Sedimentological Description of the Calhoun Shale in Three Cores from the Hamilton Area, Greenwood County, Kansas

by

Angela Torres-Zamora and Diana Ortega-Ariza

Kansas Geological Survey Open-File Report No. 2026-40

KU KANSAS GEOLOGICAL SURVEY
The University of Kansas

1930 Constant Ave., Lawrence, KS 66047 • (785) 864-3965 • www.kgs.ku.edu

Disclaimer: The Kansas Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations based on data used in the production of this document or decisions based thereon.

Sedimentological Description of the Calhoun Shale in Three Cores from the Hamilton Area, Greenwood County, Kansas

Angela Torres-Zamora and Diana Ortega-Ariza

Introduction

The Calhoun Shale is part of the Upper Pennsylvanian (Virgilian) Shawnee Group in eastern Kansas. Collected in the Hamilton area of Greenwood County, Kansas, the Calhoun Shale was previously described in 10 Kansas Geological Survey (KGS) cores by Leonard (1991). His study provided lithologic logs and a stratigraphic framework for the Deer Creek Limestone, Calhoun Shale, Topeka Limestone, and locally preserved Hamilton beds.

This open-file report presents a sedimentological revision of the Calhoun Shale in three of these cores: KGS #1 Lyke, KGS #3 Lyke, and KGS #1 Ulrich (fig. 1; table 1). The objective is to document the lithologies, textures, grain size, sedimentary structures, skeletal and nonskeletal grains, and bioturbation within the Calhoun Shale interval.

The descriptions and stratigraphic framework of Leonard (1991) are used as the basis for identifying the Calhoun Shale interval in the three cores examined here. This report does not revise the stratigraphic framework established by Leonard (1991); rather, it provides additional sedimentological detail and interpretation of the Calhoun Shale interval.

Stratigraphic Background of Calhoun Shale

According to Leonard (1991), the Calhoun Shale is in the upper part of the Shawnee Group (Virgilian, Upper Pennsylvanian) and directly overlies the Deer Creek Limestone. It is overlain by the Topeka Limestone (fig. 2). This unit commonly consists of four distinct lithologic intervals: a lower shale interval, a sandy interval in the middle, a thin skeletal packstone to grainstone overlying the sandy interval, and an upper shale interval (Leonard, 1991).

Methods

The Calhoun Shale interval in KGS #1 Lyke, KGS #3 Lyke, and KGS #1 Ulrich was examined systematically with a hand lens to identify and document key sedimentary characteristics, including lithology and texture (following Dunham, 1962; Dott, 1964; and Folk, 1980), grain size (following Wentworth, 1922), skeletal and nonskeletal constituents, sedimentary structures (following Pettijohn and Potter, 1964), bedding, bed thickness, contacts, and bioturbation (following Pemberton et al., 1992). Photographs were taken of selected features, and the locations of these features were recorded on the stratigraphic section for each core.

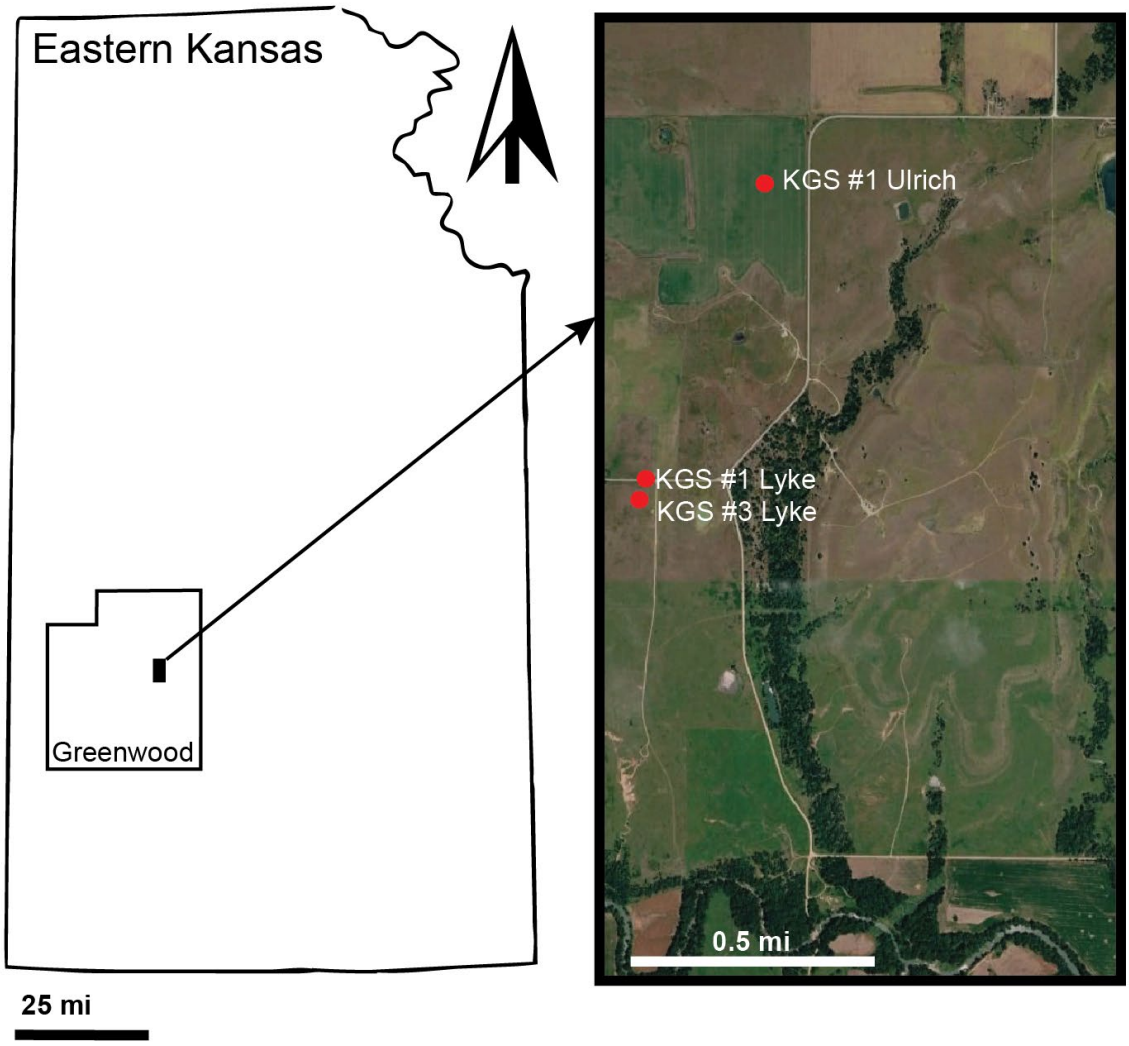


Figure 1. Map showing locations of the three examined cores collected in Greenwood County, Kansas.

Core	Latitude (WGS84)	Longitude (WGS84)	Calhoun Shale Thickness (ft)	Calhoun Shale Thickness (m)	Location (Leonard, 1991)
KGS #1 Lyke	37.9867	-96.1200	31.3	9.55	SE SE SW, Sec. 5, T24S, R12E
KGS #3 Lyke	37.9863	-96.1202	23.5	7.16	SE SE SW, Sec. 5, T24S, R12E
KGS #1 Ulrich	37.9955	-96.1156	32.4	9.87	NE SW NE, Sec. 5, T24S, R12E

Table 1. Location and thickness of the Calhoun Shale in the three examined cores.

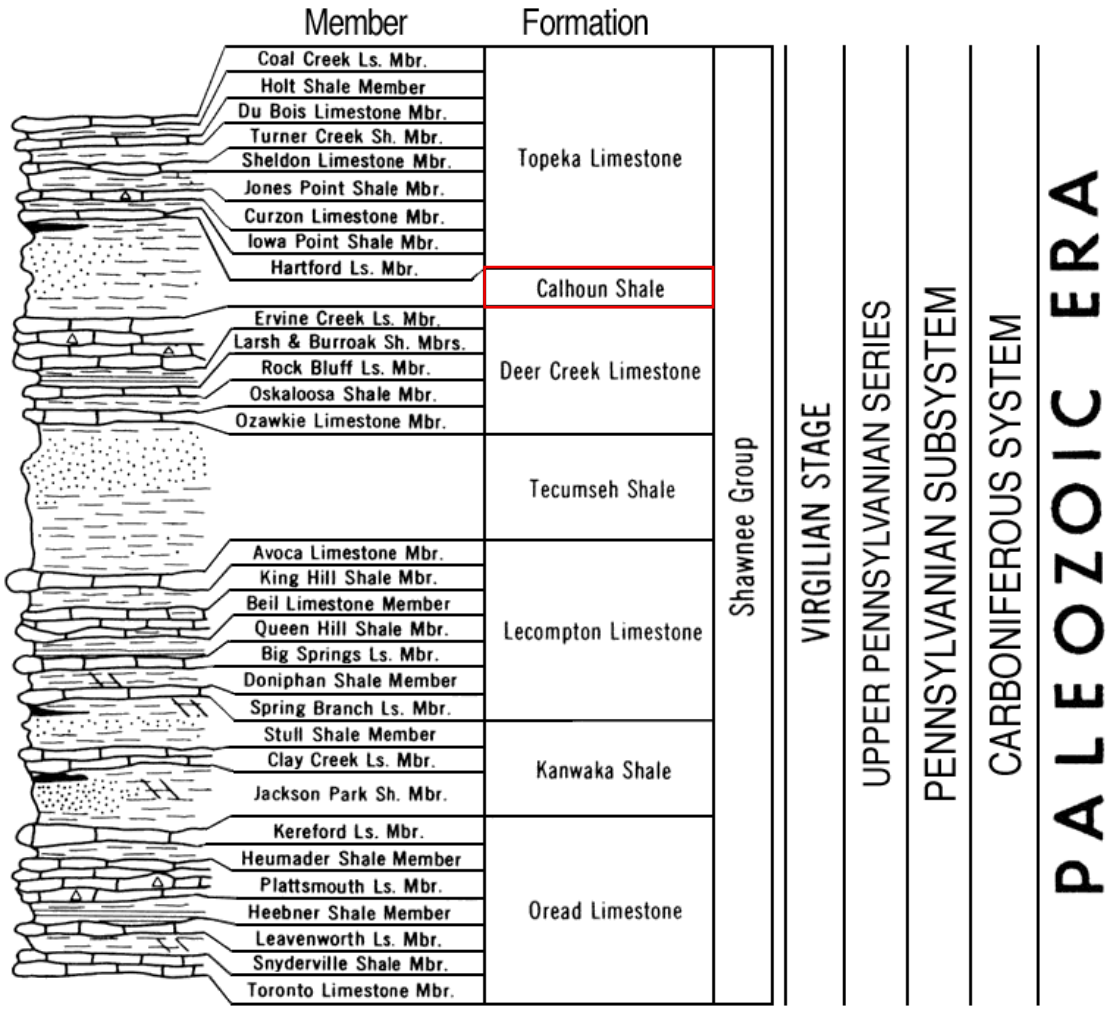


Figure 2. Generalized stratigraphic position of the Calhoun Shale (red rectangle outline) within the Shawnee Group in Kansas (Jewett et al., 1968; Sawin et al., 2009).

Comparison of Calhoun Shale Core Descriptions

Comparison of the core descriptions by Leonard (1991) with the sedimentological descriptions presented in this report shows that the two studies provide complementary records of the Calhoun Shale. Leonard (1991) documented the principal lithologic changes, colors, fossil constituents, other compositional features observed in the cores, and contacts. The present study builds on this framework by further subdividing the lithologies based on textural variations and graphically representing their internal variability. For example, intervals described by Leonard (1991) as shale were further differentiated in this study as claystone, mudstone, siltstone, or sandy siltstone where these distinctions could be recognized in the core.

The graphic logs also were constructed to represent interbedding and interlamination between lithologies. These relationships are illustrated to allow the reader to readily recognize vertical changes and the predominant lithology within each interval while also identifying smaller-scale variations such as sandstone or siltstone laminae and lenses.

Another difference is the representation of bioturbation. Although Leonard (1991) documented burrows in several intervals, this study incorporates a qualitative assessment of bioturbation intensity directly into the graphic logs. Bioturbation was divided into three columns and represented in brown along the right side of the core description. From left to right, the columns represent absent to low, moderate, and high bioturbation. This approach allows changes in bioturbation intensity to be compared visually with lithologic and sedimentological variations throughout each core.

In this report, organic matter was documented in greater detail because it is abundant and variable in its distribution. It occurs either dispersed within the sediment or concentrated along laminae, where it can accentuate internal sedimentary structures. Organic matter was included as a separate column in the graphic logs and represented in red along the right side of the core description to illustrate its distribution throughout the core. Leonard (1991) did not document organic matter in the same detail, but he noted the presence of plant debris in several intervals, which may account for some of the organic matter observed in this study.

In some intervals identified as missing core by Leonard (1991), the graphic log in this report is shown as continuous. This occurs where the reported missing interval is less than 1 ft or where core fragments are present within the reported gap, allowing the sedimentological description to be represented as continuous.

This report is accompanied by three appendices corresponding to KGS #1 Lyke (Appendix 1), KGS #3 Lyke (Appendix 2), and KGS #1 Ulrich (Appendix 3). For each core, Appendices 1a, 2a, and 3a present the core descriptions; Appendices 1b, 2b, and 3b contain selected core photographs; and Appendices 1c, 2c, and 3c provide the original descriptions from Leonard (1991). The following sections examine each core individually, beginning with a brief summary of Leonard's (1991) description, followed by a brief sedimentological description from this study and a comparison between the two.

KGS #1 Lyke

Leonard (1991) described the Calhoun Shale in KGS #1 Lyke as a heterogeneous siliciclastic succession that includes silty shale, sandy shale, silty sandstone, and silty calcareous sandstone. Sedimentary structures reported by Leonard (1991) include flaser bedding, lenticular bedding, and soft-sediment deformation. Plant fragments occur within several siliciclastic intervals, and reported fossil components include *Lingula*, bivalves, brachiopods, crinoids, bryozoans, and gastropods. The Calhoun Shale in KGS #1 Lyke overlies strata assigned to the Deer Creek Formation/Limestone and is overlain by the unnamed Calhoun Limestone.

Based on the sedimentological description conducted for this report, the Calhoun Shale in KGS #1 Lyke (Appendix 1a) begins, from base to top, with approximately 12 ft of mudstone and siltstone characterized by minor sedimentary structures, including discontinuous wavy to parallel lamination. This interval is capped by two thin (<1 ft) beds of calcareous fine- to medium-grained sandstone containing skeletal grains and abundant organic matter.

The middle part of the core includes approximately 5 ft of interbedded sandy siltstone and calcareous fine-grained sandstone characterized by wavy lamination and moderate to high bioturbation. This interval is overlain by approximately 5 ft of fine- to medium-grained

sandstone interlaminated with siltstone. Wavy lamination, ripple structures, and moderate bioturbation are common throughout this interval.

Above this interval, approximately 6 ft of calcareous fine- to medium-grained sandstone exhibits wavy lamination and moderate bioturbation. The uppermost part of the succession consists of approximately 2 ft of calcareous medium- to coarse-grained sandstone containing skeletal grains and characterized by high bioturbation. Abundant organic matter is a common feature throughout the succession. It occurs locally dispersed within the sediment or concentrated along laminae and is commonly associated with plant remains.

Overall, the description of KGS #1 Lyke by Leonard (1991) and the description presented in this report show similar major lithologic changes. However, the present description represents additional lithologic and sedimentological variability between 8 and 26 ft. Within this interval, Leonard (1991) described a thick succession of silty calcareous sandstone and provided detailed observations of its characteristics, including fossil content, although limited internal lithologic variation is represented in the graphic log.

In this report, the same interval begins with fossiliferous calcareous sandstone, followed by interbedded sandy siltstone and sandstone with moderate to high bioturbation. Above, sandstone, including both calcareous and non-calcareous beds, is interlaminated with abundant siltstone laminae and exhibits ripple structures. Between approximately 8 and 16 ft, the interval consists predominantly of calcareous sandstone and shows an upward increase in grain size, from fine-grained sandstone to nearly coarse-grained sandstone toward the top. The uppermost bed is fossiliferous and highly bioturbated. The present description documents greater lithologic detail and more systematically records grain-size changes, internal sedimentary structures, and bioturbation throughout the interval.

KGS #3 Lyke

In KGS #3 Lyke, Leonard (1991) described the Calhoun Shale as a succession dominated by sandy shale and sandstone. Reported sedimentary features include lamination, lenticular bedding, and soft-sediment deformation. Plant fragments are present in several intervals and are locally associated with bivalves, burrows, and other fossil material. The Calhoun Shale overlies the Deer Creek Formation/Limestone and is overlain by the Hamilton beds.

Based on the sedimentological description conducted for this report, the Calhoun Shale in KGS #3 Lyke (Appendix 2a) begins, from base to top, with one thin bed of finely laminated calcareous claystone and a thin bed of calcareous fine-grained sandstone. These beds are followed by approximately 7 ft of mudstone with wavy lamination, including a 2-ft-thick bed of sandy siltstone in the middle of the interval. Toward the top, approximately 1 ft of interbedded siltstone, calcareous medium-grained sandstone, and sandy siltstone exhibits synsedimentary deformation.

Above this interval, approximately 4 ft of siltstone is characterized by wavy lamination and plant remains. The middle part of the core consists of approximately 8 ft of interbedded sandy siltstone, muddy sandstone, and calcareous fine-grained sandstone. At the base, this interval contains skeletal grains, including brachiopods, crinoids, bryozoans, and mollusks, whereas the overlying deposits exhibit wavy lamination and moderate bioturbation. The uppermost approximately 10 ft consists predominantly of calcareous very fine- to medium-grained

sandstone interlaminated with siltstone laminae and lenses. This interval exhibits wavy lamination, moderate bioturbation, and abundant organic-matter laminae.

The description of KGS #3 Lyke by Leonard (1991) and the description presented in this report show some differences in the representation of lithologic variability. In Leonard's (1991) graphic log, much of the Calhoun Shale is represented as sandy shale and silty sandstone, resulting in a relatively homogeneous lithologic pattern. However, his written description provides detailed observations of fossil content and composition.

In the present description, the graphic log documents more pronounced vertical lithologic changes throughout the core. At the base, mudstone alternates with calcareous sandstone, siltstone, and sandy siltstone, followed upward by a thicker siltstone interval containing plant remains. Soft-sediment deformation occurs at approximately 25 ft. Between 21 and 14 ft, the core is characterized by heterogeneous interbedding of calcareous sandstone and sandy siltstone, with wavy lamination and moderate bioturbation. The upper part of the core consists predominantly of calcareous sandstone interlaminated with siltstone laminae and lenses and exhibits ripples and wavy lamination. This upper sandstone interval also records an upward decrease in grain size, from medium-grained sandstone at the base to very fine-grained sandstone toward the top.

The present description documents greater vertical lithologic detail and more systematically represents interbedding and interlamination, grain-size changes, internal sedimentary structures, and bioturbation throughout the core.

KGS #1 Ulrich

Leonard (1991) described a heterogeneous Calhoun Shale succession in KGS #1 Ulrich composed of silty shale, sandy shale, sandstone, and a limestone (from 14–15 ft). Sedimentary structures reported from the siliciclastic intervals include lenticular bedding, ripple cross-stratification, and soft-sediment deformation or slump structures. Plant fragments occur throughout parts of the succession and are locally associated with *Lingula* and burrows. The Calhoun Shale in KGS #1 Ulrich overlies strata assigned to the Deer Creek Formation/Limestone and is overlain by the Topeka Limestone.

Based on the sedimentological description conducted for this report, the Calhoun Shale in KGS #1 Ulrich (Appendix 3a) begins, from base to top, with approximately 12 ft of claystone and mudstone with local wavy lamination and minor sandstone lenses. This interval is followed by approximately 14 ft of interbedded fine-grained sandstone and siltstone. Within this interval, sandstone beds contain siltstone laminae and lenses, whereas siltstone beds contain sandstone laminae and lenses. Sedimentary structures are abundant and include wavy lamination and ripples, some of which are bidirectional, as well as possible cross-bedding toward the top. At approximately 22 ft, a <1-ft-thick bed of coarse-grained sandstone with wavy lamination occurs. Moderate bioturbation is observed immediately above this bed. The interbedded sandstone and siltstone are capped by a <1-ft-thick limestone bed with a packstone texture composed primarily of brachiopods and mollusks. The uppermost part of the Calhoun Shale consists of approximately 7 ft of claystone characterized by wavy lamination.

Overall, the description of KGS #1 Ulrich by Leonard (1991) and the description presented in this report show similar major lithologic changes. However, the present description documents

greater lithologic and sedimentological detail between 16 and 30 ft. Within this interval, Leonard (1991) reported, from base to top, interbedded shale and sandstone followed by silty sandstone and sandy to silty shale. His description provides additional details on color and fossil constituents and notes the presence of burrows.

In the present description, the same interval consists, from base to top, of interbedded and interlaminated siltstone with laminae, lenses, and beds of sandstone. Some sandstone beds also contain siltstone interlaminations. The most prominent sedimentary structures include bidirectional ripples, wavy to parallel lamination, and low to moderate bioturbation. Between 14 and 22 ft, below the limestone bed, a siltstone interval contains interlaminated laminae and lenses of fine-grained sandstone. Toward the top of this interval, the sandstone laminae display wavy lamination and possible cross-bedding. Moderate bioturbation occurs at approximately 22 ft.

References

Dott, R., 1964, Wacke, graywacke and matrix; what approach to immature sandstone classification?: Journal of Sedimentary Research, v. 34, p. 625–632.

Dunham, R. J., 1962, Classification of carbonate rocks according to depositional textures, in Ham, W. E., ed., Classification of Carbonate Rocks—A Symposium: American Association of Petroleum Geologists, Memoir, p. 108–121.

Folk, R. L., 1980, Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin, 182 p.

Jewett, J. M., O'Connor, H. G., and Zeller, D. E., 1968, Pennsylvanian System, in Zeller, D. E., ed., The stratigraphic succession in Kansas: Kansas Geological Survey, Bulletin 189, p. 21–43, https://doi.org/10.17161/kgsbulletin.no.i189.22214

Leonard, K. W., 1991, A log of ten cores of the Deer Creek Limestone, Calhoun Shale, Topeka Limestone, and Hamilton Lagerstätte (Virgilian, Upper Pennsylvanian) from the Hamilton area, Greenwood County, Kansas: Kansas Geological Survey, Open-File Report 91-58, 30 p.

Pemberton, G., Frey, R., Ranger, M., and MacEachern, J., 1992, The conceptual framework of ichnology: applications of ichnology to petroleum exploration, a core workshop, ed. Pemberton, G., p.1–32.

Pettijohn, F., and Potter, P., 1964, Atlas and Glossary of Primary Sedimentary Structures, Springer-Verlag, Berlin-Göttingen, Heidelberg , 370 p. https://link.springer.com/book/10.1007/978-3-642-94899-2

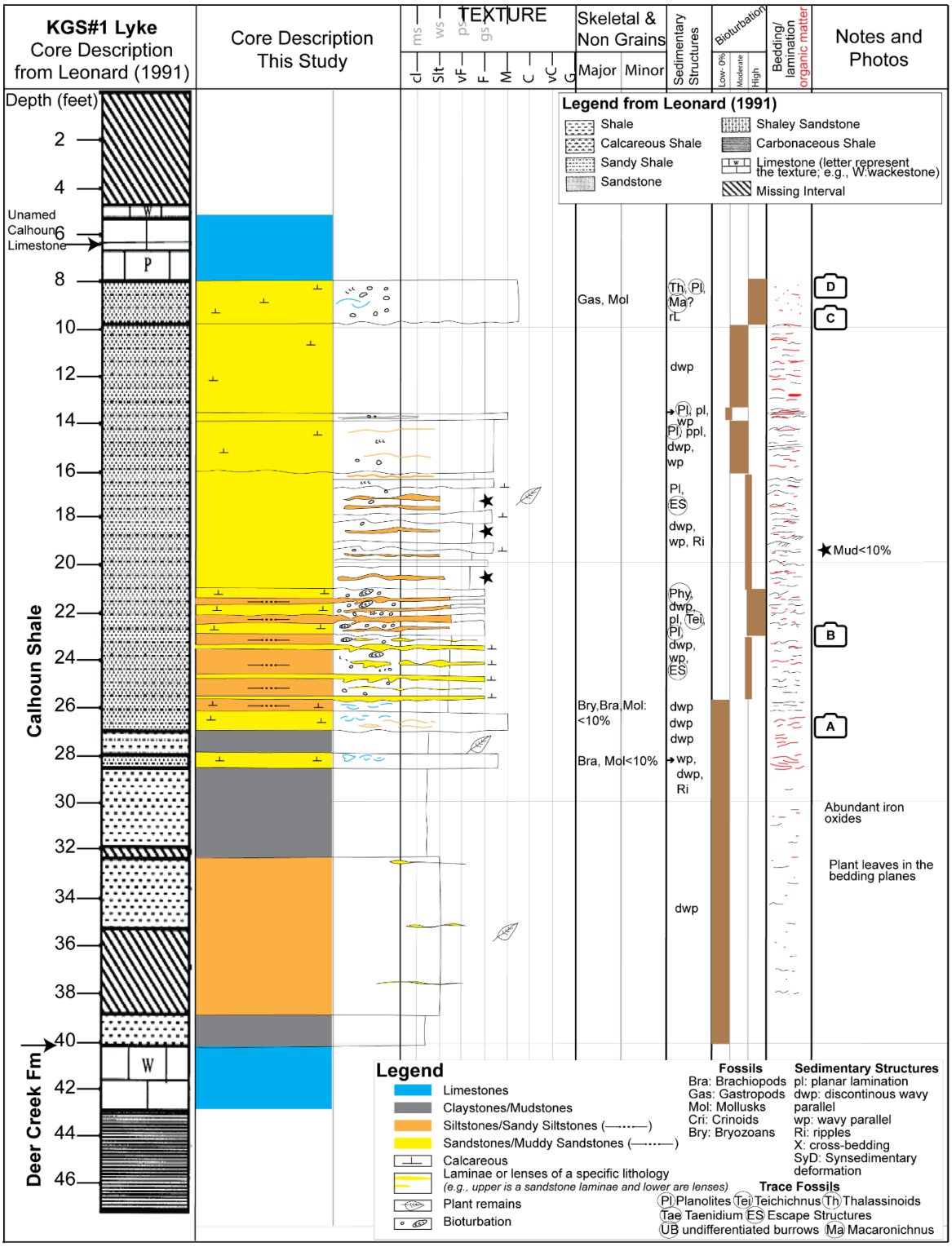
Sawin, R. S., Franseen, E. K., Watney, W. L., West, R. R., and Ludvigson, G. A., 2009, New stratigraphic rank for the Carboniferous, Mississippian, and Pennsylvanian in Kansas; in Current Research in Earth Sciences: Kansas Geological Survey, Bulletin 256, part 1, p. 1–4. https://doi.org/10.17161/kgsbulletin.no.256.20374

Wentworth, C. K., 1922, A scale of grade and class terms for clastic sediments: The Journal of Geology, v. 30, p. 377–392.

Appendices

Appendix 1. KGS #1 Lyke Core

Appendix 1a. Core description.



Appendix 1b. Selected photos from core.



Photo A. KGS #1 Lyke at 26.6 ft. Mollusk shells.



Photo B. KGS #1 Lyke at 23 ft. Abundant trace fossils.

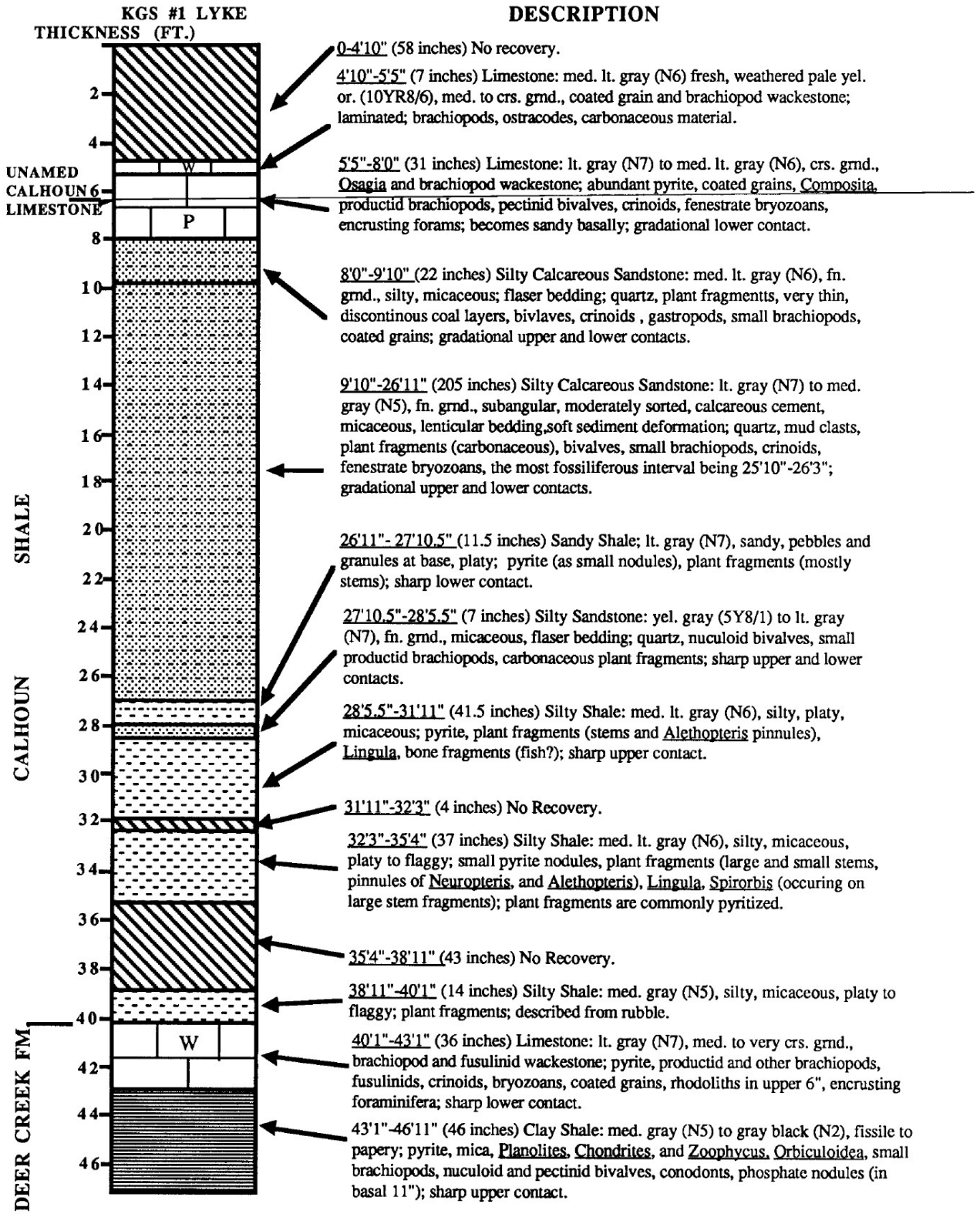


Photo C. KGS #1 Lyke at 10 ft. Bioturbation.



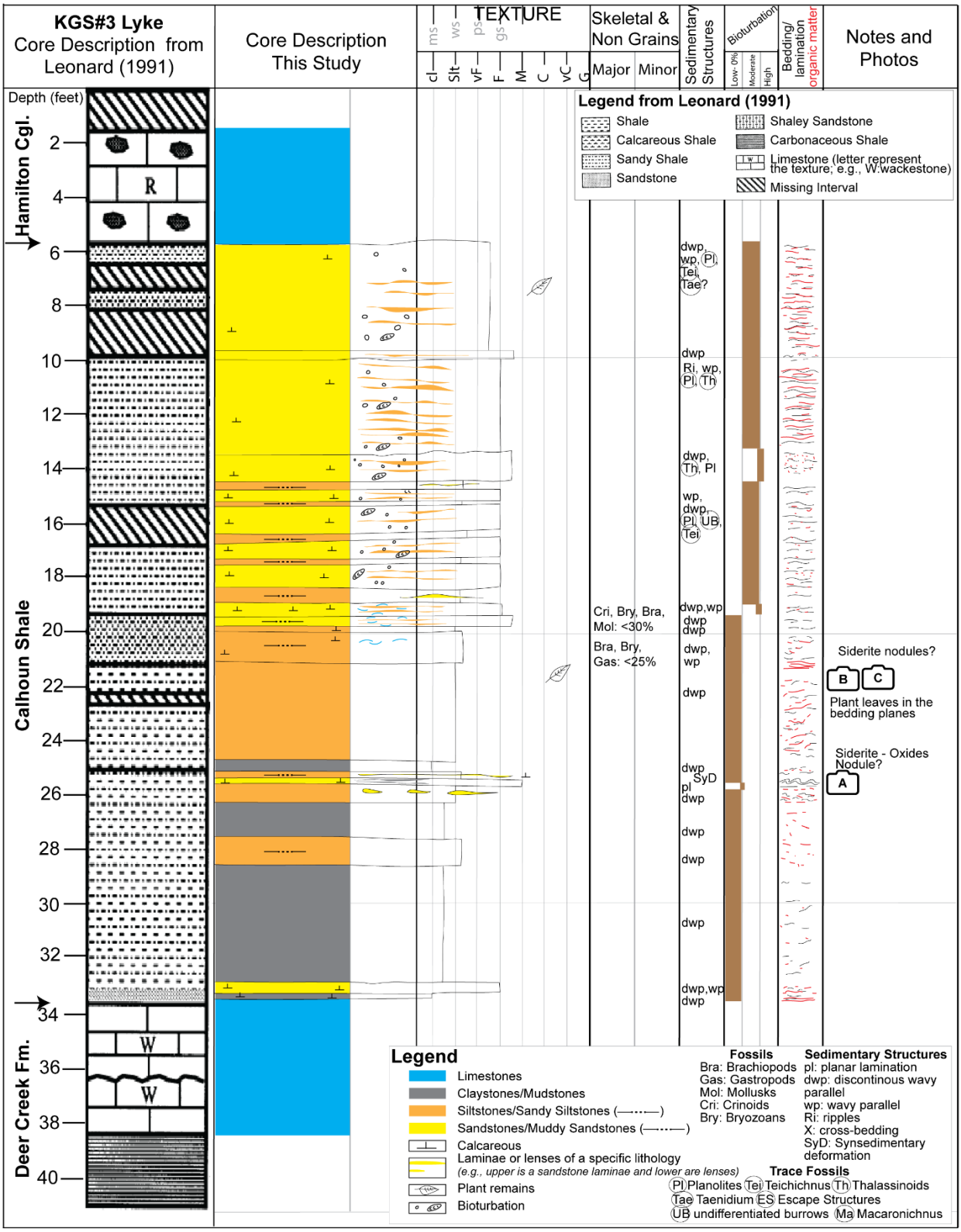
Photo D. KGS #1 Lyke at 9 ft. High bioturbation.

Appendix 1c. Core description from Leonard (1991).



Appendix 2. KGS #3 Lyke Core

Appendix 2a. Core description.



Appendix 2b. Selected photos from core.



Photo A. KGS #3 Lyke at 25 ft. Synsedimentary deformation.

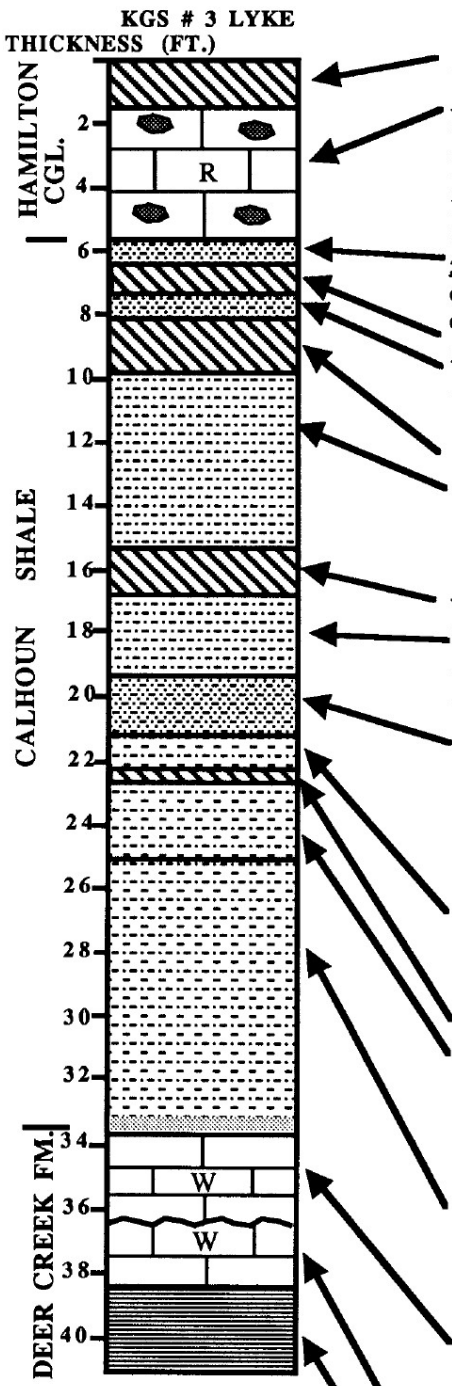


Photo B. KGS #3 Lyke at 21 ft. Plant remains.



Photo C. KGS #3 Lyke at 21 ft. Plant remains.

Appendix 2c. Core description from Leonard (1991).



DESCRIPTION

0-1'6" (18 inches) No Recovery.

1'6"-5'9" (51 inches) Conglomeratic Limestone: very lt. gray (N8) to med. gray (N5) to weatherd pl. tel. or. (10YR8/6), crs. grnd to pebble size clasts, sparry matrix, intraclast and skeletal rudstone; pyrite, intraclasts (at least 6 different lithologies), fuslinids, productid and other brachiopods, crinoids, echinoids, bryozoans, gastropods, bivalves, rhodoliths, coated grains, smaller foraminifera; sharp lower contact.

5'9"-6'6.5" (9.5 inches) Silty Sandstone: med. lt. gray (N6), fn. grnd., calcareous cement, micaceous, silty, soft sediment deformation, laminated, flaser bedding; quartz, plant fragments.

6'6.5"-7'7.5" (13 inches) No Recovery.

7'7.5"-8'2" (6.5 inches) Silty Sandstone: med. lt. gray (N6), fn. grnd., silty, micaceous, calcareous cemnt, flaser bedding, soft sediment deformation; plant fragments, fish teeth and bones.

8'2"-9'10" (20 inches) No Recovery.

9'10"-15'5" (67 inches) Sandy Shale: med. lt. gray (N6), silty to fn. grnd., micaceous, calcareous, soft sediment deformation, lenticular bedding; quartz, plant fragments, burrows (Planolites?), bivalves.

15'5"-16'9" (16 inches) No Recovery.

16'9"-19'5" (32 inches) Sandy Shale: very lt. gray (N8) to med. lt. gray (N6), silty to fn. grnd., laminated, micaceous, soft sediment deformation; quartz, pyrite, plant fragments (small stems), burrows (Planolites); gradational lower contact.

19'5"-21'4.5" (23.5 inches) Very Silty Sandstone: very lt. gray (N8) to med. lt. gray (N6), silty to fn. grnd., calcareous, micaceous, laminated, soft sediment deformation; quartz, pyrite, selenite, myalinid and pectinid bivalves, productid and other brachiopods, bryozoans, gastropods, plant fragments (large and small stems), Spirorbis; skeletal grains broken and abraded; sharp lower contact.

21'4.5"-22'2.5" (10 inches) Sandy Shale: med. lt. gray. (N6), clay to very fn. sand, laminated, platy; plant fragments (pinnules of Alethopteris, and small and large stems; plant fragments are pyritized.

22'2.5"-22'2.7" (5 inches) No Recovery.

22'7.5"-25'3" (31.5 inches) Sandy Shale: med. lt. gray (N6), clay to very fn. grnd. sand, laminated, platy, micaceous; pyrite, plant fragments (pinnules of Alethopteris, Pecopteris, and Neuropteris, and large and small stems), ostracodes (smooth tests), Spirorbis; gradational lower contact.

25'3"-33'9" (102 inches) Sandy Shale: lt. gray (N7) to med. lt. gray (N6), silty to fn. grnd., platy to flaggy, low angle cross-bedding in upper part of unit, laminated, micaceous; pyrite, selenite, quartz, plant fragments (pinnules of Neuropteris, and small and large stems), burrows (Planolites); sharp basal contact.

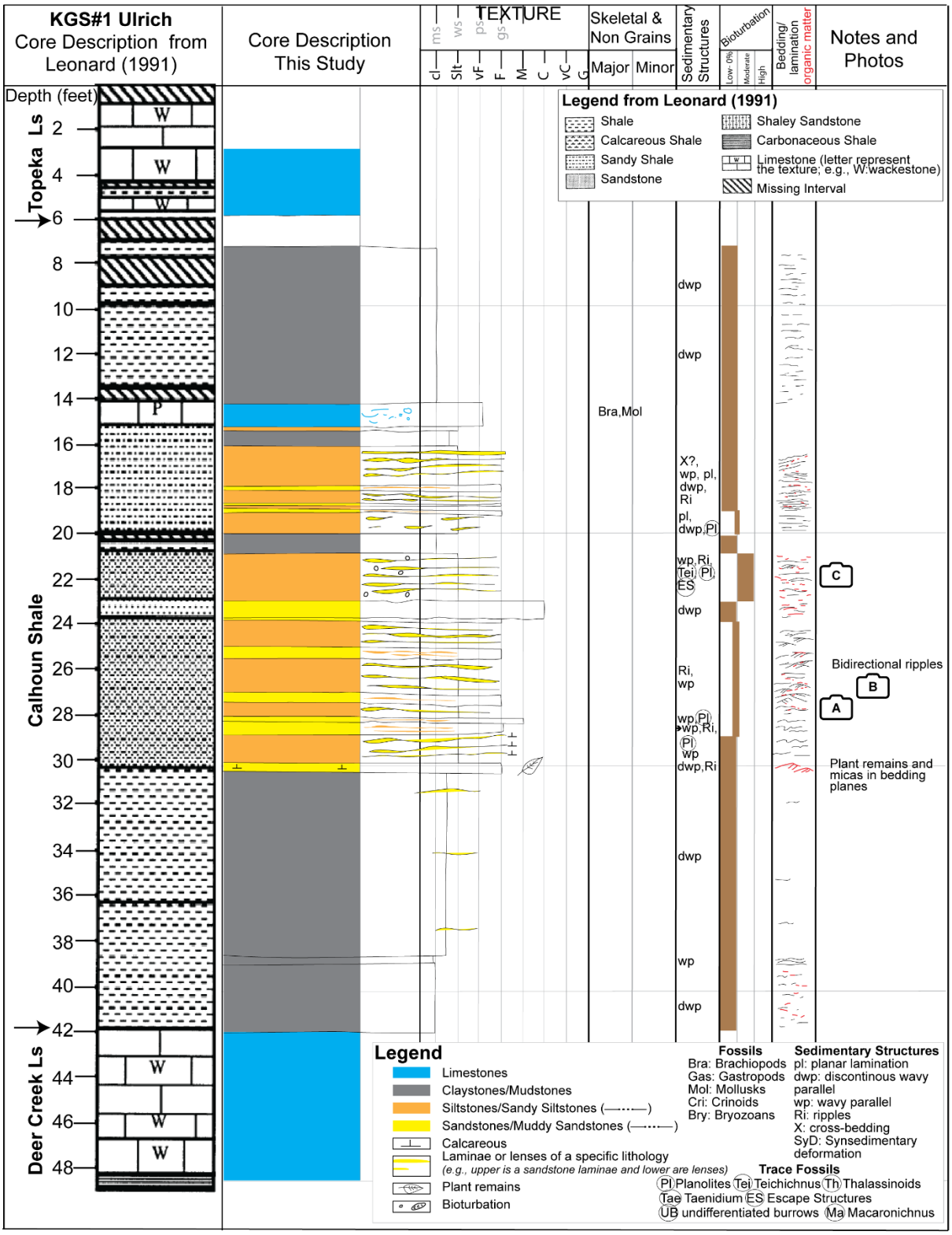
33'9"-36'6" (33 inches) Limestone: lt. gray (N7) to lt. br. gray (5YR6/1), crs. to very crs. grnd., rhodolith and brachiopod wackestone; pressure solution features (seams, styolites, and thin shale breaks) spar filled fractures; rhodoliths, productid and other brachiopods, bryozoans, gastropods, smaller and encrusting foraminifera, fusulinids, phylloid algae, ostracodes, rugose corals, sponges, coated grains; abundant skeletal debris at base; wavy lower contact.

36'6"-38'3.5" (21.5 inches) Limestone: med. lt. gray (N6) to lt. gray (N7), med. to very crs. grnd., Osagia and brachiopod wackestone.

38'3.5"-41'3" (35.5 inches) Clay Shale: med. gray (N5) to grayish black (N2), laminated, papery to fissile; sharp upper contact.

Appendix 3. KGS #1 Ulrich Core

Appendix 3a. Core description.



Appendix 3b. Selected photos from core.



Photo A. KGS #1 Ulrich at 28 ft. Interlamination of siltstone and sandstones.



Photo B. KGS #1 Ulrich at 27 ft. Sandstones interlaminated with siltstones and ripples.

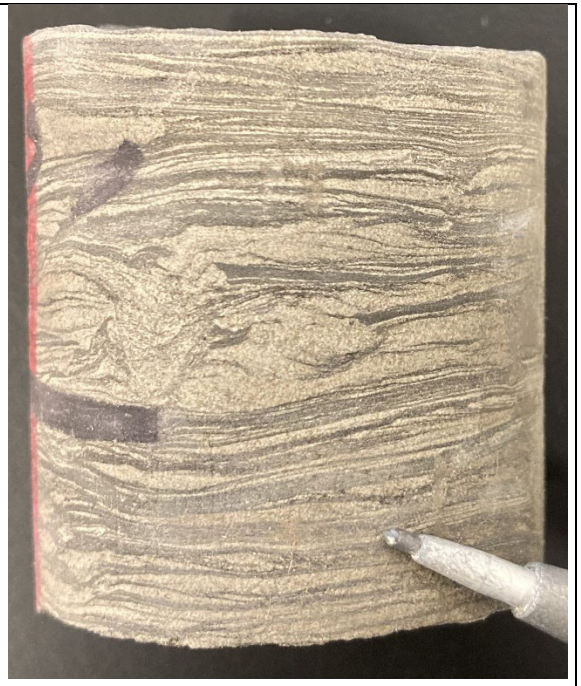
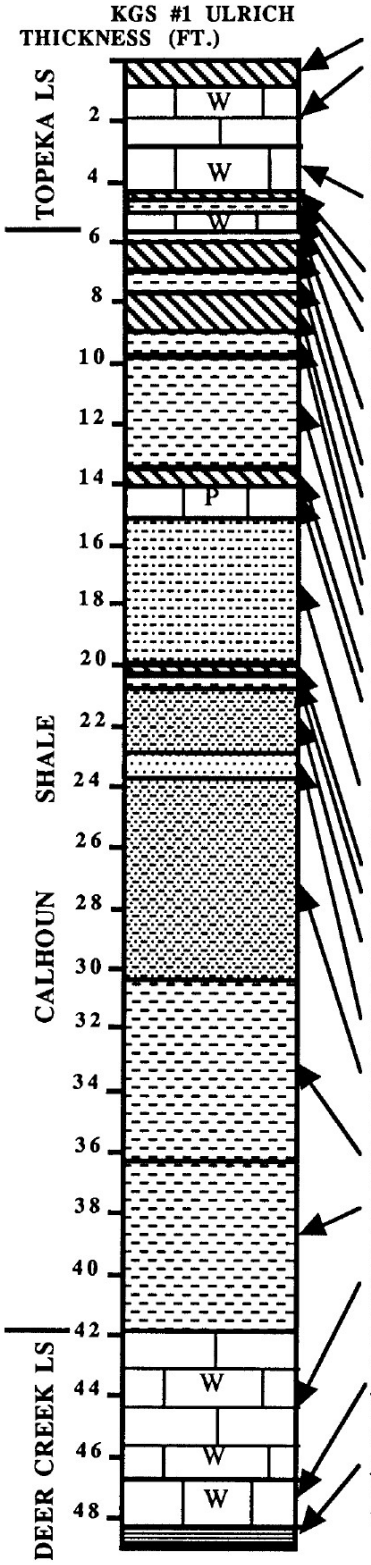


Photo C. KGS #1 Ulrich at 22 ft. Bioturbation and wavy lamination.

Appendix 3c. Core description from Leonard (1991).



DESCRIPTION

0-8" (8 inches) No Recovery.

8"-2'10" (26 inches) Limestone: lt. brn. gray (5YR6/1) to weathered very lt. gray (N8) and mottled dk. yel. or. (10YR6/6), med. to very crs. grnd., vuggy, brachiopod and crinoid wackestone; Composita and other brachiopods, crinoids, ostracodes, phylloid algae, fusulinids, gastropods; spar filled vugs and fractures; lower boudary is a sharp change in the amount of weathering and fossil content.

2'10"-4'2" (16 inches) Limestone: lt. gray (N7) to weatherd mottled gr. or. (10YR7/4), crs. to very crs. grnd., sandy, vuggy, crinoid and brachiopod wackestone; pyrite, crinoids, small productids and other bachiopods, coated grains, encrusting foraminifera, sponges.

4'2"-4'4" (2 inches) No Recovery.

4'4"-5'1" (9 inches) Shale: Drilled.

5'1"-5'7.5" (6.5 inches) Limestone: lt. gray (N7), crs. to very crs. grnd., crinoid and brachiopod wackestone to packstone; crinoids, brachiopods, coated grains, encrusting foraminifera, sponges; sharp basal contact.

5'7.5"-5'10.5" (3 inches) Silty Shale: med. lt. gray (N6), silty, micaceous, platy, sandy; plant fragments (small stems).

5'10.5"-6'11.5" (13 inches) No Recovery.

6'11.5"-7'9.5" (10 inches) Silty Shale: med. lt. gray (N6), silt to very fine sand, micaceous, platy; plant fragments (small stems).

7'9.5"-9'0.5" (15 inches) No Recovery.

9'0.5"-9'9.5" (9 inches) Shale: Drilled.

9'9.5"-13'6" (44.5 inches) Silty Shale: med. lt. gray (N6), sandy, platy, micaceous; plant fragments (small stems), burrows (Planolites).

13'6"-14'1" (7 inches) No Recovery.

14'1"-15'2" (13 inches) Limestone: med. lt. gray (N6), crs. to very crs. grnd., coated grain and bivalve packstone; coated grains, large, robust bivalves, crinoids, productid brachiopods, encrusting foraminifera, sponges; sharp lower contact.

15'2"-19'11.5" (57.5 inches) Sandy Shale: med. lt. gray (N6) to very lt. gray (N8), clay to very fn. sand, platy, micaceous, laminated, lenticular bedding, ripple cross-stratification and slump; pyrite nodules, quartz sand, plant fragments (often pyritized), Lingula.

19'11.5"-20'2.5" (3 inches) No Recovery.

20'2.5"-20'7.5" (5 inches) Silty Shale: med. lt. gray (N6), sandy, platy, micaceous; plant fragments.

20'7.5"-22'10.5" (27 inches) Sandy Shale: med. lt. gray (N6) to very lt. gray (N8), clay to very fn. sand, micaceous, platy, sandy lenses, laminated, lenticular bedding; pyrite, qurtz, plant fragments; gradational lower contact.

22'10.5"-23'9.5" (11 inches) Silty Sandstone: lt. gray (N7) to very lt. gray (N8), fn. grnd., minor carbonate cement; quartz, mica, plant fragments.

23'9.5"-30'5.75" (80.25 inches) Interbedded Shale and Sandstone: med. lt. gray (N6) to very lt. gray (N8), silty shale, very fn. grnd. sand, flaser anmd lenticular bedding, soft sediment deformation; plant fragments; sharp upper and lower contact.

30'5.75"-36'4" (70.25 inches) Silty Shale: med. gray (N5) to lt. gray (N7), platy, slightly micaceous, laminated; plant fragments, burrows, Lingula; gradational lower contact.

36'4"-41'11" (67 inches) Clay Shale: med. dk. gray (N4) to dk. gray (N3), platy to fissile, silty; pyrite nodules, plant fragments, becomes more fossiliferous basally with bryozoans, small productid brachiopods, and crinoids; sharp lower contact.

41'11"-46'8" (57 inches) Limestone: lt. gray (N7), to med. gray (N5), med. to crs. grnd., wavy bedded, brachiopod and fusulinid wackestone; Composita, Hustedia, small productid brachiopods, fusulinids, Astartella, bryozoans, crinoids, ostracodes, coated grains, sponges; gradational lower contact.

46'8"-48'3" (19 inches) Limestone: med. lt. gray (N6) to brn. gray (5YR4/1), med. to crs. grnd., brachiopod and crinoid wackestone; small brachiopods, crinoids, encrusting foraminifera, coated grains; sharp lower contact.

48'3"-49'3" (12 inches) Clay Shale: med. dk. gray (N4) to gray blk. (N2), platy to fissile, finely laminated; burrow mottled (Chondrites and Planolites), small bivalves, Orbiculoidea, plant fragments.