intensely burrowed.
Calcarenite, very fossiliferous (undiff bivalves)

Calcarenite, sandy at base with rip up clasts, abundant bivalves throughout.

(A3-B1) RS 92-7-1 @2430.75
Dark grey to black shale, boturbated with pyrite throughout.
Limestone, sandy throughout.
(Aalenian) RS 92-7-2@2433.4

Rock Creek Carbonate and Sandstones
Date logged: April 27, 1993
Logged by: Rudy Strobl
Remarks: Good core for photos.

Sandstone, highly bioturbated to churned
Chert clast
RS 92-5-1 @2166.4 m (Toarcian-Pliensbachian)
(Ripped up Poker Chip block?)
Nordegg coquina unit
Sharp contact with pebble lag at base of coquina
Light grey siltstone, slightly calcareous
Abundant mudstone infilling vertical fractures, possible paleosol.
Green mudstone, infilling vertical fractures.
Calcite infilling fracture.
Greenish grey dolomitic mudstone and dolomites, Shunda Formation.
Vuggy porosity, recrystallized calcite.
Green mudstone infilling fractures
RS 93-121 @2167.0 m (?Nordegg)
Green oxidized mudstone, typical lower portion of the Poker Chip along the unconformity contact.
Chert pebble conglomerate marking unconformity contact.
Nordegg sandstone, massive with minor dissolution porosity.

Green to light grey dolomitic mudstones, Shunda Formation.
Atlantic Hespero
12-10-39-3w5

Date logged: July 21, 1992
Logged by: Rudy Strobl
Remarks: Previously described by Rall (1980), along Mississippian high bordering the J Valley. Possible reinterpretation as southern extension of the J-Valley?

![Diagram showing geological strata and core gamma with labels for various rock types and locations.]

(Cretaceous). RS 92-1-1 @6924'
- Dark shales with abnt pyrite, occasional wood imprints and coal remains
- Pyritized burrows, sharp contact
- Very fine grained quartzose interval, highly bioturbated to churned, high diversity of trace fossils (Skol, Planolites and Asterosoma most abundant)
- Series of vertical calcite filled fractures above contact.

(P2-T2) RS92-1-2 @6956'
- Breccia consists of cobble sized, angular carbonate clasts with argillaceous matrix.

(Indet) RS92-1-3 @6982.5'
- Green shale with manganese staining, possibly chloritic
- Breccia consists of cobble sized, angular, white carbonates with green shale matrix
Date logged: July 22, 1992
Logged by: Rudy Strobl
Remarks: Along Mississippian high east of regional Rock Creek erosional edge,

Geophysical log gamma curve

GRAN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay

Highly bioturbated, clean sandstone

Green, waxy shale with abundant pyrite, possibly chloritic.

Chert fragments with minor sandy inclusions.

Highly saturated, argillaceous sandstone, appears to have abundant dissolution porosity.

Cretaceous

Reworked Poker Chip?
Sun Dome Med R
12-15-39-3w5

Date logged: July 23, 1992
Logged by: Rudy Strobl
Remarks: Within the J Valley, Xray of shales from Rall (1980)

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Core gamma

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

---

Cretaceous Channel Sandstone

- Organic rich, highly bioturbated sandstone.
- Well sorted, homogeneous, buff sandstone.
- Massive, dark grey shale
- (Cretaceous) RS92-10-1 @6942.5'
- 6 cm diameter wood fragment
- Highly bioturbated vfg sandstone, oil saturated throughout.
- Bleached appearance, massive white sandstone, highly bioturbated to churned.
Cdn Superior Med River
8-16-39-3w5

Date logged: April 28, 1993
Logged by: Rudy Strobl
Remarks: Redescribed from July well. To get Pekisko and Shunda contacts. Anomalous gamma ray at base of Nordeg sandstone (mudstone response) - thin section taken.

**Thin section @6935**' Quartzose, minor chert, recrystallized calcite, pyritic

**Thin section @6956** Quartzose, dominantly carbonate cemented

Black mudstone drape or clast?
Quartose sandstone, minor rock fragments and recrystallized calcite. Possible Ellerslie?
Sandstone pebbles, subrounded green mudstone clasts, chert clast, abundant pyrite indicates Cretaceous?
Dissolution porosity throughout, calcareous throughout.
Calcite infilling vertical and inclined fractures.
Green and black mudstone clasts, calcite filled fractures
Sharp contact. Core 1 Box 4 , top of second column. Green mudstone ripups with associated breccia.
Calcite infilling fractures, very fine grained, quartose sandstone, likely Nordegg.

Green mudstone infilling fractures.
Sandstone and black mudstone, possibly part of karst pipe.
Possible Shunda/Pekisko contact.
Pekisko limestone?, oil stained throughout.
Greenish grey mudstone/limestone breccia
20 cm long breccia pipe (Karst feature), abundant crinoids in host rock.
Euhedral calcite infilling along 30 cm fracture plane.
Date logged: July 23, 1992
Logged by: Rudy Strobl
Remarks: Located immediately west of J-Valley, Clay mineralogy done by Rall (1980).

- Carbonaceous debris, plant stem at top of core 1 box 3.
- Pyrite filled burrows
- Upper contact, argillaceous, weathered, green calcareous mudstone infilling fractures.
- Homogeneous fine grained sandstone, oil saturated throughout
Date logged: May 13, 1993
Logged by: Rudy Strobl

Salt and Pepper sandstone with abundant angular black mudstone rip up clasts, minor carbonaceous material
Upper fg to lower mg sandstone, abundant lithic fragments, choked with interstitial clays (tight).
Quartzose sandstone, massive, oil saturated, massive.
Greenish grey mudstone laminae
RS 93-119 @7052.4' (probably late Aalenian)
RS 93-120 @7068.0 (probably late Aalenian)
Greenish grey massive mudstone, typical Poker Chip appearance, minor pyrite.

Massive oil saturated sandstone, typical Nordegg, churned at top
Calcereous sandstone, shows up as spike on geophysical log.
Rubble in core, Shunda/Nordegg contact uncertain.
Calcite and green mudstone filled fractures common.
Green to light grey dolomite mudstones, typical of the Shunda Formation.
Sun Med River
13-18-39-3w5

Date logged: April 28, 1993
Logged by: Rudy Strobl
Remarks: Core to confirm Shunda pick.

Greenish grey Poker Chip
Green, oxidized? Poker Chip along Nordegg contact.

White, massive, siltstone
Black mudstone rip up clast.

Contact with Shunda (karst), calcareous with
dolomitic breccia.

Brecciated throughout.
Green to greenish grey dolomitic mudstones
and dolomites typical of the Shunda Fm.

Green dolomitic mudstone, highly deformed,
possible karst feature.

Solution vugs infilled with calcite
Date logged: October 9, 1992
Logged by: Rudy Strobl

Channel sandstones with rooted zones, lags, or chaotic bedding (high bioturbated) marking succession boundaries.

Highly bioturbated to churned, fine sandstone, abundant wood frags at top.

Limestone unit, appears to be cherty in places.

Rock Creek?

(P2-T2) RS 92-32-1 @7201.3

Poker Chip Shales, dk to med grey, platy

(P2-T2) RS 92-32-2 @7210.6

(P2-T2) RS 92-32-3 @7220.3

Sharp contact - pale green to white shale of the Nordegg

Dolomitic sandstone, oil stained throughout.
H.B. Medicine River
16-20-39-3w5

Date logged: May 12, 1993
Logged by: Rudy Strobl

RS 93-104 @7090' (P2-T2)

- Black Poker Chip mudstone, platey, silty in part.
- Lower 50 cm green oxidized?
- Sharp scoured lower contact, with abundant rounded chert and mudstone clasts.
- Chalky, white, calcareous, possible paleosol?
- White, calcareous in part, fractures filled by calcite, abundant pin pt vugs.
- Green mudstone infilling fractures.
- minor pin pt vugs, dissolution porosity?
- Carbonate rip up clasis, subrounded; minor green mudstone.
- Light greenish grey, dolomitic mudstone, typical of the Shunda Formation.
- Disturbed, brecciated, abundant fracture filling.
- Shunda Karst interval.
- Green mudstone marks contact with Pekisko limestones
- Pekisko Limestone, vuggy porosity, oil saturated.
- Deformed, green mudstones associated with Karst features, isolated breccias.

Slumped green mudstone.
Date logged: October 16, 1992
Logged by: Rudy Strobl
Remarks: Sand on sand Cretaceous/Nordegg contact

GRAIN SIZE

Core gamma

Cretaceous Valley Fill

Organic rich siltstone
Coaly siltstone, abundant plant remains and coal fragments
Channel sandstones of the Cretaceous, ripple lamination and rootlets (non calcareous)
Calcareous, vfg sandstone, mottled appearance due to cementation of calcite
Dolomitic sandstone, typical of the Med River Mbr.

Nordegg
Limestone, brecciated with interbedded calcareous shales, it grey to buff, extensive karsting.
Dolomitic shales, light grey to buff
Base of karst

Slumped Shunda?

Pekisko
Clean, crinoidal limestone of the Pekisko Fm
Date logged: July 22, 1992
Logged by: Rudy Strobl
Remarks: Sampled by Rall (1980), possible J Valley extension?

Core gamma

(P2-T2) Poker Chip RS92-2-1 @7103'
- Possible hard ground
- Chert and limestone breccia, surrounded by cobble sized clasts.
- Very fine grained to argillaceous sands, convoluted and highly fragmented sands with cherts.
- Clean, very fine grained, white massive sandstone
Date logged: May 7, 1993
Logged by: Rudy Strobl
Remarks: J2 sandstone, slabbed in part allowing recognition of structure and bedding.

Fine grained, quartzose J2 sandstone, oil stained throughout, generally massive.

Bioturbation likely present throughout the core, but difficult to recognize in unslabbed portions.

Mottled appearance resembling macriconiclus. Some branching observed in cross section.

Finely draped organic rich laminae.

Base of J2 unit?
J1 or detrital at base of valley fill?
Blue grey and greenish grey mudstones, pyritic clast zone with angular mudstone rip up clasts and white highly deformed sandstone.
HB Medicine River
6-28-39-3w5

GRIAN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

7.0 0.0 7.0 0.0 7.0 0.0 7.0 0.0 7.0 0.0 7.0 0.0

- Cretaceous
- Reboxing of core - possible lost core at base of box 2.
- Cret/J3 contact @7001?
- Dense, argillaceous sandstone, appears to have high kaolinite content.
- Base of J3 marked by tan coloured, brecciated concretion. Possible weathered interval? Sharp kick on geophysical logs.
- J2 Sandstone, massive, oil saturated throughout.

- Greenish, silty mudstone, marking contact with PokerChip.
- RS 92-48-1 @7061.7' (P2-T2)
- RS 92-48-2 @7071.7' (P2-T2)
HB Medicine River
8-28-39-3w5

Date logged: May 6, 1993
Logged by: Rudy Strobl
Remarks: Well defined and preserved J3 and J2 contained in this core.
Clear distinction with Ellerslie successions.

<table>
<thead>
<tr>
<th>GRAIN SIZE</th>
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<tbody>
<tr>
<td>cobble</td>
</tr>
<tr>
<td>pebble</td>
</tr>
<tr>
<td>granule</td>
</tr>
<tr>
<td>sand</td>
</tr>
<tr>
<td>silt</td>
</tr>
<tr>
<td>clay</td>
</tr>
</tbody>
</table>

- Rythmic laminated sandstone, possible couplets indicating tidal influence?
- Sandy siltstone, abundant pyrite, possible shell debris (pyritized).
- Early Cret @6921.5' Early Cret @6922.0'
  (Palynology compliments of Crestar)
- Salt and pepper sandstones marking base of Ellerslie
- White, kaolinitic fine grained sandstone
- Appearance of Macronichnus -possible bioturbation or diagenetic?
- Remaining core not slabbed. No bedding features recognized.
Highly bioturbated to churned, pyrite marks contact, note gamma spike on geophysical log.

Interlaminated green siltstone and vfg sandstone, soft sediment deformation throughout.

Argillaceous sandstone (J3) with kaolinite matrix, green siltstone laminations, minor bioturbation.

Quartzose, very clean, massive, oil saturated J2 sandstone.
HB Unit/Medicine River
6-29-39-3w5

Date logged: January 20, 1993
Logged by: Rudy Strobl

G R A I N  S I Z E

- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma
Poker Chip
Nordegg Sandstone

Shunda?
Pekisko?

RS 93-122 @7085' (P2-T2)
- Dk grey, silt-rich shale, minor pyrite throughout,
- typical Poker Chip

RS 93-123 @7108' (P2-T2)
- Green oxidized pyrite rich siltstone
- Calcareous sandstone, massive, white to light grey, Nordegg
- Abundant shell material

Base of sandstone with calcite infilled fractures and green shale clasts

Correlation of Mississippian uncertain due to karsting.

Brecciated limestone with green shale infilling fractures
- Oil stained throughout the lower part
Date logged: October 16, 1992
Logged by: Craig Siemens and Rudy Strobl

**Grain Size**
- cobble
- pebble
- granule
- sand
- silt
- clay

**Core Gamma**
- Cretaceous Channel Successions
- Rock Creek
- Poker Chip

**Siltstone, black, carbonaceous**
- Very carbonaceous to coaly siltstone
- Lag marking base of channel succession - base of Cretaceous
- Massive, buff coloured Rock Creek? sandstone
- Minor shale clasts, some shale laminae

(Mid-late Aalenian) RS92-50-1 @2195m
- Silty shale, dark grey, Poker Chip Shale

(Mid-late Aalenian) RS92-50-2 @2199m
Brink Med R
16-31-39-3w5

Date logged: July 24, 1992
Logged by: Rudy Strobl

- Cretaceous Valley Fill
  - (Cret) RS 92-15-1 @7024.8'
  - Large wood fragment
  - Ripple laminated, possibly fluvial sandstone
  - Black to dark grey, massive shale, pyritic

- Fernie
  - (Oxfordian) RS 92-15-2 @7036.7'
  - Very well sorted, churned fine grained sandstone, likely Rock Creek

- Rock Creek
  - (Toarcian) RS 92-15-3 @7053.5'
  - Greenish grey to dark grey, massive shale, possible Poker Chip Shale

- Poker Chip
  - (T2-P2) RS 92-15-4 @7063.0'
ROCS Medicine River
16-32-39-3w5

Date logged: April 28, 1993
Logged by: Rudy Strobl

GRAIN SIZE

FEET

B I O T U R B

COBBLE

PEBBLE

GRANULE

SAND

SILT

CLAY

Core gamma

Ellerslie

Fernie

Rock Creek or J Sand?

Coquina

Nordegg

Shunda

Pekisko?

RS 93-102 @6930' (Oxfordian)

Black, carbonaceous? mudstone, concoidal fractures, minor interlaminated sandstone.

RS 93-103 @6944' (P2-T2)

Greenish grey, oxidized? mudstone, silty in part.
Nordegg - Coquina equivalent?
Dissolution porosity, massive, Nordegg sandstone.

Greenish grey calcareous mudstone - Shunda.
Euhedral calcite infilling fracture.
Breccia pipe

Dolomitic below breccia zone. Max karst?

Karst features include breccias and calcite infill along fracture planes.
Possible Pekisko contact? Less altered than above.
Date logged: October 16, 1992
Logged by: Craig Siemens and Rudy Strobl
Remarks: Immediately adjacent to J Valley edge

Grain size:
- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

J2?

Poker Chip

J1

Shunda

Greenish grey sandstone, bioturbated, green shale laminae
Channel Sandstone, high angle cross bedding, assorted clasts
(P2-T2) RS 92-49-1 @6999.7'
Greenish grey shale (oxidized or weathered?)
Poker Chip shale, dark grey, platey, some slickensides
(P2-T2) RS 92-49-2 @7014.7'

Nordegg-type sandstone, vlg, massive
Green, disturbed shale, highly pyritic, marking transition to underlying Mississippian

Highly fractured and disturbed dolomitic shales
Date logged: January 20, 1993
Logged by: Rudy Strobl
Remarks: Eastern edge of J-Valley

G R A I N  S I Z E

- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

Ellerslie

J2?

Poker Chip?

J1

Mississippian (Pekisko?)

Highly bioturbated, carbonaceous laminae at top

Massive, f.g. sandstone, relatively featureless, likely J2?

(Late Pleistocene/Early Toarcian) RS 93-03 @7020.5'

Green oxidized silty shale to siltstone

Dk grey, sl. silty massive shale, appears to contain minor carbonaceous specks, slickensides throughout

Green silty shale, oxidized, slickensides

(Late Pleistocene/Early Toarcian) RS 93-04 @7029'

Carbonate and sandstone clasts in green silty shale matrix

Crinoidal limestone, likely Pekisko

Greenish grey, to lt grey dolomitic mudstone
Date logged: May 7, 1993
Logged by: Rudy Strobl
Remarks: Well to evaluate proposed eastern extension of J Valley. Possible ledge containing J3 sandstone.

- RS 93-116 @2134.5 m (Cret) - Black silty mudstone, with calcareous sandstone laminations, minor shell debris.
- RS 93-117 @2138.6 m (Cret) - Abundant pyritized shell material
- White (bleached appearance) sandstone with kaolinitic matrix typical of the J3
- Green mudstone laminations, highly bioturbated.
Taurus Murphy Condor
10-6-39-4w5

Date logged: July 29, 1992
Logged by: Rudy Strobl
Remarks: Channellized well? (possibly reworked Rock Creek?)
Has been resampled to confirm.

---

Intensely burrowed quartzose sandstone, very fine grained, most bedding disturbed by bioturbation.

Greenish grey shale, massive, scattered pyrite
(Cretaceous) RS 92-18-1 @7682.0'
(Barren) RS 92-18-4 @7682.3'
(Cretaceous) RS 92-18-2 @7686.8'
(Barren) RS 92-18-5 @7688.5'

Fractured, brecciated limestone
(Indet) RS 92-18-3 @7689.0'

Highly fractured, steeply dipping, contorted very fine grained sandstone, muds infill fractures

Limestone, highly fractured, argillaceous
Green, highly bioturbated bedded shale
Apache BA Med River 8-13MU
8-13-39-4w5

Date logged: May 12, 1993
Logged by: Rudy Strobl

- Laminated sandstone, appears to contain minor rock fragments, moderate bioturbation.
- Tight zone, weathered white, friable.
- Lower 0.75 metres oil saturated.
- Churned mudstone/sandstone, abundant planolites and palaeophycus.
- Low angle laminated sandstone, possible couplets, typical estuarine Ellerslie.

**Palynology**
- RS 93-109 @ 7045' (early Bajocian)
- RS 93-110 @ 7045.5' (late Aal - early Baj)
- RS 93-111 @ 7046.0' (late Aal - early Baj)
- RS 93-112 @ 7048.0' (early Bajocian)
- RS 92-47-1 @ 7048.5' (early Bajocian)

**Thin sections**
- @7019' Quartzose, well sorted, well rounded minor mica and chlorite.
- @7027 Quartzose, mod sorted, subangular to subrounded, minor micas and glauconite present
- @7037 Quartzose, abnt mica and carbonate grains, pyritic, mod. altered.

- Greenish grey, typical Poker Chip
- Green, oxidized, pyritic
- Nordegg
- Coquina equivalent? Highly recrystallized.
- 3 cm diameter articulated shells
- Pitted, dissolution porosity

- RS 92-47-2 @ 7093.2' (P2-T2)
- RS 92-47-3 @ 7094.0' (P2-T2)

Nordegg Limestone/Coquina (not common at this level)
Grey dolomitic mudstone typical of Shunda
Thin section @ 7450' Quartzose, well sorted, subangular to subrounded, minor heavy minerals, biotite, feldspar (microcline?), carbonate cemented.

RS 93-113 @ 7455.5' [P2-T2]
- Minor black mudstone laminae, Palaeophyus common along bedding.
- Quartzose sandstone, appears to contain up to 5% rock fragments, likely Cretaceous. Thin section to confirm.
- Sharp angular contact.
- Greenish grey, typical Poker Chip, Oxidized green mudstone at base.
- Nordegg Coquina
- Nordegg Sandstone, sharp angular contact.
- Green mudstone matrix and laminae
- Sharp angular, slumped green mudstones, pyrite rich mark the Miss contact.
- Lt grey and greenish grey dolomitic mudstones, Shunda Formation.
- Black mudstone, possible karst pipe?
Date logged: October 9, 1992
Logged by: Rudy Strobl
Remarks: Nordegg / Shunda interval. Control well to test paly applications for Jur/Miss picks

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

Nordegg

Karst

Shunda

Dolomitic sandstone with interbedded dolomitic shales/siltstones
Sharp contact between dolomitic sandstone to limestone, unconformity on logs
Dolomitic siltstone/sandstone? sharp angular contact
Dolomite and dolomitic shales, Shunda Formation, it grey with calcite fracture fills

(Indet) RS 92-31-1 @7272.3
(Indet) RS 92-31-2@7273.8
Date logged: March 11, 1992
Logged by: John Kramers

(Cretaceous) JK 92-55-1 @2213.2
(Cretaceous) JK 92-55-2 @2214.5
Sandstone, vlg to fg, quartzose, appears massive, may have rootlets at top
(Toarcian) JK 92-55-3 @2218.0

Shale, olive green to greyish green, flaky, silty at top,
(Toarcian) JK 92-55-4 @2224.0
Date logged: July 24, 1992
Logged by: Rudy Strobl
Remarks: Reexamined and resampled May 12th. Good well to view the transitional Rock Creek mudstones.

Core gamma

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

BIOTURB

FEET

(Oxfordian) RS 83-118 @7280.0
Black, carbonaceous mudstone at upper contact.

Thin section @7289'
Quartz arenite, well sorted, subangular to subrounded, abnt quartz overgrowths
Quartzose sandstone, well sorted, bitumen infilling pores, friable in upper portion.

(Bajocian) RS 92-16-1 @7305.0
Finely interbedded to laminated mudstones and vfg sandstones, abundant Planolites.
Mudstone, greenish grey, pyritic, similar to Poker Chip

(Aalenian) RS 92-16-2 @7330.0'
Thin section @7333'
Quartzose, poorly sorted, subangular to subrounded, pyrite banding, minor heavy minerals, carbonate cemented.
Date logged: October 6, 1992
Logged by: Rudy Strobl
Remarks: Rock Creek, Poker Chip absent, and Bioclastic limestones of the Nordegg
Murphy Leafland
16-16-39-5w5

Date logged: October 6, 1992
Logged by: Rudy Strobl
Remarks: Rock Creek Sandstone

---

**Core gamma**

**Rock Creek**

- Highly bioturbated, Rock Creek sandstone, abundant asterosoma and palaeophycus
- Limestone, argillaceous, grades into lower sands
- Well sorted, highly bioturbated Rock Creek quartz litharenites

(?Bajocian) RS 92-26-1 @7761.1
Date logged: October 5, 1992
Logged by: Rudy Strobl
Remarks: 2nd and part of 3rd succession of Shunda Fm.
Date logged: July 24, 1992
Logged by: Rudy Strobl

![Diagram of core gamma and grain size analysis with labeled sections: Cretaceous channel sandstones, coaly, organic debris, Cretaceous channel sands, ripple laminated to massive.](image-url)

(Cretaceous) RS 92-14-1 @2334.2
Date logged: July 24, 1992
Logged by: Rudy Strobl

White Rose Leafland
6-23-39-5w5

Core gamma

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Poker Chip

(T3-Aal) RS 92-13-1 @ 7683.4'
(Toarcian) RS 92-13-3@ 7689.9'
(Toarcian) RS 92-13-2 @ 7703.7'
(T2-P2) RS 92-13-4 @ 7705.2'
Hud Bay Richfield Eckville
10-2-40-3w5

Date logged: July 29, 1992
Logged by: Rudy Strobl
Remarks: Located along the eastern edge of the J valley
        Thick shale sections for sampling.

---

GRAIN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay

---

Core Gamma

- Dark grey to black, carbonaceous shale (Cretaceous)
- Wood fragments, coal fragments
- Carbonaceous debris, possible rooting lower in the section?
- Ellerslie sands, wavy bedding (some ripple lamination), with carbonaceous debris scattered throughout.
  (Cretaceous) RS 92-17-1 @6941.5'
  (Cretaceous) RS 92-17-2 @6958.2'
  (Cretaceous) RS 92-17-3 @6977.8'
  (Cretaceous) RS 92-17-4 @7003.8'

---

J3 ? or Cret?

- Highly bioturbated to churned, very fine grained sandstone, distorted bedding, minor pyrite throughout.
Brink Medicine River
4-5-40-3w5

Date logged: October 15, 1992
Logged by: Craig Siemens and Rudy Strobl
Remarks: Nordegg Producer immediately west of J Valley

Geophysical log gamma curve

GRAN SIZE

Sandstone, bioturbated with soft sediment deformation

(P2-T2) RS 92-46-1 @7010.4
Poker Chip shale, dark grey

(P2-T2) RS 92-46-2 @7038.1
Green, waxy shale marking transition to Nordegg
Dolomitic sandstone (Med River Mbr of Collar, 1990)

Green dolomitic shales

Shunda

Nordegg

Poker Chip

cobble
pebble
granule
sand
silt
clay
Date logged: May 13, 1993
Logged by: Rudy Strobl
Remarks: Limestone at base of Nordegg Sandstone.

Nordegg Sandstone, massive, silt calcareous, some dissolution porosity.
Calcite filled voids.
Possible Nordegg carbonate?
Dolomitic mudstones, green and light grey typical of the Shunda.
Date logged: May 13, 1993
Logged by: Rudy Strobl
Remarks: Anomalous well. Deeply incised Cret valley fill?

Core gamma

Grain size

- cobble
- pebble
- granule
- sand
- silt
- clay

Bioturb

FEET

Black mudstone with abundant shell material.
Green, silty mudstone (oxidized?)
Most of the core appears to be Cretaceous
Black mudstone, carbonaceous

(Indet) RS 93-124 @7105.5'

- High angle contacts, minor carbonaceous debris, bioturbated in part.
- Large carbonate rip up clast and deformed green dolomitic mudstone
- Breccia consists of rounded carbonate cobbles, vfg sandstone and green mudstones.
- Green dolomitic mudstone, likely weathered Shunda Fm.
Cretaceous sandstone with plant remains overlying siltstone.

Distorted bedding. Silica filled fractures.

Rip ups and chert clasts.

(Indet) RS 92-43-1 @7058.9 (likely reworked)
Date logged: October 14, 1992
Logged by: Rudy Strobl, Craig Siemens
Remarks: Type section for Nordegg Coquina and calcareous to dolomitic sandstone in the Medicine River area.

Coquina, oyster bed, as described by Collar. Capping Nordegg sands.
Nordegg sandstone. Calcareous throughout with abundant shell material.
Uno Tex Gilby
16-19-40-3w5

Date logged: May 13, 1993
Logged by: Rudy Strobl

Nordegg Sandstone, massive, calcareous
Very calcareous with well preserved shell molds
Recrystallized calcite infilling voids
Brecciated limestone, fractures infilled by calcite Nordegg or Pekisko?
Core out of place in last 2 boxes. Likely Pekisko contact.
Pekisko limey mudstone, crinoidal.
Date logged: October 14, 1992
Logged by: Rudy Strobl, Craig Siemens
Remarks: J2 Sandstone within main J-Valley

- Valley fill J-2 sands. Oil stained
- Double mud drapes?
- Wavy laminated sands. Minor blue grey argillaceous laminae.
- Unconformity, base of J sand. 5 cm of green waxy mudstone.
Date logged: October 15, 1992
Logged by: Rudy Strobl, Craig Siemens

Only partial gamma ray log available

Grain Size
- cobble
- pebble
- granule
- sand
- silt
- clay

Poker Chip

(P2-T2) RS 92-44-1 @6874.5

(P2-T2) RS 92-44-2 @6898.9

Nordegg

Pekisko

Karst interval

Top of core uncertain.

Base of Nordegg marked by rounded mudstone clasts, organic laminae, and bioturbation

Pekisko limestone, oil saturated, vuggy porosity.

Quartzose sandstone, calcareous mudstones (karst pipe?)

Well developed crinoidal limestone
Date logged: May 14, 1993
Logged by: Rudy Strobi
Remarks: Overthickened Poker Chip just inside J-Valley edge. Describe to interpret if muds are authigenic or alloogenic. Sample top and base for paly.

Green, oxidized mudstone typical of uppermost Poker Chip
Greenish grey mudstone, Poker Chip, no obvious erosional contacts, however, it is unusual to find calcareous units.
RS 93-125 @ 2130.0 m (P2-T2)
Laminated siltstone, pyritic, calcareous.
Calcite infilling vertical fractures.
RS 93-126 @ 2140.4 m (P2-T2)
Date logged: October 14, 1992
Logged by: Rudy Strobl, Craig Siemens

Breccia, angular to rounded chert shale and dolomite clasts. Pyritic throughout. High angle beds indicate scree slope.
Green with abundant pyrite. Slump block?
Fracture filled,
Limestone, grey to greenish grey, massive, highly fractured, calcite infilling vugs.
Can Seabd et al Gilby
12-28-40-3w5

Date logged: May 7, 1993
Logged by: Rudy Strobl


Geophysical log gamma curve

GRAIN SIZE

coible
pebble
granule
sand
silt
clay

BIOTURB

RS 93-114 @7067' (?Cretaceous)
- Finely interlaminated vfg sandstone and mudstone. Ripple laminated in part.
- Silty micaceous mudstone, dk grey to black, carbonaceous in part.
- Salt and pepper, sandstone laminations

RS 93-115 @7086' (?Cretaceous)
Tex Gilby PEX
3-29-40-3w5

Date logged: October 13, 1992
Logged by: Rudy Strobl, Craig Seimens
Remarks: Rall's (1980) core, within main J-Valley; clearly shows that J fill is post lower Poker Chip (P2-T2). See paly results in 7-29.

Diagram:
- J3 Sandstone
- J2 Sandstone
- Poker Chip
- J1 Sandstone

Grafit Size: cobble, pebble, granule, sand, silt, clay.

SP log:
- 6960
- 6980
- 6970
- 6990
- 7000
- 7010
- 7020
- 7030
- 7040
- 7050
- 7060

FEET:
- White, kaolinitic sandstone
- Massive vfg sandstone, white appearance
- Striped light and dark rhythmically bedded vfg sandstone, possible double mud drapes
- Massive sands
- Friable, oil stained throughout
- Highly bioturbated to churned, Palaeophycus common.
- Shale rip ups from underlying unit
- Greenish (oxidized?) shale near contact with Poker Chip
- Dark grey, massive Poker Chip Shale
- Waxy green shale near contact with J1
- White weathered, argillaceous sandstone (Paleosol zone)
Date logged: October 13, 1992
Logged by: Rudy Strobl
Remarks: J-Valley fill.

Richfield Gabriel Lake
7-29-40-3w5

**GRAIN SIZE**
cobble
pebble
granule
sand
silt
clay

---

Friable, unconsolidated 7032.5' to 7033.5'
Typical J2 Sandstone, quartose, oil saturated throughout.

Pokerchip shale with abrt rip up clasts
(Aal, PC-RC transition?) RS 92-34-1 @7058.0
Breccia/conglomerate assoc with vfg sandstone, well rounded pebbles
High angle contacts
Well rounded clasts up to 5 cm diameter
(Aal, PC-RC transition?) RS 92-34-2 @7072.1

Angular, shale rip up clasts

(P2-T2) RS 92-34-3 @7101.0
Green, slickensided shale, pyritic at base,
sand filled (Burrows?) at base
(Indet) RS 92-34-4 @7107.85

J1 (weathered zone)
Vfg sandstone similar to Nordegg

Soft sed deformation, shale rip up clasts
Silty green shales, possible large scale clasts,
detrital along (unconformity) zone
Fracture fills and large clasts
Sandy poorly sorted, abrt clasts, load structures marking base of detrital zone
Dolomitic shale, light grey, massive
(Banff Fm)
Date logged: May 13, 1993
Logged by: Rudy Strobl

**GRAIN SIZE**
- cobble
- pebble
- granule
- sand
- slit
- clay

**BIOTURB**

**FEET**

**Nordegg Sandstone, massive, calcareous**

**Highly altered (weathered?) Pekisko Formation.**
Chert and mudstone clasts.

**Pekisko Formation, highly weathered (bleached) appearance.**

**Limestone, heavily oil saturated throughout.**

**Top of Banff based on logs.**
Limestone, oil saturated.
Date logged: January 20, 1993
Logged by: Rudy Strobl
Remarks: Contains Nordegg coquina over Nordegg Sandstones (Med River Member of Collar, 1990)

Nordegg Member

Core gamma

Nordegg coquina

Pyrite and calcite filled fractures

Large (4 cm diameter) thick shells selectively preserved

Pyritic? infilled burrow in laminated calcareous sandstone

GRAIN SIZE

- cobble
- pebble
- granule
- sand
- silt
- clay
Date logged: May 14, 1993
Logged by: Rudy Strobl

Nordegg Sandstone, quartzose, calcareous, minor shell dissolution.

Very limey at base grading into a calcareous mudstone. Rubble, contact not clear.
ARCO Giby
11-32-40-3w5

Date logged: May 14, 1993
Logged by: Rudy Strobl

Geophysical log gamma curve

5 cm thick coal
Carbonaceous mudstones, black, slickensided, coal frags common.
Sharp contact with quartose, highly bioturbated J-sandstone.
**Thin section @7034.8'** Quartz arenite, clean, well sorted, subrounded grains.
Contact not clear. Last two boxes fragmented - possible lost core.
Green, oxidized mudstone, typical of the Poker Chip/Rock Creek contact.
Poker Chip @7048' on cross section
Gulf Gilby
8-33-40-3w5

Date logged: October 15, 1992
Logged by: Rudy Strobl, Craig Siemens
Remarks: Within J valley

Note the cni/density separation on logs, typical of J3
Rippled sandstones with greenish grey laminated mudstones.

Highly bioturbated to churned.

J3 Sandstone
Core gamma

J2 Sandstone

Poker Chip

J1 Sandstone

J1 Lower or Detrital

GRAN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

PET

METRES

2.1
2.0
2.1
2.1
2.4
2.3
2.5
2.3
2.1
2.6
2.9
2.7
3.0

Green waxy shale.
(P2-T2) RS 92-45-2 @2147.7
(Indet) RS 92-45-3 @2148.6

Dark grey shale. Poker Chip?
(Indet) RS 92-45-1 @2155.0

Greenish grey near unconformity surface.

(?P2-T2?) RS 92-45-4@2163.0 (likely reworked)

Green waxy silty shale.
Date logged: October 13, 1992
Logged by: Rudy Strobl. Craig Seimens

- Fine grained, massive sandstone, alternating oil stained zones throughout
- Weathered? clay rip ups - soft sed deformation
- Large angular sand rip ups? (or slumped)
- Breccia consisting of rounded to angular chert and carbonate clasts up to 5 cm diameter
- Fracture fills with abundant pyrite
- Green shaly matrix with abundant white clasts
- Layered clasts sizes up to full core diameter
- Dolomitic shales of Banff

**Core gamma**

**J1 Sandstone**

**J1 Lower**

**Banff** (karst)
CPOG Med River
6-12-40-4w5

Date logged: October 14, 1992
Logged by: Rudy Strobl and Craig Siemens
Remarks: Similar interval to 4-13-40-4W5

Geophysical log gamma curve

GRAN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Poker Chip shale, silty, dark grey
Green silty shale marking transition to Nordegg
Limestone, vuggy porosity, shell fragments, minor pyrite
Contact, highly disturbed with angular rip ups
White, fractured, silty shale (large clast?)
Date logged: October 14, 1992
Logged by: Craig Siemens and Rudy Strobl
Remarks: Rock Creek, Poker Chip, Coquina and Nordegg Sandstone

- Core gamma
- Rock Creek
- Poker Chip
- Nordegg Coquina
- Nordegg Sandstone

- Very fossiliferous, calcareous
- Poker Chip shale, dark grey, minor pyrite
  (P2-T2) RS 92-40-1 @7096.9

- Green, pyritic shale marking transition to
- Nordegg
- Limestone, abnt shell fragments and
dissolution porosity
- Coquina overlying the Nordegg (Med River Mbr) Sandstone
  (P2-T2) RS 92-40-2@7115.8
Uno Tex Gilby
10-13-40-4w5

Date logged:  April 27, 1993
Logged by:  Rudy Strobl
Remarks:  Key well to define upper blocky sands, Line 2A, Cretaceous to 7150'

Core gamma

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Ellerslie

- Silty green, abundant pyrite.
- Pyritic, black, carbonaceous mudstone
- Greenish grey, micaceous siltstone/mf sandstone
- Quartzose fine grained sandstone, highly carbonaceous with abundant plant debris and coal fragments. Rooting?
Date logged: April 27, 1993
Logged by: R. Strobl
Remarks: Line 2A Rock Creek, Nordegg Coquina and Nordegg SS.

Core gamma

Poker Chip

Coquina

Nordegg Sandstone

Shunda

Greenish grey mudstone, flaggy, typical Poker Chip
Green, oxidized? Poker Chip
Nordegg, calcareous, pyritic sandstone, sharp possibly scoured base.
Large shell material selectively preserved
Calcite infilling fracture, very calcareous
Sandy limestone to very calcareous sandstone
Well preserved oyster, full width of core.
Calcareous sandstone/sandy limestone
Possible Glossofungites at contact. Base of Core 3 Box 4.
Fracture filling brecciated mudstone.
Calcareous mudstone and dolomites of the Shunda Formation. Karst features at top.
Lt grey dolomites and green dolomitic shales, Shunda Formation.
Pekisko limestone, oil saturated throughout.
Date logged: April 27, 1993
Logged by: Rudy Strobl
Remarks: Nordegg Sandstone

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Core gamma

Nordegg Sandstone calcareous, dissolution porosity prominent.
Date logged: February 25, 1992.
Logged by: John Kramers

Diagram:
- **Core gamma**
- **Grain size**
  - cobble
  - pebble
  - granule
  - sand
  - silt
  - clay

**Rock Creek**
- Crataceous?

**Stratigraphic column**
- (Indet) JWK 92-31-1 @2345.1
- (Prob Jurassic) JWK 92-31-2 @2345.35
- Sandstone, fg, quartzose, argillaceous in part, some shale wisps
- (Prob Jurassic) JWK 92-31-3 @2354.7
- Shell hash, with sandy to argillaceous matrix, scattered pyrite
Date logged: January 19, 1993
Logged by: Rudy Strobl

**GRAIN SIZE**

- cobble
- pebble
- granule
- sand
- silt
- clay

**F E E T**

Core gamma

Nordegg Member

Nordegg Medicine River Sandstone (note abundance of >50% calcite intervals, likely dissolved shell material - see 6-30 desc)

Pekisko? White massive limestone, fractured, minor green shale

Oil stained massive limestone with calcite filled fractures and vugs

Pekisko Formation, oil impregnated throughout

3 cm vug rimmed by euhedral calcite and bitumen
Date logged: January 19, 1993
Logged by: Rudy Strobl

GRAN SIZE

RS 93-127 @7087.5'
(late Aal to early Baj)

Silty to sandy dk grey mudstone,
interlaminated sandstone 7185 - 88'
Date logged: April 27, 1993
Logged by: Rudy Strobi
Remarks: Line 2A. First core showing green grey mudstone capping Nordegg Sandstone and underlying Nordegg Coquina.
B.V.X. Willesden Green
14-4-40-5w5

Date logged: October 14, 1992
Logged by: Rudy Strobi, Craig Siemens
Remarks: Lower Cretaceous to Rock Creek.

Core gamma
Contact @2340 m based on logs

Cretaceous

Rock Creek
RC-PC Transition?

GRAIN SIZE
- cobble
- pebble
- granule
- sand
- silt
- clay

Soft sediment deformation.
Finely interlaminated vfg sands with
muds plus double clay drapes?
(reworked Oxfordian?) RS 92-39-1 @2336.4
(reworked Oxfordian?) RS 92-39-4 @2336.3
Shale - dark grey to black, slickensided
throughout. Likely reworked.

Chert replacement as bands.

Fossiliferous, highly bioturbated, Rock
Creek sandstone.

Bioturbated with vfg dark drapes.

(Late Aalenian) RS 92-39-2@2353.0
Appendix 2
(Palynological Introduction)

Medicine River/Sylvan Area
(Twps 37,38,39 and 40 Rges 3,4 and 5W5)

Dolby and Associates
PALYNOCLOGICAL ANALYSIS OF CRETACEOUS, JURASSIC & MISSISSIPPIAN CORE SAMPLES FROM THE GILBEY-MEDICINE RIVER AREA, CENTRAL ALBERTA

by
G. Dolby

Project 92.11

Prepared for:
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The Jurassic-Cretaceous palynological succession in central Alberta was described in detail in Report 92.01, March 1982. It is repeated here with modifications to include Bathonian assemblages which were not found in the 92.01 study.

There is a noticeable absence of Late Toarcian to mid-Aalenian strata i.e., the upper Poker Chip, in the Glibey-Medicine River area. Late Aalenian to Bajocian Rock Creek sediments often lie unconformably on lower Poker Chip rocks of Early Toarcian-Late Pliensbachian age.

Two samples from the 14-4-40-5W5 well were tentatively assigned to the Oxfordian based on the palynomorphs recovered. However, there are questionable specimens of species present which range from the Late Kimmeridgian to the Albian. Furthermore, the shale samples come from a unit above a sandstone with the distinct "pepper and salt" lithology typical of the Cretaceous. Further work is needed to confirm whether these assemblages are in situ or reworked on a massive scale. Similar problems have occurred elsewhere and were reported on in the 92.01 study. In those cases, some samples were assigned a ?Cretaceous age and others a Jurassic age. They are listed in the discussion of the results from 14-4-40-5W5 (page 54).

In some wells it proved difficult to decide whether limestone sequences belonged to the Nordegg or the Mississippian Shunda or Elkton Formations. None of the samples taken from these cores yielded palynomorphs.

Late Pliensbachian - Middle Toarcian Assemblages

These are characterised by an abundance of sapropelic kerogen and large clumps of small sphaeromorphs. In north-west Europe, sphaeromorphs 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 semitabulatum  
Scriniocassis weberii  
Dinocyst PC-1  
Dinocyst 12-2  
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. In the Gilbey-Medicine River area N. senex dominates with smaller numbers of Dinocyst 12-2. The other species listed above are extremely rare. Acritarchs are occasionally numerous and rare specimens of prasinophytes may occur.

Apart from the sphaeromorphs, which are usually termed Spheripollenites, the pollen and spore flora is poorly developed. Small numbers of the following species may be present:

Distalunnulisporites incertus  
Corrugatisporites anagramensis  
Classopolis spp.  
Mathesporites tumulosus  
C. amplectaeformis

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, apart from Dinocyst 12-2, and Lithodinia serrulata and Dinocyst PC-1 may be abundant. Species such as Evansia evitil and Phallocysta spp. may also occur sporadically and the first Fromea spp. may also occur toward the top of the zone.

*Spheripollenites* 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 Toarcian 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 dictyambonis* 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 Alberta 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 here they are rare. The *Escharisphaeridia - 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. anagammensis* and *C. amplectaeformis* 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 *Scriniocassis weberii*. In Alberta it appears that 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 *Fromea* 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 *Escharisphaeridina - Batiacasphaera* spp. (especially large forms of the former) and by the appearance of *Evansia tripartita* and *Melourogonyaulax decapitata*. *Nannoceratopsis dictambonis* probably dies out in the Early Bajocian (discites Ammonite Zone) and *Phallicysta minuta* probably dies out slightly later. The mid- to late Early Bajocian is distinguished by the disappearance of *Scriniocassis priscus* more or less concomitant with the appearance of *Acanthaulax crispa* and *Escharisphaeridina 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:

**DOLBY & ASSOCIATES**
Callialasporites dampsieri
Araucariacites australis
Classopolis spp.

C. turbatus
Lycopodiumsporites
Corollina spp.

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

**Bathonian Assemblages**

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. Their occurrences in the Late Bajocian are rare and sporadic and when several of the group are found together, especially in significant numbers, the sample is unlikely to be older than Bathonian. Typical species include:

*Ctenidodinium combazii*
*C. continuum*
*Scriniodium luridum*
*Hystrichogonyaulax regalis*
*Korystocysta gochii/ kettonense*
*Cassiculosphaeridia dictydia*

*C. ornatum*
*Diacanthum filipicatum*
*Ellipsoidiotsym cinctum*
*H. pectinigera*
*Aldorfa aldorfense*

The range of *C. combazii* extends into the earliest Callovian but for all practical purposes it can be used as a Bathonian marker. *D. filipicatum* and *H. regalis* can also be considered as Bathonian indicators.

*Gonyaulacysta jurassica* appears at the base of the Bathonian but probably does not become significant until the middle of the stage where it is joined by *Sirmiodinium grossi* and later by *Hystrichogonyaulax cladophora*.

In contrast with the underlying stages, bissaccate pollen can be abundant. The other terrestrial species are usually long-ranging and include the *Callialasporites* group as well as *Cerebropollenites mesozoicus*. 
Oxfordian - Kimmeridgian Assemblages

No evidence for Callovian strata was seen in this or the 92.01 study. The earliest Oxfordian palynofloras can be found in the latest Callovian but no Callovian index species were recovered.

Early Oxfordian assemblages are characterised by *Sentusidinium* spp., especially *S. rioultii* and *S. villersense*, *Escharisphaeridia rudis* and *Ellipsoidictyum gochtii*. *Acanthaulax* spp. and *Gonyaulacysta jurassica* are usually present and can be abundant. Other species present include *Valensiella ovula*, *Ellipsoidictyum cinctum*, *Aldoria dicyota*, *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 early Middle and Early Jurassic, bisaccate pollen can be abundant. *Classopollis* spp. are more numerous than in the overlying Cretaceous.

Cretaceous Assemblages

Some of the samples in the 92.01 study 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 *Concavissimisportites exquisitus* and *C. apiverrucatus* which are known to range down to the latest Kimmeridgian (*rotunda* Ammonite Zone, J2). The 14-4-40-5W5 well has such a section but the Jurassic content predominates (see page 54).
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 contains the following:

- Cicatricosisporites spp.
- Concaavisimisporites spp.
- C. trioreticulatus
- Couperisporites tabulatus
- Taxodiaceaeapollenites hiatus
- Appendicisporites spp.
- C. tribotrys
- Foraminisporis wonthaggiensis
- Aequitriradites spinulosus
- Januasporites spiniferus

Classopollis spp. are usually very rare in contrast to the Jurassic. Most samples yield terrestrial assemblages but a small number contain dinocysts. The most distinctive of these are 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.
REFERENCES


Appendix 3
(Palynology Sample Descriptions)

**Medicine River/Sylvan Area**
(Twps 37, 38, 39 and 40
gses 3, 4 and 5W5)

Dolby and Associates
WELL: 14-19-37-3W5
Sample: JWK 93-2-1
Depth: 2266.65m
Age: Cretaceous

Remarks
The sample proved to be rich in highly oxidized kerogen with a few, mostly unidentifiable palynomorphs. A specimen of *Cicatricosisporites exilioides* indicates a Cretaceous age.

Sample: JWK 93-2-2
Depth: 2267.3m
Age: Cretaceous (by inference)

Remarks
The organic residue is similar to 93-2-1 but no identifiable palynomorphs are present.

Sample: JWK 93-2-3
Depth: 2268.43m
Age: Cretaceous

Remarks
The organic residue is similar to 2-1 and 2-2 but contains some less oxidized debris. Specimens of *Taxodiaceaepollenites hiatus* and cf. *Spiniferites* sp., if in situ, indicate a Cretaceous age.
Sample:
JKW 93-2-4
Depth:
2270.5m
Age:
?Cretaceous

Remarks
The kerogen is identical to 2-1 and 2-2 but no palynomorphs are present.

Samples:
JKW 93-2-5, 6
Depths:
2272m, 2272.75m
Age:
Jurassic, Early Oxfordian, J9A-B

Remarks
Both samples are rich in highly degraded kerogen. Palynomorphs are abundant but usually difficult to identify. Dinocysts assignable to *Sentusidinium* spp. and *Escharisphaeridia* spp. resemble those found in Early Oxfordian strata elsewhere including the 12-30-37-3W5 well (JKW 92-66-3, 7394.2').

Significant species

<table>
<thead>
<tr>
<th>Bisaccate pollen (A)</th>
<th>Corollina spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cerebropollenites mesozoticus</em></td>
<td><em>Callialasporites dampieri</em></td>
</tr>
<tr>
<td><em>Concavissimisporites southevensis</em></td>
<td><em>Sestrosorites pseudoalveolatus</em></td>
</tr>
</tbody>
</table>

*Sentusidinium* spp.
*Gonyaulacysta jurassica*

*Escharisphaeridia* cf. *rudis*
*Leptodinium* ct. *mirabile*

Samples:
JKW 93-2-7, 8, 9
Depths:
2279.2m, 2284.2m, 2285.75m
Age:
Jurassic (by inference)

Remarks
Samples 2-7 and 2-8 are rich in degraded, amorphous kerogen but 2-9 yielded very little residue. Rare, poorly preserved specimens of *Classopolis* spp. are present in 2-7 and 2-8 but nothing was recovered which could help in assigning a more precise age.
WELL: 12-20-37-3W5
Samples: RS92-59-1, 59-2
Depths: 7415.2', 7419'
Age: Indeterminable

Remarks
These samples yielded very little kerogen and no palynomorphs were recorded.
WELL: 4-27-37-3W5
Samples: RS92-24-1, 24-2
Depths: 2180.35m, 2180.9m
Age: Bathonian, probably mid to Late, J11B

Remarks
Both samples contain rich assemblages of dinocysts many of which appear in the latest Bajocian but do not become significant until the Bathonian. *Ctenidodinium combazi*, present in the upper sample, does not range above the earliest Callovian but is essentially a Bathonian marker. Fragments of *Gonyaulacysta jurassica* in the lower sample indicate that the sample is no older than Bathonian and *Sirmiodinium grossii* in 24-1 indicates a mid to Late Bathonian age.

Significant species
*Ctenidodinium ornatum*  
*C. combazi*  
*C. continuum*  
*Sirmiodinium grossii*  
*Gonyaulacysta jurassica*  
*Ellipsoidicyctum cinctum*  
*Hystrichogonyaulax regalis*  
*H. pectinigera*  
*Diacanthum filapicatum*  
*Scriniodynamium luridum*

Sample: RS92-24-3
Depth: 2194.25m
Age: ?Bajocian

Remarks
This sample yielded a very small residue and few palynomorphs but two specimens of *Escharisphaeridia cf. asymmetra* suggest a Bajocian age.
Samples: RS92-24-4, 24-5
Depths: 2194.75m, 2195m
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
These samples resemble others from the lower Poker Chip in this study containing abundant amorphous kerogen and clumps of *Spheripollenites* spp. *Dinocyst 12-2* is also present in the lower sample.

Significant species
*Spheripollenites* spp. (A)  
*Mathesporites tumulosus*  
*Corrugatisporites amplectaeformis*  
*Nannoceratopsis senex*  
*Classopolis* spp. (A)  
*Distalannulisporites incertus*  
*Lycopodiacidites spinatus/baculatus*  
*Dinocyst 12-2*
WELL: 4-29-37-3W5
Sample: RS92-60-1
Depth: 7320'
Age: Indeterminable

Remarks
A virtually barren sample.

Samples: RS92-60-2, 60-3
Depths: 7323', 7324.8'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
Both samples yielded Poker Chip assemblages with Spheripollenites spp., Nannoceratopsis senex and Dinocyst 12-2.

Significant species
Spheripollenites spp. Classopolis spp. (A)
Mathesporites tumulosus Corrugatisporites anagromensis
Nannoceratopsis senex (A) Dinocyst 12-2
WELL: 2-30-37-3W5
Samples: JWK91-10-1, 10-2
Depths: 7354', 7363'
Age: Cretaceous

Remarks
Both samples contain abundant palynomorphs which are poorly preserved, probably due to biodegradation. The presence of Appendicisporites cf. bilateralis, Aequitriradites spinulosus and abundant Cicatricosisporites spp. indicate a Cretaceous age.

Significant species
Appendicisporites cf. bilateralis
Cicatricosisporites spp. (A)
C. australiensis
Bisaccate pollen (A)
Aequitriradites spinulosus
C. hughesi
Concavissimispores cf. montuosus

Sample: JWK91-10-3
Depth: 7377.5'
Age: Indeterminable

Remarks
This sample yielded a small organic residue with no recognisable palynomorphs.

Sample: JWK91-10-4
Depth: 7386'
Age: Possibly Cretaceous

Remarks
The kerogen consists largely of amorphous inertinitic particles with a very small number of palynomorphs. A single specimen of Cicatricosisporites sp. suggests a Cretaceous age but the sample is extremely poor.
Samples: JWK91-10-5, 10-6
Depths: 7419', 7445'
Age: Indeterminable

Remarks
Sample 10-5 yielded amorphous inertinitic material similar to that in 7-1 and 9-1.
Sample 10-6 contained a very small amount of inertinite grains.

Sample: JWK91-10-7
Depth: 7462'
Age: Indeterminable

Remarks
Unidentifiable small spores and pollen and bisaccate pollen are numerous in this sample but the preservation is extremely poor. No obviously Cretaceous taxa were identified, given that some Cretaceous markers are distinctive even when poorly preserved. However, no Jurassic species, particularly dinocysts, were recognised either.

Sample: JWK92-68-1
Depth: 7465.2'
Age: Indeterminable

Remarks
(See JWK91-10, Report 91.16, p.14)
The sample is rich in amorphous inertinitic debris but no palynomorphs are present.
Sample: JWK92-68-2
Depth: 7468'
Age: Indeterminable

Remarks
Although palynomorphs are numerous in this sample, the identifiable species are long-ranging. An age cannot be assigned based on the overall character of the assemblage.

Significant species
Bisaccate pollen
Cerebropollenites mesozoicus

Neoraistrikkia truncata
Concavissimisporites sp.
WELL: 4-30-37-3W5
Samples: JWK92-67-1, 67-2
Depths: 7445', 7489'
Age: Indeterminable

Remarks
Both samples yielded residues rich in kerogen but with no identifiable palynomorphs. In the upper one the kerogen consists of amorphous inertinitic debris and in the lower one, vitrinite and in semifusinite are prominent.
WELL: 4-30-37-3W5
Sample: JWK91-2-1
Depth: 7391'
Age: Cretaceous

Remarks
This sample yielded abundant palynomorph debris. However, few species are identifiable due to a combination of thermal maturation, biodegradation and pyrite crystals. The recognisable spores are typical of late Early Cretaceous to Cenomanian strata. Indeterminate dinocysts are also present.

Significant species
Cicatricosisporites spp.
Appendicisporites cf. erdtmanii
Aequitriradites spinulosus
Gleicheniidites senonicus
Escharisphaeridia sp.
C. hallei
A. cf. problematicus
Concavissimisporites sp.
Foraminisporis cf. worthaggiensis
Dinocysts (indet.)

Sample: JWK91-2-2
Depth: 7406'
Age: Indeterminable

Remarks
This sample yielded an extremely small residue. Single specimens of Leptolepidites sp. and Uvaesporites sp. resemble those recovered from Jurassic sediments in this study. However, given their rarity and the quality of the sample it is unlikely that these are in place.

Significant species
Uvaesporites sp.
Leptolepidites sp.
Classopollis sp.
Samples: JWK91-2-3 to 2-9
Depths: 7428', 7431', 7454', 7476', 7478', 7494', 7496'
Age: Indeterminable

Remarks
The residues from these samples generally consist of large amounts of amorphous organic matter with rare inertinitic grains. Apart from a non-diagnostic bisaccate pollen grain in sample 2-4, no identifiable palynomorphs are present.

Sample: JWK91-2-10
Depth: 7525'
Age: latest Bathonian, Zone J11B

Remarks
This assemblage is dominated by extremely abundant but poorly-preserved dinocysts. The presence of *Ctenidodinium combazii* and *Aldoria aldorifense* indicates that the sample is no younger than earliest Callovian, i.e., the lower part of the *macrocephalus* Ammonite Zone. The abundance of the former species suggests that a Bathonian age is more appropriate. *Gonyaulacysta jurassica* ranges to the base of the Bathonian but is rare below the latest Bathonian. Its abundance here is used to confine the age to the latest Bathonian.

Gymnosperm pollen are numerous but spores are relatively rare.

Significant species
*Ctenidodinium combazii* (A)  
*Gonyaulacysta jurassica* (A)  
*Hystrichogonyaulax cladophora*  
*Cassiculospheraeida dictydia* (A)  
*Korystocysta gochti/kettonense* (A)  
Bisaccate pollen (A)  
*Cerebropollenites mesozoicus*  
*C. ornatum*  
*Aldoria aldorifense*  
*A. cf. dictyota*  
*Valensiella ovula*  
*Escharisphaeridia* spp.  
*Classopolis* spp.  
*Callialasporites trilobatus*
Sample: JWK91-2-11
Depth: 7566'
Age: Bathonian-Bajocian undifferentiated

Remarks
The palynomorphs in this sample are highly degraded and largely unidentifiable. Dinocyst fragments which resemble Korystocysta gochii/kettonense indicate that the sample is no older than late Bajocian.

Sample: JWK91-2-12
Depth: 7569'
Age: Indeterminable

Remarks
This sample contained rare, unidentifiable dinocysts and abundant, thermally altered kerogen. An accurate age could not be assigned.

Sample: JWK91-2-13
Depth: 7573'
Age: No younger than Bajocian

Remarks
Although palynomorphs are abundant, the high level of maturation has rendered most of them unidentifiable. A specimen of Nannoceratopsis gracilis is present. This species is rare above the middle Bajocian and the fact that the majority of the indeterminate dinocysts are small, relatively simple forms favors a slightly older age. However, a more precise age cannot be assigned due to the preservation.

Significant species
Nannoceratopsis gracilis
Callialasporites turbatus
Staplinisporites caminus

Small, indeterminate cysts
Classopollis sp.
Bisaccate pollen (A)
Sample: JWK91-2-14
Depth: 7579'
Age: Jurassic

Remarks
This sample yielded a very small residue in which *Classopollis* spp. are numerous.
A questionable specimen of the dinocyst *Evansia* sp. favors a Jurassic age.
WELL: 8-30-37-3W5
Samples: JWK91-1-1, 1-2, 92-69-1, 91-1-3, 92-69-2
Depths: 2247.2m, 2255.2m, 2257m, 2261.2m, 2261.5m
Age: Indeterminable

Remarks
The samples are either barren or consist of small residues of inertinite or semifusinite. No palynomorphs were recorded.
WELL: 10-30-37-3W5
Samples: JWK91-7-1, 92-65-1
Depths: 7342.2', 7349'
Age: Indeterminable

Remarks
Although kerogen-rich, neither sample yielded identifiable palynomorphs.

Sample: JWK91-7-2
Depth: 7352.5'
Age: Probably Cretaceous

Remarks
This sample is similar to 7-1 except that it contains extremely rare spores including two specimens of Cicatriconesporites sp. This number in such a poor sample favors a Cretaceous rather than a Jurassic age.

Samples: JWK92-65-2, 91-7-3, 7-4, 7-5
Depths: 7359', 7361.6', 7364', 7390'
Age: Indeterminable

Remarks
The first sample is rich in kerogen in contrast to the other three but no identifiable palynomorphs are present.
<table>
<thead>
<tr>
<th>WELL:</th>
<th>12-30-37-3W5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samples:</td>
<td>JWK91-9-1, JWK92-66-1</td>
</tr>
<tr>
<td>Depths:</td>
<td>7385', 7387'</td>
</tr>
<tr>
<td>Age:</td>
<td>Indeterminable</td>
</tr>
<tr>
<td>Remarks</td>
<td>These samples yielded amorphous kerogen similar to sample 91-7-1. No identifiable palynomorphs are present.</td>
</tr>
</tbody>
</table>

| Sample: | JWK91-9-2 |
| Depth: | 7390.4' |
| Age: | Probably Cretaceous |
| Remarks | This extremely poor assemblage contains a specimen of Cicatricosisporites sp. which favors a Cretaceous age (see JWK91-7-2). |

| Sample: | JWK92-66-2 |
| Depth: | 7393.7' |
| Age: | Indeterminable |
| Remarks | This sample is similar to JWK91-9-1 and 92-66-1. |

| Sample: | JWK92-66-3 |
| Depth: | 7394.2' |
| Age: | ?Oxfordian |
| Remarks | The palynomorphs and kerogen in this sample appear to have been subjected to severe bacterial attack leaving few identifiable beyond a generic or group level. Several dinocyst specimens resemble the Sentusidinium species found in the |
Early Oxfordian and another specimen resembles *Escharisphaeridia rudis*. The overall impression is of a post-Rock Creek Jurassic assemblage. (See RS92-39.)

**Significant species**

- Bisaccate pollen
- *Sentusidinium* spp.
- *Classopollis* spp.
- *Escharisphaeridia* cf. *rudis*

**Sample:** JWK91-9-3  
**Depth:** 7395.5'  
**Age:** Latest Bathonian, J11B

**Remarks**

The palynomorphs in this sample are poorly preserved and mostly unidentifiable. The presence of fragments *Ctenidodinium combazii* and numerous specimens of *Gonyaulacysta jurassica* indicate that the age is most likely latest Bathonian.

**Significant species**

- *Classopollis* spp.
- *Lycopodiumsporites* sp.
- *Corollina* sp.
- *Cerebropollenites mesozoicus*
- *Gonyaulacysta jurassica*
- *Ctenidodinium combazii*

**Samples:** JWK91-9-4, 9-5, 9-6  
**Depths:** 7415.5', 7440.5', 7457.5'  
**Age:** Indeterminable

**Remarks**

Samples 9-4 and 9-5 yielded very small quantities of inertinitic kerogen but no recognisable palynomorphs. Sample 9-6 proved to be barren.
WELL: 16-13-37-4W5
Sample: RS92-54-1
Depth: 2302.5m
Age: Mid to late Aalenian, J14A

Remarks
This assemblage resembles those from RS92-50 and RS92-53. *Dissildodinium* spp. are abundant and *Fromea senilis* is present.

Significant species

| Classopollis spp. (A)                     | Exesipollenites spp. (A)              |
| Callialasporites dampieri               | C. dampieri                           |
| Cerabropollenites mesozoicus           | Ovalipollis enigmatica                |

| Fromea senilis                        | F. 83/1                               |
| Dissildodinium spp. (A)                | Scriniocassis weberii                 |
WELL: 7-22-37-4W6
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 Ellipsoidictyym 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, inertinitic debris. No age can be assigned.
WELL: 2-36-37-4W5
Sample: RS93-105
Depth: 7375'
Age: Cretaceous

Remarks
Although the yield and preservation was poor, numerous specimens of Cicatricosisporites spp. and rare Microreticulatisporites uniformis indicate a Cretaceous age.

Significant species
Cicatricosisporites spp.  
Microreticulatisporites uniformis  
Cinguliriletes clavus  

Bissaccate pollen (A)  
Contignisporites cooksonii  
Stereisporites antiquasporites

Samples: RS93-106, 107
Depths: 7424', 7426'
Age: Late Aalenian to Early Bajocian, J13B-J14A

Remarks
Dissilicidinium spp. are abundant in both samples which is typical of the latest Aalenian and Early Bajocian. The lower sample also contains Scriniocassis priscus and Nannoceratopsis gracilis. Although dinocysts are abundant, no Bajocian markers are present.

Significant species
Classopollis spp. (A)  
Caliliasporites dampieri  
Mathesporites tumulosus  

Dissilicidinium spp. (A)  
Scriniocassis priscus (R)  

Mathesporites tumulosus  
C. turbatus  
Staplinisporites caminus  

Escharisphaeridia spp.  
Nannoceratopsis gracilis (R)
Sample: RS93-108
Depth: 7441.5'
Age: Indeterminable

Remarks
Apart from one unidentifiable dinocyst, the sample yielded few significant palynomorphs.
**WELL:** 10-36-37-4W5  
**Sample:** RS92-53-1  
**Depth:** 7360'  
**Age:** Mid to late Aalenian, J14A

**Remarks**  
This sample is similar in composition to RS92-50-1, 50-2. *Fromea senilis* is quite numerous and *Dissilioidinium* spp. are abundant.

**Significant species**

<table>
<thead>
<tr>
<th>Classopolis spp. (A)</th>
<th>Exesipollenites spp. (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Callialasporites tubatus</td>
<td>C. dampieri</td>
</tr>
<tr>
<td>Corollina spp.</td>
<td>Cerebropollenites mesozoicus</td>
</tr>
<tr>
<td>Ovalipollis enigmatica</td>
<td>Staplinisporites caminus</td>
</tr>
<tr>
<td>Lycopodiumsporites spp.</td>
<td>Ischyosporites crateris</td>
</tr>
<tr>
<td>Dissilioidinium spp. (A)</td>
<td>Fromea senilis</td>
</tr>
<tr>
<td>Nannoceratopsis gracilis</td>
<td>Scrinicassids weberi</td>
</tr>
</tbody>
</table>

**Samples:** RS92-53-2, 53-3  
**Depths:** 7381', 7382'  
**Age:** Early Toarcian-Late Pliensbachian, J14C-D

**Remarks**  
Although the yields were low, the kerogen and palynomorphs assign these samples to the lower Poker Chip.

**Significant species**

<table>
<thead>
<tr>
<th>Spheripollenites spp.</th>
<th>Classopolis spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathesporites tumulosus</td>
<td>Distalannulisporites incertus</td>
</tr>
<tr>
<td>Corrugatisporites amplacteiformis</td>
<td>Lycopodiacidites spinatus/baculatus</td>
</tr>
</tbody>
</table>

*Nannoceratopsis senex*
WELL: 12-15-38-3W5
Samples: RS92-23-1, 23-2
Depths: 2167.1m, 2169m
Age: Cretaceous

Remarks
Both samples are rich in spores and pollen, especially bisaccates, but are relatively limited in composition which is not unusual for the Early Cretaceous of this area.

Significant species
Cicatricosisporites spp.
Concavissimisporites tribotrys
C. apiverrucatus
Appendicisporites bilateralis
Aequitriradites spinulosus
C. tricraticulatus
Januasporites spiniferus
Foraminisporis wonthaggiensis
**WELL:** 10-18-36-3W5

**Sample:** RS92-19-1
**Depth:** 2250.6m
**Age:** Cretaceous

**Remarks**
A typical Cretaceous sample with abundant bisaccate pollen as well as marker species.

**Significant species**
- Cicatricosisporites spp.
- Appendicisporites bilateralis
- Concavissimisporites tribotrys
- Januasporites spiniferus

**Samples:** RS92-19-2, 19-3, 19-4
**Depths:** 2260m, 2261.7m, 2264.6m
**Age:** Indeterminable

**Remarks**
These samples were virtually barren.
WELL: 1-20-38-3W5
Samples: RS92-22-1, 22-2
Depths: 2217m, 2220.3m
Age: Cretaceous

Remarks
Both samples yielded typical Cretaceous assemblages rich in bisaccate pollen with numerous marker spore species. A questionable specimen of Balmula sp. in 22-2 suggests a correlation with the Ostracod Zone.

Significant species
Cicatricosisporites spp.
Concavissimisporites tribotrys
C. apierrucatus

Foraminisporis wonthaggiensis (A)
C. trioreticulatus
Januaspores spiniferus

Sample: RS92-22-3
Depth: 2229.9m
Age: Probably Cretaceous

Remarks
Most of kerogen residue consists of inertinitic debris but the palynomorph assemblage consists almost entirely of bisaccate pollen. The sample is almost certainly Cretaceous although no marker species were recorded.
WELL: 8-21-38-3W5
Sample: RS92-63-1
Depth: 2180.5m
Age: Early Albian-Late Aptian

Remarks
In this sample, bisaccate pollen are abundant and Cretaceous markers such as Cicatricosisporites spp. also occur. The presence of a specimen of Balmula tripenta suggests that the sample comes from the Ostracod Zone.

Significant species
Bisaccate pollen (A)  Taxodiaceae pollenites hiatus
Cicatricosisporites spp.  C. australiensis
Concaevissimisporites tribotrys  Januasporites spiniferus
Dictyotiletes granulatus  Foraminisporis wonthaggiensis
Balmula tripenta
WELL: 4-31-38-3W5
Samples: RS92-4-1, 4-2
Depth: 7241', 7245'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
The higher assemblage is rich and diverse but the deeper one is relatively poor.
Both contain species typical of the Poker Chip.

Significant species
Spheripollenites spp. (A)  Distalannulispores incertus (A)
Classopollis spp. (A)  Mathesporites tumulosus
Corrugatisporites unagramensis  C. amplexaeformis
WELL: 8-2-38-4W5
Samples: JWK93-A-1, A-2
Depths: 2271.5m, 2272.2m
Age: Cretaceous

Remarks
Both samples are rich in palynomorphs but most have been severely damaged by bacterial corrosion. Cretaceous spores are present in significant numbers, especially in A-2, but dinocysts are rare and suggest a brackish environment.

Significant species
Cicatricosisporites spp. Foraminisporis wonthaggiensis
Couperisporites tabulatus Aequitriradites spinulosus
Concaissimisporites reticulatus Rousaisporites reticulatus

Balmula tripenta (R) cf. Atopodinium (R)
WELL: 8-2-38-4W5
Samples: RS92-52-1, 52-2, 52-3
Depths: 2278.2m, 2279m, 2280m
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
All three samples contain rich assemblages assignable to the lower Poker Chip. Their composition closely resembles other Early Toarcian-Late Pliensbachian samples in this study.

Significant species
Spheripollenites spp.
Corullina spp.
Distalannulispores incertus
Nannoceratopsis senex (A)

Classopolis spp.
Mathesporites tumulosus
Corrugatisporites spp.
Dinocyst 12-2
WELL: 14-21-38-4W5
Samples: RS92-20-1, 20-2, 20-3
Depths: 2322.4m, 2324.3m, 2326.8m
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
All three samples are typical of the lower Poker Chip yielding large amounts of amorphous sapropelic debris and abundant clumps of Spheripollenites spp. Other markers such as Nannoceratopsis senex and Dinocyst 12-2 are also present, the latter being particularly abundant in 20-2.

Significant species
Spheripollenites spp. (A)
Classopollis spp.
Corrugatisporites anagramensis
Lycopodiacidites spinatus/baculatus

Mathesporites tumulosus (A)
Distalannulospores incertus
C. amplectaeformis

Nannoceratopsis senex

Dinocyst 12-2
WELL: 11-22-38-4W5
Samples: JWK92-46-1, 46-2, 46-3, 46-4, 46-5, 46-6
Depths: 7445.5', 7451.5', 7456.5', 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 significant number of Cretaceous spores.

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

Samples: JWK92-46-7, 46-8
Depths: 7506', 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', 7536.6'
Age: Probably Early Toarcian-late Pliensbachian, J14C-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)        *N. gracilis*
Distalannulisporites incertus     Corrugatisporites anagrammensis
Mathesporites tumulosus           *C. amplectaeformis*
WELL: 4-27-38-4W5
Samples: RS82-28-1, 28-2
Depths: 7641.5', 7647.5'
Age: Indeterminable

Remarks
Both samples yielded extremely small organic residues with rare, unidentifiable palynomorphs.
WELL: 4-28-38-4W5
Samples: RS92-29-1, 29-2
Depths: 7615.27', 7619.17', 7623.9'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
The upper two samples contain rich assemblages typical of the lower Poker Chip.
Sample 29-3 yielded mostly amorphous kerogen but the palynomorph composition is similar to the overlying samples.

Significant species
Spheripollenites spp. (A) Classopollis spp (A)
Mathesporites tumulosus Distalainulisporites incertus
Corrugatisporites amplexaeformis C. anagrammensis
Nannoceratopsis senex (A) Dinocyst 12-2
WELL:  4-32-38-4W5
Samples: RS92-12-1, 12-2
Depths: 7645.5', 7647.6'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
Both samples yielded assemblages typical of the lower Poker Chip and also abundant degraded, ?sapropelic kerogen. The lower sample contains a new dinocyst, Dinocyst sp. 12-2, which also occurs in other samples of the same age in this study.

Significant species
Spheripollenites spp. (A)  Classopollis (A)
Distalannulispores incertus  Mathesporites tumulosus
Corrugatisporites amplexaeformis  
Nannoceratopsis senex (A)  Dinocyst sp. 12-2

Sample: RS92-12-3
Depth: 7648.5'
Age: Indeterminable

Remarks
A very small residue with rare, unidentifiable spores and much oil residue.
**Well:** 4-34-38-4W5

**Sample:** RS92-6-1
**Depth:** 2287m
**Age:** Indeterminable

**Remarks**
A barren sample.

**Sample:** RS92-6-2
**Depth:** 2288m
**Age:** Early Toarcian-Late Pliensbachian, J14C-D

**Remarks**
*Spheripollenites* spp., *Classopolis* spp. and *Nannoceratopsis senex* are abundant but show evidence of bacterial corrosion. The assemblage is typical of the lower Poker Chip.

**Significant species**

*Classopolis* spp. (A)  
*Distalannullisporites incertus*  
*Nannoceratopsis senex* (A)  
*Spheripollenites* spp. (A)  
*Mathesporites tumulosus*

**Samples:** RS92-6-3, 6-4
**Depths:** 2289.7m, 2305.6m
**Age:** Indeterminable

**Remarks**
Both samples yielded small residues with few identifiable palynomorphs.
WELL: 11-28-38-5W5
Sample: RS92-7-1
Depth: 2430.75m
Age: Early Bajocian-late Aalenian, J13B-J14A

Remarks
This is a typical Rock Creek assemblage in which *Escharisphaeridia* spp. are abundant. The presence of *Phallocysta minuta*, *P. cf. erregulensis* and *Scriniocassis priscus* confirm that the age is no younger than Early Bajocian and the lack of earlier, Aalenian markers confirms the lower age limit.

Significant species

<table>
<thead>
<tr>
<th><em>Escharisphaeridia</em> spp. (A)</th>
<th><em>Scriniocassis priscus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Phallocysta minuta</em></td>
<td><em>P. cf. erregulensis</em></td>
</tr>
</tbody>
</table>

Sample: RS92-7-2
Depth: 2433.4m
Age: Probably middle to late Aalenian, J14A

Remarks
*Escharisphaeridia* spp. are much rarer here and *Nannoceratopsis senex* is present. The lack of early markers suggests that this is middle to late Aalenian in age, possibly from the Rock Creek Poker Chip transition.
WELL: 6-5-39-3W5
Sample: RS92-5-1
Depth: 2166.4m
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
This is an assemblage typical of the lower Poker Chip. *Nannoceratopsis senex* is particularly abundant.

Significant species
*Classopolis* spp.
*Distalannulisporites incertus*

Mathesporites tumulosus
*Corrugatisporites* spp.
*Nannoceratopsis senex* (A)

Sample: RS92-5-2
Depth: 2178.3m
Age: Indeterminable

Remarks
A barren sample.
WELL: 10-7-39-3W5
Sample: RS93-121
Depth: 2167m
Age: Early Jurassic, "Nordegg"

Remarks
The sample yielded amorphous kerogen and rare, unidentifiable palynomorphs. Nordegg samples yield similar material but there is nothing present to assign a precise age.
WELL: 12-10-39-3W5
Sample: RS92-1-1
Depth: 6924'
Age: Cretaceous

Remarks
This sample yielded a rich assemblage of typically Cretaceous spores although the preservation is poor due to bacterial attack. A questionable specimen of Balmula sp. suggests that this may have come from the Ostracod Zone.

Significant species
Cicotricosisporites spp. Januasporites spiniferus (A)
Foraminisporis wonthaggiensis (A) ?Balmula sp.

Sample: RS92-1-2
Depth: 6956'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
This assemblage is typical of the lower part of the Poker Chip Shale. It is rich in small Spheripollenites spp. and Nannoceratopsis senex is quite numerous.

Significant species
Spheripollenites spp. (A) Classopollis spp. (A)
Distalannulisporites incertus Mathesporites tumultuosus
Corrugatisporites anagramensis Lycopodiacidites spinatus/baculatus

Nannoceratopsis senex

Sample: RS92-1-3
Depth: 6982.5'
Age: Indeterminable

Remarks
The kerogen yield from this sample was extremely low. No useful palynomorphs were identified.
**WELL:** 12-15-39-3W5  
**Sample:** RS92-10-1  
**Depth:** 6942.5'  
**Age:** Cretaceous

**Remarks**  
This sample yielded a rich, non-marine assemblage of Cretaceous spores and pollen.

**Significant species**

<table>
<thead>
<tr>
<th>Bisaccate pollen (A)</th>
<th>Foraminisporis wonthaggiensis (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Januasporites spiniferus</td>
<td>Cicatricosisporites spp.</td>
</tr>
<tr>
<td>Concavissilisporites tribotrys</td>
<td>C. apiverrucatus</td>
</tr>
</tbody>
</table>
WELL: 4-18-39-3W5
Samples: RS93-119, 120
Depths: 7052.4', 7068'
Age: Probably late Aalenian, J13A

Remarks
Both samples yielded rich assemblages typical of the Aalenian - Bajocian transition. The spores are more typical of the Aalenian - Toarcian than the Bajocian in this study as is the presence in the upper sample of a small number of Nannoceratopsis gracilis. A questionable specimen of Fromea senilis and specimens of Scriniocassis weberti also favor an Aalenian age.

Significant species
Classopolis spp. (A) Mathesporites tumulosus (C)
Staplinisporites caminus Ischyosporites crateris
Corrugatisporites anagramidensis I. marburgensis

Nannoceratopsis gracilis
Scriniocassis weberti
Batiacasphaera spp.

Fromea cf. senilis
Dissiliocodium spp.
Escharisphaeridia spp.
WELL: 14-18-39-3W5
Samples: RS92-32-1, 32-2, 32-3
Depths: 7201.3', 7210.6', 7220.3'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
These assemblages closely resemble others from the lower part of the Poker Chip in this study.

Significant species
*Spheripollenites* spp. (A)  
*Mathesporites tumulosus*  
*Corrugatisporites amplectaeformis*  
*Nannoceratopsis senex* (A)  
*Classopollis* spp (A)  
*Distalannulisporites incertus*  
*Lycopodiacidites spinatus/baculatus*  
*Dinocyst 12-2*
WELL: 16-20-39-3W5
Sample: RS93-104
Depth: 7090'
Age: Late Pliensbachian - Early Toarcian, J14C-D

Remarks
A very low yield dominated by amorphous kerogen. Small Spheripollenites spp. are numerous, sometimes in clumps, which is typical of the "lower" Poker Chip. The low yield is probably linked to the weathered appearance of the sample.

Significant species
Spheripollenites spp. (A)  Distalannulisporites incertus
Nannoceratopsis senex
WELL: 14-21-39-3W5
Sample: RS92-2-1
Depth: 7107'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
The organic residue is dominated by amorphous debris which, with the abundance of Spheripollenites spp. and numerous Nannoceratopsis senex, is typical of the lower part of the Poker Chip.

Significant species
Spheripollenites spp.  
Nannoceratopsis senex  
Distalannulisporites incertus
WELL: 6-28-39-3W5
Samples: RS92-48-1, 48-2
Depths: 7055.7', 7065.4'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
These samples appear to have come from the lower Poker Chip. They are rich in amorphous debris and *Nannoceratopsis senex* is abundant.

Significant species
- *Classopollis* spp. (A)
- *Corollina* spp.
- *Distalannulisporites incertus*
- *Nannoceratopsis senex* (A)
- *Spherozamites* spp.
- *Mathesporites tumulosus*
- *Corrugatisporites* spp.
- Dinocyst 12-2
WELL: 6-29-39-3W5

Samples: RS93-122, 123
Depths: 7085', 7108'
Age: Late Pliensbachian - Early Toarcian, J14C-D

Remarks
Both samples yielded typical "lower" Poker Chip assemblages similar to others in the study.

Significant species
Sphaeripollenites spp. (A)  Distalannulisporites incertus
Lycopodiacidites baculatus  Mathesporites tumulosus
Corrugatisporites anagramidensis  C. amplectaeformis
Nannoceratopsis senex  Micrhystridium spp.
WELL: 12-30-39-3W5
Samples: RS92-50-1, 50-2
Depths: 2195m, 2199m
Age: Mid to late Aalenian, J14A

Remarks
Both samples contain Fromea senilis but lack the early Aalenian dinocyst markers. A mid to late Aalenian age is therefore assigned.

Significant species
Exesipollenites spp. (A)  Classopollis spp. (A)
Callialasporites dampieri (A)  C. turbatus (A)
Corollina spp. (A)  Lycopodiumsporites spp. (A)
Araucariacites australis  Cerebpollenites mesozoicus
Fromea senilis  F. 83/1
Caddasphaera halosa  Scrinicassis weberii
Nannoceratopsis gracilis  Phallocysta minuta
WELL: 16-31-39-3W5
Sample: RS92-15-1
Depth: 7024.8'
Age: Cretaceous

Remarks
This rich Cretaceous sample is dominated by Cicatricosisporites spp.

Significant species
Cicatricosisporites spp. (A)  C. australiensis
C. pseudotripartitus  C. exilioides
Couperisporites tabulatus  Dictyotrilites granulatus
Aequitriradites spinulosus  Concavissimisporites tribotrys

Sample: RS92-15-2
Depth: 7036.7'
Age: Oxfordian

Remarks
Gonyaulacysta jurassica is abundant in this slide which, in other wells in this and related studies, has been typical of the Oxfordian. A single specimen of the basal Aptian to Berrisan species Phoberocysta neocomica is probably a contaminant although the preservation states are similar.

Significant species
Gonyaulacysta jurassica (A)  (Phoberocysta neocomica)
Leptolepidites psarosus

Sample: RS92-15-3
Depth: 7053.5'
Age: Possibly mid-Toarcian, J14B

Remarks
This rich assemblage is typical of the Poker Chip Shale. The presence of Lithodinia aff. serrulata with specimens of Scriniocassis priscus and S. weberti suggests a slightly younger age than the usual lower Poker Chip assemblages although these species do range into older strata. The sample appears to be pre-
Late Toarcian since the usual dinocyst assemblage is absent as is Callialasporites dampierii. Dinocyst sp. 12-2 is present which also tends to favor an older age.

**Significant species**

*Classopolis* spp. (A)  
*Corrugatisporites anagramensis*  
*Mathesporites tumulosus*  

*Distalannulisporites incertus*  
*C. amplexaformis*  
*Lycopodiacidites spinatus/baculatus*

*Nannoceratopsis senex*  
*Scriniocassis weberii*  
*Lithodinia aff. serrulata*

Dinocyst 12-2  
*S. priscus*

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**Sample:** RS92-15-4  
**Depth:** 7063′  
**Age:** Early Toarcian-Late Pliensbachian, J14C-D

**Remarks**

The spore-pollen assemblage is similar to 15-3 except that *Spheripollenites* spp. are present as single specimens as well as clumps. This feature is more typical of the lower Poker Chip. The only dinocyst species present is *Nannoceratopsis senex*. 
WELL: 16-32-39-3W5

Sample: RS93-102
Depth: 6930'
Age: Probably Oxfordian, ?J8-J9B

Remarks
Most of the palynomorphs are corroded and unidentifiable. Specimens of Gonyaulacysta jurassica and Sentusidinium spp. indicate that the age is most probably Oxfordian when compared with other somewhat more diverse Oxfordian assemblages from Alberta.

Significant species
Gonyaulacysta jurassica  
Sentusidinium spp.

Sample: RS93-103
Depth: 6944'
Age: Late Toarcian - ?early Aalenian, ?J14A-J14B

Remarks
This rich, well preserved assemblage lacks the distinctive kerogen association of the "lower" Poker Chip. Spores and pollen typical of the Toarcian-Aalenian are abundant but dinocysts are rare. Callialesporites dampieri indicates an age no older than Late Toarcian and specimens of Dinocyst cf. PC-1 indicate an age no younger than early Aalenian. No Aalenian markers were recorded.

Significant species
Classopollis spp. (A)  
Corrugatisporites anagrammensis  
Callialesporites dampieri  
Lycopodiacidites baculatus  
Nannoceratopsis senex  

Distalannulisporites incertus (A)  
Mathesporites tumulosus  
Corrugatisporites amplextaeformis  
L. spinatus  
Dinocyst cf. PC-1
**WELL:** 14-33-39-3W5  
**Samples:** RS92-49-1, 49-2  
**Depths:** 6999.7', 7014.7'  
**Age:** Early Toarcian-Late Pliensbachian, J14C-D

**Remarks**  
Both samples are rich and the assemblages are typical of the lower Poker Chip.

**Significant species**  
- *Spheripollenites* spp.  
- *Mathesporites tumulosus*  
- *Distalannulisporites incertus*  
- *Nannoceratopsis senex*  
- *Classopollis* spp. (A)  
- *Corrugatisporites* spp.  
- *Corollina* spp.  
- *Dinocyst 12-2*
WELL: 4-35-39-3W5

Samples: RS9303, 9304
Depth: 7020.5', 7029'
Age: Late Pliensbachian - Early Toarcian, J14C-D

Remarks
The organic residues in both samples are dominated by amorphous kerogen which obscures many of the palynomorphs. This is typical of the "lower" Poker Chip. Marker species which confirm the age include Dinocyst 12-2, Spheripollenites spp. (often in clumps) and Nannoceratopsis senex.

Significant species
Spheripollenites spp. (A)                        Classopollis spp.
Mathesporites tumulosus                        Corrugatisporites anagrammensis
Distalannulisporites incertus                  C. amplectaeformis

Nannoceratopsis senex                          Dinocyst 12-2
WELL: 6-36-39-3W5

Samples: RS93-116, 117
Depths: 2134.5m, 2138.6m
Age: Cretaceous

Remarks
Both samples yielded heavily corroded, Cretaceous spores and pollen.

Significant species
Bisaccate pollen (A)  
Microreticulatisporites uniformis
Concavissimisporites tribotrys
Januasporites spiniferus

Cicatricosisporites spp.
Appendicisporites sp.
A. erdtmanii
Dictyotriletes granulatus
WELL: 10-6-39-4W5

Samples: RS92-18-1, 18-4, 18-2
Depths: 7682', 7682.3', 7686.8'
Age: Cretaceous

Remarks
Samples 18-1 and 18-2 contain Cretaceous assemblages although the yields were very low. Sample 18-4 is extremely poor with only two long-ranging palynomorphs present.

Significant species
Cicatricosisporites spp. Foraminisporis wonthaggiensis
Appendicisporites bilateralis Januaspores spiniferus
Concaivissimisporites tribotrys C. apiverrucatus

Samples: RS92-18-5, 18-3
Depths: 7688.5', 7699'
Age: Indeterminable

Remarks
The organic yields were extremely small and no marker species are present.
WELL: 8-13-39-4W5

Samples: RS93-109, 110, 111
Depths: 7045', 7045.5', 7046'
Age: latest Aalenian - Early Bajocian, J13B-J14A

Remarks
All three assemblages are dominated by specimens of *Dissiliodinium* spp. with smaller numbers of *Escharisphaeridia* spp. typical of the Aalenian Bajocian transition. The rarity of Aalenian-Toarcian spores and the presence at 7045' of *Evansia granulata* suggests that the upper part of the shale may be Early Bajocian.

Significant species
- *Classopolis* spp. (A)
- *Ischiysporites crateris*
- *Callialasporites dampieri*
- *Dissiliodinium* spp. (A)
- *Evansia granulata*
- *Mathesporites tumulus* (R)
- *Corrugatispores* spp.
- *C. turbatus*
- *Escharisphaeridia* spp.
- *Phallocysta cf. minuta*
WELL: 8-13-39-4W5
Sample: RS92-47-1
Depth: 7051'
Age: Early Bajocian, J13B

Remarks
The presence of Sestrosorites pseudaliceolatus with Scriniocassiss priscus indicates an Early Bajocian age. Dissillodinium spp. are abundant.

Significant species
Classopollis spp. (A)  Bisaccate pollen (A)
Sestrosorites pseudaliceolatus Callialesporites turbatus
Ovalipollis enigmaticus C. damperii
Dissillodinium spp. (A)    Escharisphaeridium spp.
Scriniocassiss priscus

Samples: RS92-47-2, 47-3
Depths: 7100.2', 7101.2'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
Sapropelic debris is abundant but palynomorphs are rare. Those present, which are listed below, are typical of the lower Poker Chip.

Significant species
Spheripollenites spp.  Classopollis spp.
Mathesporites tumulosus Corrugatisporites spp.
Distalannulisporites incertus Ischyosporites marburgensis
Nannoceratopsis senex
WELL: 10-19-39-4W5
Sample: RS93-113
Depth: 7445' 
Age: Late Pliensbachian - Early Toarcian, J14C-D

Remarks
A typical "lower" Poker Chip assemblages where most specimens are obscured by amorphous kerogen.

Significant species
Spheripollenites spp. (A)  
Nannoceratopsis senex  

Distalannulisporites incertus  
Dinocyst 12-2
WELL: 2-24-39-4W5
Samples: RS92-31-1, 31-2
Depths: 7272.3', 7273.8'
Age: Indeterminable

Remarks
Virtually barren samples.
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
Concaevissimisporites trioreticulatus  C. tricotrys
Foraminisporites 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 Spheripollenites spp. Assemblages such as this are typical of Early Toarcian to Late Pliensbachian in the Sverdrup Basin and north-west Europe. Samples 46-9 and 46-10 are similar except that the Spheripollenites spp. are not so prominent.

Significant species
Nannoceratopsis senex (A)  Spheripollenites spp. (A)
Distalannulisporites incertus  Mathesporites tumulosus
Corrugatisporites anagrammensis  C. ampliplectaeformis
WELL: 10-35-39-3W5
Sample: RS93-118
Depth: 7280'
Age: Oxfordian, J7-J9B

Remarks
The abundance of Gonyaulacysta jurassica and the amorphous, vitrinitic kerogen association correlates the sample with other Oxfordian assemblages seen in this study.

Significant species
Gonyaulacysta jurassica (A)

cf. Acanthaulax sp.

WELL: 10-35-39-4W5
Samples: RS92-16-1, 16-2
Depths: 7307.6', 7333'
Age: Late Aalenian, J14A

Remarks
Both samples are rich with abundant specimens and fragments of the dinocyst Dissilodinium sp. Fromea 83/1 is present at 7307.6' and F. senilis at 7333' suggesting a late Aalenian age.

Significant species
Dissilodinium spp. (A)
Nannoceratopsis gracilis
Fromea 83/1

Wallodinum sp.
Escharisphaeridia spp.
F. senilis
WELL: 12-11-39-5W5
Sample: RS92-33-1
Depth: 7835.6' ?Late Toarcian, J14B
Age: 

Remarks
Inertinitic debris is extremely abundant and the palynomorphs are highly corroded. A somewhat questionable specimen of Callialasporites dampieri suggests an age no older than Late Toarcian. The remaining species are all typical of the Toarcian including Dinocyst 12-2 which generally occurs in mid-Toarcian and older sediments in this study.

Significant species
Callialasporites cf. dampieri
Corrugatisporites amplexicaformis
Classopolis spp.
C. anagramensis
Dinocyst 12-2

Samples: RS92-33-2, 33-3, 33-4, 33-5, 33-6
Depths: 7849.4', 7871.3', 7881', 7890.5', 7917.2'
Age: Indeterminable

Remarks
Sample 33-2 yielded a small residue of inertinitic debris and rare, unidentifiable palynomorphs. No palynomorphs were recorded in the other samples which are dominated by amorphous inertinitic debris except for 33-5 which contains platy, resinous-looking kerogen.

WELL: 12-11-39-5W5
Samples: RS92-27-1, 27-2, 27-3, 27-4
Depths: 7883.7', 7896.9', 7903.5', 7918.5'
Age: Indeterminable

Remarks
The yields from these samples are extremely low with rare, unidentifiable palynomorphs. A highly questionable specimen of Triquisrites sp., a Carboniferous spore, is present in 27-4.
WELL: 16-16-39-5W5
Sample: RS92-26-1
Depth: 7761.1'
Age: Jurassic, ?Bajocian

Remarks
Although this sample is rich in organic debris it has obviously been winnowed in a high-energy environment. *Classopollis* spp. are the most numerous of the palynomorphs and indicate that the age is most probably Jurassic. A questionable specimen of *Escharisphaeridia asymmetra* suggests a Bajocian age but this is tentative.

Significant species
*Classopollis* spp.
*Exesipollenites* spp.

*Escharisphaeridia ?asymmetra*
WELL:  4-19-39-5W5

Samples:  RS92-25-1, 25-2, 25-3
Depths:  8091.2', 8099.5', 8110'
Age:  Indeterminable

Remarks
The samples were virtually barren of organic debris.
WELL: 10-21-39-5W5
Sample: RS92-14-1
Depth: 2334.16m
Age: Cretaceous

Remarks
A poor sample in which bisaccate pollen dominate. A specimen of Dictyotrilites granulatus indicates a Cretaceous age.

Sample: JWK92-45-1
Depth: 2334.3m
Age: Indeterminable

Remarks
Despite a fair kerogen yield, palynomorphs are extremely rare and an age cannot be assigned.
WELL: 6-22-20-5W6
Sample: RS92-13-1
Depth: 7683.4'  
Age: Aalenian-Late Toarcian, J14A-B

Remarks

This is a rich assemblage of Poker Chip aspect in which a specimen of Callialasporites dampieri places a lower age limit of Late Toarcian. Microplankton are rare and a more precise age cannot be assigned.

Significant species

Classopollis (A)  
Mathesporites tumulosus  
Callialasporites dampieri  
Nannoceratopsis senex

Distalannulisporites incertus (A)  
Lycopodiacidites spinatus/baculatus  
C. turbatus  
N. cf. gracilis

Samples: RS92-13-3, 13-2, 13-4  
Depths: 7689.9', 7703.7', 7705.2'  
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks

The spore-pollen assemblages are similar to 13-1 except that C. dampieri is absent and bacterially altered debris is more abundant. The presence of Dinocyst sp. 12-2 in 13-2 and Sphericolleneites spp. clumps in 13-3 and 13-4 also confirm the age.
WELL: 10-2-40-3W5
Samples: RS92-17-1, 17-2, 17-3, 17-4
Depths: 6941.5', 6958.2', 6977.8', 7003.8'
Age: Cretaceous

Remarks
These samples vary in richness and diversity but all contain numerous Cretaceous spores and pollen.

Significant species
Cicatricosisporites spp. C. australiensis
C. exilioides C. hughesii
Concavissimisporites tribotrys C. trioreticulosus
Couperisporites tabulatus Aquitriradites spinulosus
Schizosporis parvus S. reticulatus
WELL: 4-5-40-3W5
Samples: RS92-46-1, 46-2
Depths: 7110.4', 7138.1'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
These samples are rich in amorphous debris and Spheripollenites spp., particularly 46-2. The spore/pollen/dinocyst assemblage is typical of the lower Poker Chip.

Significant species
Spheripollenites spp. (A)  Classopollis spp. (A)
Distalannulisporites incertus (A)  Ovalispollis enigmatica
Mathesporites tumulosus  Ischyosporites marburgensis
Corrugatisporites spp.  Lycopodiacidites spinatus/baculatus

Nannoceratopsis senex  Dinocyst 12-2
<table>
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<th>WELL</th>
<th>12-8-40-3W5</th>
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<tr>
<td>Sample</td>
<td>RS93-124</td>
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<tr>
<td>Depth</td>
<td>7105.5'</td>
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<tr>
<td>Age</td>
<td>Indeterminable</td>
</tr>
</tbody>
</table>

Remarks

The kerogen consists of inertinite and semi-fusinite with unidentifiable palynomorphs. An age could not be assigned.
WELL: 6-15-40-4W5
Sample: RS92-43-1
Depth: 7058.9'
Age: Indeterminable

Remarks
The residue consists of inertinitic debris with very rare, unidentifiable palynomorphs.
WELL: 7-27-40-3W5
Samples: RS92-44-1, 44-2
Depths: 6874.5', 6898.9'
Age: Early Toarcian-Late Pliensbachian, J14C-D
Remarks
These assemblages are typical of the lower Poker Chip with abundant amorphous debris, *Spheripollenites* spp. and *Nannoceratopsis senex*.

Significant species

*Spheripollenites* spp. (A)  
_Corrugatisporites anagaramensis_  
*Nannoceratopsis senex*

*Classopollis* spp. (A)  
*Mathesporites tumulosus*  
_Dinocyst 12-2_
WELL: 12-27-40-3W5

Samples: RS93-125, 126
Depths: 2130m, 2140.4m
Age: Late Pliensbachian - Early Toarcian, J14C-D

Remarks
The kerogen and palynomorph associations are typical of the "lower" Poker Chip.

Significant species
Spheripollenites spp. (A)  Classopollis spp. (A)
Distalannulispores incertus  Mathesporites tumulosus
Lycopodiumites baculatus  Corrugatisporites amplextaeformis

Nannoceratopsis senex  Dinocyst 12-2
Remarks
Although the kerogen yield was good, palynomorphs are rare and poorly preserved, possibly due to primary oxidation. The most abundant palynomorphs are bisaccate pollen which together with the kerogen association favor a Cretaceous age. However, no marker species were recorded.
WELL: 7-29-40-3W5
Samples: RS92-34-1, 34-2
Depths: 7058', 7072.1'
Age: ?Early Bajocian-late Aalenian, ?J13B-J14A

Remarks
The yield was low and inertinite is prominent in the upper sample. *Classopolis* spp. and bisaccate pollen are abundant and the presence of rare *Distiliadinium* sp. and typically Aalenian-Pliensbachian spores suggest an ?Early Bajocian-late Aalenian age. The lower sample contains numerous *Nannoceratopsis gracilis*, which is more typical of Aalenian and older sediments, and a questionable *Evansia* sp. A late Aalenian age is the most likely. It is possible that some of the spores were recycled from the Poker Chip.

Significant species
*Classopolis* spp. (A)  
*Bisaccate pollen* (A)  
*Exesipollenites* spp.  
*Mathesporites tumulosus*  
*Corrigatisporites anagamensis*  
*Cerebropollenites mesozoicus*  
*Calilasporites dampilii*  
*Ischyosporites marburgensis*  
*Distalannulisporites incertus*  
*Corollina* spp.  
*Nannoceratopsis gracilis*  
*N. senex*  

Sample: RS92-34-3
Depths: 7101'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
A typical Poker Chip assemblage with numerous *Corrigatisporites* spp., *Distalannulisporites incertus*, *Mathesporites tumulosus* and rare *Nannoceratopsis senex*.

Significant species
*Classopolis* spp. (A)  
*Small spores/pollen* (A)  
*Corrigatisporites anagamensis*  
*C. amplexaformis*  
*Distalannulisporites incertus* (A)  
*Mathesporites tumulosus*  
*Lycopodiecildites spinatus/baculatus*  
*Nannoceratopsis senex*  
*Dinocyst cf. 12-2*
Sample: RS62-34-4
Depth: 7107.8'
Age: Indeterminable

Remarks
An essentially barren sample.
**WELL:**

**Sample:** 8-33-40-3W5

**Depth:** 2147.7m

**Age:** Early Toarcian-Late Pliensbachian, J14C-D

**Remarks**

Amorphous debris is abundant in this sample which, with the numerous Spheripollenites spp. is typical of the lower Poker Chip.

**Significant species**

- Spheripollenites spp. (A)
- Distalannulisporites incertus (A)
- Corrugatisporites spp.
- Nannoceratopsis senex

**Classopollis spp. (A)**

- Mathesporites tumulosus
- Lycopodiacidites spinatus/baculatus
- Dinocyst 12-2

**Samples:**

**Depth:**

- 2148.6m, 2155m

**Age:** Indeterminable

**Remarks**

Essentially barren samples.

**Sample:**

**Depth:** 2164m

**Age:** ?Jurassic

**Remarks**

The yield from this sample was extremely small. Rare palynomorphs typical of the Poker Chip could be contaminants.

**Significant species**

- Classopollis sp.
- Mathesporites tumulosus

- Spheripollenites sp.
WELL: 4-13-40-5W5
Samples: RS92-40-1, 40-2
Depths: 7096.9', 7115.8'
Age: Early Toarcian-Late Pliensbachian, J14C-D

Remarks
Both samples are typical of the lower Poker Chip with an abundance of amorphous debris, Speripollenites spp. and Nannoceratopsis senex. The lower sample is particularly rich.

Significant species
Speripollenites spp. (A) Classopollis spp. (A)
Distalannulisporites incertus Mathesporites tumulosus
Corrugatisporites amplectaeformis C. anagramensis
Nannoceratopsis senex Dinocyst 12-2
**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: 10-28-40-4W5
Sample: RS9302
Depth: 7186'
Age: Late Aalenian, J14A

Remarks
The preservation of the palynomorphs is extremely poor but the composition of the assemblage is not dissimilar to RS9301 (8-6-39-3W5). The presence of small, simple dinocysts such as Escharisphaeridia sp., with rare specimens of Distalannulisporites incertus and Mathesporites tumulosus suggest a late Aalenian age.

Significant species
Mathesporites tumulosus
Corrugatisporites spp.                     Distalannulisporites incertus
Escharisphaeridia spp.                    Staplinisporites caminus
WELL: 10-26-40-4W5
Sample: RS93-127
Depth: 7087.5'
Age: Probably late Aalenian, J13A

Remarks
This poorly preserved assemblage contains elements typical of the Aalenian-Bajocian transition. The presence of several specimens of *Nannoceratopsis gracilis* is more typical of Aalenian samples in this study although the taxon ranges through the Bajocian.

Significant species

*Classopollis* spp. (A)  
*Callialasporites damierii*  
*Nannoceratopsis gracilis*  
*Staplitesporites caminus*  
*C. turbans*  
* Dissillicinum spp.*
WELL: 4-36-40-4W5
Sample: RS93-101
Depth: 7094'
Age: Indeterminable

Remarks
This Nordegg sample yielded a very small residue dominated by inertinite and semifusinite grains. Rare Classopollis spp. and bisaccate pollen are not sufficient to assign a precise age.
WELL: 14-4-40-5W5
Samples: RS92-39-4, 39-1
Depths: 2336.2m, 2336.4m
Age: ?Oxfordian

Remarks
Despite their position above a Cretaceous-looking sand, both samples yielded assemblages which appear to be Jurassic, possibly Oxfordian. It is possible that the shale was derived from the Jurassic but there is no strong evidence for this apart from a questionable specimen of the late Kimmeridgian to Cretaceous species Concavissimisporites apiverrucatus and specimens of Ischyosporites cf. pseudoreticulatus. Undoubted specimens of the latter have a similar range to C. apiverrucatus. Bisaccate pollen are very abundant which is typical of Cretaceous but also of the Late Jurassic in the area.

The Jurassic species include Gonyaulacysta jurassica, Sentusidinium spp. and Klukisporites cf. lacunus. Classopollis spp. are abundant in the lower sample which is more typical of the Jurassic than the Cretaceous.

Lycopodiumsporites spp. are numerous in both samples. This is a long-ranging group but in the previous studies (e.g., 92.01, March 1992) these species have tended to be more abundant in the Jurassic samples. Other samples in the 92.01 study which are not dissimilar to this one include JWK91-14-1, 14-2 (possibly Early Cretaceous), JWK91-13-1 (possibly Early Cretaceous), JWK91-16-2 (possibly Cretaceous), JWK92-13-3 (possibly Early Cretaceous), JWK92-26-1 (?late Jurassic), JWK92-30-1 (Jurassic), JWK92-47-1, 47-2 (probably Oxfordian), JWK92-53-1 (Middle to Early Oxfordian) and JWK92-66-3 (i.e., well JWK91-9, ?Oxfordian).

Significant species
Bisaccate pollen (A)  Classopollis spp. (A)
?Concavissimisporites apiverrucatus  Lycopodiumsporites spp. (A)
Neoraistrickia truncata  Ischyosporites cf. pseudoreticulatus
Klukisporites cf. lacunus

Gonyaulacysta jurassica  Sentusidinium spp.
Sample: RS92-39-2  
Depth: 2353m  
Age: Late Aalenian, J14A

Remarks

Palynomorphs are rare in this inertinite dominated sample. Specimens of Scriniocassis priscus, S. weberii, Escharisphaeridia spp. and Dissiliodinium spp. indicate a late Aalenian age.

Significant species

<table>
<thead>
<tr>
<th>Classopollis spp (A)</th>
<th>Corollina spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebropollenites mesozoicus</td>
<td>Ischyosporites crateris</td>
</tr>
<tr>
<td>Lycopodiumsporites spp.</td>
<td>Staplinisporites caminus</td>
</tr>
<tr>
<td>Mathesporites tumulosus</td>
<td>Callialasporites turbatus</td>
</tr>
<tr>
<td>Scriniocassis priscus</td>
<td>S. weberii</td>
</tr>
<tr>
<td>Escharisphaeridia spp.</td>
<td>Dissiliodinium spp.</td>
</tr>
</tbody>
</table>