Jurassic Boundary Study

Medicine River/Sylvan Lake

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

ARC Open File Report 1993-23

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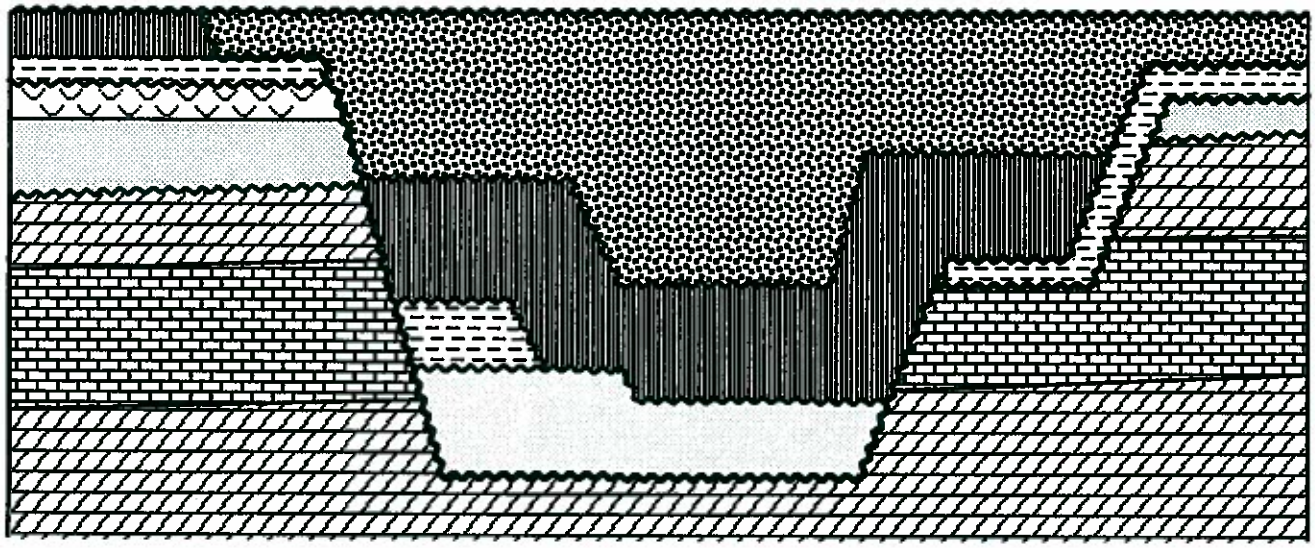

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Executive Summary

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 publically 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).

Table of Contents

List of Figures

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, Glauconitic, 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.

Publications outlining the general geology and lithofacies associations for Jurassic and Mississippian successions in the central and western portions of the basin include papers by Chamney (1957), Springer et al. (1963), Watkins (1966 a,b), Carlson (1968), Deere and Bayliss (1969), Stanley et al. (1971), Bovell (1979), Marion (1982, 1984), Hall (1984), Banerjee (1986), Losert (1986, 1987), Poulton et al., (1990), ERCB (1992), Putnam and Moore (1993), Richards et al. (1993), Sperenza (1993) and Kramers and Dolby (1993). Studies focussing on the Medicine River, Gilby and Sylvan Lake areas include those by Rall (1980), Hopkins (1981, 1982), Collar (1990), and Handcock et al. (1993), which investigate the Jurassic stratigraphy, and work by Penner (1958) and Martin (1967) on the Mississippian.

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:

- o Appendix 1 (Intepreted Core Descriptions)
- o Appendix 2 (Palynological Analysis - Introduction and Summary)
- o Appendix 3 (Palynological Analysis - Sample Descriptions)

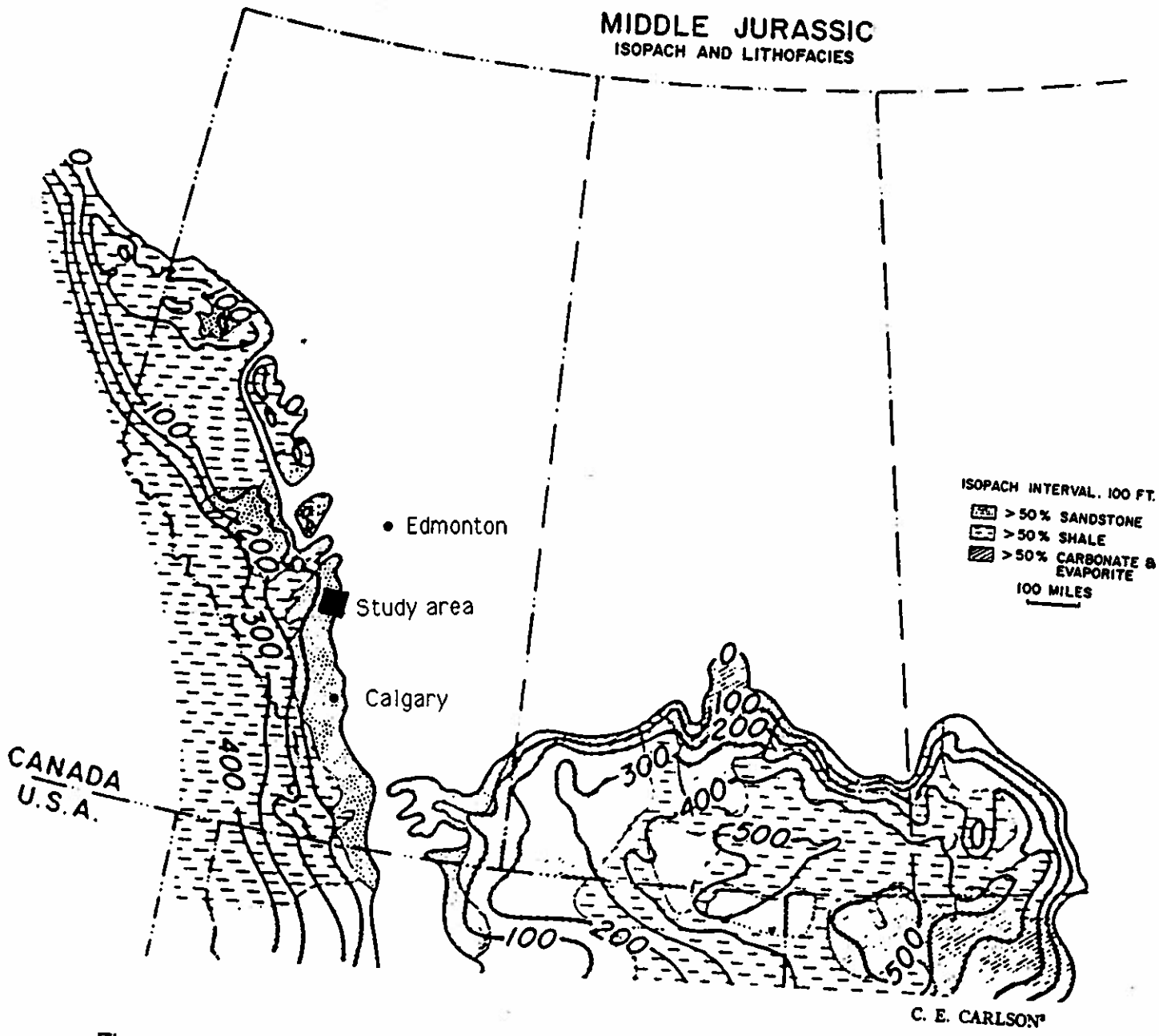

Figure 1. Location of the detailed study area with respect to regional trends (modified after Springer et al., 1963 and Carlson, 1968).

R.5 R.4 R.3 R.2 W5M

T.40 T.39 T.38 T.37

Jurassic valley fill

Jurassic ? valley fill

Cretaceous and Jurassic valley fill

Control wells

Geophysical logs only

Core described

Rock Creek erosional edge

Nordegg erosional edge

Valley fill successions

Figure 2.
Rock Creek and Nordegg erosional edges and location of major Jurassic ? valley fill successions

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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).

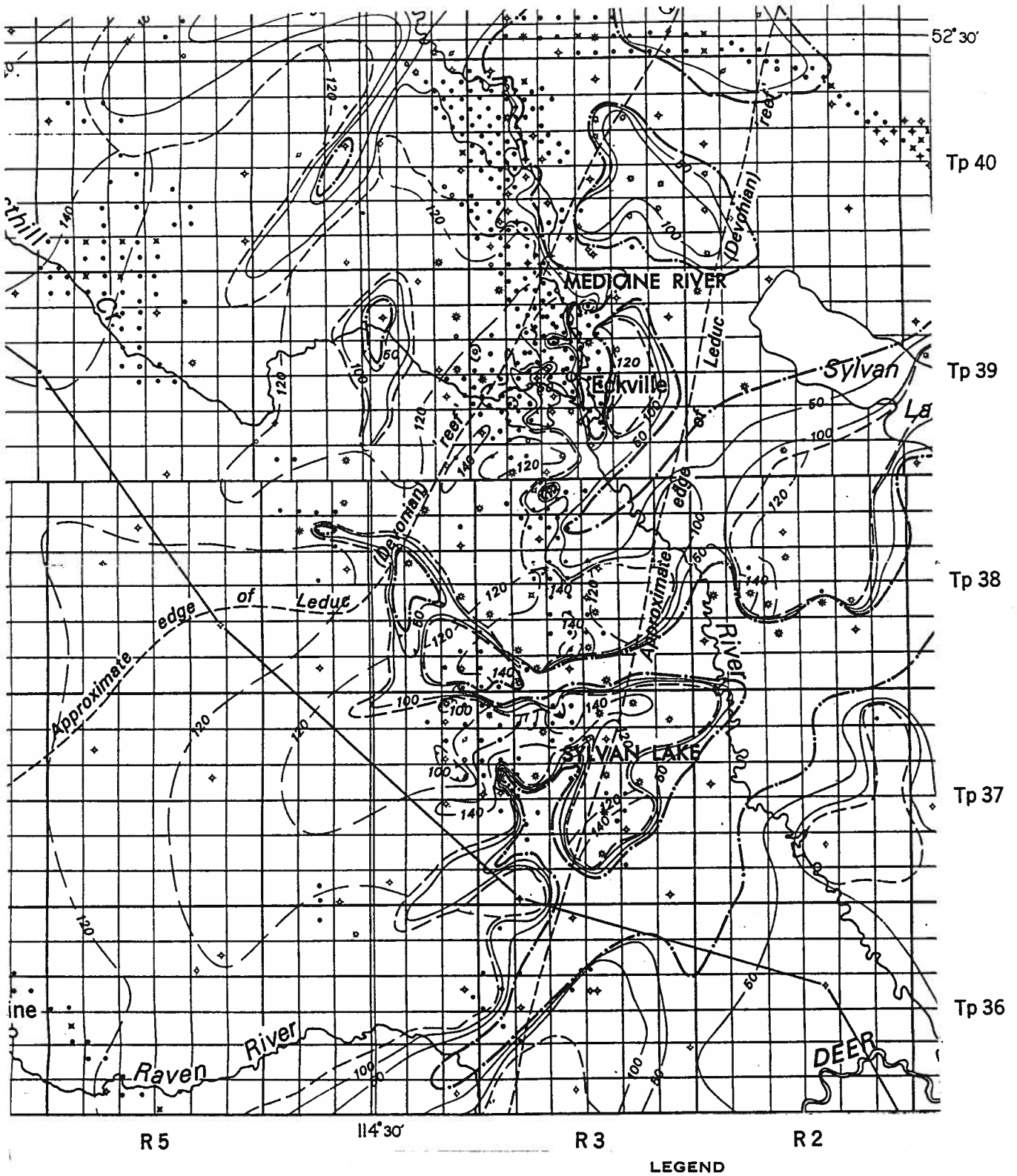
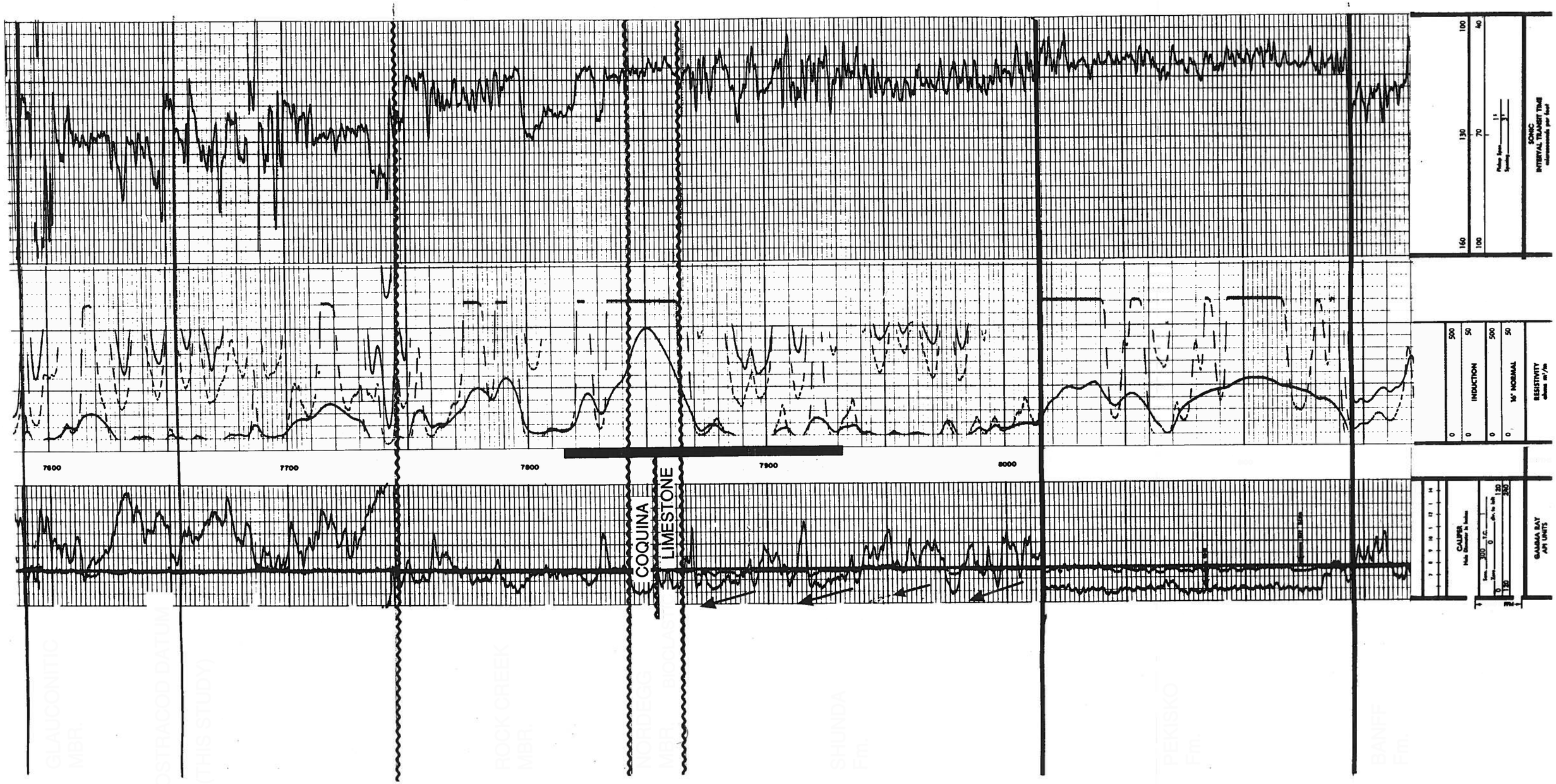


Figure 3. Isopach map of Pekisko Formation. Note the orientation of post-Mississippian incised valleys (from Martin, 1967).

Figure 4. Type log 12-11-39-5W5, Poker Chip shale absent.



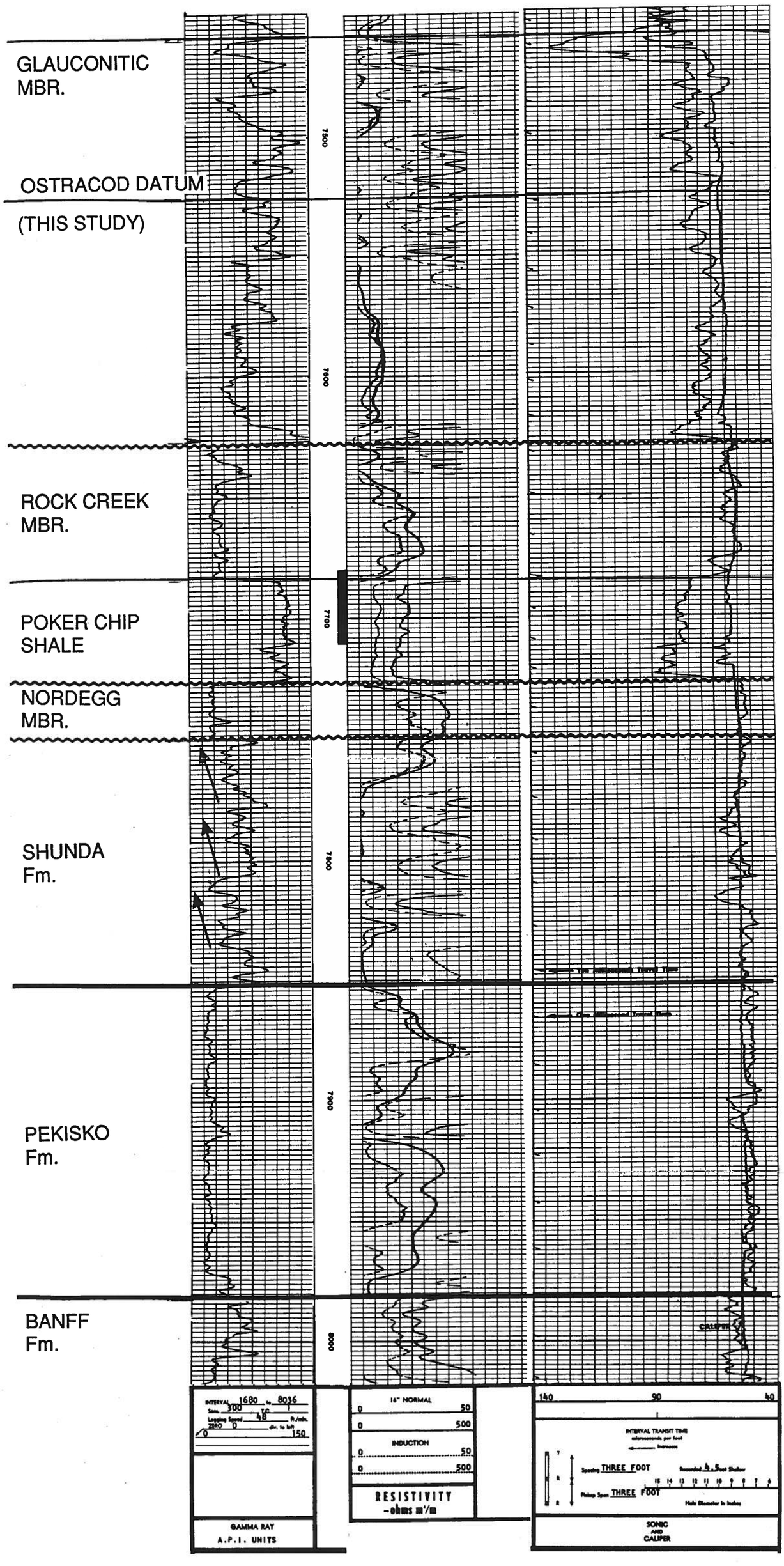


Figure 5. Type log 6-23-39-5W5, partial erosion of Shunda Formation.

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 overly 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 incisement, 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').

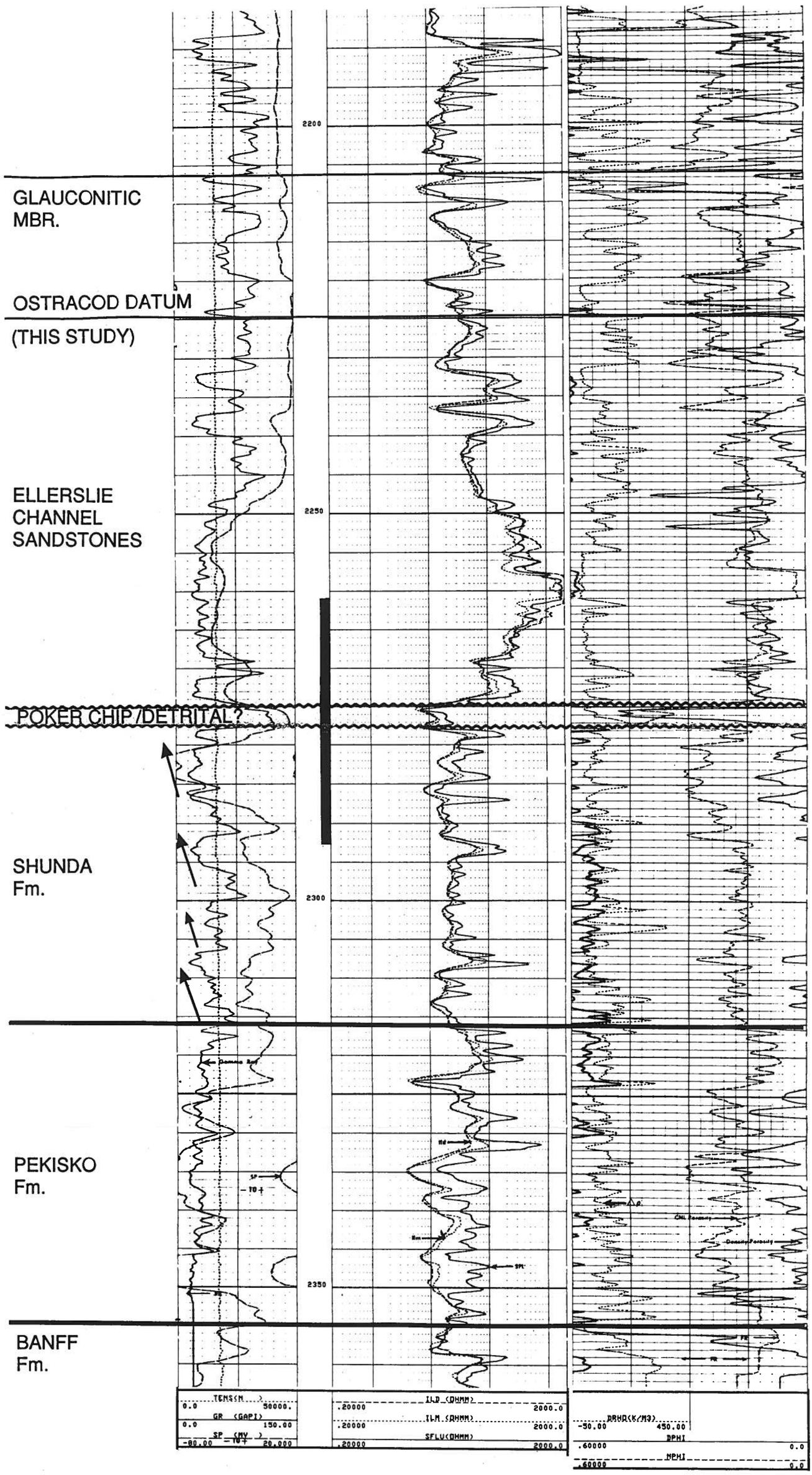


Figure 6. Type log 8-2-38-4W5, Cretaceous capping Mississippian.

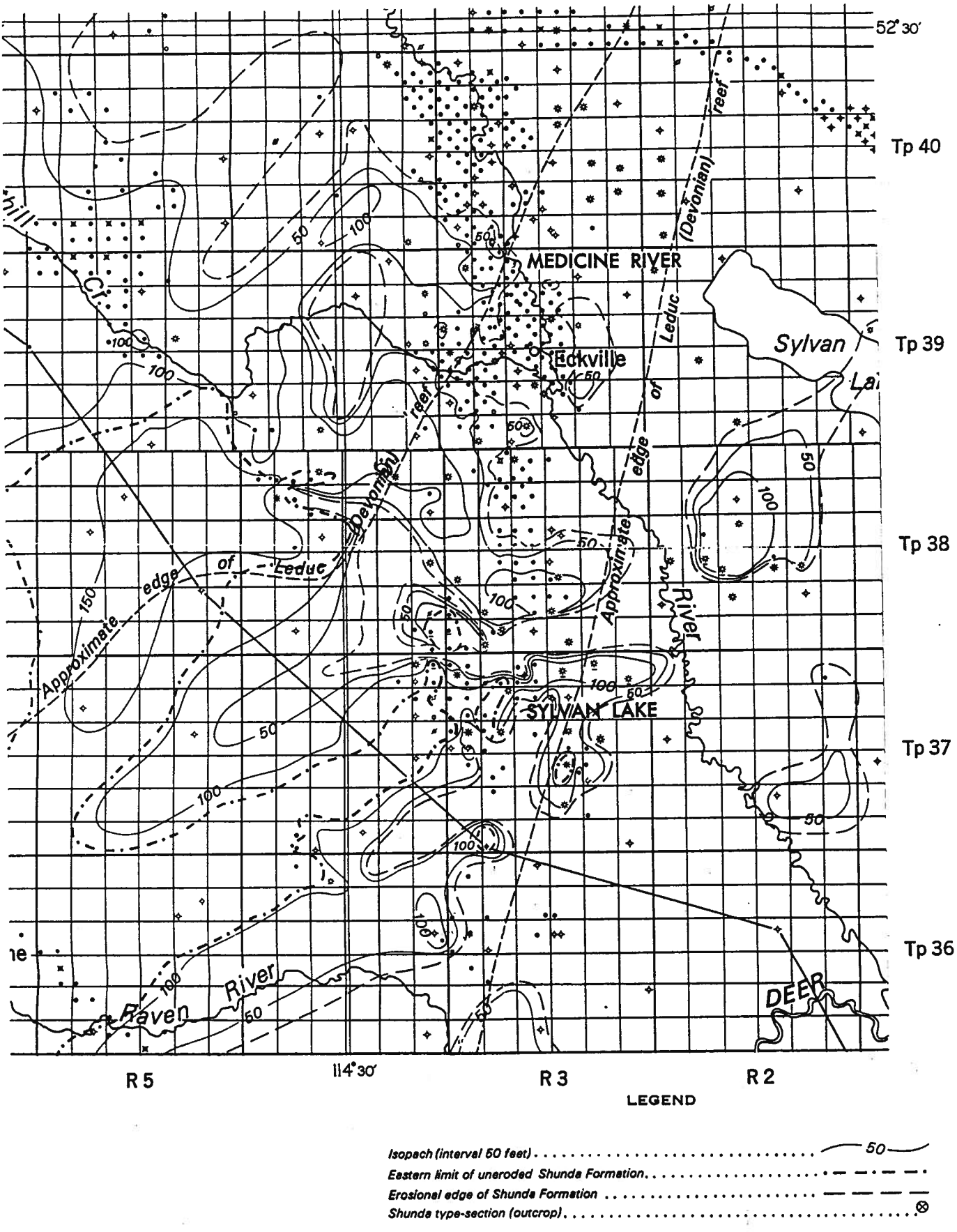


Figure 7. Isopach map of the Shunda Formation illustrating erosional outliers and post-Mississippian valley systems (from Martin, 1967).

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 30^0 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').

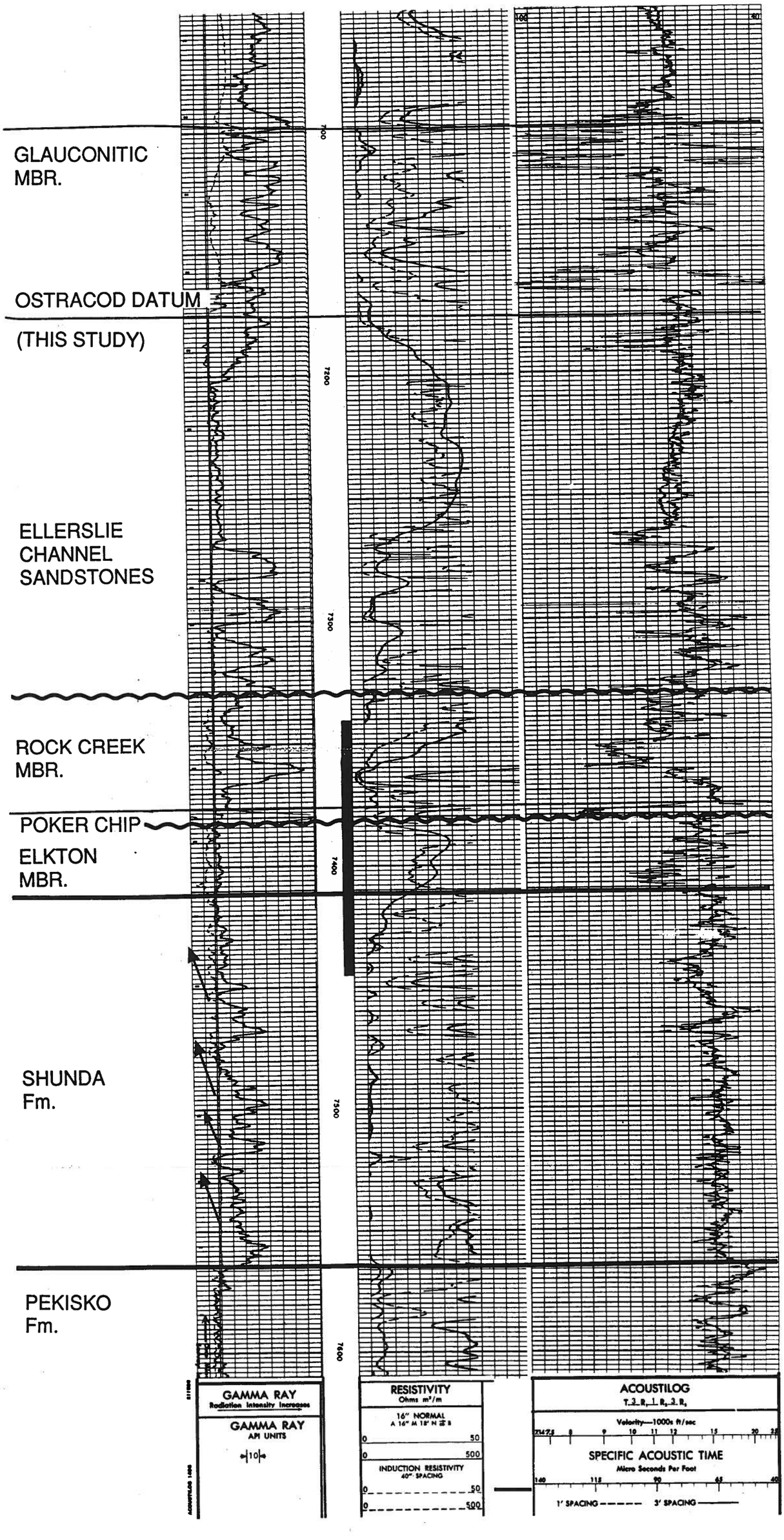


Figure 8. Type log 10-36-37-4W5, Elkton preserved.

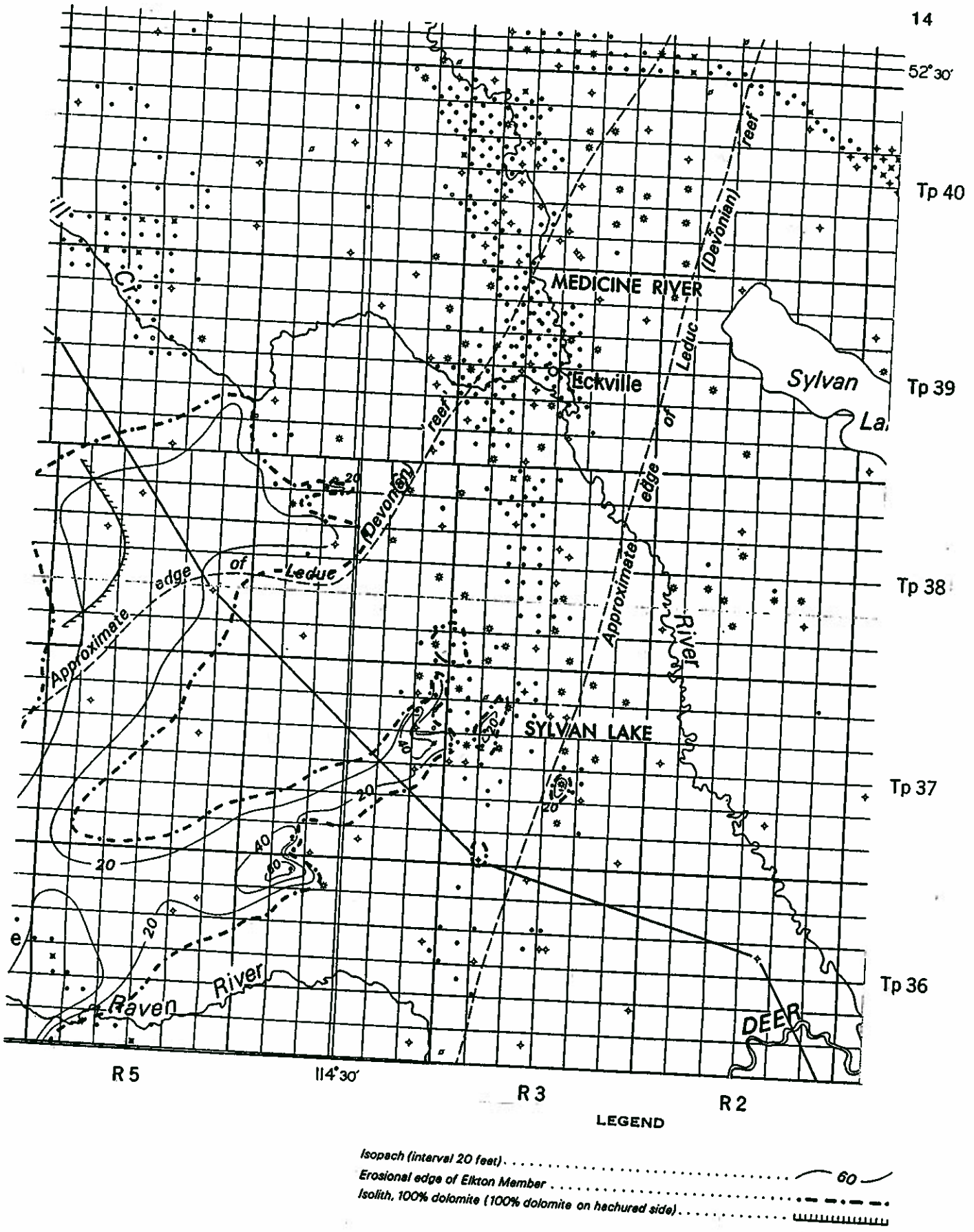


Figure 9. Isopach map of the Elkton Member illustrating prominent Mississippian highlands (from Martin, 1967).

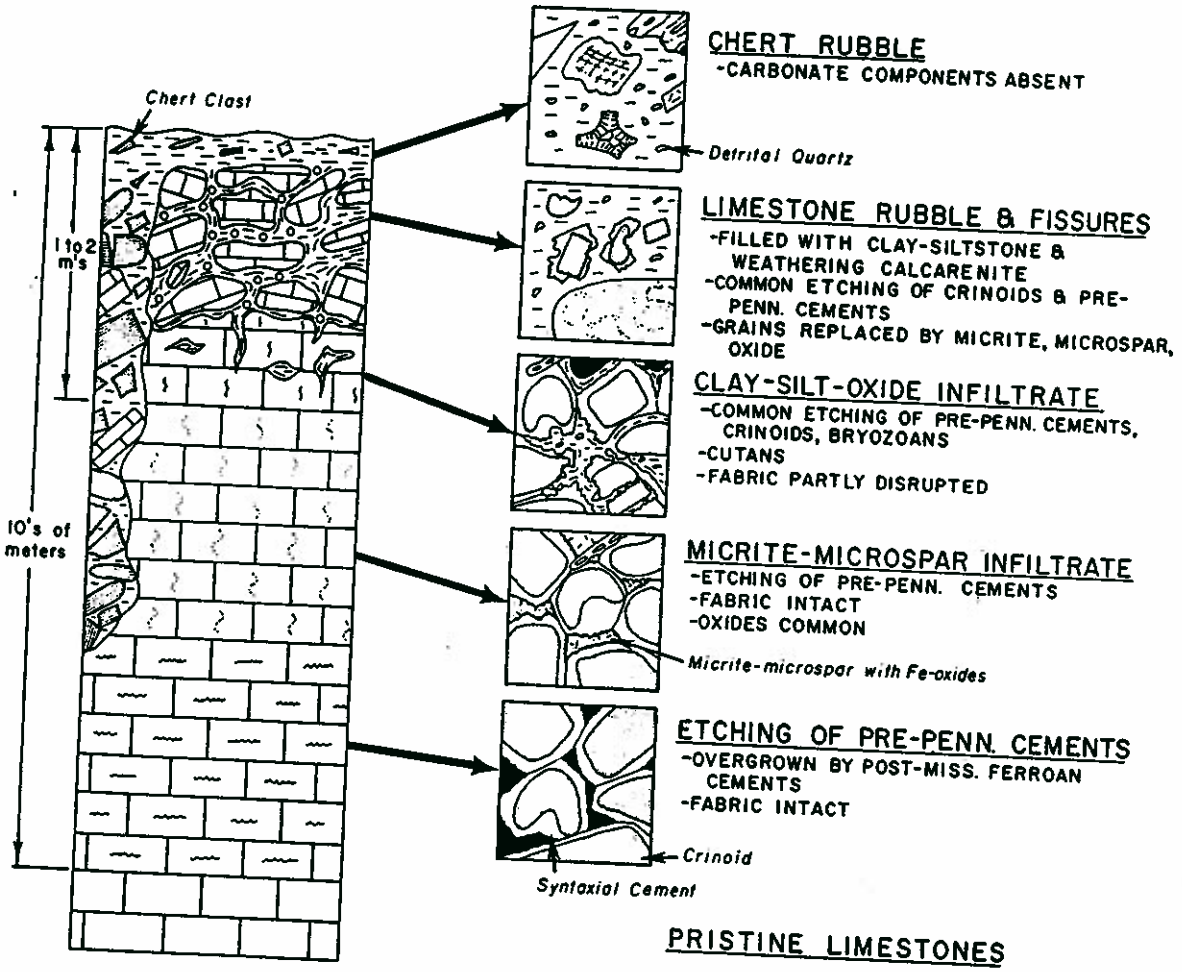


Figure 10. Karst features of New Mexico Mississippian carbonates - possible analogues for the Mississippian strata in the Sylvan Lake/Medicine River area (from Meyers, 1988).

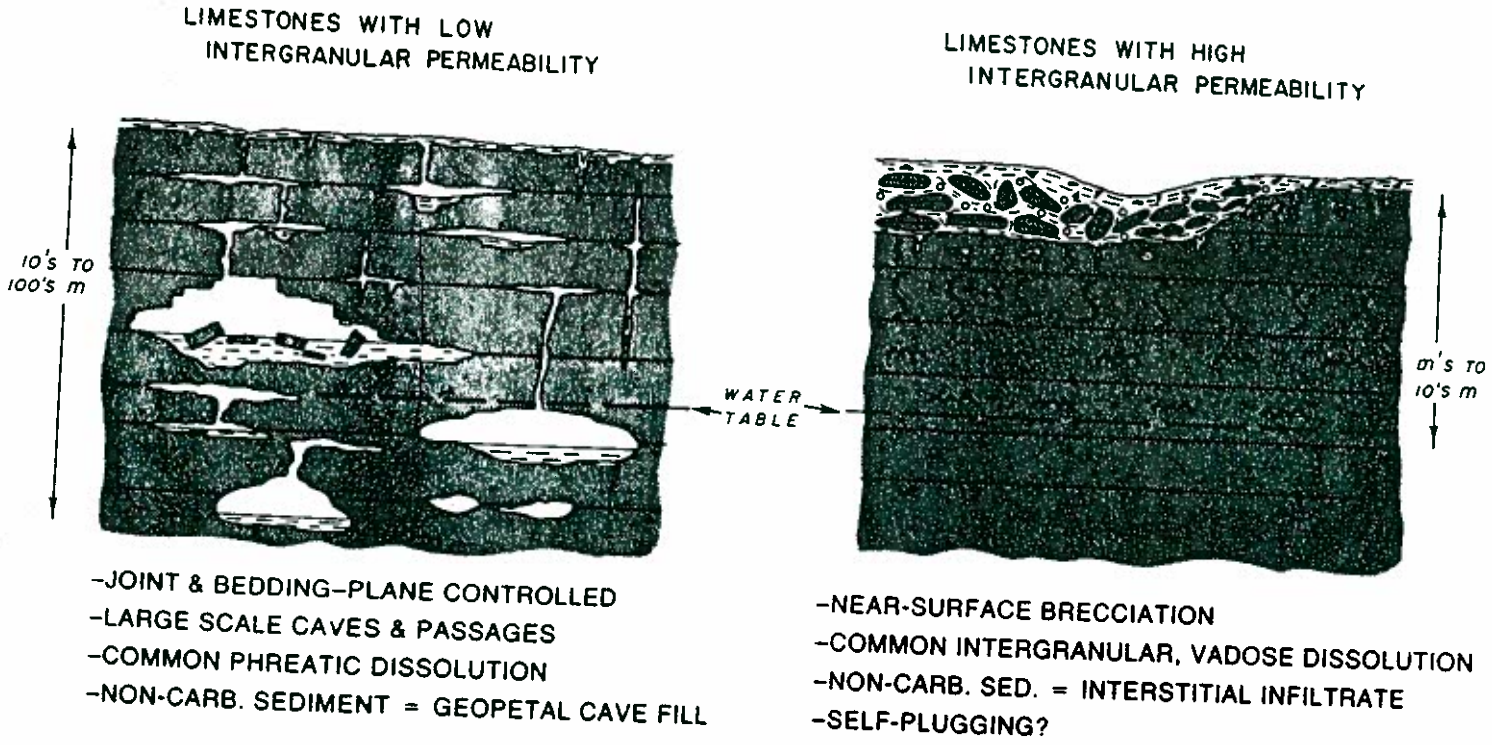


Figure 11. Variations in karsting effects associated with carbonate lithofacies (from Meyers, 1988).

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 paleohighlands. 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').

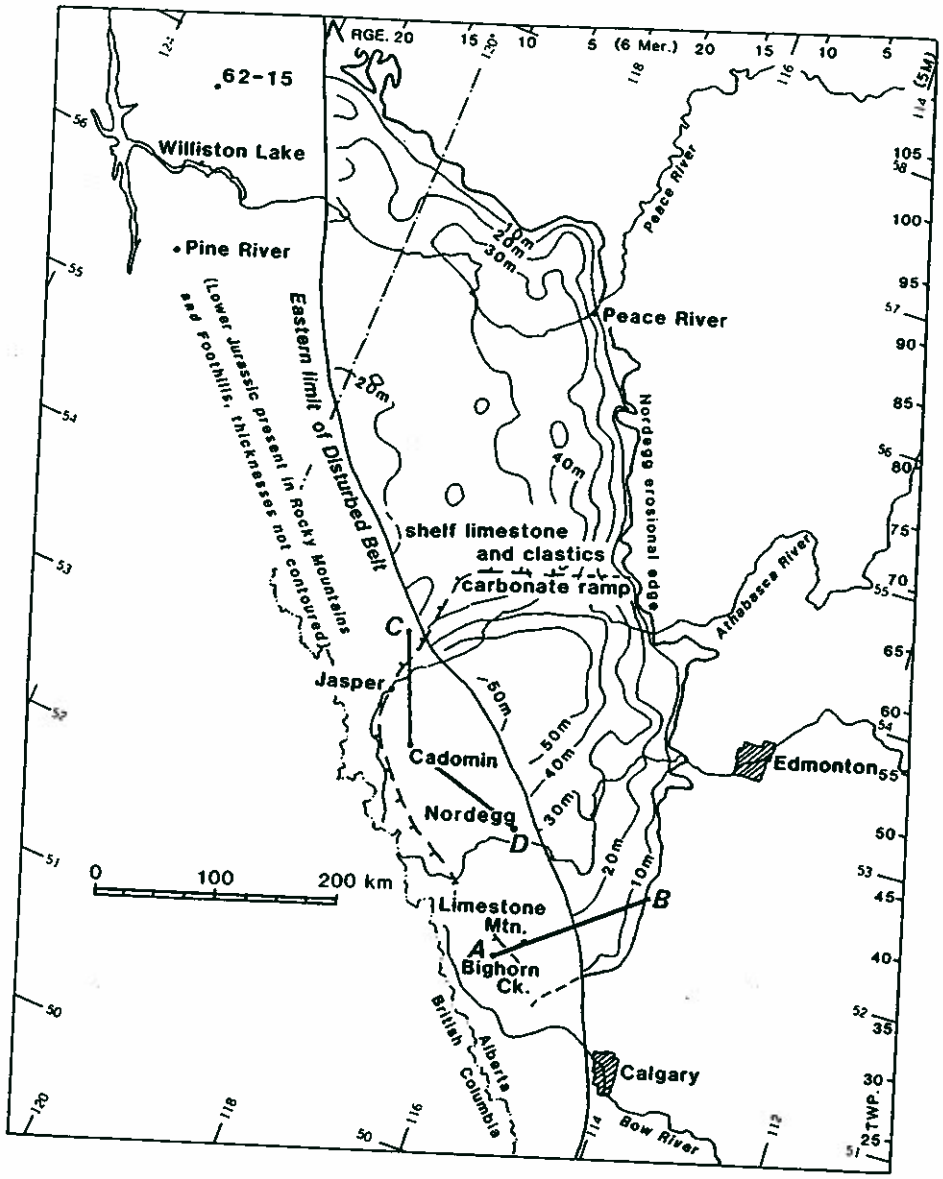


Figure 12. Generalized lithofacies and isopach map of the Nordegg Member (from Poulton et al., 1990).

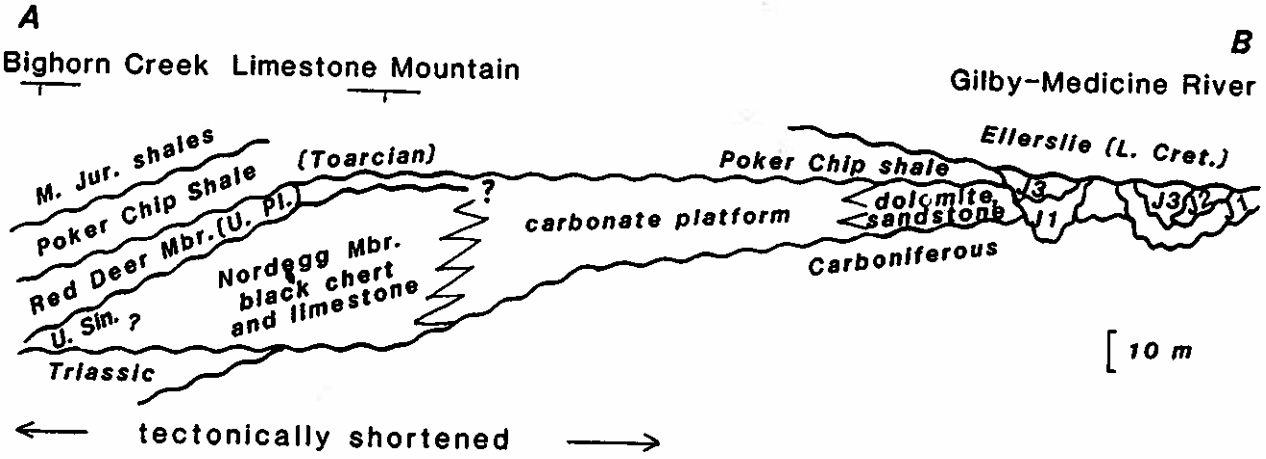


Figure 13. Schematic cross section illustrating lithofacies transitions and stratigraphic relationships associated with the Nordegg Member (from Poulton et al., 1990).

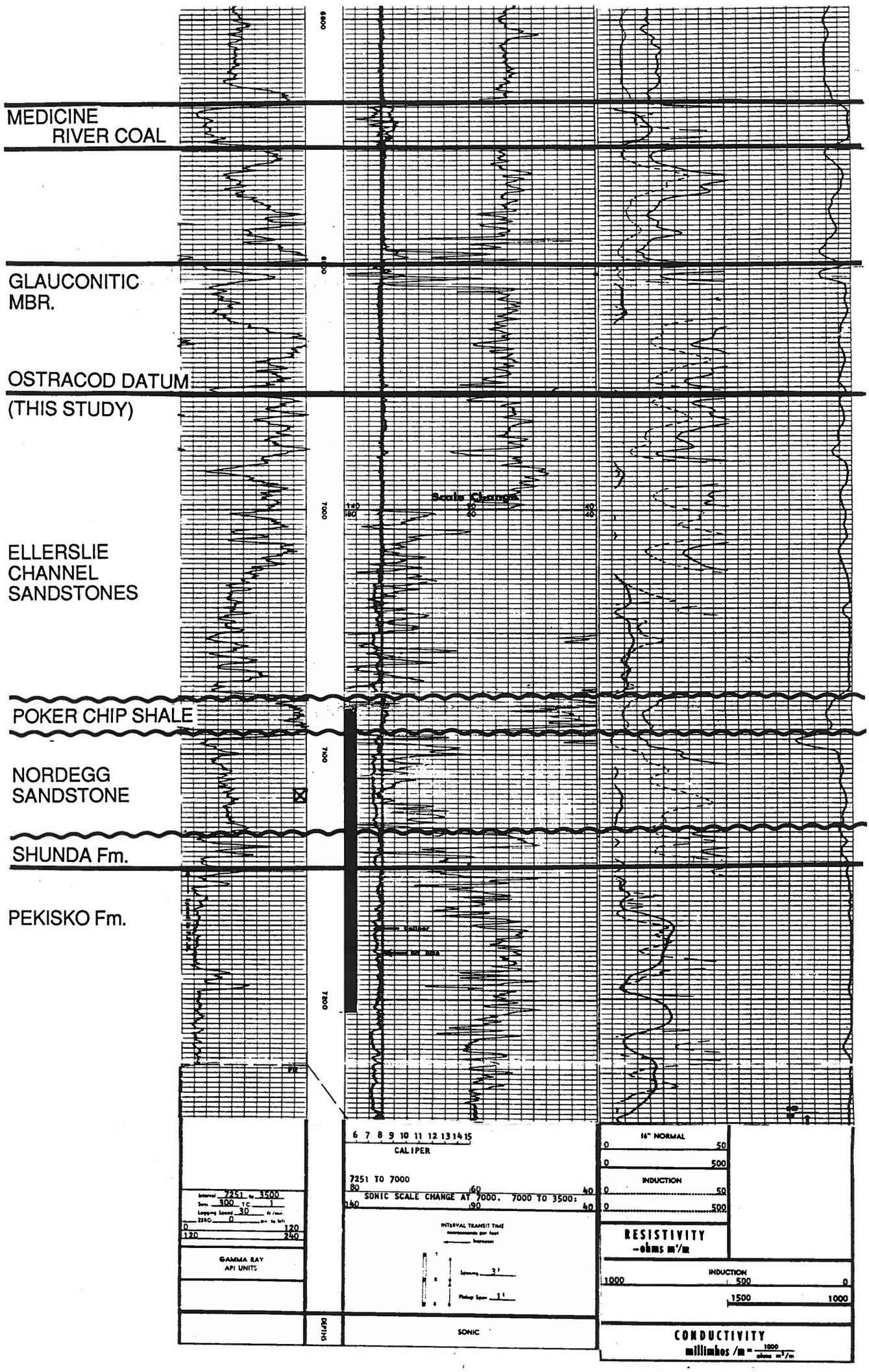


Figure 14. Type log 16-20-39-3W5, Nordegg dolomitic sandstone named "Medicine River member" by Collar (1990).

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*, *Rhyzocorallium*, *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').

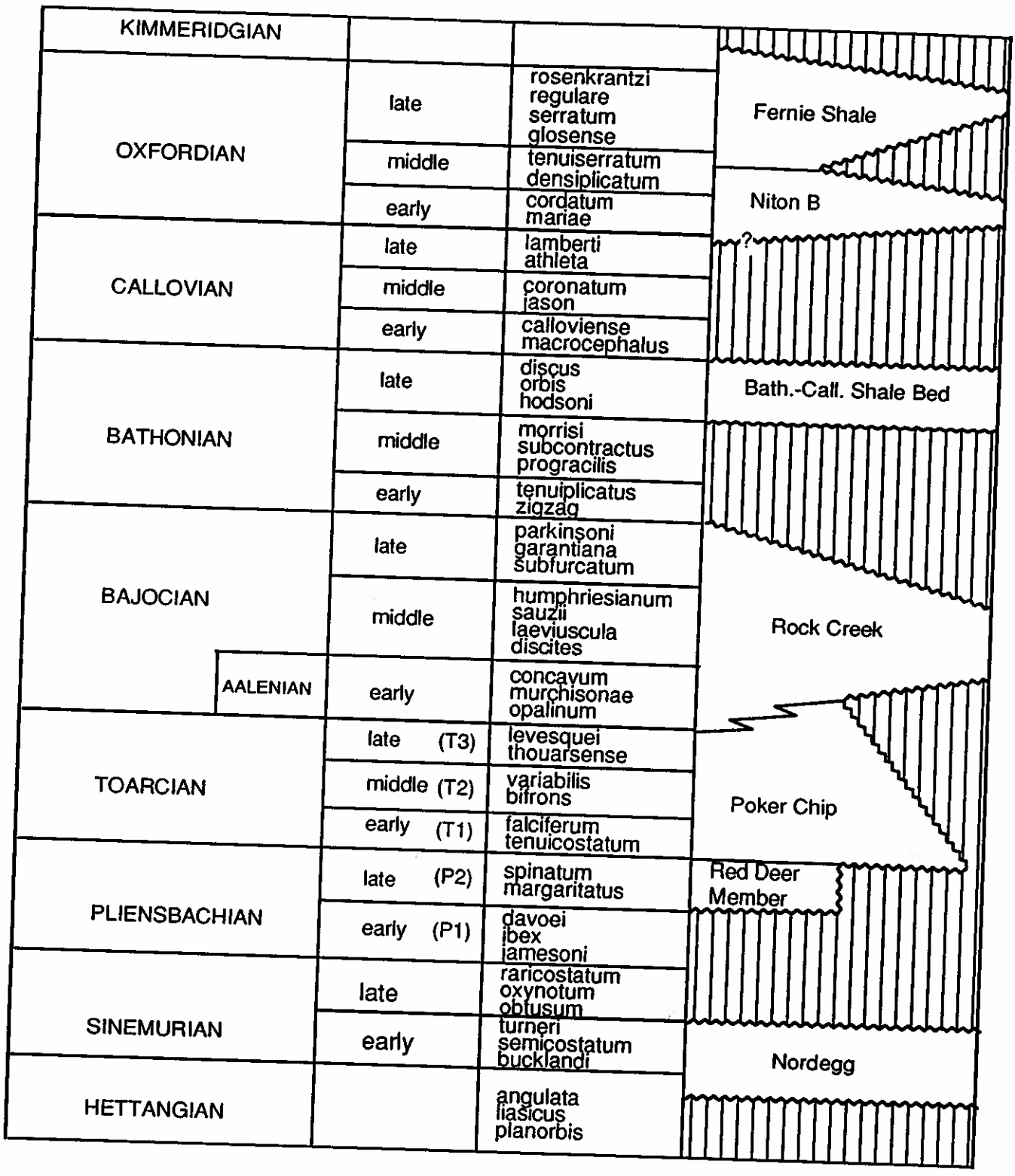


Figure 15. Jurassic palynological zonation and lithostratigraphy, (modified after Poulton et al., 1990).

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.

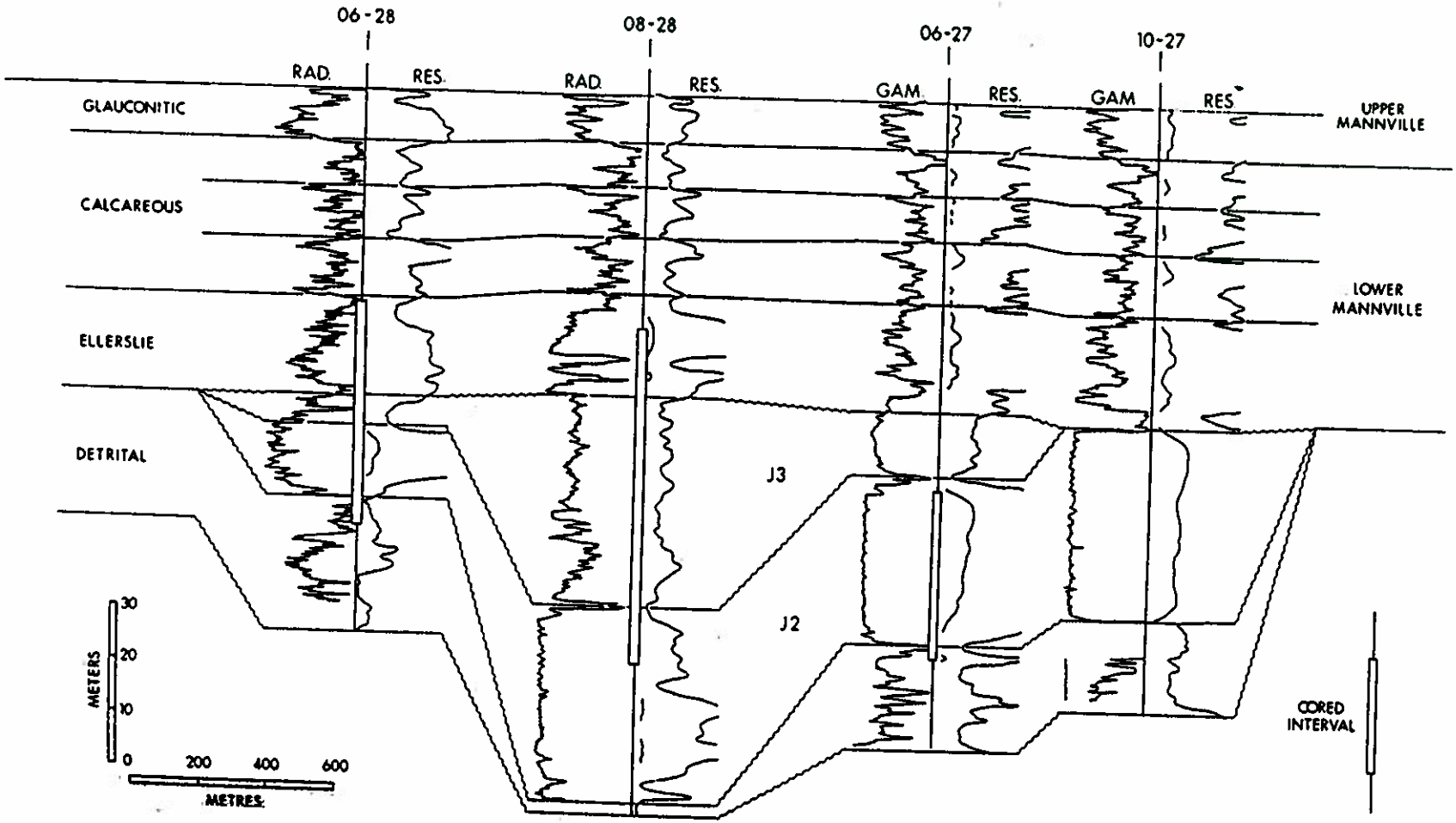


Figure 16. J Valley reservoir sandstones in Township 39 Range 3W5 (from Hopkins, 1981).

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 (ie. 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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Appendix 1
(Core Descriptions)

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

List of Cores

14-9- 37-3W5
14-16-
14-19-
12-20-
4-27-
4-29-
16-29-
2-30-
4-30-
8-30-
10-30-
12-30-
4-32-

2- 5-37-4W5
16-13-
7-22-
2-36-
10-36-
12-36-

12-15-38-3W5
10-18-
1-20-
8-21-
14-22-
4-27-
14-28-
4-31-
12-34-

8- 2-38-4W5
14-21-
11-22-
4-27-
4-28-
4-32-
8-32-
6-33-
4-34EK-

11-28-38-5 W5

6- 5- 39-3W5
10-7-
12-10-
8-11-
12-15-
8-16-
14-16-
4-18-
13-18-
14-18-
16-20-
6-21-
14-21-
6-27-
6-28-
8-28-
6-29-
12-30-
16-31-
16-32-
14-33-
4-35-
6-36-

10- 6- 39-4W5
8-13-
10-19-
2-24-
8-24-
10-35-

12-11-39-5W5
16-16-
4-19-
10-21-
6-23-

10- 2 - 40-3W5
4- 5 -
4-8-
12-8-
6-15-
10-19-
16-19-

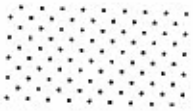
14-21-40-3W5
7-27-
12-27-
10-28-
12-28
3-29-
7-29-
13-29Mu-
6-30-
10-30-
11-32-
8-33-
6-34-

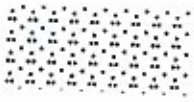
6-12-40-4W5
4-13-
10-13-
12-13-
16-13-
14-19-
6-25-
10-26-
4-36-

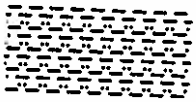
14- 4 - 40-5W5

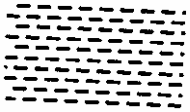
Symbols used in the core study:

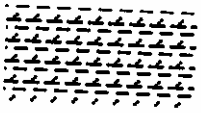
Lithology

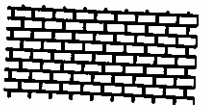
 Sandstone

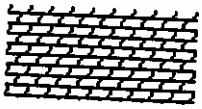
 Silty Sandstone

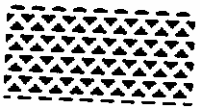
 Silty Mudstone

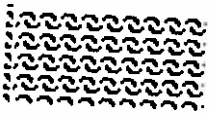
 Mudstone

 Dolomitic Mudstone

 Limestone

 Dolostone

 Breccia

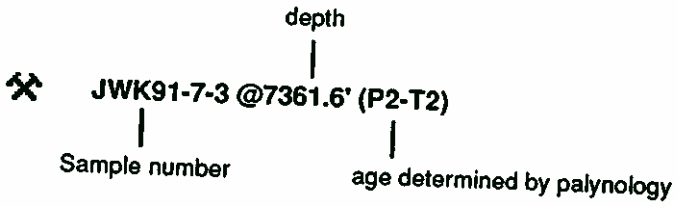
 Coquina

Contacts

 Erosional (scoured)

 Sharp

Samples



Structures

- Planar tabular bedding
- Low angle tabular bedding
- Flaser bedding
- High angle cross bedding
- Current ripples
- Slickensides
- Stylolites
- Chaotic bedding

Accessories

- Rip up clasts
- Breccia horizon
- Calcareous
- Dolomitic
- Py Pyrite
- Wd Woody material
- Palsl Paleosol horizon
- C Coal lamina
- Coal fragments
- Siltstone lamina
- Mudstone lamina
- Organic mudstone lamina
- Pebbles/granules

Ichnofossils

- Rootlets
- Diplocraterion
- Planolites
- Palaeophycus
- Teichichnus
- Asterosoma
- Zoophycus
- Escape trace

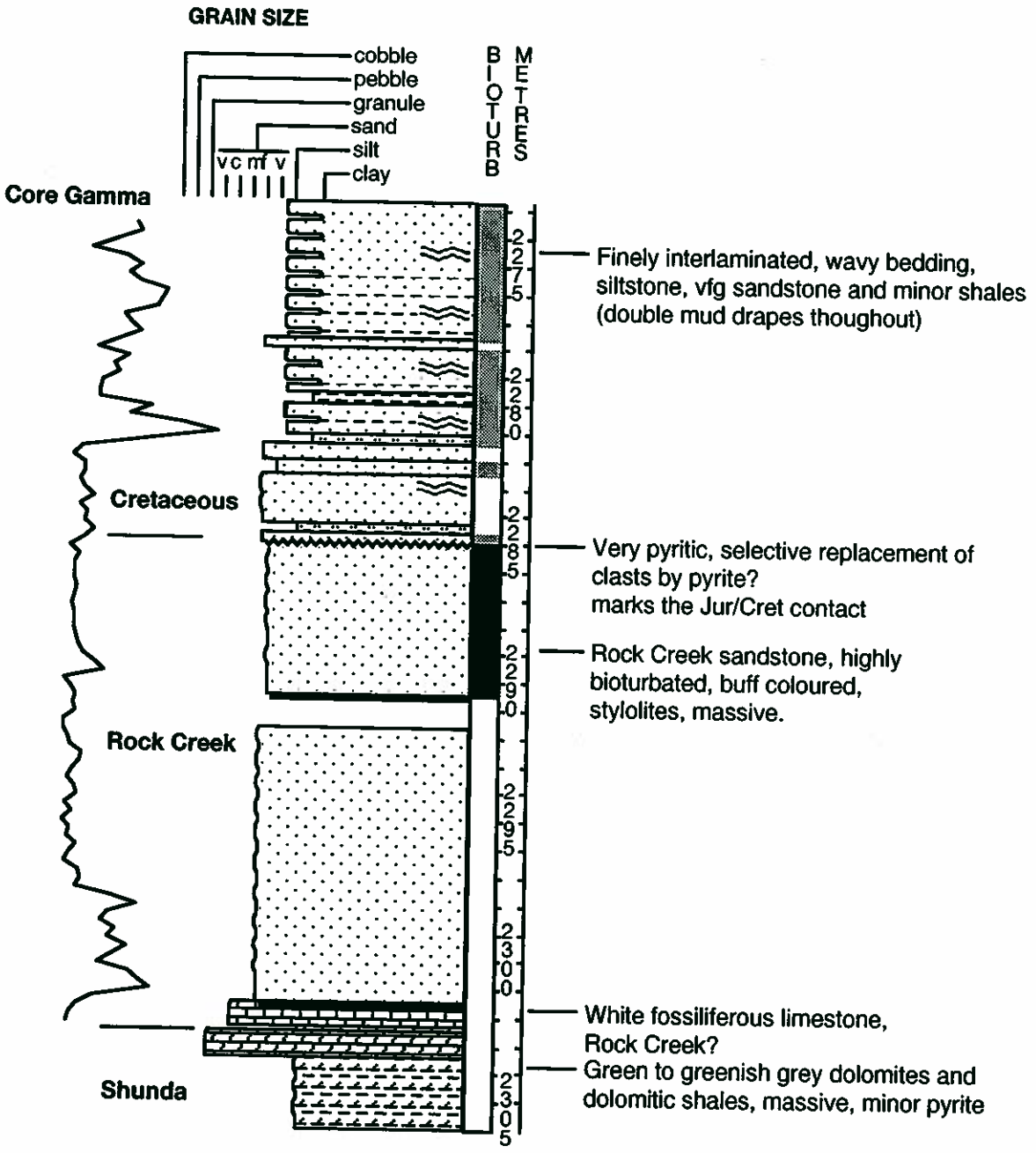
Fossils

- Plant remains
- Pelecypods
- Crinoids
- Corals
- Molluscs
- Shell fragments

Murphy et al Sylvan Lake
14-9-37-3w5

Date logged: October 23, 1992

Logged by: Rudy Strobl

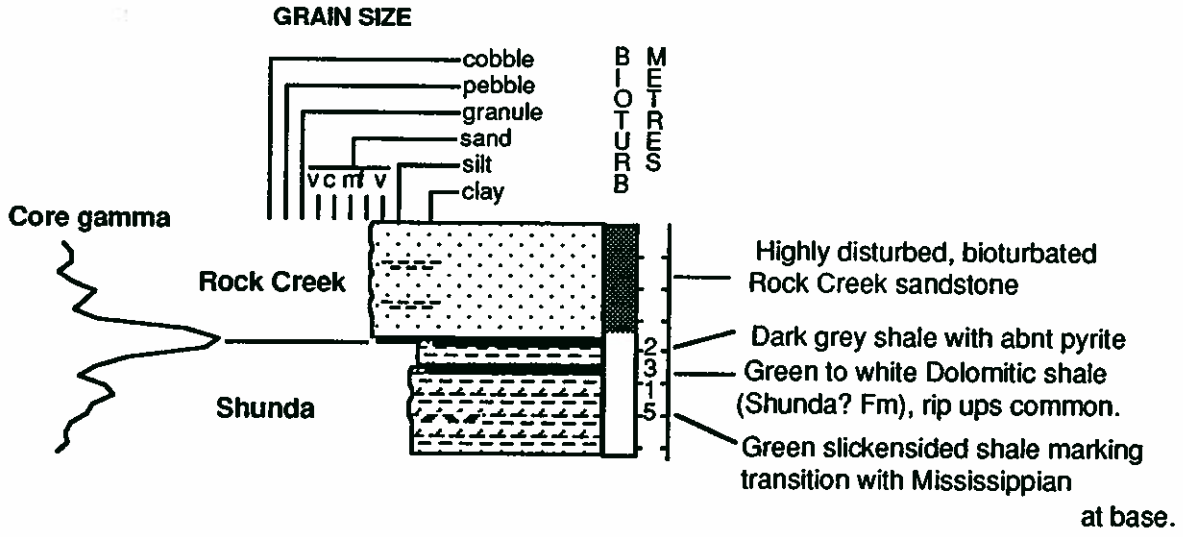


Murphy et al Sylake
14-16-37-3w5

Date logged: October 22, 1992

Logged by: Rudy Strobl

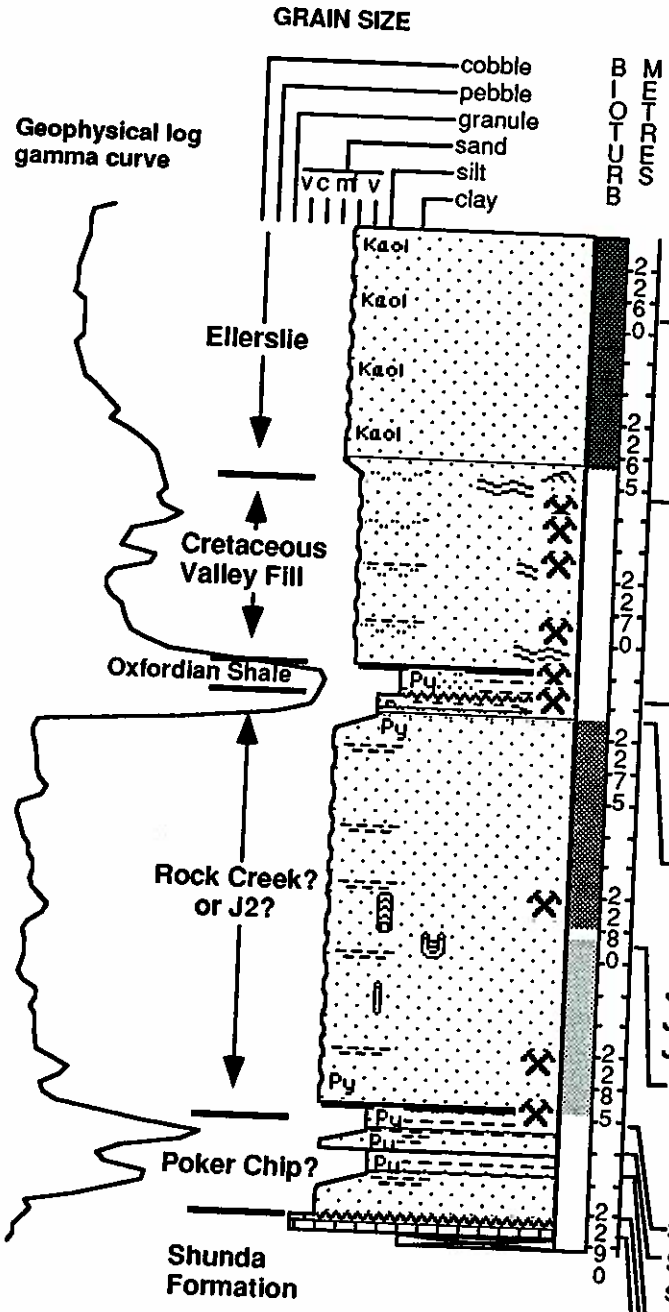
Remarks: Rock Creek over Mississippian High



Gulf et al Sylvan Lake
14-19-37-3w5

Date logged: July 15, 1993

Logged by: John Kramers



Sandstone, fine grained, koalinitic, 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'laminations. 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 horiontal laminae @2280. Could be Jurassic J2 sand.

Sandy shale to shaly sand, abundant pyrite

Sandstone, vf to f grained, pyrite, scattered shale laminae

Sandy shale to shaly sand, pyrite

Sandstone, argillaceous, scattered shaly laminae, may have minor bioturbation

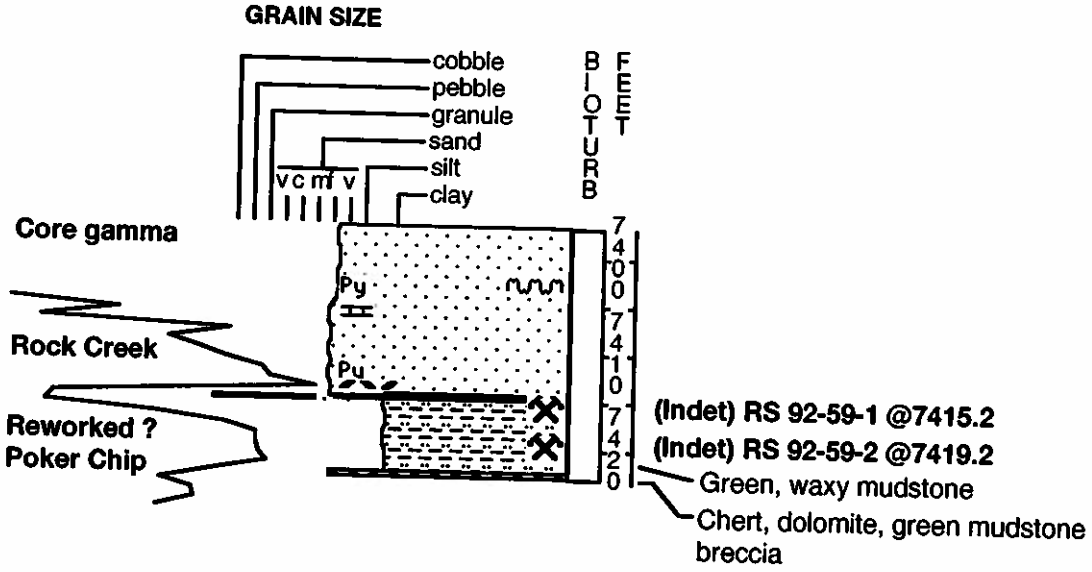
Carbonate breccia, with minor sand between clasts

Sun Sylvan Lake
12-20-37-3w5

Date logged: October 22, 1992

Logged by: Rudy Strobl

Remarks: Rock Creek erosional outlier

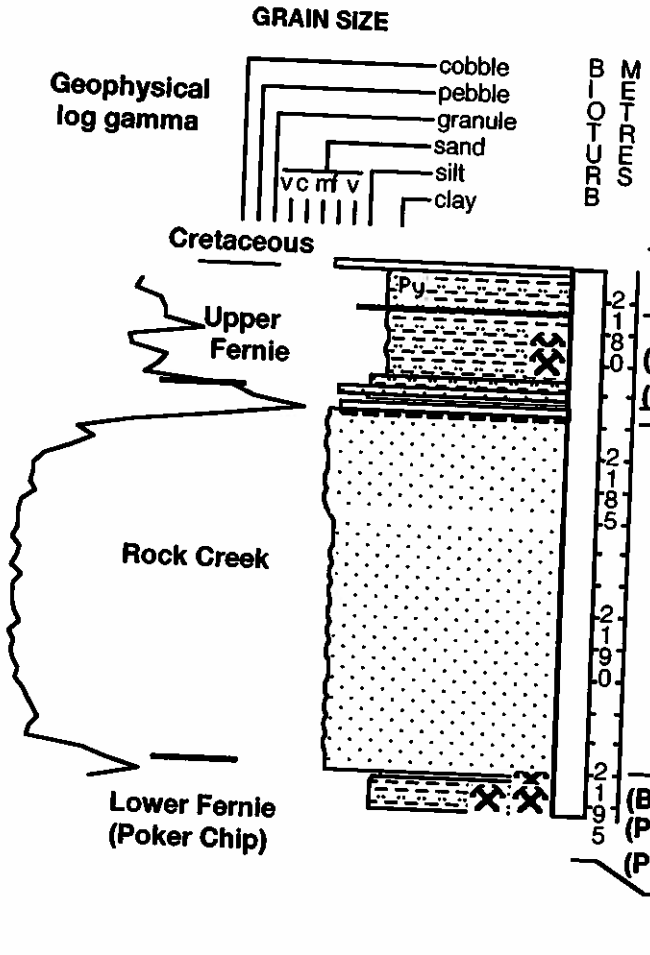


Glenora Shelter
4-27-37-3w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

Remarks: Well defined Rock Creek at this location, capped by Fernie mudstones.



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

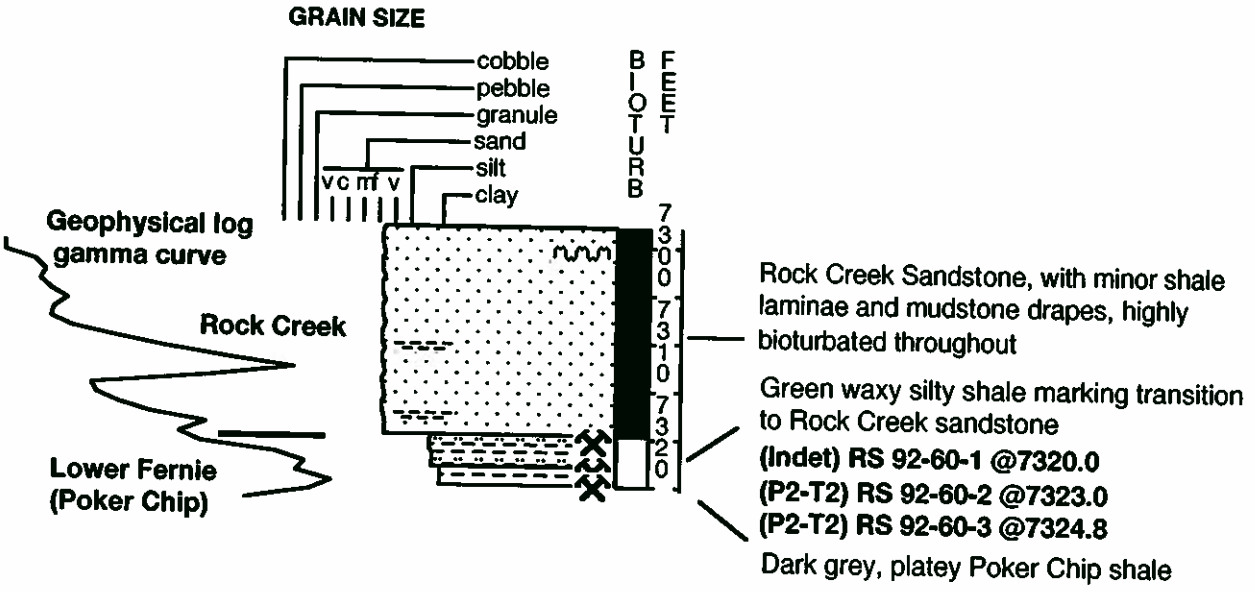
(P2-T2) RS 92-24-4@2194.75

(P2-T2) RS 92-24-5@2195.00

Black massive mudstones typical of Poker Chip

Fina Pacific Sylake
4-29-37-3w5

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)

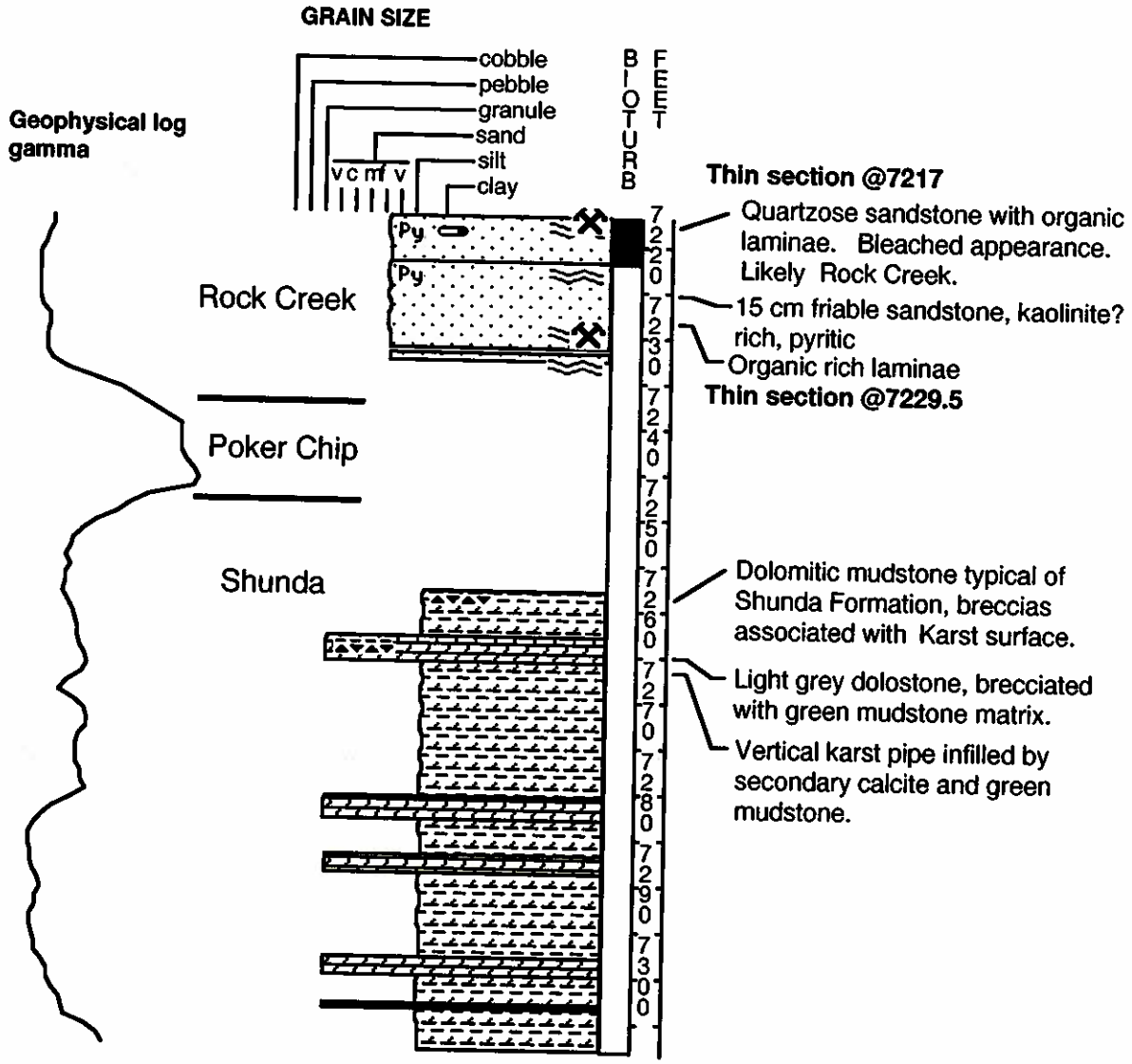


HB Texaco BA Sylake
16-29-37-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

Remarks: To determine Rock Creek VS Ellerslie.

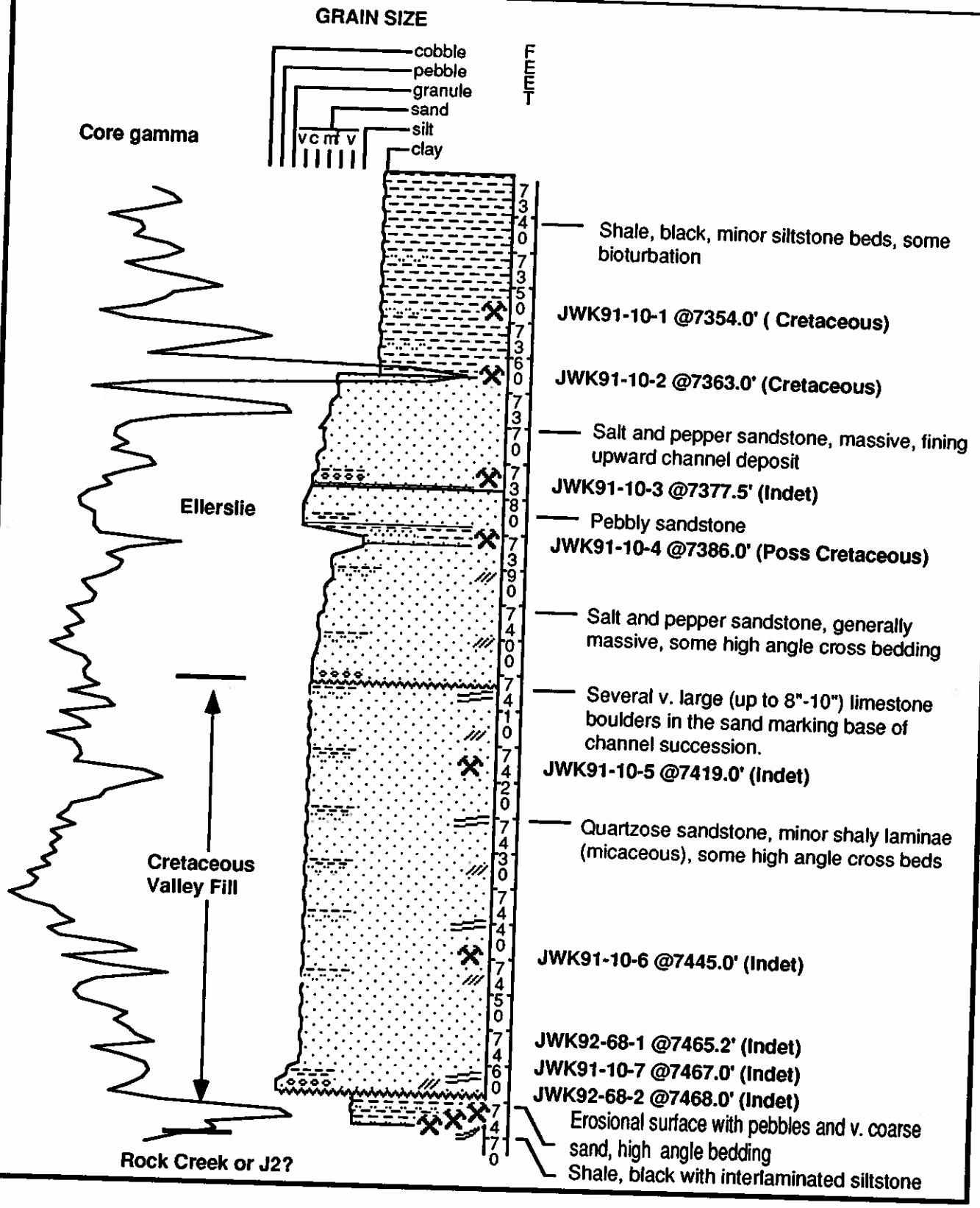


Thin section @7217 Well sorted, clean, quartzose sandstone, subrounded to subangular, rare chert, mica inclusions, quartz overgrowths common.

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

Kewanee Sylvan Lake 2-30
02-30-37-03w5

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

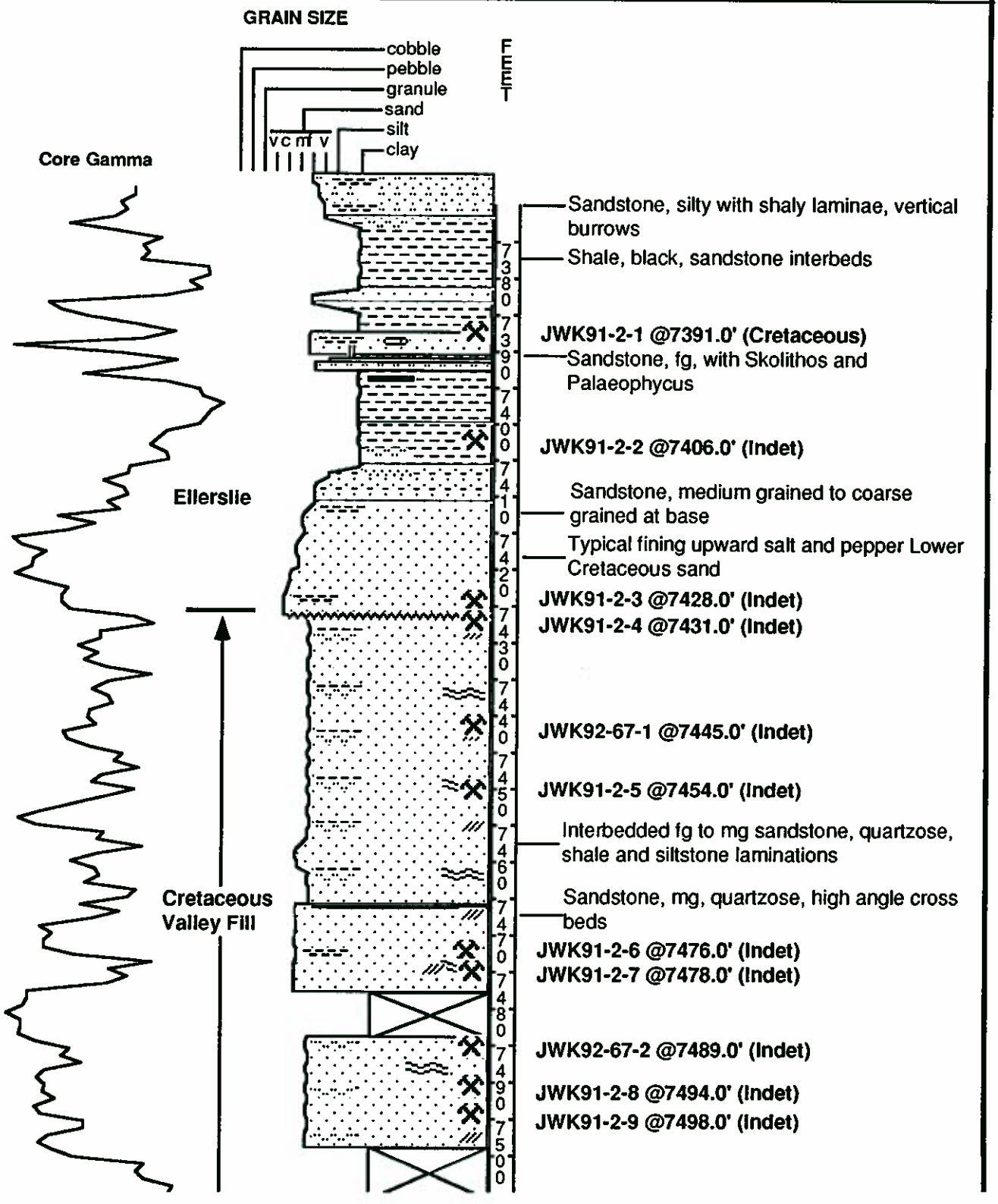


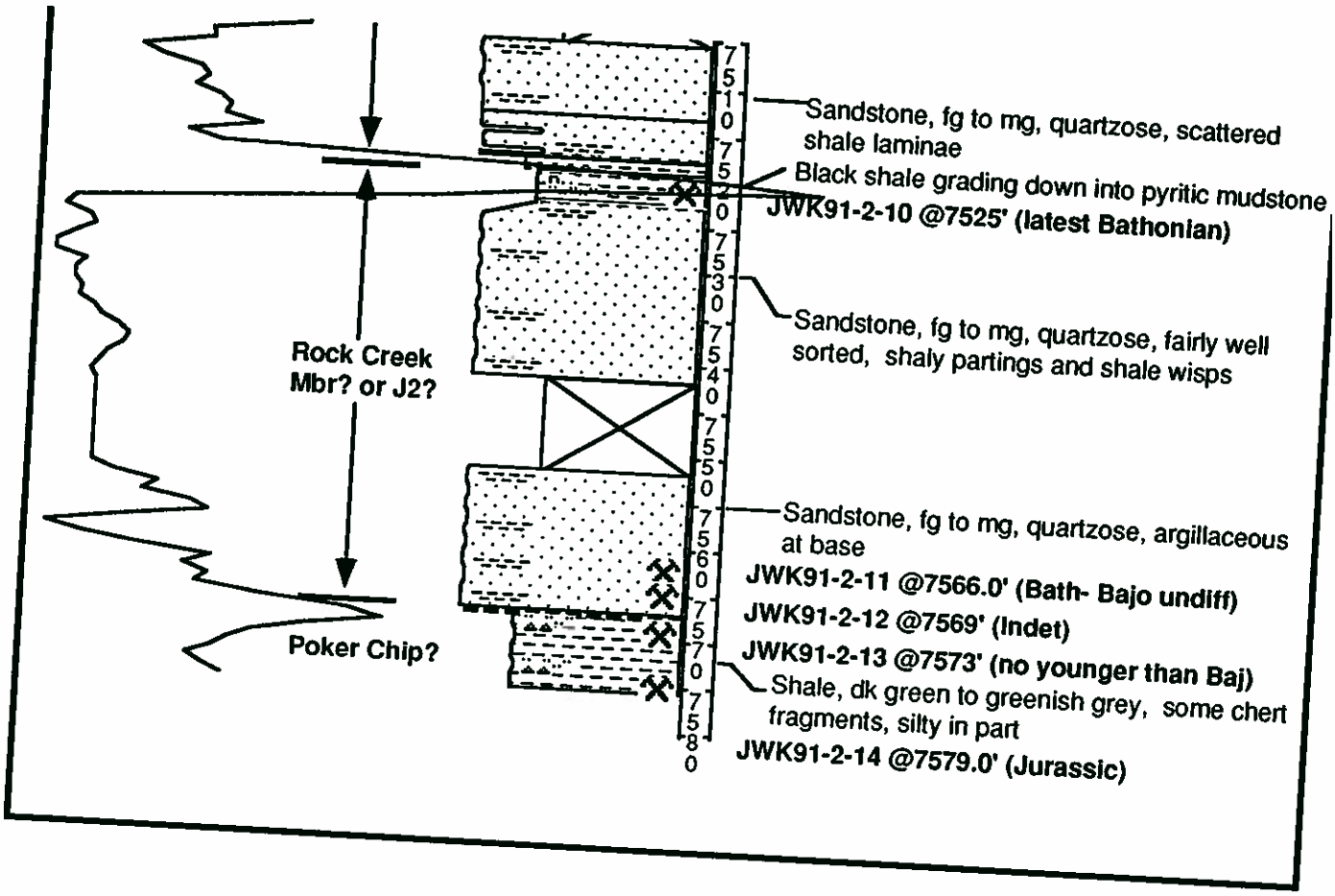
Kewanee Sylvan Lake 4-30
04-30-37-03w5

Date logged: August 13, 1991 / July 7, 1992

Logged by: John Kramers

Remarks: Valley Fill

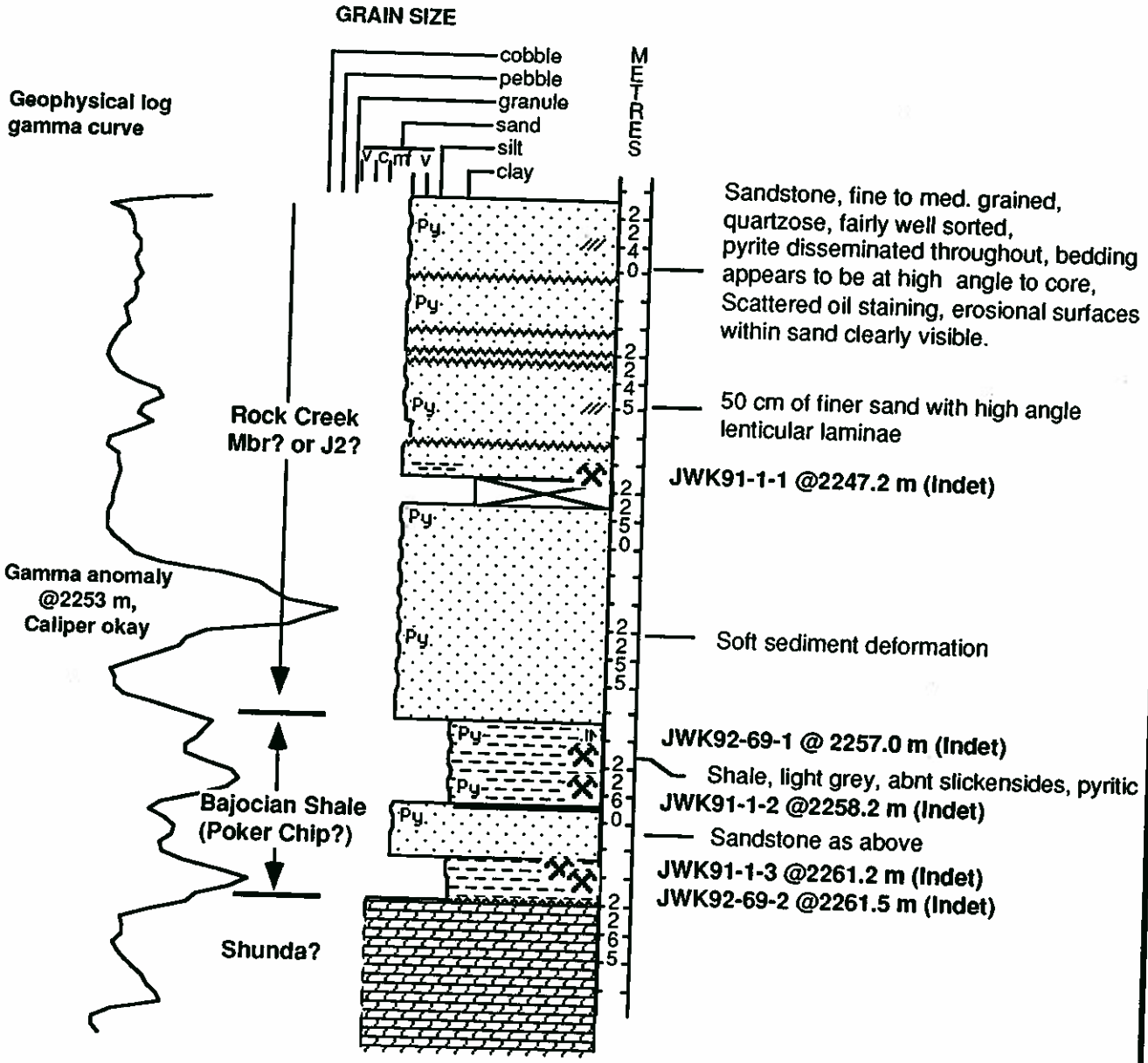



7510
7525
7530
7540
7550
7560
7570
7580
Sandstone, fg to mg, quartzose, scattered shale laminae
Black shale grading down into pyritic mudstone
JWK91-2-10 @7525' (latest Bathonian)
Sandstone, fg to mg, quartzose, fairly well sorted, shaly partings and shale wisps
Rock Creek Mbr? or J2?
Sandstone, fg to 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)
Poker Chip?

Conwest Sylvan Lake 8-30
08-30-37-03w5

Date logged: August 13, 1991 / July 7, 1992

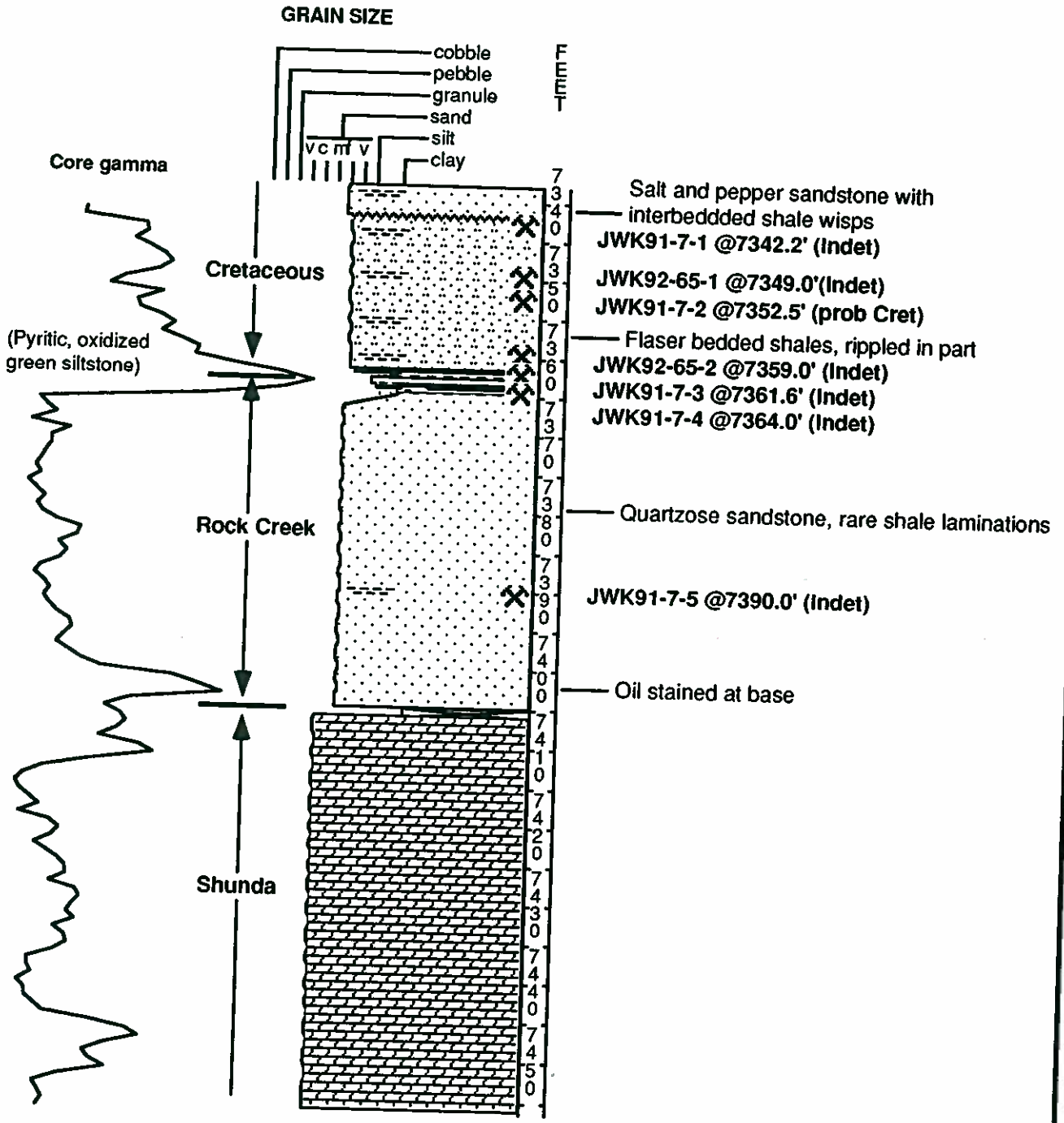
Logged by: John Kramers



HB Texaco Sylvan Lake 10-30
10-30-37-03w5

Date logged: August 13, 1991 / July 7, 1992

Logged by: John Kramers

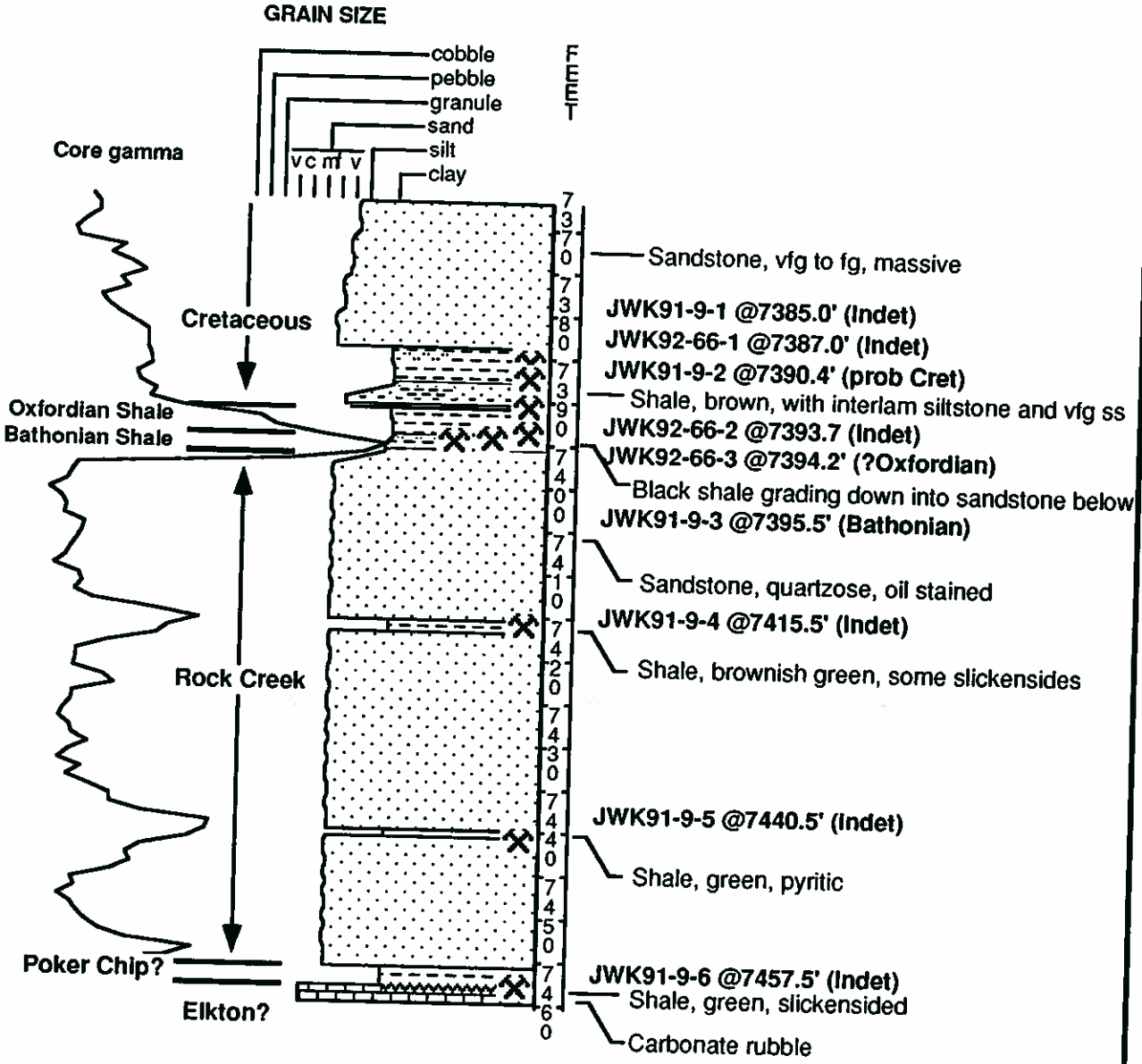


HB Texaco Sylvan Lake 12-30
12-30-37-03w5

Date logged: August 13,1991, July 7, 1992

Logged by: John Kramers

Remarks: Along Mississippian high, west of valley

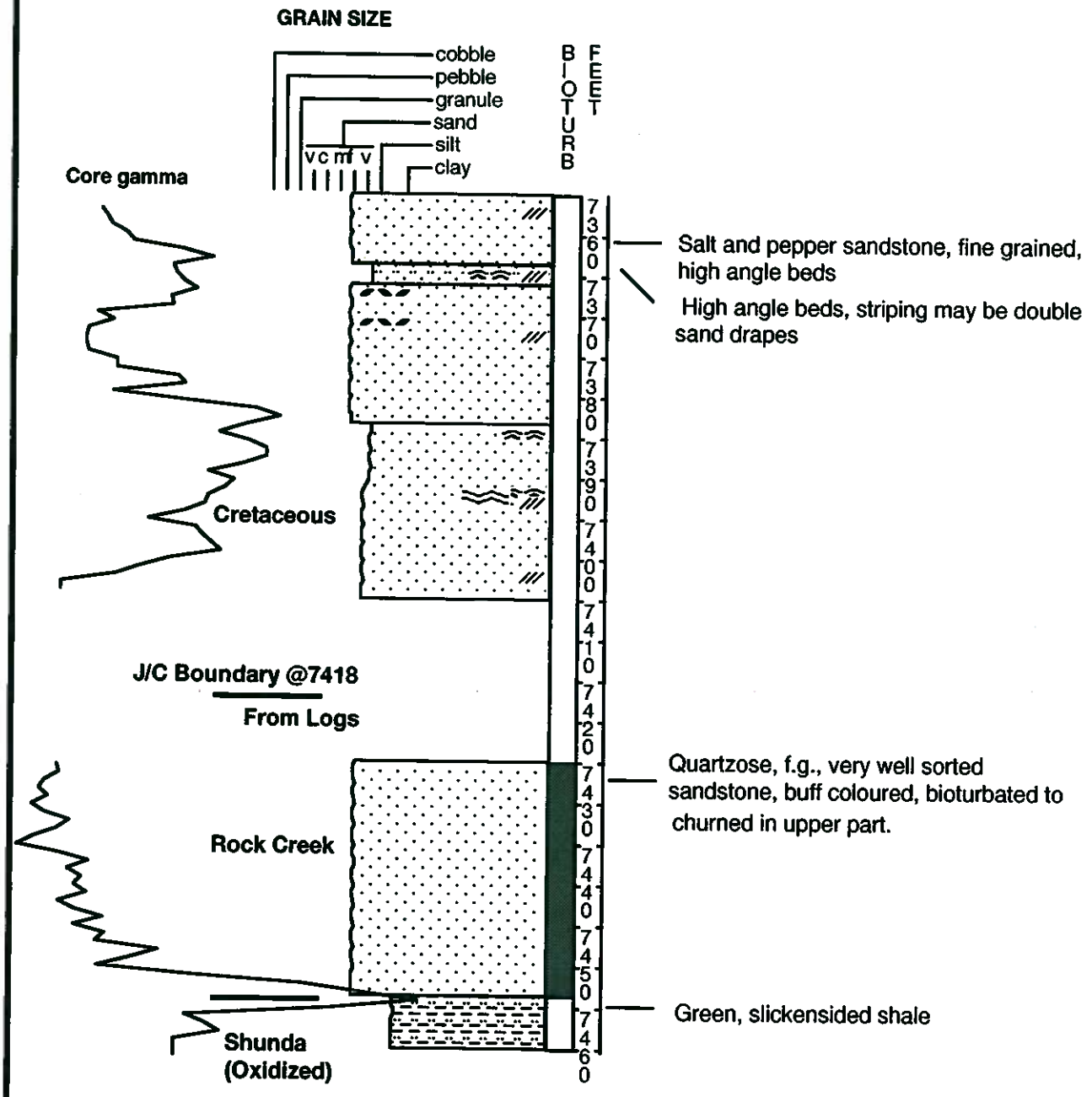


HB Texaco Sylvan Lake
4-32-37-3w5

Date logged: October 22, 1992

Logged by: Rudy Strobl

Remarks: Thin Rock Creek - east side of valley

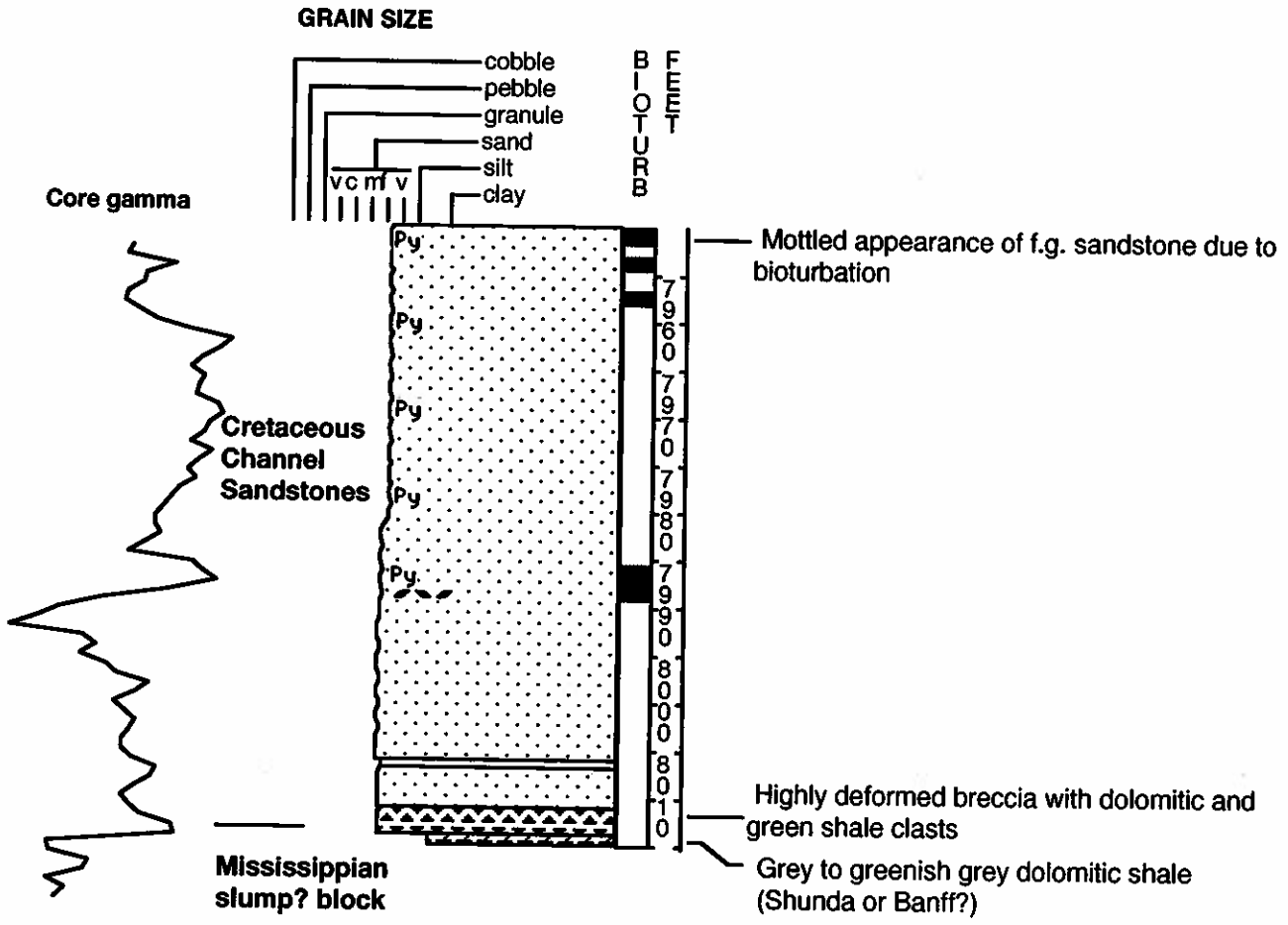


Dekalb Lanaway
2-5-37-4w5

Date logged: October 22, 1992

Logged by: Rudy Strobl

Remarks: Erosion down to Banff, west of Rock Creek outlier

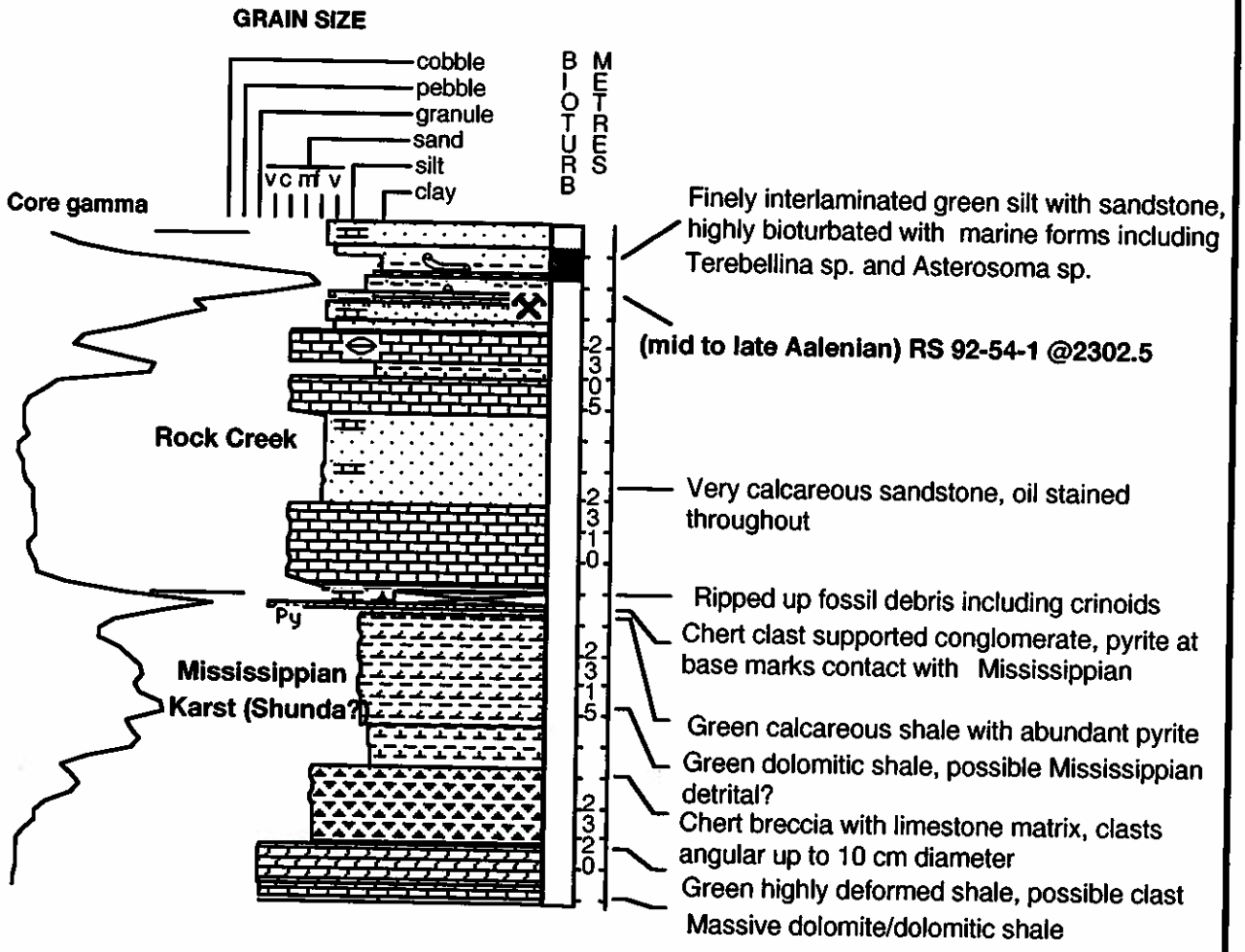


Gulf Sylvan Lake
16-13-37-4w5

Date logged: October 21, 1992

Logged by: Rudy Strobl

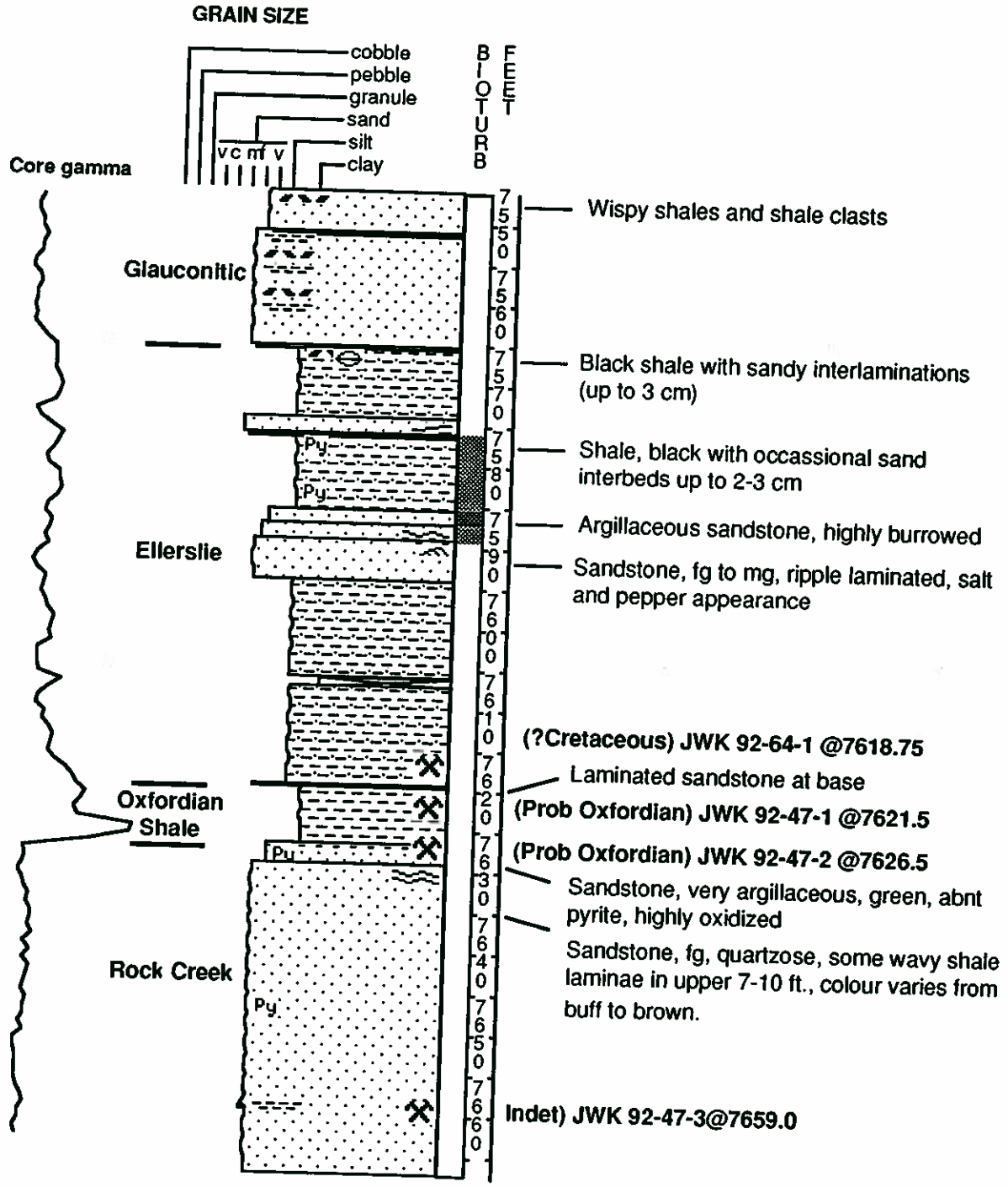
Remarks: Along Mississippian high, appears to have significant reworking along the base of the Rock Creek.



HB Baysel Sylake 7-22
7-22-37-4w5

Date logged: February 27, 1992

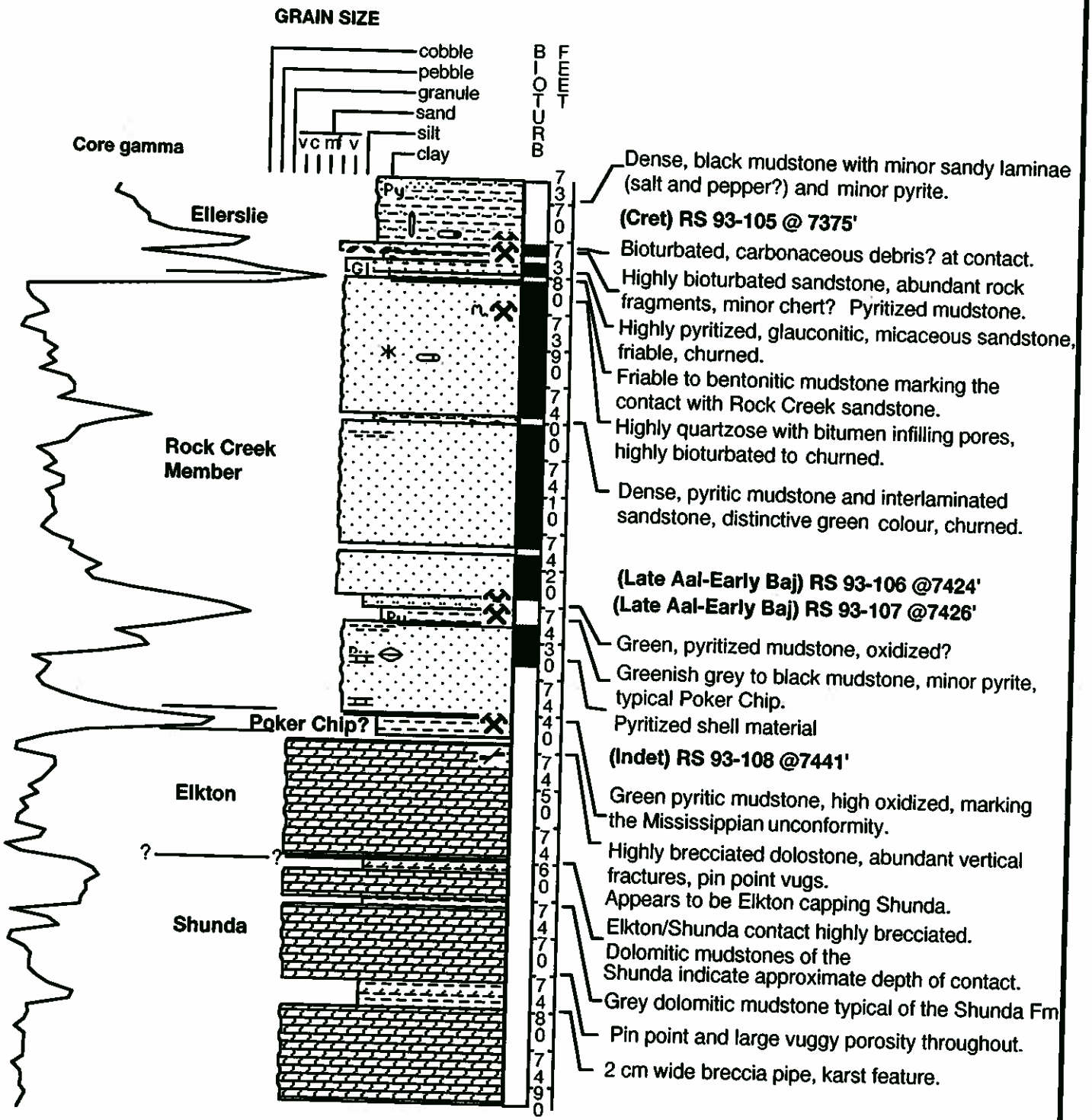
Logged by: J. Kramers



H.B. Texaco Sylvan Lake
2-36-37-4w5

Date logged: May 12, 1993

Logged by: Rudy Strobl

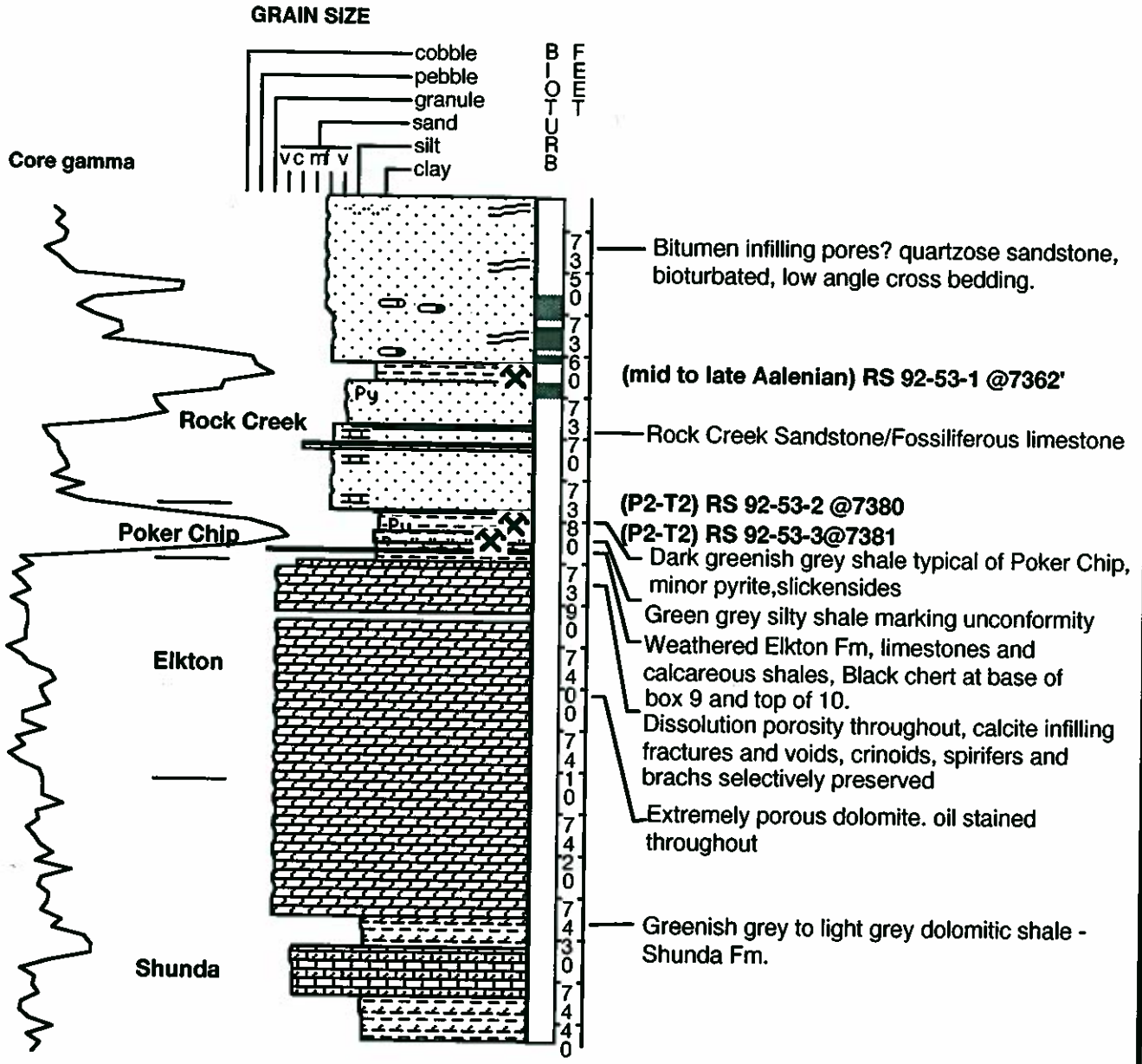


H.B. Texaco Sylake
10-36-37-4w5

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.



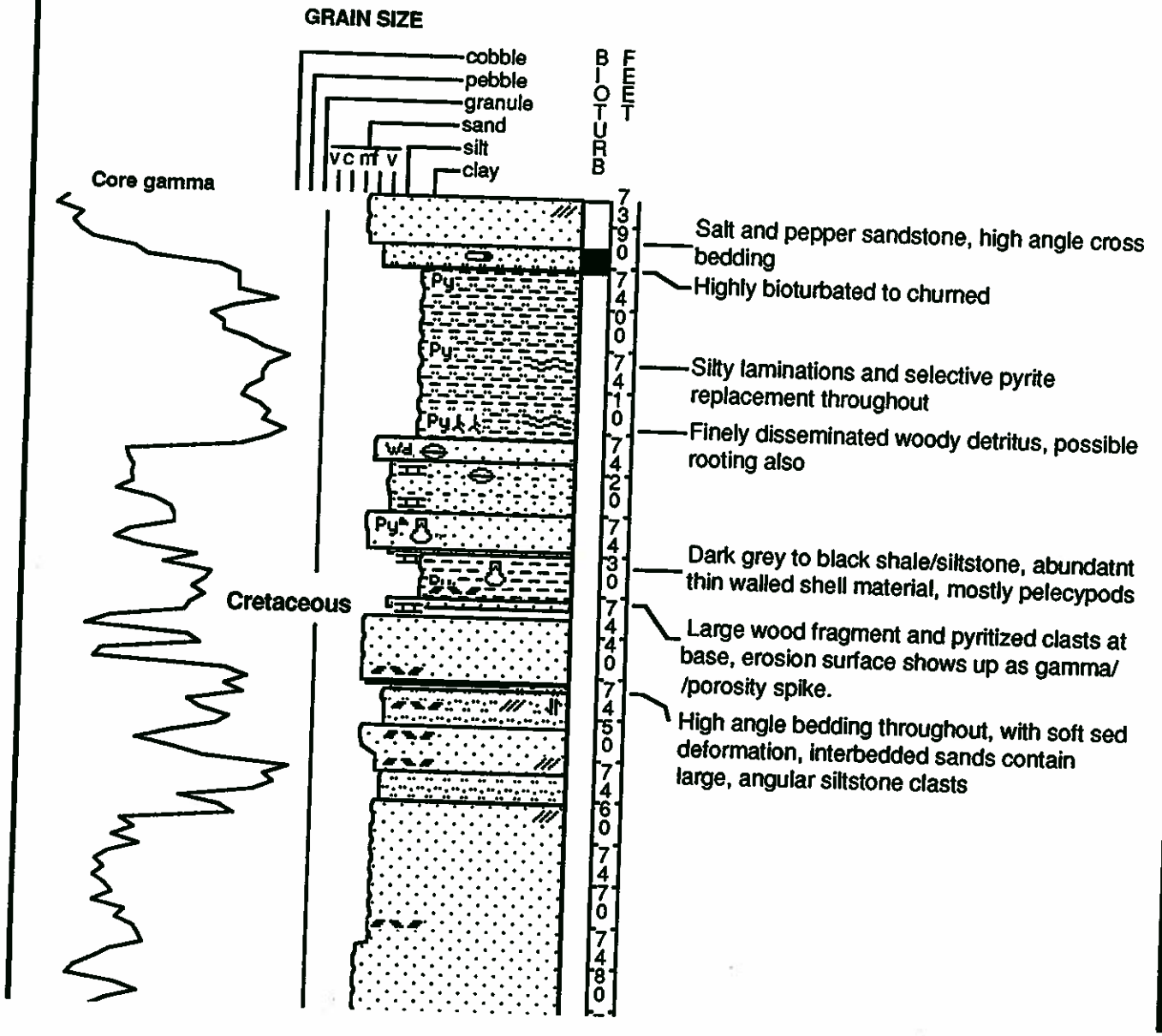
***Correlation of Rock Creek - compare Sp, deep resistivity and gamma ray logs of 10-36 and 2-36-37-4W5**

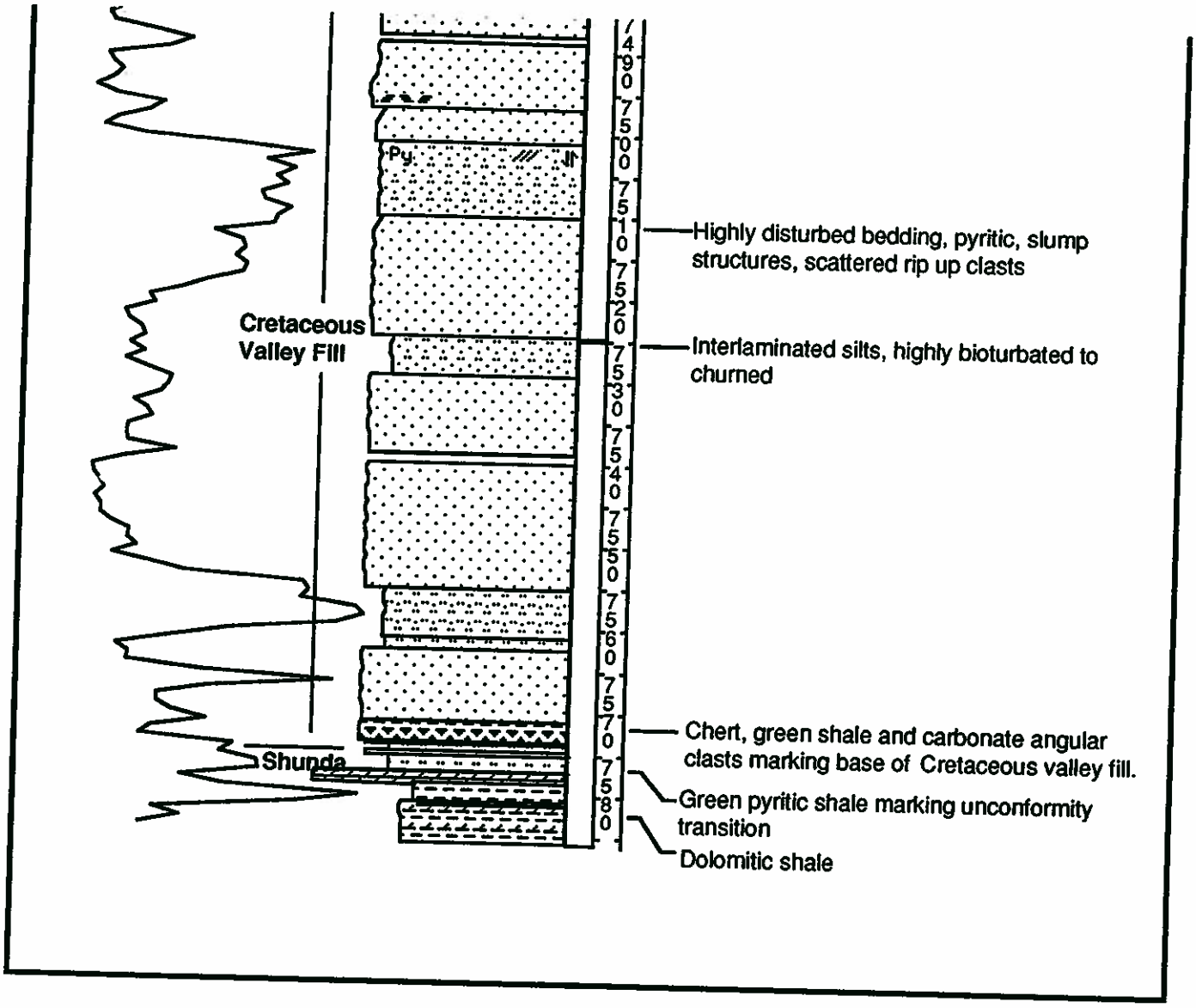
H.B. Texaco Sylvan Lake
12-36-37-4w5

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).



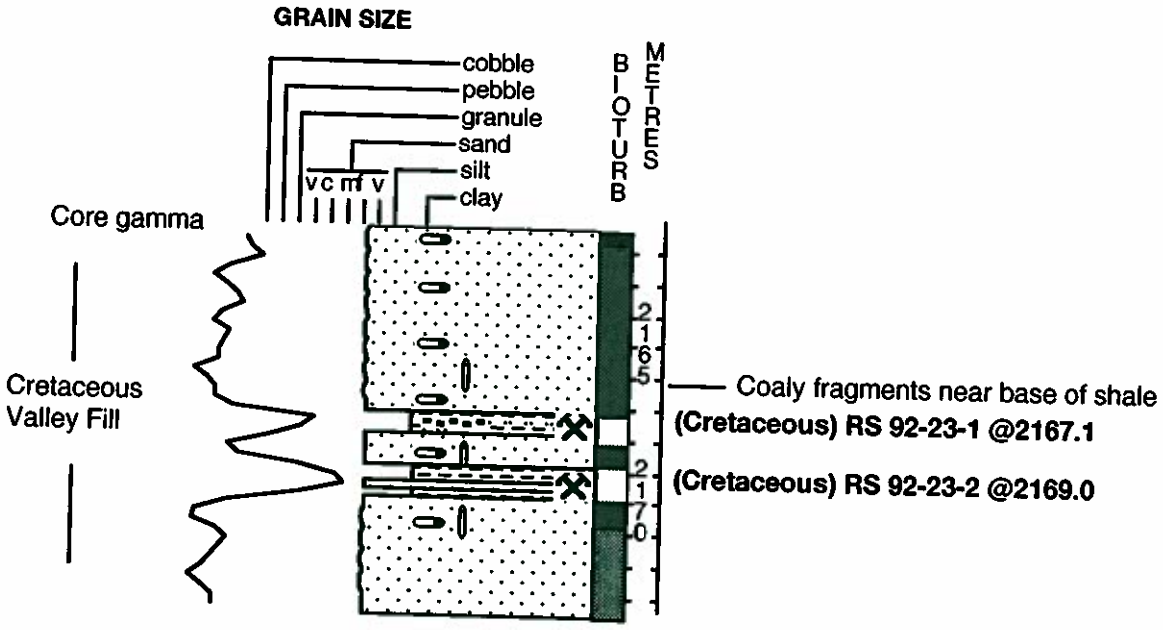

Py
Cretaceous
Valley Fill
Shunda
Highly disturbed bedding, pyritic, slump structures, scattered rip up clasts
Interlaminated silts, highly bioturbated to churned
Chert, green shale and carbonate angular clasts marking base of Cretaceous valley fill.
Green pyritic shale marking unconformity transition
Dolomitic shale

Gulf Sylvan Lake
12-15-38-3w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

Remarks: Within thick Cretaceous valley fill(75 m) of clean sandstones.

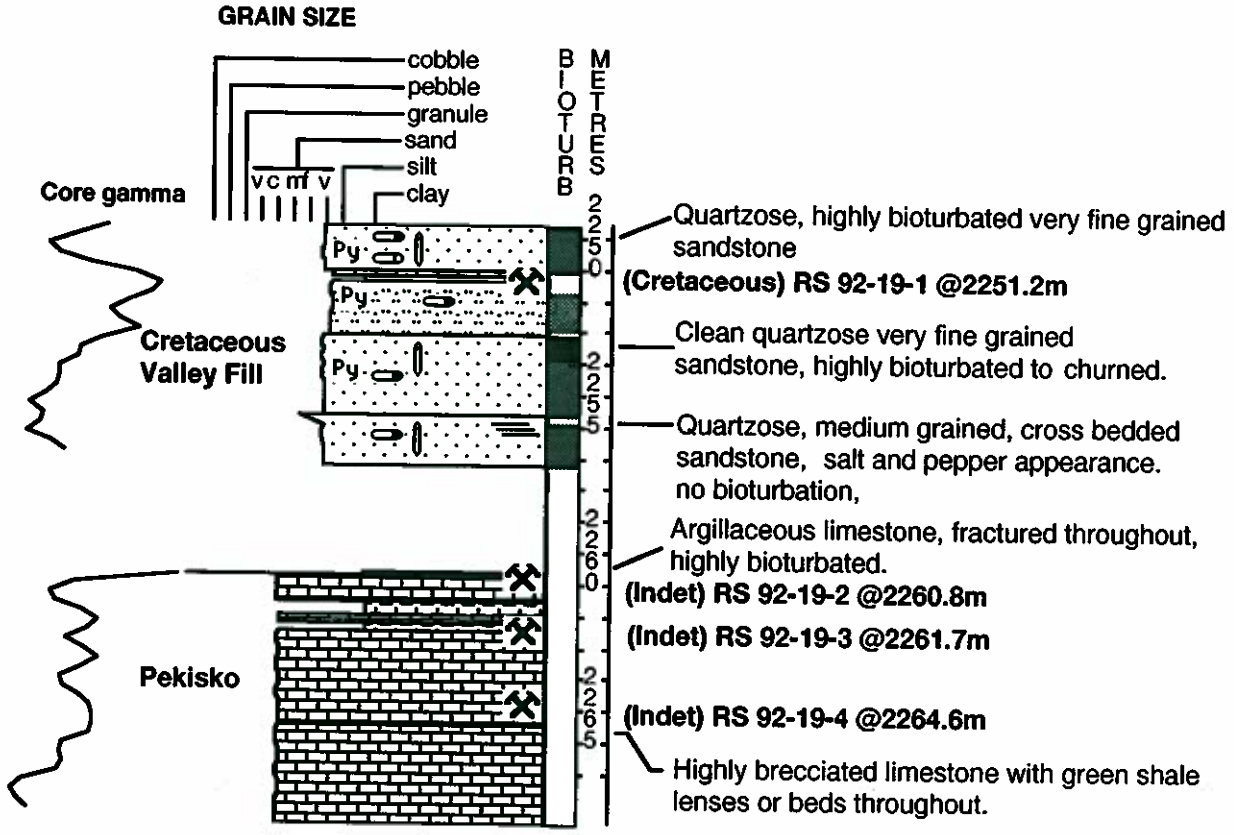


Gulf et al Sylvan Lake
10-18-38-3w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

Remarks: Well located on Mississippian High

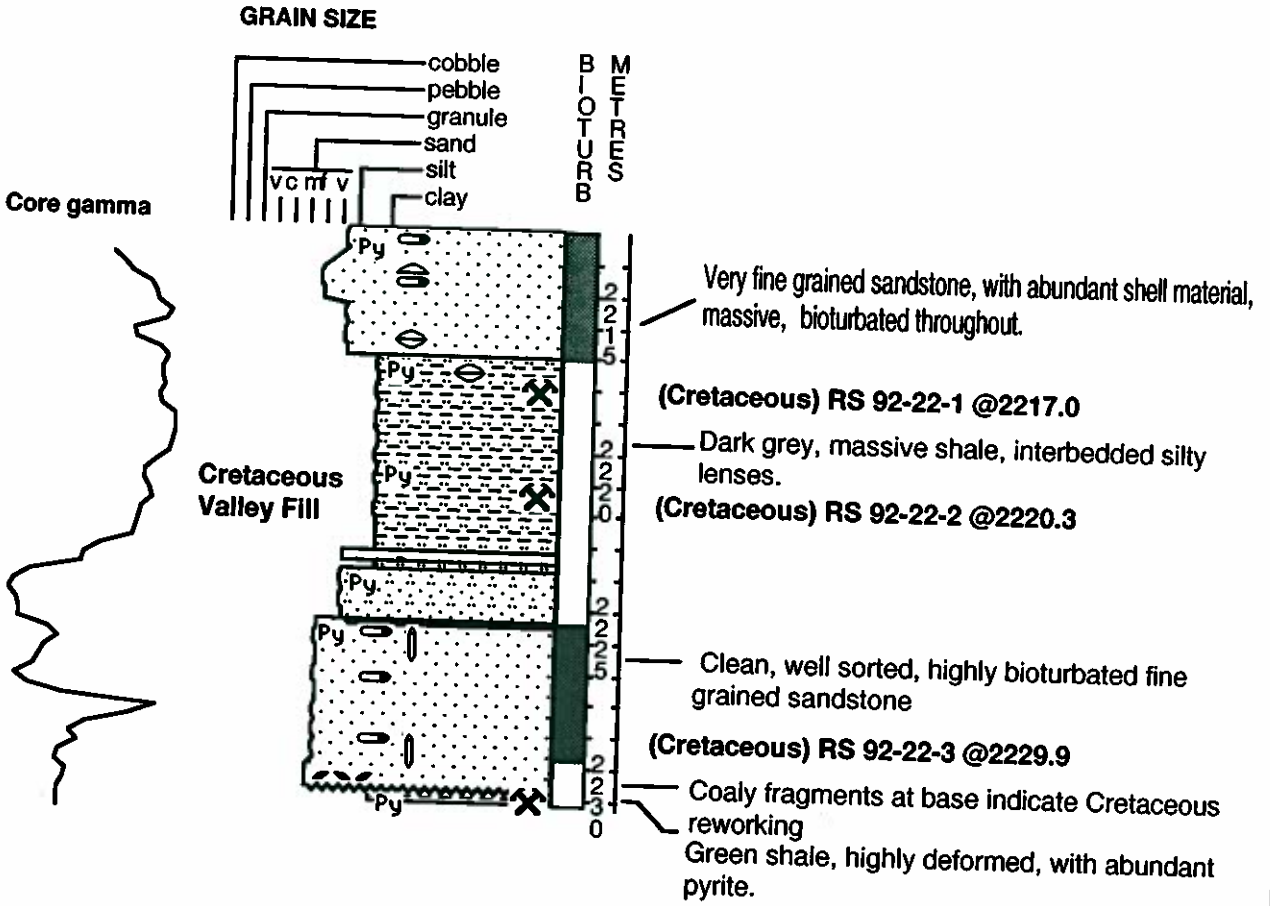


Gulf Maxus Sylvan Lake
1-20-38-3w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

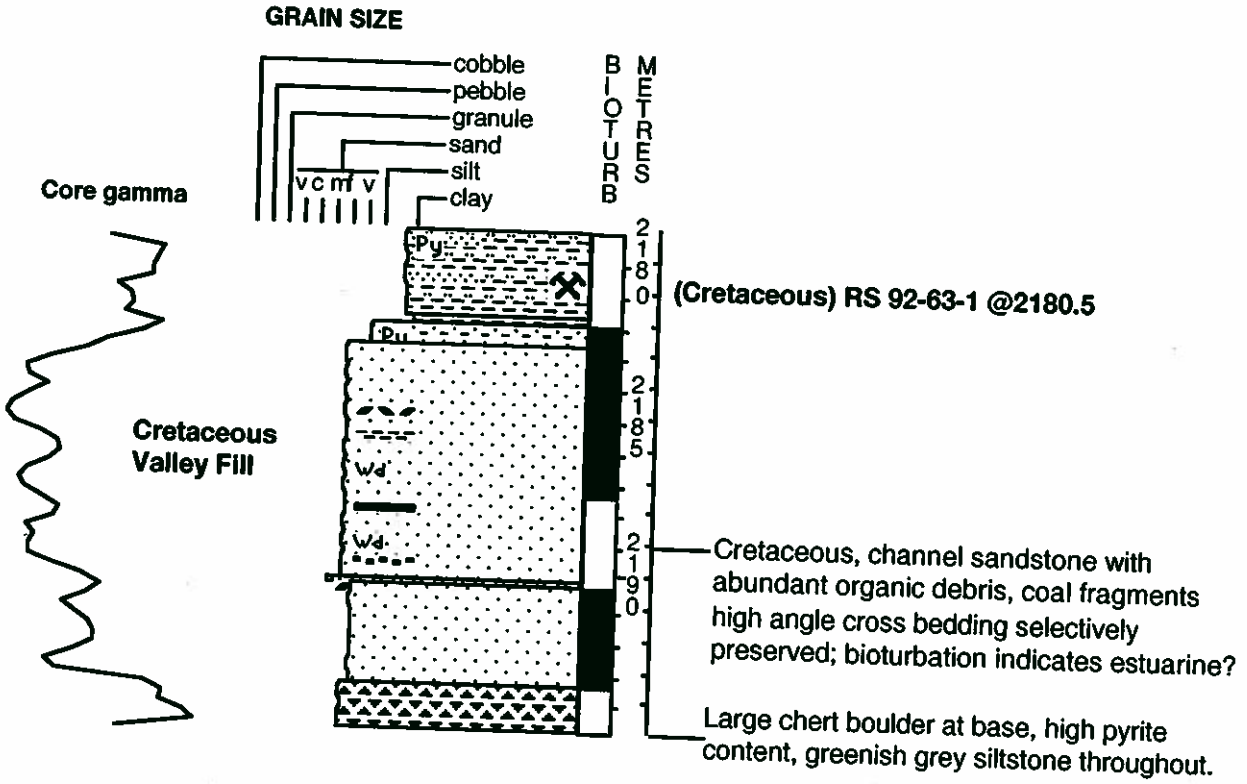
Remarks: Located on Mississippian high, east and south of regional Rock Creek erosional edge.



Gulf Sylvan Lake
8-21-38-3w5

Date logged: October 23, 1992

Logged by: Rudy Strobl

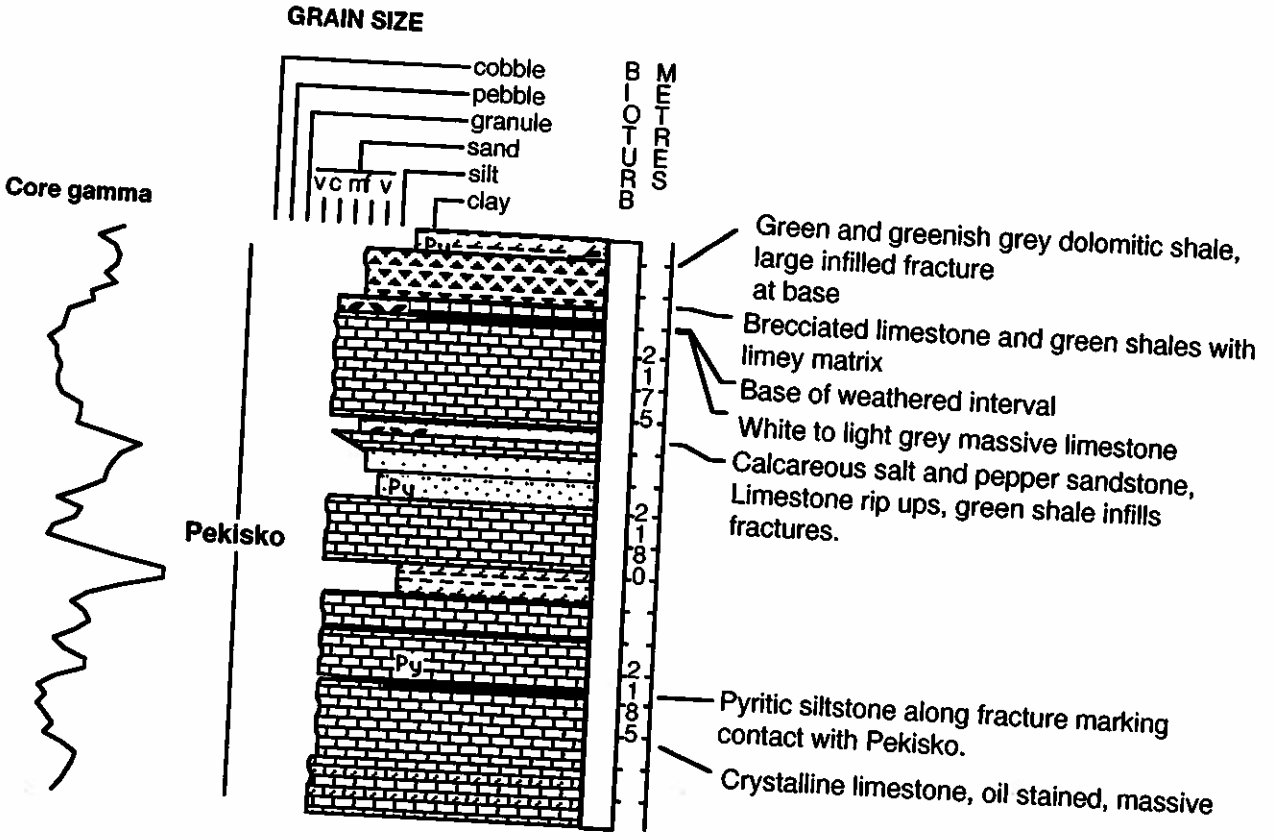


Win Can et al Sylvan Lake
14-22-38-3w5

Date logged: October 23, 1992

Logged by: Rudy Strobl

Remarks: Thick Mississippian - weathered succession - appears to be severely karsted

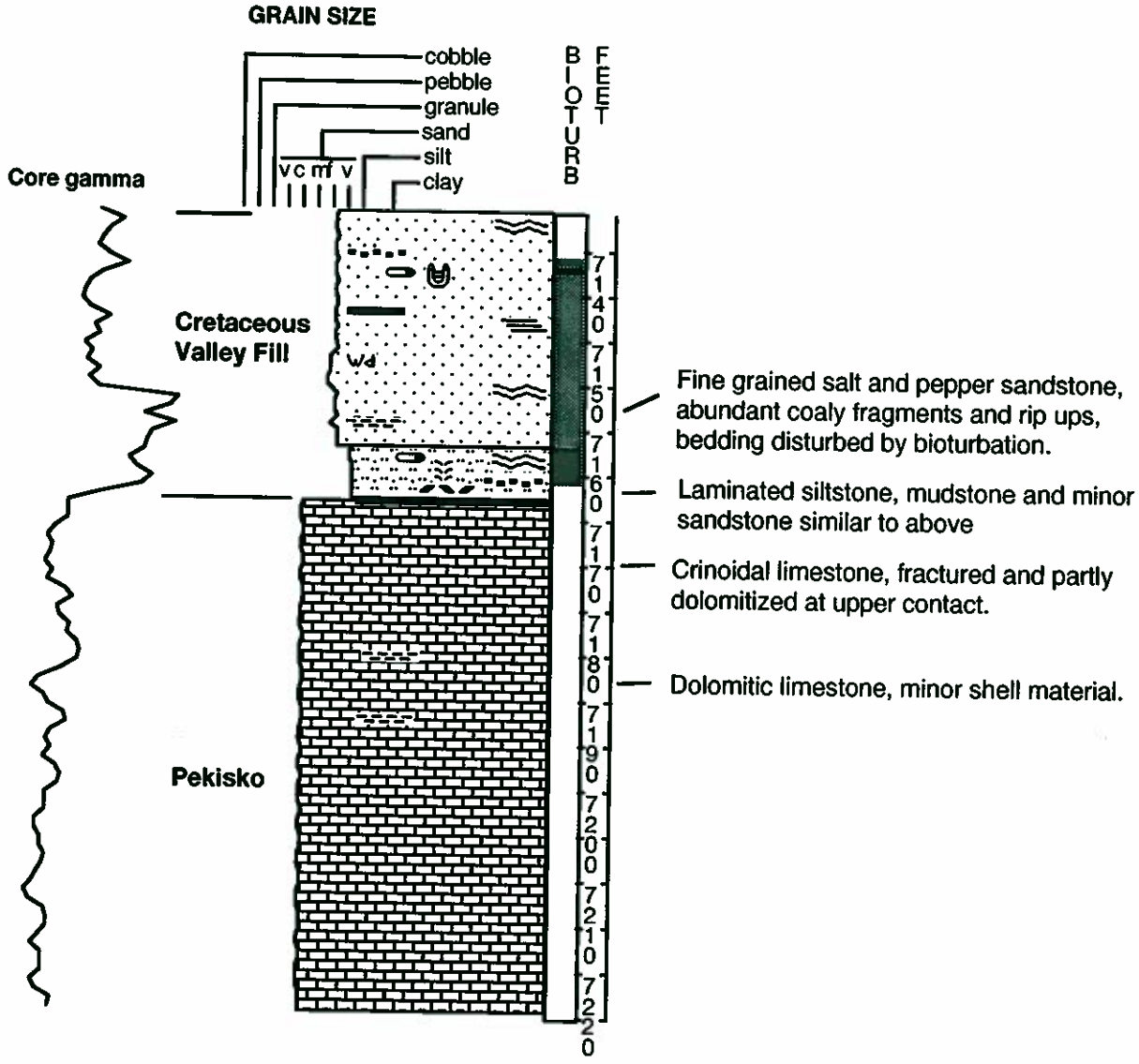


Altair et al Med R
4-27-38-3w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

Remarks: Along Mississippian High, east of Rock Creek erosion edge.

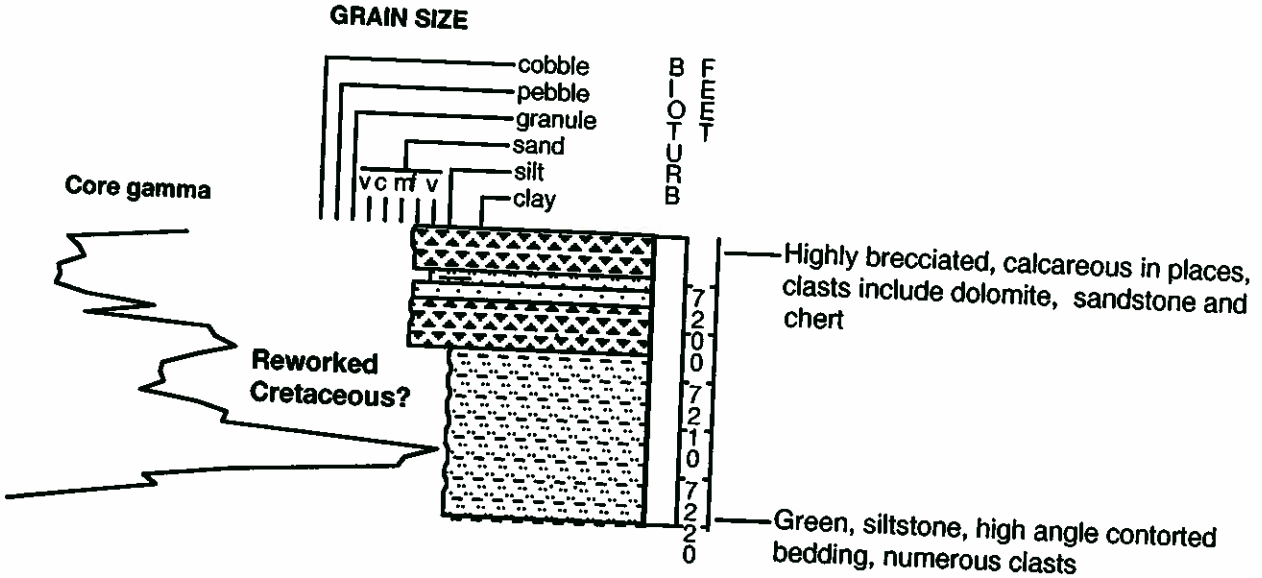


HB Murphy RD Corp HESP
14-28-38-3w5

Date logged: October 21, 1992

Logged by: Rudy Strobl

Remarks: Near erosional edge of Jurassic? Valley

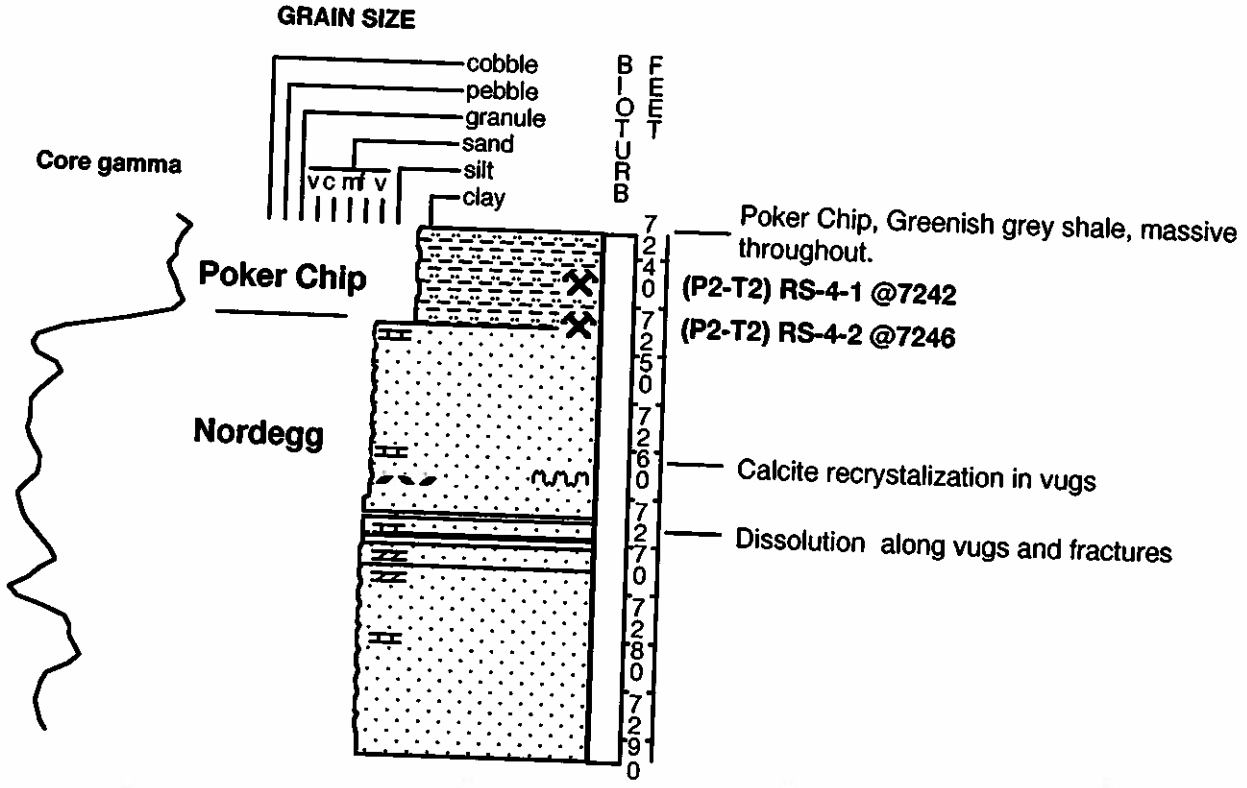


Brink Hespero
4-31-38-3w5

Date logged: July 22, 1992

Logged by: Rudy Strobl

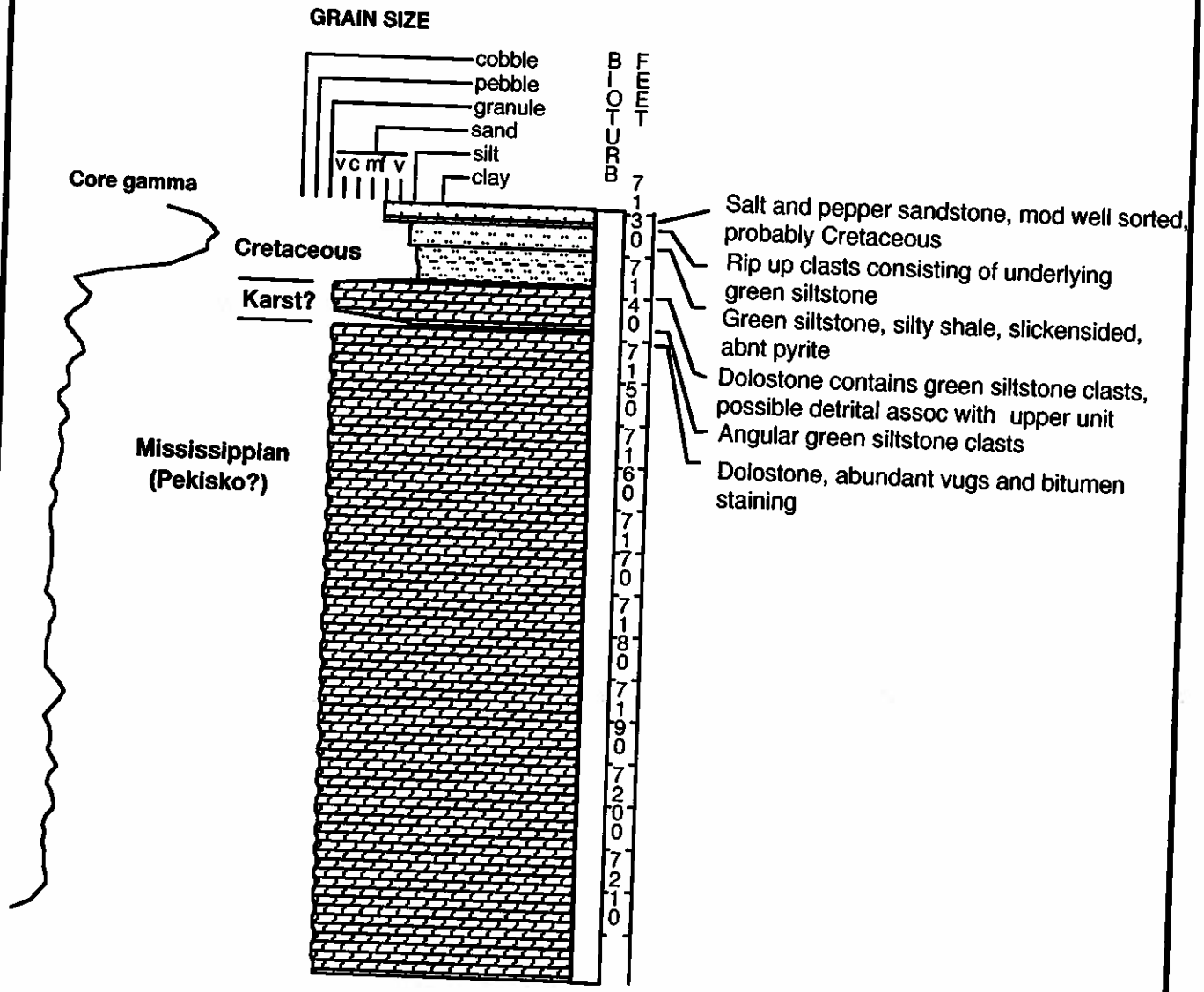
Remarks: Poker Chip over Nordegg



Altair et al Hespero
12-34-38-3w5

Date logged: October 7, 1992

Logged by: Rudy Strobl

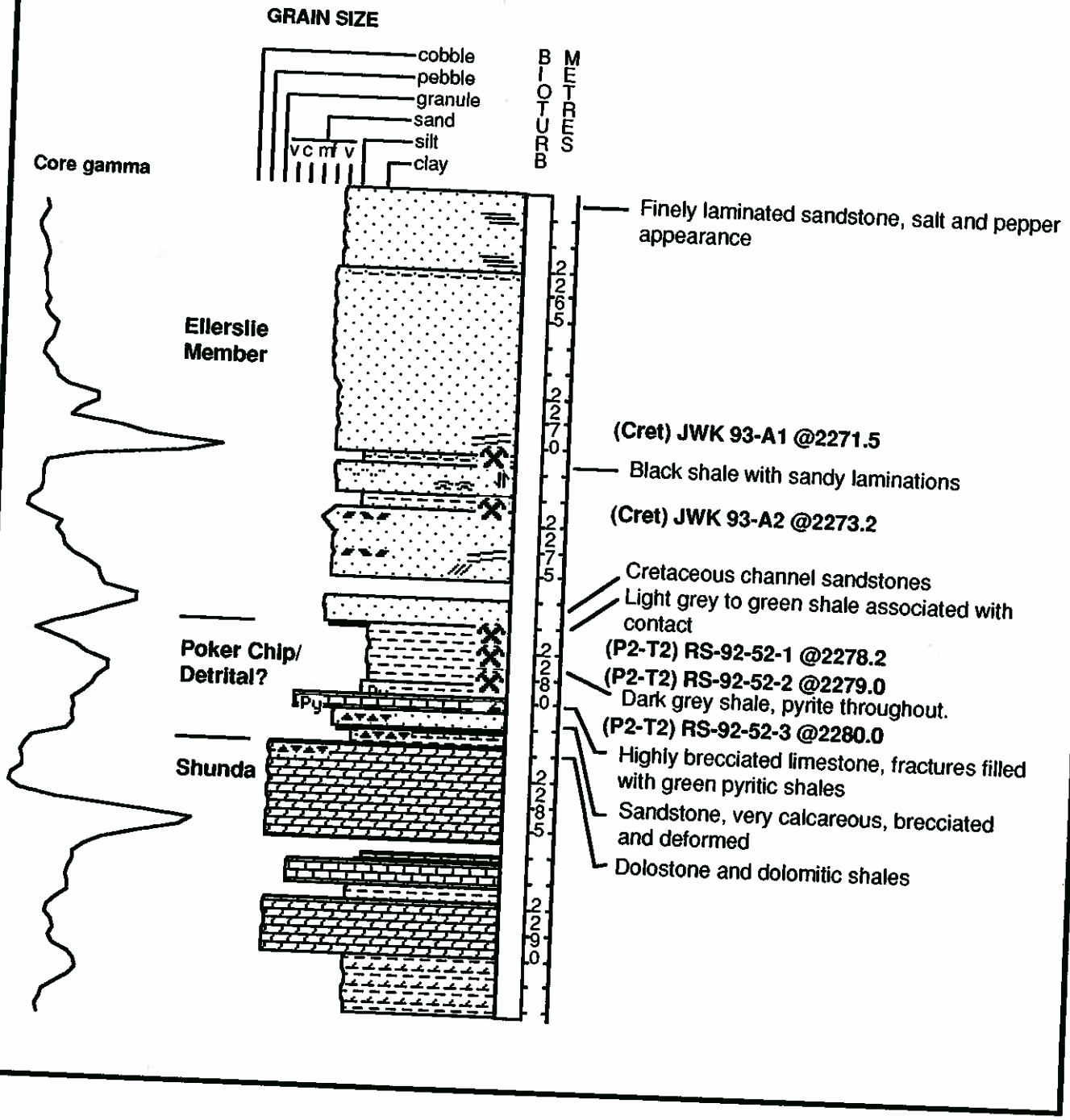


Resman Sylvan Lake
8-2-38-4w5

Date logged: October 16, 1992

Logged by: Craig Siemens and Rudy Strobl

Remarks: Poker Chip slump block? May be part of larger Cretaceous valley system.

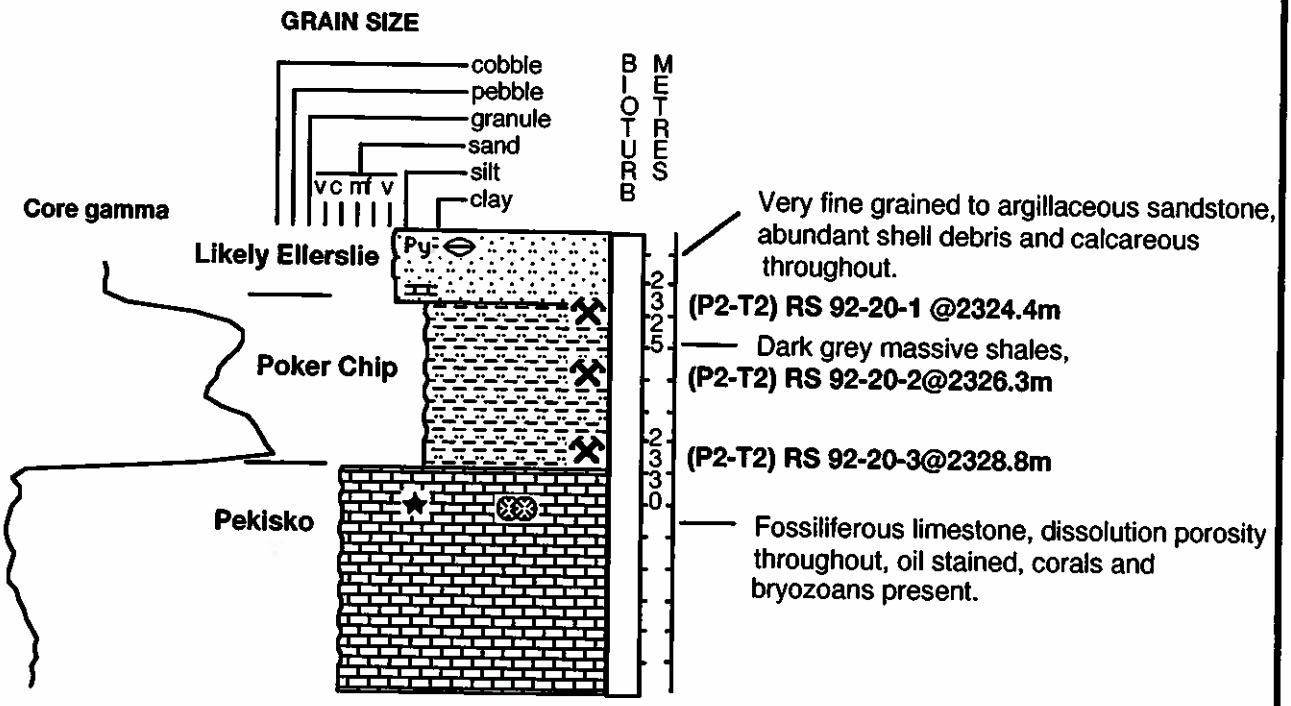


Suncor et al Med R
14-21-38-4w5

Date logged: July 30, 1992

Logged by: Rudy Strobl

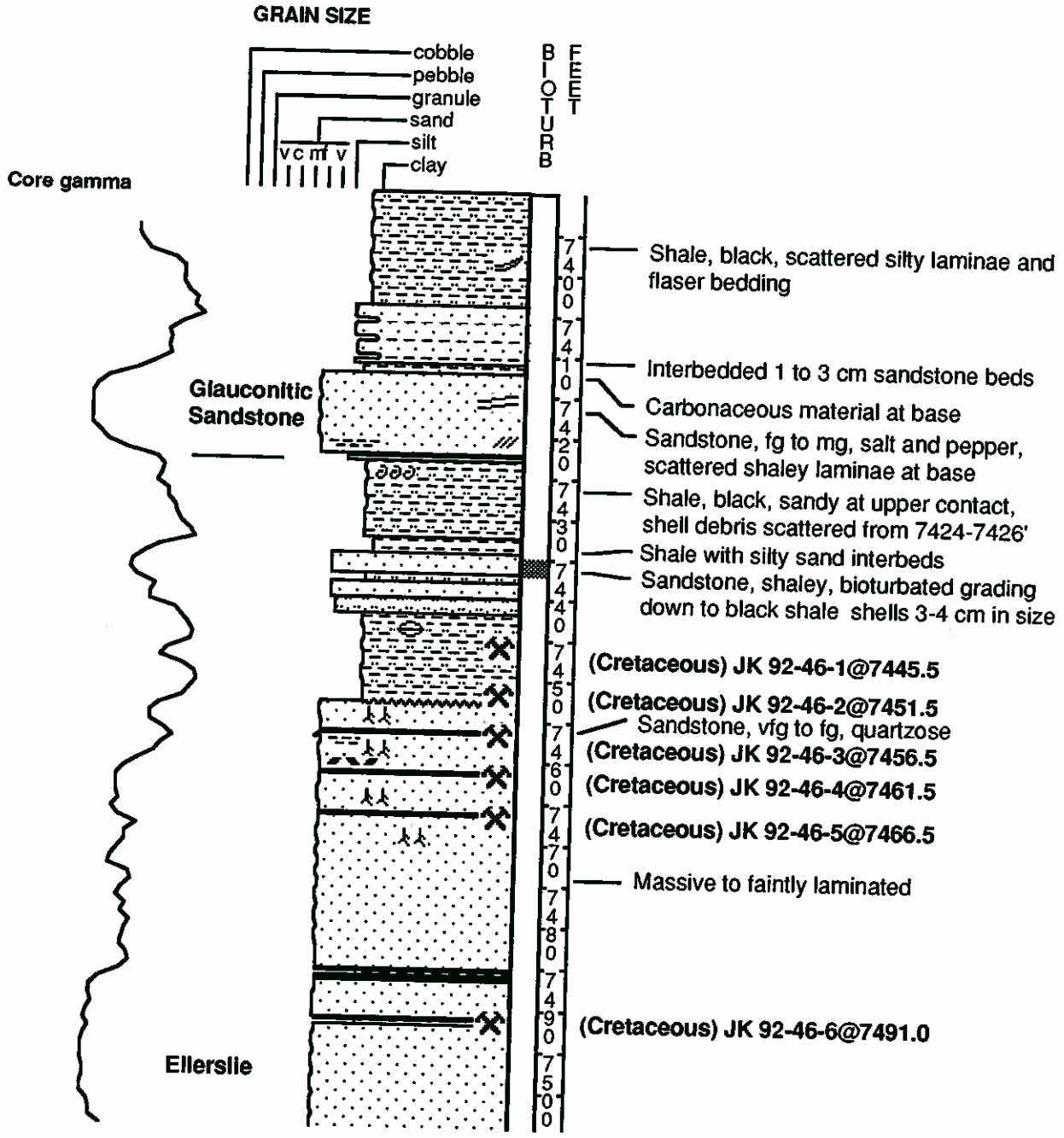
Remarks: Located east of proposed Rock Creek erosional edge. Need detailed cross section to confirm Ellerslie vs Rock Creek.

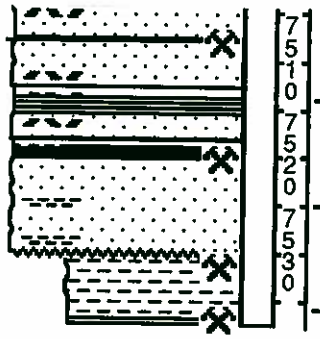


Midwest et al. Sylake 11-22
11-22-38-4w5

Date logged: February 27, 1992

Logged by: J. Kramers





Lower portion of
core gamma missing

Poker Chip

(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

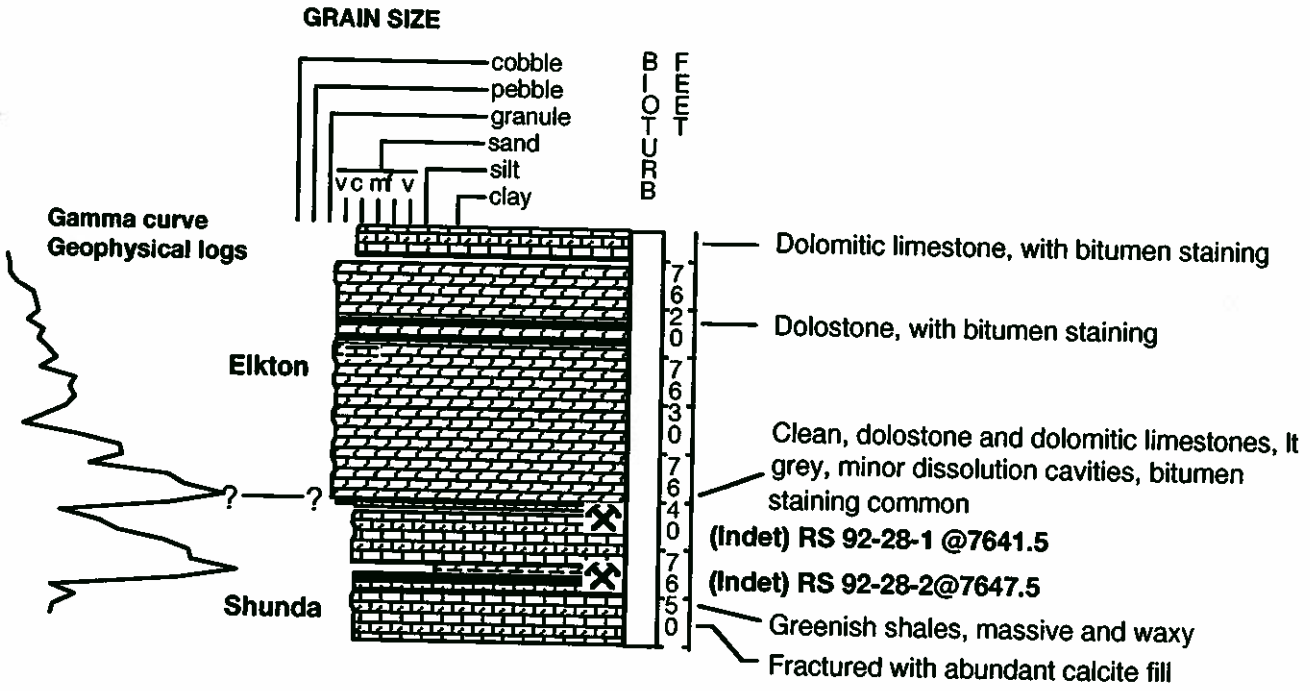
(Toarcian) JK 92-46-10 @7536.8

Mississppian unconformity @7546 (from logs)

Cdn Sup et al Med R
4-27-38-4w5

Date logged: October 7, 1992

Logged by: Rudy Strobl

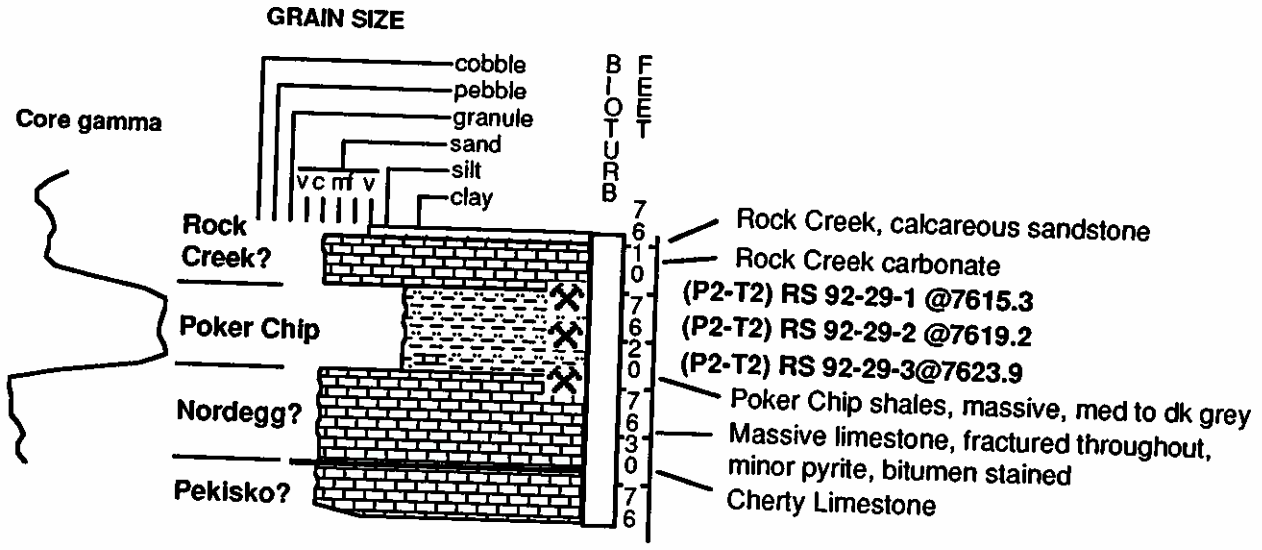


Brink Condor
4-28-38-4w5

Date logged: October 7, 1992

Logged by: Rudy Strobl

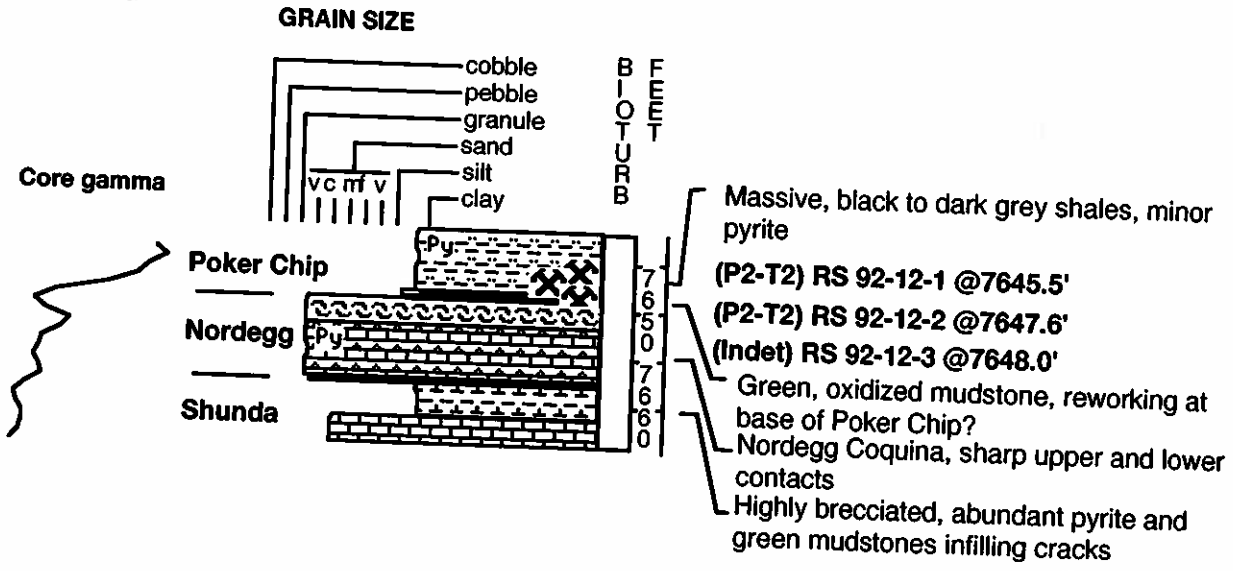
Remarks: Well developed Poker Chip, Appears to have a limey Rock Creek, brecciated Nordegg (need detailed cross section to confirm)



Apache Condor
4-32-38-4w5

Date logged: July 24, 1992

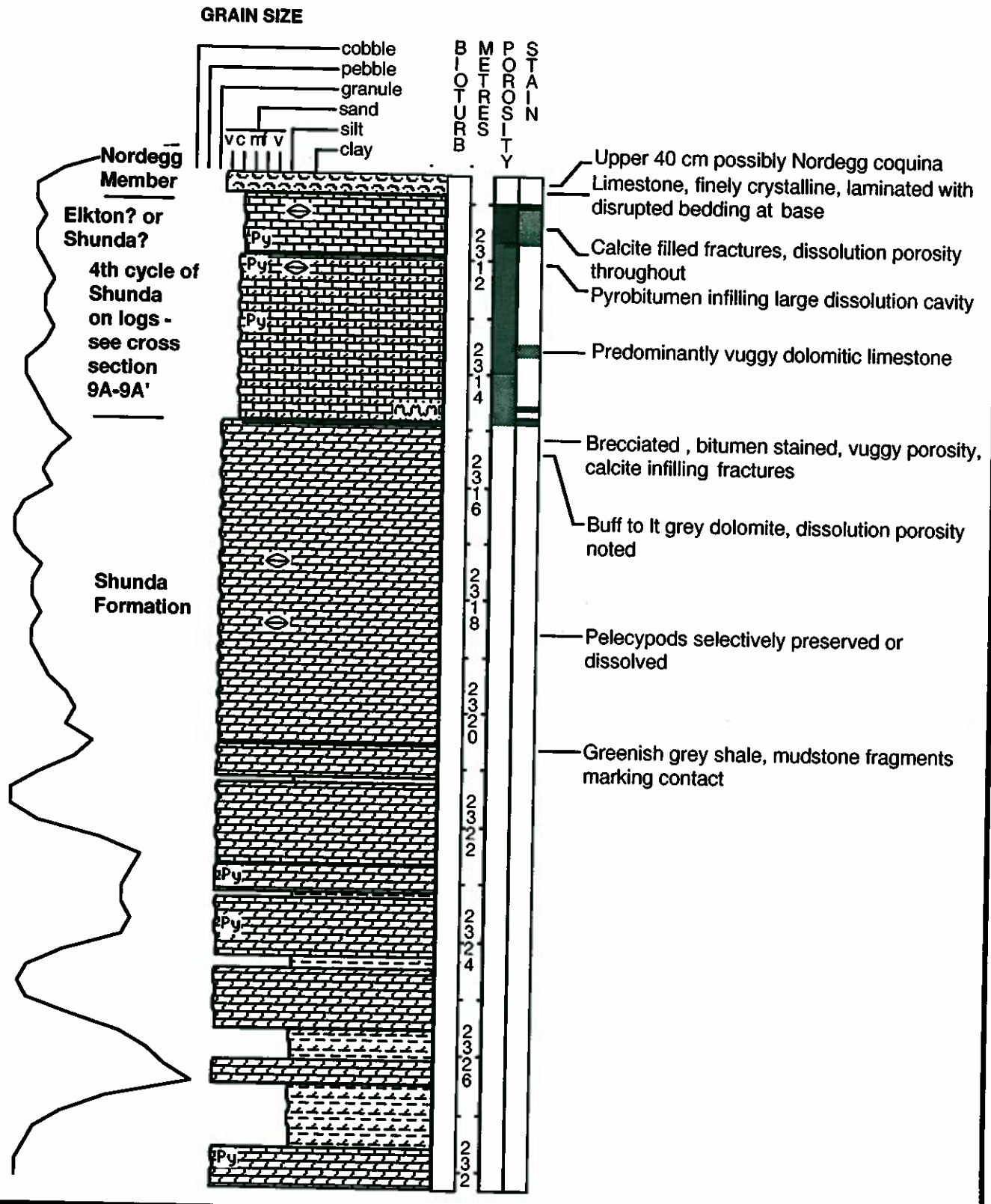
Logged by: Rudy Strobl



WESTBURNE ET AL MED RIVER
8-32-38-4w5

Date logged: January 19, 1993

Logged by: Rudy Strobl

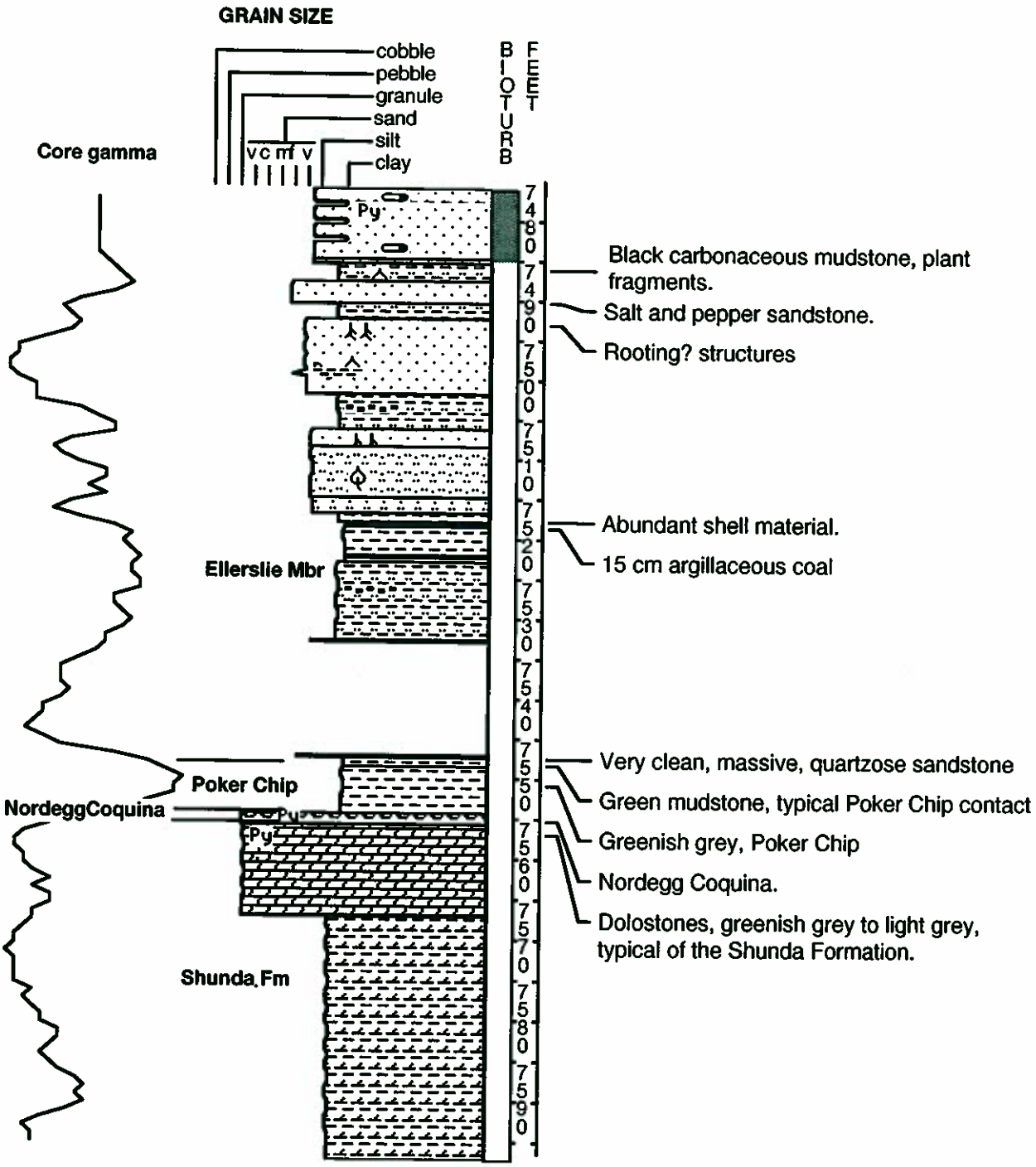


Brink et al Evergreen
6-33-38-4w5

Date logged: May 14, 1993

Logged by: Rudy Strobl

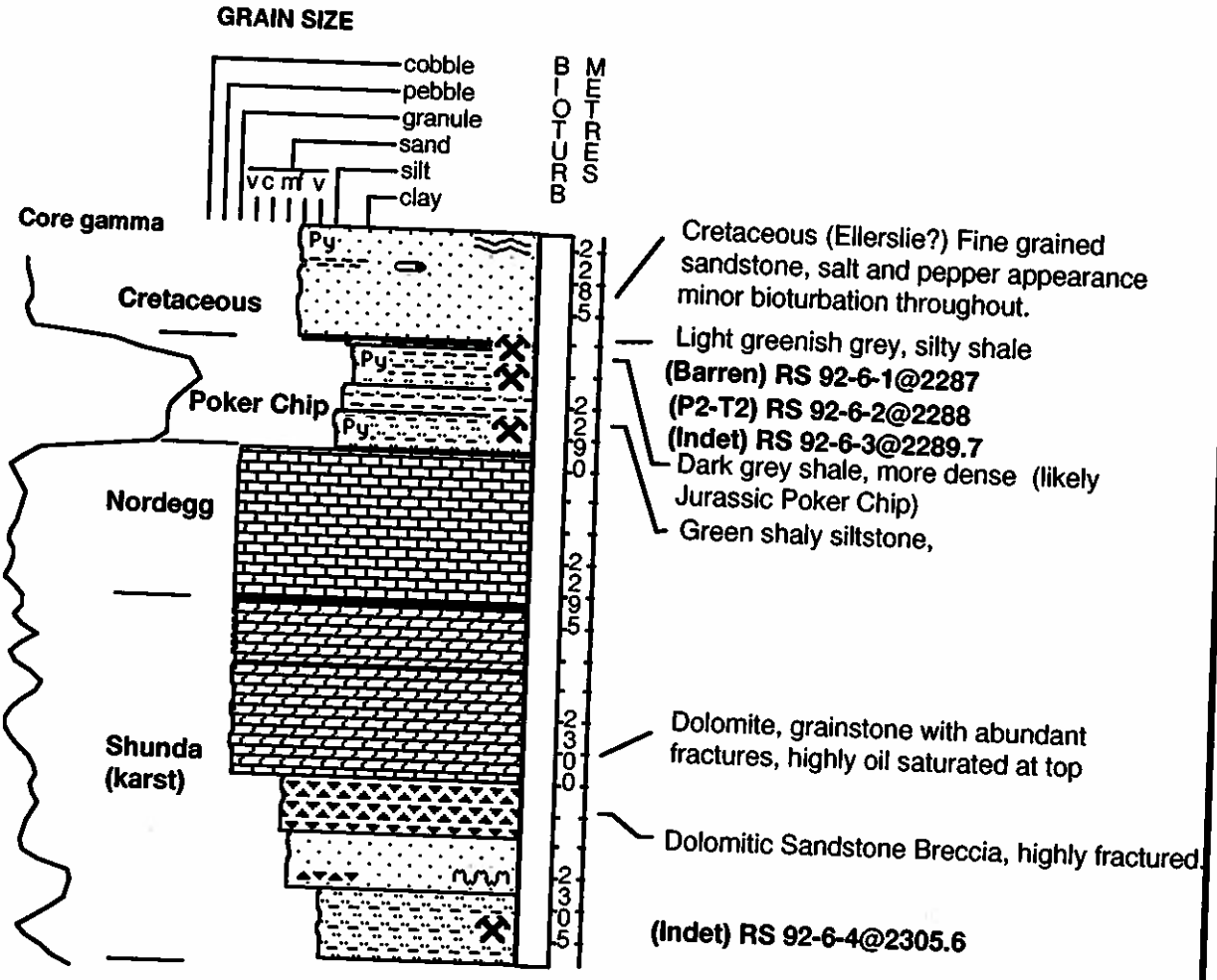
Remarks: Core interval to differentiate Rock Creek vs Ellerslie Section 9A.
Ties in with 4-34Ek-38-4W5 well.



Cdn Sup Trns MedR
4-34-38-4w5 EK

Date logged: July 23, 1992

Logged by: Rudy Strobl

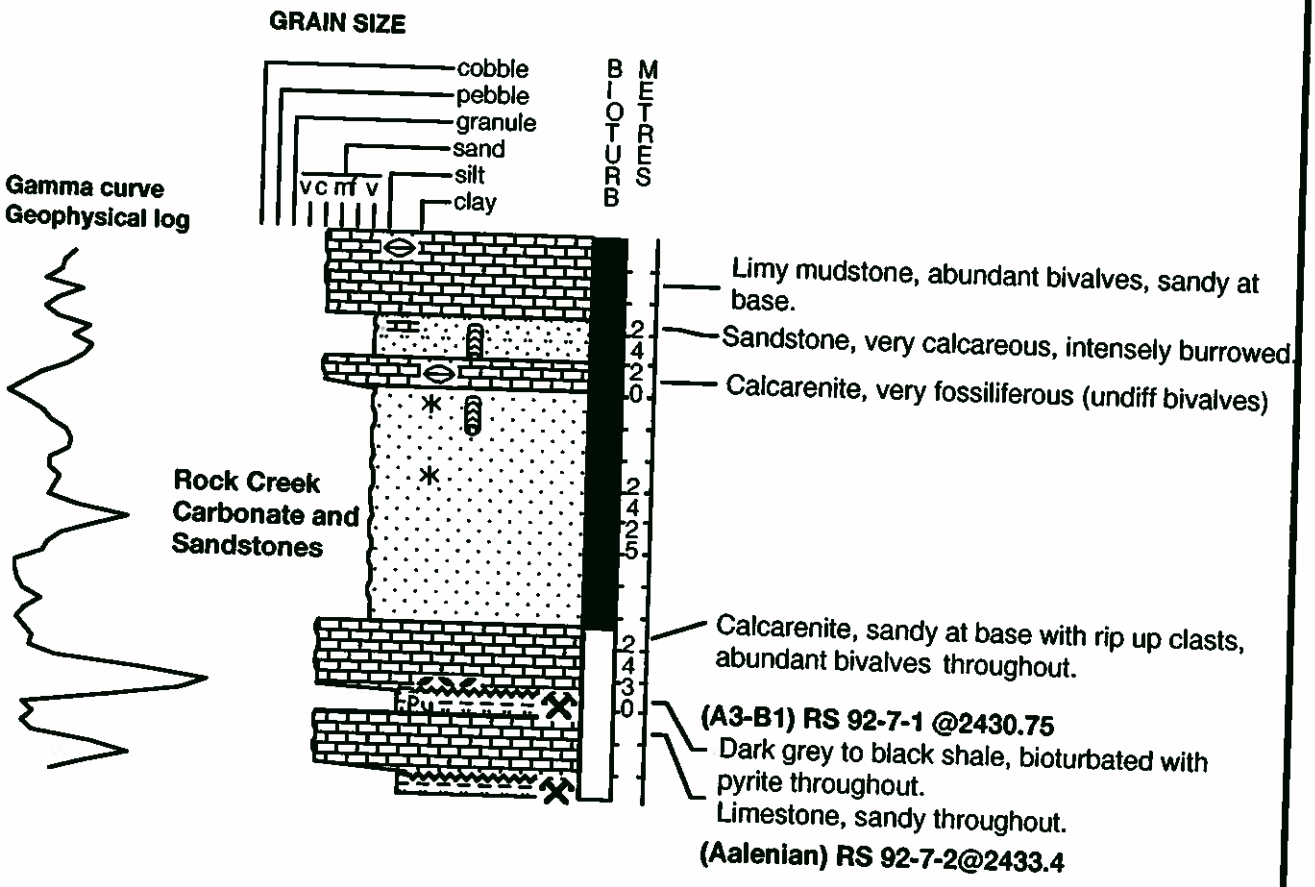


Thin Section @2285.5 m Quartzose, fine grained with abundant altered feldspars, clay in pore space, highly altered and cemented.

Dome Butte
11-28-38-5w5

Date logged: July 23, 1992

Logged by: Rudy Strobl

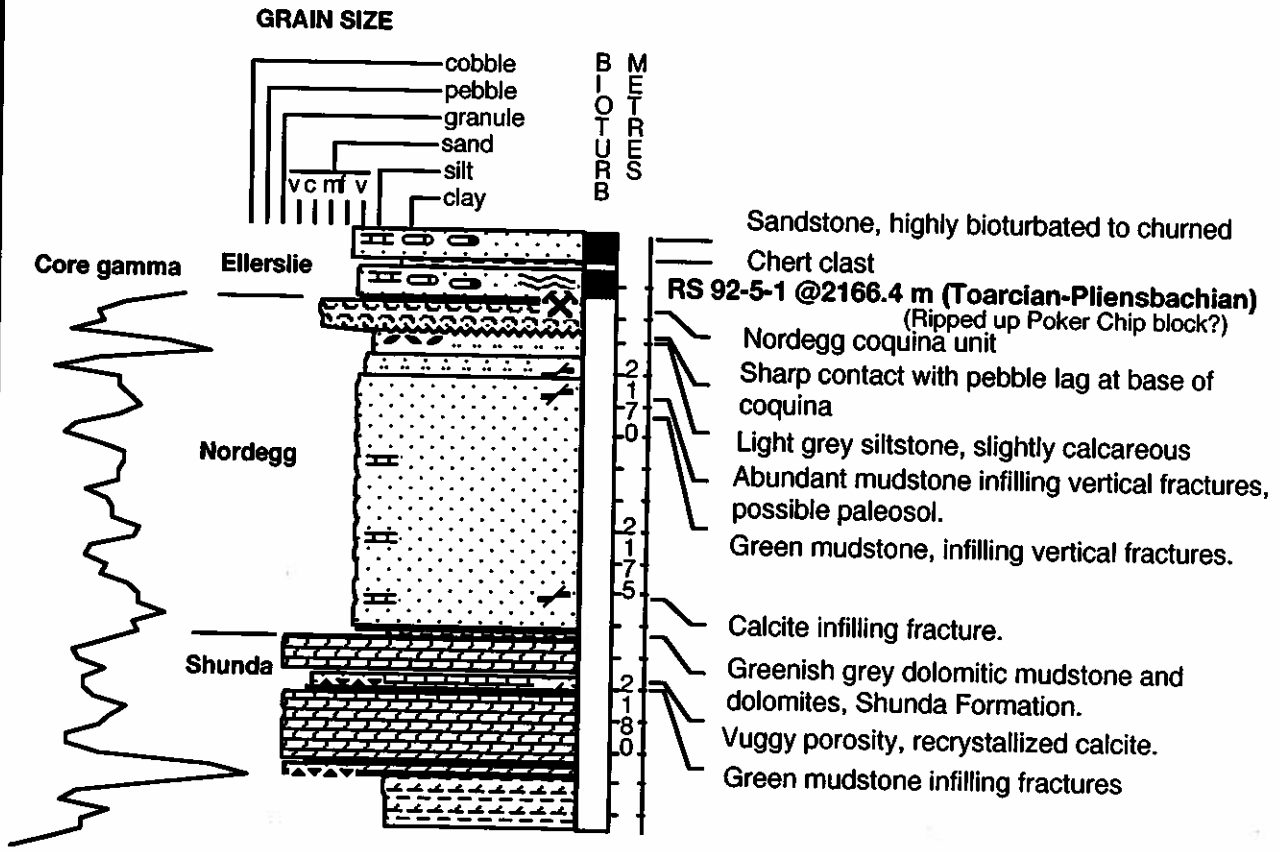


Suncor et al MedR
6-5-39-3w5

Date logged: April 27, 1993

Logged by: Rudy Strobl

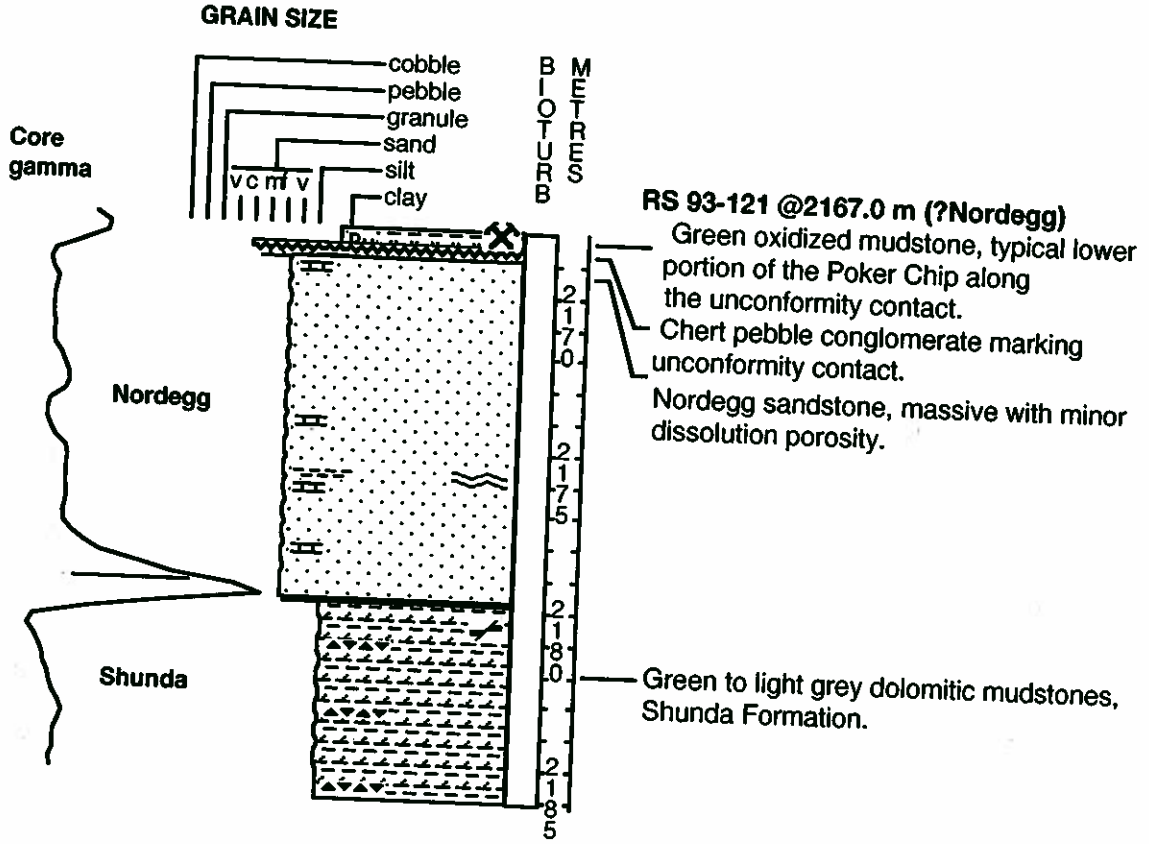
Remarks: Good core for photos.



Suncor et al Med R
10-7-39-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

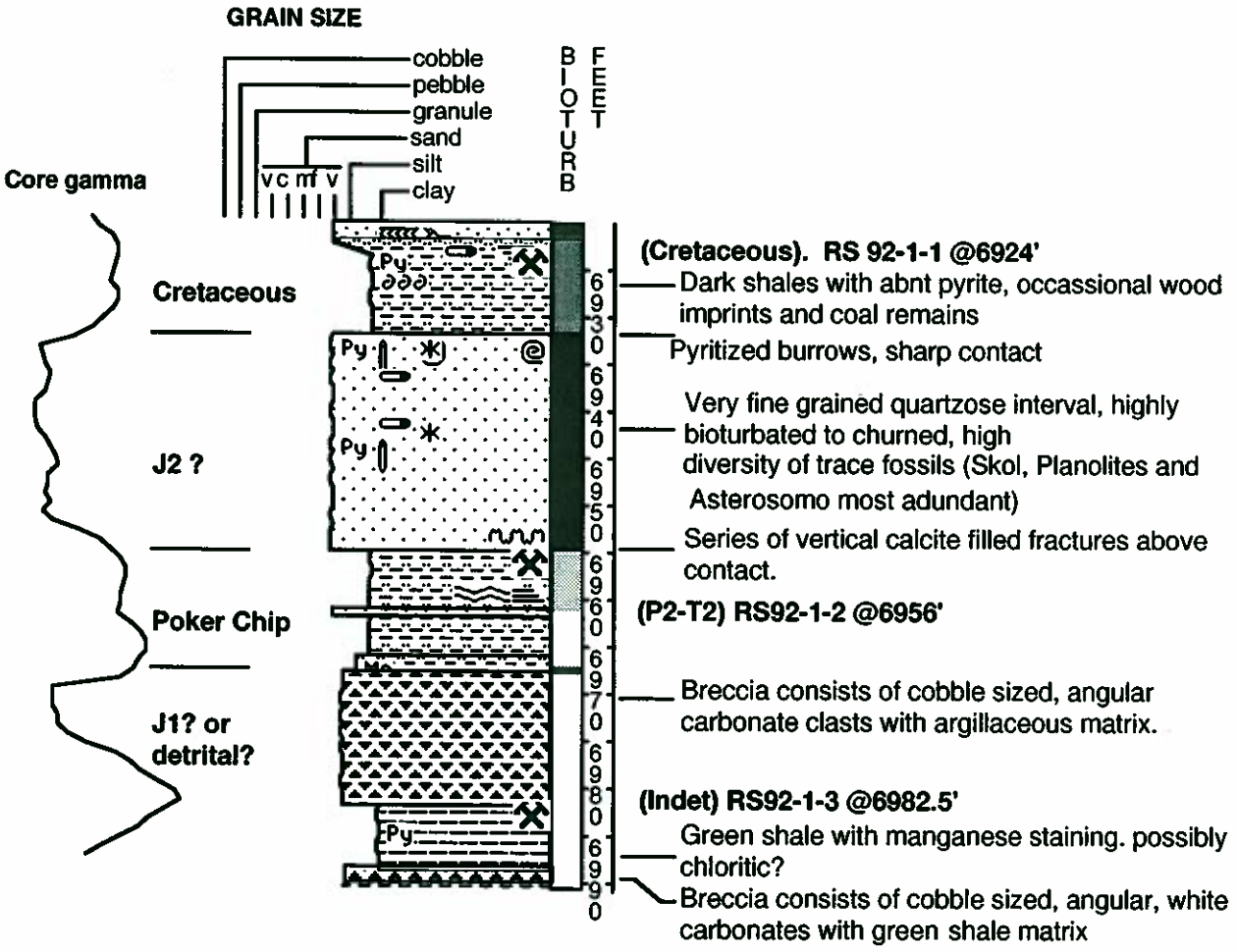


Atlantic Hespero
12-10-39-3w5

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?

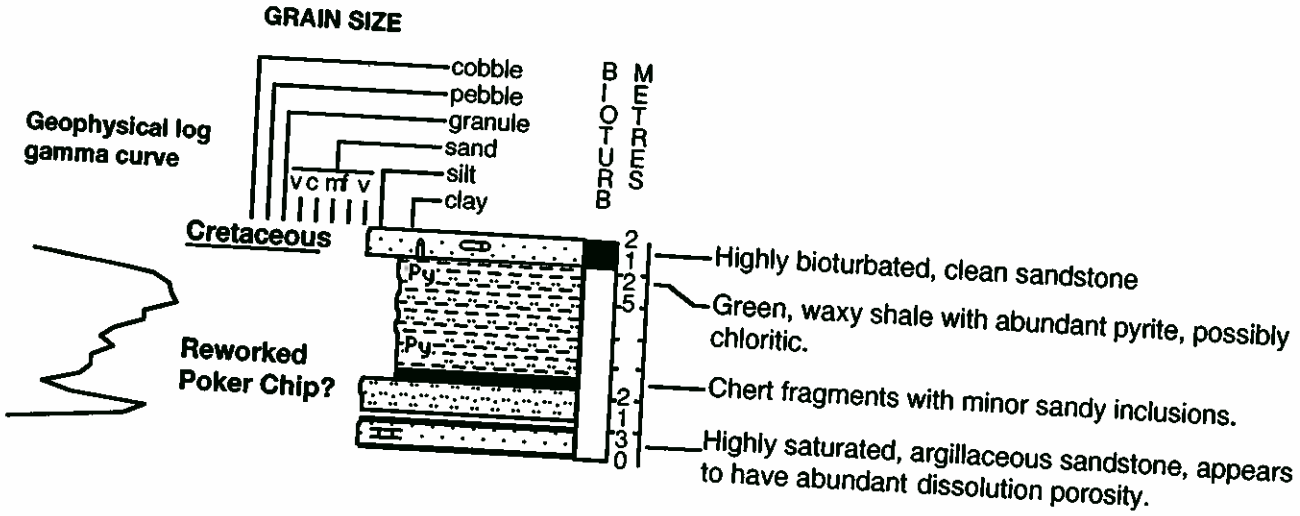


Pembina et al Med R
8-11-39-3w5

Date logged: July 22, 1992

Logged by: Rudy Strobl

Remarks: Along Mississippian high east of regional Rock Creek erosional edge,



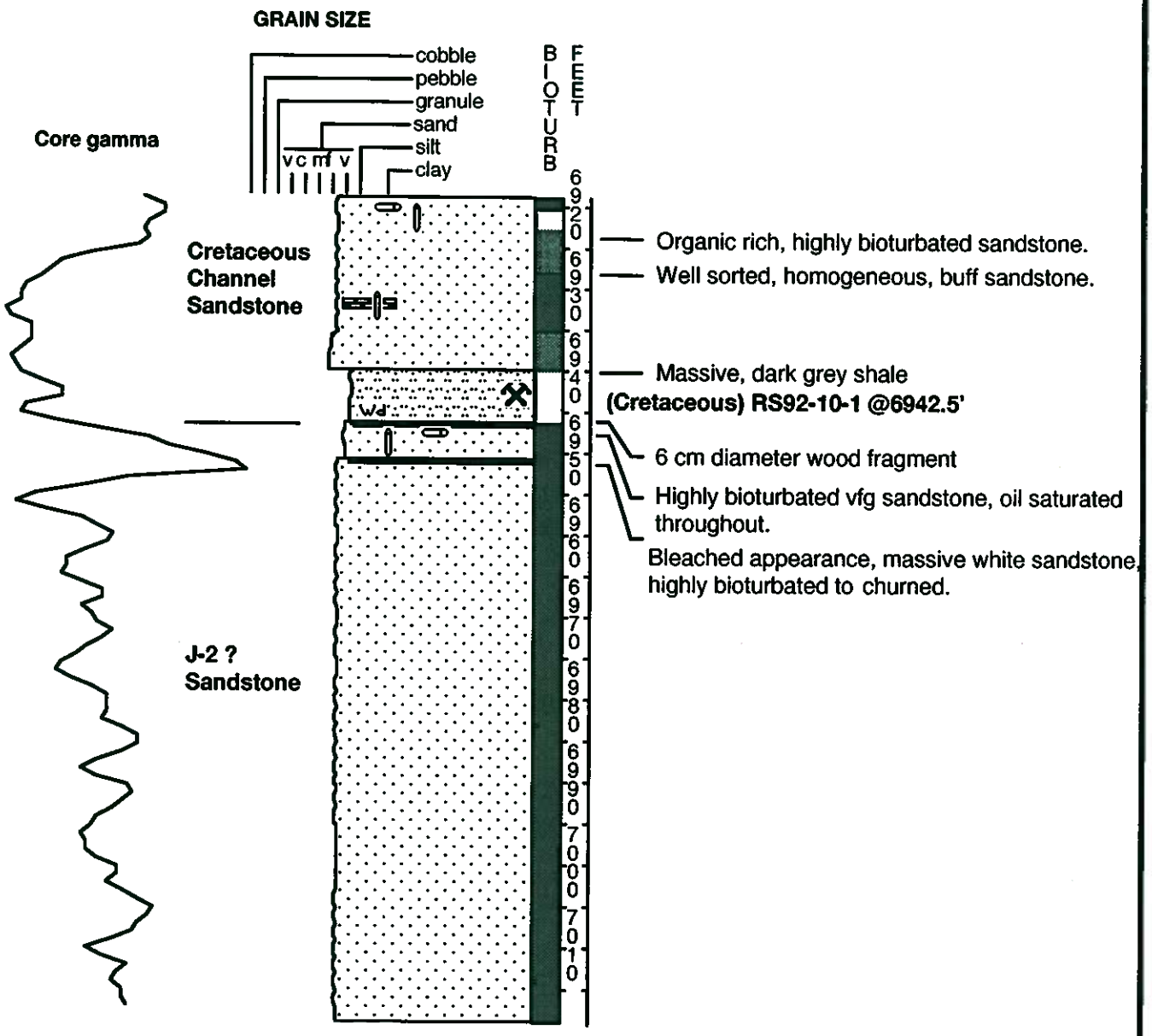
Sun Dome Med R

12-15-39-3w5

Date logged: July 23, 1992

Logged by: Rudy Strobl

Remarks: Within the J Valley, Xray of shales from Rall (1980)

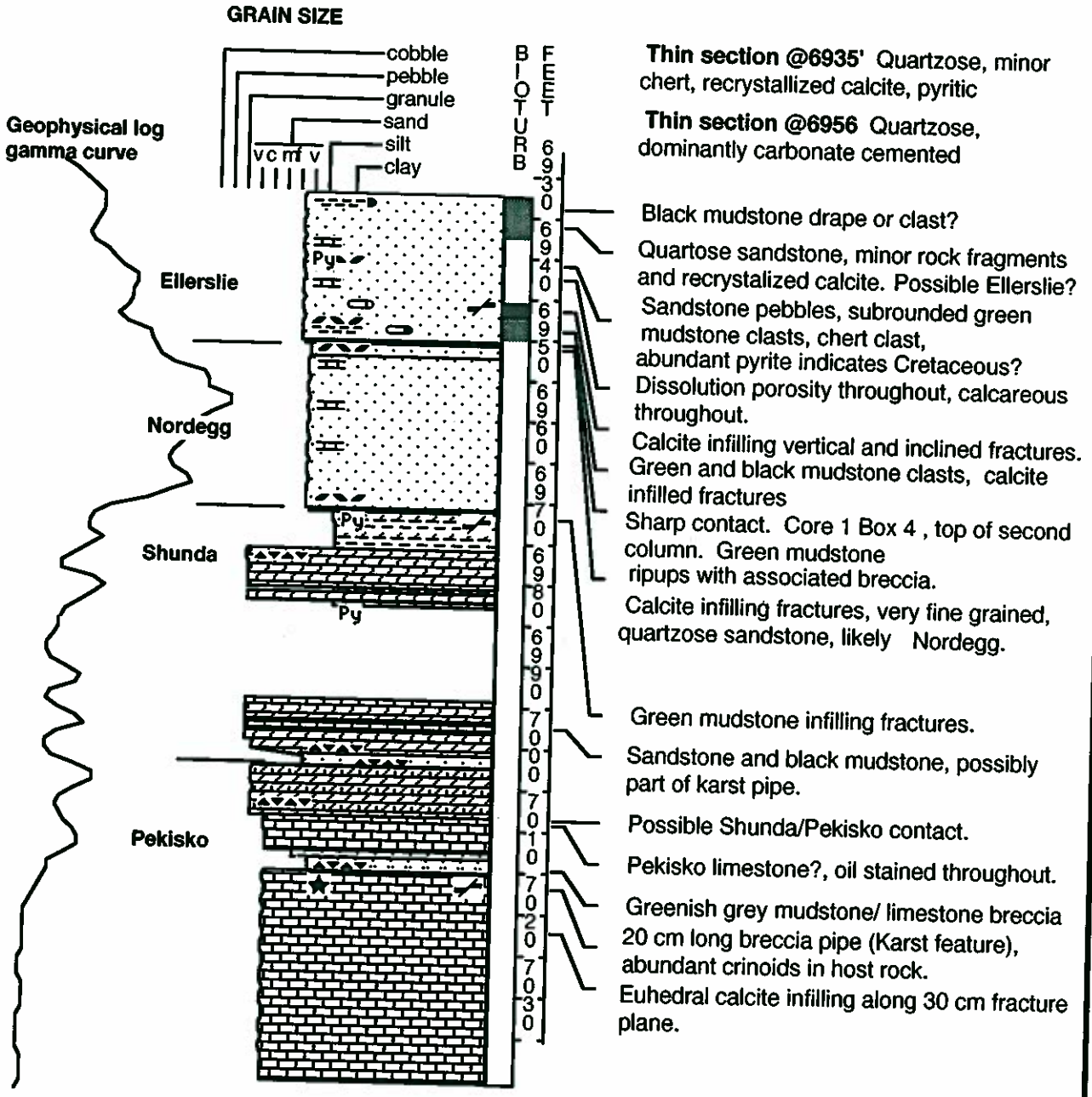


Cdn Superior Med River
8-16-39-3w5

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 Nordegg 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 recrystalized 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 infilled fractures

Sharp contact. Core 1 Box 4 , top of second column. Green mudstone ripups with associated breccia.

Calcite infilling fractures, very fine grained, quartzose 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.

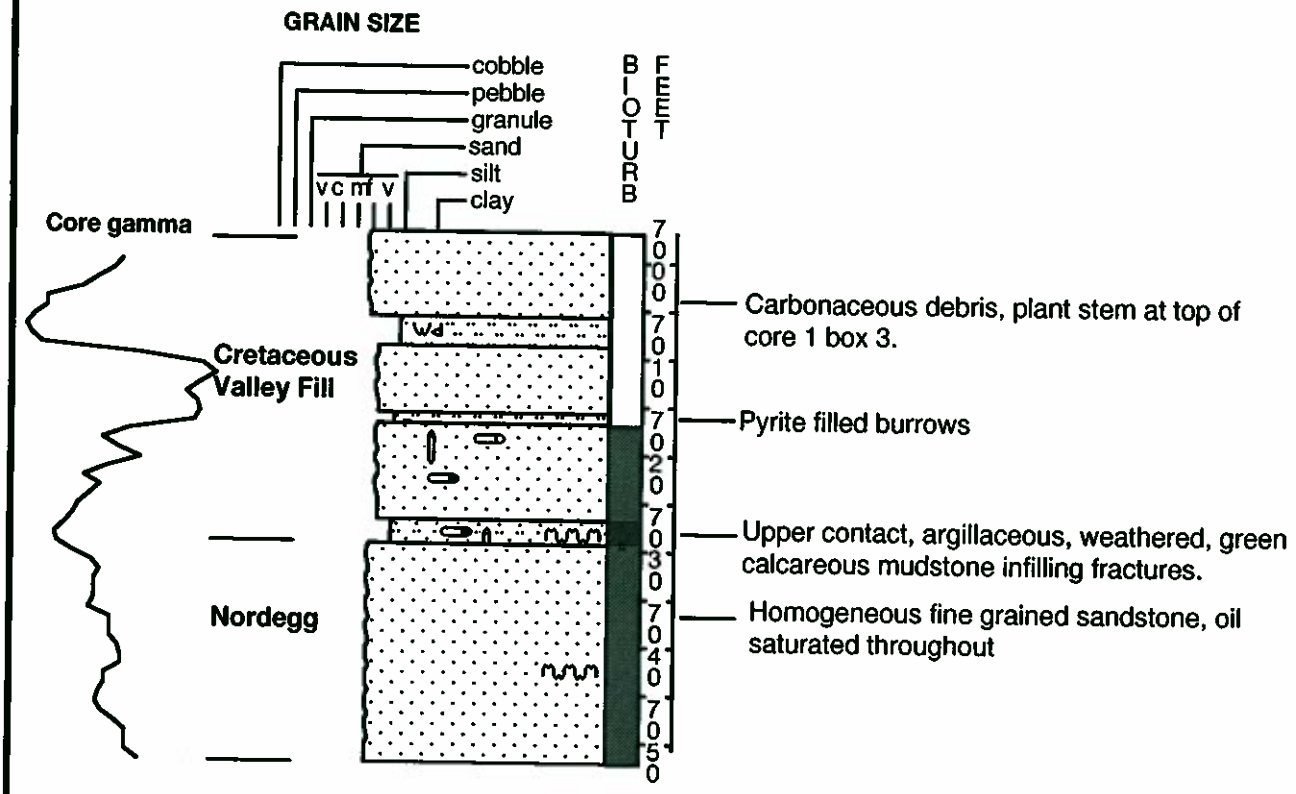
Euhedral calcite infilling along 30 cm fracture plane.

H.B. Med R
14-16-39-3w5

Date logged: July 23, 1992

Logged by: Rudy Strobl

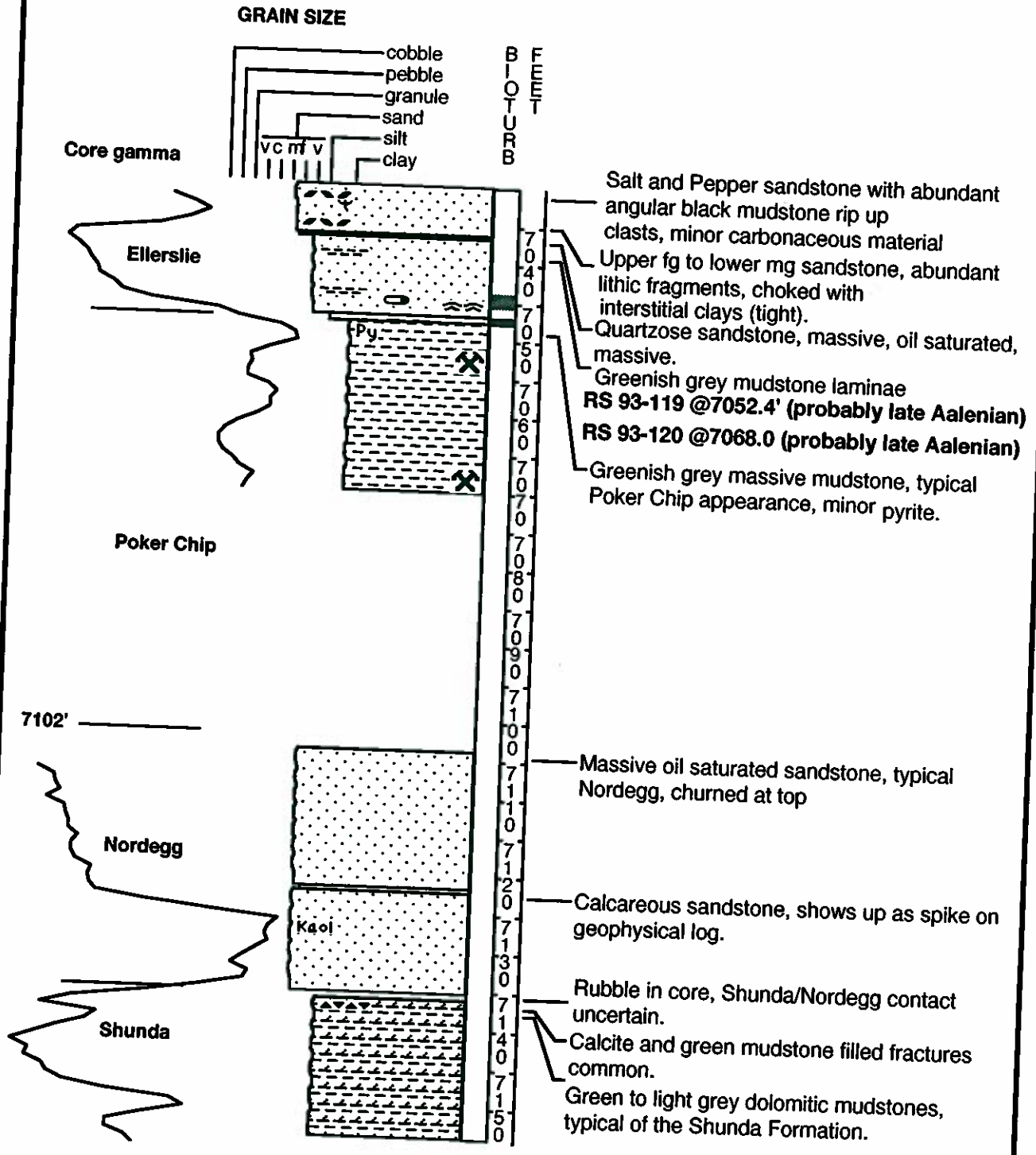
Remarks: Located immediately west of J-Valley, Clay mineralogy done by Rall (1980).



Brink Dea et al Med River
4-18-39-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

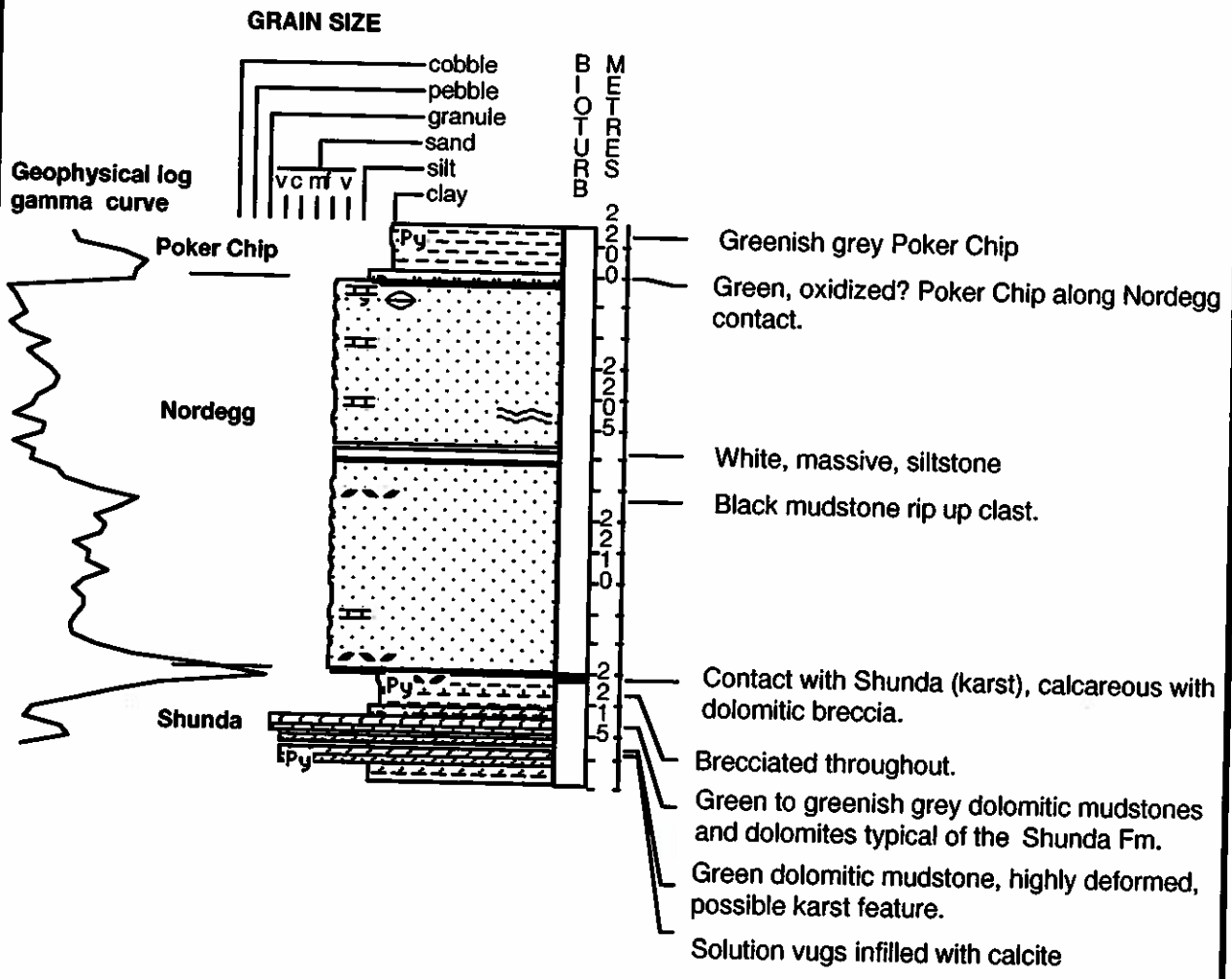


Sun Med River
13-18-39-3w5

Date logged: April 28, 1993

Logged by: Rudy Strobl

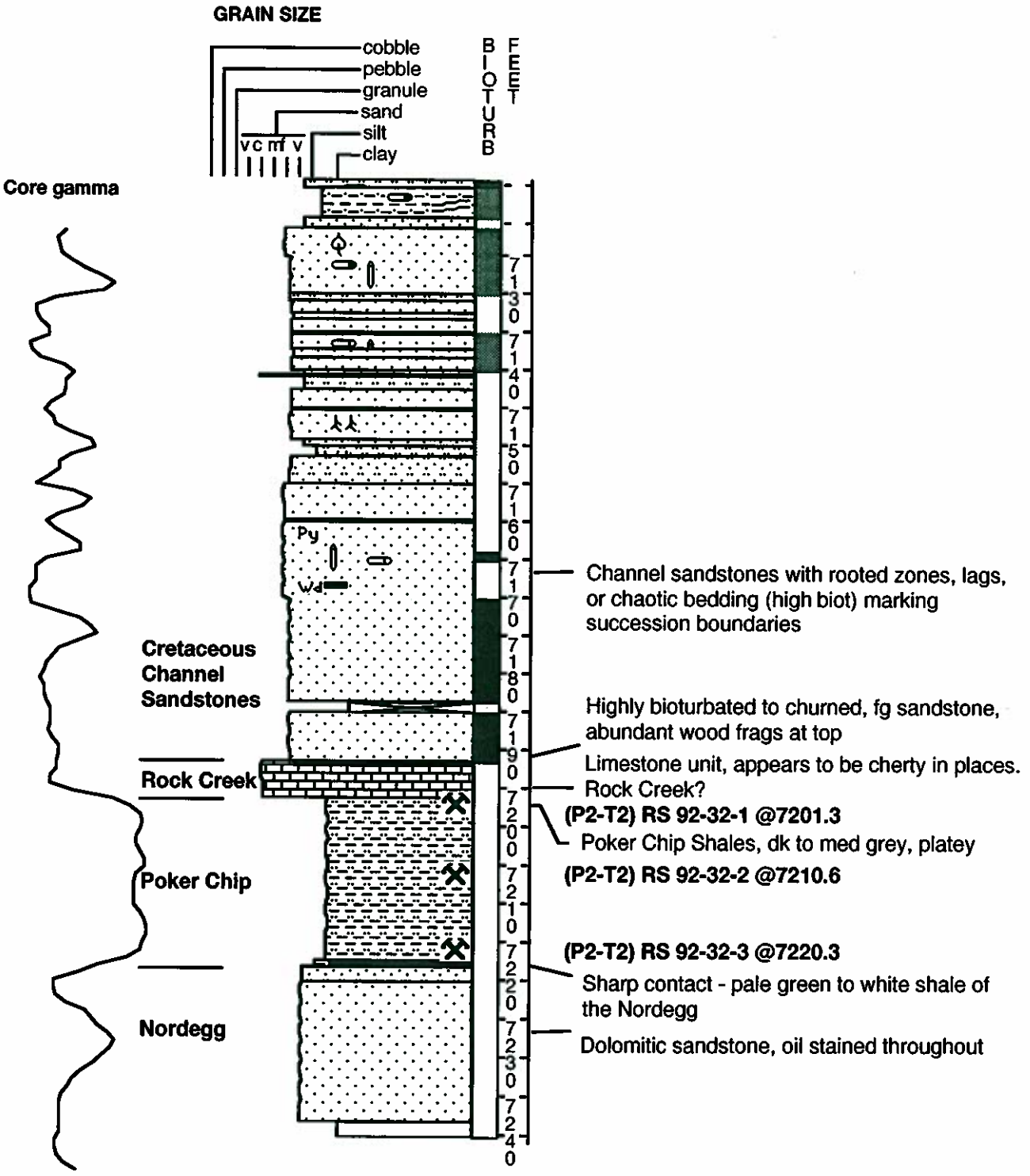
Remarks: Core to confirm Shunda pick.



Brink Dea et al Med River
14-18-39-3w5

Date logged: October 9, 1992

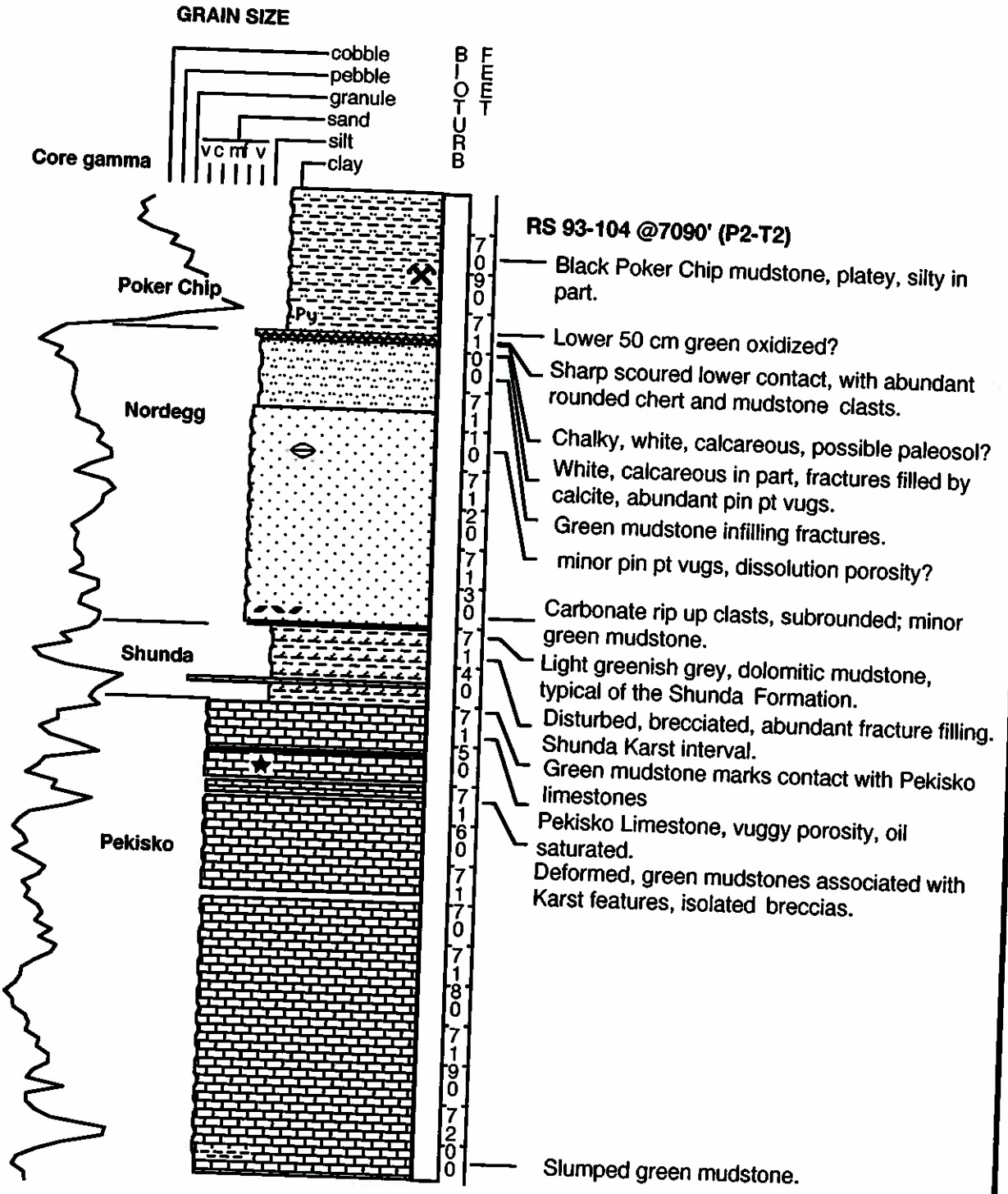
Logged by: Rudy Strobl



H.B. Medicine River
16-20 -39-3w5

Date logged: May 12, 1993

Logged by: Rudy Strobl



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

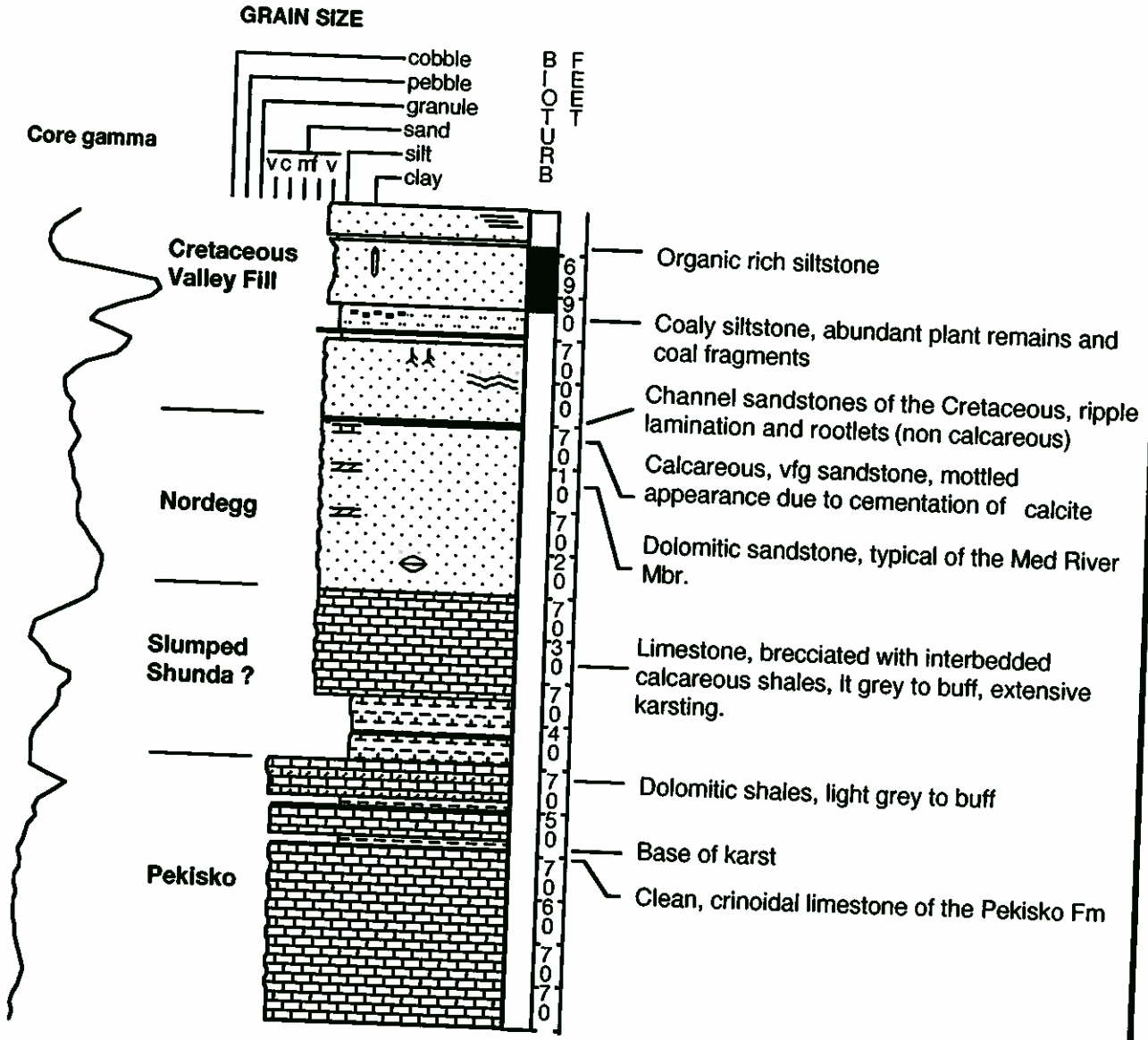
- Black Poker Chip mudstone, platey, silty in part.
- Lower 50 cm green oxidized?
- Sharp scoured lower contact, with abundant rounded chert and mudstone clasts.
- Chalky, white, calcareous, possible paleosol?
- White, calcareous in part, fractures filled by calcite, abundant pin pt vugs.
- Green mudstone infilling fractures.
- minor pin pt vugs, dissolution porosity?
- Carbonate rip up clasts, 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.

BA CPR Victor Med River
6-21-39-3w5

Date logged: October 16, 1992

Logged by: Rudy Strobl

Remarks: Sand on sand Cretaceous/Nordegg contact

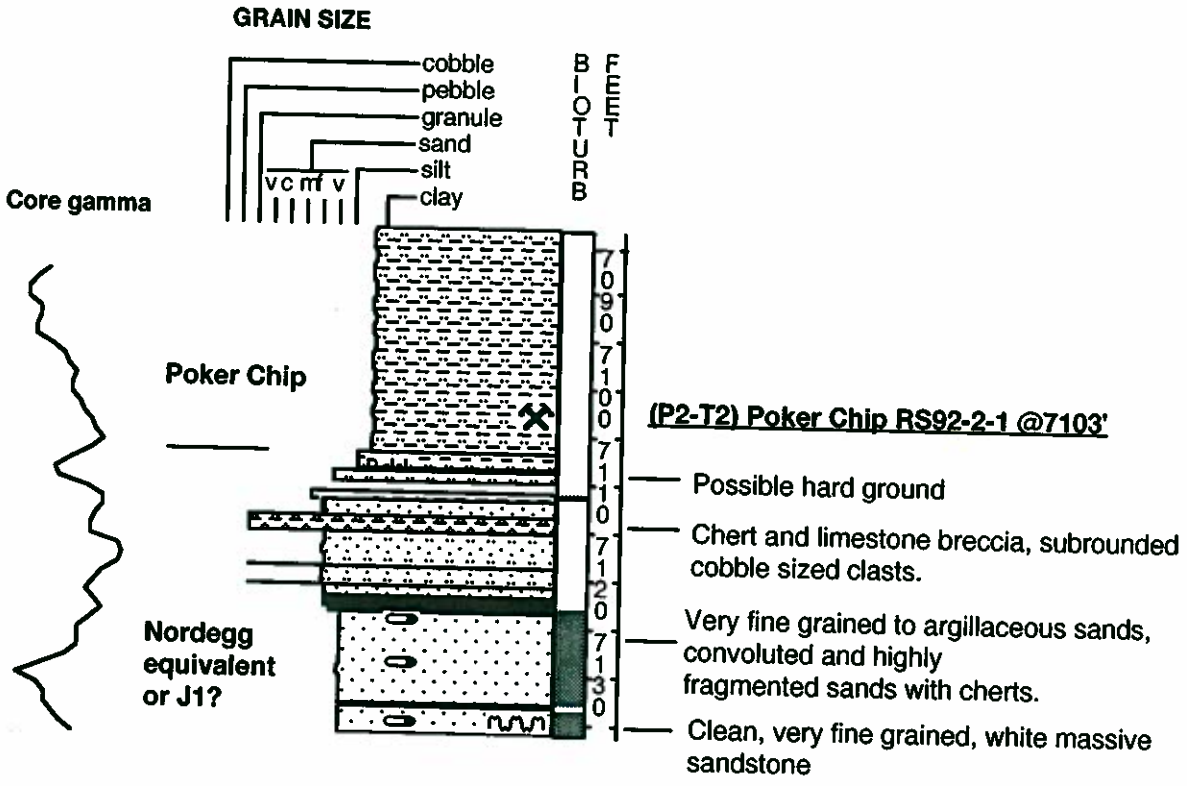


B.A. CPR Victor Med R
14-21-39-3w5

Date logged: July 22, 1992

Logged by: Rudy Strobl

Remarks: Sampled by Rall (1980), possible J Valley extension?

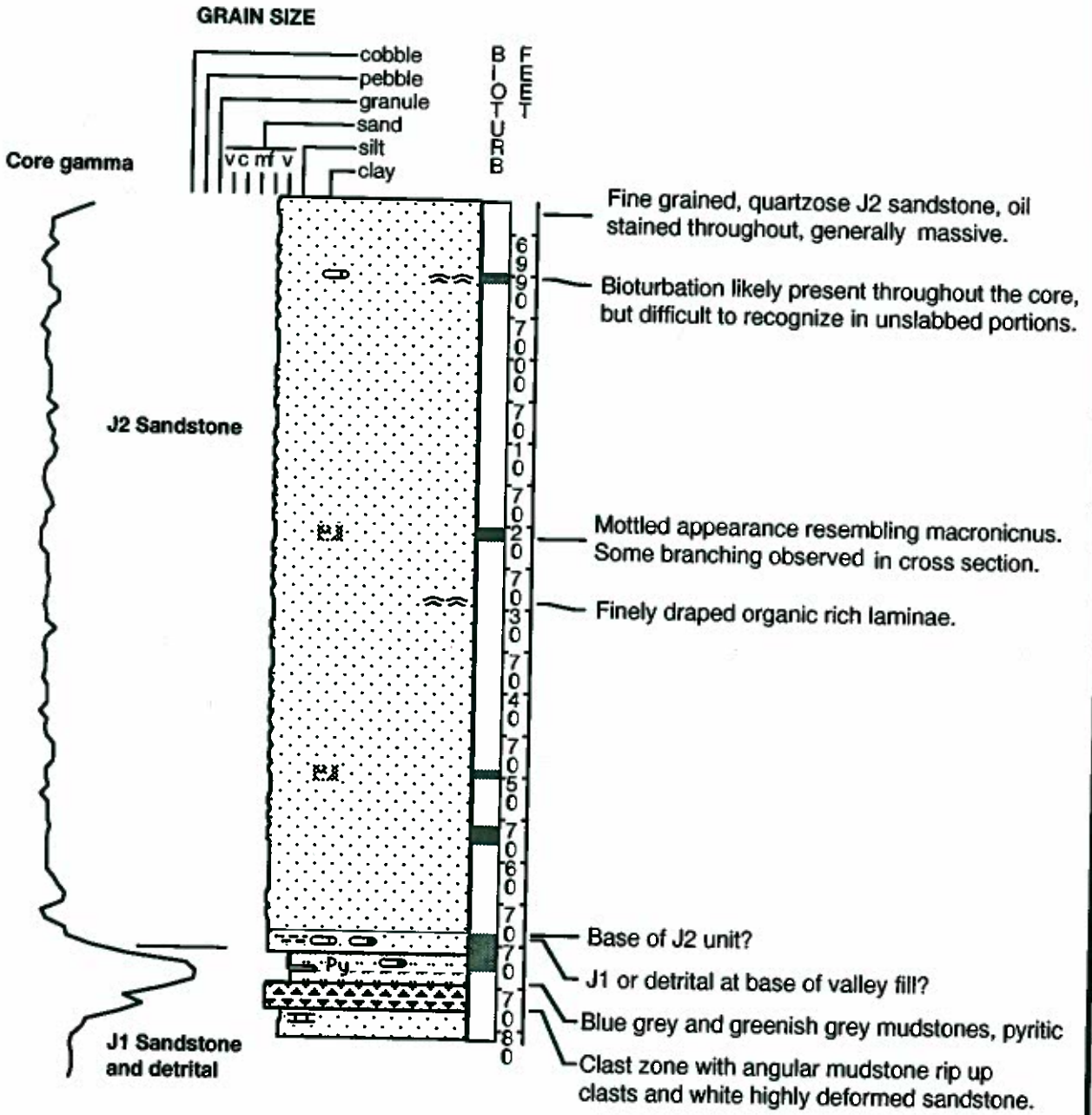


Sun Med River
6-27-39-3w5

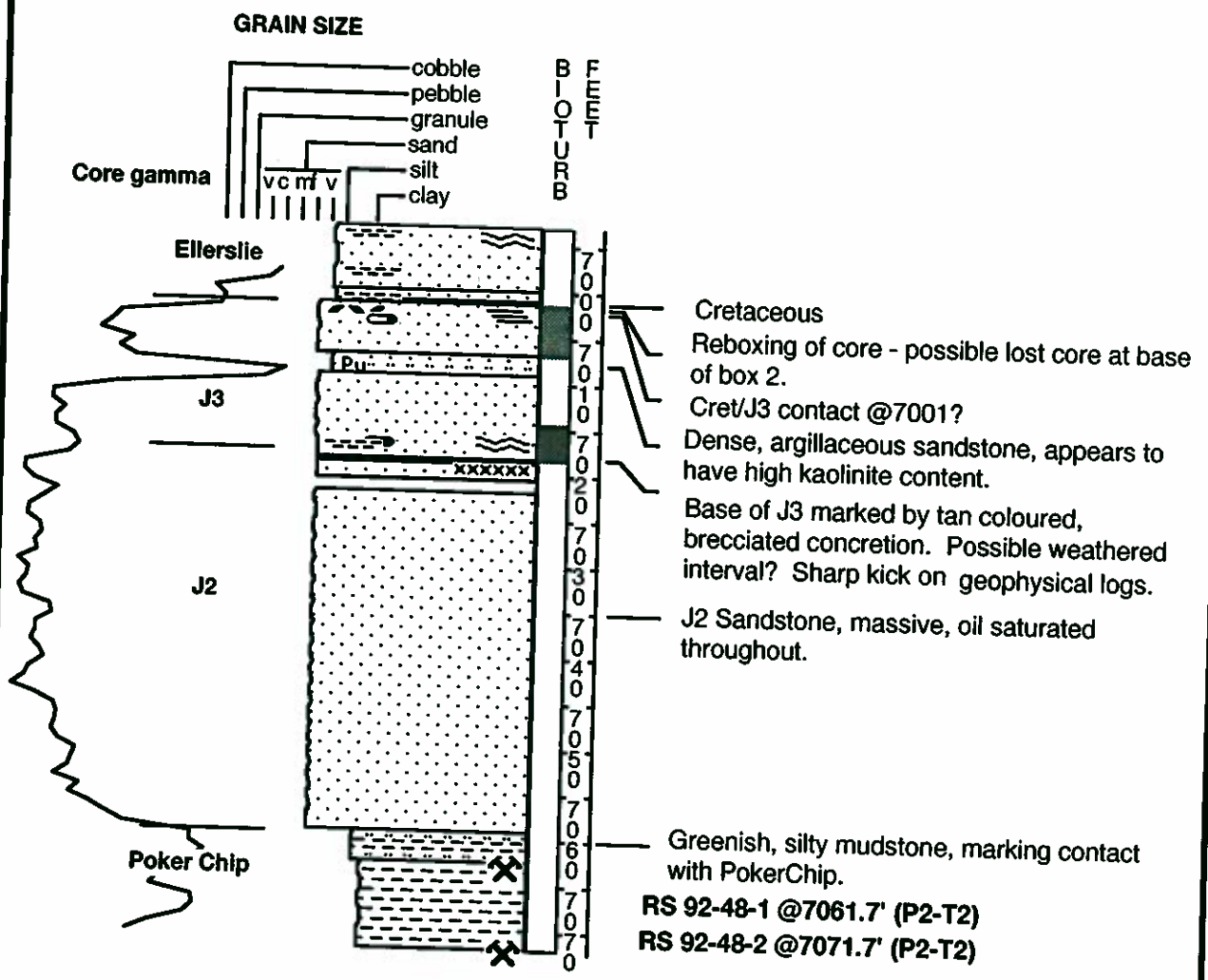
Date logged: May 7, 1993

Logged by: Rudy Strobl

Remarks: J2 sandstone, slabbed in part allowing recognition of structure and bedding.



HB Medicine River
6-28-39-3w5

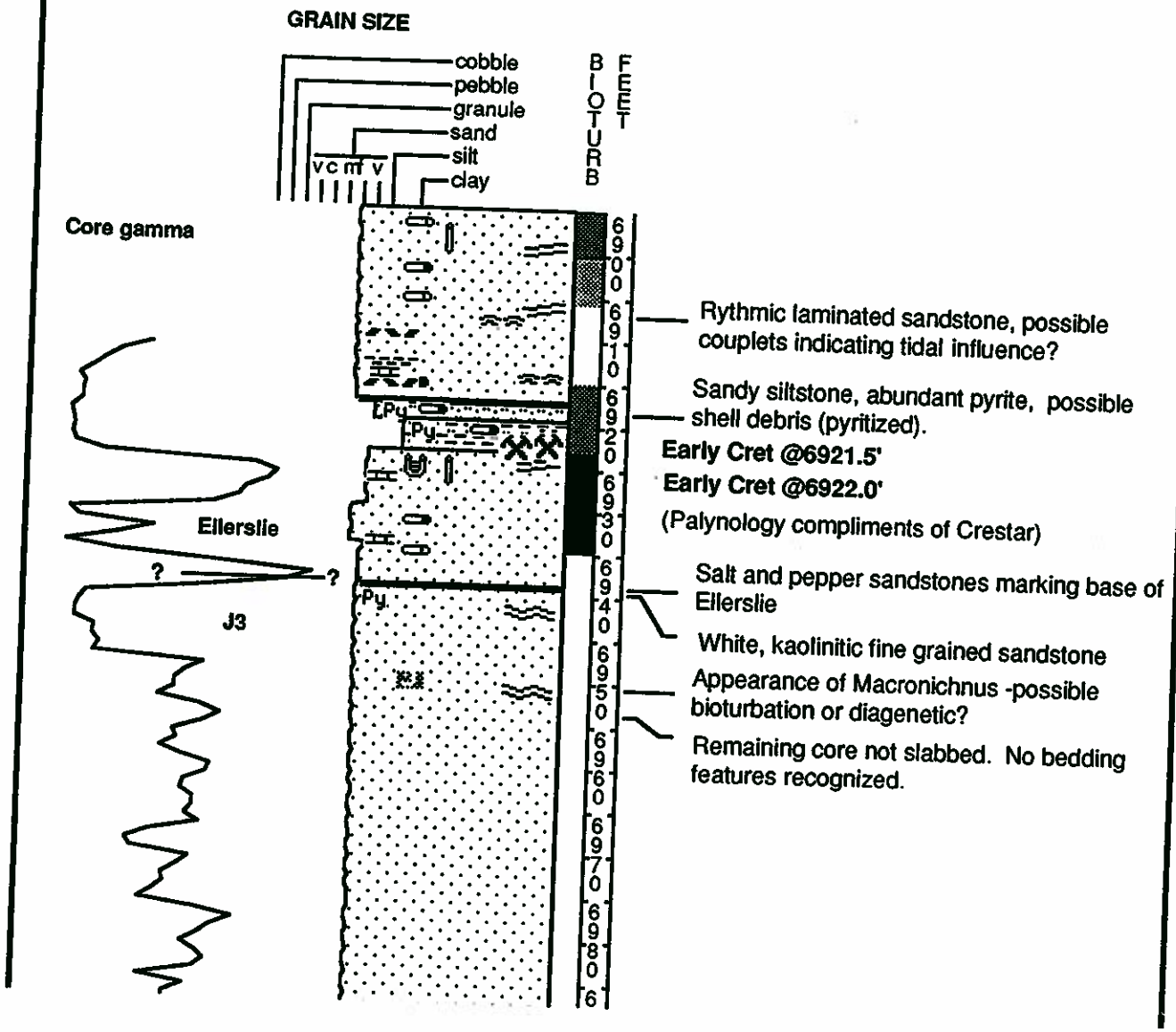


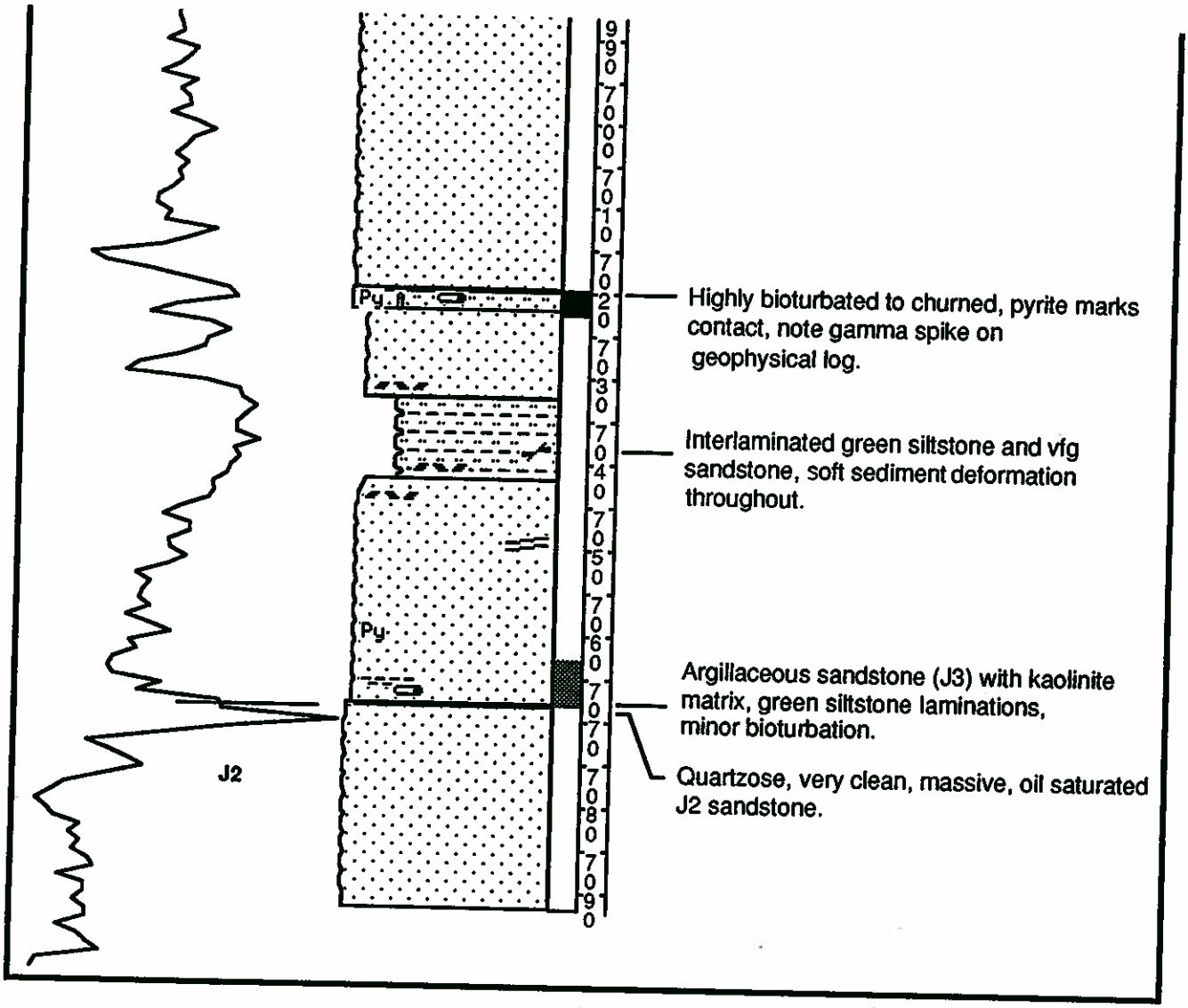
HB Medicine River
8-28-39-3w5

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.

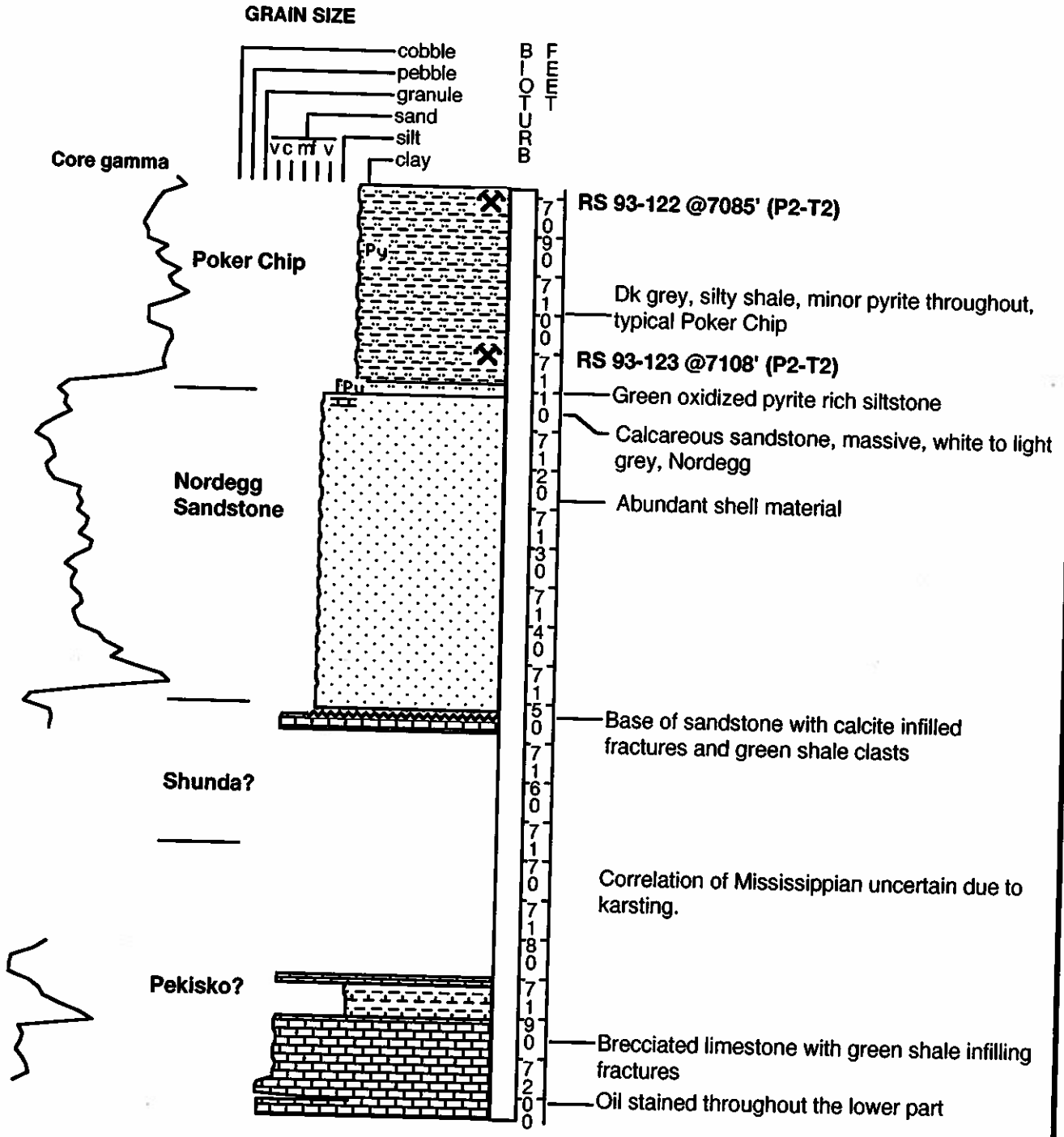



Py
Py
J2
9900
7000
7010
7020
7030
7040
7050
7060
7070
7080
7090
Highly bioturbated to churned, pyrite marks contact, note gamma spike on geophysical log.
Interlaminated green siltstone and vfg sandstone, soft sediment deformation throughout.
Argillaceous sandstone (J3) with kaolinite matrix, green siltstone laminations, minor bioturbation.
Quartzose, very clean, massive, oil saturated J2 sandstone.

HB Unit/Medicine River
6-29-39-3w5

Date logged: January 20, 1993

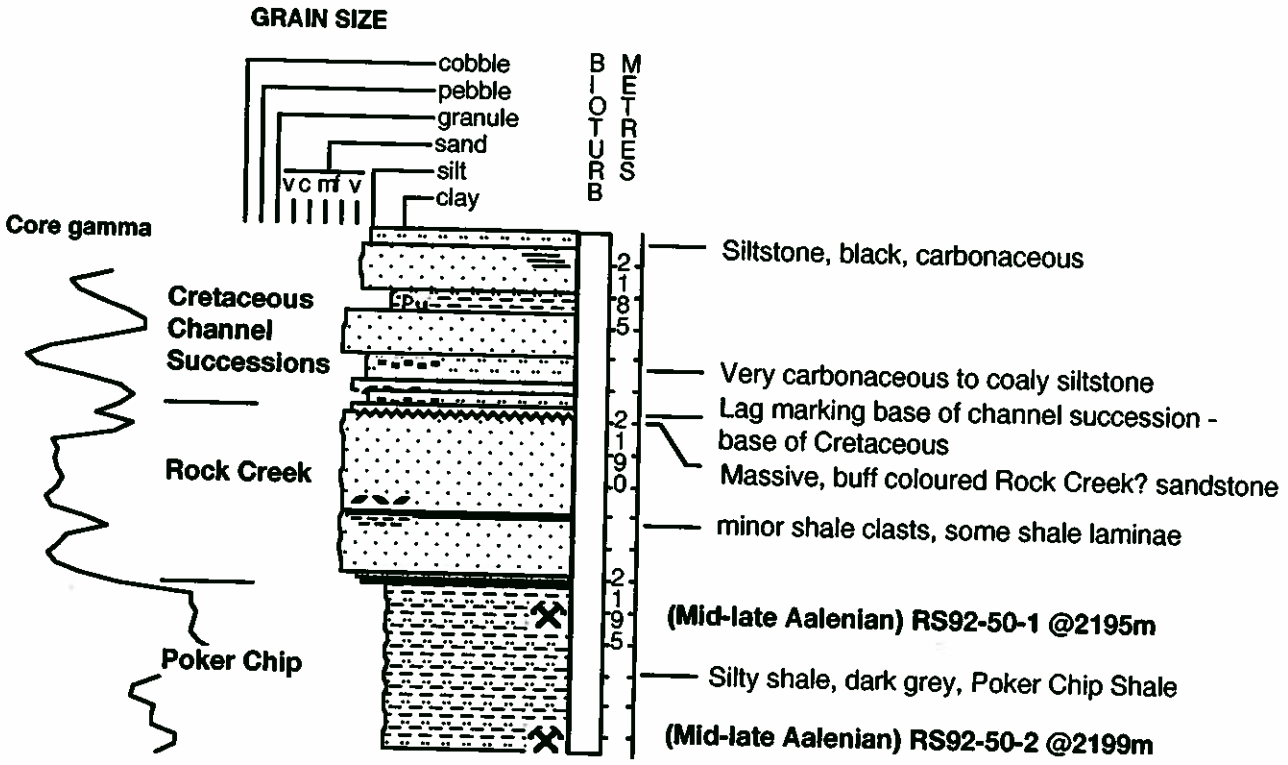
Logged by: Rudy Strobl



Blue Rge et al MedR
12-30-39-3w5

Date logged: October 16, 1992

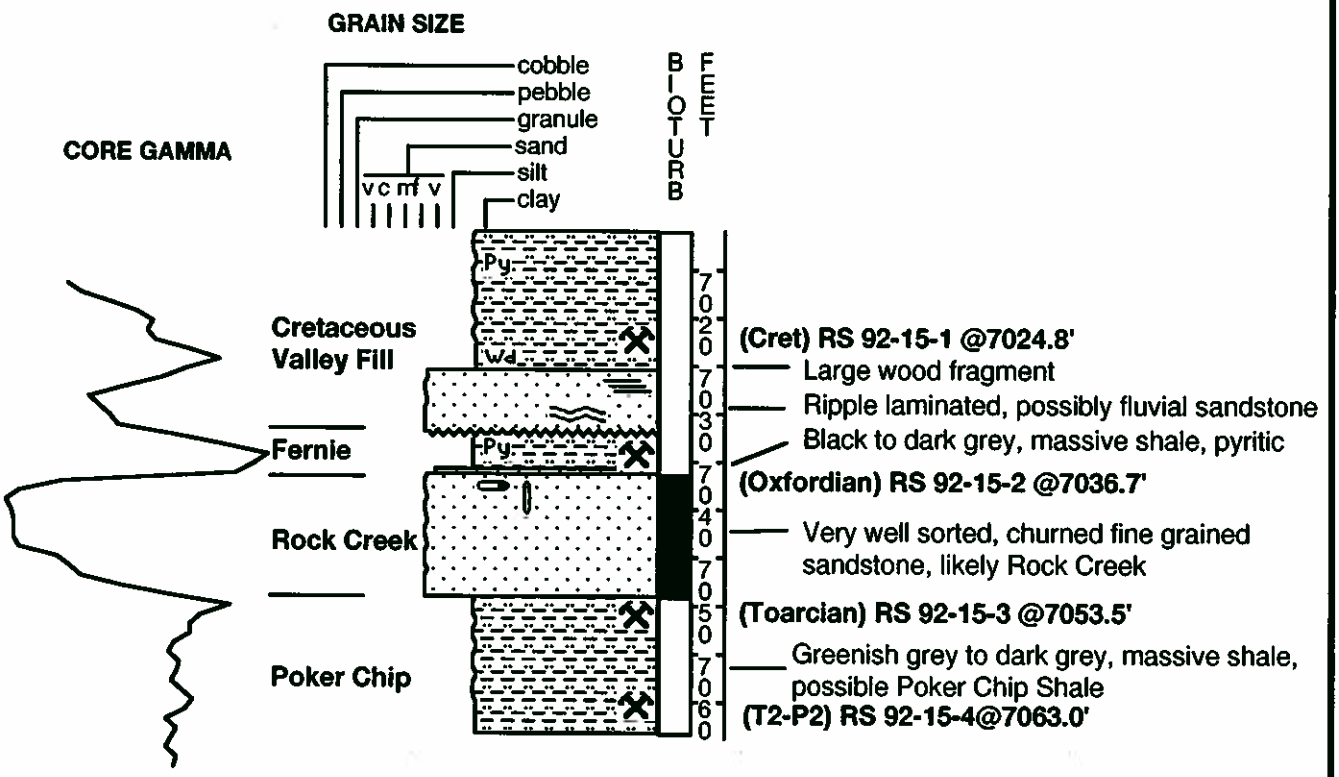
Logged by: Craig Siemens and Rudy Strobl



Brink Med R
16-31-39-3w5

Date logged: July 24, 1992

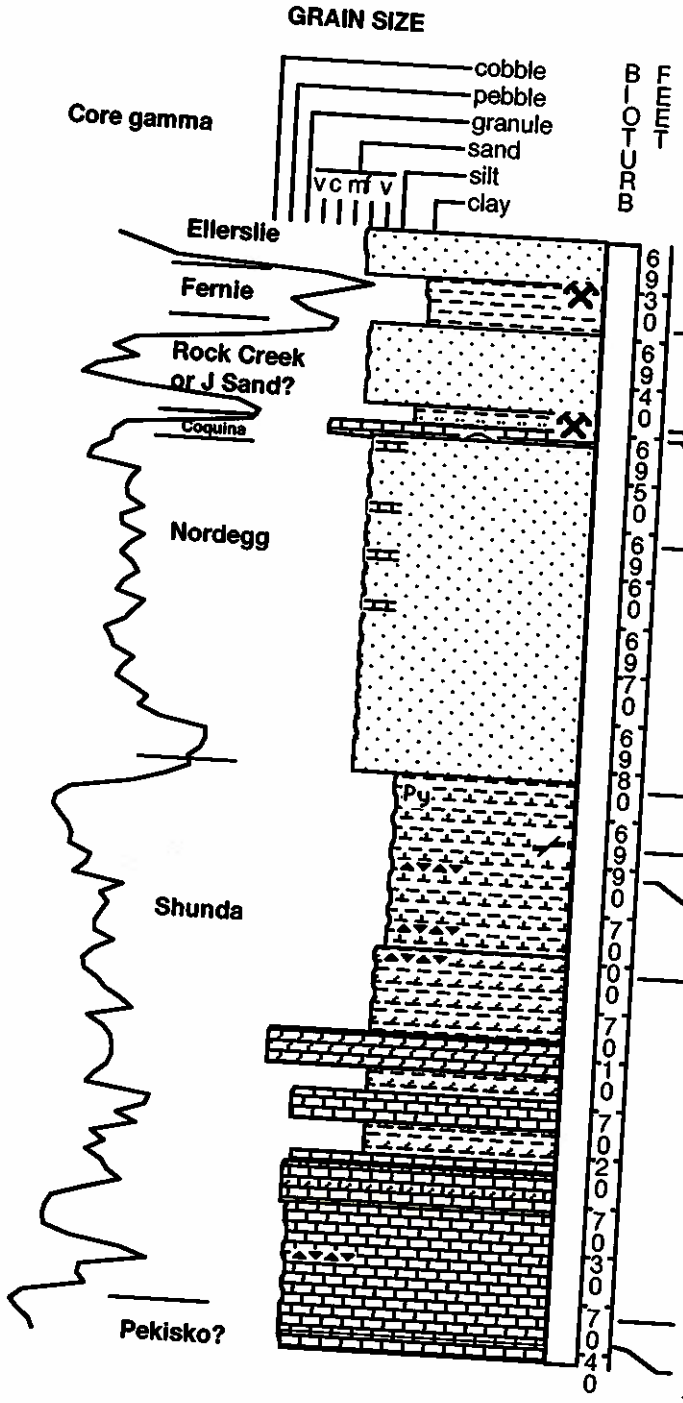
Logged by: Rudy Strobl



ROC Medicine River
16-32-39-3w5

Date logged: April 28, 1993

Logged by: Rudy Strobl



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.

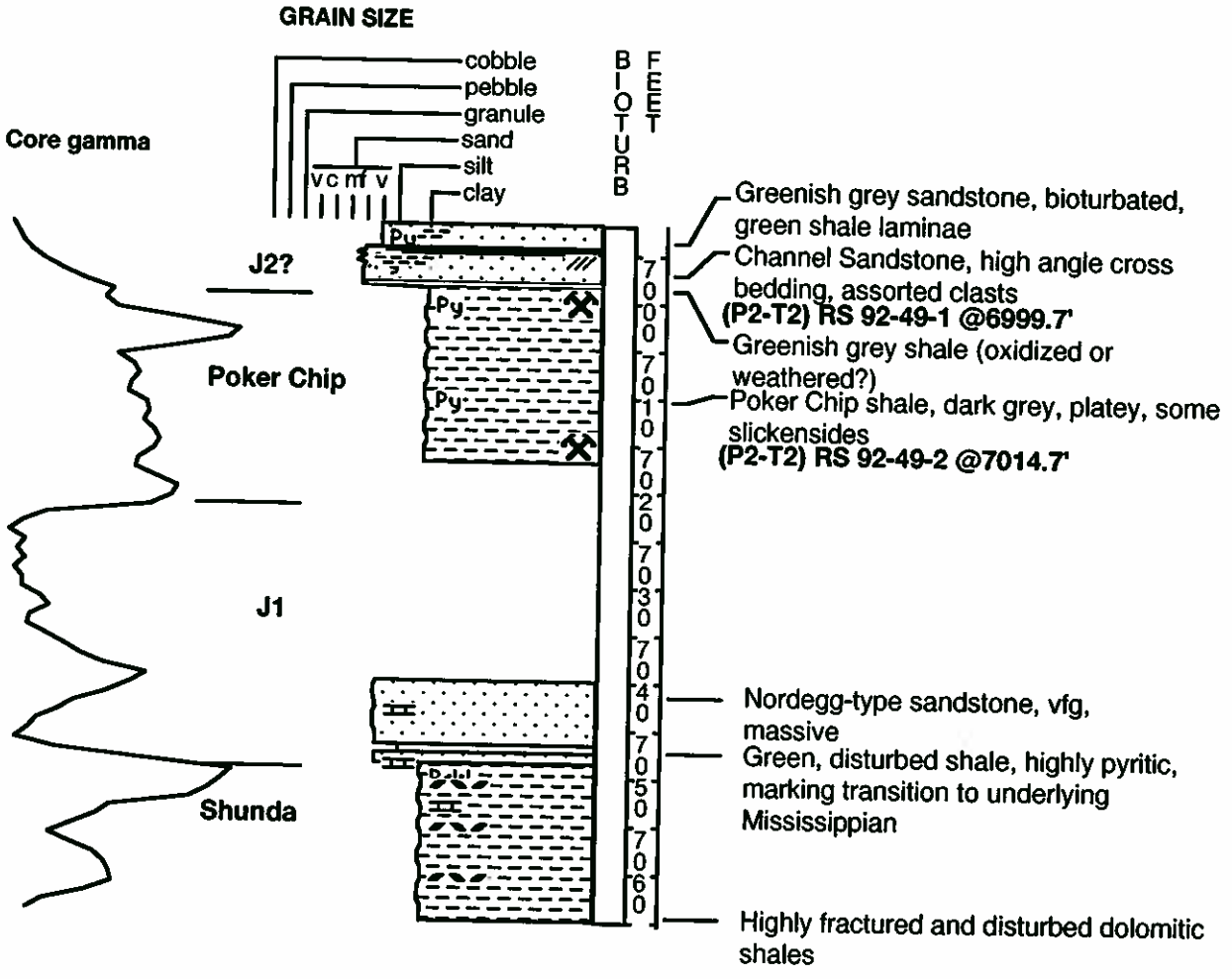
Possible Pekisko contact? Less altered than above.

BA CPR Gay Med R
14-33-39-3w5

Date logged: October 16, 1992

Logged by: Craig Siemens and Rudy Strobl

Remarks: Immediately adjacent to J Valley edge

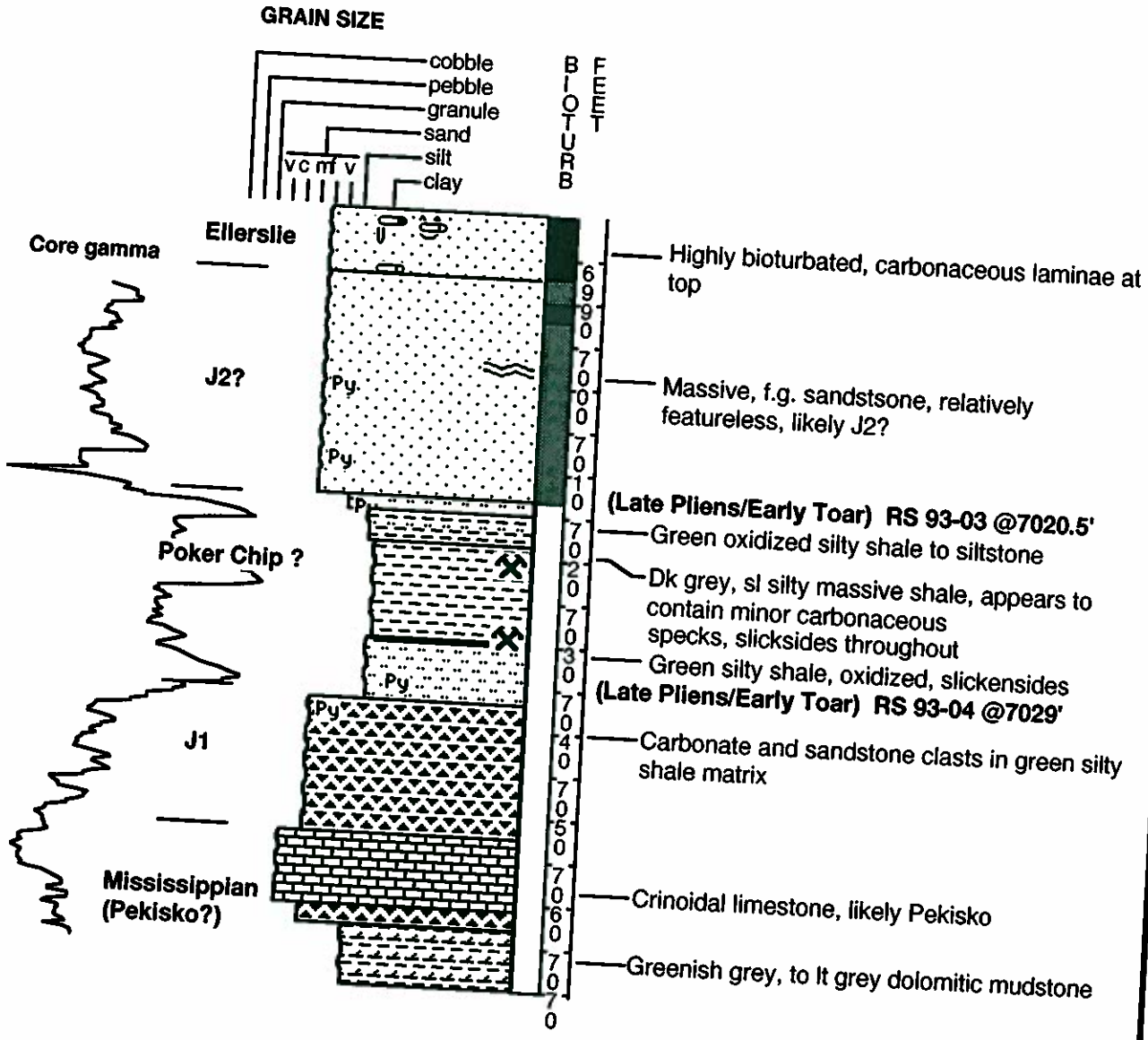


CPOG Med R
4-35-39-3w5

Date logged: January 20, 1993

Logged by: Rudy Strobl

Remarks: Eastern edge of J-Valley

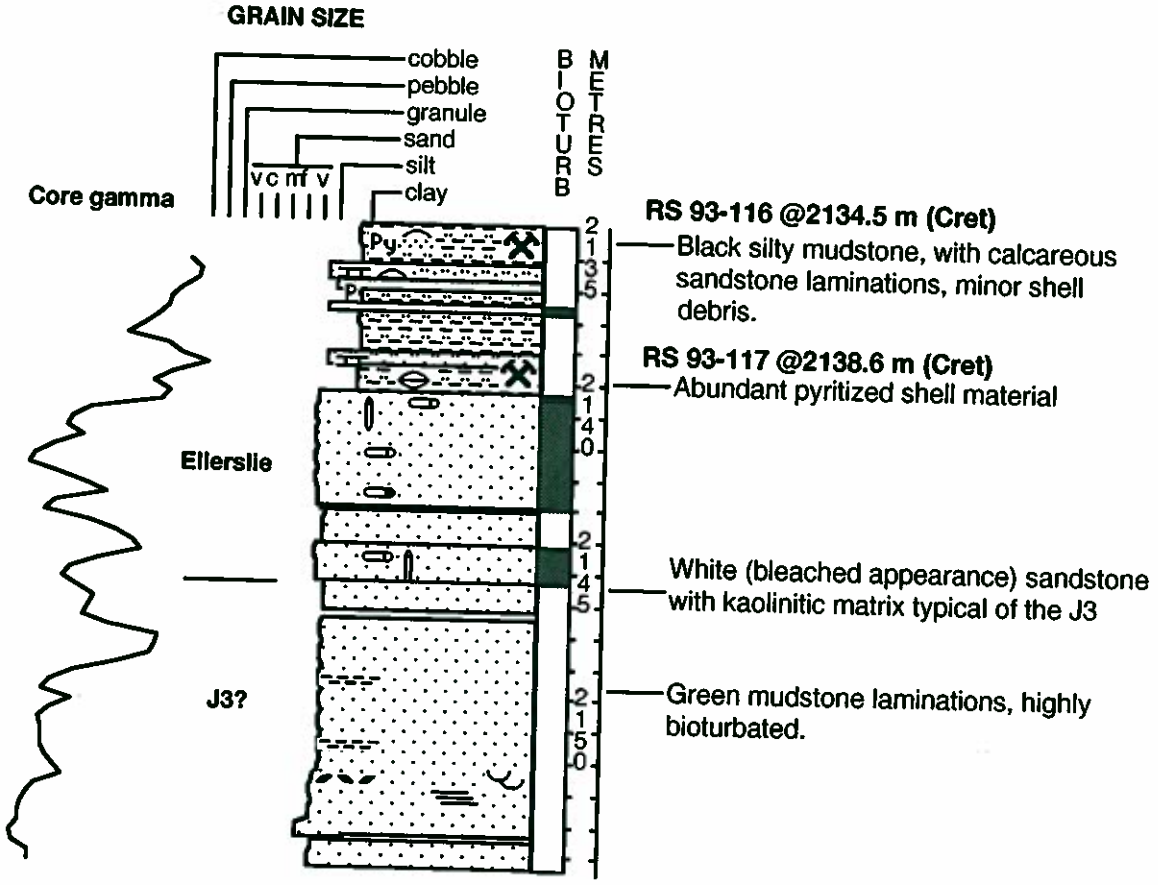


Sabine et al. Gilby
6-36-39-3w5

Date logged: May 7, 1993

Logged by: Rudy Strobl

Remarks: Well to evaluate proposed eastern extension of J Valley.
Possible ledge containing J3 sandstone.

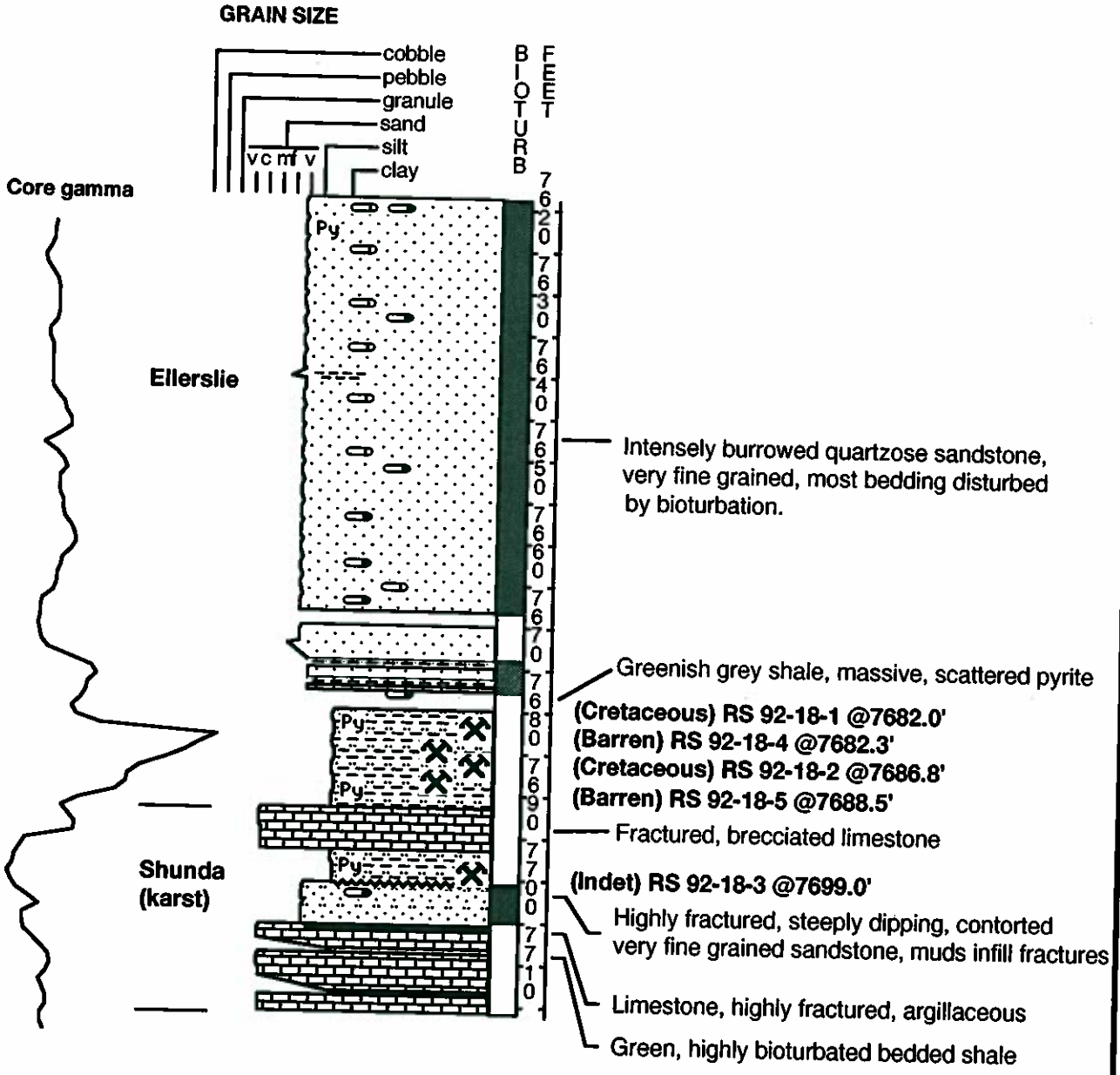


Taurus Murphy Condor
10-6-39-4w5

Date logged: July 29, 1992

Logged by: Rudy Strobl

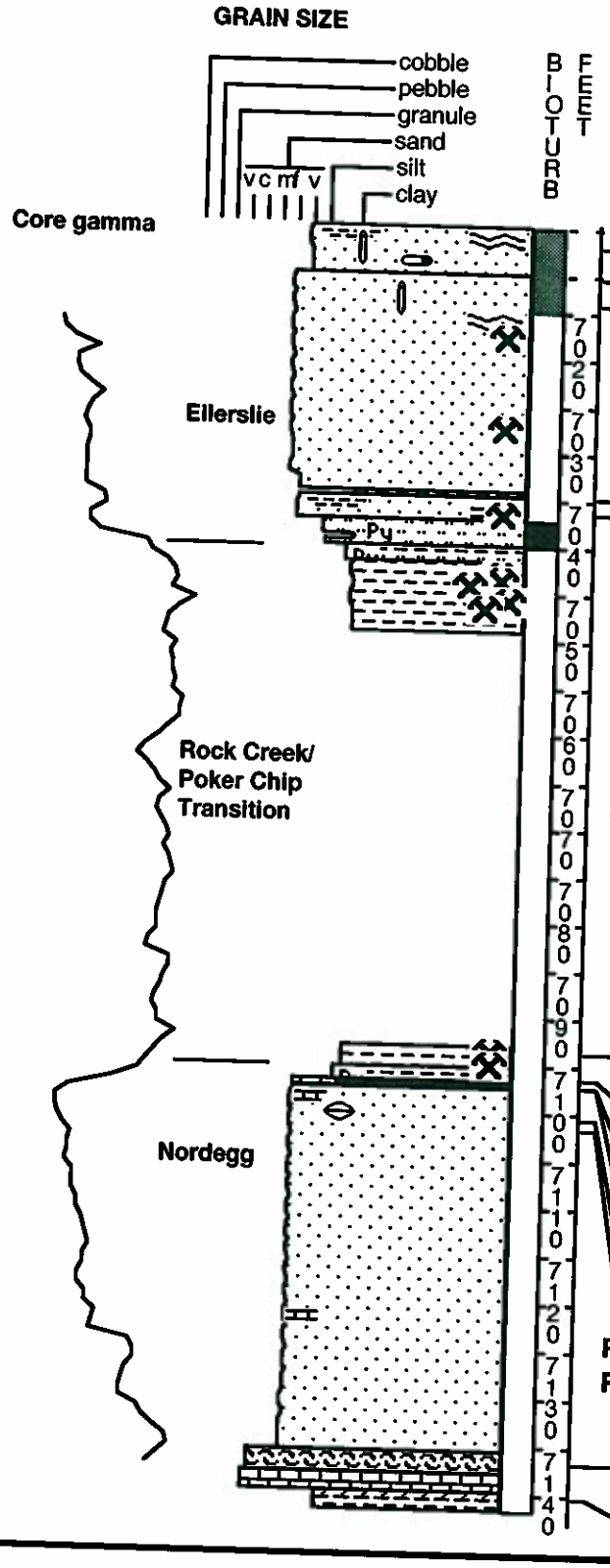
Remarks: Channellized well? (possibly reworked Rock CreeK?)
Has been resampled to confirm.



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)

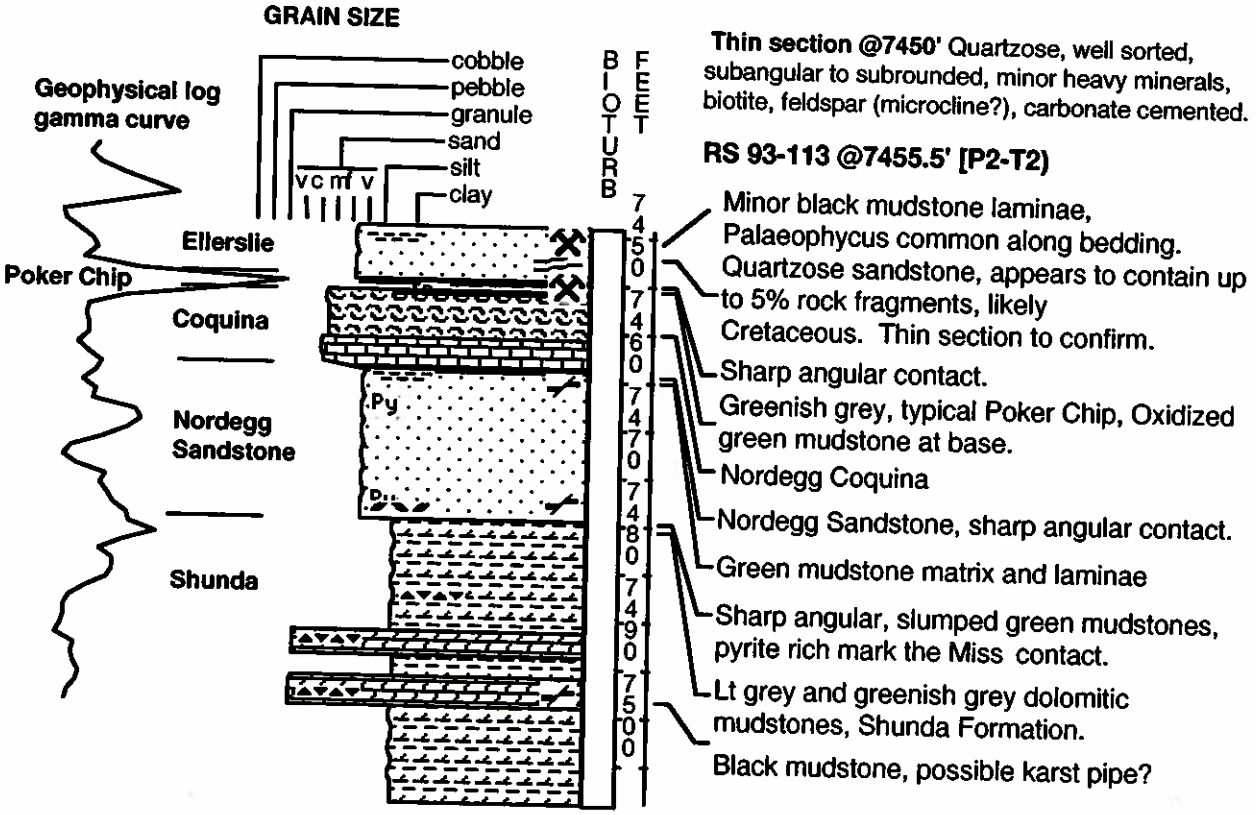
Nordegg Limestone/Coquina (not common at this level)

Grey dolomitic mudstone typical of Shunda

H.B. Home Med R
10-19-39-4w5

Date logged: May 12, 1993

Logged by: Rudy Strobl



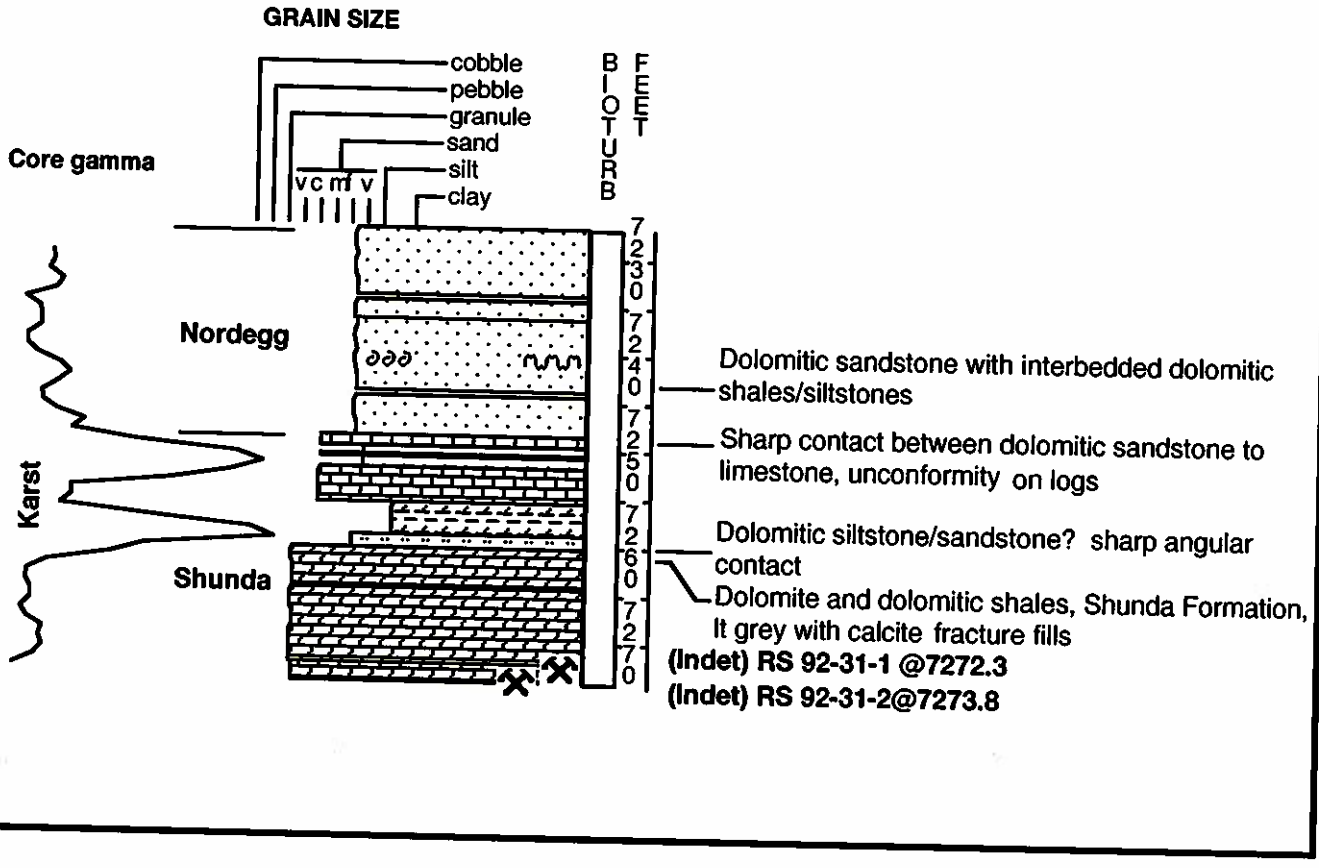
Brink Dea et al

2-24-39-4w5

Date logged: October 9, 1992

Logged by: Rudy Strobl

Remarks: Nordegg /Shunda interval. Control well to test paly applications for Jur/Miss picks

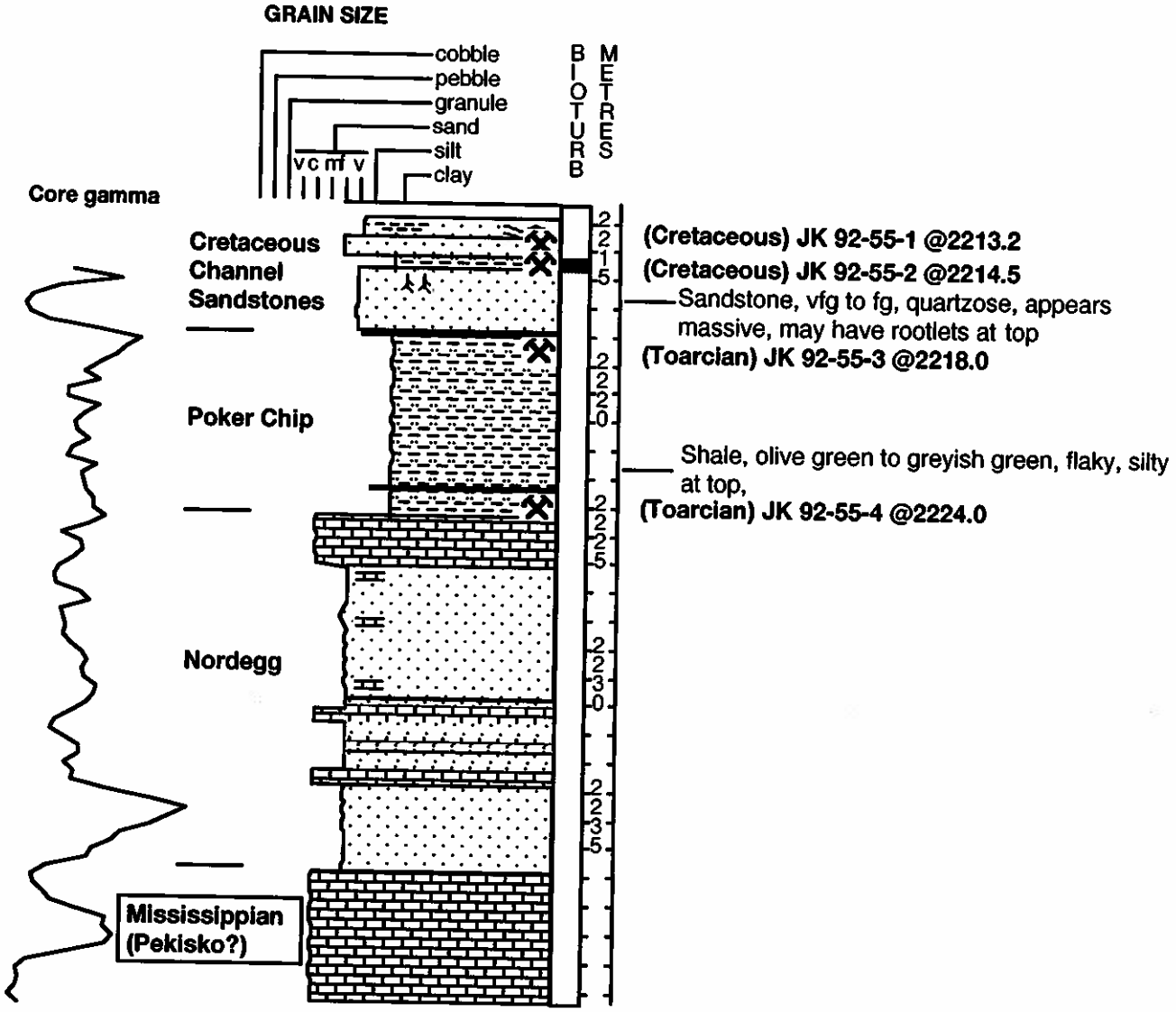


Suncor MedR 8-24
8-24-39-4w5

Date logged: March 11, 1992

Logged by: John Kramers

Remarks: Converted to AppleCore by RS November 10, 1992.

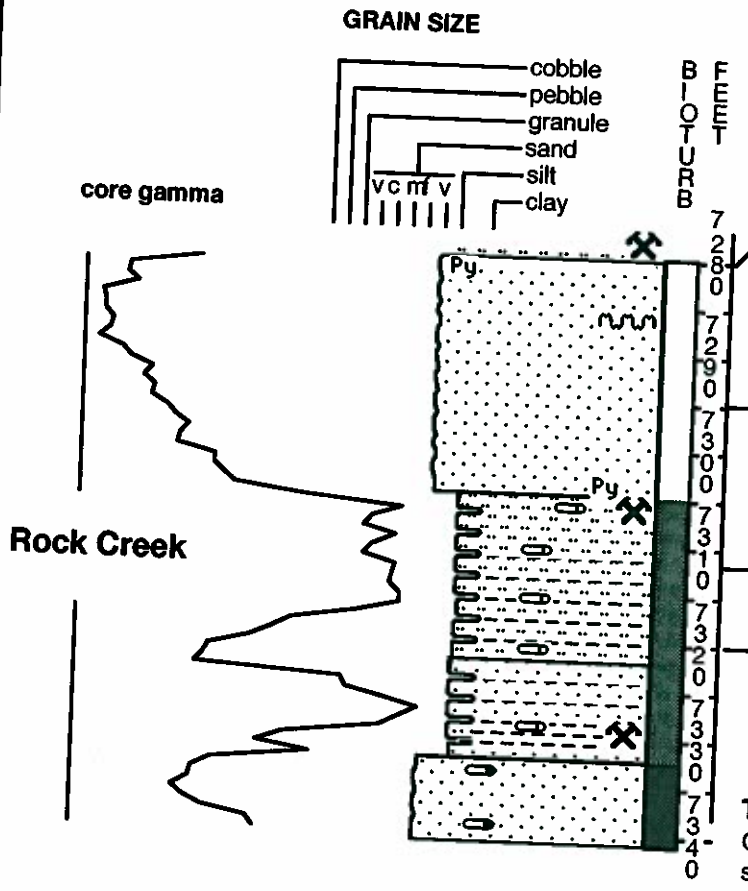


Brink Ashland Med R
10-35-39-4w5

Date logged: July 24, 1992

Logged by: Rudy Strobl

Remarks: Reexamined and resampled May 12th. Good well to view the transitional Rock Creek mudstones.



(Oxfordian) RS 93-118 @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'

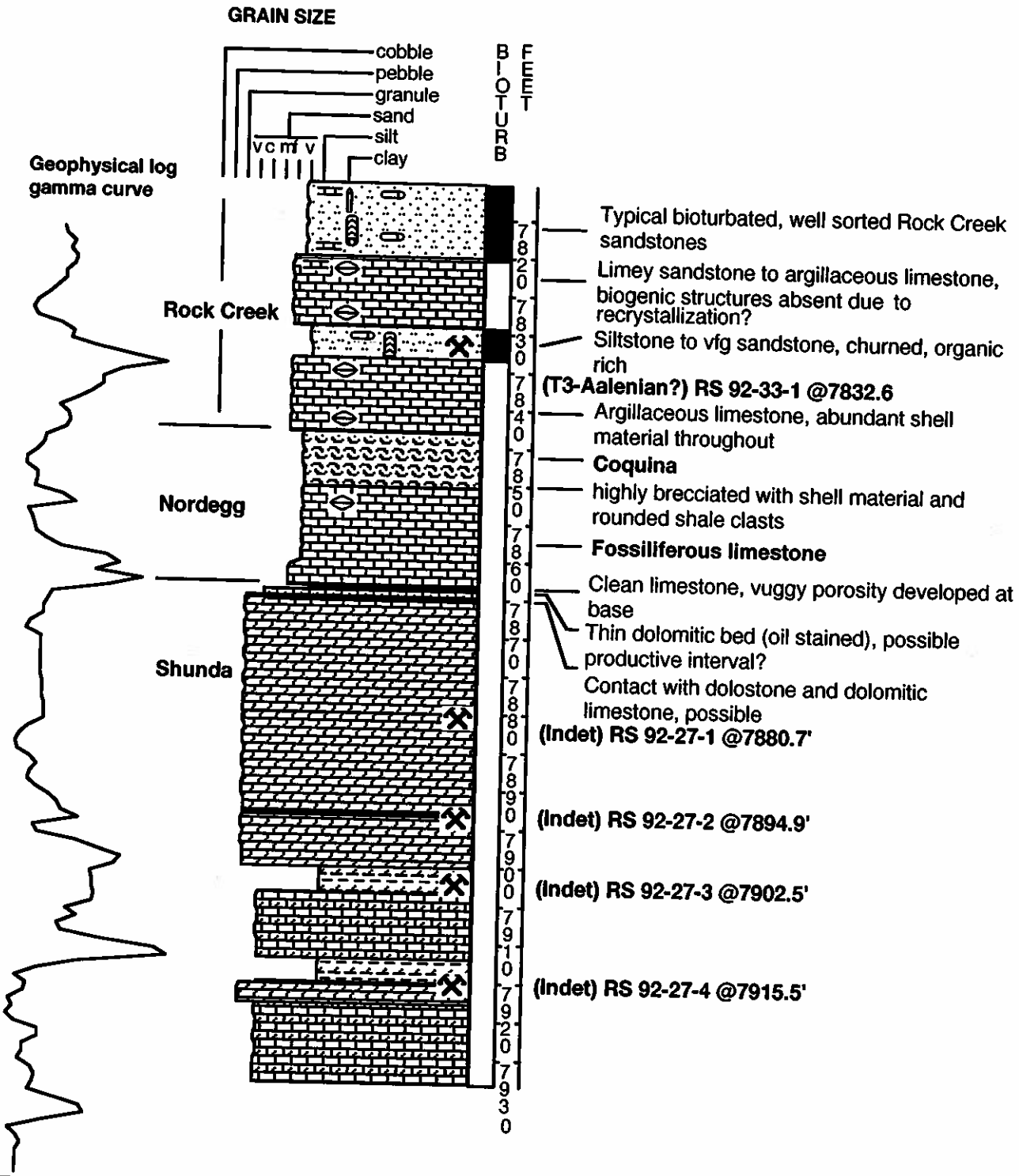
Thin section @7333'
Quartzose, poorly sorted, subangular to subrounded, pyrite banding, minor heavy minerals, carbonate cemented.

CPOG Mobil
12-11-39-5w5

Date logged: October 6, 1992

Logged by: Rudy Strobl

Remarks: Rock Creek, Poker Chip absent, and Bioclastic limestones of the Nordegg

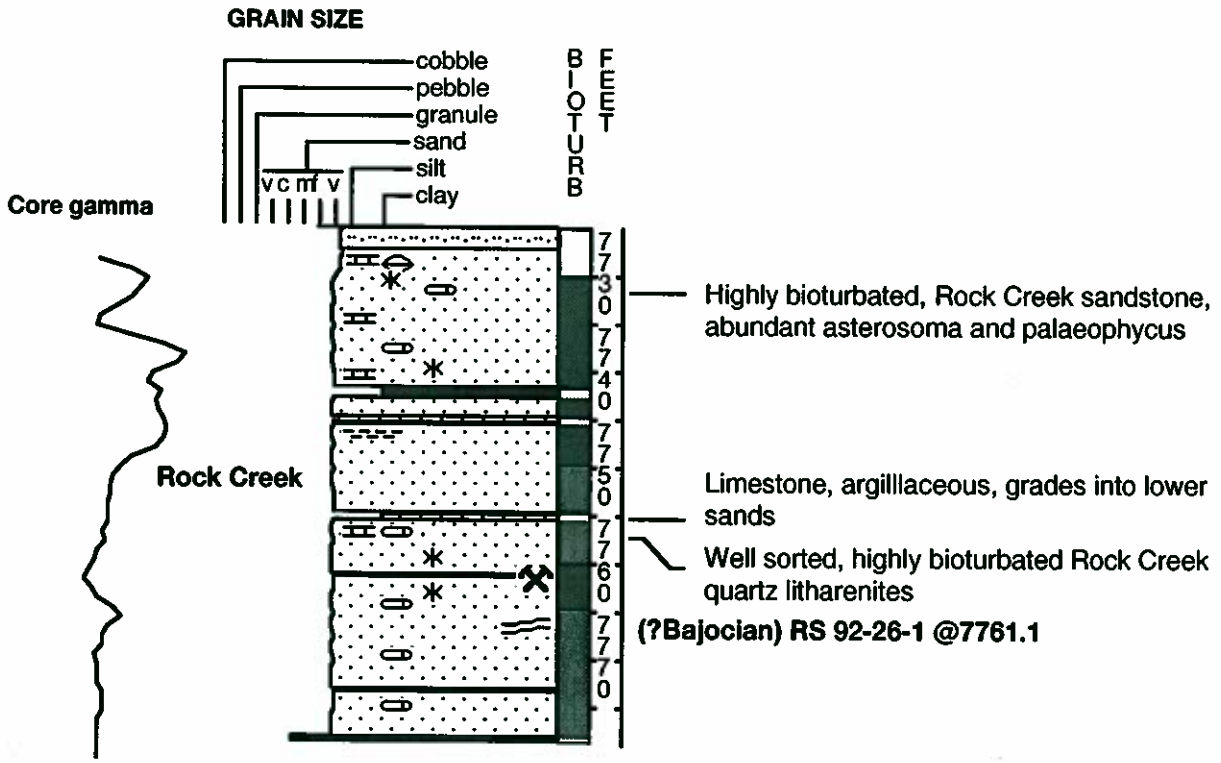


Murphy Leafland
16-16-39-5w5

Date logged: October 6, 1992

Logged by: Rudy Strobl

Remarks: Rock Creek Sandstone

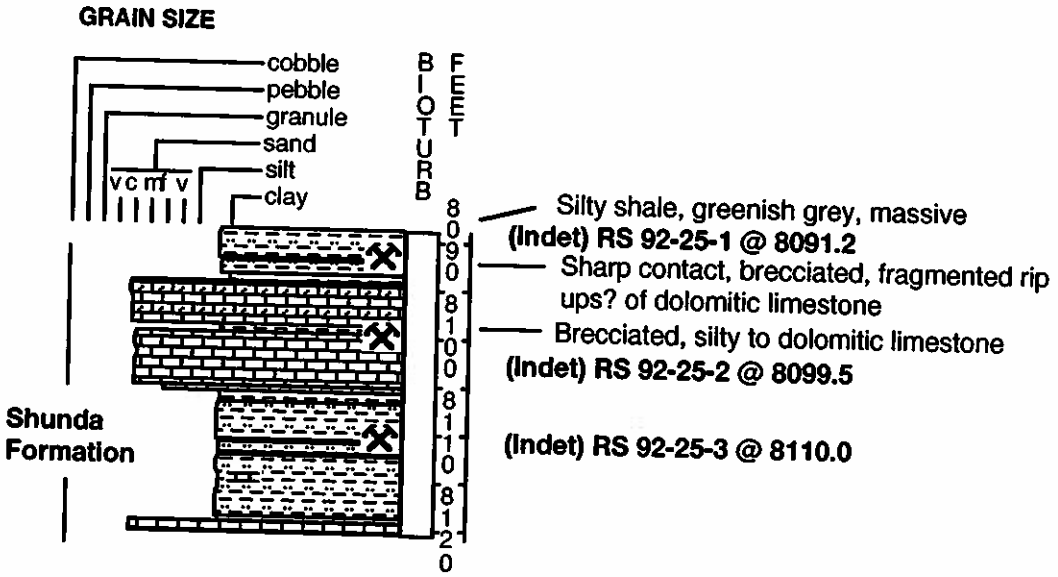


Mobil WillGR
4-19-39-5w5

Date logged: October 5, 1992

Logged by: Rudy Strobl

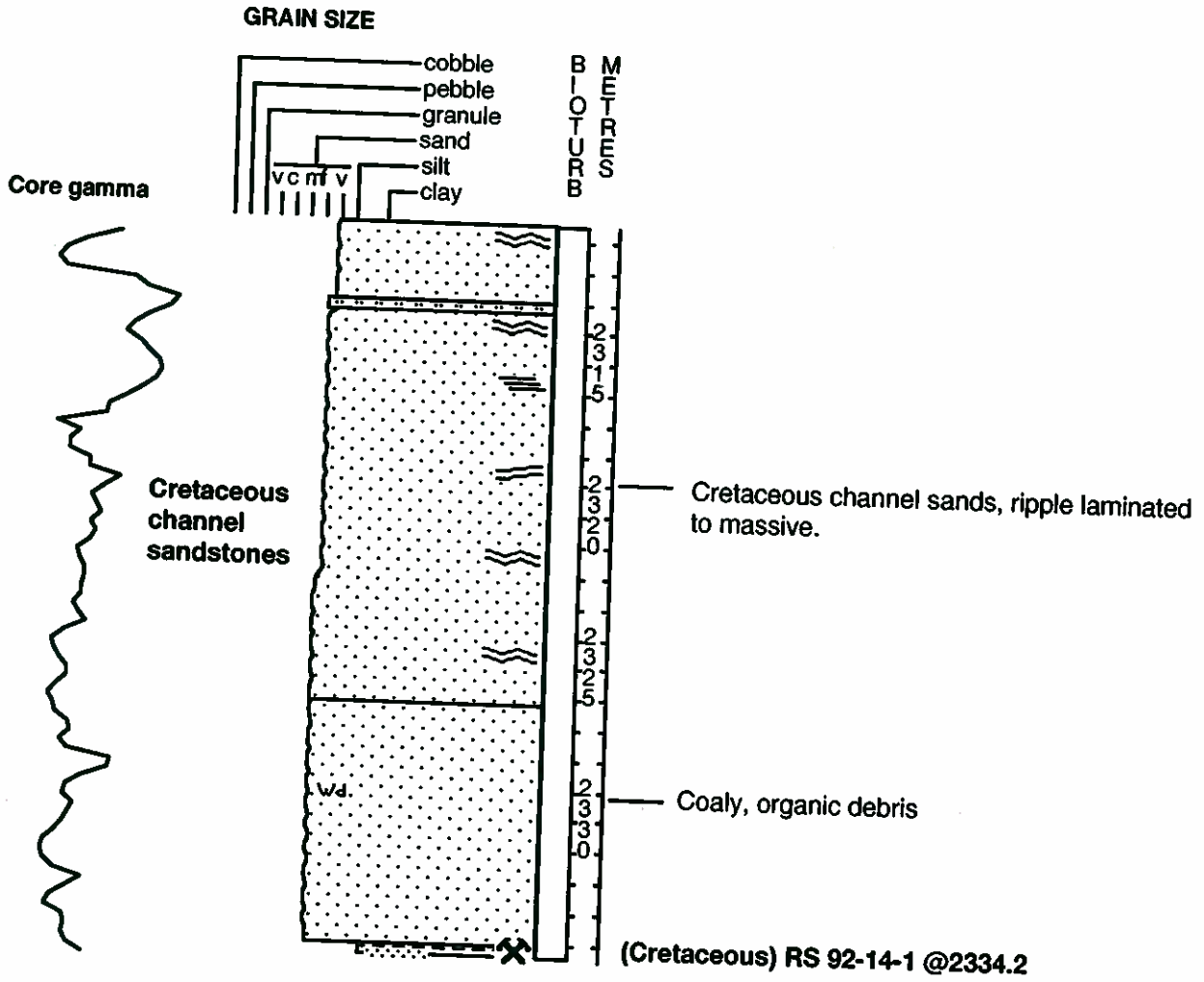
Remarks: 2nd and part of 3rd succession of Shunda Fm.



Dekalb et al Will Gr
10-21-39-5w5

Date logged: July 24, 1992

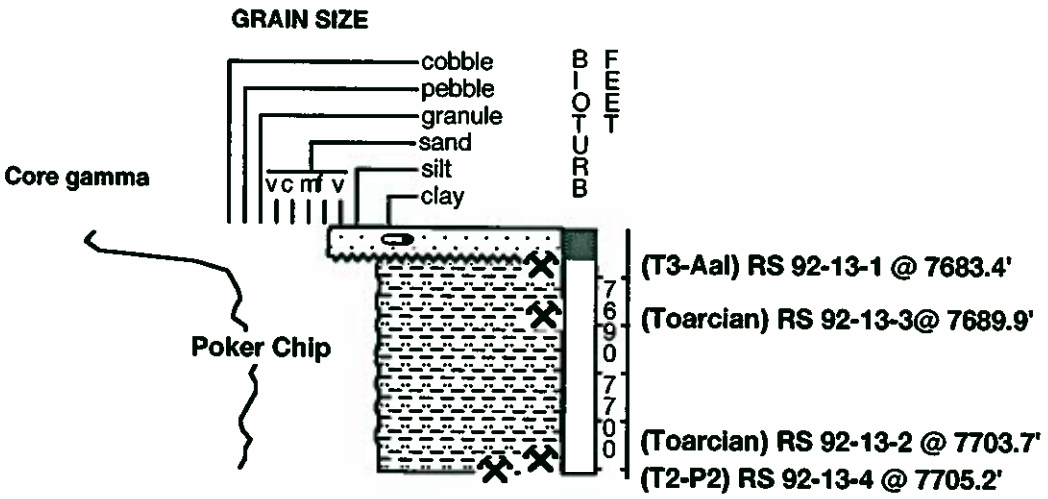
Logged by: Rudy Strobl



White Rose Leafland
6-23-39-5w5

Date logged: July 24, 1992

Logged by: Rudy Strobl

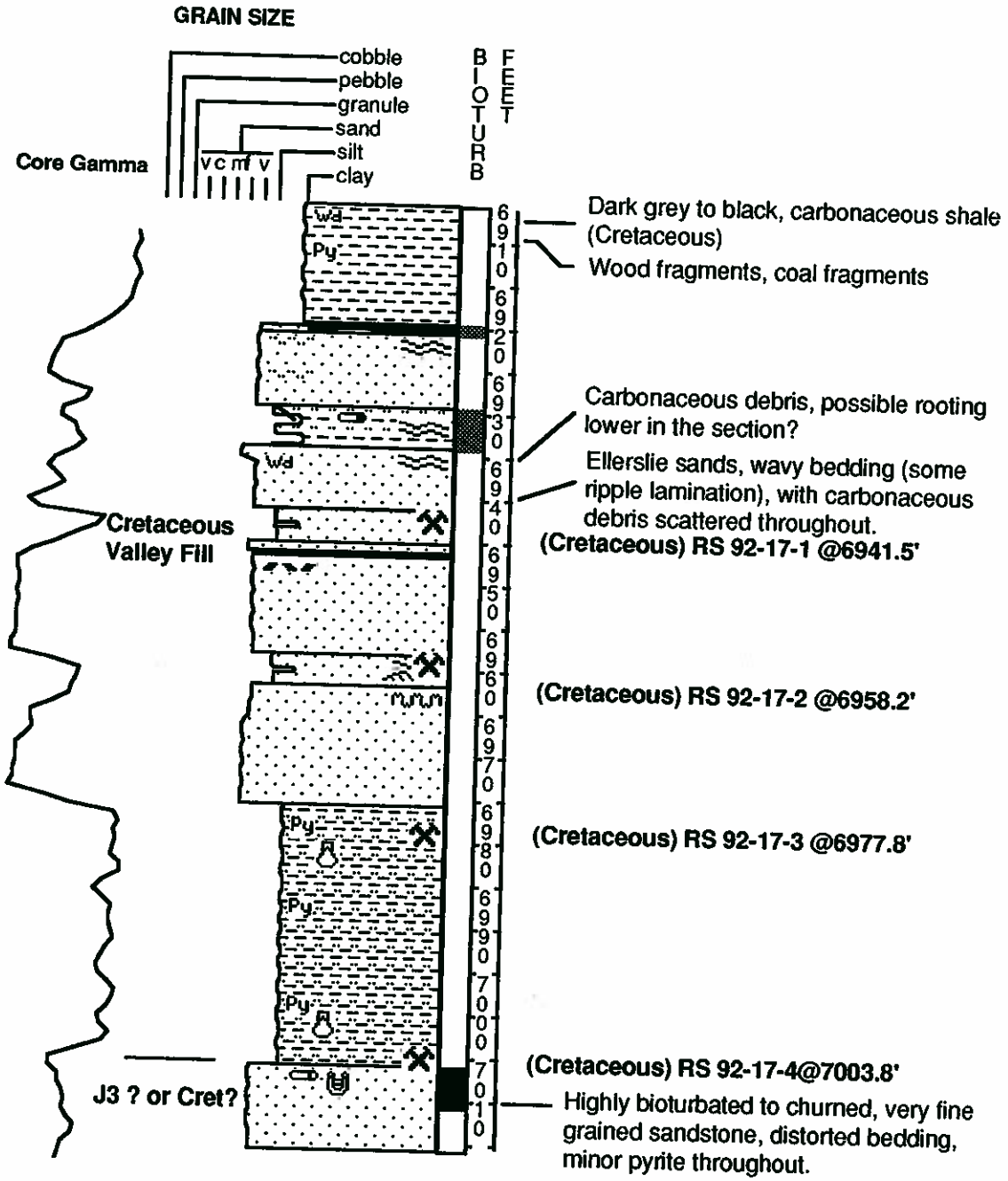


Hud Bay Richfield Eckville
10-2-40-3w5

Date logged: July 29, 1992

Logged by: Rudy Strobl

Remarks: Located along the eastern edge of the J valley
Thick shale sections for sampling.

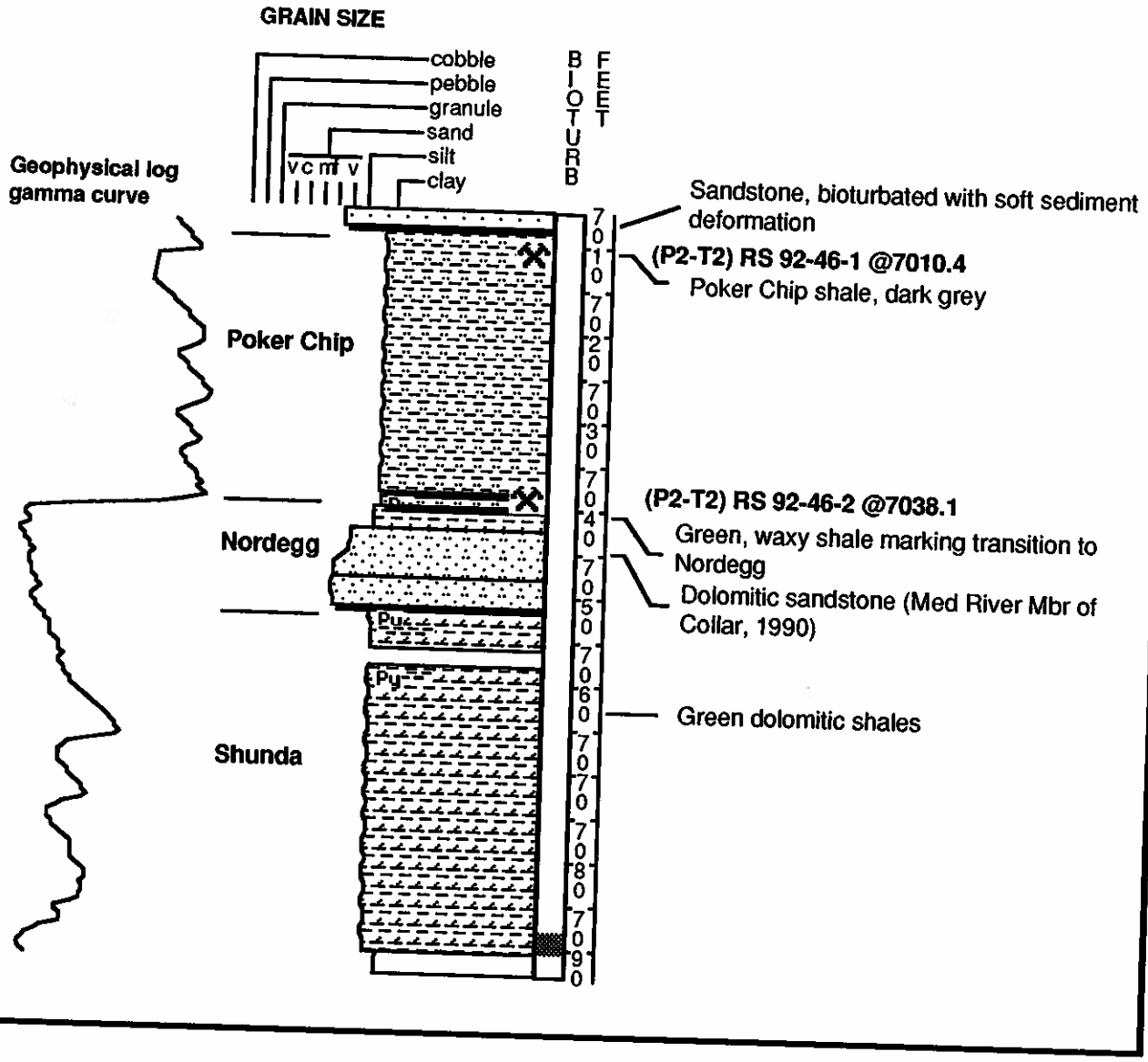


Brink Medicine River
4-5-40-3w5

Date logged: October 15, 1992

Logged by: Craig Siemens and Rudy Strobl

Remarks: Nordegg Producer immediately west of J Valley

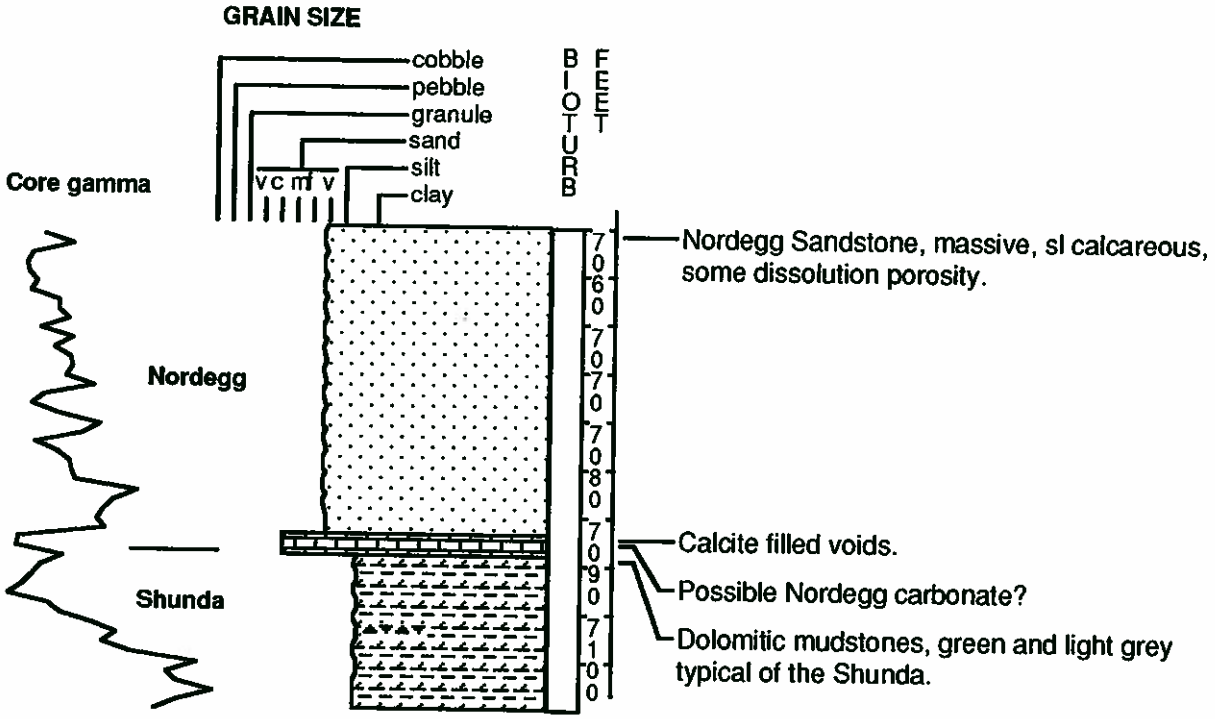


HB Medicine River
4-8-40-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

Remarks: Limestone at base of Nordegg Sandstone.

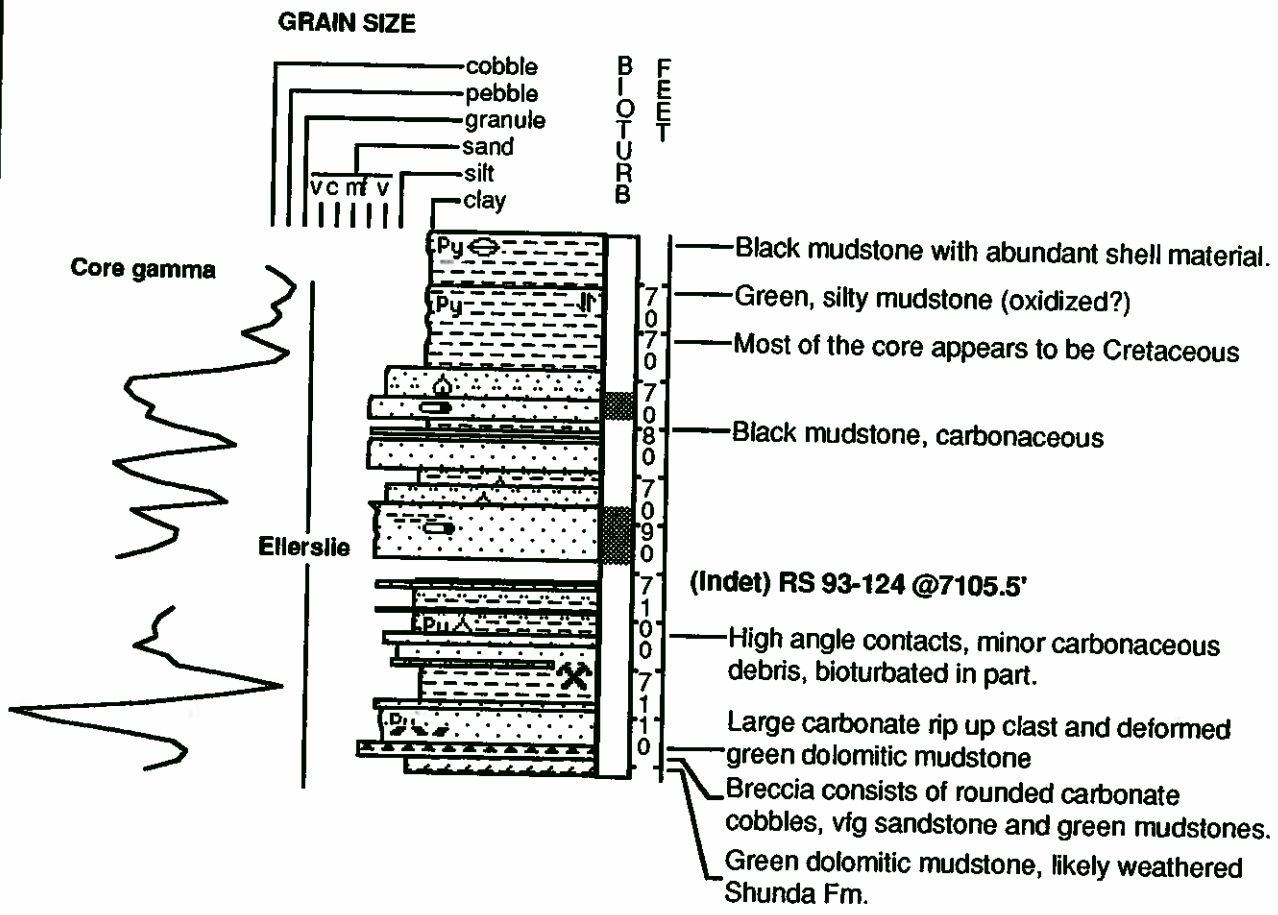


Uno Tex Eckville Med R
12-08-40-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

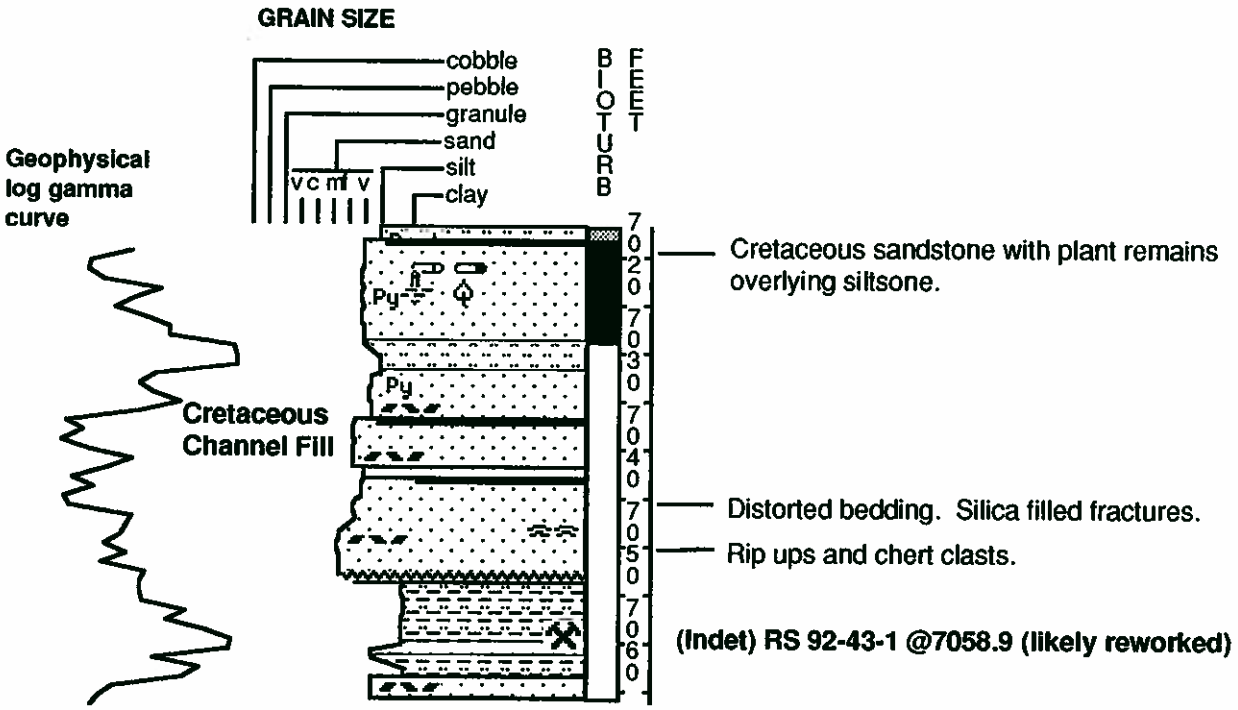
Remarks: Anomalous well. Deeply incised Cret valley fill?



Cox et al Gilby
6-15-40-3w5

Date logged: October 14, 1992

Logged by: Rudy Strobl, Craig Siemens

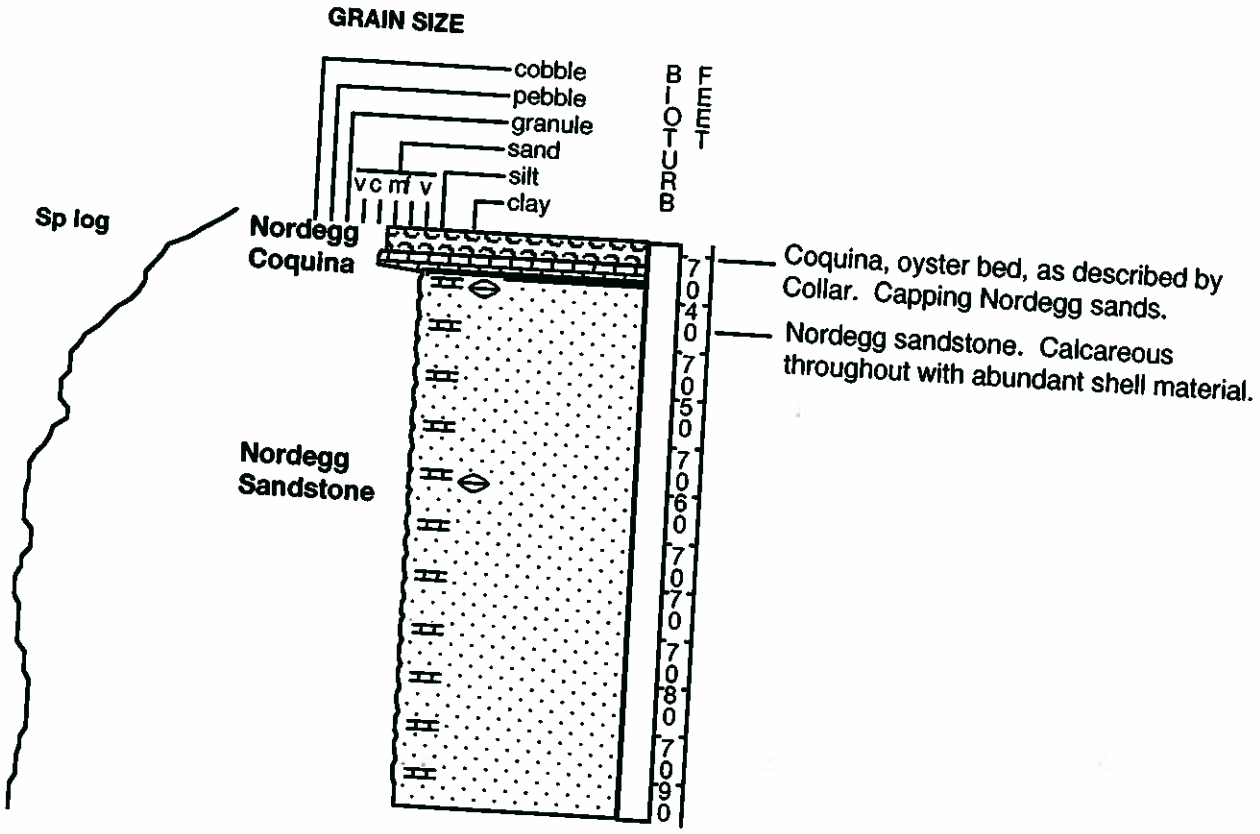


A.P.C.O. Dryland Gilby
10-19-40-3w5

Date logged: October 14, 1992

Logged by: Rudy Strobl, Craig Siemens

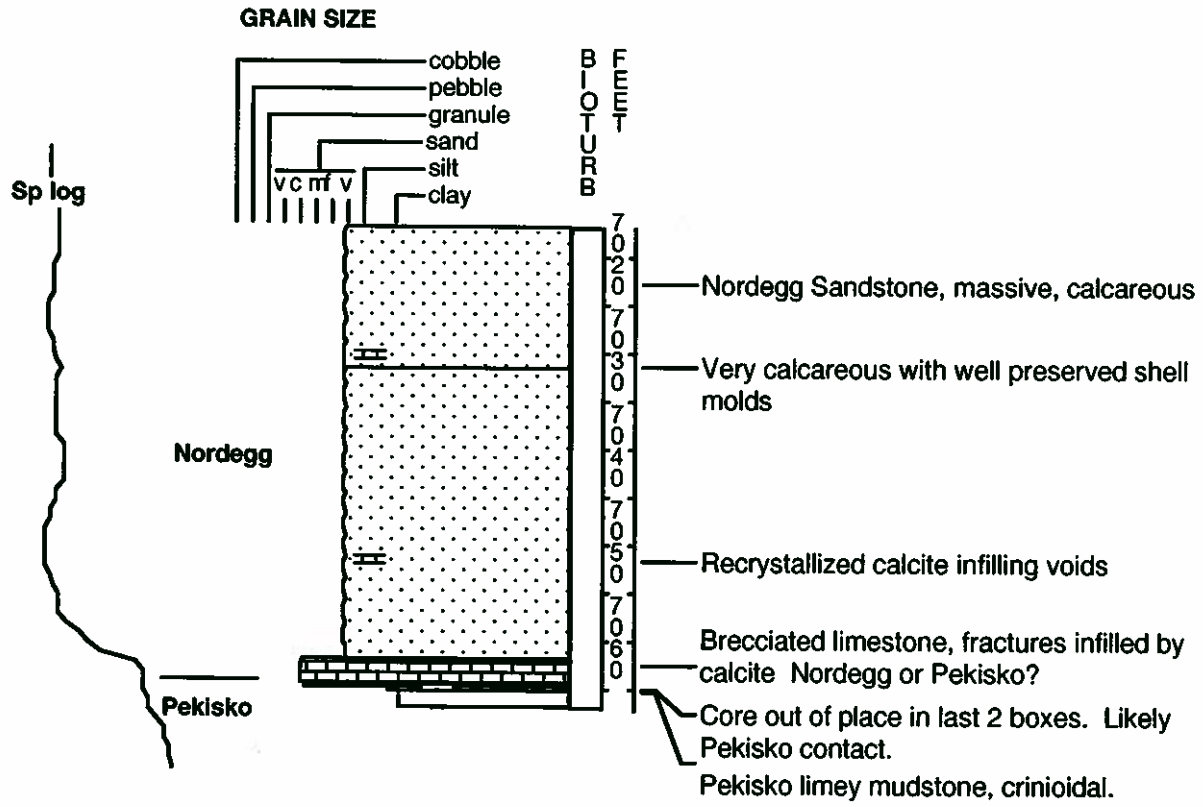
Remarks: Type section for Nordegg Coquina and calcareous to dolomitic sandstone in the Medicine River area.



Uno Tex Gilby
16-19-40-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

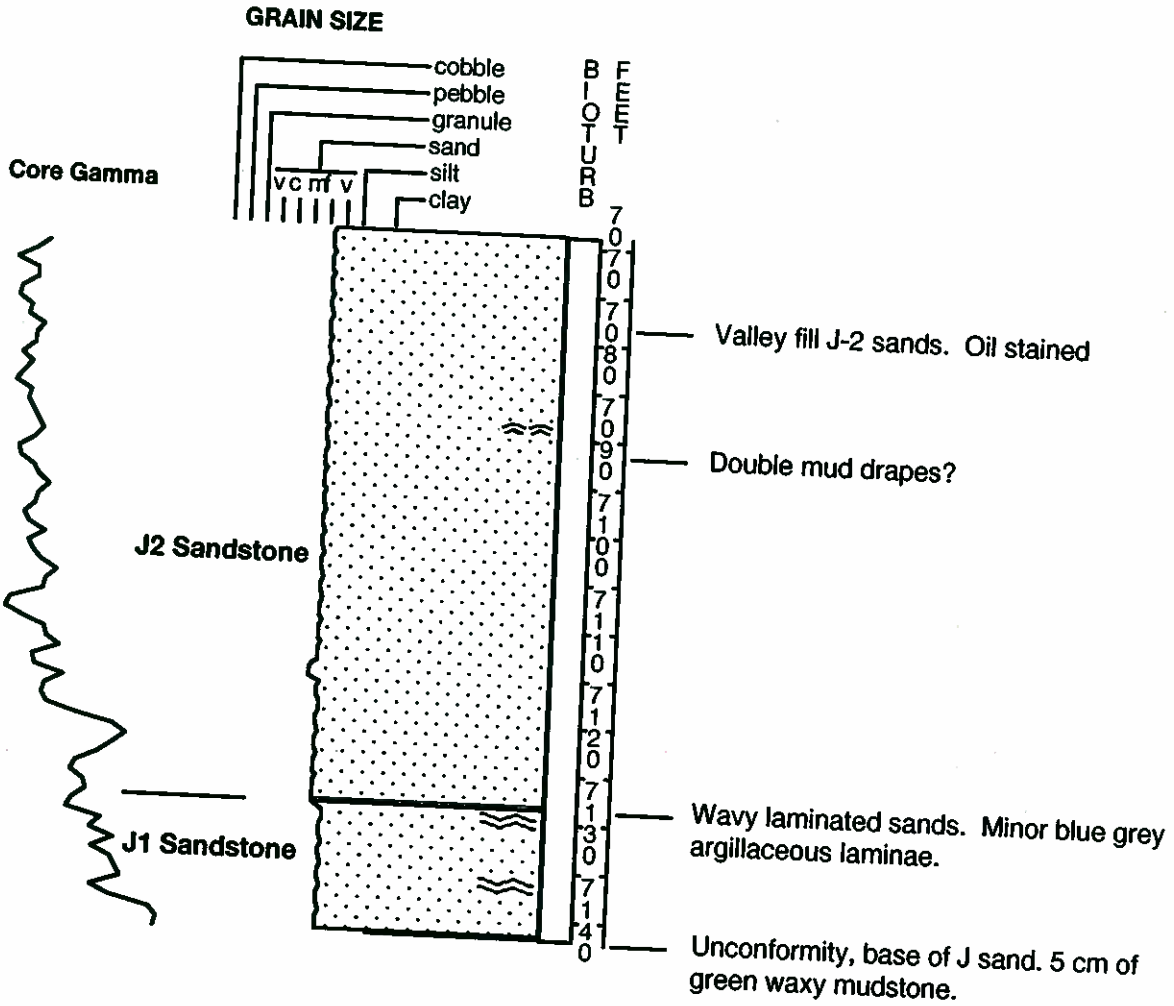


C.P.O.G. Gilby
14-21-40-3w5

Date logged: October 14, 1992

Logged by: Rudy Strobl, Craig Siemens

Remarks: J2 Sandstone within main J-Valley

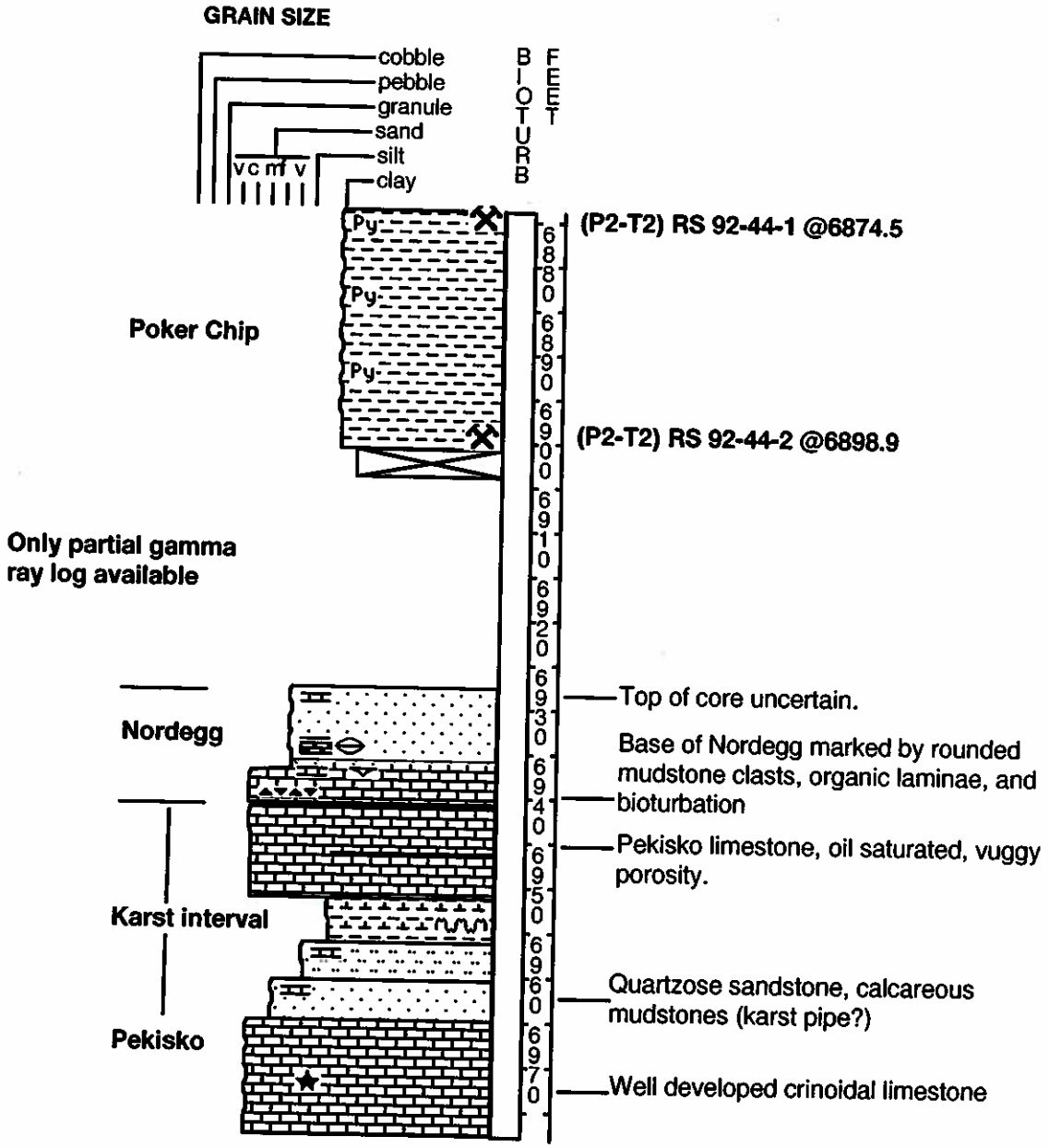


Fina et al Gilby
7- 27-40-3w5

Date logged: October 15, 1992

Logged by: Rudy Strobl, Craig Siemens

Remarks: East of J valley. Nordegg outlier.

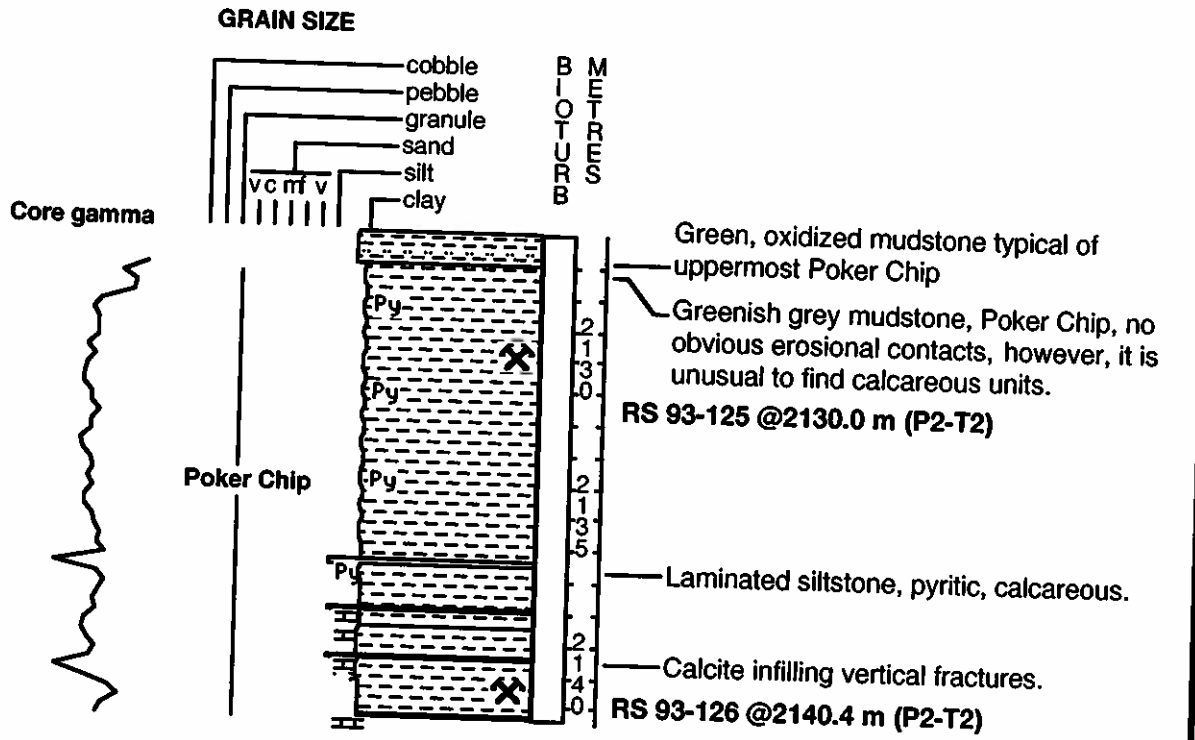


PCP Gilby
12-27-40-3w5

Date logged: May 14, 1993

Logged by: Rudy Strobl

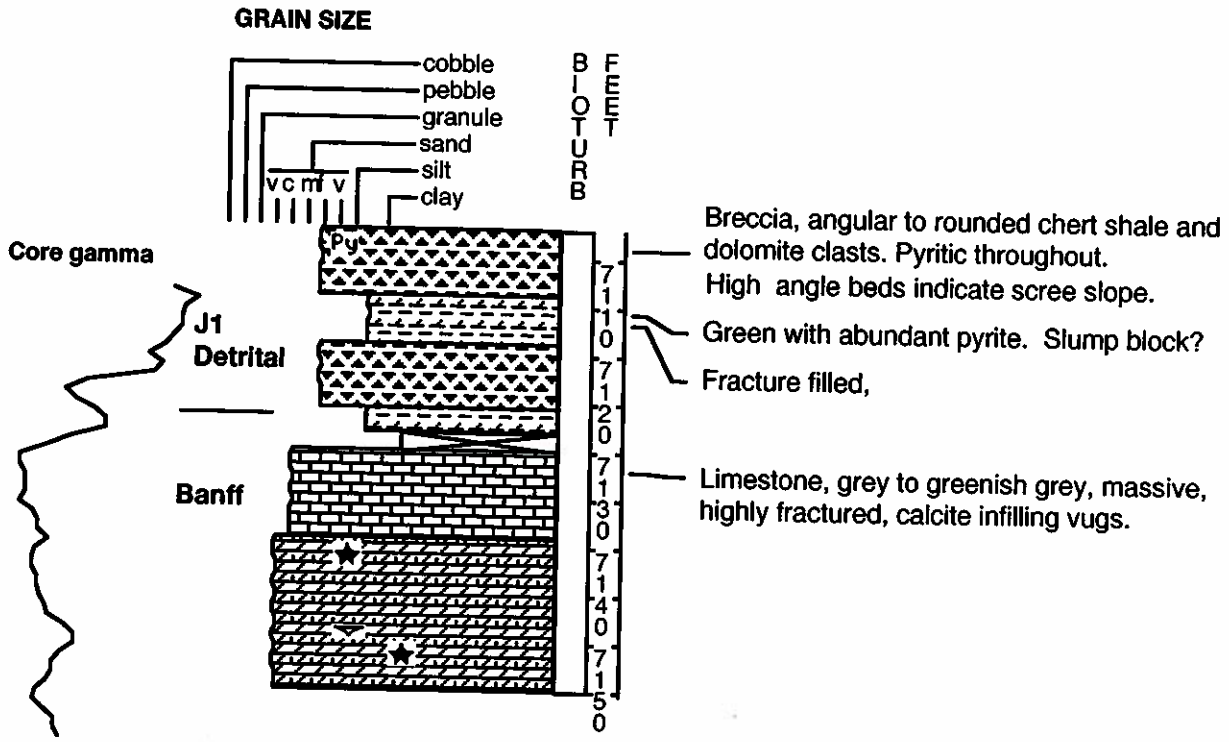
Remarks: Overthickened Poker Chip just inside J-Valley edge. Describe to interpret if muds are authigenic or allogenic. Sample top and base for paly.



Can Seaboard Gilby
10-28-40-3w5

Date logged: October 14, 1992

Logged by: Rudy Strobl, Craig Siemens

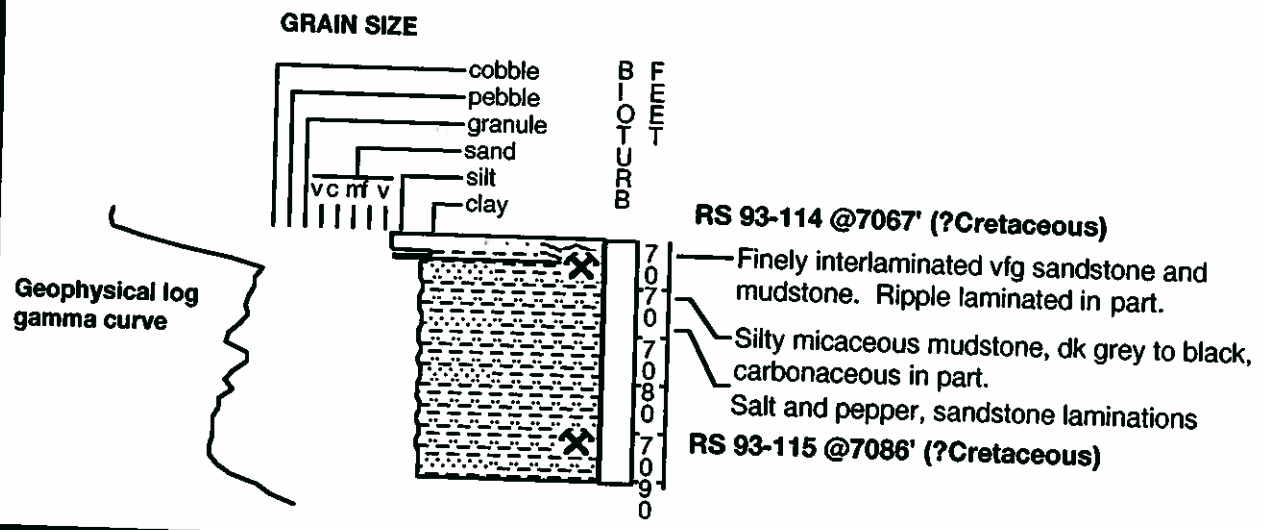


Can Seabd et al Gilby
12-28-40-3w5

Date logged: May 7, 1993

Logged by: Rudy Strobl

Remarks: High resistivity mudstone marking the Cretaceous in Twp 40 Range 3 W5. Good marker in the J-Valley, commonly present. Paly to confirm age.

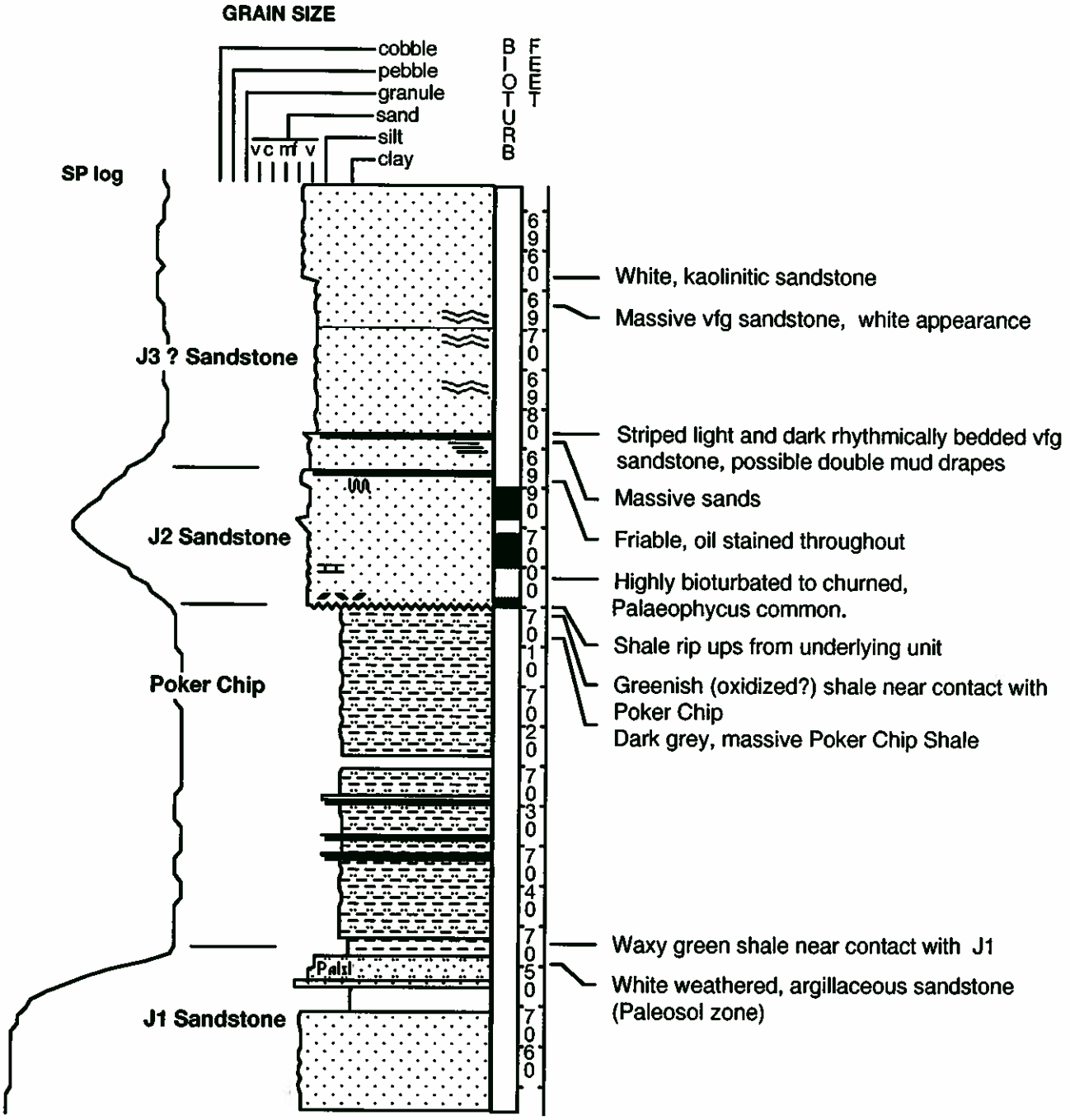


Tex Gilby PEX
3-29-40-3w5

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.

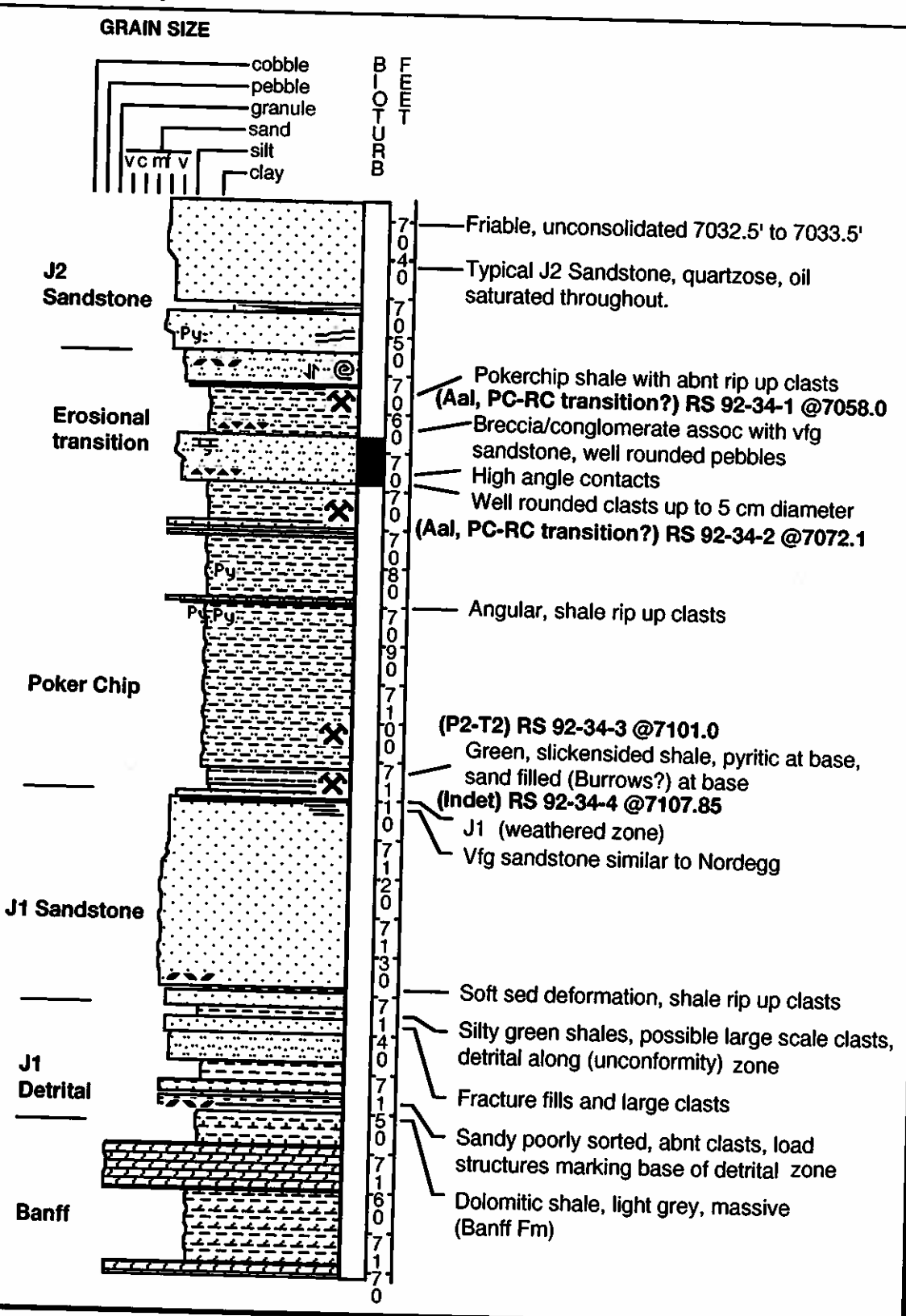


Richfield Gabriel Lake
7-29-40-3w5

Date logged: October 13, 1992

Logged by: Rudy Strobl

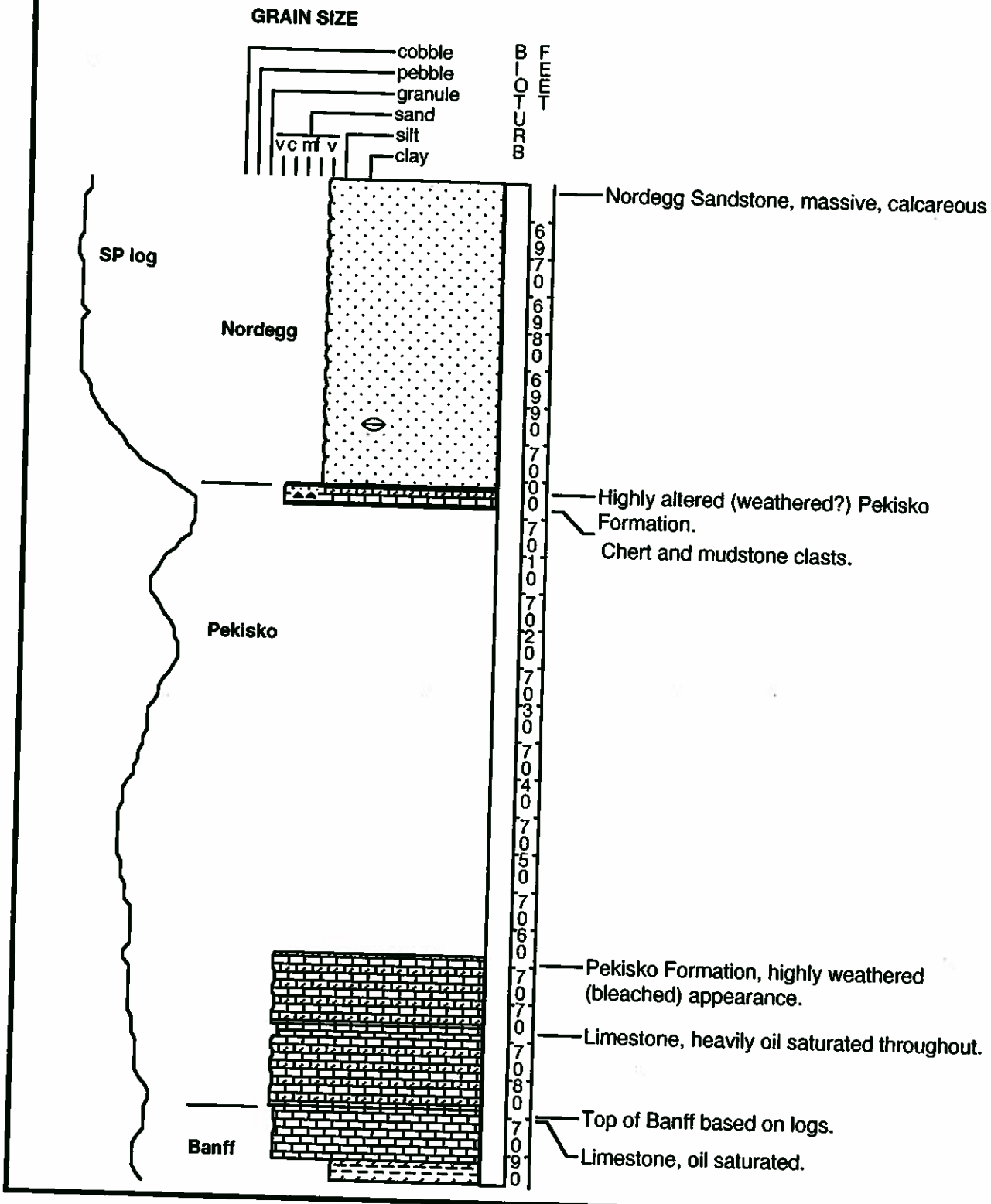
Remarks: J-Valley fill.



RO Corp Gilby 13-29 MU
13-29-40-3w5

Date logged: May 13, 1993

Logged by: Rudy Strobl

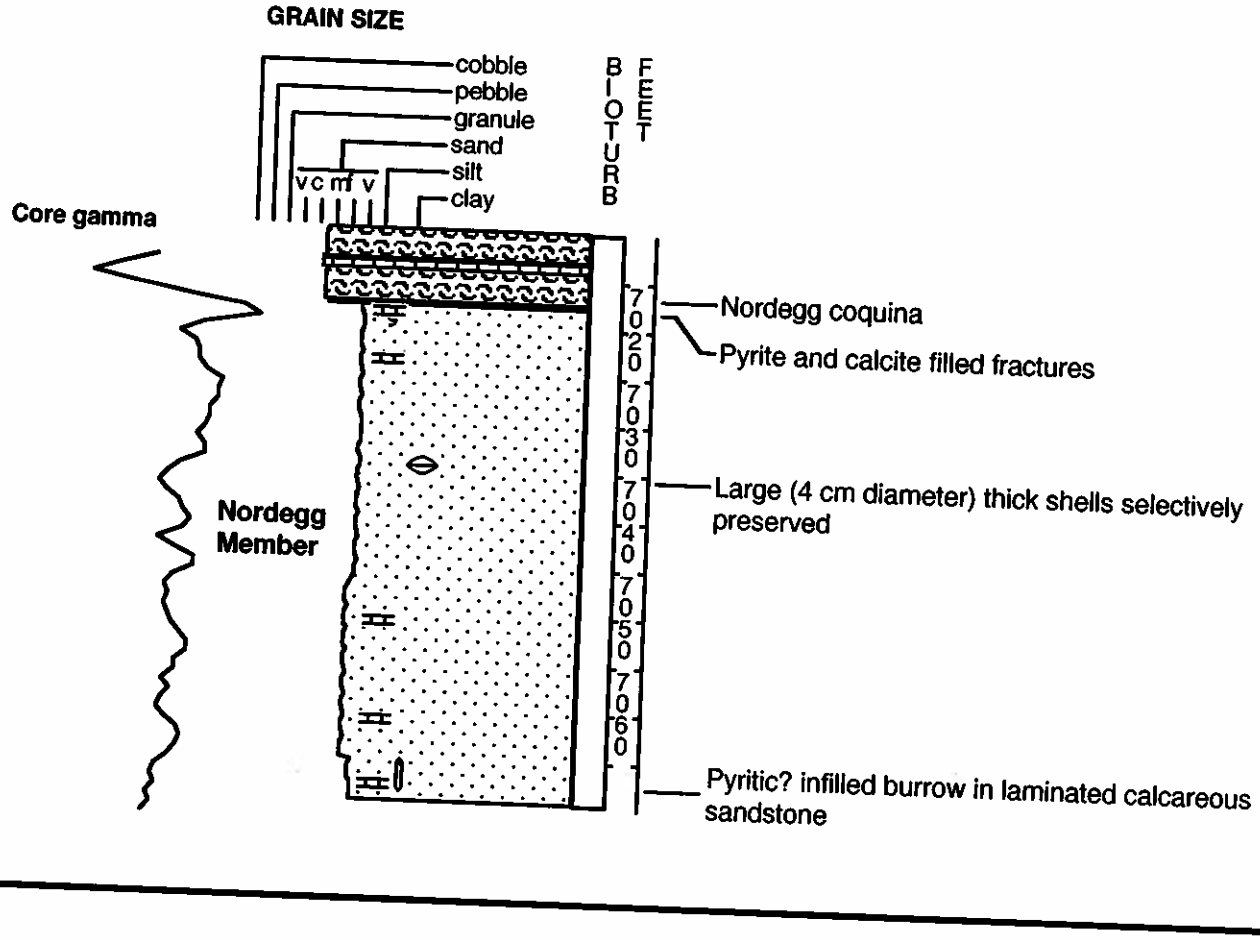


Uno Tex Gilby
6-30-40-3w5

Date logged: January 20, 1993

Logged by: Rudy Strobl

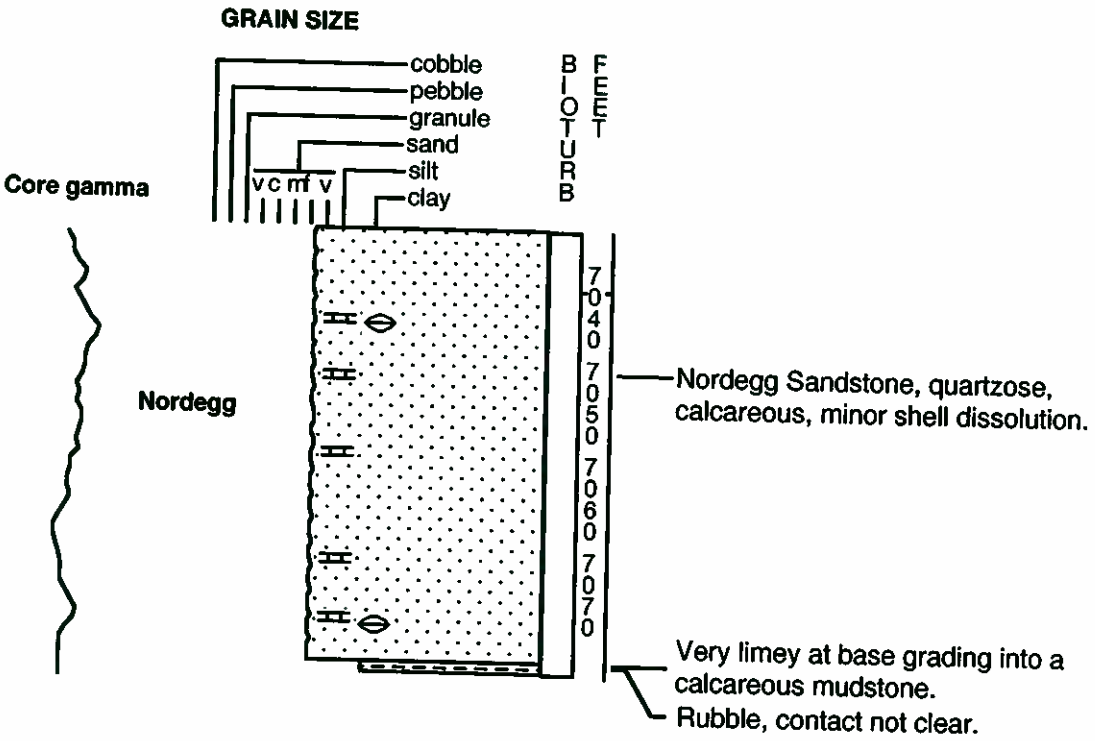
Remarks: Contains Nordegg coquina over Nordegg Sandstones (Med River Member of Collar, 1990)



Uno Tex Gilby
10-30-40-3w5

Date logged: May 14, 1993

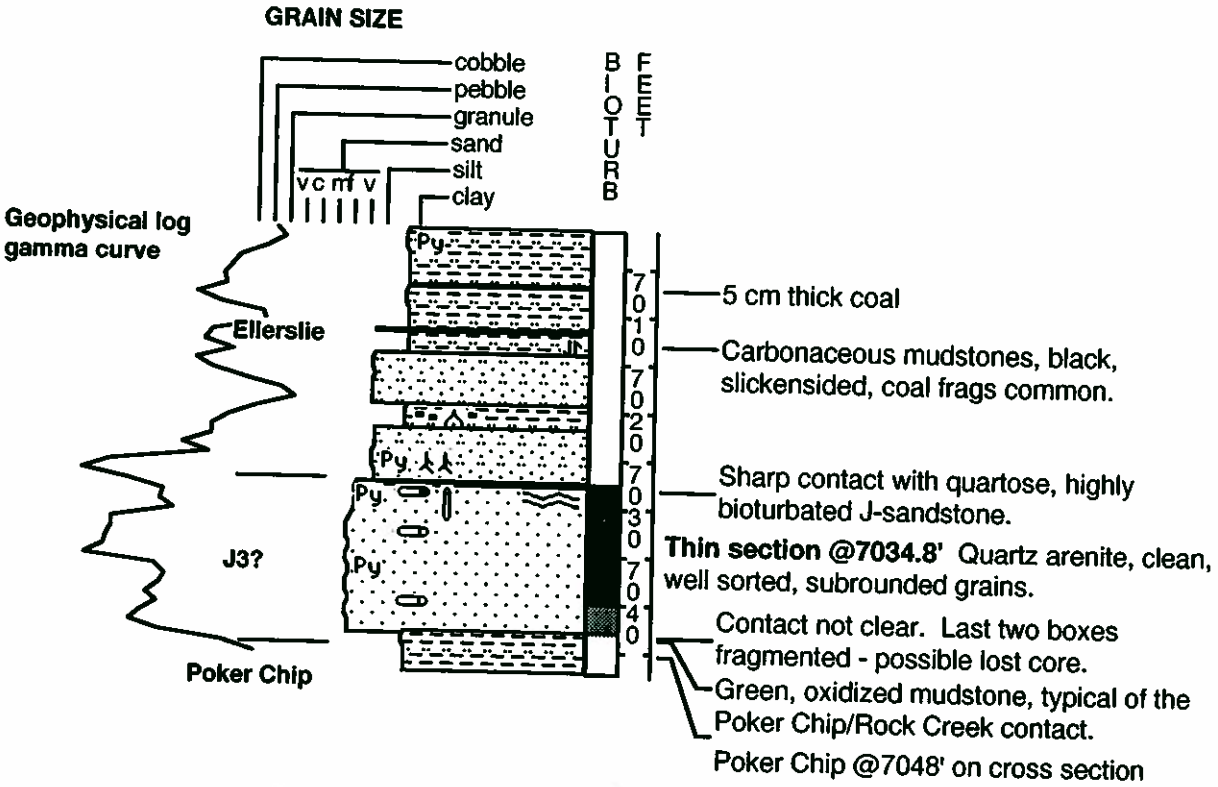
Logged by: Rudy Strobl



ARCO Giby
11-32-40-3w5

Date logged: May 14, 1993

Logged by: Rudy Strobl

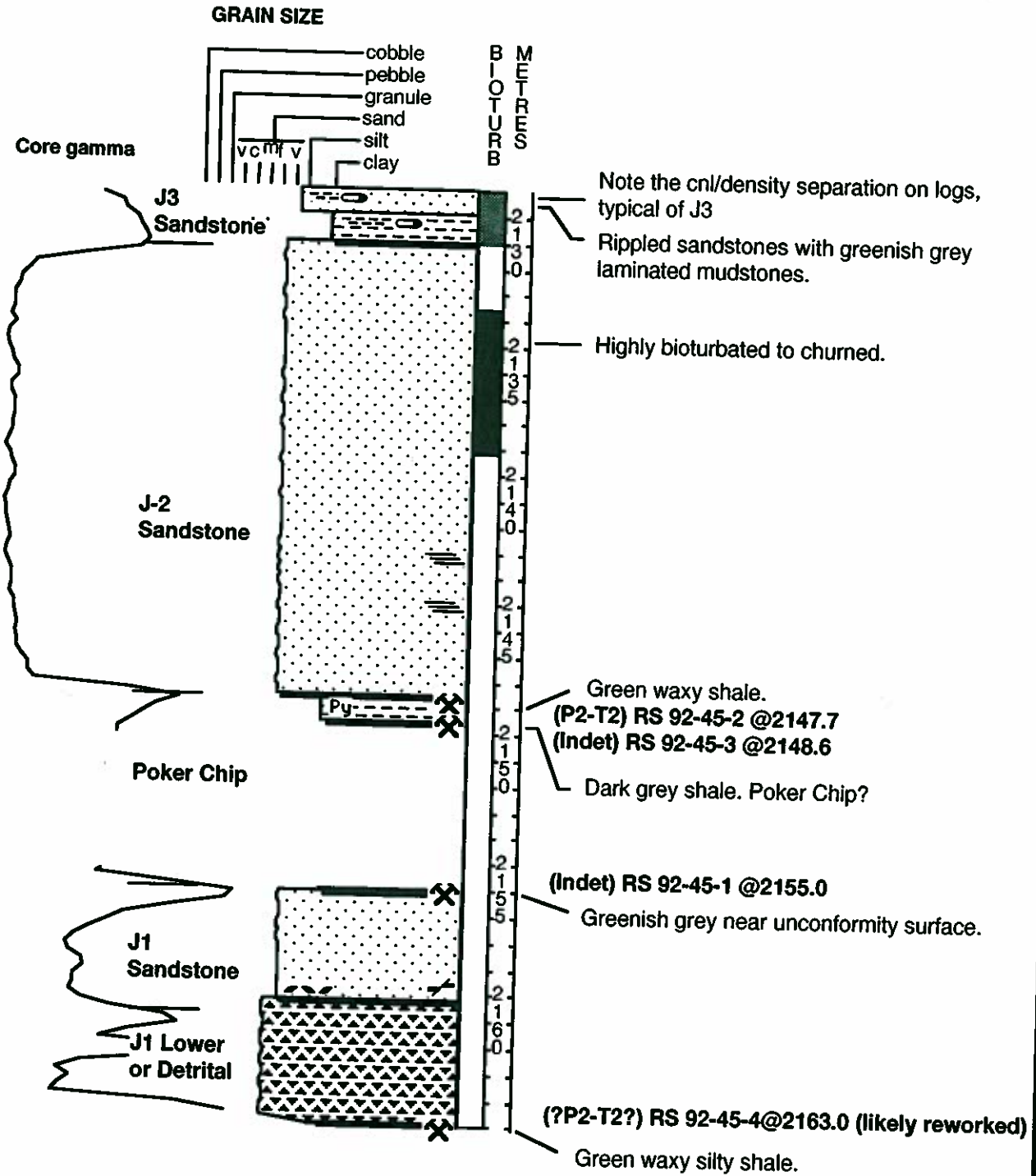


Gulf Gilby
8-33-40-3w5

Date logged: October 15, 1992

Logged by: Rudy Strobl , Craig Siemens

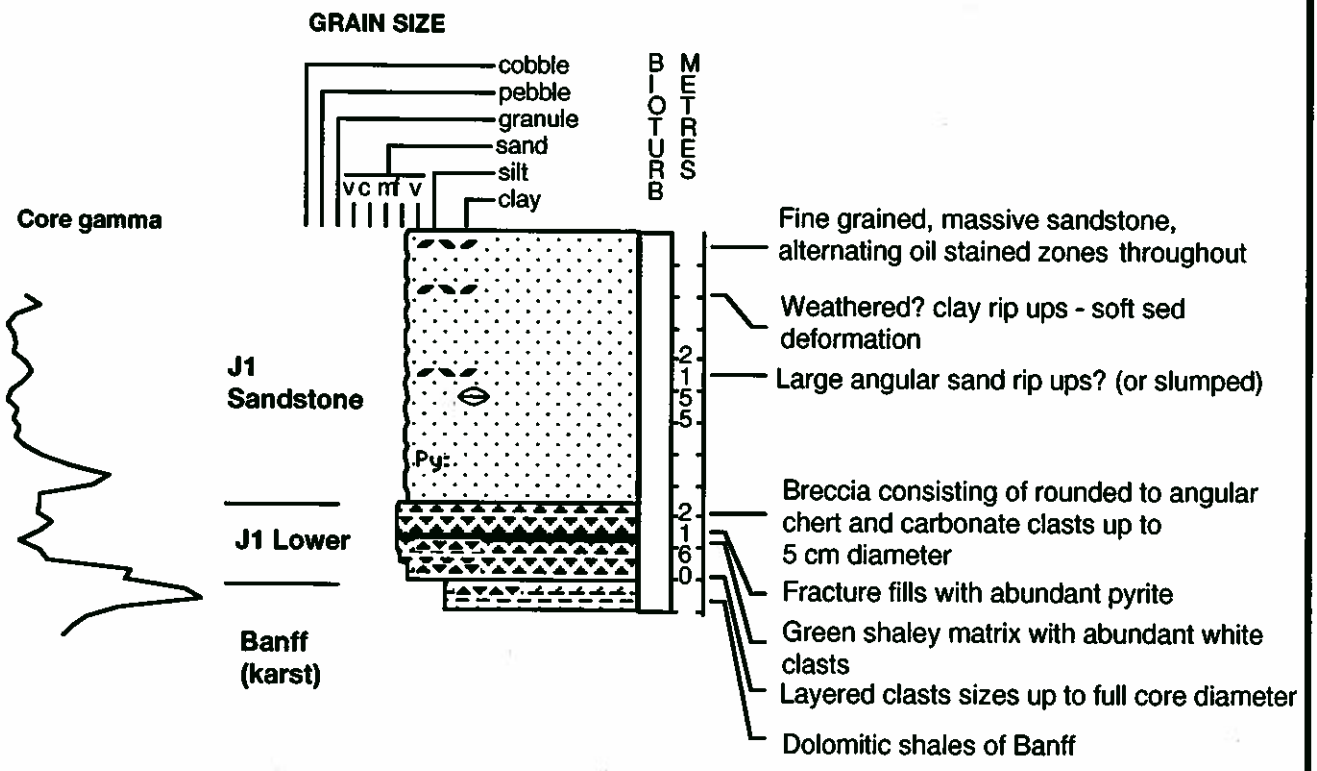
Remarks: Within J valley



Aberford Et Al Gilby
6-34-40-3w5

Date logged: October 13, 1992

Logged by: Rudy Strobl. Craig Seimens

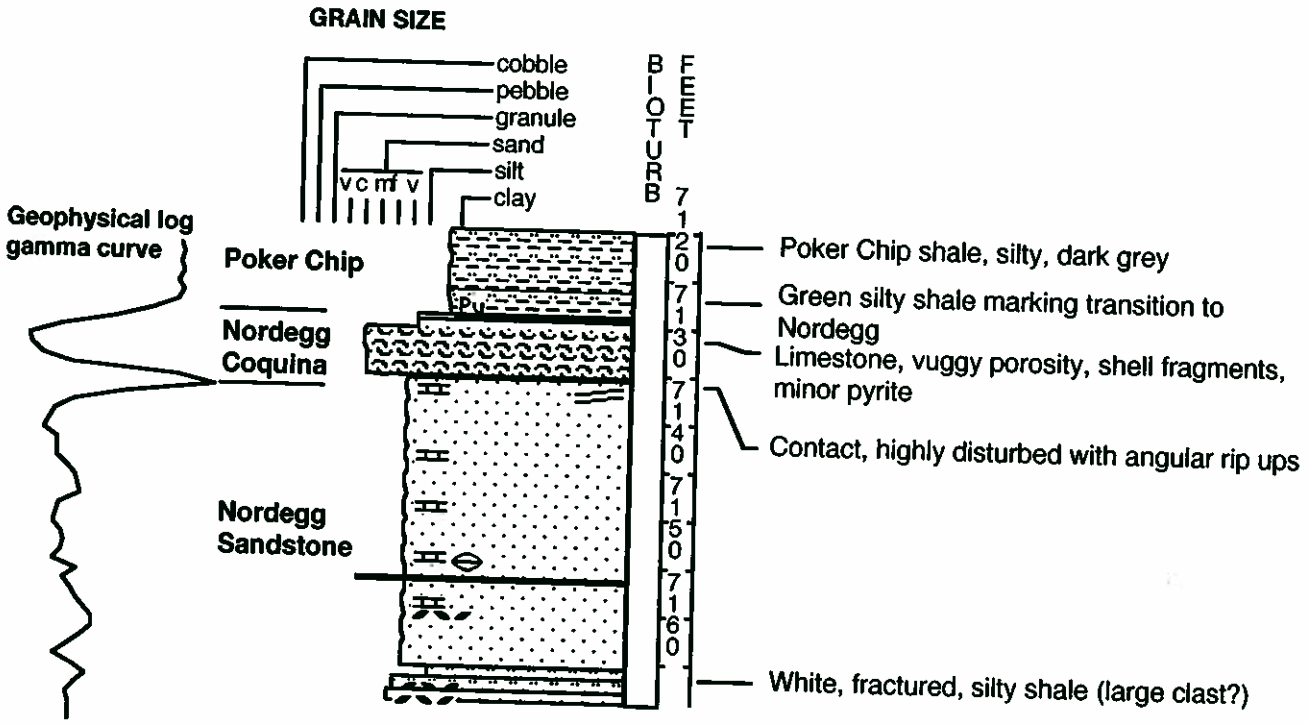


CPOG Med River
6-12-40-4w5

Date logged: October 14, 1992

Logged by: Rudy Strobl and Craig Siemens

Remarks: Similar interval to 4-13-40-4W5

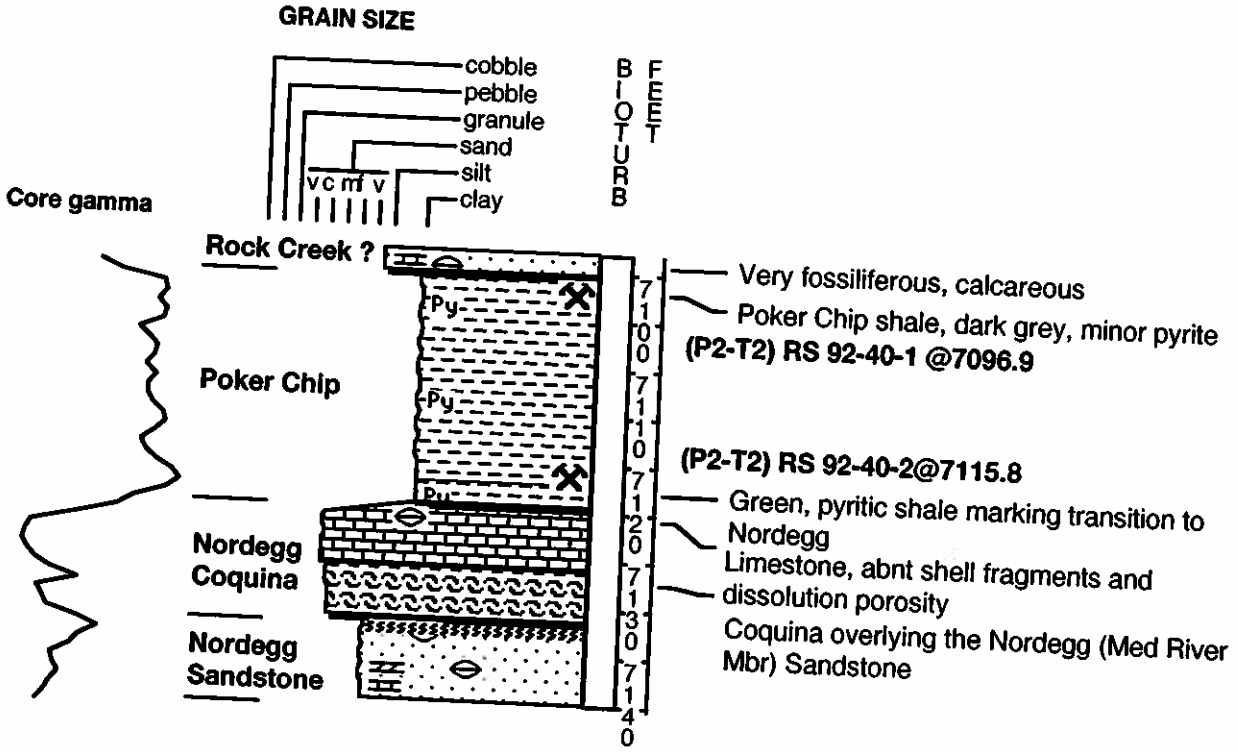


CPOG Med River
4-13-40-4w5

Date logged: October 14, 1992

Logged by: Craig Siemens and Rudy Strobl

Remarks: Rock Creek, Poker Chip, Coquina and Nordegg Sandstone

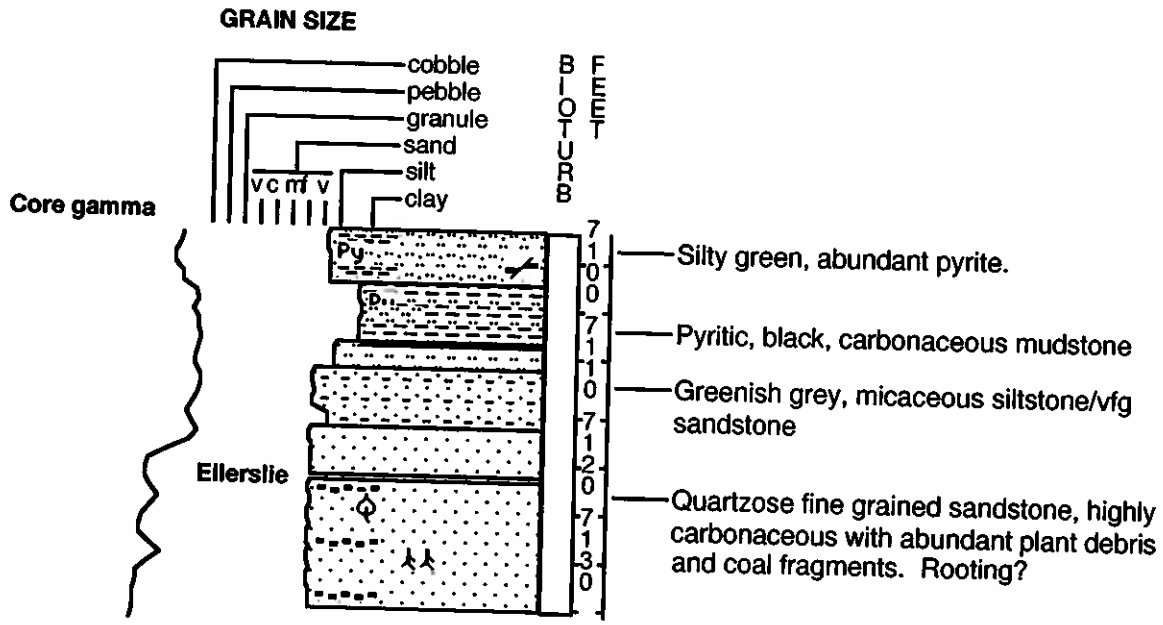


Uno Tex Gilby
10-13-40-4w5

Date logged: April 27, 1993

Logged by: Rudy Strobl

Remarks: Key well to define upper blocky sands, Line 2A, Cretaceous to 7150'

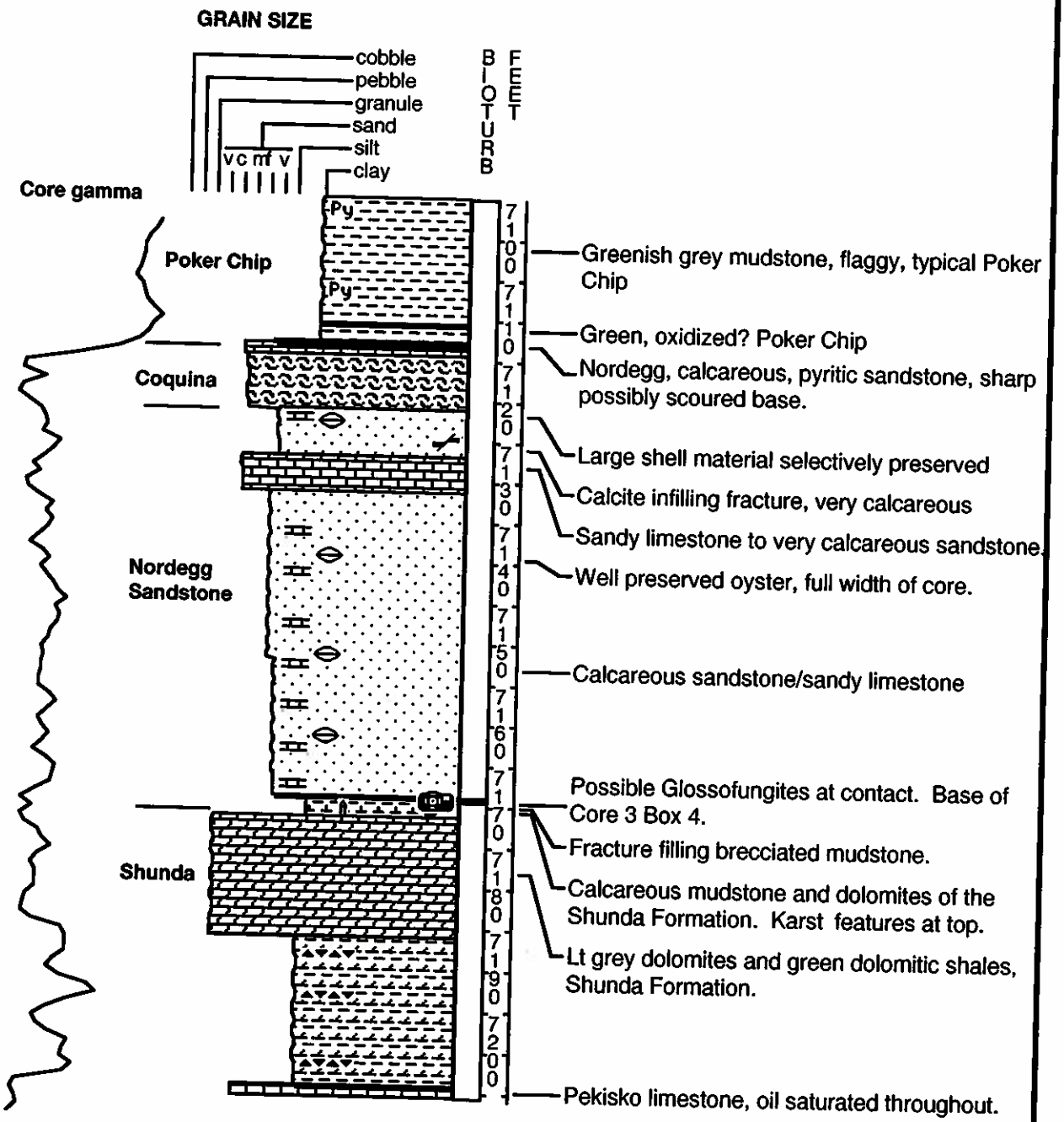


CPOG Med River
12-13-40-4w5

Date logged: April 27, 1993

Logged by: R. Strobl

Remarks: Line 2A Rock Creek, Nordegg Coquina and Nordegg SS.

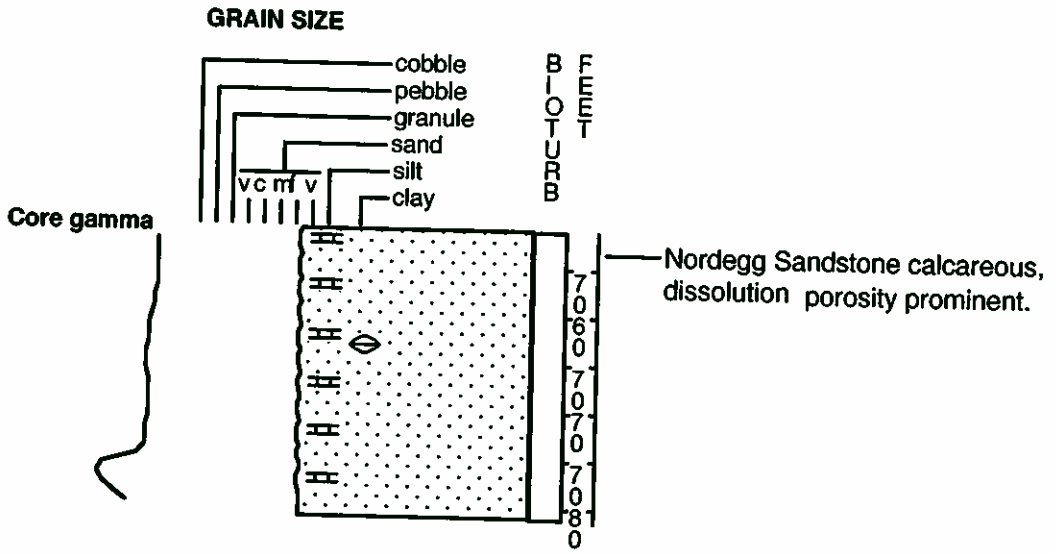


APCO Pregoda Gilby
16-13-40-4w5

Date logged: April 27, 1993

Logged by: Rudy Strobl

Remarks: Nordegg Sandstone

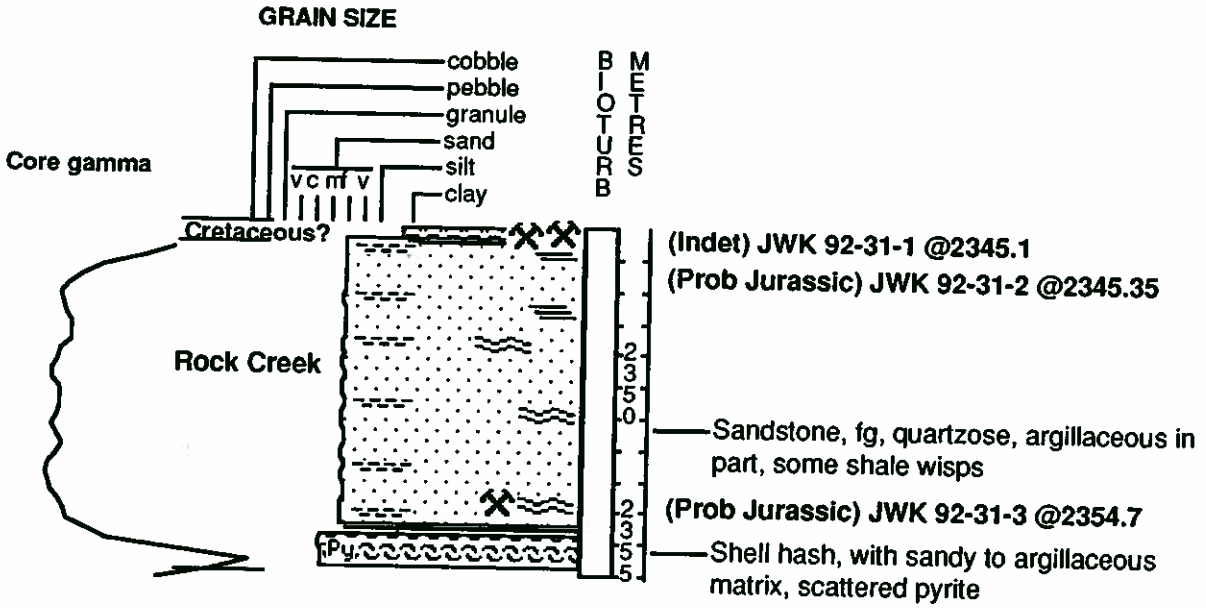


Orbit et al Gilby 14-19
14-19-40-4w5

Date logged: February 25, 1992.

Logged by: John Kramers

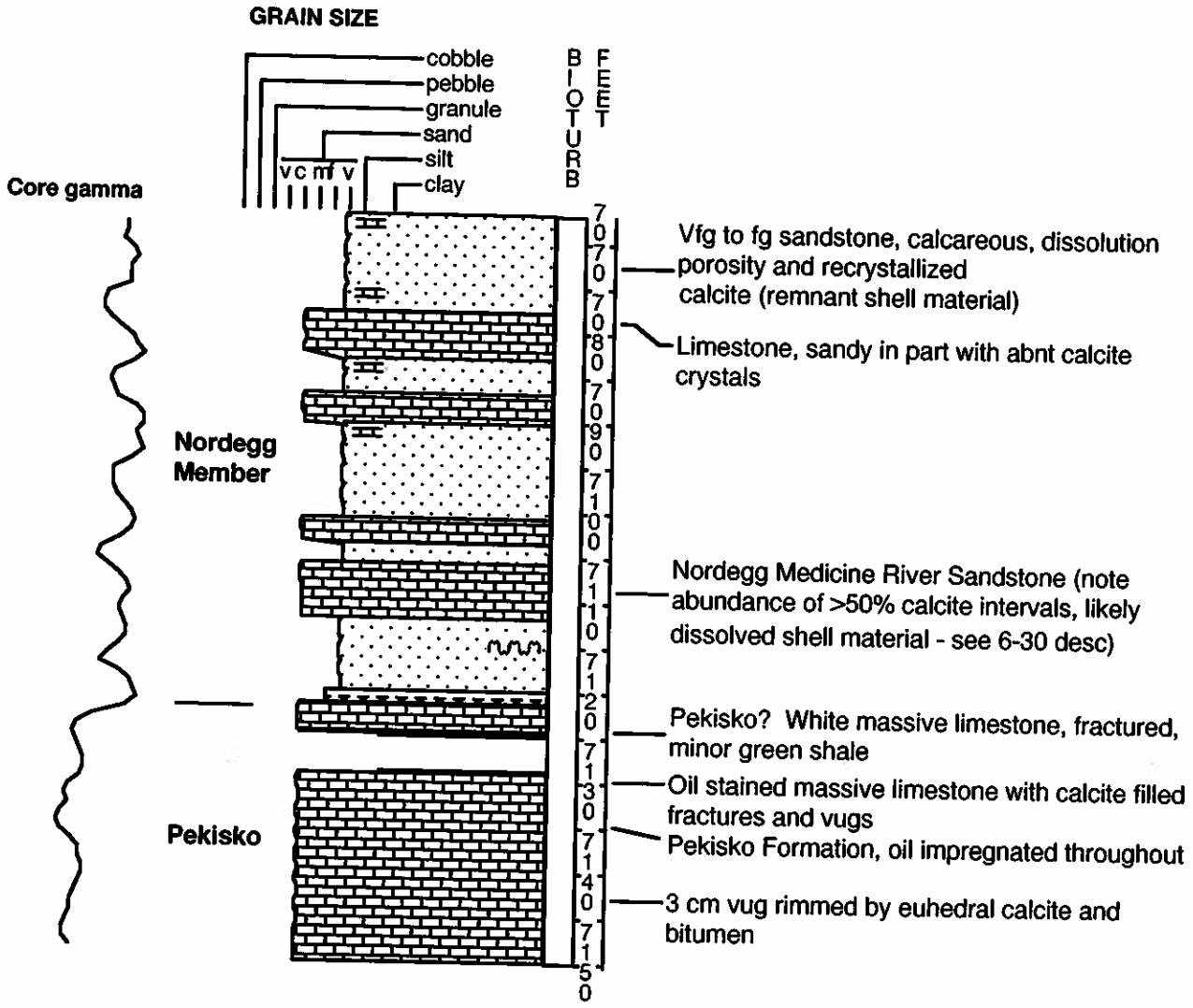
Remarks: Converted to AppleCore by RS November 10, 1992.



Uno Tex B.A. Gilby
6-25-40-4w5

Date logged: January 19, 1993

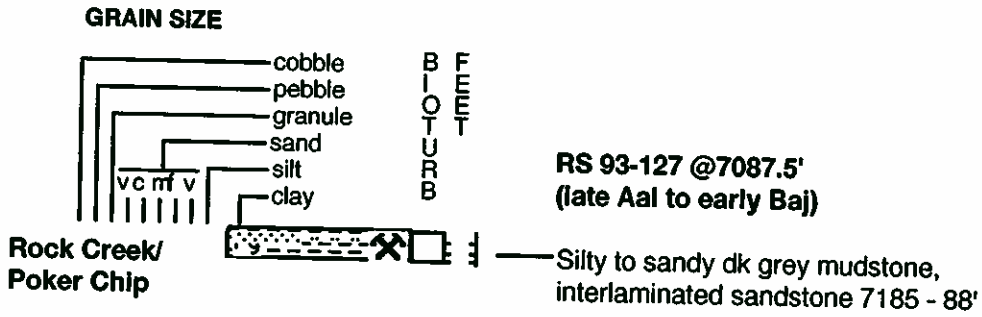
Logged by: Rudy Strobl



Siebens Gilby
10-26-40-4w5

Date logged: January 19, 1993

Logged by: Rudy Strobl

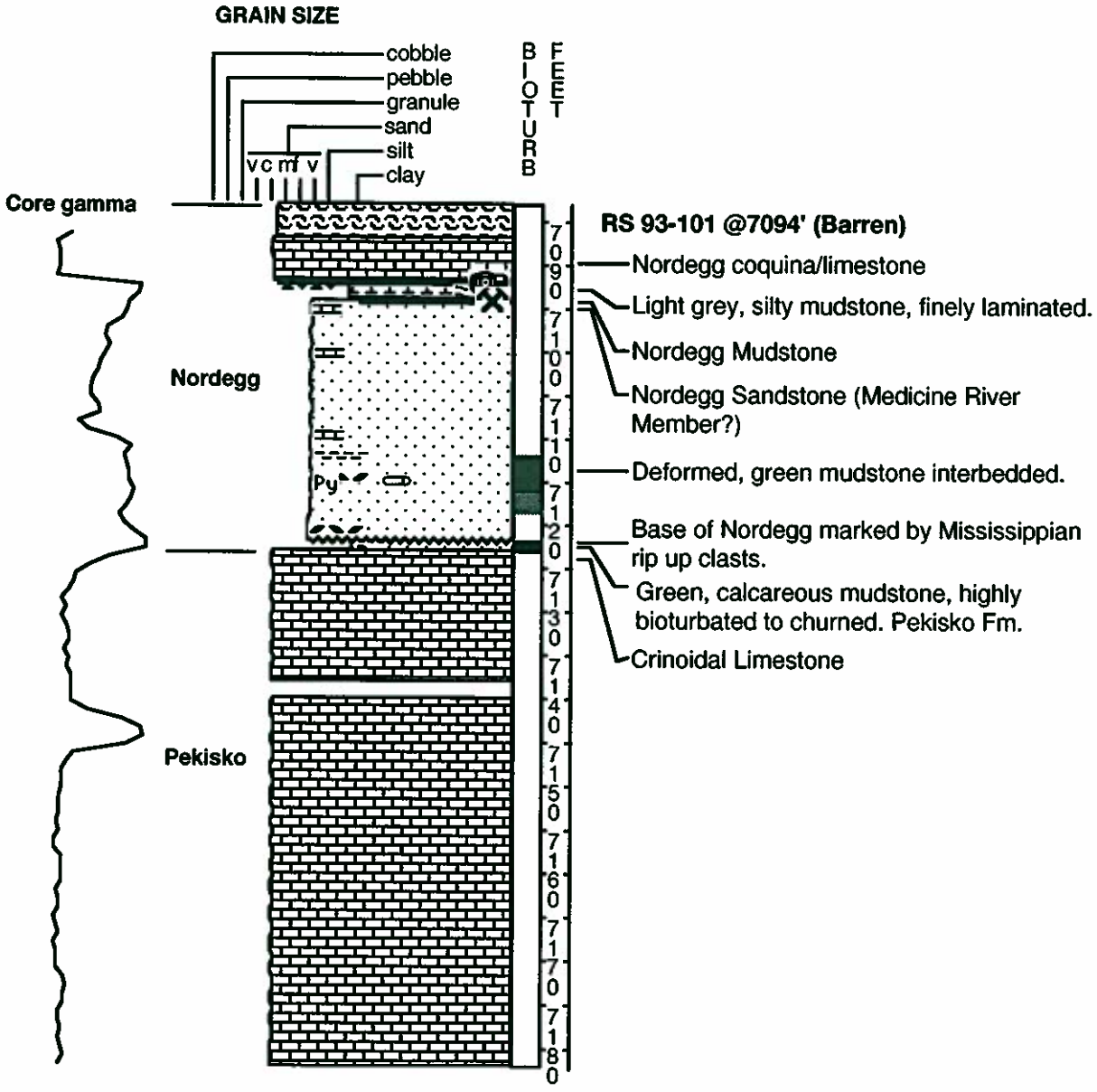


Uno Tex Gilby Crown
4-36-40-4w5

Date logged: April 27, 1993

Logged by: Rudy Strobl

Remarks: Line 2A. First core showing green grey mudstone capping Nordegg Sandstone and underlying Nordegg Coquina.

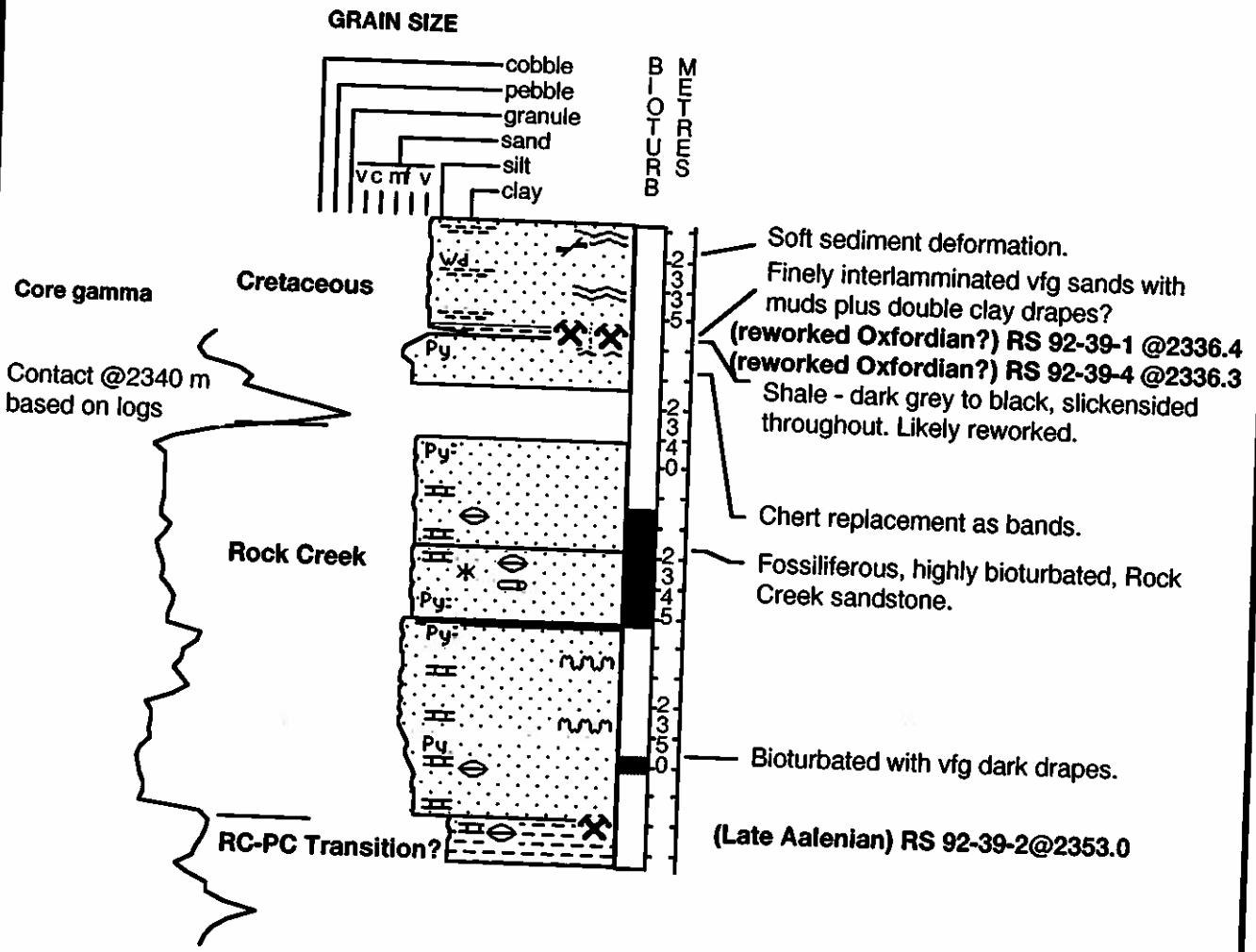


B.V.X. Willesden Green
14-4-40-5w5

Date logged: October 14, 1992

Logged by: Rudy Strobl, Craig Siemens

Remarks: Lower Cretaceous to Rock Creek.



Appendix 2
(Palynological Introduction)

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

Dolby and Associates

PALYNOLOGICAL ANALYSIS OF CRETACEOUS, JURASSIC & MISSISSIPPIAN CORE SAMPLES FROM THE GILBEY-MEDICINE RIVER AREA, CENTRAL ALBERTA

by
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Project 92.11

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The Jurassic-Cretaceous palynological succession in central Alberta was described in detail in Report 92.01, March 1992. 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 Gilbey-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 Kimmerdigian 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:

Distalannulisporites incertus
Corrugatisporites anagrammensis
Classopollis 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 dampierii* 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 evittii* 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. anagrammensis* 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 *Escharisphaeridia* - *Batiacasphaera* spp. (especially large forms of the former) and by the appearance of *Evansia tripartita* and *Meiourogonyaulax decapitata*. *Nannoceratopsis dictyambonis* probably dies out in the Early Bajocian (*discites* Ammonite Zone) and *Phallocysta 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 *Escharisphaeridia asymmetra*. *N. senex* dies out at the top of the Early Bajocian as does *N. gracilis* for all practical purposes.

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

Callialasporites dampierii
Araucariacites australis
Classopollis 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
Scriniodinium luridum
Hystrichogonyaulax regalis
Korystocysta gochtii/kettonense
Cassiculosphaeridia dictydia
C. ornatum
Diacanthum filapicatum
Ellipsoidictyum cinctum
H. pectinigera
Aldorfia 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. filapicatum* 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*, *Aldorfia dictyota*, *Scriniodinium crystallinum* and *Leptodinium eumorphum*.

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

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

The terrestrial assemblages consist generally of long-ranging species. In contrast to the 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 *Concavissimisporites 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 by the following:

Cicatricosisporites spp.
Concavissimisporites spp.
C. trioreticulosus
Couperisporites tabulatus
Taxodiaceaepollenites 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.

Davies, E.H., 1983. The dinoflagellate Oppel-zonation of the Jurassic-Lower Cretaceous sequence in the Sverdrup Basin, Arctic Canada. G.S.C. Bull. 359.

Dolby, G., 1990. Palynological analysis of Jurassic samples from west-central and northern Alberta. Project 89/13, DSS contract 23294-9-0646/01-XSG prepared for the Geol. Surv. Canada.

Dolby, G., 1991. Palynological analysis of samples from the 8-30-37-3W5, 4-30-37-3W5, 13-27-55-11W5 and 4-34-55-11W5 wells. Report 91.12 prepared for the Alberta Research Council.

Dolby, G., 1991. Palynological analysis of samples from the 10-29-55-11W5, 13-21-55-11W5, 10-30-37-3W5, 12-19-37-3W5, 12-30-37-3W5 and 2-30-37-3W5 wells. Report 91.16 prepared for the Alberta Research Council.

Dolby, G., 1992. Palynological analysis of Cretaceous and Jurassic core samples from central Alberta. Report 92.01 prepared for the Alberta Research Council.

Dolby, G., 1992. Palynological analysis of Cretaceous and Jurassic core samples from central Alberta. Report 92.07 prepared for the Alberta Research Council.

Jansonius, J., 1986. Reexamination of Mesozoic Canadian dinoflagellate cysts published by S.A.J. Pocock (1962, 1972). Palynology 10.

Johnson, C.D. and Hills, L.V., 1973. Microplankton zones of the Savik Formation (Jurassic) Axel Heiberg and Ellesmere Islands, District of Franklin. Bull. CSPG 21.

Pocock, S.A.J., 1970. Palynology of the Jurassic sediments of western Canada. Part 1, Terrestrial species. Palaeontographica B130.

Pocock, S.A.J., 1972. Part 2, Marine species. *Ibid* B137.

Riding, J.B., 1984. A palynological investigation of Toarcian to early Aalenian strata from the Blea Wyke area, Ravenscar, North Yorkshire. Proc. Yorkshire G.S. 45.

Riding, J.B., Walton, W., and Shaw, D., 1991. Toarcian to Bathonian (Jurassic) palynology of the Inner Hebrides, north-west Scotland. Palynology 15.

Singh, C., 1971. Lower Cretaceous microfloras of the Peace River area, northwestern Alberta. Research Council of Alberta. Bull. 28.

Appendix 3
(Palynology Sample Descriptions)

Medicine River/Sylvan Area
(Twps 37,38,39 and 40
Rges 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: JWK 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: JWK 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 (JWK 92-66-3, 7394.2').

Significant species

Bisaccate pollen (A)
Cerebropollenites mesozoicus
Concavissimisporites southeyensis

Sentusidinium spp.
Gonyaulacysta jurassica

Corollina spp.
Callialasporites dampieri
Sestrosporites pseudoalveolatus

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

Samples: JWK 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 *Classopollis* 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 combazii*, 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. continuum
Gonyaulacysta jurassica
Hystrichogonyaulax regalis
Diacanthum filapicatum
C. combazii
Sirmiodinium grossii
Ellipsoidictyum cinctum
H. pectinigera
Scriniodinium 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

Classopollis 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.
Mathesporites tumulosus
Nannoceratopsis senex (A)
Classopollis spp. (A)
Corrugatisporites anagramensis
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. hughesii
Concavissimisporites 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
Neoraistrickia 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. *wonthaggiensis*

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.
Classopollis sp.

Leptolepidites sp.

Samples: **JWK91-2-3 to 2-9**
Depths: 7428', 7431', 7454', 7476', 7478', 7494', 7498'
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 *Aldorfia aldorfense* 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
Cassiculosphaeridia dictydia (A)
Korystocysta gochtil/kettonense (A)

Bisaccate pollen (A)
Cerebropollenites mesozoicus

C. ornatum
Aldorfia aldorfense
A. cf. *dictyota*
Valensiella ovula
Escharisphaeridia spp.

Classopollis 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 gochtil/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	Small, indeterminate cysts
Callialasporites turbatus	*Classopollis* sp.
Staplinisporites caminus	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 *Cicatricosisporites* 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.

WELL: **12-30-37-3W5**

Samples: **JWK91-9-1, JWK92-66-1**
Depths: 7385', 7387'
Age: Indeterminable

Remarks

These samples yielded amorphous kerogen similar to sample 91-7-1. No identifiable palynomorphs are present.

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	*Classopollis* spp.
Sentusidinium 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.	*Corollina* sp.
Lycopodiumsporites 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. *Dissiliodinium* spp. are abundant and *Fromea senilis* is present.

Significant species

Classopollis spp. (A)
Callialasporites dampierii
Cerebropollenites mesozoicus

Fromea senilis
Dissiliodinium spp. (A)

Exesipollenites spp. (A)
C. dampierii
Ovalipollis enigmatica

F. 83/1
Scriniocassis weberii

WELL: 7-22-37-4W5

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 *Ellipsoidictyum* 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
Cingutriletes clavus
Bissaccate pollen (A)
Contignisporites cooksonii
Stereisporites antiquasporites

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

Remarks

Dissiliodinium 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)
Callialasporites dampierii
Mathesporites tumulosus
Mathesporites tumulosus
C. turbatus
Staplinisporites caminus
Dissiliodinium spp. (A)
Scriniocassis priscus (R)
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 *Dissiliodinium* spp. are abundant.

Significant species

Classopollis spp. (A)
Callialasporites turbatus
Corollina spp.
Ovalipollis enigmatica
Lycopodiumsporites spp.

Dissiliodinium spp. (A)
Nannoceratopsis gracilis

Exesipollenites spp. (A)
C. dampierii
Cerebropollenites mesozoicus
Staplinisporites caminus
Ischyosporites crateris

Fromea senilis
Scriniocassis weberii

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

Spheripollenites spp.
Mathesporites tumulosus
Corrugatisporites amplectaeformis

Nannoceratopsis senex

Classopollis spp.
Distalannulisporites incertus
Lycopodiacidites spinatus/baculatus

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. trioreticulatus
Januasporites spiniferus
Foraminisporis wonthaggiensis

WELL: **10-18-38-3W5**

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. apiverrucatus
Foraminisporis wonthaggiensis (A)
C. trioreticulatus
Januasporites spiniferus

?Balmula sp.

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)
Cicatricosisporites spp.
Concavissimisporites tribotrys
Dictyotriletes granulatus
Taxodiaceaepollenites hiatus
C. australiensis
Januasporites spiniferus
Foraminisporis wonthaggiensis

Balmula tripenta

WELL: **4-31-38-3W5**

Samples: **RS92-4-1, 4-2**
Depths: 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)
Classopollis spp. (A)
Corrugatisporites anagramensis
Distalannulisporites incertus (A)
Mathesporites tumulosus
C. amplectaeformis

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.
Couperisporites tabulatus
Concavissimisporites tribotrys

Balmula tripenta (R)

Foraminisporis wonthaggiensis
Aequitriradites spinulosus
Rouseisporites reticulatus

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.
Corollina spp.
Distalannulisporites incertus

Nannoceratopsis senex (A)

Classopollis 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

Nannoceratopsis senex

Mathesporites tumulosus (A)
Distalannulisporites incertus
C. amplectaeformis

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

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

Remarks

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

Samples: **JWK92-46-9, 46-10**
Depths: 7531', 7536.8'
Age: Probably 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)
Distalannulisporites incertus
Mathesporites tumulosus
N. gracilis
Corrugatisporites anagrammensis
C. amplectaeformis

WELL:	**4-27-38-4W5**
Samples:	**RS92-28-1, 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)
Mathesporites tumulosus
Corrugatisporites amplectaeformis

Classopollis spp (A)
Distalannulisporites incertus
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)
Distalannulisporites incertus
Corrugatisporites amplectaeformis
Classopollis (A)
Mathesporites tumulosus
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., *Classopollis* spp. and *Nannoceratopsis senex* are abundant but show evidence of bacterial corrosion. The assemblage is typical of the lower Poker Chip.

Significant species

Classopollis spp. (A)
Distalannulisporites incertus
Spheripollenites spp. (A)
Mathesporites tumulosus

Nannoceratopsis senex (A)

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

Escharisphaeridia spp. (A)
Phallocysta minuta
Scriniocassis priscus
P. cf. *erregulensis*

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

Classopollis 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

Cicatricosisporites spp.
Foraminisporis wonthaggiensis (A)
Januasporites spiniferus (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)
Distalannulisporites incertus
Corrugatisporites anagramensis
Classopollis spp. (A)
Mathesporites tumulosus
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

Bisaccate pollen (A)
Januasporites spiniferus
Concavissimisporites tribotrys
Foraminisporis wonthaggiensis (A)
Cicatricosisporites spp.
C. apiverrucatus

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 weberii* also favor an Aalenian age.

Significant species

Classopollis spp. (A)
Staplinisporites caminus
Corrugatisporites anagrammensis

Nannoceratopsis gracilis
Scriniocassis weberii
Batiacasphaera spp.

Mathesporites tumulosus (C)
Ischyosporites crateris
I. marburgensis

Fromea cf. *senilis*
Dissiliodinium 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.

Distalannulisporites incertus

Nannoceratopsis senex

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)

Spheripollenites 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

Spheripollenites spp. (A)
Lycopodiacidites baculatus
Corrugatisporites anagrammensis

Nannoceratopsis senex

Distalannulisporites incertus
Mathesporites tumulosus
C. amplectaeformis

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)
Callialasporites dampierii (A)
Corollina spp. (A)
Araucariacites australis

Classopollis spp. (A)
C. turbatus (A)
Lycopodiumsporites spp. (A)
Cerebropollenites mesozoicus

Fromea senilis
Caddasphaera halosa
Nannoceratopsis gracilis

F. 83/1
Scriniocassis weberii
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. pseudotripartitus
Couperisporites tabulatus
Aequitriradites spinulosus
C. australiensis
C. exilioides
Dictyotriletes granulatus
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 Berriasian species *Phoberocysta neocomica* is probably a contaminant although the preservation states are similar.

Significant species

Gonyaulacysta jurassica (A)
Leptolepidites psarosus
(*Phoberocysta neocomica*)

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. weberii 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

Classopollis spp. (A)
Corrugatisporites anagramensis
Mathesporites tumulosus

Nannoceratopsis senex
Scriniocassis weberii
Lithodinia aff. *serrulata*

Distalannulisporites incertus
C. amplectaeformis
Lycopodiacidites spinatus/baculatus

Dinocyst 12-2
S. priscus

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. *Callialasporites dampierii* 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
Callialasporites dampierii
Lycopodiacidites baculatus

Distalannulisporites incertus (A)
Mathesporites tumulosus
Corrugatisporites amplectaeformis
L. spinatus

Nannoceratopsis senex

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
Depths: 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)
Mathesporites tumulosus
Distalannulisporites incertus

Nannoceratopsis senex

Classopollis spp.
Corrugatisporites anagrammensis
C. amplectaeformis

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.
Appendicisporites bilateralis
Concavissimisporites tribotrys
Foraminisporis wonthaggiensis
Januasporites spiniferus
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

Classopollis spp. (A)
Ischyosporites crateris
Callialasporites dampierii

Dissiliodinium spp. (A)
Evansia granulata

Mathesporites tumulosis (R)
Corrugatisporites 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 *Sestrosporites pseudalveolatus* with *Scriniocassis priscus* indicates an Early Bajocian age. *Dissiliodinium* spp. are abundant.

Significant species

Classopollis spp. (A)
Sestrosporites pseudalveolatus
Ovalipollis enigmatica

Dissiliodinium spp. (A)
Scriniocassis priscus

Bisaccate pollen (A)
Callialasporites turbatus
C. damperii

Escharisphaeridia spp.

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.
Mathesporites tumulosus
Distalannulisporites incertus

Nannoceratopsis senex

Classopollis spp.
Corrugatisporites spp.
Ischyosporites marburgensis

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)

Distalannulisporites incertus

Nannoceratopsis senex

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.
Concavissimisporites trioreticulatus
Foraminisporis wonthaggiensis
Appendicisporites erdtmannii
C. tribotrys
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)
Distalannulisporites incertus
Corrugatisporites anagrammensis
Spheripollenites spp. (A)
Mathesporites tumulosus
C. amplectaeformis

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 *Dissiliodinium* sp. *Fromea* 83/1 is present at 7307.6' and *F. senilis* at 7333' suggesting a late Aalenian age.

Significant species

Dissiliodinium spp. (A)
Nannoceratopsis gracilis
Fromea 83/1
Wallodinium sp.
Escharisphaeridia spp.
F. senilis

WELL: **12-11-39-5W5**

Sample: **RS92-33-1**
Depth: 7835.6'
Age: ?Late Toarcian, J14B

Remarks

Inertinitic debris is extremely abundant and the palynomorphs are highly corroded. A somewhat questionable specimen of *Callialasporites dampierii* 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. *dampierii*
Corrugatisporites amplectaeformis
Classopollis 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 wee 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 *Triquitrites* 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.

Corollina sp.

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 *Dictyotriletes 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: **6-23-39-5W5**

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 dampierii* 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
Calliasporites dampierii
Distalannulisporites incertus (A)
Lycopodiacidites spinatus/baculatus
C. turbatus
Nannoceratopsis senex
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. dampierii* is absent and bacterially altered debris is more abundant. The presence of Dinocyst sp. 12-2 in 13-2 and *Spheripollenites* 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. exilioides
Concavissimisporites tribotrys
Couperisporites tabulatus
Schizosporis parvus
C. australiensis
C. hughesii
C. trioreticulosus
Aequitriradites spinulosus
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)
Distalannulisporites incertus (A)
Mathesporites tumulosus
Corrugatisporites spp.

Nannoceratopsis senex

Classopollis spp. (A)
Ovalispollis enigmatica
Ischyosporites marburgensis
Lycopodiacidites spinatus/baculatus

Dinocyst 12-2

WELL: **12-8-40-3W5**

Sample: RS93-124
Depth: 7105.5'
Age: Indeterminable

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 anagramensis

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)
Distalannulisporites incertus
Lycopodiacidites baculatus

Nannoceratopsis senex

Classopollis spp. (A)
Mathesporites tumulosus
Corrugatisporites amplectaeformis

Dinocyst 12-2

WELL: **12-28-40-3W5**

Samples: RS93-114, 115
Depths: 7067', 7086'
Age: ?Cretaceous

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. *Classopollis* spp. and bisaccate pollen are abundant and the presence of rare *Dissiliodinium* 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

Classopollis spp. (A)
Exesipollenites spp.
Corrugatisporites amplectaeformis
Callialasporites dampierii
Distalannulisporites incertus

Dissiliodinium sp.
Nannoceratopsis gracilis

Bisaccate pollen (A)
Mathesporites tumulosus
Cerebropollenites mesozoicus
Ischyosporites marburgensis
Corollina spp.

?Evansia sp.
N. senex

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

Remarks

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

Significant species

Classopollis spp. (A)
Corrugatisporites anagramensis
Distalannulisporites incertus (A)
Lycopodiacidites spinatus/baculatus

Nannoceratopsis senex

Small spores/pollen (A)
C. amplectaeformis
Mathesporites tumulosus

Dinocyst cf. 12-2

Sample:	**RS92-34-4**
Depth:	7107.8'
Age:	Indeterminable

Remarks

An essentially barren sample.

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

Sample: **RS92-45-2**
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.
Classopollis spp. (A)
Mathesporites tumulosus
Lycopodiacidites spinatus/baculatus
Nannoceratopsis senex
Dinocyst 12-2

Samples: **RS92-45-3, 45-1**
Depths: 2148.6m, 2155m
Age: Indeterminable

Remarks

Essentially barren samples.

Sample: **RS92-45-4**
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, *Spheripollenites* spp. and *Nannoceratopsis senex*. The lower sample is particularly rich.

Significant species

Spheripollenites spp. (A)
Distalannulisporites incertus
Corrugatisporites amplectaeformis

Nannoceratopsis senex

Classopollis spp. (A)
Mathesporites tumulosus
C. anagramensis

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: **10-26-40-4W5**

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.

Escharisphaeridia spp.

Distalannulisporites incertus
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 dampierii

Nannoceratopsis gracilis

Staplinisporites caminus
C. turbatus

Dissiliodinium 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)
?Concavissimisporites apiverrucatus
Neoraistrickia truncata
Klukisporites cf. *lacunus*

Gonyaulacysta jurassica

Classopollis spp. (A)
Lycopodiumsporites spp. (A)
Ischyosporites cf. *pseudoreticulatus*

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

Classopollis spp. (A)
Cerebropollenites mesozoicus
Lycopodiumsporites spp.
Mathesporites tumulosus

Corollina spp.
Ischyosporites crateris
Staplinisporites caminus
Callialasporites turbatus

Scriniocassis priscus
Escharisphaeridia spp.

S. weberii
Dissiliodinium spp.

Figure 2. Preglacial Sand and Gravel Deposits and Sites of Alberta

1001 Deposits

S1001 Sites

Highways

Kilometres

0 20 40 60

1:1 200 000

Note: Some portions of the rivers are not shown as a complete hydrogeology base at this scale was not available to the AGS at the time of printing.

Index C

Index B

Index A

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