Oklahoma
Geological
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2004

Special Publication 2004-1

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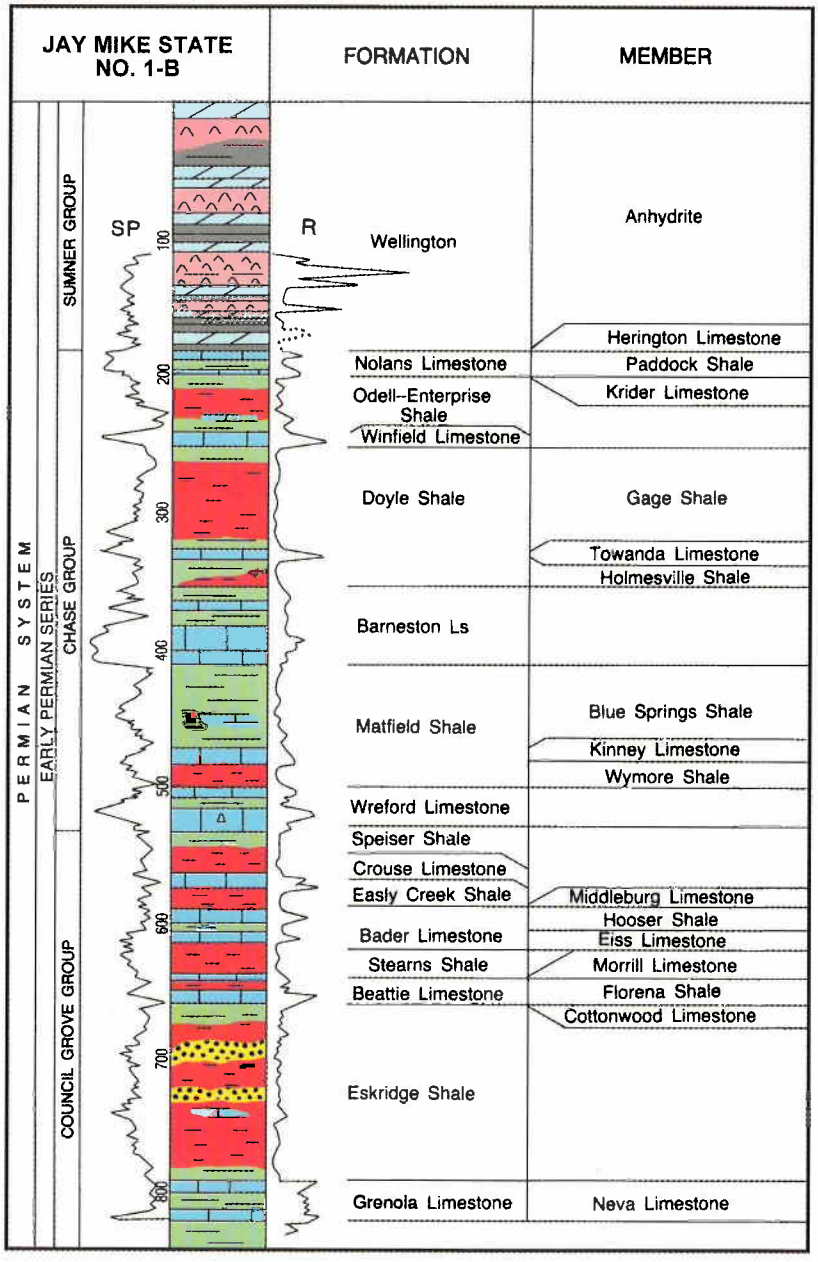

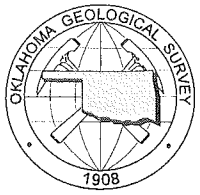

Special Publication 2004-1
ISSN 0275-0929

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James R. Chaplin

Oklahoma Geological Survey
Charles J. Mankin, *Director*

The University of Oklahoma
Norman, Oklahoma

2004

Front Cover

General lithologic log for Lower Permian stratigraphic units in the study area, showing correlations with wireline-log signatures of the Jay Mike State No. 1-B well in the NW¼NE¼NE¼ sec. 13, T. 27 N., R. 1 E., Newkirk SW Quadrangle, Kay County, Oklahoma. Lithologic interpretations are based on data from Core Hole KC-7 (Appendix 7) drilled 1.5 mi north of the Jay Mike State No. 1-B well.

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Core Drilling and Stratigraphic Analysis of Lower Permian Rocks, Northern Oklahoma Shelf, Kay County, Oklahoma

James R. Chaplin
Oklahoma Geological Survey

ABSTRACT.—The purpose of this investigation was to obtain information about the local bed sequence, thickness variations, stratigraphic-boundary relationships, and regional facies changes in Lower Permian rocks in Kay County, Oklahoma. The new core-hole data supplemented data gathered from the examination of surface rocks for the purpose of constructing an areal geologic map of Kay County. The purpose of the new data was to evaluate the accuracy of existing interpretations of stratigraphy and structure.

Detailed descriptions of lithologic units cored in 10 holes and the description of one measured surface section, as well as stratigraphic interpretations, are presented in this report. These detailed descriptions are the first published data describing a continuous stratigraphic sequence from this interval of Lower Permian rocks in central northern Oklahoma.

Reevaluation of published geologic interpretations, and comparison with new core-hole data, resulted in revisions of earlier geologic mapping in Kay County.

INTRODUCTION

Fundamental to all other activities of the Oklahoma Geological Survey (OGS) is the need for accurate, detailed geologic-map coverage of the State. Surface geologic mapping at a scale of 1 in. = 1 mi or larger is in progress. Most of the data for a mapping project come from field work—measuring and describing sections on outcrop. However, since the purchase of a core-drilling rig by the OGS, subsurface data have provided important information for clarifying local bed sequence, thickness variations, stratigraphic-boundary relationships, and regional facies changes.

Detailed descriptions of the core-hole logs (appendixes) drilled by the OGS during the initial stages of the surface mapping of Kay County are the focus of this report.

Previous Investigations

Published data on the general surface geology of Kay County are almost exclusively limited to discussions of a regional nature (Gould, 1900, 1905, 1925; Clark and Cooper, 1927; Raasch, 1941, 1946; Fay, 1972; Chaplin, 1988, 1994). Detailed discussions of the stratigraphy and depositional environments of the Chase Group in Kay County include those of Toomey (1992) and Chaplin (1996). Unpublished information regarding the general surface geology is found primarily in theses (Raasch, 1946; Noll, 1955; Hruby, 1955; Chinsomboon, 1976).

Subsurface studies are represented primarily by information on individual oil and gas fields or structures in the County (Ohern and Garrett, 1912; Aurin, 1920; Pratt, 1923; Clark and Cooper, 1927; Luza and Lawson, 1982; Davis, 1984, 1985; Dolton and Finn, 1989; Schloeder, 1998; Gay, 1999, 2003). Unpublished subsurface studies primarily include theses (Henderson, 1922; Weinzierl, 1922; Vanzant, 1926; Bryan, 1950; Smith, 1954, 1955; Querry, 1957, 1958; Bradshaw, 1959; Clements, 1961).

Purpose

The primary purpose of the stratigraphic tests was to obtain information concerning the lithologic character, thickness, and stratigraphic sequence of Lower Permian strata of the Northern Oklahoma Shelf in Kay County. A core-drilling project for the County was initiated when it became apparent that abrupt changes in facies and thicknesses of individual units, coupled with limited and poor surface exposures, effectively prevented the compilation of a complete and continuous stratigraphic section. The core-hole data were used in conjunction with surface data and electric logs to summarize the areal extent and stratigraphic relations of Lower Permian rocks in Kay and adjacent counties.

The second purpose of this study was to reevaluate the accuracy of interpretations of stratigraphy and structure of previous workers. Some necessary revising of earlier geologic mapping resulted from the core-hole data.

Methods

Drill-hole sites were selected to maximize the collection of stratigraphic data for all surface-mapped geologic units over a county-wide area. Two-in.-diameter cores were recovered with the OGS core-drilling rig, using water as the drilling fluid. Detailed descriptions of the geologic logs (appendixes) were made in the field at the drill sites. Core recovery from a total cumulative stratigraphic interval of 3,125 ft varied from 85% to 91%. The poorest recovery of cores came from those intervals with mudstone-rich rocks containing marble-

and golf-ball-size calcareous nodules. Poor core recovery also occurred in anhydrite/gypsum-rich intervals, where coring was difficult because of frequent hole-breaching.

The boxed and labeled cores are stored at the OGS Core Library in Norman.

Locations

Ten core holes were drilled in Kay County by the OGS for stratigraphic tests. Figure 1 shows the locations of the 10 core-hole sites (KC-1–KC-10), 4 reference-log wells (E-1–E-4), and 1 measured surface section (K-24) in Kay County. The index map shows the location of Kay County (black) in Oklahoma as well as the Northern Oklahoma Shelf (ruled). The legal description of the location of each drill site is given in the core-log heading.

General Stratigraphy

All of the holes were drilled in rocks of the upper Council Grove, Chase, and lower Sumner Groups (Lower Permian) (Chaplin, 1988). Figures 2 and 3 are composite stratigraphic sections compiled from measured surface sections and core-hole data. A description of one measured surface section (K-24) is included in this report with Core Hole KC-1 (Appendix 1) for the purpose of stratigraphic completeness. Therefore, measured surface section K-24 and Core Hole KC-1 should be viewed as a continuous sequence. Because the stratigraphic succession exhibits a southward facies change, it is appropriate to describe the Lower Permian sequence in terms of northern and southern Kay County (Chaplin, 1988, p. 97). Northern Kay County includes T. 28–29 N., R. 2 W.–5 E., and southern Kay County includes T. 25–27 N., R. 2 W.–5 E. The stratigraphic succession, general facies, and average thicknesses of the northern facies are shown in Figure 2, and those of the southern facies in Figure 3. Some discrepancies in thicknesses may occur between those shown in Figures 2 and 3, and thicknesses shown for reference electric logs (Table 1). Lithologic symbols used in the columns are explained in Figure 4. A detailed description of the stratigraphic relations of physically correlative rocks, at least in part, in Kansas and Nebraska is given in Chaplin (1988).

Lithologic descriptions and stratigraphic interpretations were made by the author. Stratigraphic names of units cored are given in the core logs.

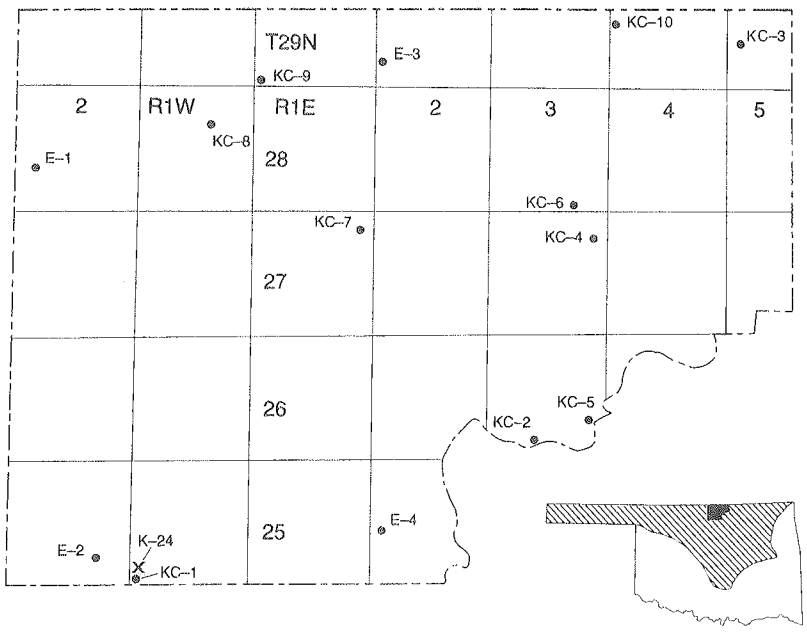

Figure 1. Locations of core-hole sites (•KC-), reference-log wells (•E-), and the measured section (x K-24) in Kay County, central northern Oklahoma. Index map shows Kay County in Oklahoma and the Northern Oklahoma Shelf.

CORE-HOLE LOGS

Core-hole logs are numbered according to drilling sequence and are keyed to the letters and numbers in the location map (Fig. 1). The letters *KC* preceding each number refer to "Kay County Core Hole," and the number to the order in the drilling sequence. The cores were field logged at the drill site. Table 2 shows the locations of the core holes, total depths of the holes, and depths to formation and member tops.

The lithologic column at the left side of each page (see appendixes) diagrammatically shows the sequence of rocks described in the log and gives the thicknesses and stratigraphic names of the units cored. Lithologic symbols used in the columns are explained in Figure 4.

REFERENCE ELECTRIC LOGS

Figures 5–8 demonstrate the characteristic log signatures one might reasonably expect from lithostratigraphic units cored in Kay County. For the sake of stratigraphic completeness, reference logs were chosen only from those parts of Kay County where the cored sequence is complete. No one log response is sufficient to demonstrate the local and regional facies relationships of Lower Permian rocks in Kay County. See Figure 1 for locations of the wells. Table 1 is a summary of the locations of the reference electric logs and the depths to formation and member tops.

STRATIGRAPHIC ANALYSIS OF CROSS SECTIONS

Significance

This study is the first to integrate core-hole data with electric-log signatures to clarify the facies distribution and to test the effectiveness of the correlations of Lower Permian cyclic sequences in central northern Oklahoma. In the past, the lithologic significance of prominent log

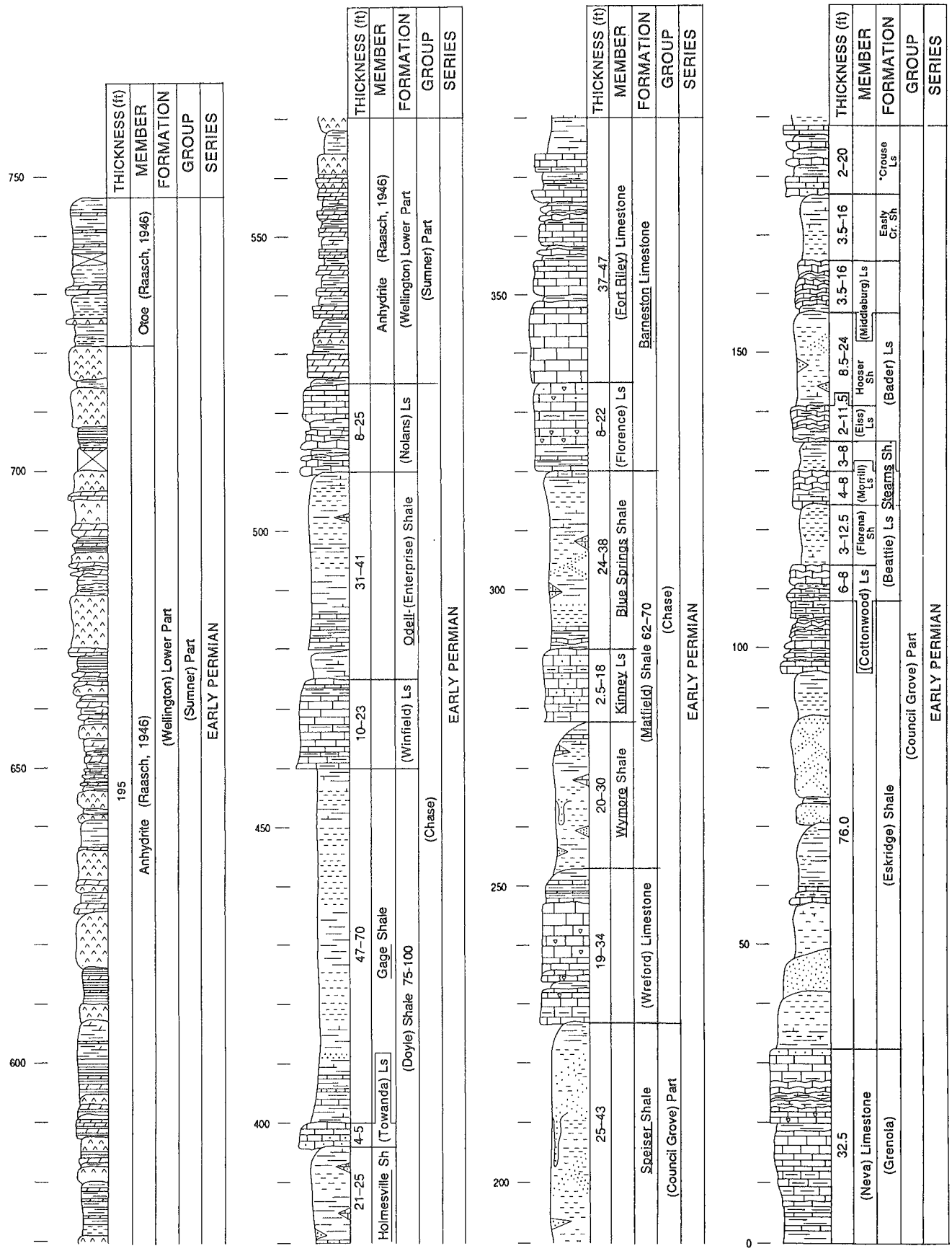

Figure 2. Composite stratigraphic section for northern Kay County, T. 28–29 N., R. 2 W.–5 E. Data from measured sections and cores. See Figure 4 for explanation of lithologic symbols.

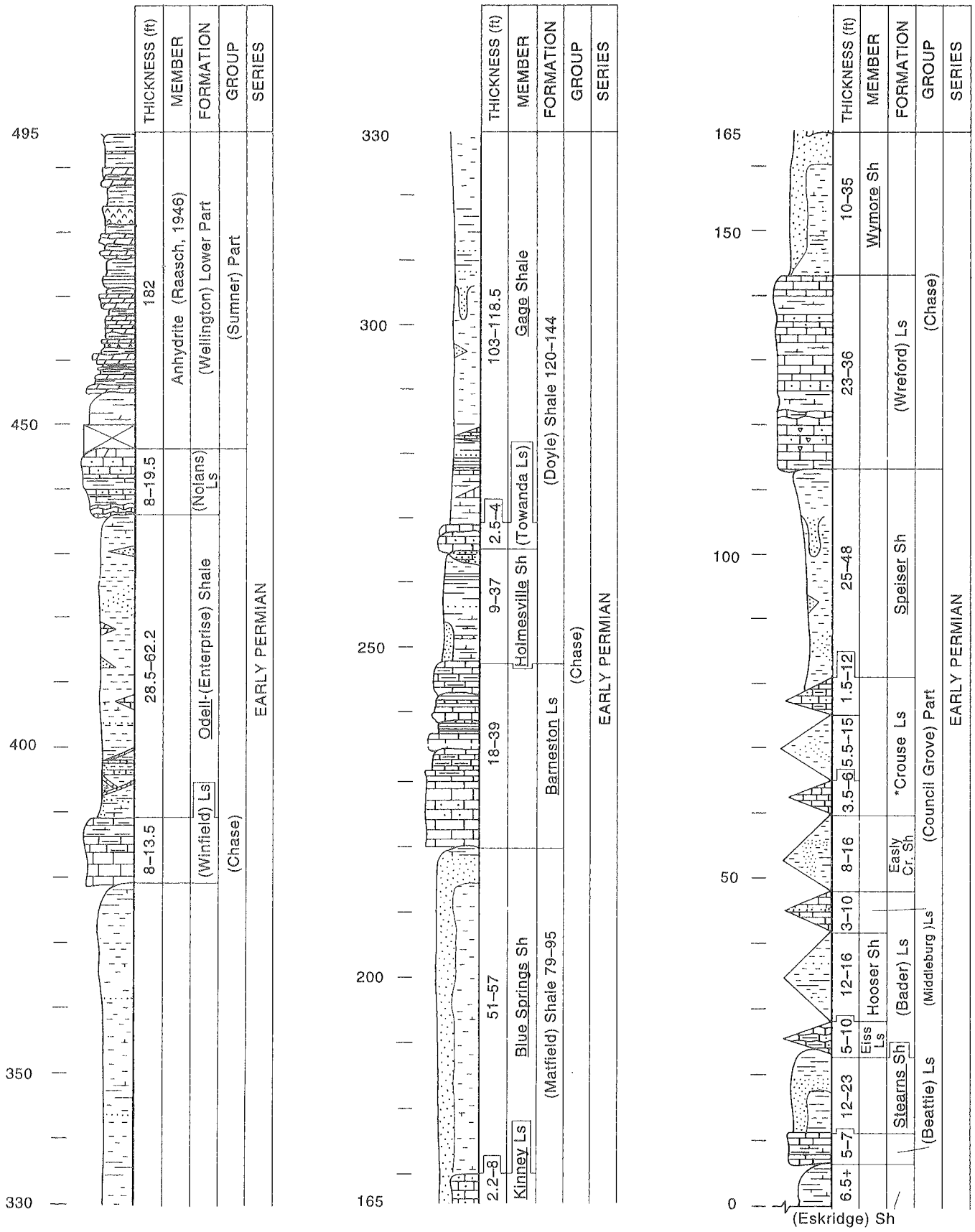

Figure 3. Composite stratigraphic section for southern Kay County, T. 25–27 N., R. 2 W.–5 E. Data from measured sections and cores. See Figure 4 for explanation of lithologic symbols.

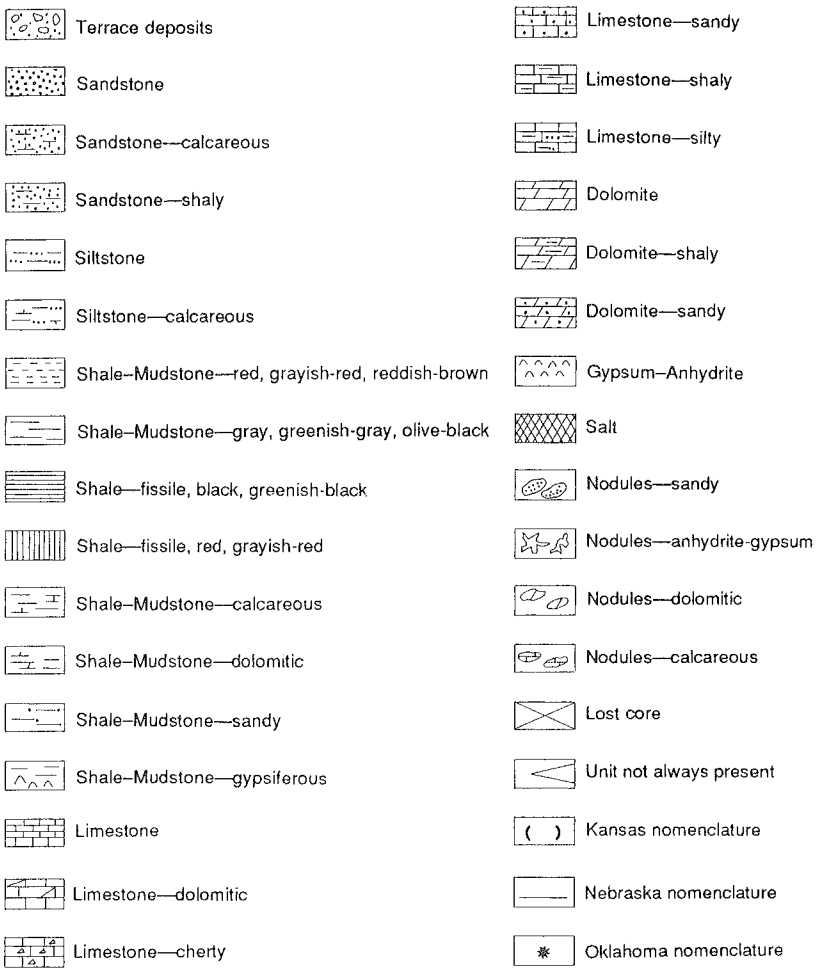

Figure 4. Lithologic symbols used in Figures 2 and 3 and appendixes.

markers was largely unknown because of the lack of good core control. Correlations cannot be based solely on log markers; they also depend on relating facies in cores to their well-log signatures. In order to show an approximate restoration of depositional topography wherever possible, a datum horizon at the top of the Wreford Limestone is used in cross section A–A′, Plate 1 (in envelope).

Methodology

Core-hole data were integrated with spontaneous-potential (SP) and resistivity electric-log signatures to construct two stratigraphic cross sections: A–A′, Plate 1, and B–B′, Plate 2 (in envelope), across western and eastern Kay County, respectively. The SP curve is at the left of each electric log, and the resistivity curve is at the right. The cross sections were constructed approximately parallel to strike (i.e., north–south). In order to show an approximate restoration of depositional topography wherever possible, a datum horizon at the top of the Wreford Limestone was used in cross section A–A′ (Pl. 1). However, in cross section B–B′ (Pl. 2) the difference in core-hole and electric-log vertical scales, and the greater overall stratigraphic thicknesses recorded from core holes, logistically prohibit the selection of a datum. In order to define detailed lithologies, core-hole data are illustrated at a vertical scale of 1 in. = 15 ft. Electric logs are shown at a vertical scale of 1 in. = 100 ft. For the most part, gamma-ray, neutron, sonic, and other types of geophysical logs were unavailable for this study area. Electric logs and cores are correlated with outcrop data (Chaplin, 1988).

Objectives

The objectives for construction of the cross sections are sixfold: to (1) establish vertical lithologic sequences, (2) extend detailed facies from core holes to electric-log signatures, (3) test lithostratigraphic correlations, (4) illustrate vertical and lateral relationships of individual lithic units, (5) show local and regional thickness and facies variations, and (6) document the stratigraphic positions of locally reported sandstone reservoirs that produce petroleum.

STRATIGRAPHIC CROSS SECTION A–A′ (Plate 1)

Stratigraphic cross section A–A′ extends north to south from T. 29 to T. 25 N., and east to west from R. 1 E. to R. 2 W. in western Kay County. The stratigraphic interval illustrated by electric logs in this section ranges from the Neva Limestone Member of the Grenola Limestone at the base into the Midco Member of the Wellington Formation at the top. However, core-hole data for this cross section are confined predominantly to the Barneston–Wellington stratigraphic interval. The formal stratigraphic nomenclature for the interval is shown along the left margin of the cross section. Drillers' terms or informal subsurface names assigned to the stratigraphic interval are shown in Figures 5 and 6.

The overall lateral persistence of rock units is demonstrated by the close conformity of electric logs with cores and nearby outcrops. The cross section also illustrates the complexity of sand distribution both vertically and laterally—particularly in the Eskridge, Beattie–Speiser, Matfield, and Doyle intervals—and emphasizes the difficulty of mapping individual sand bodies. Thicknesses, facies, and sequences are based primarily on core-hole data.

Council Grove Group

Only the upper part of the Council Grove Group is included in this study. In ascending order, the interval includes the Neva Limestone Member of the Grenola Formation, the Eskridge Shale, the Beattie Limestone, the Stearns Shale, the Bader Limestone, the Easly Creek Shale, the Crouse Limestone, and the Speiser Shale (Figs. 2, 3). A variable thickness of 240–320 ft is recorded for this interval. The stratigraphic sequence, from the

Table 1. — Locations of Reference Electric Logs and Depths to Selected Formation and Member Tops

Log no.	Quadrangle	County	Oklahoma coordinates	Ground elevation (ft)	Depth to formation and member tops (ft)
E-1	Blackwell	Kay (north-western)	E½ NE NW, sec. 20, T. 28 N., R. 2 W.	1,124	Wellington
					Anhydrite 445
					Nolans
					Herington 725
					Odell–Enterprise 745
					Winfield 795
					Doyle 810
					Barneston 905
Well designation: Cleary Petroleum, Inc., No. 1 Harris					Matfield 970
					Wreford 1,045
					Speiser 1,090
					Beattie
					Cottonwood 1,200
					Eskridge 1,210
					Grenola
					Neva 1,310
E-2	Billings	Kay (south-western)	NE NE SW, sec. 27, T. 25 N., R. 2 W.	1,050	Wellington
					Anhydrite 450
					Nolans
					Herington 720
					Odell–Enterprise 735
					Winfield 780
					Doyle 790
Well designation: Arthur Finston No. 1 Simmons					Barneston 890
					Matfield 945
					Wreford 1,035
					Speiser 1,065
					Beattie
					Cottonwood 1,200
					Eskridge 1,205
					Grenola
					Neva 1,350
E-3	Newkirk	Kay (north-central)	SE SE SE, sec. 30, T. 29 N., R. 2 E.	1,196	Nolans
					Herington 235
					Odell–Enterprise 255
					Winfield 300
					Doyle 311
					Barneston 392
Well designation: H. Waggoner & Co. No. 1 Scott					Matfield 465
					Wreford 535
					Speiser 570
					Beattie
					Cottonwood 682
					Eskridge 690
					Grenola
					Neva 800
E-4	Ponca City	Kay (south-central)	NW NE NE, sec. 19, T. 25 N., R. 2 E.	960	Winfield 110
					Doyle 120
					Barneston 220
					Matfield 266
					Wreford 355
Well designation: Falcon Seaboard Drilling Co. No. 1 George Calls Him					Speiser 380
					Beattie
					Cottonwood 515
					Eskridge 521
					Grenola
					Neva 645

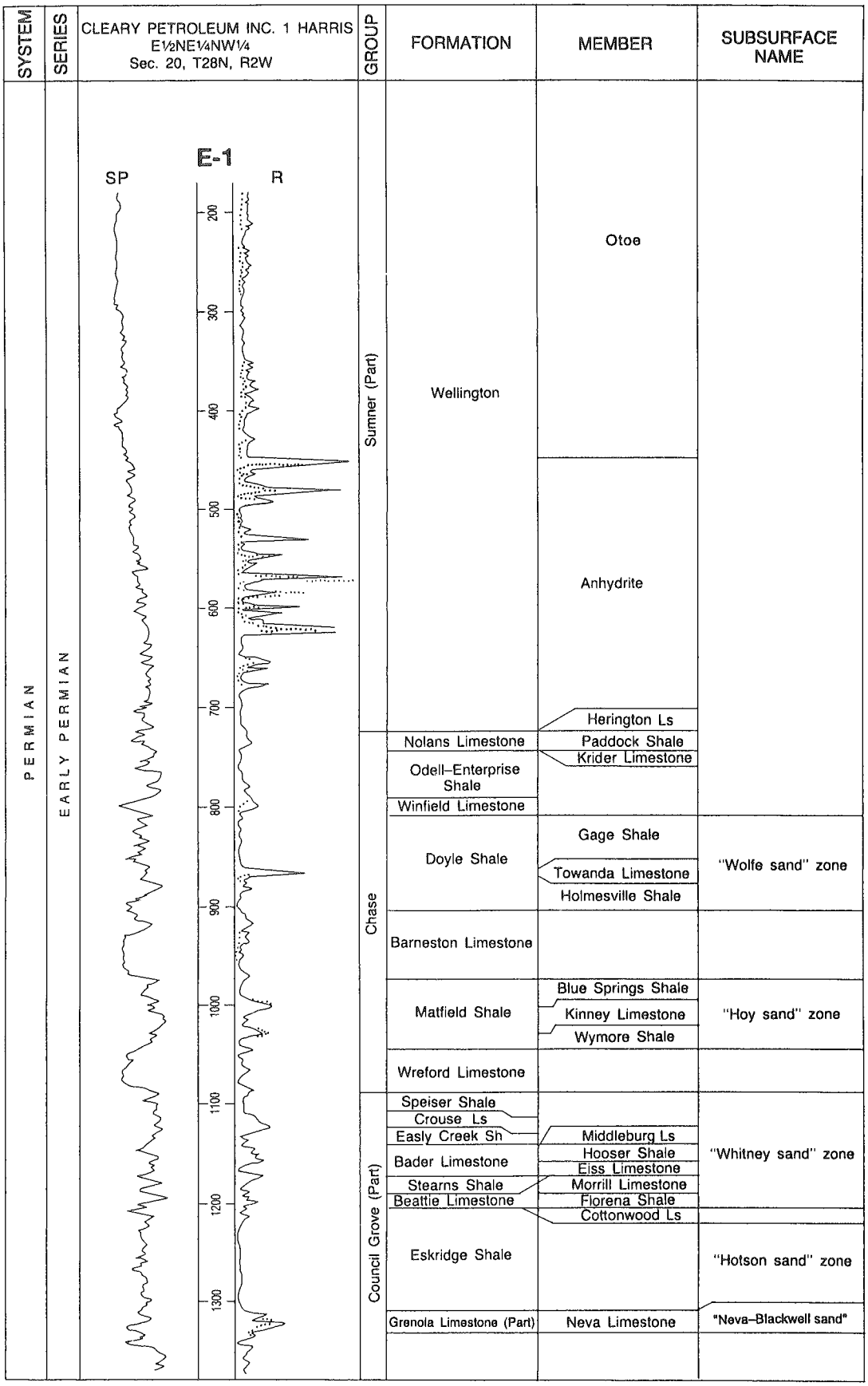

Figure 5. Reference electric log (E-1) for Lower Permian rocks cored in northwestern Kay County, Oklahoma.

Table 2. — Locations of Core Holes, Total Depths of Holes, and Depths to Formation and Member Tops

Hole no.	Quadrangle	County	Oklahoma coordinates	Elevation (ft)	Total depth (ft)	Depth to formation and member tops (ft)	
KC-1	Tonkawa SE	Kay	NE SE NW SW sec. 31, T. 25 N., R. 1 W.	1,032	303.9	Wellington	
						Otoe	127.5
						Anhydrite	282.6
Core Hole designation: Kay County Shale Pit							
KC-2	Charlie Creek West	Kay	NW SE NW NE sec. 33, T. 26 N., R. 3 E.	1,056	316.0	Odell–Enterprise	10.5
						Winfield	65.0
						Doyle	75.5
Core Hole designation: Sheehan Farm						Barneston	193.6
						Matfield	230.0
KC-3	Hardy	Kay	SW NW SW SE sec. 19, T. 29 N., R. 5 E.	1,180	290.0	Wreford	15.4
						Speiser	49.7
						Crouse	86.0
						Easly Creek	104.6
						Bader	
						Middleburg	111.0
						Hooser	120.9
Core Hole designation: Hammons Ranch						Eiss	144.9
						Stearns	156.7
						Beattie	
						Morrill	162.0
						Florena	166.8
						Cottonwood	177.6
						Eskridge	185.0
						Grenola	
						Neva	258.0
KC-4	Uncas	Kay	NW NE NW NW sec. 12, T. 27 N., R. 3 E.	1,170	289.3	Odell–Enterprise	8.0
						Winfield	47.0
						Doyle	
						Gage	60.4
						Towanda	140.2
						Holmesville	144.2
Core Hole designation: Pink & Trudie Daniel Property						Barneston	
						Fort Riley	166.5
						Florence	211.3
						Matfield	
						Blue Springs	220.0
						Kinney	275.7
						Wymore	283.6
KC-5	Charlie Creek West	Kay	NW SW SW NW sec. 25, T. 26 N., R. 3 E.	1,140	405.0	Nolans	
						Herington	18.4
						Odell–Enterprise	30.8
						Winfield	93.0
						Doyle	105.0
Core Hole designation: State Fish and Wildlife Property						Barneston	217.6
						Matfield	
						Blue Springs	252.8
						Kinney	303.6
						Wymore	307.0
						Wreford	342.1
						Speiser	364.6

(Table 2 continued on facing page.)

base of the Beattie Limestone to the base of the Wreford Limestone, is the most variable interval in terms of thicknesses, lithologies, and lateral extent of stratigraphic units in the study area. The upper part of the Council Grove Group is best characterized by thin, repetitive sequences of algal, non-cherty, micritic limestones and shales with locally developed lenticular sandstones.

Grenola Formation

Neva Limestone Member

The Neva Limestone, at the base, generally consists of two limestone beds separated by a shale interval. The top is usually a sharp contact, whereas the base is commonly gradational. Stray limestones near or at the base

Table 2. — *Continued*

Hole no.	Quadrangle	County	Oklahoma coordinates	Elevation (ft)	Total depth (ft)	Depth to formation and member tops (ft)
KC-6	Uncas	Kay	NE SW SE SW sec. 35, T. 28 N., R. 3 E.	1,221	285.0	Barneston
						Fort Riley 12.5
						Florence 31.0
						Matfield
						Blue Springs 37.0
						Kinney 94.3
						Wymore 102.4
Core Hole designation: Larchey Pit						Wreford 118.4
						Speiser 151.0
						Crouse 175.9
						Easly Creek 210.8
						Bader
						Middleburg 227.3
						Hooser 232.6
						Eiss 244.7
						Stearns 249.7
						Beattie
						Cottonwood 262.1
KC-7	Newirk SW	Kay	SW NW NE SW sec. 1, T. 27 N., R. 1 E.	1,079	275.0	Nolans
						Herington 185.0
Core Hole designation: Johnson Ranch						Odell–Enterprise 204.3
						Winfield 228.6
						Doyle 250.0
KC-8	Braman	Kay	NW SE NE SE sec. 10, T. 28 N., R. 1 W.	1,058	215.0	Wellington
						Anhydrite 47.0
Core Hole designation: Bell Ranch						
KC-9	Peckham	Kay	SE NW NE SW sec. 31, T. 29 N., R. 1 E.	1,070	355.0	Nolans
						Herington 115.9
						Odell–Enterprise 140.9
						Winfield 179.8
						Doyle
Core Hole designation: Pratt Ranch						Gage 205.4
						Towanda 254.0
						Wymore 259.0
						Barneston
						Fort Riley 279.4
						Florence 326.7
KC-10	Kaw City NW	Kay	SE NW NW SW sec. 18, T. 29 N., R. 4 E.	1,168	390.3	Barneston
						Fort Riley 18.0
						Florence 62.0
						Matfield
						Blue Springs 83.0
						Kinney 103.8
						Wymore 132.7
						Wreford 142.6
						Speiser 178.0
						Crouse 211.0
						Easly Creek 231.3
Core Hole designation: Lane Ranch						Bader
						Middleburg 240.2
						Hooser 254.9
						Eiss 265.3
						Stearns 282.8
						Beattie
						Morrill 285.4
						Florena 293.0
						Cottonwood 296.0
						Eskridge 304.0
						Grenola
						Neva 378.2

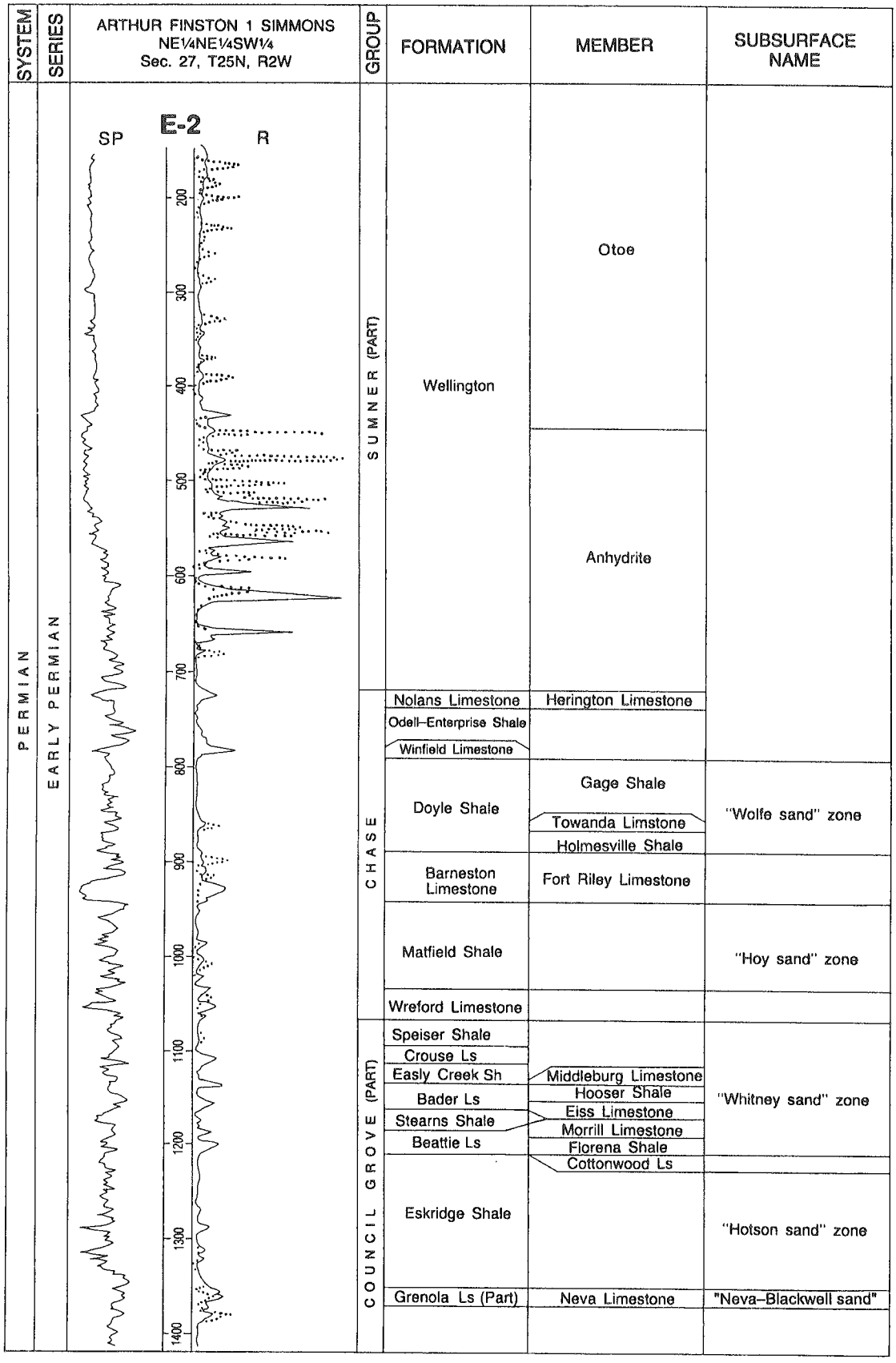

Figure 6. Reference electric log (E-2) for Lower Permian rocks cored in southwestern Kay County, Oklahoma.

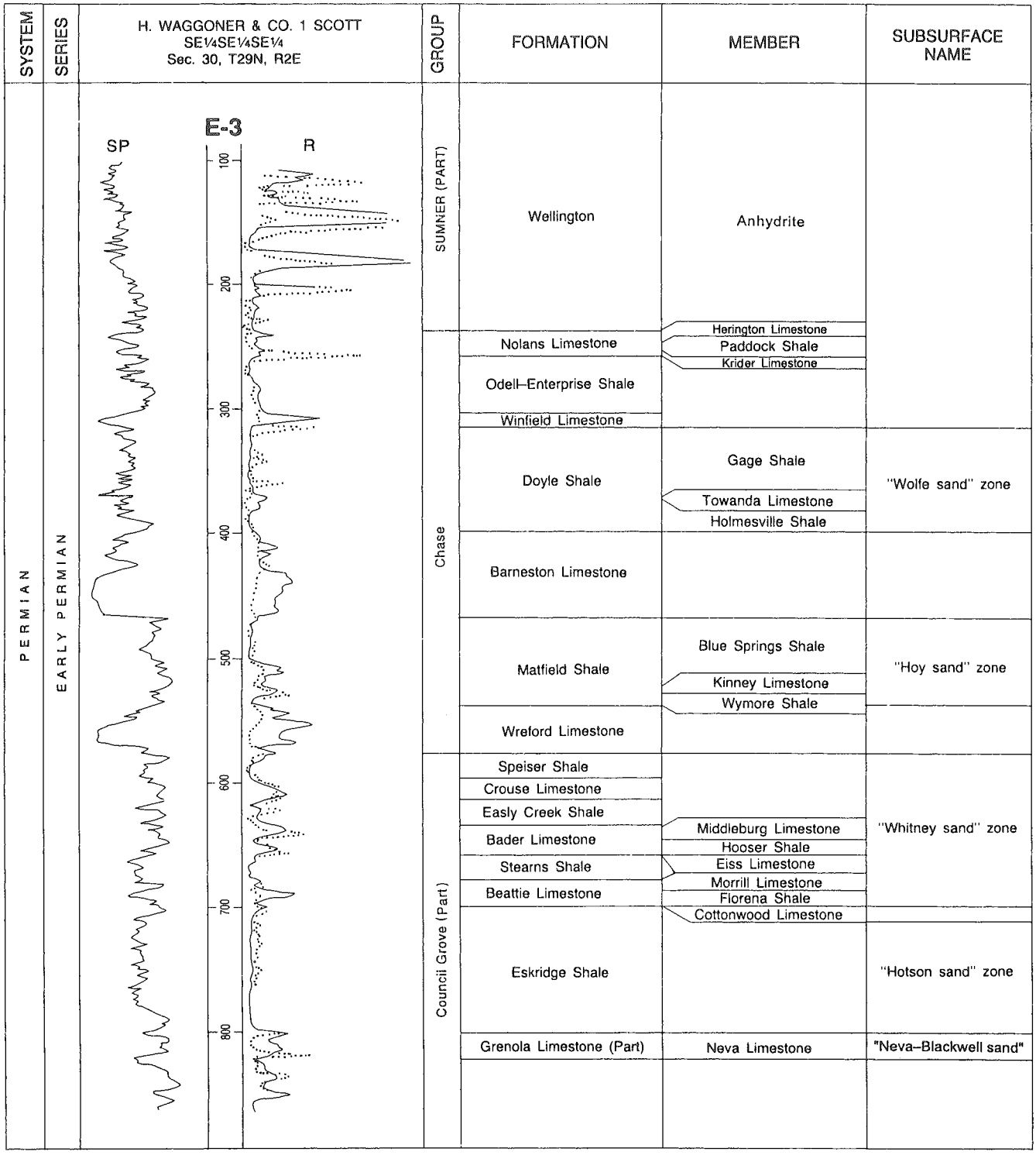

Figure 7. Reference electric log (E-3) for Lower Permian rocks cored in central northern Kay County, Oklahoma.

of the overlying Eskridge Shale produce a gradational top at places. Locally the Neva is represented by a single limestone bed, with shaly limestones above and below. The average thickness of the Neva is 25 ft.

Eskridge Shale

The Eskridge Shale varies in thickness from 80–100 ft in the north to 145 ft in the south (Table 1, log E-2). The interval consists mainly of shale, with locally developed individual sandstone bodies up to 10–20 ft thick. The sandstone bodies are erratic in their vertical distribution, occurring at any stratigraphic position within the interval. In the subsurface, this sand buildup between the Neva Limestone below and the Beattie Limestone (Cottonwood Limestone Member) above is referred to as the "Hotson sand" zone (Figs. 5, 6). Some thin,

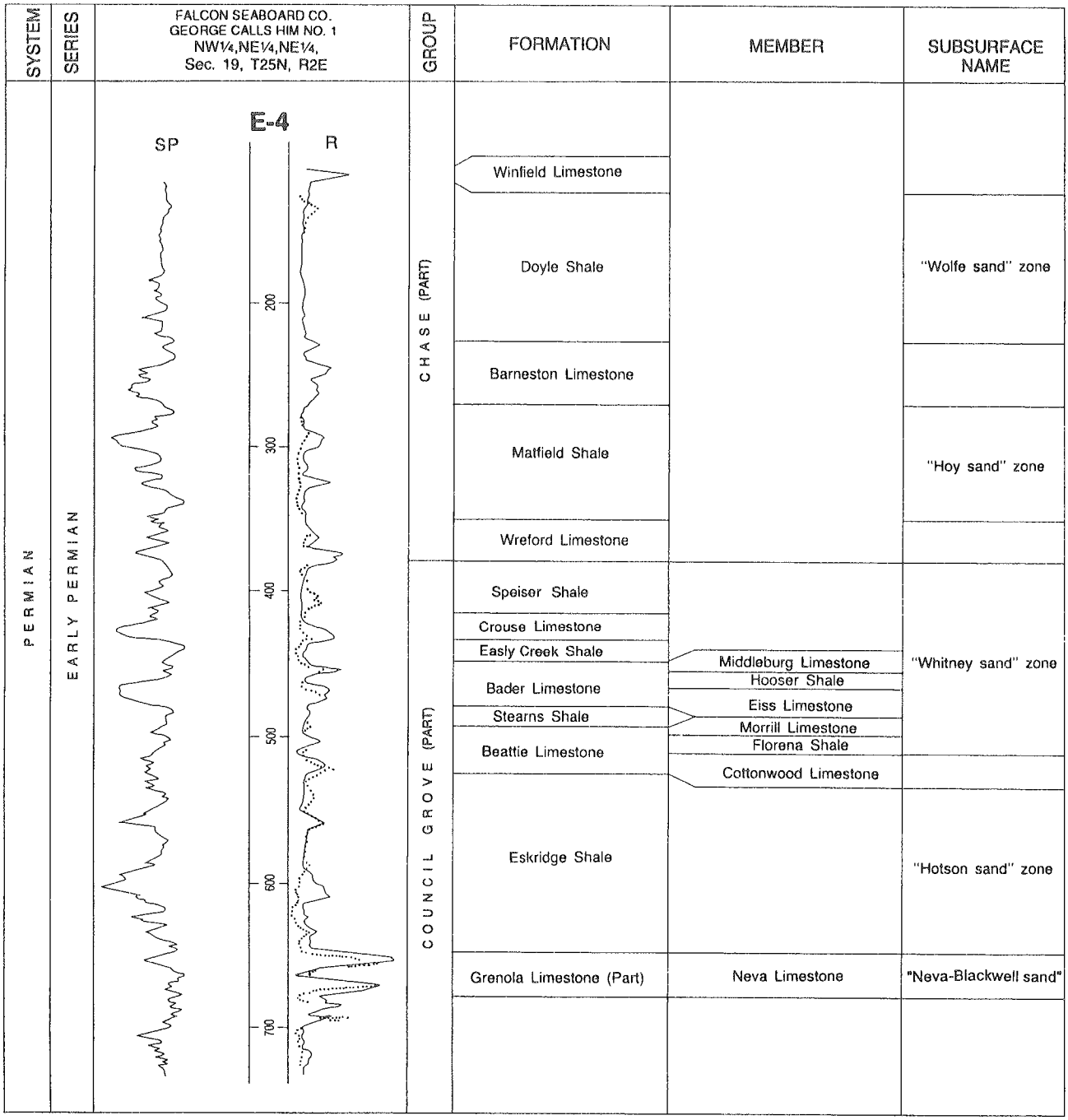

Figure 8. Reference electric log (E-4) for Lower Permian rocks cored in central southern Kay County, Oklahoma.

discontinuous limestone beds also occur within the interval and, where present, are found most commonly near the top or near the base.

Beattie Limestone

The Beattie Limestone can be subdivided, in ascending order, into the Cottonwood Limestone, Florena Shale, and Morrill Limestone. Because of its vertical and lateral persistence, the Cottonwood Limestone Member is an excellent subsurface marker bed. The thickness of the Beattie interval varies from 20 to 30 ft. However, the Cottonwood is consistently 5–10 ft thick. The carbonate units that are used to subdivide the interval from the top of the Cottonwood Limestone to the base of the Wreford Limestone become progressively more difficult to identify to the south and southwest.

Stearns Shale

The Stearns Shale varies in thickness from 3–8 ft in the north to 12–23 ft in the south (Fig. 3) and consists

of shale with thin interbedded sandstones. However, the Stearns attains thicknesses locally of 30–40 ft in more sand-rich sections (e.g., well logs 8, 13, 15, 18, 22).

Bader Limestone

The overlying Bader Limestone can usually be subdivided into a lower limestone unit (Eiss), a middle shale unit (Hooser), and an upper limestone unit (Middleburg). The thickness of the Bader varies from 10 to 30 ft. In those sections to the south (e.g., well logs 8, 13, 15, 18), where the underlying Stearns Shale reaches thicknesses up to 40 ft, the Bader usually is represented by a single limestone unit.

Easly Creek Shale

The Easly Creek Shale overlies the Bader Limestone and consists predominantly of shales, with some thin sandstone beds locally. The thickness is commonly 10 ft, and locally it approaches 20 ft.

Crouse Limestone

The Crouse interval usually consists of a single limestone unit. Locally, however, two limestone units separated by shale define the interval (well log 7). The interval is commonly 10–15 ft thick.

Speiser Shale

The Speiser Shale varies in thickness from 25 to 40 ft. The interval is principally shale, but at some places locally discontinuous sandstone beds occupy various stratigraphic positions within the interval. In addition, a stray limestone bed occurs locally near the top of the interval. In the subsurface the development of sandstone units in the stratigraphic interval from the top of the Cottonwood Limestone to the base of the Wreford Limestone is assigned informally to the "Whitney sand" zone (Figs. 5, 6).

Chase Group

This group averages 335 ft in thickness and includes in this study all beds between the base of the Wreford Limestone and the top of the Nolans Limestone (Herington Limestone Member) (Fig. 2). The Chase Group consists of limestone units averaging 20–25 ft in thickness. Many, in contrast to those in the Council Grove Group, are chert bearing and highly fossiliferous. Mudstones and shales in the Chase Group are less common but are thicker than those of the Council Grove Group, averaging 30–40 ft. Lenticular sandstones are more common and thicker in the Chase Group.

Wreford Limestone

The base of the Wreford Limestone defines the base of the Chase Group. The top of the Wreford Limestone is the datum horizon for stratigraphic cross section A–A′. The Wreford is characteristically 30 ft thick. The interval consists at places of a lower, more massive limestone unit separated from an upper, more shaly limestone unit by 5–10 ft of calcareous shale. In other places the interval includes interbedded shaly limestone and calcareous shale. Lower beds of the Wreford are commonly chert bearing. To the south and southwest the chert content decreases, and the entire interval becomes more shaly and locally sandy. Horizontal forms of the trace fossil *Rhizocorallium* are common on the top surfaces of the Wreford (Fig. 9).

In cross section A–A′ the Wreford Limestone has characteristic SP and resistivity log signatures consisting of two distinct, sharp, positive deflections, one in the lower part separated from another in the upper part by a distinct negative shale "kick" (e.g., well logs 2, 3, 7). The lower log signature generally is more rounded and distinct than the upper.

Matfield Shale

The Matfield Shale can be subdivided into three members wherever the middle limestone member (Kinney)

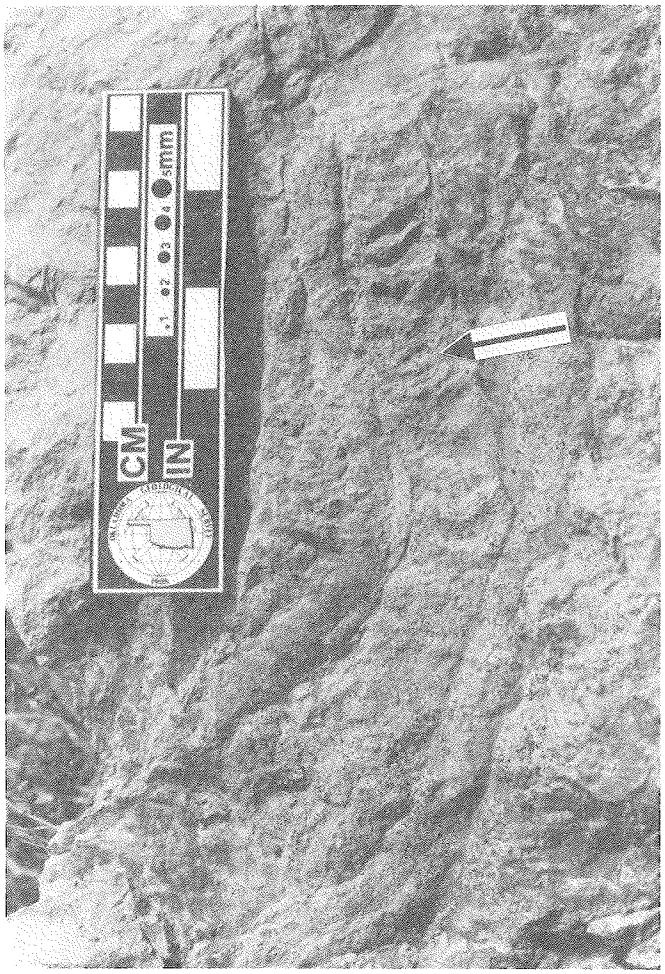

Figure 9. Horizontal form of the trace fossil *Rhizocorallium* isp. on the top surface of the highest (last) transgressive marine carbonate bed in the Wreford Limestone. The protrusive spreiten (arrow) represent the gradual downward adjustment of the trace maker to erosion. Note also the distinctive distal (downward) expansion of the trace, which is a function of growth. Locality K-12, N½NE¼NE¼ sec. 25, T. 27 N., R. 4 E., Kaw City Quadrangle, Kay County.

is present. The basal Wymore Shale and the overlying Kinney Limestone are each commonly 10 ft thick. However, the Wymore locally attains a thickness of 30–35 ft. The upper Blue Springs Shale Member is 50–60 ft thick and contains thin limestone beds throughout the interval. The development of sand bodies is common throughout the Matfield, and in the subsurface the interval is assigned to the "Hoy sand" zone (Figs. 5, 6). The Matfield Shale varies in thickness from 70 ft in the north to 95 ft in the south.

Barneston Limestone

The first core-hole data for stratigraphic cross section A–A′ begins in the Barneston Limestone (well log 4). In the north the Barneston includes a 10–20-ft-thick sequence of micritic, chert-bearing, fusulinid-rich limestones (Florence Limestone Member). This is overlain by a 40–50-ft-thick interval of thick-bedded algal limestones in the lower part, overlain by a sequence of alternating beds of fossiliferous shaly limestones and calcareous shales (Fort Riley Limestone Member) (well log 4). A thin shale member (Oketa) that separates the two limestones in northern Kansas is absent in north-central Oklahoma and in much of central and southeastern Kansas.

The soles of limestone beds within the Barneston are commonly associated with Y-branching burrow systems of the trace fossil *Thalassinoides* (Fig. 10).

To the south the lower chert-bearing limestone member (Florence) loses the cherty characteristics seen in the north. Consequently, with the absence of shale separating the two thick limestone members, coupled with the loss of distinguishing chert in the lower limestone member (Florence), the interval is undifferentiated in north-central Oklahoma, with the name *Barneston* assigned to the entire interval. The overall thickness of the Barneston varies from 50–60 ft in the north to 35–55 ft in the south.

Throughout much of southern Kay County the Barneston includes only the upper thick, massive, more resistant member (Fort Riley), characterized by a lower 30–40-ft-thick section of thick-bedded algal limestones that produce a distinctive blocky SP signature on electric logs. The lower massive limestone sequence is overlain by a 20–30-ft-thick sequence of alternating beds of fossiliferous shaly limestones and calcareous shales that produce a distinctive serrated log signature on both the SP and resistivity curves.

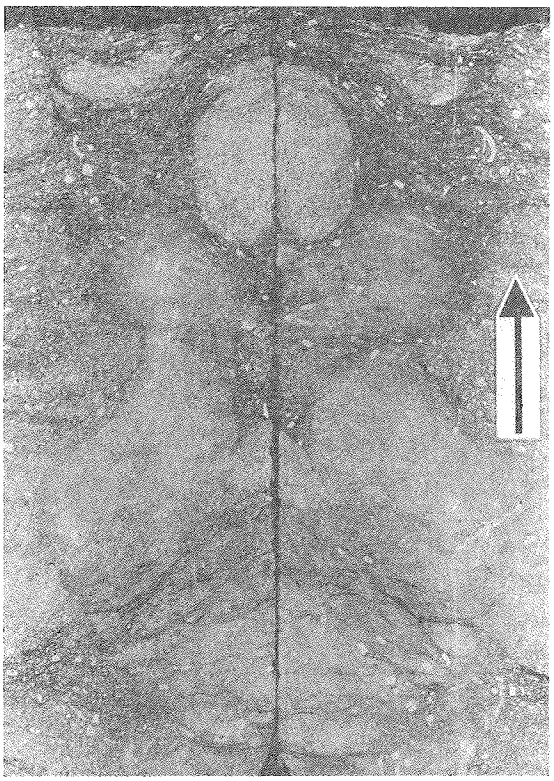

Figure 10. Paired slabs of 2-in.-diameter core showing oval to circular Y-branching burrows of the trace fossil *Thalassinoides* isp. in the Barneston Limestone. Core Hole KC-10.

Doyle Shale

The Doyle Shale varies in thickness from 75–100 ft in the north to 120–144 ft in the south. The Doyle can be subdivided into three lithologic units: a lower 10–15-ft-thick, generally unfossiliferous bluish-gray shale and shaly limestone unit (Holmesville); a thin 5–10-ft-thick sparsely fossiliferous, sandy, yellowish-gray limestone (Towanda); and an upper 50–110-ft-thick reddish-brown shale and mudstone sequence that locally contains one or two stray, thin sandy limestone or dolomite beds. The Towanda Limestone is a laterally persistent limestone bed but is locally absent (e.g., well logs 16, 19, 22). In general, the Doyle thickens to the south, where the increase in stratigraphic thickness is primarily accommodated in the uppermost Gage Shale Member. In western Kay County, some thin anhydrite/gypsum beds occur in various stratigraphic positions throughout the Doyle interval (well log 4) (Fig. 11).

In addition, lenticular sandstone bodies are present locally, particularly in the upper part of the Doyle. In the subsurface the occurrence of sandstone bodies above the Barneston Limestone and below the Winfield Limestone is assigned informally to the "Wolfe sand" zone (Figs. 5, 6). The lower contact with the Barneston is highly gradational and is often difficult to place in outcrops, cores, and on electric logs. The upper contact with the Winfield Limestone is sharp.

Winfield Limestone

The Winfield Limestone is an excellent subsurface marker bed, with sharp-spiked SP and resistivity log signatures. The Winfield is composed of 10–20 ft of fossiliferous limestones. The lower part is massive, and the upper part is generally very shaly, with alternating beds of shaly limestones and calcareous shales.

In southeastern Nebraska and northern and central Kansas the Winfield is subdivided into a lower, locally cherty limestone member (Stovall), a fossiliferous shale (Grant), and an upper, locally cherty limestone mem-

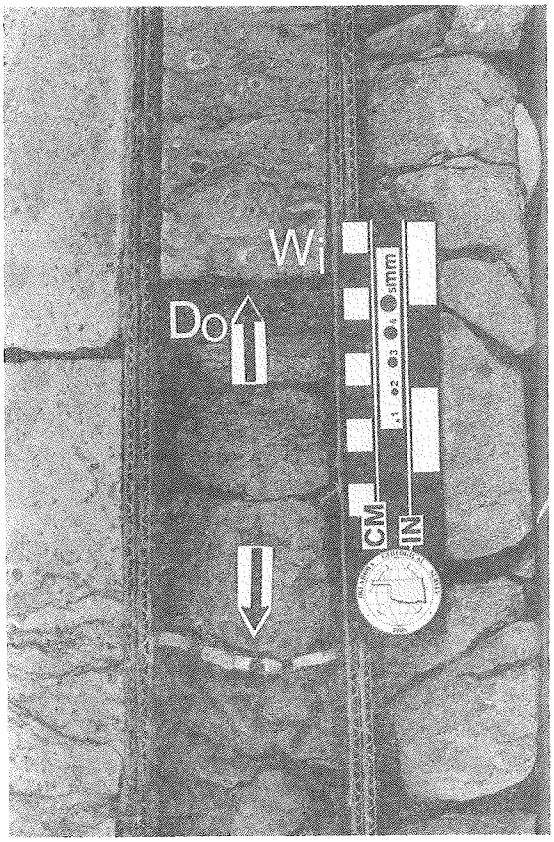

Figure 11. Part of core showing base (upper arrow) of subtidal-marine carbonate facies (transgressive event) of the Winfield Limestone (*Wi*); note algal- and/or foraminiferal-coated grains (osagid grains) at base of carbonate unit. Below the contact (sequence boundary) are marginal-marine and continental red-bed clastics (regressive event) of the Doyle Shale (*Do*). Lower arrow points out gypsum band in regressive facies. Core Hole KC-7.

ber (Cresswell). However, in southern Kansas and north-central Oklahoma the two lower lithic subdivisions cannot be identified. In Kay County the Winfield generally includes either a single massive limestone bed or two massive beds of fossiliferous limestone ~10–15 ft thick. The Winfield of north-central Oklahoma is lithostratigraphically correlative with the Cresswell Limestone Member of the northern outcrop belt (Chaplin, 1988, p. 108).

Approximately 5–10 ft above the top of the Winfield is a 5–15-ft-thick sequence of thin, ripple-marked, cross-bedded, bioturbated, grayish-red sandy micritic limestones and calcareous shales. The beds in the interval are probably physically correlative, at least in part, with the "Luta Limestone" of Kansas (Chaplin, 1988, fig. 6). The sequence produces a distinct, rounded-shoulder log signature on the resistivity curve (e.g., well logs 12–15). Subsurface workers often include this interval in the Winfield Limestone. However, the sequence is ubiquitously separated from the underlying limestones of the Winfield by a 3–5-ft-thick greenish-gray to reddish-brown shale or mudstone. In this study, the interval is included in the basal part of the Odell–Enterprise Shale sequence.

Odell–Enterprise Shale

The interval above the Winfield Limestone and below the Nolans Limestone is tentatively assigned to the Odell–Enterprise Shale (Chaplin, 1988, p. 92). The lack of good exposures that demonstrate the boundary relationships at the type localities or in their vicinity (Odell in Nebraska, Enterprise in Kansas), and the lack of designated type sections, introduce some doubt as to what name to retain until more detailed regional studies of the boundary relationships and lithologic character of the interval in Okahoma can be completed.

The interval is commonly 30–40 ft thick (e.g., well logs 21, 22), but it may attain a thickness of 62 ft in the south. It consists of beds of limestone/dolomite alternating with calcareous shales and mudstones. The shales are generally reddish brown. The interval is particularly carbonate rich in western Kay County and characteristically lacking in sandstone beds. The upper contact with the Nolans Limestone is commonly marked by a greenish-gray calcareous shale. Both the lower and upper contacts are sharp.

Nolans Limestone

The Nolans Limestone in southeastern Nebraska and north-central Kansas consists of an upper limestone member (Herington) and a lower limestone member (Krider) separated by a shale member (Paddock). However, in southern Kansas and north-central Oklahoma the member boundaries are not always distinguishable. The Nolans in Kay County, particularly in southern Kay County, consists primarily of only the upper member (Herington). The threefold lithologic subdivision of the Nolans is recognizable on electric logs in the northern and western parts of Kay County (well logs 1–10) but becomes less identifiable to the south (well logs 11–22). The Nolans is characteristically 20–30 ft thick in the north and 10–15 ft thick in the south. The Herington Limestone Member includes 8–15 ft of yellowish-gray, fossiliferous shaly limestones alternating with fossiliferous calcareous shales. The limestone beds are either brachiopod or mollusk rich, and an algal-biscuit bed occurs locally near the base. The algal-biscuit bed is probably the physical equivalent of the Krider Limestone Member, at least in part, of the northern facies. The upper part of the Herington commonly includes a distinctive resistant 1-ft-thick crinoidal-limestone bed. In this study the top of the Nolans (Herington Limestone Member) is placed at the highest (last) occurrence of this crinoidal-limestone bed. Dolomite and dolomudstone beds are present only in the northern sections (well logs 4, 6). Siliceous and calcareous geodes and concretions and cauliflower-shaped chert nodules occur locally in the Herington. The lower contact with the Odell–Enterprise Shale is usually sharp. However, very thin limestone beds and calcareous shales occur locally in a 2–5-ft-thick transitional interval below the contact. This

interval may physically represent, in part, the Krider–Paddock of the northern facies in central and northern Kansas and southeastern Nebraska.

Sumner Group

Core-hole data for the lower 500 ft of the Sumner Group are included in this study. Lithologically, little is known of this interval, so core descriptions from OGS Core Holes KC-7, KC-8, and KC-9 (well logs 9, 6, and 4, respectively) represent the first published detailed information about facies, sequences, and thicknesses of this interval.

Wellington Formation

The contact of the Nolans Limestone (Herington) with the Wellington Formation above is not usually exposed. Cores recovered for this study indicate that a lithologically transitional contact does exist. The transitional interval includes 30–40 ft of thin dolomite beds alternating with greenish-gray dolomudstones and shales containing thin gypsum partings. Many subsurface workers include this transitional interval in the Herington Limestone Member. In this study the interval is included in the overlying Anhydrite Member.

Anhydrite Member

The base of the Anhydrite Member of the Wellington Formation is placed about 30–40 ft above the highest (last) occurring marine crinoidal-limestone bed of the Nolans and the lowest (first) occurrence of a thick, continuous sequence of anhydrite beds. The Anhydrite Member produces a distinctive log signature, consisting of a strongly spiked resistivity curve that commonly shows an off-scale deflection on both the microlog and micro-laterolog. In addition, sonic logs, where available, show characteristic velocities of 50–52 sec/ft. The Anhydrite Member varies in thickness from 150 to 250 ft. The member includes thick anhydrite beds alternating with greenish-gray to olive-gray dolomudstones and shales. Many of the shales are fissile, with varved-like bedding. Commonly the dolomudstones and shales contain gypsum bands and veinlets. Gypsum-filled vertical fractures and gypsum-lined slickensided fracture surfaces are common both in the shales and in the blocky dolomudstones. Salt beds occur locally. Bioturbation observed in some dolomite beds disrupts the horizontal parallel laminae. Some olive-black and greenish-black laminated shales occur throughout the interval. The laminations give the shales a distinct varved-bedding appearance. Sandstone and siltstone units are characteristically rare to absent. Body and trace fossils are rare to absent.

Otoe Member

Lithologic data for this interval are confined primarily to OGS Core Hole KC-1 (well log 20). The base of this member of the Wellington Formation in this study is placed at the highest (last) occurrence of thick (>1 ft) anhydrite beds and the lowest (first) continuous occurrence of grayish-red to dark-reddish-brown mudstones and shales, light-gray siltstones, and pale-red to yellowish-brown sandstones. Dolomite, anhydrite, and gypsum beds are rare.

The mudstones and shales commonly contain wispy dolomite laminations and exhibit convolute bedding. Reddish-brown to pale-red fissile shales containing convoluted sandy laminae characterize the Otoe Member. Cavities of nodular gypsum were observed in some of the mudstones and shales.

The siltstones are commonly light gray, sandy, dolomitic, slightly laminated, and mottled, and they exhibit contorted bedding.

Sandstones are generally pale brown to pale red and very fine grained, and they contain wavy dolomitic-mudstone laminae. Several of the sandstones exhibit churned bedding resulting from bioturbation. Soft-sediment deformation that produced convolute bedding characterizes many of the sandstones.

The overall thickness of the Otoe Member varies from 155 to 200 ft. The electric-log character for the Otoe is primarily a distinctive shale signature, similar to the signature produced by the overlying Midco Member, making placement of the lithic boundary between these two members problematic.

Midco Member

Data for this stratigraphic interval are restricted primarily to OGS Core Hole KC-1 (well log 20). The Midco Member of the Wellington is ~185 ft thick at this locality (measured surface section K-24). That thickness includes 55 ft of the upper part of the member, exposed in a shale pit (Fig. 12). The contact with the underlying Otoe Member is highly transitional. The base of the Midco in this study is placed at the highest (last) continuous occurrence of siltstones, sandstones, and reddish-brown fissile shales and the lowest (first) continuous occurrence of dark-gray, greenish-gray, and grayish-black fissile shales and mudstones. Several of the shales and mudstones contain lenticular dolomite laminae. The mudstones are commonly highly variegated (e.g., greenish gray, grayish red, grayish orange, pale purple) and dolomitic, with gypsum-lined slickensided fracture surfaces. Some mudstones exhibit mudcracks and contain lungfish burrows (Fig. 13).

In the upper part of the Midco, insect beds occur locally in usually a 1.5-ft-thick interval consisting of 1- to 2-in.-thick light-gray dolomite beds alternating with 1-in.-thick olive-black, fissile, highly organic papery shale beds. The entire interval has a distinctive rhythmically banded bedding. Gypsum and anhydrite occur throughout as veinlets and as fracture fillings and linings.

Dolomite beds are rare but are more common than in the underlying Otoe Member. The beds are generally less than 1 ft thick and are light gray and thin bedded with lenticular laminae of fissile shale. The bases of some dolomite beds are brecciated, producing a conglomerate-like texture. Stromatolitic bedding structures were observed in some dolomite beds.

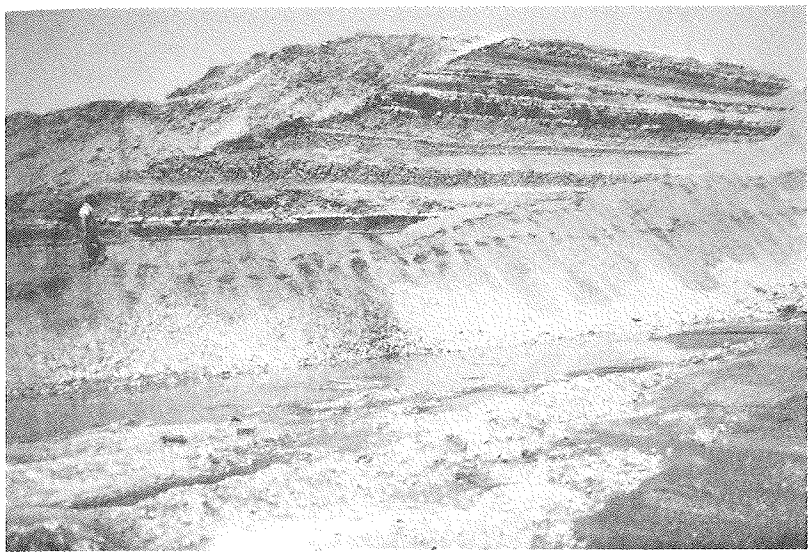

Figure 12. Upper 55 ft of the Midco Member of the Wellington Formation. Through a stratigraphic interval of 55 ft, 43 different stratigraphic units were identified and described, demonstrating the extreme small-scale cyclicity within the Midco Member. Appendix 1, measured section K-24, Kay County Shale Pit.

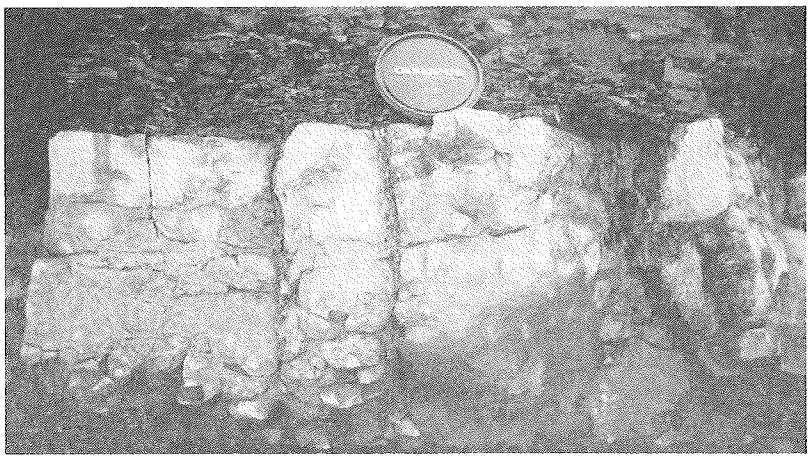

Figure 13. Lungfish-burrow bed, unit 27 in the upper part of the Midco Member of the Wellington Formation. Burrows are 7.5 in. long and 3 in. wide. Appendix 1, measured section K-24, Kay County Shale Pit.

Siltstone and sandstone beds are rare to absent. However, the top of the Midco Member is commonly marked by a 1- to 2-ft-thick, very fine grained ripple-marked sandstone containing load casts and vertical burrows (Appendix 1, measured section K-24, unit 43).

STRATIGRAPHIC CROSS SECTION B–B′, EASTERN KAY COUNTY (Plate 2)

Stratigraphic cross section B–B′ extends north to south from T. 29 to T. 25 N. and east to west from R. 5 to R. 2 E. in eastern Kay County. This cross section includes beds between the Neva Limestone and the lower part of the Wellington Formation (Fig. 2). Core control for this interval is good, permitting clarification of facies and physical correlations with electric-log signatures. Discussions of this cross section are confined to those stratigraphic intervals that lacked core control in cross section A–A′ and specifically to those intervals that demonstrate any variations in facies, thicknesses, and correlations unlike those shown and discussed for cross section A–A′.

Council Grove Group

The thickness of the upper part of this group varies from ~250 ft in the north to ~285 ft in the south. Individual sandstone beds are thicker and characteristically more common throughout the interval when compared to those in western Kay County (cross section A–A′). The overall identity of individual limestone beds that were marker beds for subdividing clastic intervals in western Kay County is less distinct, and some of these beds may be absent locally. Carbonate units in general are thinner and more sand rich.

Grenola Limestone

Neva Limestone Member

The Neva is typically 20–30 ft thick and consists of two limestone beds separated by shale. In the north, chert is present locally in the upper part (well log 1). The interval becomes more shaly and sand rich to the south, producing a highly serrated SP and resistivity log pattern.

Limestones in the Neva are light gray to greenish gray, fine to very finely crystalline, nodular bedded, slightly algal, and locally chert bearing in the upper part. Most of the limestones contain greenish-gray calcareous-shale stringers and veinlets. Locally, some of the limestones are fusulinid rich.

The lower contact is sharp. The upper contact is usually sharp, but a stray limestone locally near or at the base of the overlying Eskridge Shale can make placement of the upper contact arbitrary (well logs 4, 6, 11).

Eskridge Shale

The Eskridge Shale varies in thickness from 80 to 120 ft. The interval consists of predominantly bluish-gray, greenish-gray, and reddish-brown mudstones and shales. Mudstones are typically color mottled and slightly calcareous, and they contain nodules of finely crystalline limestone. Sandstones are more common and thicker than in western Kay County but still maintain their erratic vertical distribution. Sandstones are light olive gray to grayish red, fine to very fine grained, and

locally cross-laminated. Some sandstones exhibit churned bedding from intense bioturbation. Mudstone clasts and nodules of finely crystalline limestone were noted in some sandstones. Locally, the upper 5–10 ft of the interval contains interbedded light-gray, finely crystalline, nodular, algal, fossiliferous limestone, and dusky-yellow to dark-gray shale beds packed with algal-coated grains and cross sections of brachiopods and bryozoans (well log 3). The top of the Eskridge Shale is placed at the lowest (first) continuous section of fusulinid-bearing limestone beds (Cottonwood Limestone Member of the Beattie Limestone).

Beattie Limestone

The Beattie Limestone can be subdivided into a lower limestone member (Cottonwood) and an upper limestone member (Morrill), separated by a middle shale member (Florena), throughout most of eastern Kay County (Fig. 2). Because of space limitations, correlations of individual members of this interval are not shown in the cross section. Locally, the middle shale and upper limestone members are absent, and the Cottonwood Limestone is the sole representative of the Beattie Limestone (Fig. 3). The presence or absence of these members is directly related to the thickness of sand development in the overlying Stearns Shale. The thicker the sand, the more likely that the middle shale and upper limestone members will be absent. The Beattie Limestone is typically 20–25 ft thick. The lower and upper contacts are sharp. The interval above the Beattie Limestone can be differentiated at least as far south as T. 28 N. South of T. 28 N. the interval contains several additional thin limestones, shales, and lenticular sandstones, and the units become difficult, and some locally impossible, to correlate with units occupying a similar stratigraphic position in the northern facies.

Stearns Shale

The Stearns Shale is typically 5–10 ft thick. To the south, thicknesses of 20–25 ft are not uncommon (well log 23). The Stearns is composed predominantly of bluish-gray to reddish-brown calcareous mudstones containing limestone nodules and granules. Locally, greenish-gray to grayish-red, very fine grained cross-laminated sandstones make up most of the interval (well logs 9, 10, 22). The lower and upper contacts are sharp.

Bader Limestone

Above the Stearns Shale is the Bader Limestone, which consists of a lower limestone member (Eiss), a middle shale unit (Hooser), and an upper limestone member (Middleburg) (Fig. 2). The correlation of these individual units is not shown in the cross section, although these members have great lateral persistence and, for the most part, can be identified and correlated from north to south. The interval is typically 30–40 ft thick in the north and 20–25 ft thick in the south.

The interval consists predominantly of either (1) a single algal-limestone unit; (2) a sequence of alternating thin, shaly algal limestones and calcareous shales; or (3) a calcareous shale containing very small cauliflower-shaped algal-limestone nodules. The middle shale unit (Hooser) locally includes several pale-red to grayish-red, fine- to very fine grained cross-laminated sandstone beds. However, more typically the Hooser includes grayish-red to greenish-gray calcareous mudstones containing calcareous nodules. The two limestone members are characteristically grayish-pink, finely to very finely crystalline, algal, vuggy, and hematite stained. Locally, the upper limestone unit is gastropod rich, with some intraformational reworking at the top. Both the lower and upper contacts are sharp.

Easly Creek Shale

The Easly Creek Shale ranges in thickness from 10 to 20 ft. It consists predominantly of bluish-gray to dark-reddish-brown calcareous mudstones and shales. The mudstones and shales commonly contain nodules of finely crystalline limestone and locally contain calcareous sandstone lenses. The lower and upper contacts are sharp.

Crouse Limestone

The Crouse Limestone is a variable unit with respect to both facies and thickness. To the south the Crouse becomes highly variable, with several facies represented. The interval consists of a single limestone unit (well logs 5–8, 11, 13, 16, 18, 21–23) or two limestone units separated by a shale or a shaly-sandstone interval (well logs 1, 3, 10, 14, 15, 17). Where two limestones are present the upper is usually the better developed. A thickness of ~5 ft for the Crouse in well log 9 is as atypical as the thickness of 40 ft in well log 10. The increase in thickness in well log 10 is directly attributable to the occurrence of unusually thick sand bodies in the interval. Regionally the Crouse varies in thickness from 5 to 40 ft, and typically it is 10–20 ft thick.

Limestones in the interval are characteristically light gray to pale pink, finely crystalline, shaly, algal, and nodular, and they contain wispy stringers of medium-dark-gray to dusky-red shale. Some rare stromatolitic wavy bedding was noted in the upper limestone unit. Some of the limestones are mottled as a result of intraformational reworking. In general, body and trace fossils are rare.

Mudstones and shales in the interval are typically greenish gray to dusky red and slightly calcareous, and they contain some scattered sandy-limestone stringers. Some of the shales show churned bedding from intense bioturbation.

Sandstones are rare, but where present they are characteristically medium gray to grayish red, very fine grained, slightly calcareous, laminated, and shaly, with some thin intervals of mud-chip conglomerates locally. Stray limestones at or near the base of the overlying Speiser Shale can make placement of the upper boundary uncertain. The lower contact with the Easly Creek Shale is sharp.

Speiser Shale

The Speiser Shale varies in thickness from 20 to 40 ft. The thickness of the Speiser is controlled by the occurrence and thickness of lenticular sandstones in the interval (Fig. 14). In general, the Speiser thickens and contains more lenticular sandstone bodies to the south and southeast.

Lithologically the Speiser includes medium-bluish-gray to reddish-brown mudstones containing nodules and granules of finely crystalline limestone. Many of the mudstones are color mottled. Beds near the base and at the top are slightly calcareous. Sandstones are typically grayish red to pale red, fine to very fine grained, and cross-laminated, containing some light-gray limestone nodules locally. Some of the sandstone laminations are inclined and highly irregular because of bioturbational churning. Body and trace fossils are rare. In Kansas a limestone unit (Funston) underlies what is called the Speiser Shale there. This unit has not been identified in Kay County. However, the sporadic occurrence of some calcareous-rich intervals, and locally some deeply weathered thin limestone-conglomerate beds, may represent, at least in part, the lithic equivalent of the Funston Limestone in the northern outcrop belt.

Chase Group

The Chase Group varies in thickness from 310 to 345 ft in eastern Kay County. This group consists of limestone units that average 20–30 ft in thickness. The exception is the Barneston Limestone, which is typically 40–50 ft thick except in extreme southern Kay County (well log 23), where a thickness of 20 ft is recorded. Unlike its occurrence in western Kay County, the Chase Group here (1) contains limestone units that are less chert bearing; (2) includes more common and thicker sandstones, shales, and mudstones; (3) rarely contains dolomite, anhydrite, and gypsum; (4) is more clastic rich and less fossiliferous; and (5) is composed of formations subdivided into members that are more difficult to identify and to correlate.

Wreford Limestone

The Speiser Shale is overlain by the Wreford Limestone, the basal unit of the Chase Group (Figs. 2, 3, 15). To the north in OGS Core Hole KC-3 (well log 1) the Wreford can be subdivided into three formally recognized units in Kansas and Nebraska: a lower limestone unit (Threemile), a middle shale unit (Havensville), and an upper limestone unit (Schroyer). However, locally to the south and southeast those subdivisions are sometimes difficult to identify, as the chert content decreases and the entire interval becomes very shaly and locally sandy (well log 16). The Wreford usually produces a characteristic tripartite electric-log signature consisting of two distinct strong deflections to the left and right on the SP and resistivity curves, respectively, indicating the presence of the lower and upper limestone units, separated by a distinct negative deflection that represents the middle shale member (e.g., well logs 4–8, 17, 18, 23).

The Wreford is commonly 25–30 ft thick and is composed predominantly of limestone beds. The limestones are commonly light to bluish gray, fine to medium crystalline, vuggy, shaly, algal (osagid grains), fossiliferous, and locally chert bearing. Body fossils are dominated by brachiopods, pelecypods (*Pinna*), and crinoid hash. Many limestone beds contain wavy stringers of dark-greenish-gray shale and mudstone. Rounded clasts bearing sponge spicules were observed in some limestones. Shales and mudstones are typically dark greenish gray, mottled dusky red, and calcareous, and they contain rounded clasts and nodules of finely crystalline limestone. The lower and upper contacts are sharp.

Matfield Shale

The Matfield Shale, above the Wreford Limestone, includes a lower 15–20-ft-thick shale and mudstone unit (Wymore), a middle 0–18-ft-thick sandy limestone unit

Figure 14. Sandstone lithofacies in the Speiser Shale. This clastic-dominated unit identifies the regressive facies of a Chase Group depositional couplet. Locality K-8, SE¼SW¼SW¼ sec. 31, T. 28 N., R. 5 E., Kaw City Quadrangle, Kay County.

(Kinney), and an upper 20–30-ft-thick calcareous-shale unit (Blue Springs) containing locally thin fossiliferous limestone beds and thin lenticular sandstones (Fig. 2). The entire interval varies in thickness from 60–80 ft in the north (well logs 3–5, 7, 9) to 80–90 ft in the south (well logs 10, 16–23).

The lower shale unit (Wymore) consists of greenish-gray to reddish-brown, mottled calcareous mudstone with rare small limestone nodules. The shales are light bluish gray to grayish red and calcareous, and they contain lenses of light-gray very fine grained sandstone. Locally the Wymore contains thin shaly-limestone beds, especially in the upper part, marking a transitional interval of 5–10 ft with the Kinney Limestone above (well logs 3, 12). The Wymore changes facies to the south, where locally it contains 20–25 ft of cross-bedded, lenticular channel sandstones (well log 19) that are equivalent, at least in part, to the "Hoy sand" zone of the subsurface (Figs. 5, 6).

The middle sandy limestone unit (Kinney) is highly variable in thickness and lateral extent. The Kinney is typically 10 ft thick, but a thickness of 29 ft was recorded in the north in OGS Core Hole KC-10 (well log 3). At Kaw Dam in sec. 25, T. 26 N., R. 3 E., just east of OGS Core Hole KC-5 (well log 19), the Kinney interval consists of a sandstone sequence that varies in thickness from 5 to 30 ft, as determined from the interpretation of core logs provided by the U.S. Army Corps of Engineers. This development of sand also correlates in part with the "Hoy sand" zone of the subsurface. Just southeast of the area covered by this cross section the Kinney Limestone is absent, and the entire Matfield interval is composed of cross-bedded, lenticular channel sandstones, physically equivalent to the "Hoy sand" zone of the subsurface. The Kinney typically is composed of light-gray, fine- to medium-crystalline, algal (osagid grains), granular to sandy limestone beds (Fig. 16). The Kinney contains abundant veinlets, some stylolitic, of dark-gray shale. Algal-coated fossil fragments of crinoid hash and gastropods are common throughout.

The upper shale unit (Blue Springs) is generally 20–30 ft thick but locally attains thicknesses of 50–60 ft wherever the Kinney is thin and sand bodies occupy the interval (e.g., well logs 9, 10, 12, 16–23). The Blue Springs Shale locally contains thin limestone beds and lenticular sandstones. The top is commonly marked by a 5–6-ft-thick transitional interval of shaly limestone and calcareous shale, forming a gradational contact

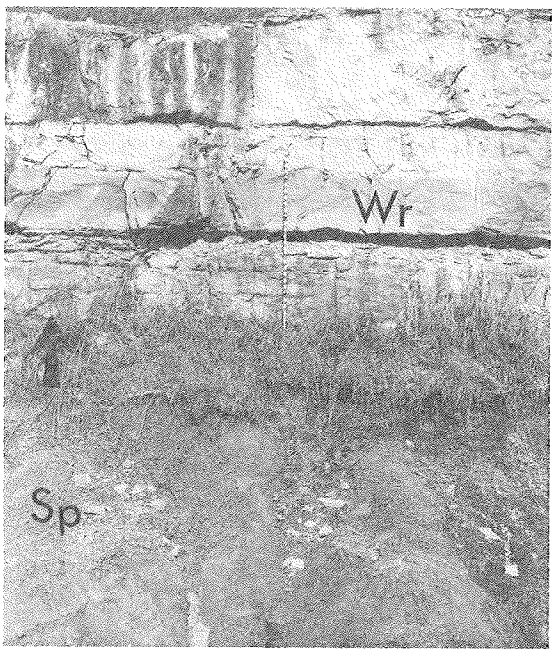

Figure 15. Outcrop showing clastic-dominated facies (Speiser Shale, *Sp*) overlain by a carbonate-dominated facies (Wreford Limestone, *Wr*). These two facies are correlative with major transgressive and regressive surfaces, respectively, and recur as distinct depositional couplets throughout the Chase Group. Arrow indicates discontinuity surface (sequence boundary) between the two facies. Staff is 1.5 m (5 ft) long. Locality K-12, N½NE¼NE¼ sec. 25, T. 27 N., R. 4 E., Kaw City Quadrangle, Kay County.

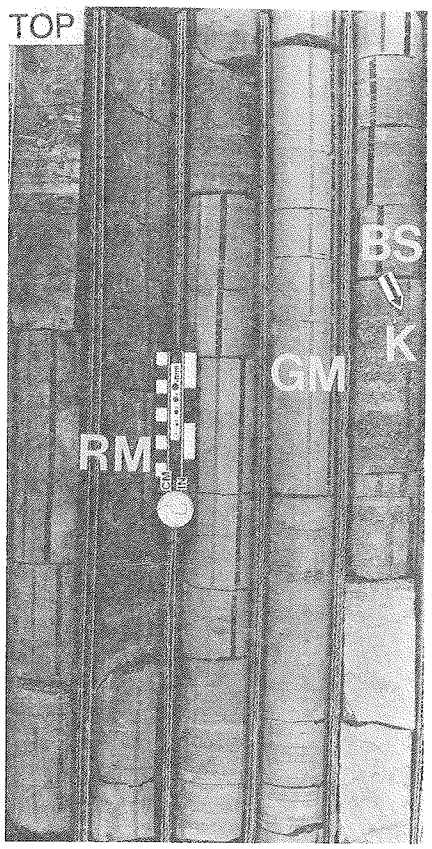

Figure 16. Matfield Shale, with arrow indicating Blue Springs Shale Member (*BS*)–Kinney Limestone Member (*K*) contact (sequence boundary). Core shows an intracycle carbonate (Kinney Limestone), indicating a minor transgressive event within a clastic-dominated, red-bed facies associated with a regressive event. Note atypical transitional 1.2-m-thick (4-ft) interval of greenish-gray mudstone (*GM*) between the lower carbonate unit and the upper red mudstone (*RM*). Core Hole KC-5.

between the Matfield Shale below and the Barneston Limestone above (Fig. 17).

Barneston Limestone

The Barneston Limestone varies in thickness from 60–70 ft in the north (well logs 3, 5, 7) to 40–50 ft in the central part of eastern Kay County, except in well log 10, where a thickness of only 25 ft is recorded in OGS Core Hole KC-6. In southern Kay County the thickness varies from 40–50 ft in T. 26 N. (well logs 16–18) to 20–25 ft in T. 25 N. (well logs 21–23).

The Barneston Limestone cannot be subdivided into members south of T. 27 N. Throughout most of eastern and southern Kay County the Barneston consists only of the upper thick, massive, highly resistant member (Fort Riley). The Fort Riley is characterized by a lower section of thick-bedded algal-limestone beds, which are overlain by a sequence of alternating fossiliferous shaly limestones and calcareous shales.

In T. 29–27 N. the northern facies of the Barneston is subdivided into a lower, chert-bearing limestone member (Florence) and an upper, non-chert-bearing limestone member (Fort Riley) (well logs 3, 10, 12). The Florence consists of yellowish-gray to light-bluish-gray, finely crystalline, thin- to medium-bedded cherty limestone. Fossils include brachiopods, solitary corals, crinoidal hash, and fusulinids. The fusulinids are concentrated particularly in chert bands in the lower 10 ft of the unit. Fossil fragments are commonly algal coated. The lower 10–15 ft of the Florence is locally very shaly, with large algal-coated grains (osagid grains). Highly irregular, partly stylolitic shale partings occur between limestone beds.

The upper member (Fort Riley) is composed characteristically of yellowish-gray to bluish-gray, medium-crystalline, medium- to thick-bedded, fossiliferous algal limestones in the lower part. Fusulinids were observed in the basal 10 ft of some sections. The upper part of the Fort Riley typically is composed of grayish-yellow to light-gray, fine- to medium-crystalline, shaly, algal fossiliferous limestones that alternate with medium-dark-gray to dark-greenish-gray, calcareous, highly fossiliferous shales. Some beds contain abundant large algal-coated grains. The weathering of these grains produces a vesicular texture. All of the units are bioturbated, and interlacing horizontal boxworks of *Thalassinoides* systems are particularly common in the upper part. Limestones in the upper part commonly contain stylolitic partings of carbonaceous-rich grayish-black shale.

In T. 27–25 N. the southern facies of the Barneston consists only of the upper thick, resistant, non-cherty member (Fort Riley). The Fort Riley is characterized by a lower section of thick-bedded algal-limestone beds that are overlain by a sequence of alternating fossiliferous shaly limestones and calcareous shales. The limestones in the lower part are typically light bluish gray, medium crystalline, algal, and fossiliferous, and they contain some medium-dark-gray shale stringers. Fossils include foraminifers, ostracodes, crinoid fragments, brachiopods, and echinoid spines. The shales are dark gray to medium dark gray and are slightly calcareous in some intervals; locally they contain lenses and laminations of pinkish-gray to light-bluish-gray very fine grained sandstone. The sandstones exhibit lenticular and churned bedding. Some of the dark-gray shales in the upper 10–15 ft are fissile and contain lenses of light-gray very fine grained sandstone that produce a distinctive rhythmically banded bedding.

At Kaw Dam in sec. 25, T. 26 N., R. 3 E., just east of OGS Core Hole KC-5 (well log 19), the Barneston interval contains numerous lenticular sandstone bodies 5–20 ft thick, as determined from the interpretations of core logs provided by the U.S. Army Corps of Engineers.

The base of the Barneston is an excellent subsurface marker, with a highly distinctive, blocky SP log signature. However, the upper contact is locally gradational throughout an interval of 5–15 ft because the overlying Doyle Shale (Holmesville Shale Member) commonly contains several alternating facies of dark-gray to bluish-gray shaly limestone and dark-bluish-gray to dark-gray fissile shale at its base. This gradational contact can be recognized on electric logs by the highly serrated log

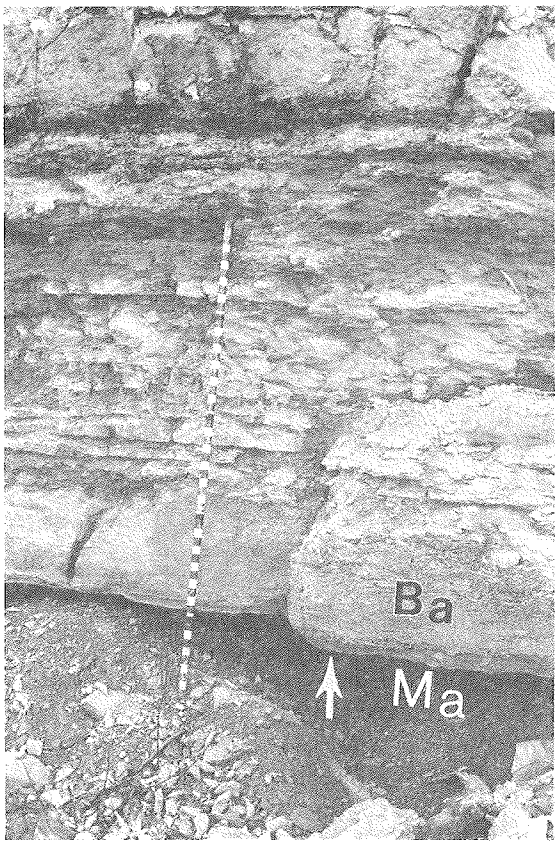

Figure 17. Outcrop showing subtidal-marine carbonate facies (Barneston Limestone, *Ba*) of a transgressive event directly overlying marginal-marine and continental red-bed clastic facies (Matfield Shale, *Ma*) of a regressive event. Arrow marks discontinuity surface (sequence boundary). Staff is 1.5 m (5 ft) long. Locality K-11, NW¼NW¼NE¼NW¼ sec. 25, T. 28 N., R. 3 E., Kaw City NW Quadrangle, Kay County.

signature shown on the SP and resistivity curves (well logs 16–18, 21).

Doyle Shale

The Doyle Shale, above the Barneston Limestone, includes three identifiable facies in T. 27 N., R. 3 E.: a lower, 10-ft-thick, generally nonfossiliferous-shale and argillaceous-limestone sequence (Holmesville Shale Member); a middle, thin, 3–8-ft-thick, sparsely fossiliferous sandy limestone (Towanda Limestone Member); and an upper, 100–120-ft-thick shale and mudstone interval (Gage Shale Member) (Fig. 3). To the south (well logs 19, 20) the Towanda Limestone cannot be identified locally, so the Doyle interval is represented by a 115-ft-thick sequence of undifferentiated shales, mudstones, and sandstones. The Doyle maintains a consistent stratigraphic thickness of ~100 ft throughout eastern Kay County.

The lower shale member (Holmesville) is composed of variegated calcareous shales and mudstones containing lenticular lenses of very fine grained calcareous sandstone. Some of the sandstone laminae exhibit contorted bedding. Bluish-gray shaly limestones are also present locally.

The Towanda Limestone is a light-bluish-gray to yellowish-gray sandy limestone, which locally is gastropod rich. A distinct positive narrow spike is produced on the resistivity curve by this 3–5-ft-thick limestone (well logs 16, 18). Locally in T. 26 N. a 5-ft-thick, fine-grained, cross-bedded, lenticular sandstone occurs between the Holmesville Shale below and the Towanda Limestone above.

The upper shale member (Gage) is the thickest clastic unit in the Chase Group, varying in thickness from 100 to 120 ft. It includes primarily grayish-red to reddish-brown, locally calcareous mudstones and shales. Calcite veinlets and pockets of brecciated limestone granules are common throughout. The Gage Member also contains some intervals of light-greenish-gray to grayish-red, very fine grained, slightly calcareous lenticular sandstones that grade locally into a siltstone facies. Nodules of finely crystalline limestone occur throughout. Fossils are limited primarily to plant- and bone-bearing concretions. Locally, 5–10-ft-thick, fine- to very fine grained lenticular sandstone bodies occur at various stratigraphic positions within the Doyle Shale (well logs 19, 20, 22). In well log 9 a 30-ft-thick sandstone interval occurs in the Gage Member. Sandstone bodies between the Barneston Limestone below, and the Winfield Limestone above, are assigned by subsurface workers to the "Wolfe sand" zone (Figs. 5, 6).

The top of the Gage Shale is commonly marked by a 1–5-ft-thick greenish-gray shale or mudstone, and the contact is sharp.

Winfield Limestone

The Winfield Limestone is an excellent subsurface marker, both in eastern and western Kay County. The Winfield usually cannot be subdivided into members in eastern Kay County. As in western Kay County, the Winfield is represented primarily by the upper member (Cresswell Limestone) of the northern outcrop belt. The interval consists of 8–15 ft of medium-gray to light-bluish-gray, fine- to medium-crystalline, thin- to medium-bedded fossiliferous limestone. The basal limestone beds contain large algal-coated grains that produce a conglomeratic-looking texture. The sole of the lowest limestone bed commonly contains extensive horizontal boxworks of the trace fossil *Thalassinoides* (Fig. 18). Locally the Winfield consists of a single bed or two massive limestone beds.

Fossils include crinoidal hash, echinoid spines and plates, and brachiopods. In the southeast the Winfield exhibits a more sand-rich and shaly facies. Shales occur primarily in the upper part and are greenish gray to bluish gray and calcareous, and they commonly contain bands of crinoidal hash and echinoid spines and plates.

Locally, in OGS Core Hole KC-4 (well log 12) the interval is characterized by a lower limestone unit and an upper limestone unit separated by a middle shale interval. The correlation of these units with the three formally recognized members of the Winfield in Nebraska and Kansas has not been documented.

Odell–Enterprise Shale

Above the Winfield Limestone is the Odell–Enterprise Shale, a 30–60-ft sequence of grayish-red to reddish-brown mudstones; thin, locally lenticular sandstones; and rare thin limestones. The sandstones increase in abundance and thickness as the sequence thickens to the south (e.g., well logs 19, 20).

The mudstones are typically variegated: grayish red

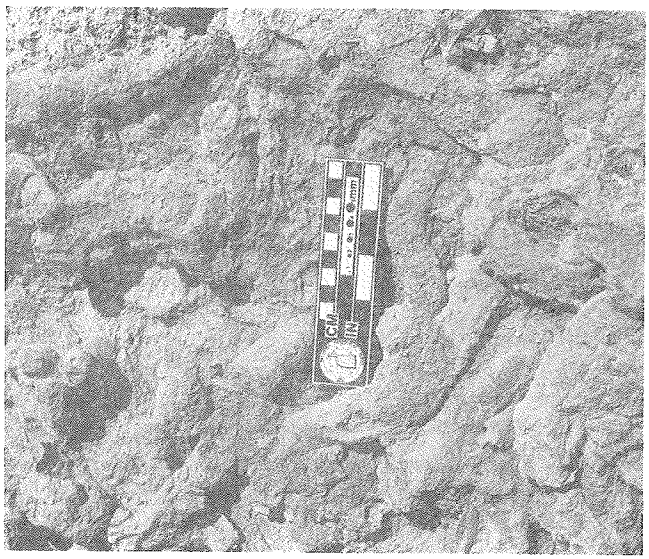

Figure 18. Horizontal, branching boxworks of trace fossil *Thalassinoides* isp. on the base of a transgressive carbonate unit (Winfield Limestone). Note distinctive Y-shaped bifurcations and robust nature of burrow systems. Locality K-23, SE¼NW¼SE¼ sec. 8, T. 28 N., R. 3 E., and NE¼NE¼NW¼NE¼ sec. 17, T. 28 N., R. 3 E., Newkirk Quadrangle, Kay County.

purple, grayish red, light olive gray, and light bluish gray with color mottling. These mudstones are generally calcareous and contain scattered limestone granules, stringers of greenish-gray mudstone, and thin lenses of very fine grained sandstone.

Sandstones in the interval are typically grayish red to greenish gray, very fine grained (most are nearly siltstone in grain size), and calcareous, and locally they contain ripple-drift cross-laminations. Most of the sandstones are bioturbated, with abundant *Chondrites*. Some sandstones exhibit parallel to lenticular laminae.

Limestones are rare in the interval, but where present they are brownish gray, fine to medium crystalline, sandy, cross-bedded, and sparsely fossiliferous.

The upper 2–5 ft of the sequence is marked by a greenish-gray calcareous shale or mudstone. Both the lower and upper contacts are sharp.

Nolans Limestone

Only one core hole, OGS Core Hole KC-5 (well log 19), penetrated the entire Nolans interval. Additional data for the interval include measured and described surface sections and electric logs. The Nolans Limestone is represented in eastern Kay County primarily by the upper limestone member (Herington) of the northern outcrop belt. In OGS Core Hole KC-5 (well log 19) a threefold lithic subdivision into a lower and an upper limestone unit separated by a shale interval is recognized. However, a definite correlation of these three lithic divisions with the three formally recognized members in the type areas, nearly 200 mi to the north in Nebraska and Kansas, is not currently warranted.

The Nolans (Herington) in eastern Kay County is composed of alternating beds of limestones and calcareous shales. The sequence is commonly 8–15 ft thick. The limestones are light gray to light bluish gray, medium crystalline, algal, sandy, locally vuggy, and fossiliferous, and they occur in 1–2-ft-thick beds. Many of the limestones contain wavy shale stringers. Some myalinid-rich beds occur near the base in association with algal biscuits, particularly in the more shaly limestone facies. The sole of the lowest limestone bed is commonly covered with horizontal boxworks of the trace fossil *Thalassinoides*. The top of the Nolans (Herington) is commonly marked by a 1-ft-thick crinoidal-rich limestone bed, the upper surface of which is covered locally by horizontal forms of the trace fossil *Rhizocorallium*. To the north, near the Kansas border, rare white chert nodules and calcareous geodes occur in the Herington Limestone Member.

Shales in the interval are medium light gray and calcareous, and they contain thin, shaly fossiliferous-limestone intercalations. Some vertical burrows were noted in the more calcareous shales.

Dolomite, anhydrite, and gypsum occurrences are rare to absent in eastern Kay County.

To the south, and just west of OGS Core Hole KC-2 (well log 20), a distinct facies of the Nolans (Herington) occurs. This facies consists of 7 ft of massive, sandy, cross-bedded limestone, the base of which is locally oolitic. This facies is restricted to this one locality.

The contact between the Nolans (Herington) and the overlying Wellington Formation was observed only in OGS Core Hole KC-5 (well log 19) and is sharp. The Nolans–Wellington contact in eastern Kay County is placed at the highest (last) continuous sequence of limestones and calcareous shales and the lowest (first) continuous occurrence of greenish-gray, grayish-red, and light-olive-gray mudstones and shales.

Sumner Group

Wellington Formation

Data for the Wellington interval in eastern Kay County are restricted to the lower 18–20 ft of core recovered in OGS Core Hole KC-5 (well log 19). The interval consists primarily of grayish-red to greenish-gray mottled calcareous mudstones containing rare stringers of "punky" limestone.

CONCLUSIONS

The interpretation of the data from outcrops, electric logs, and cores discussed in the preceding sections of this paper has led the author to the following conclusions:

1. Most of the lithostratigraphic units appear to preserve their lithologic "integrity" southward into Oklahoma, many miles from their type localities in Nebraska and Kansas, thus indicating the lateral persistence of Lower Permian cyclic rock units in the Midcontinent.

2. Regionally a north–south facies change takes place from a dominantly marine, carbonate-platform, shallow-water, open-marine subtidal facies in Nebraska and Kansas to a restricted-marine and marginal-marine subtidal to peritidal and continental facies in north-central Oklahoma. In central Oklahoma the carbonate units merge into, and disappear within, a thick wedge of dominantly fluvial and/or continental red-bed siliciclastics.

3. Limestone units (i.e., marker beds) are sufficiently well developed in northern Kay County to subdivide clastic sequences into formally recognized lithostratigraphic units. However, the identification of these limestone units becomes progressively more difficult in a southerly direction where these marker beds become thin and discontinuous before pinching out locally. Consequently, some formations cannot be subdivided locally into their formally recognized members, as in the northern outcrop belt. Thus, entire sequences remain undifferentiated and are assigned formation names (e.g., Doyle Shale, cross section A–A′, Pl. 1, well log 16).

4. Sequences identified in outcrop, for the most part, can be physically correlated into the subsurface with well-log and, most importantly, nearby core-hole data.

5. In general, carbonate units are slightly thicker, more cherty, and less clastic rich in the northern and western parts of Kay County.

6. In western Kay County, because of a more restricted-marine and marginal-marine depositional set-

ting during Early Permian time, thin dolomites and anhydrite/gypsum beds occupied various stratigraphic positions within the Council Grove and Chase Groups.

7. Clastic-rich units are characteristically more common, and individual sandstone beds thicker, in eastern Kay County, particularly in the southeastern part of the County.

8. Many Lower Permian sandstone-producing reservoirs of uncertain stratigraphic position and continuity occur in the Council Grove and Chase Groups. Good surface-to-subsurface lithostratigraphic correlation of these locally petroleum-producing sandstone intervals is now established from outcrop analogs and core-hole data tied into electric logs.

9. In Kay County, Lower Permian rocks make up the upper part of the Council Grove Group, the Chase Group, and the lower part of the Sumner Group. The Council Grove and Chase Groups consist of repeated couplets of carbonates and clastics that are correlative with major transgressivé and regressive events, respectively. Regressive parts of the depositional couplets consist of thicker (33–131 ft), more clastic-rich marginal-marine and/or continental facies dominantly composed of red and green mudstones and/or shales locally capped by exposure surfaces and paleosols. Transgressive parts of the couplets consist of thinner (3–66 ft), more carbonate-rich marine and marginal-marine facies dominantly composed of shallowing-upward units of coated-grain, fossiliferous wackestones, packstones, and grainstones. (See Chaplin, 1996, for more detailed data on depositional environments in the Chase Group.)

10. The lower part of the Sumner Group in Kay County consists of the Wellington Formation, an evaporite-bearing, mixed siliciclastic and carbonate cyclic rock succession up to 850 ft thick. Sequences of lithofacies, sedimentary structures, and depositional fabrics suggest, at least in part, a mixed sabkha and playa setting within an overall broad, coastal-plain, mud-rich, tidal-flat system.

ACKNOWLEDGMENTS

I am grateful to Dr. Charles J. Mankin, Director of the Oklahoma Geological Survey, for permission to publish this paper. I thank Jim Anderson, OGS Manager of Cartography, for his professional technical assistance in the final version of this paper. I appreciate the efforts of Christie Cooper, OGS Managing Editor, in the final compilation of this paper, and Frances Young, who reviewed a part of an earlier version of the manuscript. William D. Rose completed the final editing of the paper, and Virginia Rose did the page layout. The author is indebted to Betty Bellis for typing an earlier version of the paper.

I wish to thank Dr. Neil Suneson, OGS Assistant Director of Geological Programs, for his thorough review of a part of the final version of the appendixes.

I would also like to thank LeRoy Hemish, retired geologist of the Oklahoma Geological Survey, who reviewed the initial and final manuscripts and provided many helpful suggestions that greatly improved the content and readability of the paper.

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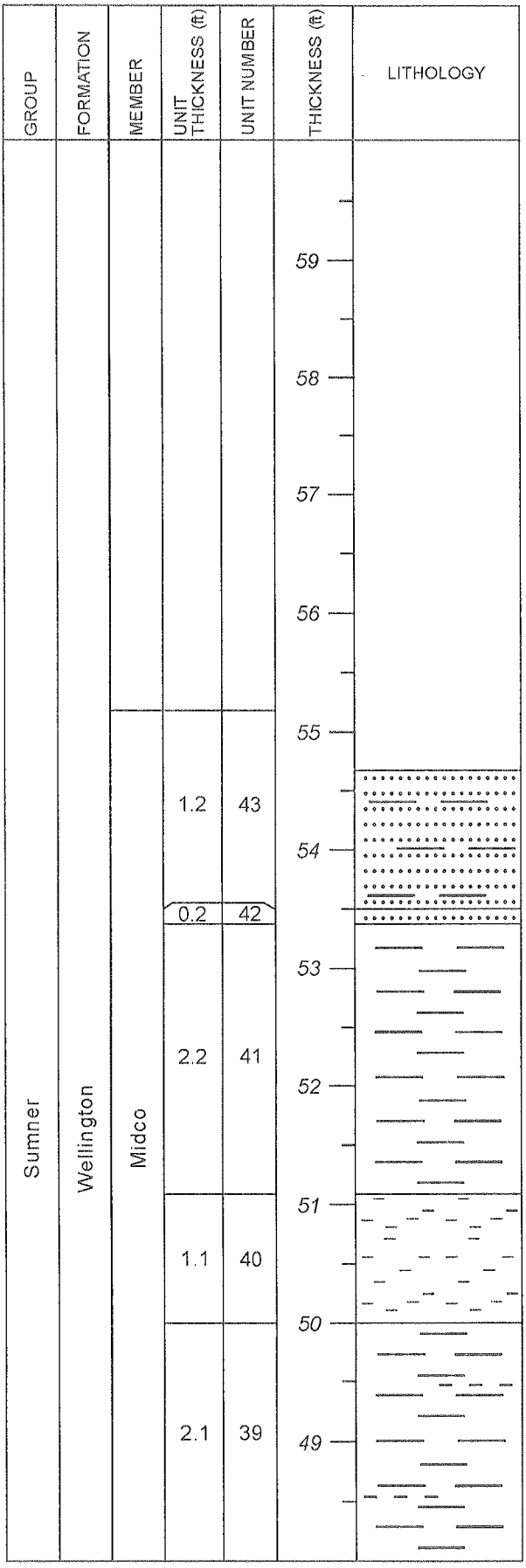
Appendixes 1–10

Field Log Descriptions

Oklahoma Geological Survey
Core Holes KC-1 – KC-10
Measured Surface Section K-24

See Figure 4 (on p. 5)
for lithologic symbols.



Measured Section K-24
KAY COUNTY SHALE PIT

NE¼SE¼NW¼SW¼ sec. 31, T. 25 N., R. 1 W., Tonkawa SE Quadrangle, Kay County. Measured section begins in lower shale pit at grove of trees marking site of Core Hole KC-1 and traverses southward to top of pit. Elevation at base of section, 1,032 ft (determined from altimeter). Section measured and described by James R. Chaplin.

SUMNER GROUP

WELLINGTON FORMATION

Midco Member (Raasch, 1946) (54.7 ft)

Unit no.

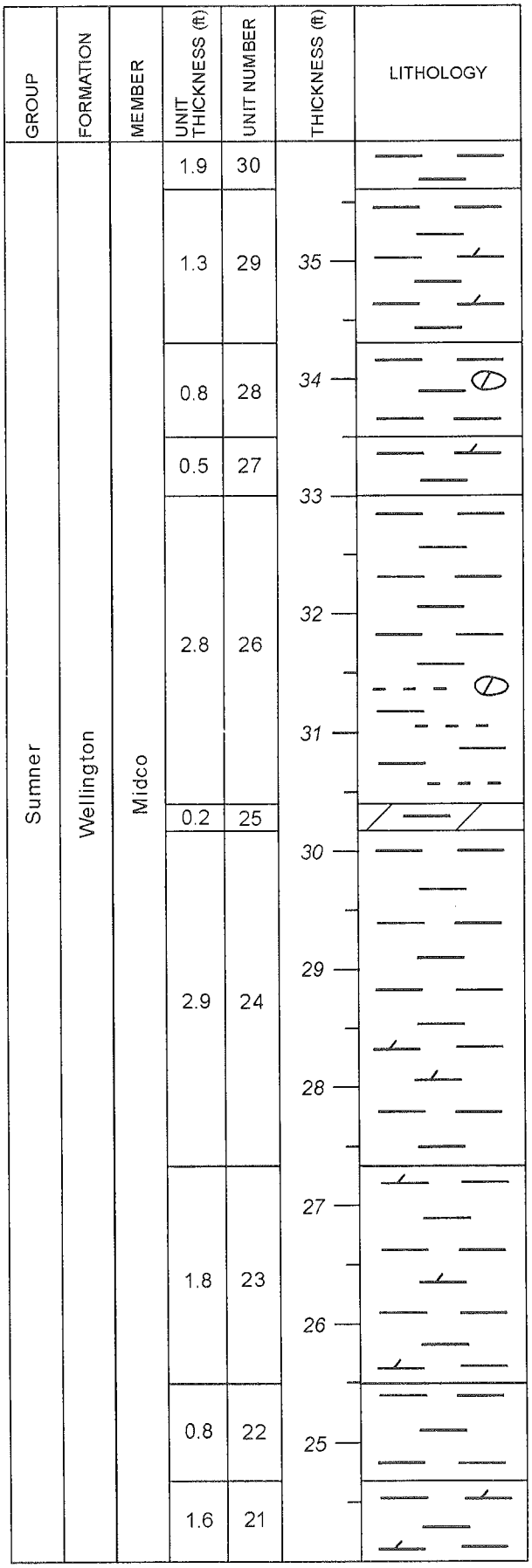
43. Sandstone, moderate-reddish-orange to moderate-orange-pink, very fine grained, rippled; interbedded with shale and mudstone; contains vertical burrows of dwelling and resting type

42. Sandstone, very light gray to light-bluish-gray, rippled-marked, very fine grained; contains load casts

41. Mudstone, dark-greenish-gray; contains calcite stringers; a white mudstone occurs ~1.5 ft above the base

40. Mudstone, grayish-red to pale-reddish-brown; contains irregularly shaped calcite plates; vertical lungfish burrows filled with greenish-gray shale

39. Shale and mudstone, mottled light-olive-gray and olive-gray to grayish-red; contains horizontal burrows



29. Mudstone, olive-gray weathers to white, dolomitic, mud cracked; alternates with very thin bedded shale; contains some horizontal burrows

28. Shale, black to olive-black, highly organic; contains dolomitic mudstone nodules and calcite stringers; includes small-scale flaser bedding; sharp basal contact

27. Mudstone, olive-black, weathers from very light gray to bluish-white, dolomitic, iron-stained; contains excellent lungfish burrows, 7.5 in. long and 3 in. wide; basal contact undulatory

26. Mudstone, variegated, gradational in color from greenish-gray to reddish-brown; lower 1.7 ft consists of dark-greenish-gray to grayish-red, dolomitic mudstone nodules; contains cross fractures and veinlets of calcite; upper 11 in. is a brownish-black mudstone; blocky

25. Dolomite, light-olive-gray, shaly, nodular-bedded, iron-stained; one distinct bed

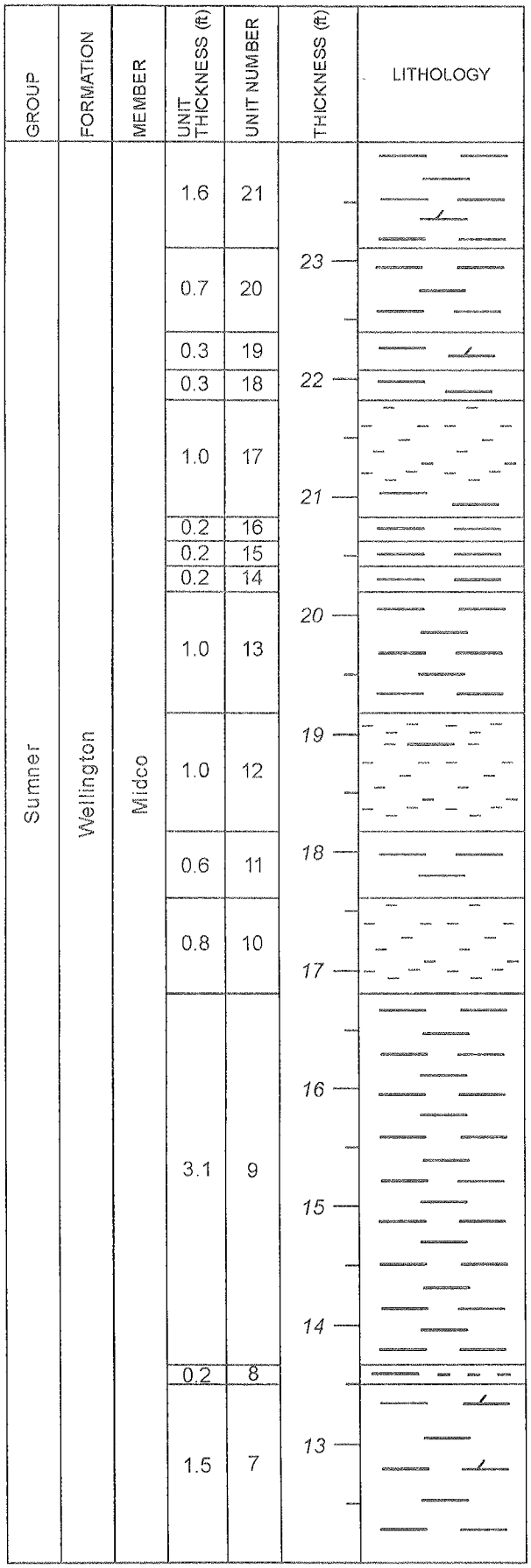
24. Mudstone, brownish-black to grayish-black, moderately to well indurated; a 2-in.-thick iron-stained dolomitic mudstone occurs ~2.1 ft above the base

23. Shale, light-gray, very dolomitic, very thin bedded; contains varvelike laminations; conchoidal break similar to fireclay; separated into very thin beds, 2–4 in. thick, by grayish-black to brownish-black shale partings; green mineralization chalcocite and/or malachite; sharp contacts between dolomitic shale partings

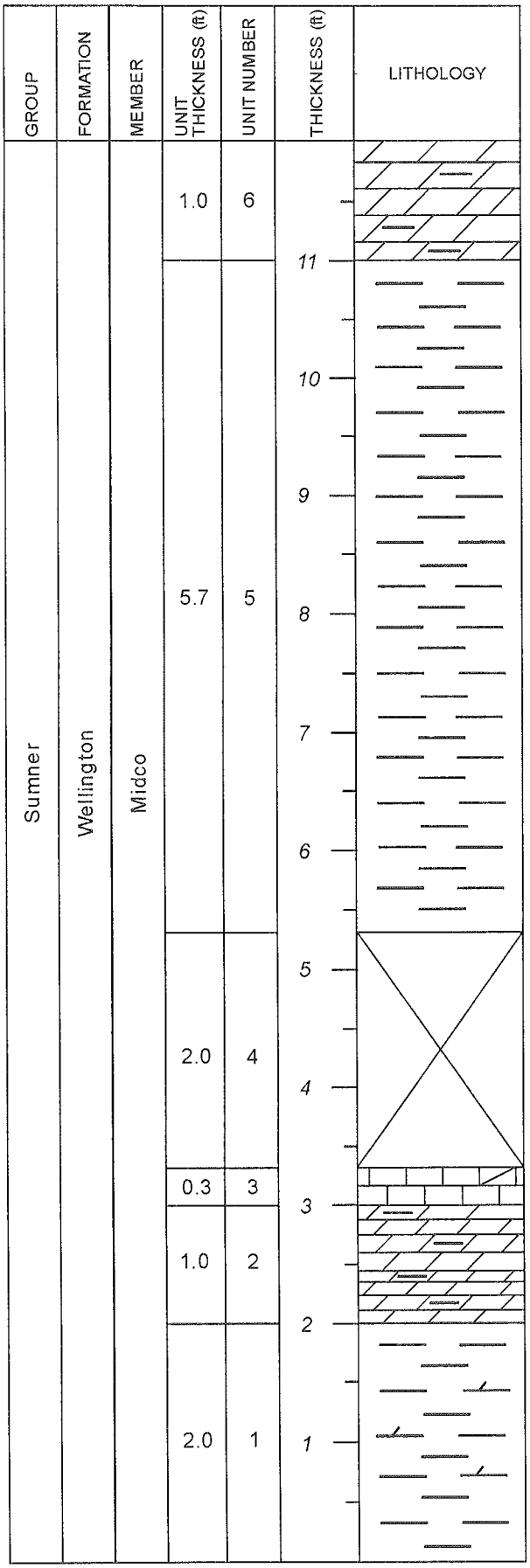
22. Mudstone, olive-black to olive-gray; includes calcitic veinlets; weathers concretionary, blocky, crumbly; basal contact gradational

21. Mudstone and shale, medium-dark-gray to olive-black, faintly laminated, slightly dolomitic

APPENDIX 1: Measured Section K-24 and Core Hole KC-1 — Kay County Shale Pit



20. Mudstone, dark-greenish-gray, concretionary; includes a 2-in.-thick distorted layer ~7 in. above the base; sharp basal contact
19. Mudstone, very light gray to bluish-gray, dolomitic, bioturbated, moderately indurated; very distinct white appearance in outcrop; vertical and horizontal burrows common; forms single distinct bed; sharp basal contact
18. Mudstone, greenish-gray; contains slickensided cross fractures filled with calcite; unit is variable in thickness
17. Mudstone, lower part dusky-brown, upper part grayish-brown to grayish-red, calcitic; includes slickensided fracture surfaces
16. Mudstone, dark-greenish-gray weathers to light-olive-gray, calcitic; contains slickensided fracture surfaces; sharp basal contact
15. Mudstone, grayish-brown to pale-brown, weathers grayish-red; contains cross fractures filled with calcite
14. Mudstone, dark-greenish-gray weathers to light-olive-gray; includes cross veinlets of calcite; gradational base
13. Mudstone, brownish-gray to grayish-brown, blocky; basal 2 in. is grayish-olive-green
12. Mudstone, lower part very dusky red, crumbly, blocky; upper part consists of medium-light-gray to pale-purple mudstone, very crumbly, breaks conchoidally like fireclay
11. Mudstone, olive-gray to dark-greenish-gray, faintly laminated, concretionary; gradational basal contact
10. Mudstone, very dusky red weathers to grayish-purple; weathers blocky; includes some calcite laminations in mudstone concretions; gradational basal contact
9. Mudstone, base moderate-brown, upper part grayish-olive-green weathering to purplish-gray at top; variegated and mottled in middle; blocky, semi-conchoidal fracture
8. Shale, grayish-red to greenish-gray, papery; poorly exposed
7. Mudstone, light-gray to very light gray, dolomitic, mud cracked; very thin papery shale partings separate unit into 1–2-in.-thick beds; iron-stained yellowish-orange



6. Dolomite, light-gray; shaly with very thin shale and thin dolomitic mudstone stringers; thicker beds are 1–3 in.; conchoidal break

5. Mudstone, greenish-gray, blocky

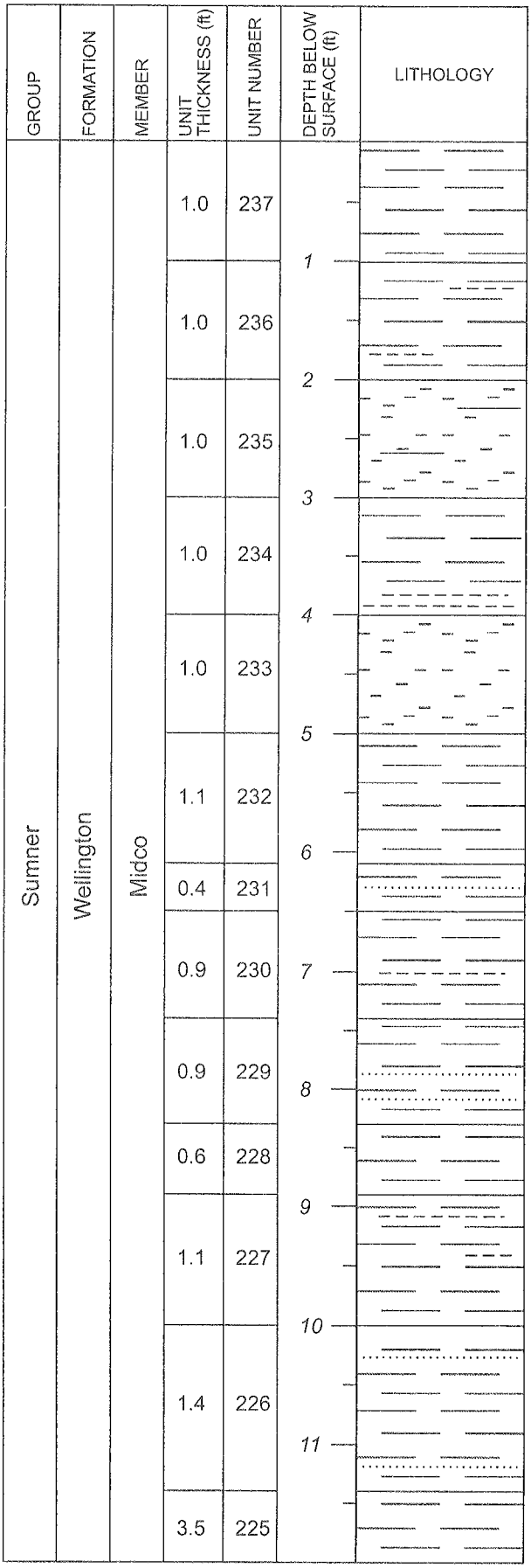
4. Covered interval

3. Limestone, very light gray, dolomitic, vesicular; contains stromatolitic structures; forms resistant ledge under trees on north side of shale pit

2. Dolomite, light-gray, thin-bedded, very shaly; contains stromatolitic structures; semi-conchoidal break into thin ringing plates

1. Shale, moderate-yellowish-brown to dusky-yellowish-brown, slightly dolomitic; fissile at top to very thin bedded below; contains laminations, some lenticular; forms a gentle slope down to drainage on north side of shale pit; interval covered from base of this unit to next units exposed in drainage

NOTE: The top of Core Hole KC-1 begins here with Unit no. 237 with no overlap or missing section.



Core Hole KC-1
KAY COUNTY SHALE PIT

NE¼SE¼NW¼SW¼ sec. 31, T. 25 N., R. 1 W., Tonkawa SE Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 1,800 ft from south line (FSL) and 1,100 ft from west line (FWL). Surface elevation from altimeter, 1,032 ft. Set 5 ft of casing. Spudded in the Wellington Formation. Total depth (TD) is estimated from electric logs to be about 190 ft above the top of the Herington Limestone Member of the Nolans Limestone. Field lithologic descriptions by James R. Chaplin.

SUMNER GROUP

WELLINGTON FORMATION

Midco Member (Raasch, 1946) (127.5 ft)

Unit no.

237. Shale, clay, medium-light-gray to light-gray

236. Shale and mudstone, medium-gray and moderate-reddish-brown

235. Shale, moderate-reddish-brown to medium-gray

234. Mudstone and shale, medium-gray to medium-light-gray at top to medium-reddish-brown at the base

233. Shale and mudstone, moderate-reddish-brown

232. Mudstone, medium-gray to medium-dark-gray, soft, poorly indurated

231. Mudstone and shale, medium-dark-gray to medium-gray, moderately indurated; sandy laminations produce a banded appearance

230. Mudstone and shale with grayish-red and light-gray to very light gray bands in lower part, moderately indurated; contains wispy, disrupted laminations

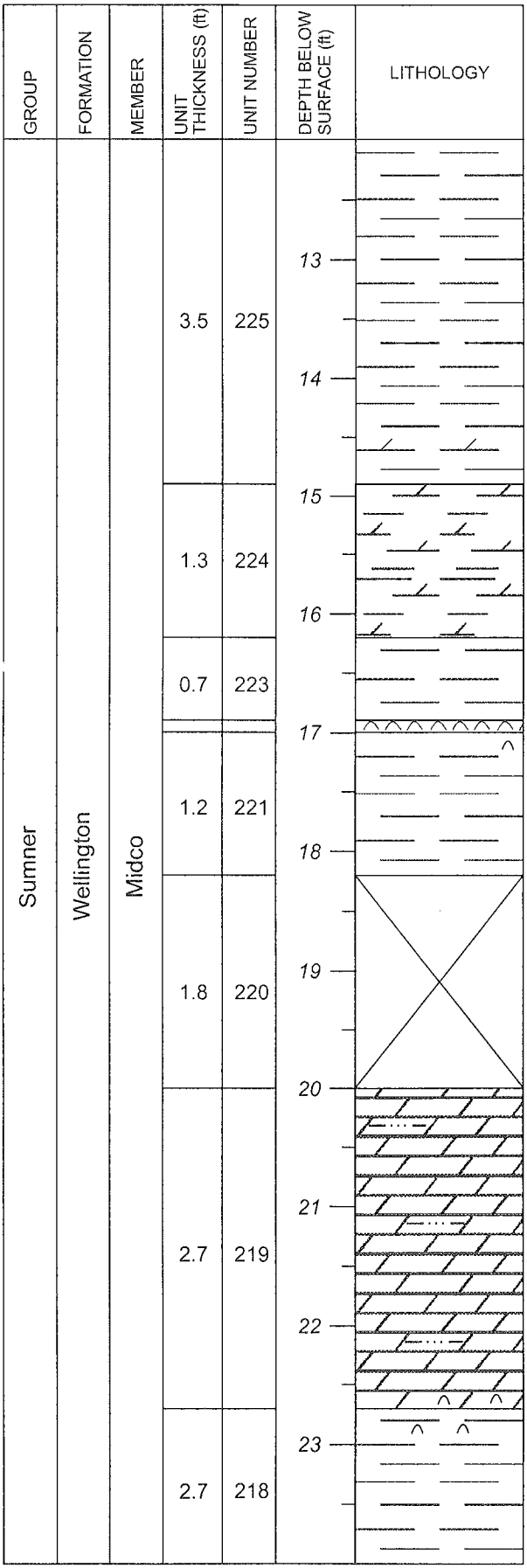
229. Mudstone, light-gray to very light gray, moderately indurated; contains thin, sandy, grayish-red laminations

228. Mudstone and shale, medium-light-gray to light-gray, clay-rich, wet, poorly indurated

227. Mudstone, grayish-red, light-gray and very light gray, moderately indurated

226. Mudstone, medium-light-gray to medium-dark-gray, moderately indurated; interbedded sandy laminations produce a banded texture; contains some wavy laminations

225. Mudstone, light-gray to medium-light-gray, well indurated; includes medium-light-gray dolomite laminations at the base



224. Mudstone, light-gray with wide bands of light-gray to medium-light-gray dolomite

223. Mudstone, medium-dark-gray to medium-gray, wet, poorly indurated

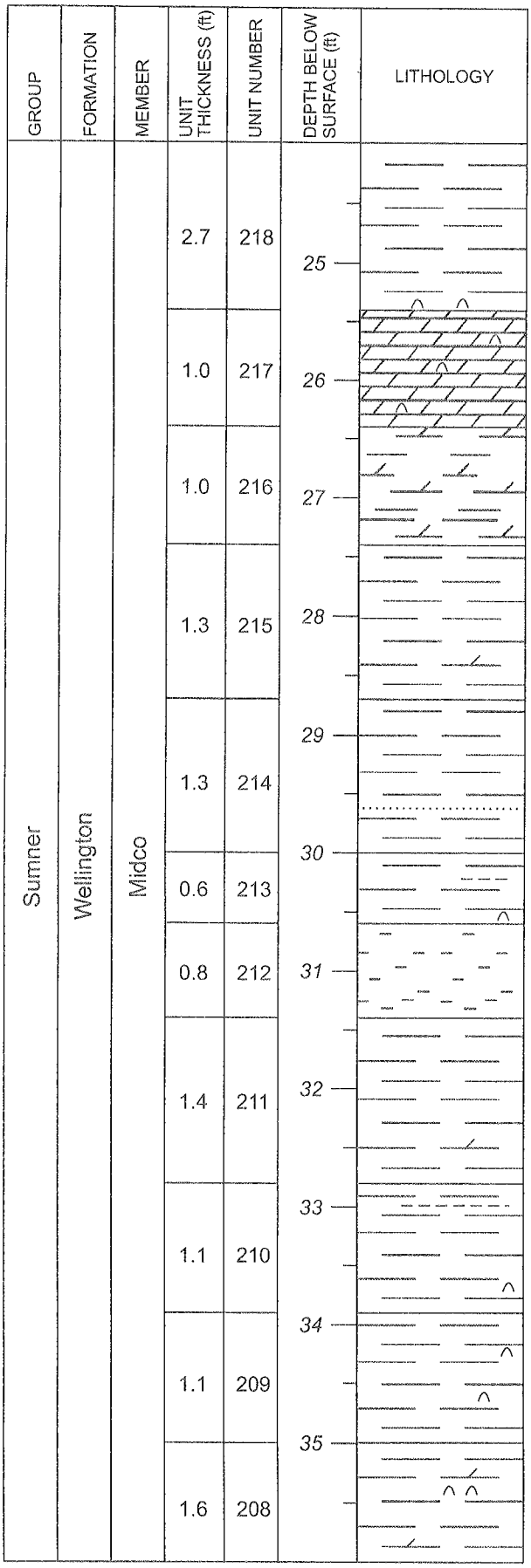
222. Anhydrite, pale-brown to grayish-orange-pink

221. Mudstone, light-gray with gypsum-lined fracture surfaces in upper 0.3 ft

220. Loss of core

219. Dolomite, light-gray to very light gray, silty, well indurated; includes some brecciated intervals; wavy laminations common; contains some medium-gray to medium-light-gray gypsum stringers in lower part

218. Mudstone, medium-light-gray to medium-gray; contains gypsum in lower and upper part



217. Dolomite, very light gray to medium-light-gray and light-gray below, moderately to well indurated; gypsum stringers and fractures common throughout; upper contact undulatory

216. Shale, medium-light-gray to medium-gray, dolomitic, laminated, moderately indurated

215. Mudstone, light-gray to light-bluish-gray, upper few inches mottled, slightly dolomitic, moderately indurated

214. Shale, moderate-yellowish-brown to medium-light-gray, poorly to moderately indurated; includes some sandy laminae

213. Shale, dark-reddish-brown, moderate-yellowish-brown, medium-light-gray, and medium-bluish-gray mottled, moderately indurated; contains gypsum in lower part

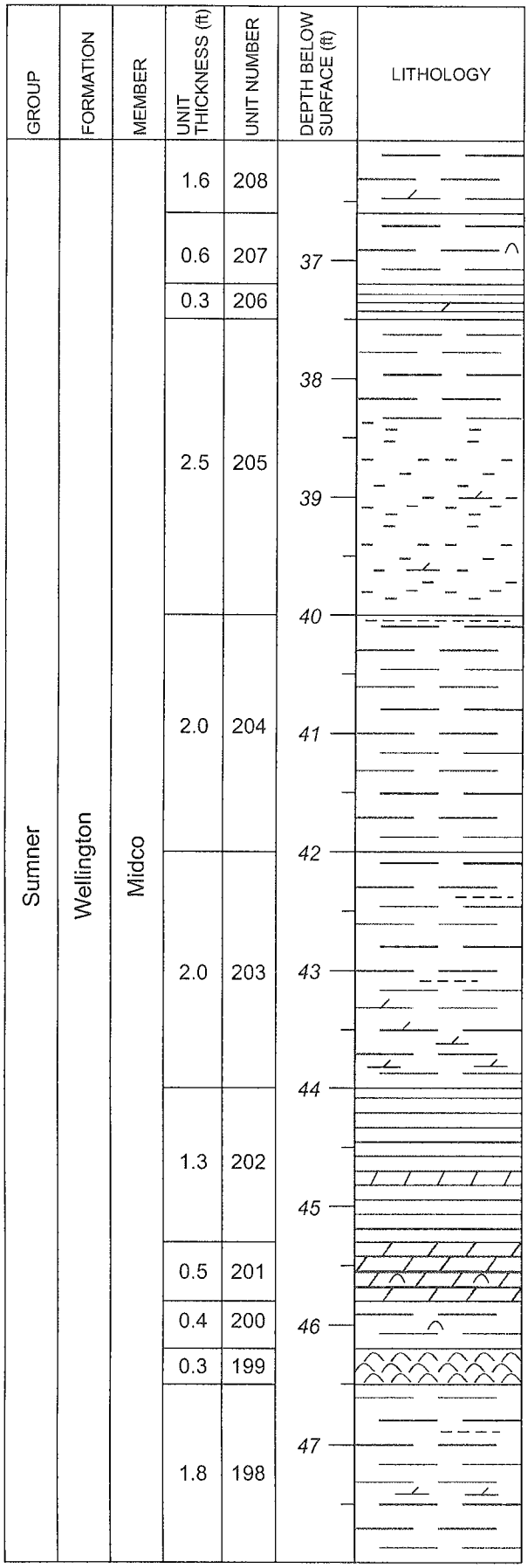
212. Mudstone, dark-reddish-brown, wet, poorly indurated

211. Shale, medium-bluish-gray to medium-light-gray, with grayish-red mottling, dolomitic, laminated

210. Mudstone and shale, dark-yellowish-brown with medium-bluish-gray to medium-light-gray intervals; includes grayish-red laminations especially at the top; contains streaks and fracture fillings of gypsum near base

209. Mudstone, medium-bluish-gray to medium-light-gray, gypsiferous, poorly to moderately indurated

208. Shale, medium-bluish-gray to medium-light-gray with grayish-red mottling, dolomitic; contains gypsum band in middle of unit



207. Mudstone, variegated medium-light-gray to medium-bluish-gray; includes gypsum granules; contains slickensided fracture surfaces

206. Shale, medium-light-gray to medium-gray, fissile, slightly dolomitic, bioturbated, moderately indurated; vertical fractures common

205. Shale, medium-light-gray to light-brownish-gray to pale red in lower 1.6 ft; lower part (38.9–39.9 ft) slightly dolomitic; moderately indurated

204. Shale, medium-light-gray to light-gray with upper 6 in. pale-red, faintly laminated; gradational to mudstone below

203. Mudstone and shale, medium-bluish-gray to grayish-red; contains dolomite laminations at 43.4–44.0 ft; poorly to moderately indurated

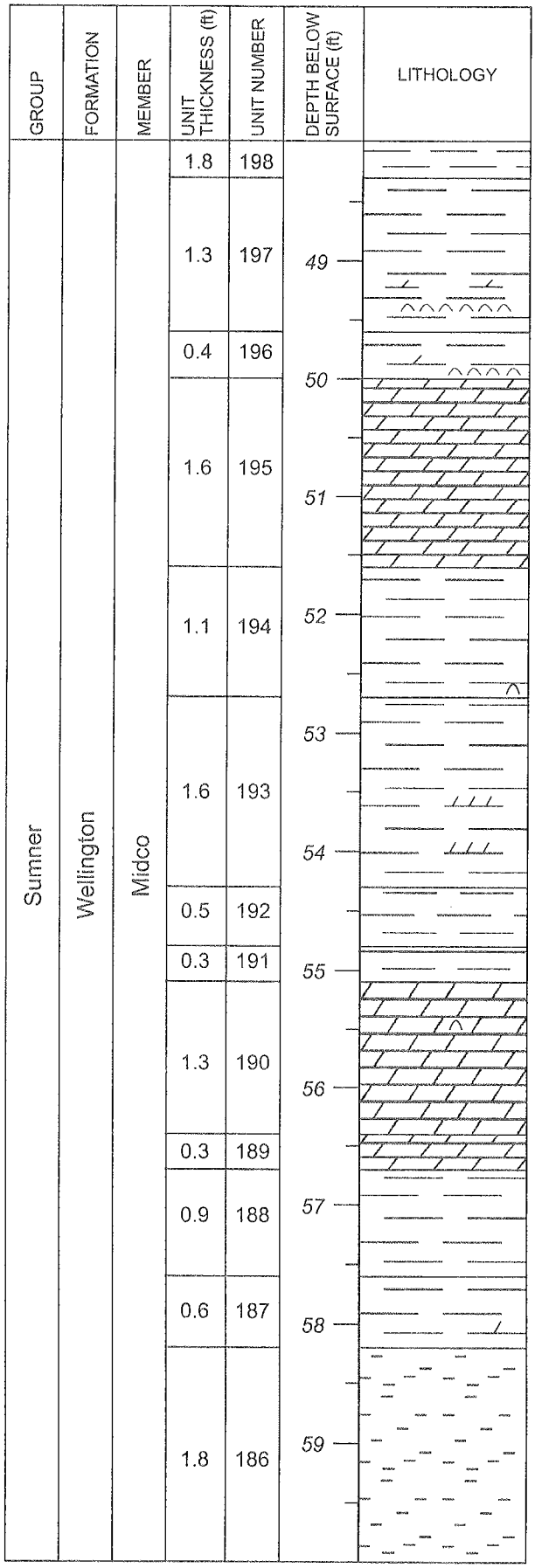
202. Shale, medium-gray to light-gray with grayish-red mottling; includes some dolomite bands; fissile; sharp contact

201. Dolomite, greenish-gray; contains gypsum stringers and gypsum-lined fractures

200. Shale, greenish-gray to dark-greenish-gray; contains gypsum stringers and fracture surfaces lined with gypsum

199. Anhydrite, yellowish-gray to white

198. Shale, medium-light-gray to light-gray; includes grayish-red and greenish-gray streaks and bands; contains some dolomite laminations



197. Shale, dark-gray to medium-gray, banded, dolomitic; dolomite laminations common; contains gypsum lamination at base

196. Mudstone, medium-light-gray, medium-gray, and pinkish-gray, dolomitic; contains moderate-orange-pink gypsum band at 49.6–49.8 ft

195. Dolomite, lower part light-gray to yellowish-gray and upper part medium-dark-gray; wavy and lenticular laminations common; churned bedding due to bioturbation

194. Shale, medium-dark-gray to medium-gray; contains 3-mm-thick pinkish-gray gypsum band at base

193. Shale, dark-gray to medium-gray with dark-yellowish-brown mottling at the top; dolomite laminations produce a banded texture; some laminations in lower part disrupted

192. Shale, greenish-gray, massive; gradational to mudstone below

191. Mudstone, medium-dark-gray to medium-gray, slightly fissile, poorly to moderately indurated

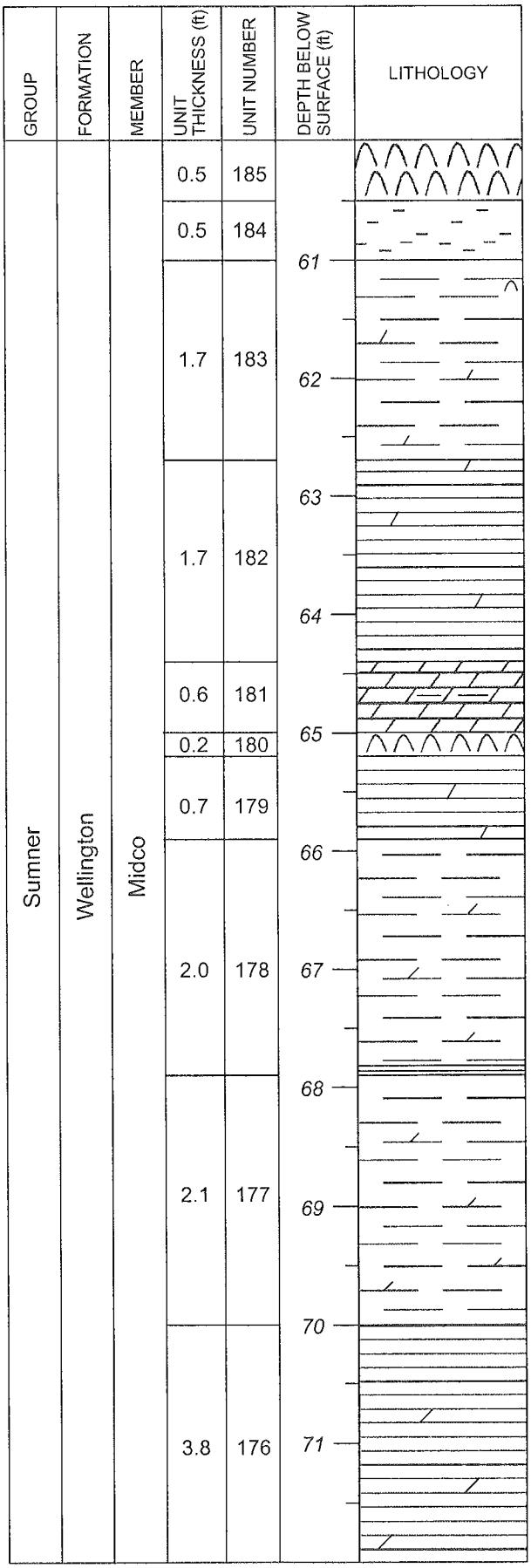
190. Dolomite, light-gray to greenish-gray, vuggy; contains rare gypsum veinlets

189. Dolomite, light-gray to greenish-gray with grayish-red mottling, banded texture

188. Mudstone and shale, greenish-gray with grayish-red and dark-reddish-brown mottling; shale is laminated; poorly to moderately indurated

187. Shale, greenish-gray at top to dark-gray and medium-dark-gray at the base; contains disrupted dolomite laminations at base

186. Mudstone, dark-reddish-brown with greenish-gray mottling at the base, poorly to moderately indurated



185. Gypsum, grayish-orange-pink, moderate-orange-pink, and white

184. Mudstone, grayish-red to dark-reddish-brown; some laminated shale at top; poorly to moderately indurated

183. Shale, light-bluish-gray, dolomitic; laminated at top to massive mudstone below; gypsum veinlet occurs at the top; includes a 3-in.-thick bioturbated dolomite band in lower part

182. Shale, dark-gray to medium-dark-gray, fissile, dolomitic; thin dolomite laminae occur at the top and at 63.7–63.8 ft

181. Dolomite, medium-light-gray to light-gray; contains bands of dark-gray to medium-dark-gray shale and mudstone; wavy shale laminations and lenticular dolomitic mudstone stringers common; some fractures are mudstone-filled

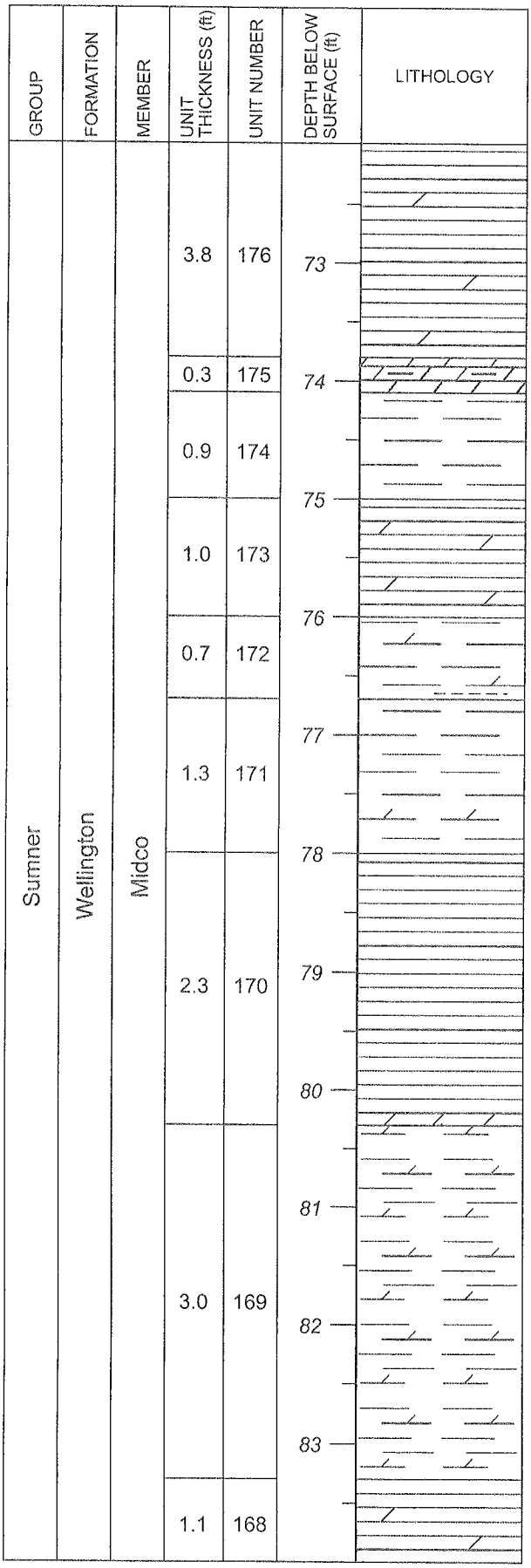
180. Gypsum, yellowish-gray stained grayish-orange

179. Shale, light-gray to medium-dark-gray, fissile; includes some thin wavy, lenticular dolomite laminae; banded texture; a 1-in.-thick dolomite band occurs at the base; basal contact undulatory

178. Shale, medium-bluish-gray to light-bluish-gray, dolomitic, massive; mottled at top; gradational to slightly fissile shale at base

177. Mudstone, dark-greenish-gray to greenish-gray with dark-yellowish-brown mottling in lower part, dolomitic; contains wavy, lenticular dolomite laminae

176. Shale, grayish-black to medium-gray, fissile; wavy, lenticular, and cross-laminae of dolomite common; bioturbated with vertical burrows



175. Dolomite, medium-gray to medium-light-gray; contains grayish-black wavy shale laminations; disrupted to wavy bedding; includes a storm deposit at the base, 74.0–74.1 ft

174. Shale, medium-dark-gray to medium-gray; gradational to a mudstone at the base

173. Shale, medium-dark-gray to medium-gray, dolomitic, fissile, laminated; contains wavy laminae of dolomite

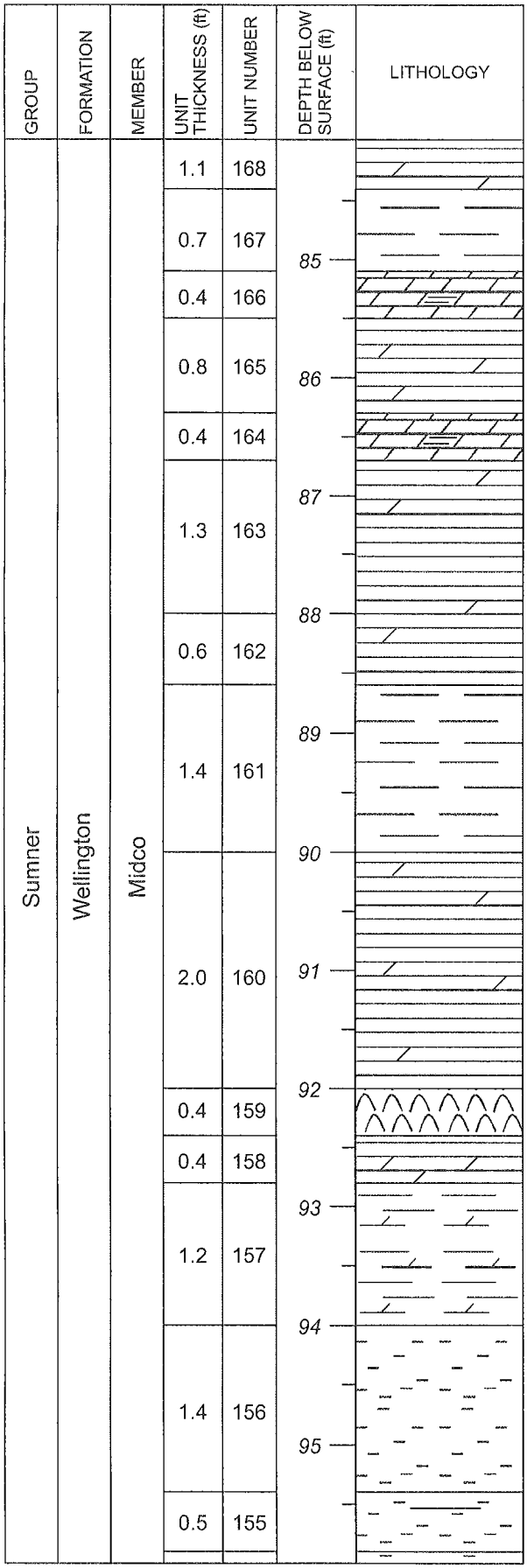
172. Shale, greenish-gray, medium-dark-gray, and medium-gray with grayish-red mottling, dolomitic, laminated; base is moderate-red to grayish-orange; includes some pinkish-gray dolomite stringers

171. Shale, medium-gray to dark-gray, laminated; dolomite bands and stringers common; base contains very wavy lenticular dolomite laminae

170. Shale, medium-gray to dark-gray, fissile; contains very thin laminae of dolomite at the base

169. Shale, medium-gray to medium-light-gray, dolomitic, slightly laminated

168. Shale, medium-dark-gray to medium-gray, dolomitic, fissile, laminated; contains very light gray laminae of dolomite, wavy at the top but becoming parallel and lenticular below



167. Mudstone and shale, light-olive-gray; mottled bedding at base; gradational base

166. Dolomite, light-gray to medium-light-gray; wavy to lenticular laminae of fissile shale common

165. Shale, dark-gray to medium-dark-gray, dolomitic, fissile; dolomite stringers common, especially at the top

164. Dolomite, light-gray with very thin medium-dark-gray dolomitic, fissile shale laminae; scoured base

163. Shale, dark-gray to medium-dark-gray, fissile, laminated; very thin dolomite laminae at top become thicker at base

162. Shale, medium-light-gray to light-gray, fissile, laminated; contains very thin laminae of dolomite; scoured base

161. Mudstone, medium-gray

160. Shale, dark-gray to medium-dark-gray, dolomitic, fissile; banded texture in lower part; laminated with stringers of dolomite

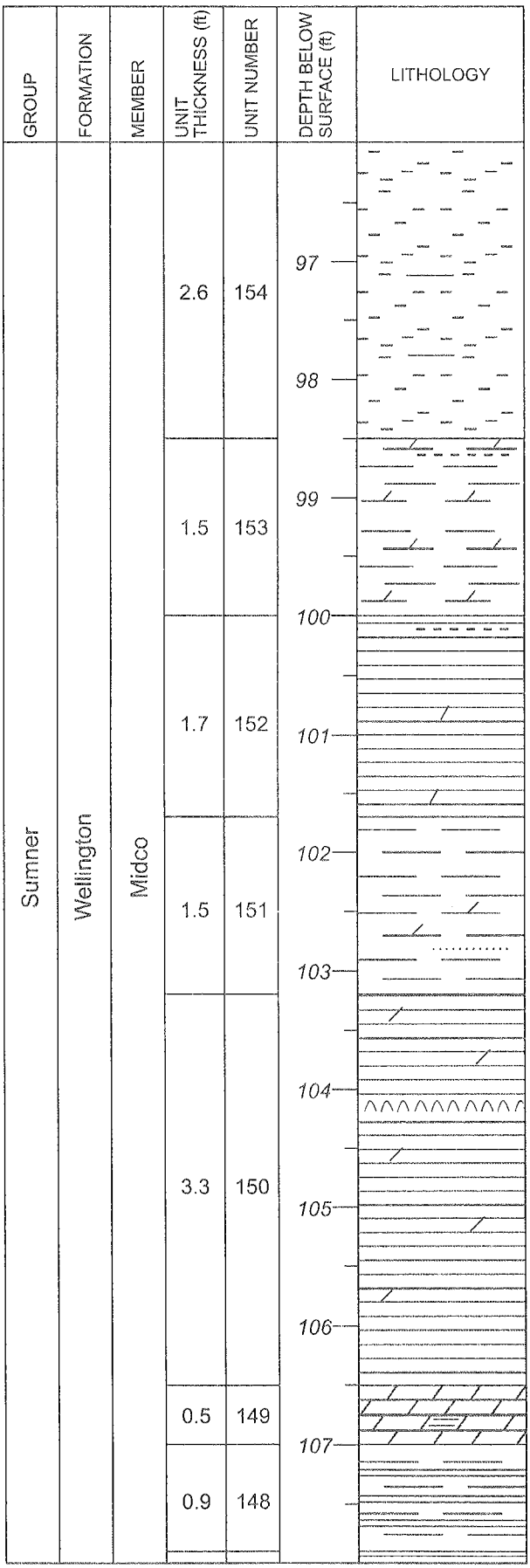
159. Gypsum, light-gray to medium-light-gray, crystalline; sutured contacts

158. Shale, medium-gray to dark-gray, dolomitic, fissile; includes dolomite laminae at the top

157. Mudstone, greenish-gray to dark-greenish-gray, mottled, dolomitic; less dolomitic at base; contains scattered veinlets of dolomite

156. Mudstone, grayish-red, wet, poorly indurated

155. Mudstone, dark-reddish-brown with greenish-gray mudstone stringers



154. Mudstone, grayish-red with bands and stringers of greenish-gray mudstone

153. Mudstone, greenish-gray to dark-greenish-gray with grayish-red mudstone bands at the top, dolomitic; contains some dolomite laminae at the top

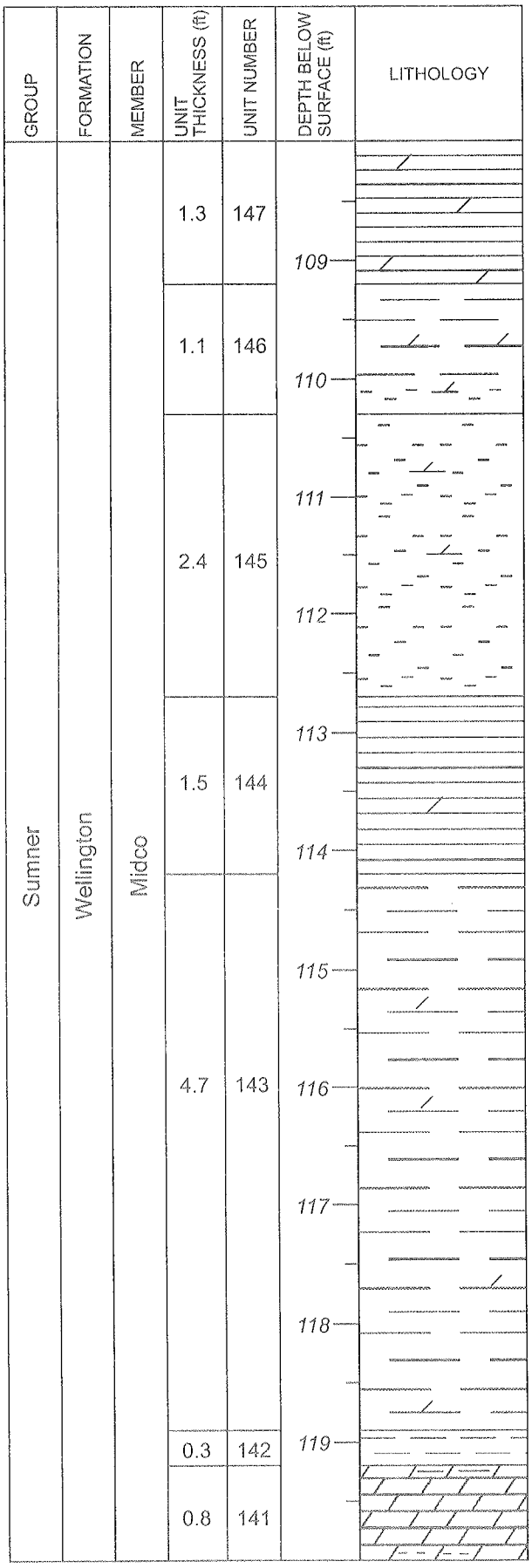
152. Shale, medium-gray with moderate-red and dark-reddish-brown mottling at the top, fissile, laminated; includes lenticular to swirled dolomite laminations; contains some laminations disrupted by vertical burrows

151. Mudstone, greenish-gray to dark-greenish-gray with some 1-in.-thick beds of light-brownish-gray and pale-brown mudstone; churned bedding due to bioturbation; contains some very sandy dolomite laminae; dolomite contacts very undulatory

150. Shale, lower part is medium-dark-gray to dark-gray and upper part is light-olive-gray to greenish-gray, dolomitic, fissile, laminated; includes some dark-reddish-brown mottling; contains some lenticular dolomite laminae; churned bedding at the top; gypsum band occurs at 104.1–104.15 ft

149. Dolomite, light-gray with fissile shale laminae

148. Mudstone, greenish-gray, slightly laminated; interbedded with fissile shale



147. Shale, medium-gray to medium-light-gray, dolomitic, fissile; moderate-brown dolomite laminae common

146. Shale, dark-greenish-gray to greenish-gray grading below to pale-red, dolomitic, slightly laminated

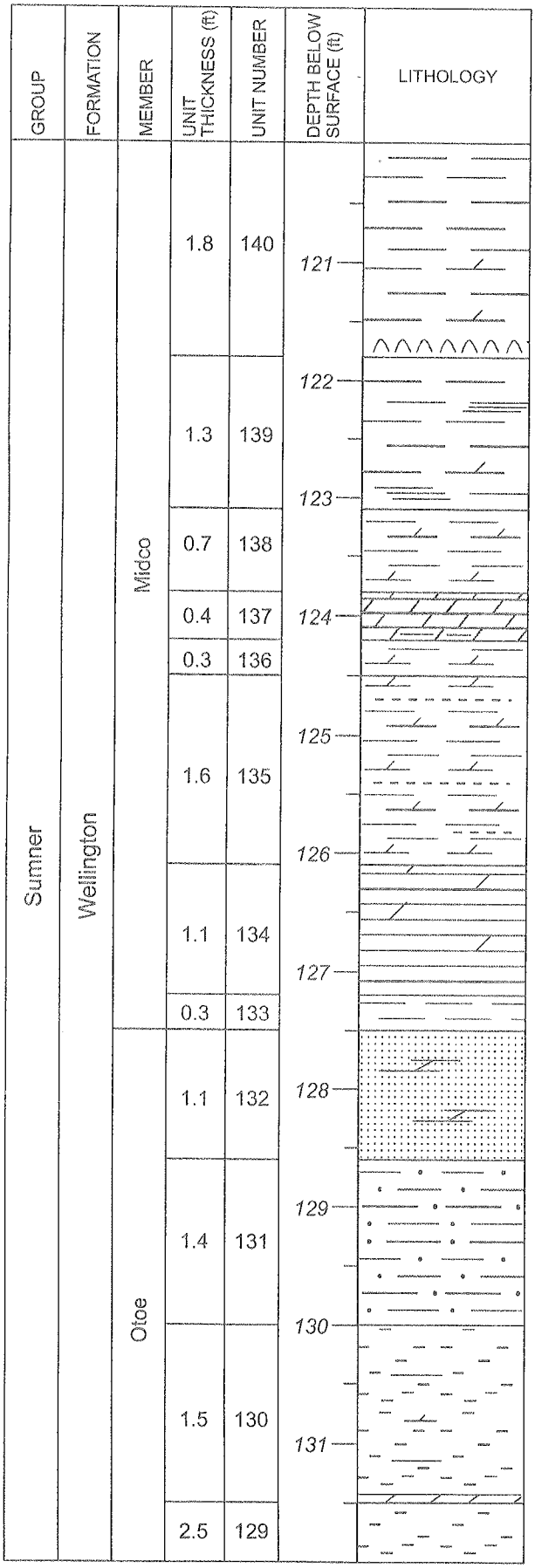
145. Mudstone, grayish-red to dark-reddish-brown, dolomitic; dolomite laminae common; churned bedding; vertical fractures common

144. Shale, light-bluish-gray to medium-bluish-gray with grayish-red to dark-reddish-brown mottling at the top and base, fissile; wavy, lenticular, and disrupted dolomite laminae common; bioturbated; includes some vertical fractures; contains some mudstone beds

143. Shale, dark-gray to greenish-black; very light gray to light gray, lenticular dolomite bands common producing a varved-like texture; dolomite most common at 116.0–116.7 ft

142. Mudstone, variegated, grayish-orange, medium-bluish-gray, and light-bluish-gray with moderate-red mottling; gradational base

141. Dolomite, light-gray to medium-gray; includes some wavy laminae of mudstone; base consists of medium-gray to medium-dark-gray mudstone; dark-reddish-brown mudstone laminae and bands common in lower part



140. Mudstone and shale, greenish-gray, dark-gray and grayish-black to brownish-gray at the top; lenticular dolomite laminae common, especially at base, 0.5-in.-thick gypsum band at base

139. Shale, medium-gray to medium-light-gray, slightly fissile; contains swirled laminae of dolomite

138. Mudstone, greenish-gray to brownish-gray at base, dolomitic; brecciated texture; probable subaerial exposure surface

137. Dolomite, light-gray to very light gray with medium-dark-gray shale laminae at base

136. Shale, medium-dark-gray to medium-gray; dolomite laminae common

135. Shale, variegated greenish-gray, dark-greenish-gray, dark-reddish-brown to grayish-red, dolomitic; lenticular dolomite laminae common

134. Shale, dark-gray to medium-dark-gray, upper part olive-gray to greenish-gray, fissile; lenticular dolomite laminae common, especially at the top

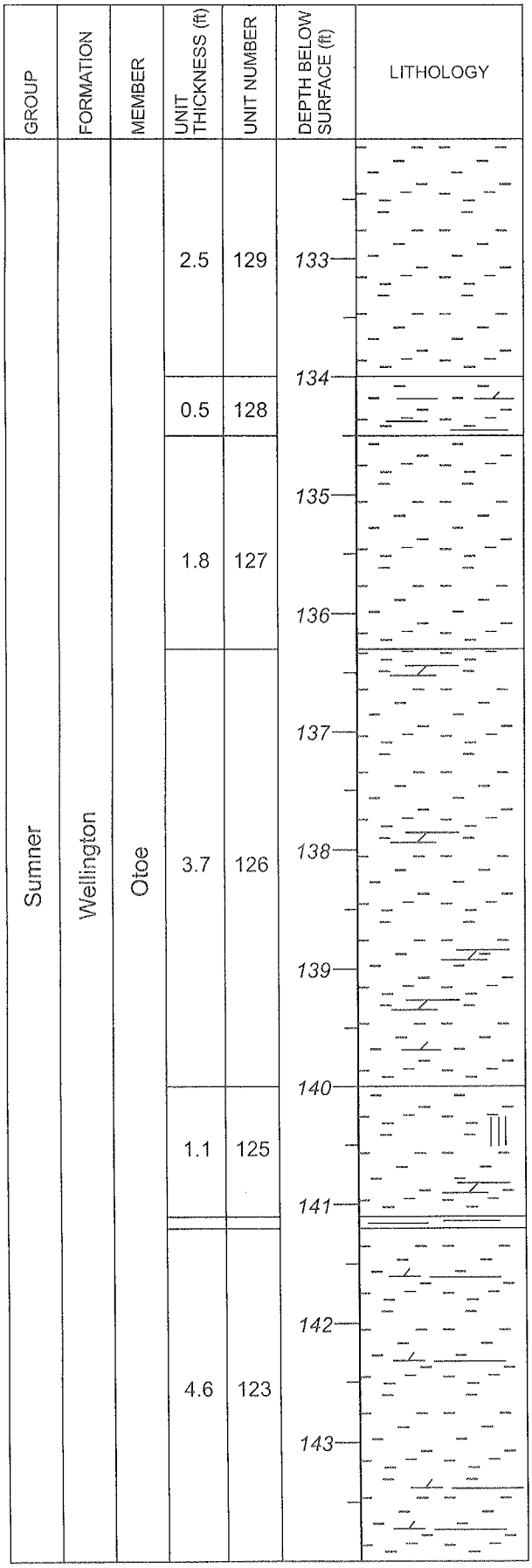
133. Mudstone, medium-gray to medium-light-gray with some interbedded shale; scoured base

Otoe Member (Raasch, 1946) (155.1 ft)

132. Sandstone, light-brownish-gray to pale-red, very fine grained; swirled laminae of shale due to bioturbation; dolomitic; soft-sediment deformation with convolute bedding

131. Mudstone, brownish-gray to pale-brown, sandy

130. Mudstone, grayish-red; very wispy dolomite laminations common; disrupted bedding; contains some olive-gray to light-olive-gray shale and mudstone flasers; includes a 1-in.-thick medium-light-gray dolomite band at the base



129. Mudstone, grayish-red

128. Mudstone, grayish-red to dark-reddish-brown interbedded with medium-dark-gray and dark-gray-shale; very light gray and light-gray dolomite laminae common; includes some convolute bedding

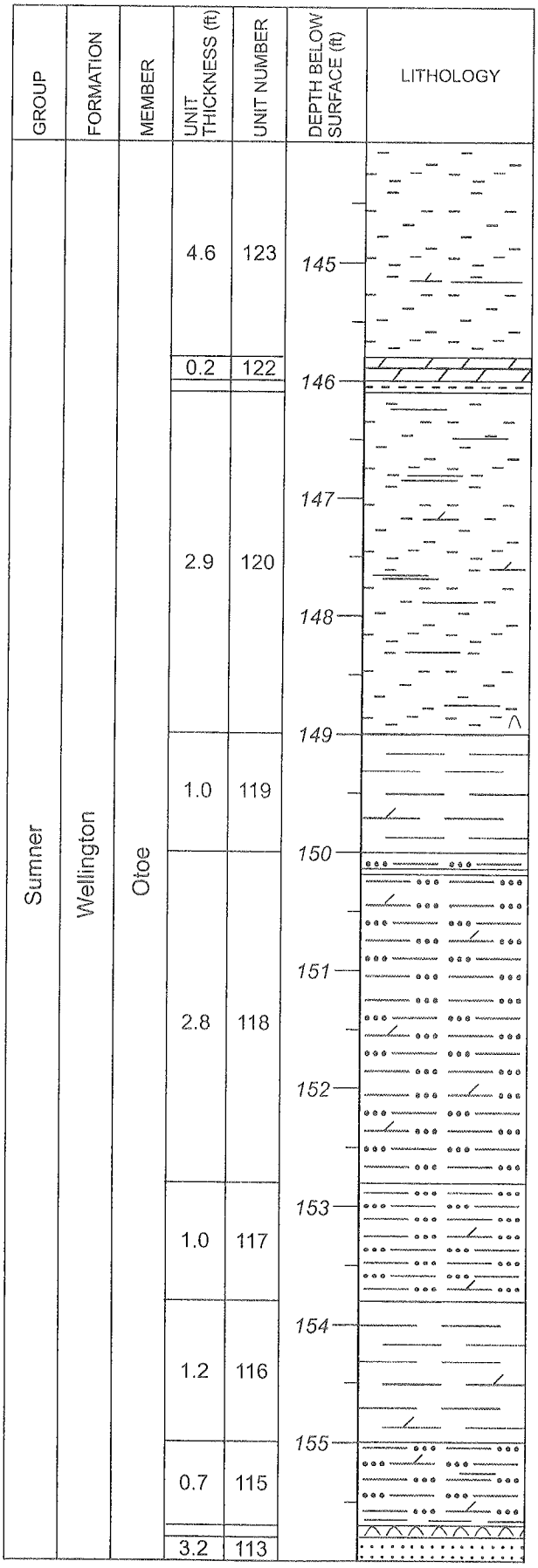
127. Mudstone, grayish-red

126. Mudstone, grayish-red, dolomitic; contains dolomite and shale laminae at the top; convolute bedding occurs throughout

125. Shale, grayish-red and dark-reddish-brown, slightly fissile; contains some light-bluish-gray dolomitic mudstone laminae; banded texture produced by laminations

124. Mudstone and shale, light-bluish-gray with medium-light-gray dolomite laminae, some lenticular

123. Shale, dark-reddish-brown and grayish-red; contains medium-light-gray and light-bluish-gray lenticular, dolomitic mudstone laminae; banded texture produced by laminations; some intervals of distorted bedding



122. Dolomite, mottled pale-red to light-gray; lower and upper contracts undulatory

121. Mudstone, dark-reddish-brown with numerous gypsum veinlets

120. Mudstone and shale, variegated greenish-gray and dark-reddish-brown; contains dark-gray and medium-dark-gray dolomite and fissile shale laminae; laminations produce a banded texture; contains some cavities of nodular gypsum

119. Mudstone, light-gray to medium-light-gray, slightly dolomitic, massive, structureless

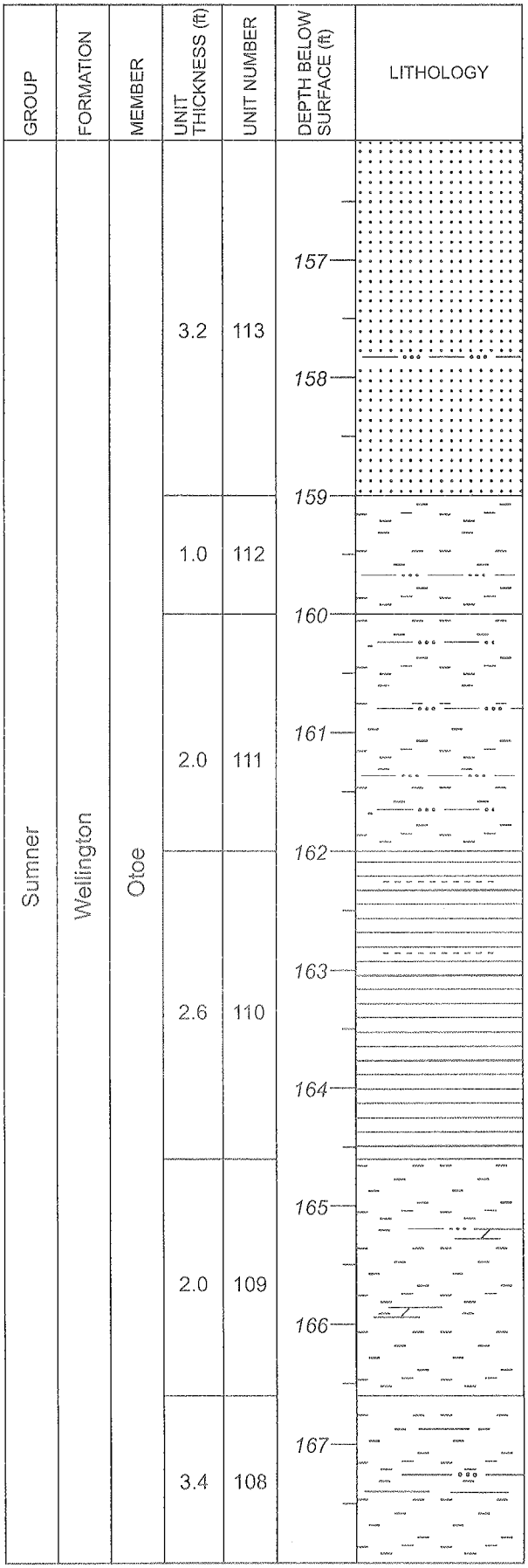
118. Siltstone, medium-gray, medium-light-gray, and light-bluish-gray; interbedded with fissile shale at top; very dolomitic; contains grayish-red and dark-reddish-brown lenticular dolomite laminae at the top; more massive in lower part; laminations produce a banded texture

117. Siltstone, medium-gray and medium-light-gray, slightly laminated; contorted bedding at the base; dolomitic

116. Mudstone and shale, medium-light-gray, medium-gray, and light-olive with dark-reddish-brown and pale-red mottling and liesegang banding; contains some dolomite laminae; contorted bedding at base

115. Siltstone, white to yellowish-gray, sandy, dolomitic; contains laminae of medium-dark-gray fissile shale and dolomite, some laminae very wavy; contorted bedding at the top; mottled texture in lower part; grades downward into light-olive-gray and olive-gray mudstone at the base

114. Gypsum, pinkish-gray with chicken-wire texture



113. Sandstone, dark-yellowish-brown, moderate-brown, very fine grained; includes some very light gray to medium-gray mottling; laminae are highly swirled; contains some highly contorted sedimentary structures; includes some rare siltstone beds

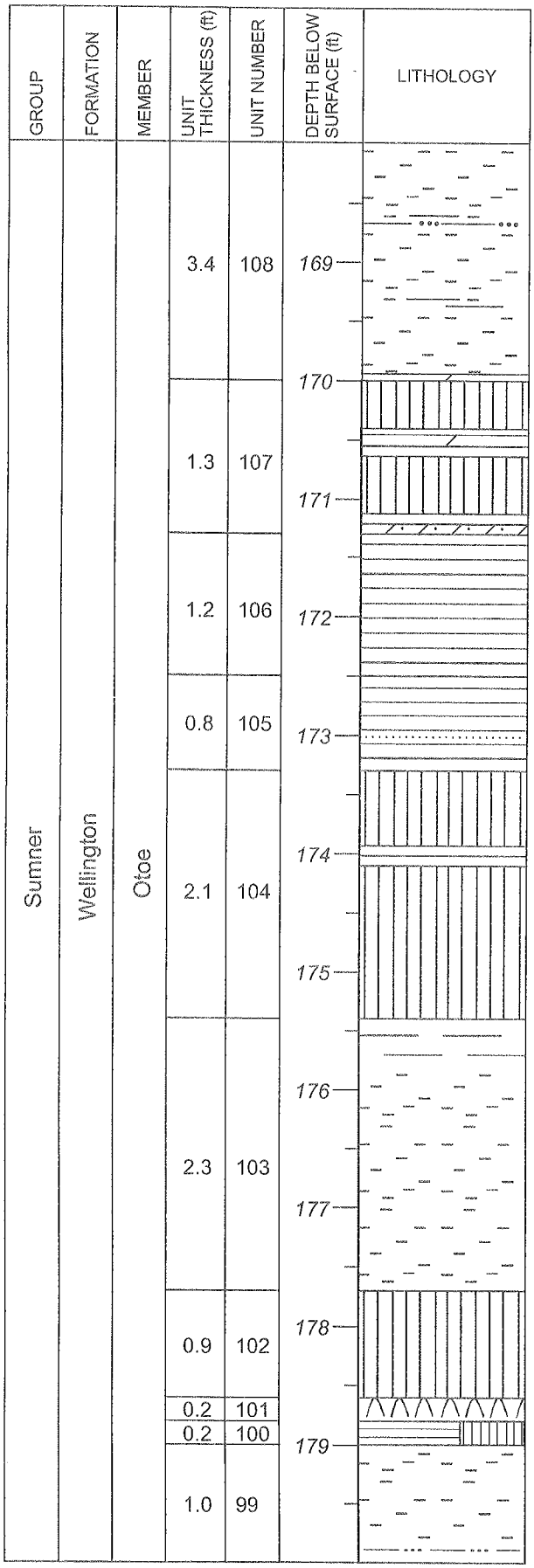
112. Mudstone, grayish-red and dark-reddish-brown, very silty

111. Mudstone, grayish-red and pale-reddish-brown, very silty; contains some yellowish-gray inclusions at the base

110. Shale, medium-light-gray and light-gray with pale-red bands, fissile, fractured

109. Mudstone, grayish-red; includes bands of silty dolomite and dolomite laminae; fractured

108. Mudstone, grayish-red with laminae of greenish-gray silty mudstone



107. Shale, variegated, grayish-red, dark-reddish-brown, medium-gray, and medium-dark-gray, fissile; includes thin, sandy, white dolomite laminae with moderate-red and moderate-reddish-brown mottling at the base; some vertical fractures

106. Shale, medium-gray, medium-dark-gray, and medium-bluish-gray with light-olive-gray staining, fissile; some moderate-reddish-brown staining at the base

105. Shale, light-olive-gray and moderate-olive-brown, fissile; contains very wavy, lenticular, very fine grained sandstone laminae

104. Shale, variegated, grayish-red, pale-red, and light-olive-brown, fissile, banded

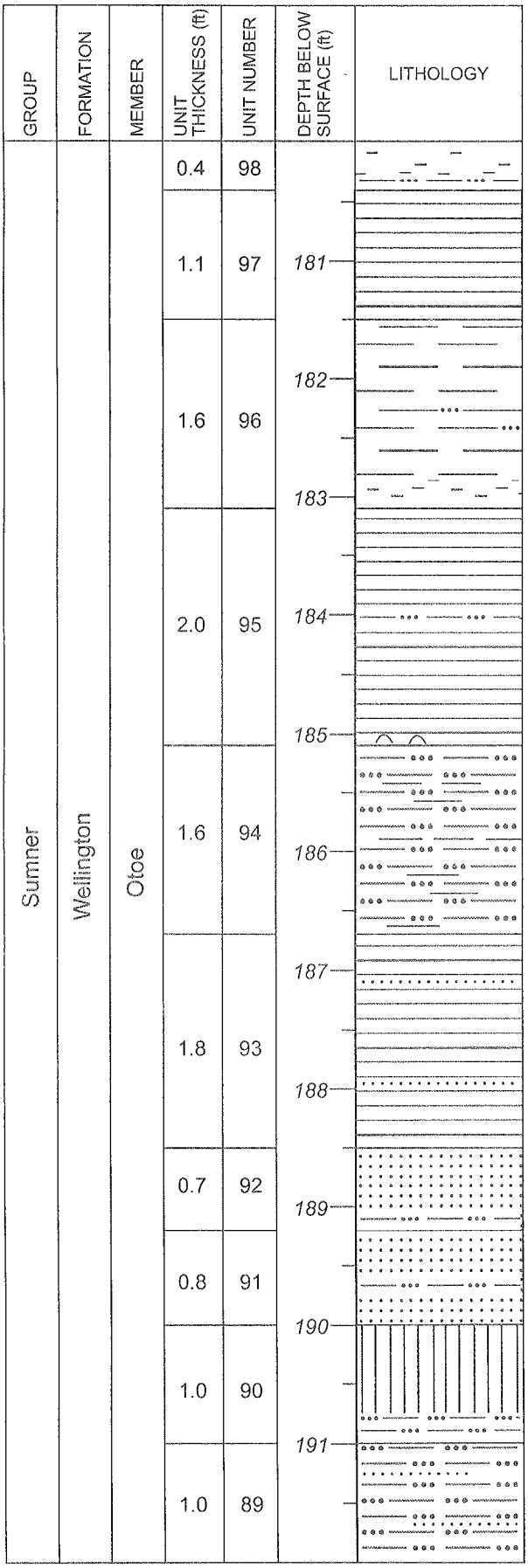
103. Mudstone, upper 6 in. light-gray and greenish-gray grading downward into pale-red and grayish-red

102. Shale, grayish-red and moderate-red, fissile; greenish-gray laminae common; basal 2 in. mottled, with brecciated-look

101. Anhydrite, medium-light-gray and pinkish-gray

100. Shale, variegated, light-bluish-gray, medium-gray and grayish-red, fissile

99. Mudstone, grayish-red; grades below into very silty mudstone



98. Mudstone, grayish-red, very silty

97. Shale, light-gray and light-bluish-gray, with grayish-red staining, fissile

96. Mudstone, medium-gray and medium-light-gray at the top to grayish-red below, silty, slightly laminated

95. Shale, variegated, medium-gray, medium-light-gray, and medium-bluish-gray with grayish-red mottling, fissile, silty; contains gypsum band at base

94. Siltstone and mudstone, medium-light-gray and light-bluish-gray, slightly laminated; includes mudstone clasts at the base

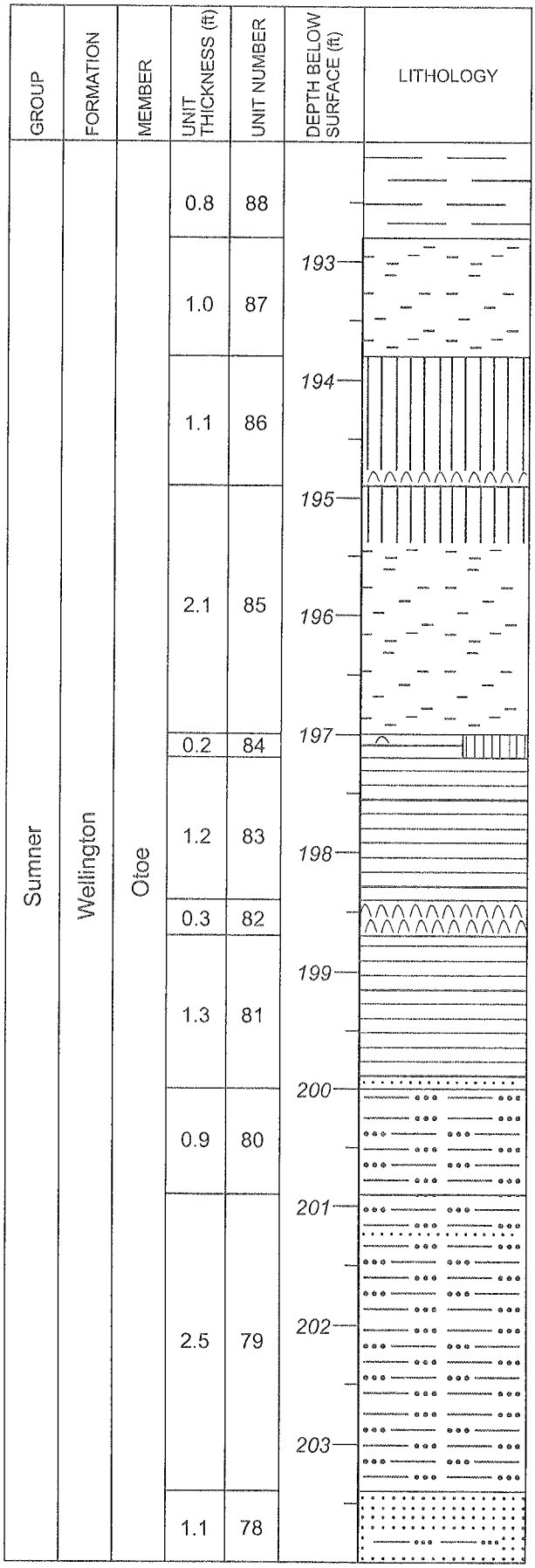
93. Shale, medium-bluish-gray, medium-gray, and medium-light-gray with grayish-red mottling, fissile; some sandy laminations are disrupted; sharp basal contact

92. Sandstone, grayish-orange-pink and pale-red, very fine grained, silty

91. Sandstone, grayish-orange-pink and pale-brown, very fine grained, silty; churned bedding due to bioturbation

90. Shale, pale-red to grayish-red, fissile, silty; grades below to siltstone; contains sandy wavy laminations at the top

89. Siltstone, medium-gray, medium-light-gray, and light-bluish-gray with pale-red mottling in the middle, sandy, slightly laminated



88. Mudstone, medium-light-gray and light-brownish-gray; soft-sediment deformation with highly contorted bedding; sedimentary structures churned by bioturbation

87. Mudstone, grayish-red with some contorted bedding

86. Shale, pinkish-gray, medium-dark-gray, and grayish-red, fissile, banded, laminated; contains gypsum stringers at the base

85. Shale, grayish-red to pale-red; slightly fissile at top grading downward into mudstone

84. Shale, grayish-red, pale-red, light-gray, and light-bluish-gray, fissile; includes some pinkish-gray irregular gypsum bands; contains nodular gypsum at the top

83. Shale, light-bluish-gray and medium-bluish-gray with pale-red mottling, fissile; wavy laminations and contorted bedding common

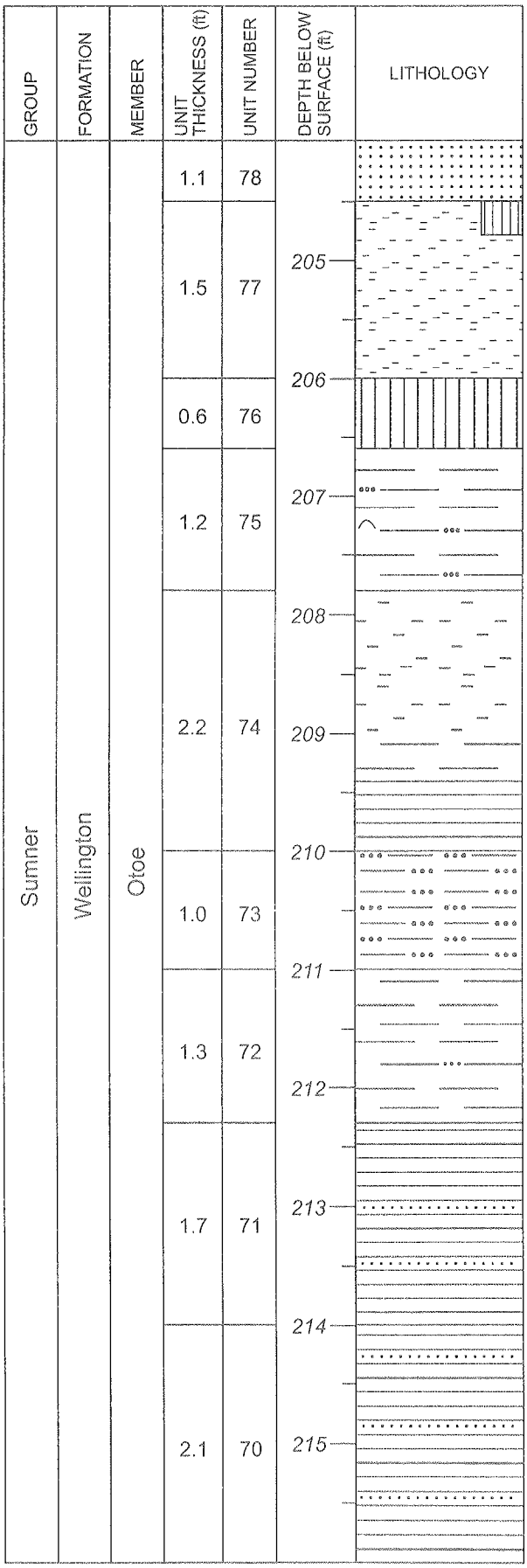
82. Gypsum, grayish-yellow and pinkish-gray, bedded

81. Shale, medium-light-gray and light-bluish-gray with dark-reddish-brown staining, fissile, banded at the top; grades below into medium-light-gray, light-gray, light-olive-gray fissile shale with highly contorted, convoluted sandy laminae

80. Siltstone, medium-light-gray at top to brownish-gray below

79. Siltstone, light-gray, light-bluish-gray, grayish-red and pale-red; contains contorted sandy laminae at the top

78. Sandstone, medium-gray and pale-red, very fine grained, silty; includes highly contorted laminae



77. Mudstone, grayish-red, slightly fissile shale at the top; slickensided fracture surfaces common

76. Shale, grayish-red and pale-red with minor medium-light-gray, fissile, banded

75. Siltstone, upper part light-bluish-gray and medium-bluish-gray grading below to pale-red, very shaly; gypsum-lined fracture surface at 207.25 ft

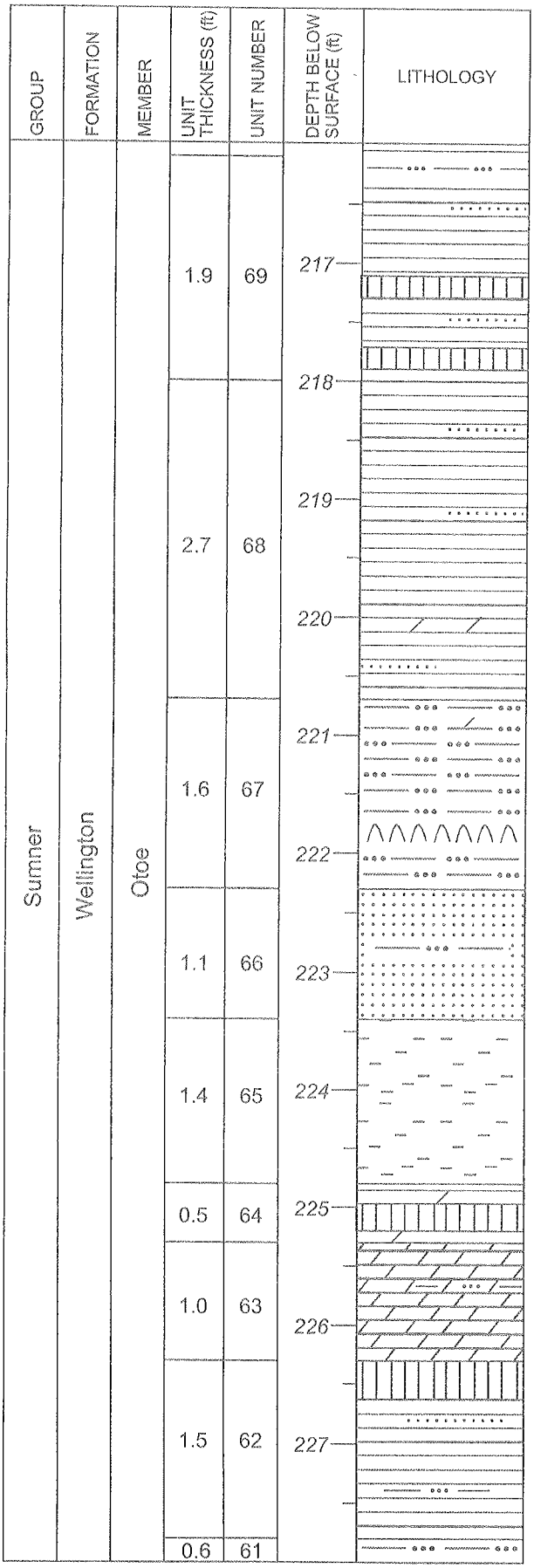
74. Mudstone, upper part pale-red, lower part light-bluish-gray to medium-bluish-gray; gradational below into fissile shale

73. Siltstone, light-bluish-gray and medium-bluish-gray with grayish-red mottling at the base; contains some laminations

72. Mudstone, medium-light-gray and light-bluish-gray, silty

71. Shale, variegated, medium-gray, medium-bluish-gray, light-olive-brown with grayish-red mottling, fissile; includes some lenticular very fine grained sandstone laminae; vertical fractures common

70. Shale, medium-light-gray and medium-bluish-gray, fissile; contains very abundant grayish-orange-pink and grayish-red, very fine-grained sandstone lenses; contorted bedding common; contains some rare vertical tubular structures; bioturbated with vertical burrows most common



69. Shale, light-bluish-gray, medium-bluish-gray, and grayish-red, fissile, especially in lower part; banded appearance; includes siltstone at the top containing scattered sandstone laminae

68. Shale, medium-bluish-gray, light-bluish-gray, medium-gray, and light-gray, fissile; contains scattered convoluted, very fine grained sandstone lenses; includes rare medium-light-gray to light-gray dolomite bands

67. Siltstone, greenish-gray and dark-greenish-gray, dolomitic; slightly brecciated in lower part; gypsum band occurs at 221.8 ft

66. Sandstone, light-bluish-gray, medium-bluish-gray to pale-red, very fine grained; contains rare thin siltstone bands; includes some vertical fractures in the lower part

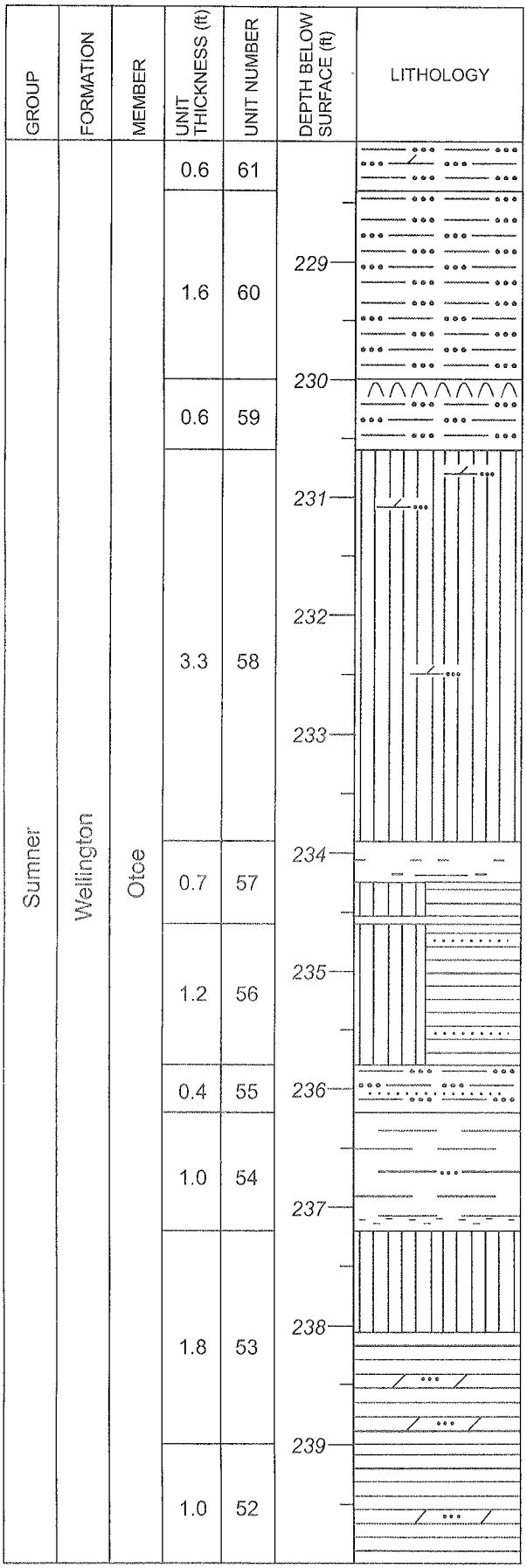
65. Mudstone, grayish-red and pale-red

64. Shale, grayish-red to pale-red with some light-bluish-gray and medium-bluish-gray, fissile, dolomitic, banded

63. Dolomite, variegated, yellowish-gray, medium-light-gray, and pale-red, silty, includes rare sandy wispy stringers; vertical fractures and stringers are filled with dolomitic mudstone

62. Shale, medium-light-gray and light-bluish-gray with grayish-red, especially at the top, fissile, silty, banded; contains scattered sandy laminae

61. Siltstone, greenish-gray, dolomitic



60. Siltstone, dusky-red and grayish-red; includes some silty mudstone bands

59. Siltstone, pale-brown, grayish-brown, and medium-bluish-gray; gypsum band at the top

58. Shale, dark-reddish-brown, fissile; contains numerous silty dolomite bands, especially at the top; distinctly banded

57. Mudstone, grayish-red and medium-bluish-gray; mottled texture due to mudstone clasts; grades into fissile shale below

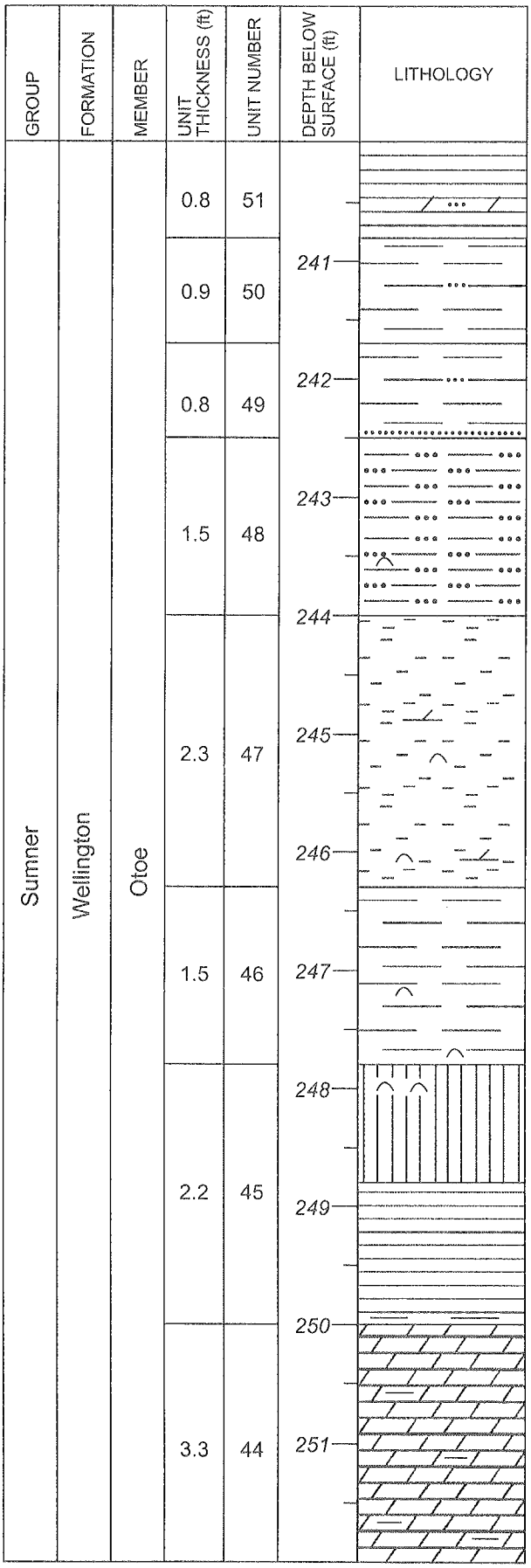
56. Shale, grayish-red, medium-bluish-gray with grayish-red mottling, fissile; includes a few sandy laminae at the top; interbedded sandy, convoluted laminations; cross-laminations rare

55. Siltstone and sandstone; siltstone, medium-dark-gray and medium-gray; sandstone, white, very fine grained; contains sandy, convoluted laminations; cross-laminations rare

54. Mudstone, light-bluish-gray and medium-bluish-gray, silty; contains grayish-red mudstone bands at the base

53. Shale, grayish-red and dark-reddish-brown at top to light-bluish-gray and medium-bluish-gray at the base, fissile; contains sandy dolomite bands

52. Shale, light-bluish-gray and medium-bluish-gray with moderate-reddish-brown and light-olive-brown mottling, fissile; slightly banded due to very thin sandy dolomite layers



51. Shale, dark-gray to medium-light-gray, fissile; banded with lenticular, sandy dolomite layers

50. Mudstone, light-brownish-gray and brownish-gray, silty, massive

49. Mudstone, dark-greenish-gray stained grayish-red, silty; very light gray, lenticular, very fine grained sandstone laminae common

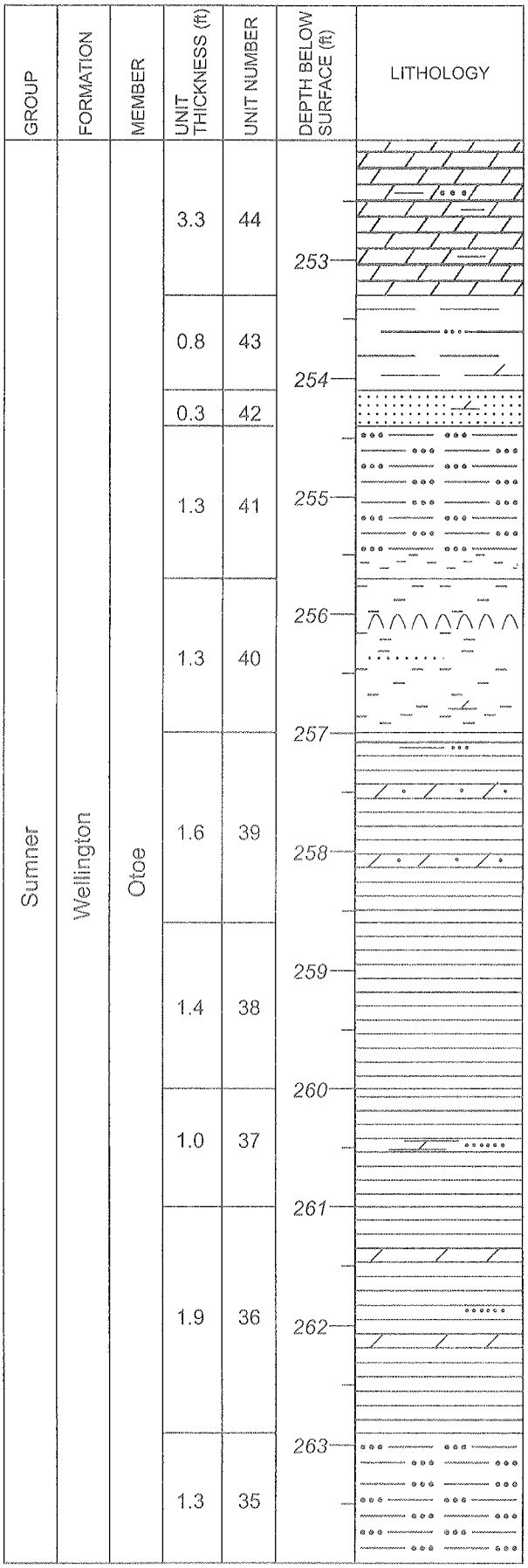
48. Siltstone, medium-light-gray to medium-gray at the top to pale-red and grayish-red at the base; gypsum-filled fracture at 243.5 ft

47. Mudstone, grayish-red; contains gypsum veinlets and stringers throughout; dolomitic

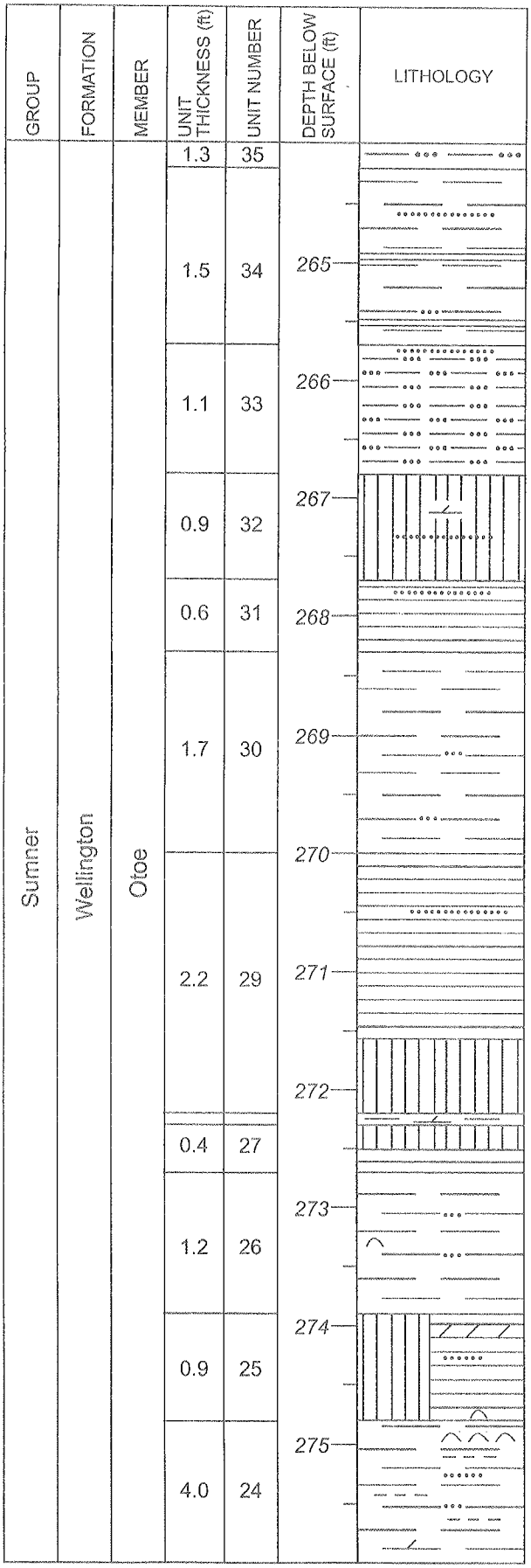
46. Mudstone, greenish-gray predominantly the matrix; very abundant pinkish-gray gypsum occurs as veinlets, nodules, fracture linings, and in massive form

45. Shale, dark-reddish-brown and grayish-red at top with greenish-gray and light-bluish-gray in lower part, fissile, slightly banded; less fissile in lower part; gypsum band at the top

44. Dolomite, medium-light-gray, silty, banded; includes indistinct dolomitic mudstone laminae; contains some vertical tubular fillings



43. Mudstone, light-bluish-gray to medium-bluish-gray, very silty; contains rare lenticular dolomitic mudstone stringers; very wavy basal contact
42. Sandstone, pale-brown and pale-red, very fine grained; contains wavy dolomitic mudstone laminae; convolute bedding
41. Siltstone, light-bluish-gray and medium-bluish-gray; grades below into grayish-red stained silty mudstone
40. Shale, grayish-red and dark-reddish-brown with greenish-gray laminae, slightly dolomitic; banded with sandy laminae; gypsum band at 256.2 ft
39. Shale, medium-bluish-gray with moderate-yellowish-brown and moderate-reddish-brown mottling, fissile; banded by very thin interbeds of sandy dolomite; very mottled and silty at top
38. Shale, dark-greenish-gray with dusky-red mottling, fissile
37. Shale, variegated, medium-light-gray and light-bluish-gray with grayish-red mottling, fissile, middle with grayish-red stained, contorted sandy dolomite laminae
36. Shale, dark-gray and medium-dark-gray, fissile; includes some medium-light-gray and light-gray dolomite bands; contains rare lenticular sandy laminae; basal contact sharp
35. Siltstone, pale-brown and medium-bluish-gray, massive; contains some silty mudstone layers



34. Mudstone, brownish-gray and medium-bluish-gray, silty; contains some interbedded fissile shale; rare scattered sandy laminae

33. Siltstone, light-brownish-gray, light-bluish-gray, medium-bluish-gray with grayish-red mudstone clasts in lower part; contains a few sandy laminae at the top

32. Shale, dark-reddish-brown, fissile; contains medium-bluish-gray dolomitic mudstone stringers and veinlets; includes some convoluted sandy laminae in the middle

31. Shale, brownish-gray, fissile; contains yellowish-gray, sandy, convoluted laminae at the top; lower part with churned, mottled texture due to bioturbation

30. Mudstone, pale-brown, silty, massive

29. Shale, top medium-bluish-gray, lower part grayish-red and dark-reddish-brown, fissile, slightly banded; contains some lenticular, sandy cross-laminations with grayish-orange staining

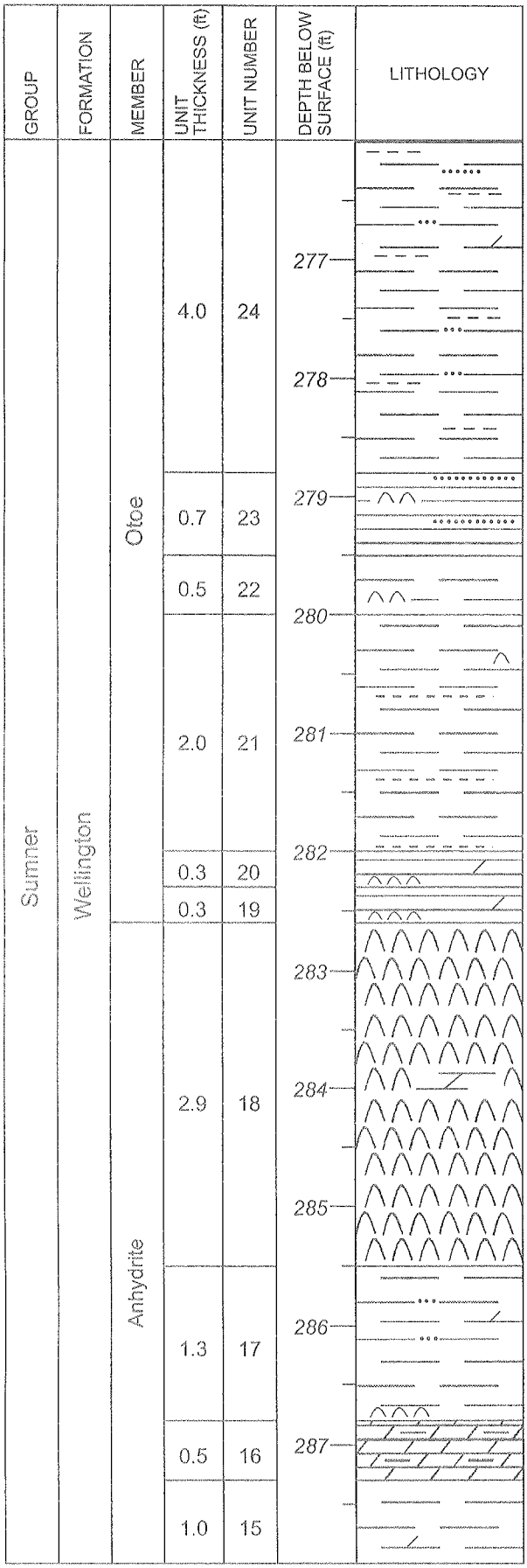
28. Mudstone, medium-bluish-gray, dolomitic; contains a yellowish-gray dolomite band; gypsum band at base

27. Shale, grayish-red and medium-bluish-gray, fissile, slightly banded

26. Mudstone, medium-light-gray and light-bluish-gray, very silty, massive; gypsum-lined fracture at 273.25 ft

25. Shale, light-bluish-gray and grayish-red, fissile, slightly banded; dolomitic at top; contains rare very thin lenticular, very fine grained sandstone laminae; gypsum band at 274.7 ft

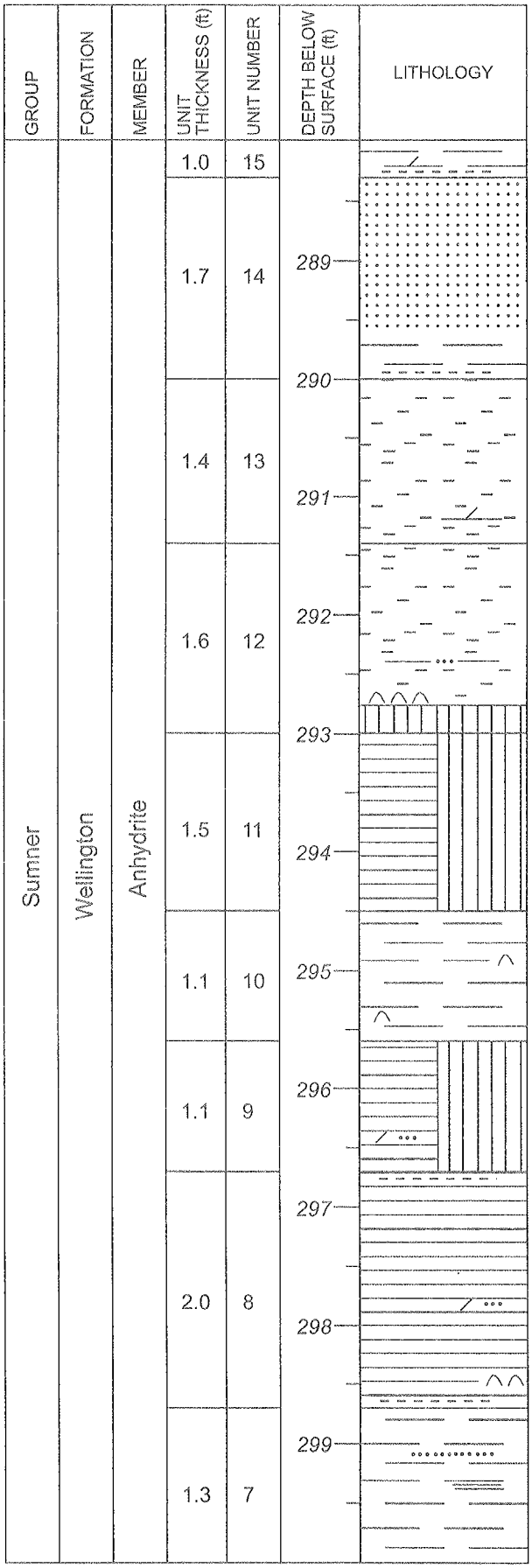
24. Mudstone, grayish-red and light-bluish-gray, silty; contains scattered sandy laminae and dolomitic lenses; includes gypsum band in upper part; some gypsum-lined fracture surfaces



23. Shale, grayish-black, fissile; contains very light gray and white very fine grained sandstone lenses; sandstone more common in lower part, with black shale stringers; contorted bedding throughout; gypsum band at 279.0 ft
22. Mudstone, variegated medium-bluish-gray and moderate-brown, massive; gypsum band at 280.0 ft
21. Mudstone, dark-reddish-brown, medium-bluish-gray, and dusky-yellow; lower part distinctly banded; gypsum-lined fracture surfaces common
20. Shale, dark-gray and medium-dark-gray, fissile, dolomitic; contains gypsum-lined fracture surfaces in middle and yellowish-gray gypsum band at the base containing shale clasts
19. Shale, dark-gray and medium-dark-gray, fissile; includes some dense dolomite bands and gypsum bands

Anhydrite Member (Raasch, 1946) (21.3 ft)

18. Anhydrite, very light-gray and white; stromatolitic structures common; contains medium-light-gray dolomite laminae and gypsum bands
17. Mudstone, greenish-gray with olive-gray mottling at the base, very silty, dolomitic, massive; gypsum bands common
16. Dolomite, light-gray interbedded with dolomitic mudstone; contains medium-dark-gray fissile shale laminae and partings; grayish-red staining at the base; dolomite duricrusts
15. Mudstone, medium-gray and medium-light-gray, dolomitic; thin dolomite bands common; grayish-red, more distinctly banded, and less dolomitic at base



14. Sandstone, light-brownish-gray, pale-brown, and pale-red, very fine grained; grades into medium-bluish-gray and grayish-red sandy mudstone at the base; churned texture due to bioturbation

13. Mudstone and shale, grayish-red and dark-reddish-brown; massive at top to banded at the base; shale and dolomite bands common near base

12. Mudstone, grayish-red, silty; massive becoming banded and grading into fissile shale at the base; gypsum band at 292.7 ft

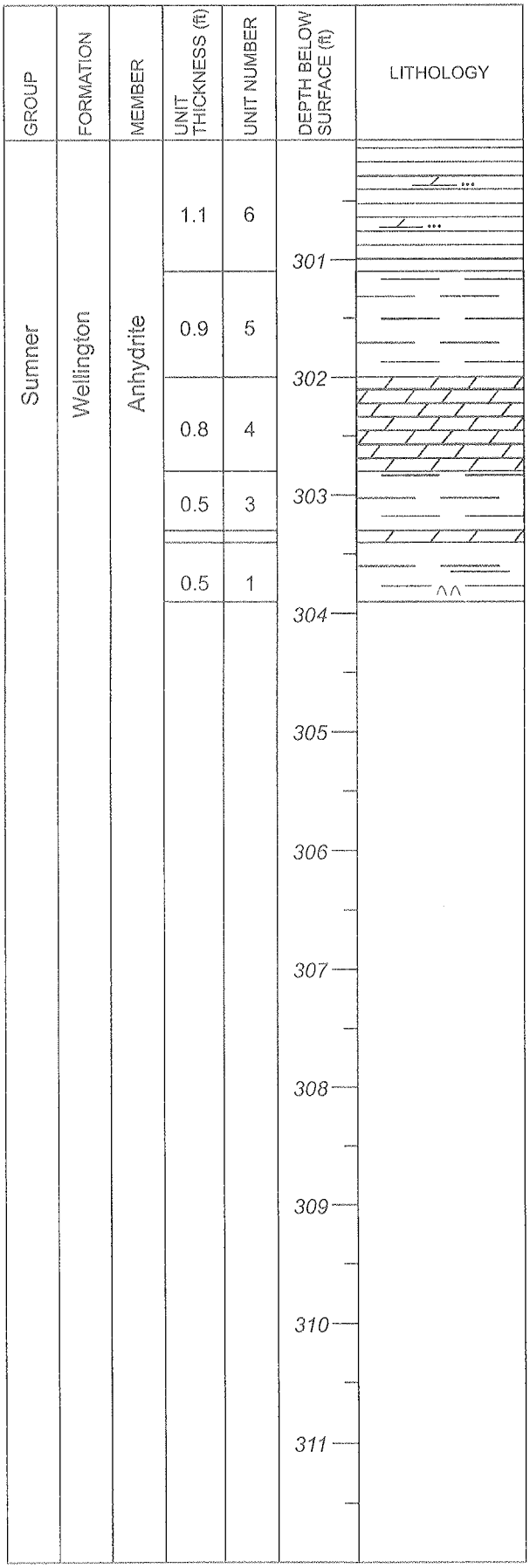
11. Shale, grayish-red and medium-bluish-gray, fissile, banded

10. Mudstone, medium-bluish-gray and light-bluish-gray, massive, gypsiferous

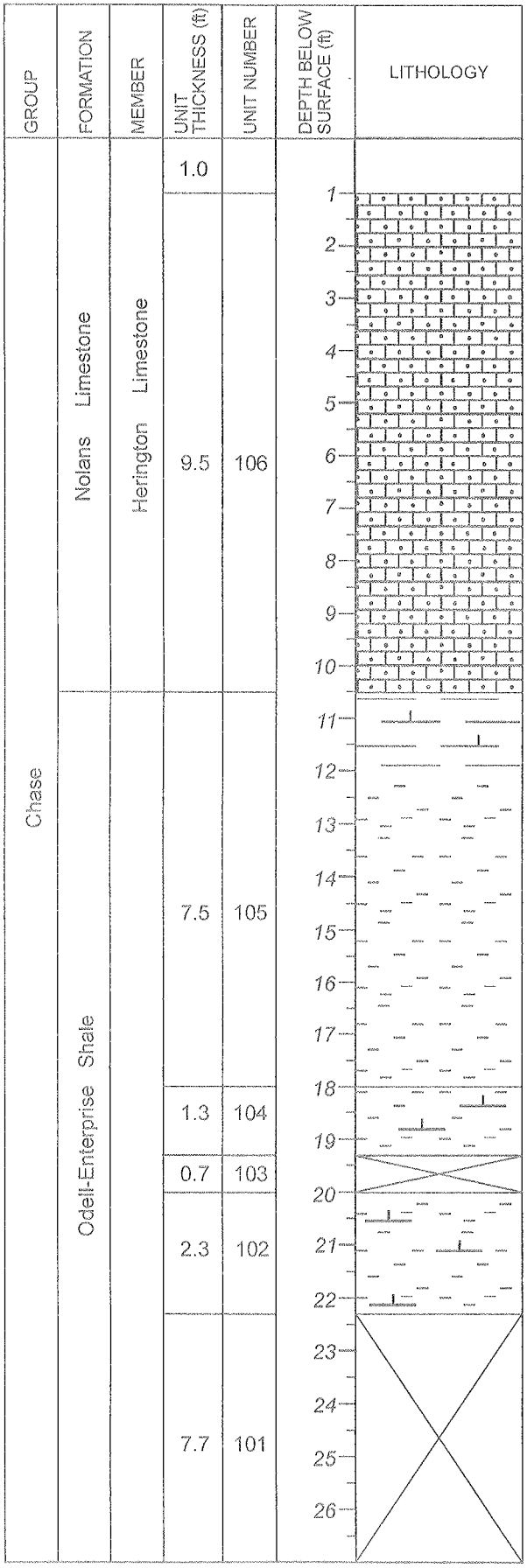
9. Shale, grayish-red, medium-bluish-gray, and light-bluish-gray, fissile, slight banding; contains sandy dolomite laminae

8. Shale, medium-dark-gray and medium-gray becoming light-bluish-gray at the base, fissile, distinctly banded; lenticular, sandy dolomite laminae common; grayish-red at top and at base; gypsum band and veinlet in mudstone matrix at base

7. Mudstone, variegated dark-greenish-gray, brownish-gray, and medium-bluish-gray; includes some very thin fissile shale seams; very undulatory bedding and churned texture due to bioturbation; contains some sandy wavy laminae; a moderate-red and moderate-reddish-brown stained mineralized zone occurs at the top; vertical tubular structures rare



6. Shale, light-brownish-gray, brownish-gray, and greenish-gray, fissile; contains dolomitic sandy laminae and bands; churned bedding at top to banded below
5. Mudstone, medium-light-gray and light-bluish-gray, massive; wavy basal contact
4. Dolomite, grayish-orange-pink, pale-red, and grayish-red; laminae highly contorted; very irregular base
3. Shale, upper part medium-bluish-gray to greenish-gray mudstone below; grayish-red staining; base irregular
2. Dolomite, light-gray and very light gray, very dense
1. Mudstone, medium-gray and medium-bluish-gray interbedded with slightly fissile shale; gypsum-lined fracture surface at the base



Core Hole KC-2
SHEEHAN FARM

NW¼SE¼NW¼NE¼ sec. 33, T. 26 N., R. 3 E., Charlie Creek West Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey, 700 ft from north line (FNL) and 1,800 ft from east line (FEL). Surface elevation from altimeter, 1,056 ft. Spudded on top of the Herington Limestone Member of the Nolans Limestone. Field lithologic descriptions by James R. Chaplin.

Soil horizon

CHASE GROUP

NOLANS LIMESTONE

Herington Limestone Member (9.5 ft)

Unit no.

106. Limestone, light-olive-gray to pale-yellowish-brown, medium-crystalline, algal, sandy, vuggy; some weathered limonitic vugs; description based on cuttings

ODELL-ENTERPRISE SHALE (54.5 ft)

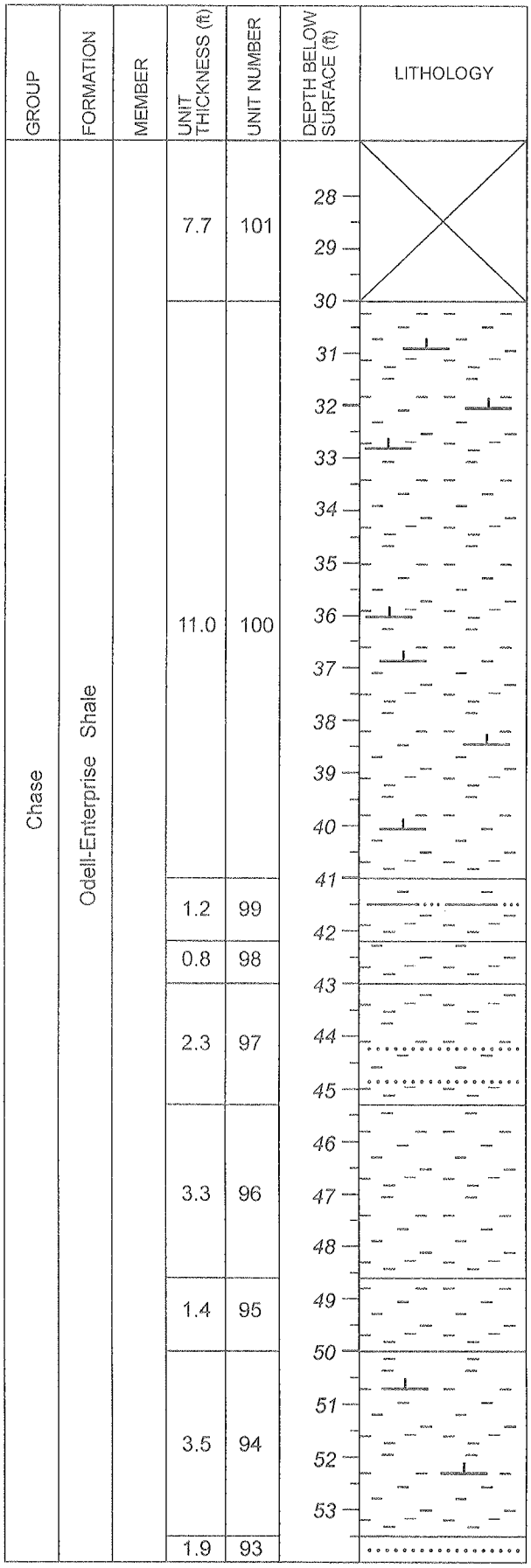
105. Mudstone, dark-reddish-brown; upper 2 ft consists of greenish-gray, calcareous mudstone with grayish-red mottling; sticky, plastic

104. Mudstone, dark-reddish-brown to grayish-red, calcareous

103. Loss of core

102. Mudstone, dark-reddish-brown, calcareous, poorly indurated

101. Loss of core



100. Mudstone, dark-reddish-brown, calcareous; partial loss of core

99. Mudstone and shale, dark-reddish-brown with greenish-gray mottling, silty; moderately indurated

98. Mudstone, dark-reddish-brown, poorly indurated

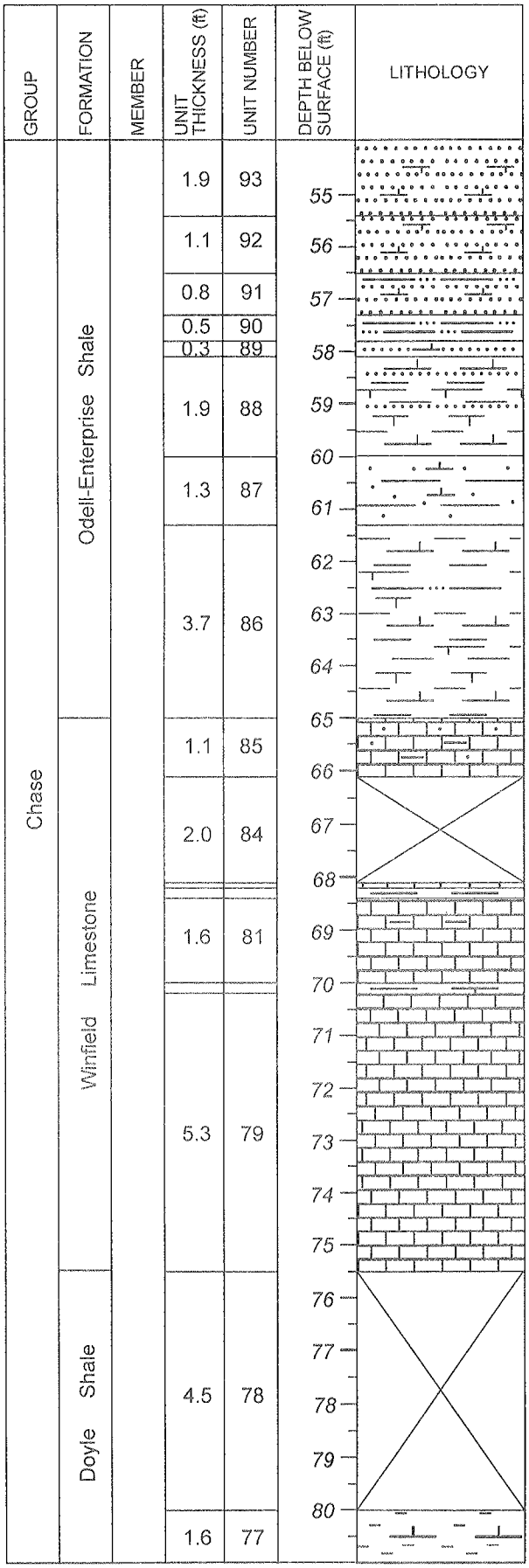
97. Shale, dark-reddish-brown with greenish-gray mottled intervals, cross-laminated, churned bedding; scattered lenses of very fine grained sandstone; mudstone at base

96. Mudstone, dark-reddish-brown, poorly indurated

95. Mudstone, dark-reddish-brown, poorly indurated; partial loss of core

94. Mudstone, dark-reddish-brown, slightly calcareous, poorly indurated; gradational base

93. Sandstone, pale-red to pinkish-gray, very fine grained, calcareous, algal; bioturbated with *Chondrites*



92. Sandstone, very light gray to yellowish-gray, very fine grained, calcareous; greenish-gray shale bands at base exhibit wavy and lenticular bedding; some greenish-gray shale inclusions

91. Sandstone and siltstone, pale-red, to grayish-red, very fine grained, calcareous, mottled, algal, bioturbated

90. Siltstone, grayish-red; lower part with stringers of pinkish-gray, very fine grained sandstone and greenish-gray shale; lenticular bedding; bioturbated

89. Sandstone, pinkish-gray to greenish-gray, calcareous; contains some lenticular shale stringers; bioturbated with *Chondrites*

88. Shale, mudstone, and sandstone; alternating lithologies produce a banded appearance; very thin bedded, laminated, calcareous; shale and mudstone, greenish-gray; sandstone, pinkish-gray, very fine grained with wavy, parallel, to lenticular laminae; some sandstone bands 1–2 cm thick; bioturbated with *Chondrites*

87. Sandstone and shale; sandstone, white to pinkish-gray, calcareous, dominant lithology; shale, greenish-gray to light-bluish-gray mottled; bioturbated with *Chondrites*

86. Mudstone, greenish-gray to medium-bluish-gray, calcareous; silty interval from 62.4 to 62.7 ft

WINFIELD LIMESTONE (10.5 ft)

85. Limestone, medium-light-gray to medium-bluish-gray, fine- to medium-crystalline, shaly,sandy, very fossiliferous; algal grains common; contains some greenish-gray shale inclusions at the base

84. Loss of core

83. Limestone, medium-gray to light-bluish-gray mottling; large osagid grains produce a conglomeratic-look

82. Mudstone, medium-dark-gray, slightly calcareous

81. Limestone, light-gray to very light gray, medium crystalline, slightly vuggy, fossiliferous; contains highly wavy to lenticular calcareous shale stringers, especially in upper part; dry surface has a distinct chalky white appearance

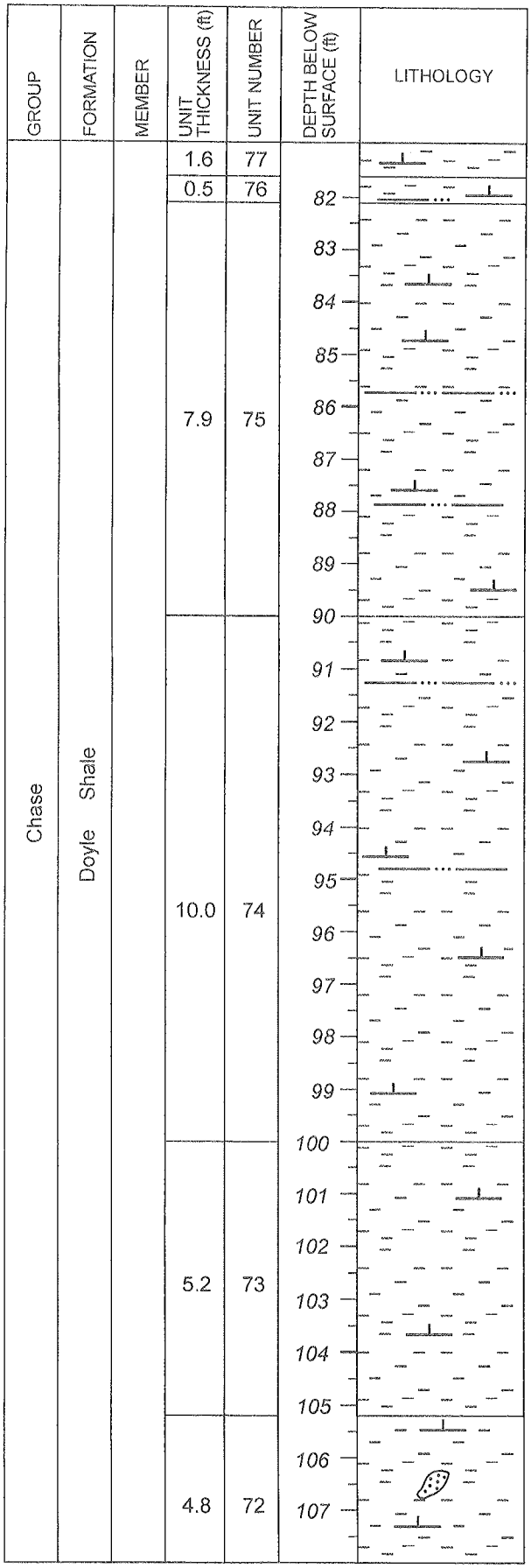
80. Mudstone, dark-greenish-gray, calcareous

79. Limestone, yellowish-gray, medium-bluish-gray, medium-gray, medium- to coarse-crystalline, vuggy, very fossiliferous, massive; algal-coated grains common; base becomes dark-greenish-gray

DOYLE SHALE (118.1 ft)

78. Loss of core

77. Mudstone, dark-reddish-brown to grayish-red, calcareous; contains some greenish-gray mudstone inclusions



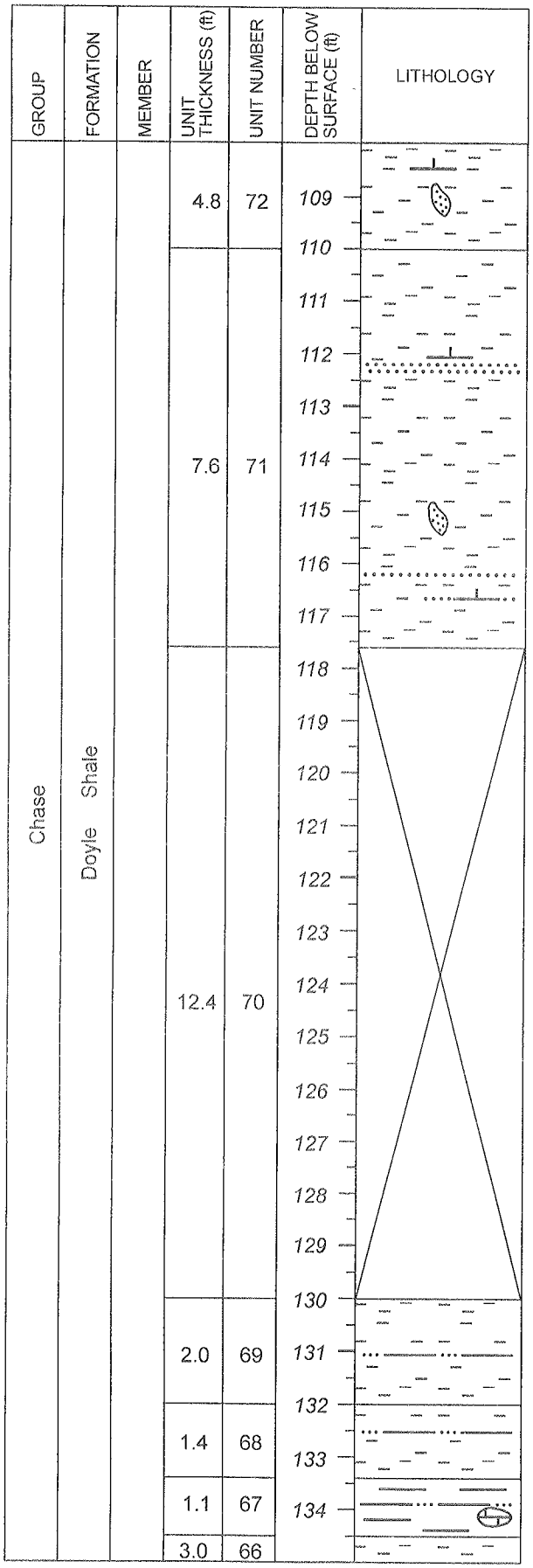
76. Mudstone, dark-reddish-brown to grayish-red, calcareous, very silty

75. Mudstone, dark-reddish-brown to grayish-red, calcareous; includes some silty intervals and scattered greenish-gray mudstone inclusions

74. Mudstone, dark-reddish-brown to grayish-red, calcareous; contains some scattered silty intervals

73. Mudstone, dark-reddish-brown to grayish-red, calcareous; includes some scattered greenish-gray shale inclusions

72. Mudstone, dark-reddish-brown, calcareous except for lower 0.6 ft; includes some mineralized sandstone nodules throughout



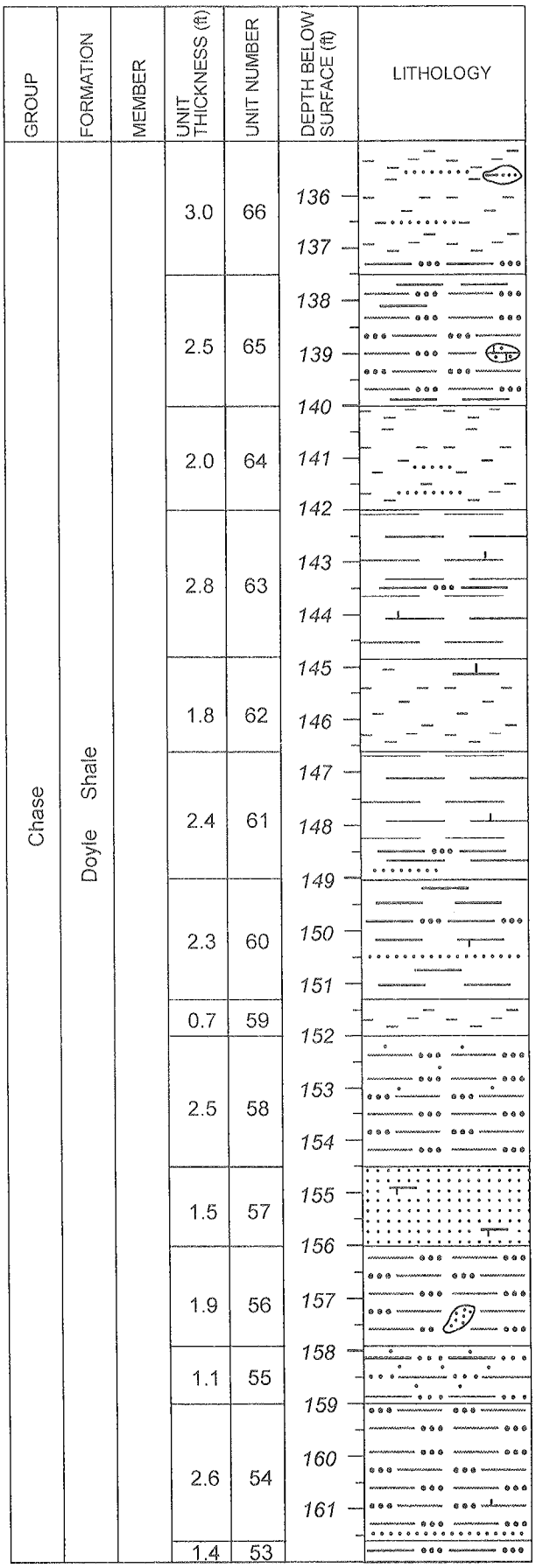
71. Mudstone, dark-reddish-brown with scattered intervals of calcareous sandstone lenses or nodules; contains some greenish-gray mudstone inclusions

70. Loss of core

69. Mudstone, dark-reddish-brown, slightly silty

68. Mudstone, grayish-red; contains some silty intervals

67. Mudstone, greenish-gray to light-bluish-gray, silty; includes scattered calcareous siltstone and silty limestone nodules; fracture surfaces are slickensided



66. Mudstone, grayish-red; includes some silty intervals and some lenses of very fine grained sandstone; rare calcareous siltstone nodules; siltstone more common in lower part; fracture surfaces are slickensided

65. Siltstone, grayish-red with some interbedded mudstone; scattered calcareous sandstone and sandy limestone nodules

64. Mudstone, pale-red to grayish-red with patches of light-bluish-gray; very fine grained sandstone lenses, especially in the lower part

63. Mudstone, light-bluish-gray to greenish-gray with pale-red and grayish-red mottling; slightly calcareous; contains calcareous siltstone lenses

62. Mudstone, pale-red to grayish-red; upper part slightly calcareous

61. Mudstone, medium-light-gray, medium-bluish-gray, and grayish-yellow with grayish-red mottling; slightly calcareous; lower part more silty and sandy

60. Mudstone, light-bluish-gray to medium-light-gray with dusky-yellow stains, silty; contains some calcareous sandstone lenses

59. Mudstone, grayish-red

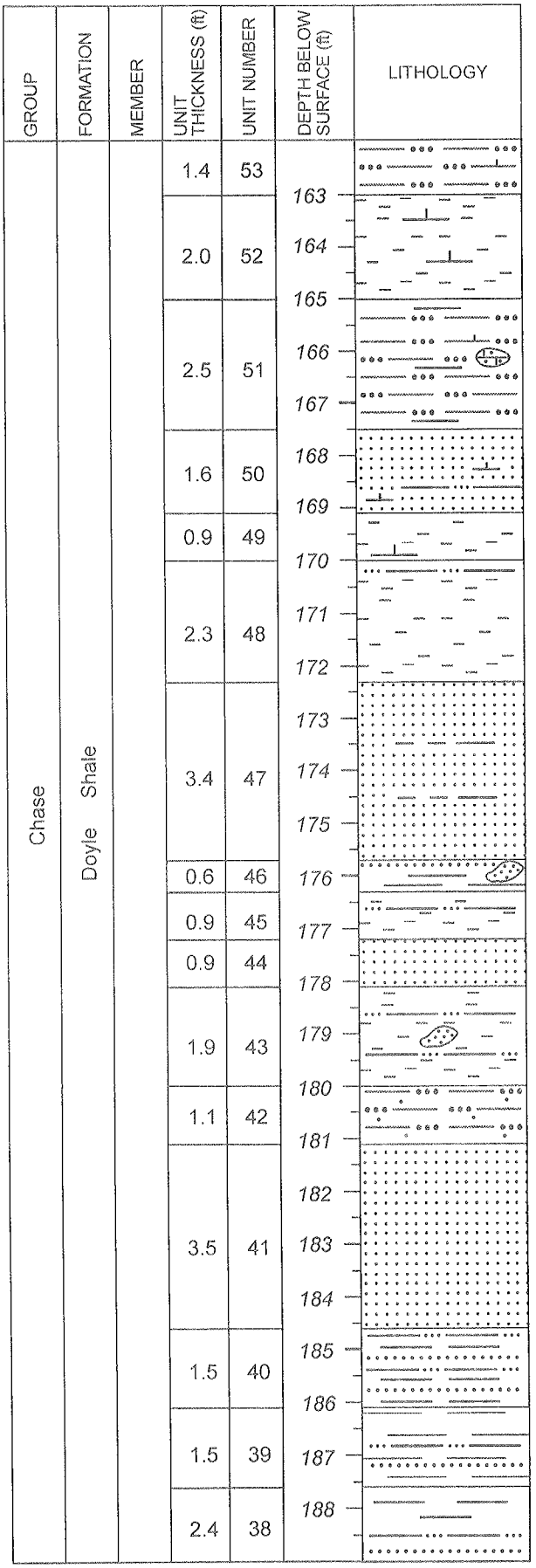
58. Siltstone, pale-red to grayish-red with medium-light-gray to light-bluish-gray mottling, sandy; lower part intensely bioturbated; gradational contacts

57. Sandstone, yellowish-gray to light-bluish-gray, very fine grained, slightly calcareous; contains wavy lenticular bands of medium-light-gray to medium-bluish-gray mudstone; includes some very sandy, vuggy (rotten-looking) intervals

56. Siltstone, light-bluish-gray to medium-bluish-gray; contains some sandstone nodules; grades into mudstone at base

55. Siltstone, pale-red to grayish-red with some yellowish-gray to light-bluish-gray sandy siltstone; sandy; upper contact gradational

54. Siltstone, predominantly pale-red with some light-gray to light-bluish-gray mottling; slightly calcareous; includes very fine grained yellowish-gray sandstone stringers at the base



53. Siltstone, pale-red, slightly calcareous; grades into mudstone at base

52. Mudstone, grayish-red, slightly calcareous

51. Siltstone, grayish-red, slightly calcareous; includes some mudstone in interval; contains some scattered very small nodules of calcareous sandstone and sandy limestone

50. Sandstone, pale-red to grayish-red, slightly calcareous, silty; contains wavy laminations

49. Mudstone, grayish-red, slightly calcareous

48. Mudstone, dark-reddish-brown, silty especially at top; contains some greenish-gray mudstone clasts; fractured; gradational lower contact

47. Sandstone, variegated, light-greenish-gray and light-bluish-gray; contains moderate-yellow-green, very dark red and dark-reddish-brown mudstone laminations; vuggy; highly contorted laminations in lower part; gradational base

46. Mudstone, light-olive-brown to light-olive-gray with blackish-red sandstones nodules; sandy at top

45. Mudstone, grayish-red, very silty

44. Sandstone, pale-red to grayish-red, very fine grained, hematitic; bluish-white sandstone stringers common at the base

43. Mudstone, grayish-red, very silty with scattered sandstone nodules

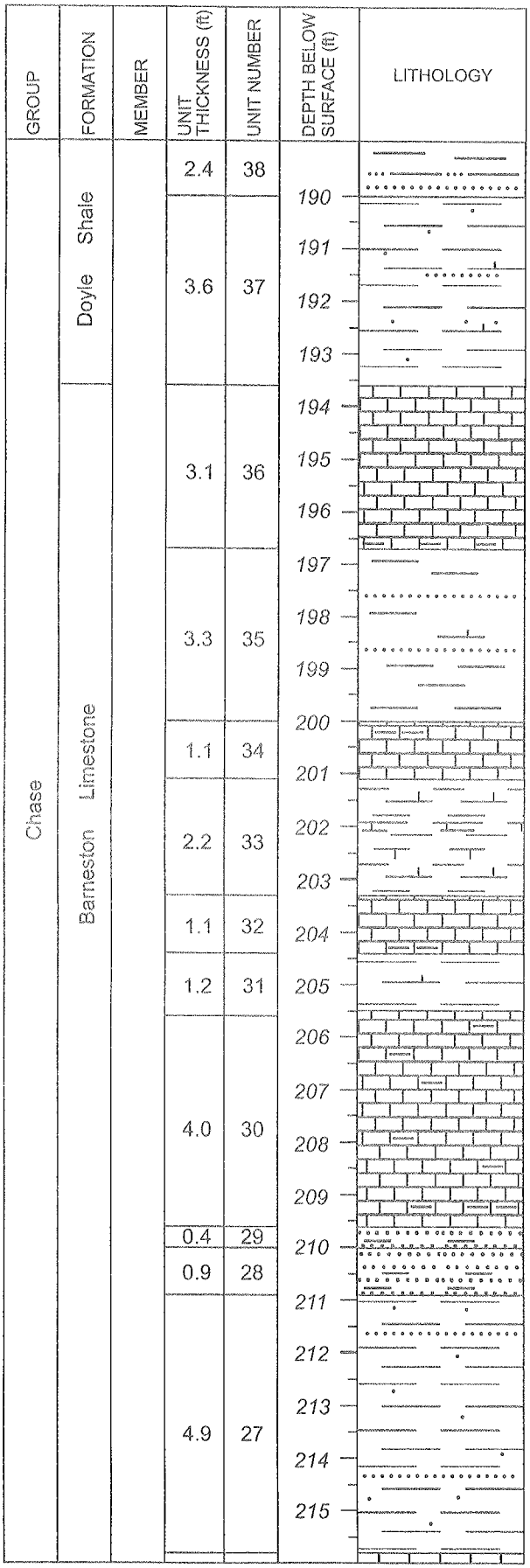
42. Siltstone, dark-reddish-brown, sandy; includes scattered mudstone partings; light-bluish-gray sandstone stringers common; wavy to cross-laminated bedding

41. Sandstone, grayish-red stained pale-yellowish-orange, very fine grained, hematitic, cross-laminated; contains mudstone clasts; distinct color change to pale-yellowish-orange and greenish-black between 184.3 and 184.6 ft; gradational base

40. Sandy shale, siltstone, and sandstone; sandstone, light-gray to light-bluish-gray, very fine grained; includes starved ripples, climbing ripples, cross-laminations, and lenticular bedding; alternating lithologies produce a banded-look; shale and siltstone, dark-gray, greenish-black and medium-bluish-gray

39. Shale and siltstone, dark-gray; contains lenses of medium-light-gray sandstone

38. Shale, grayish-black to dark-gray, silty; contains scattered lenticular stringers of medium-gray sandstone



37. Shale, light-bluish-gray to medium-bluish-gray, sandy, fossiliferous with brachiopods; includes scattered lenses of calcareous sandstone and sandy limestone; contains some lenses of crinoidal limestone; churned bedding due to intense bioturbation; sharp basal contact

BARNESTON LIMESTONE (36.4 ft)

36. Limestone, medium-light-gray to light-bluish-gray, medium-crystalline, algal, very fossiliferous with crinoid fragments, echinoid spines, and very abundant foraminifera (microcoquina); contains dark-gray shale and mudstone stringers in lower part

35. Shale, dark-gray to medium-dark-gray; slightly calcareous in certain intervals; contains scattered lenticular sandstone laminae

34. Limestone, light-gray, fine- to medium-crystalline, very fossiliferous with brachiopods; churned bedding due to bioturbation; contains some medium-dark-gray shale stringers

33. Shale, medium-bluish-gray, calcareous; contains stringers of fossiliferous limestone

32. Limestone, medium-gray, to medium-bluish-gray, slightly vuggy, fossiliferous with crinoid fragments and brachiopods; crinoidal calcareous shale stringers common in lower part

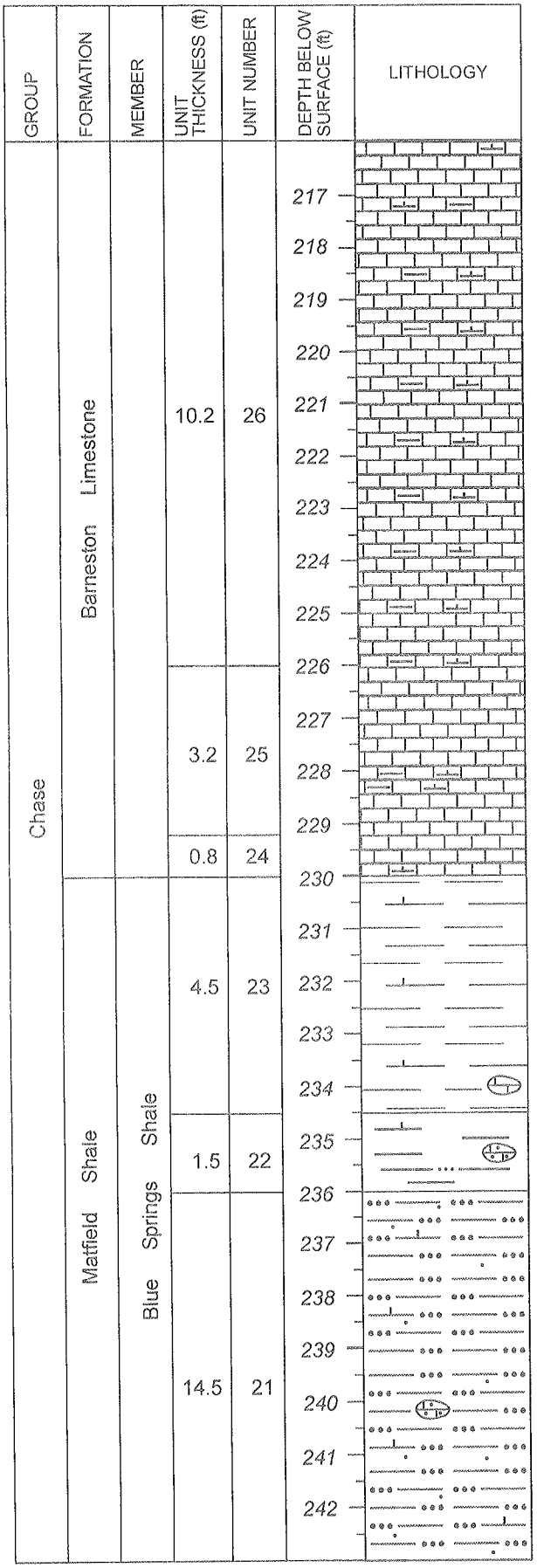
31. Shale, dark-gray, slightly calcareous, fossiliferous (crinoidal); contains a light-gray limestone bed at the base

30. Limestone, light-gray, medium-crystalline, shaly, crinoidal, vuggy, algal; includes some stringers of medium-dark-gray calcareous shale; limonitic stained vugs common

29. Shale and sandstone interbedded; shale, medium-dark-gray; sandstone, pinkish-gray to light-gray, very fine grained, churned and lenticular bedding

28. Sandstone, light-bluish-gray to medium-light-gray, very fine grained, lenticular to wispy bedding, mottled texture; contains intercalations of medium-bluish-gray shale

27. Shale, medium-bluish-gray, sandy; contains lenses and laminations of very fine-grained sandstone, especially between 214.1 and 214.3 ft; slight banded appearance; gradational base



26. Limestone, medium-light-gray to light-gray, medium-crystalline, algal (large coated grains); very fossiliferous, slightly vuggy; contains stringers of medium-dark-gray calcareous shale throughout interval

25. Limestone, medium-light-gray to light-gray, fine- to medium-crystalline; contains stringers of medium-dark-gray to dark-gray, crinoidal, calcareous shale, especially in lower part

24. Limestone, light-bluish-gray with medium-gray calcareous mudstone stringers

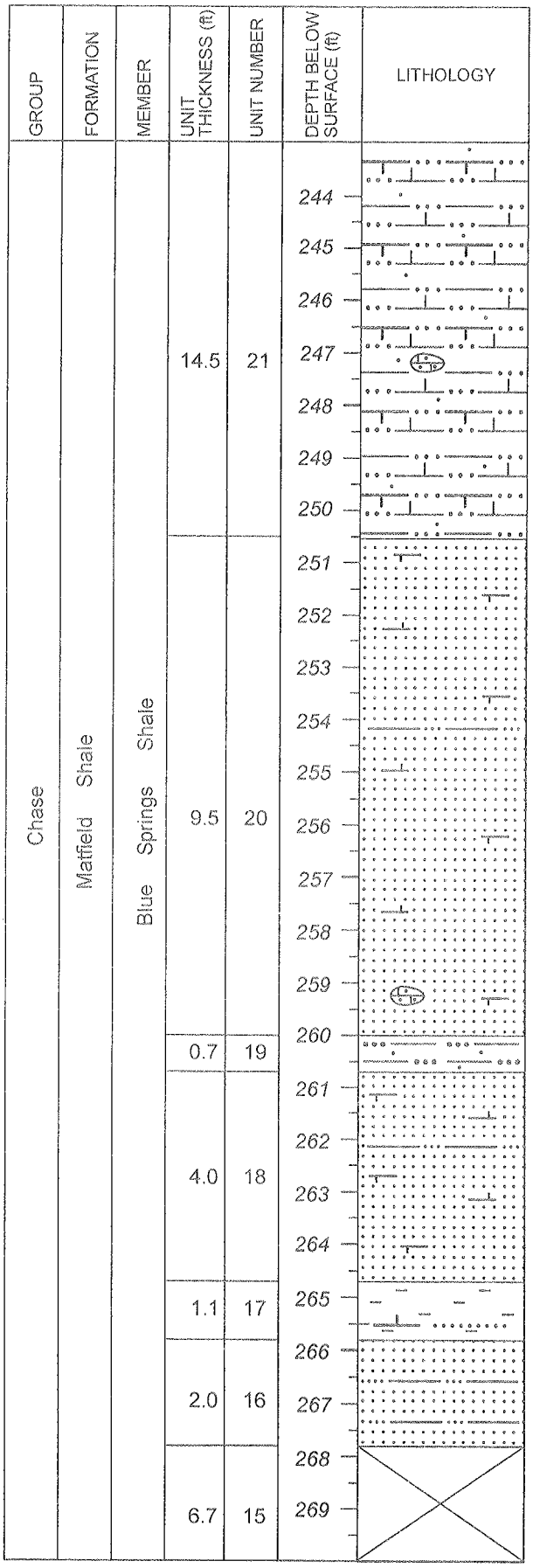
MATFIELD SHALE (86.0 ft)

Blue Springs Shale Member (55.0 ft)

23. Mudstone and shale, light-bluish-gray to medium-bluish-gray with grayish-red and dark-reddish-brown mottling throughout interval but especially common in lower part, calcareous; sandy limestone nodules common at the base

22. Mudstone, medium-bluish-gray with grayish-red stains, silty, calcareous; contains rare sandy limestone nodules

21. Siltstone, grayish-red, sandy, calcareous; contains some intercalations of silty mudstone; includes clasts of greenish-gray mudstone throughout; contains scattered sandy limestone nodules; fracture surfaces slickensided



20. Sandstone, grayish-red, very fine grained, slightly calcareous, cross-laminated, hematitic; some scattered silty intervals; contains scattered nodules of light-greenish-gray calcareous sandstone and sandy limestone especially common in lower part

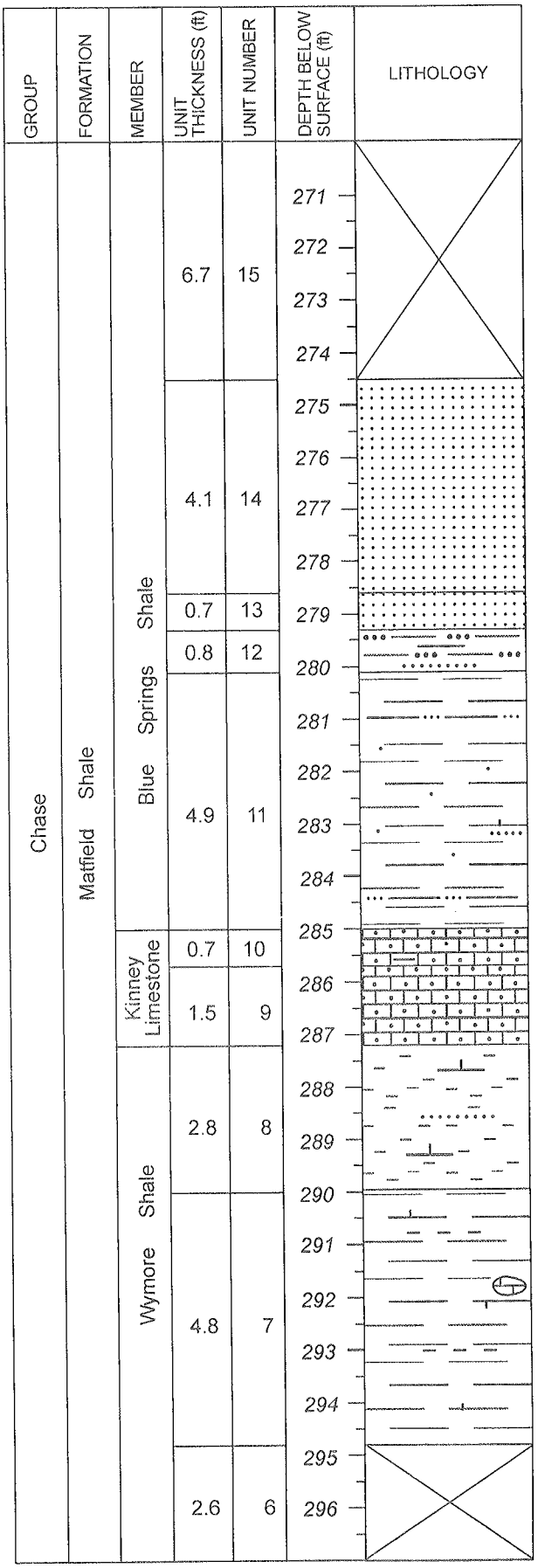
19. Siltstone, grayish-red, sandy, fractured

18. Sandstone, grayish-red, fine- to medium-grained; algal limestone nodules give unit a conglomeratic-look; contains some calcareous intervals; hematitic, silty; includes some clasts of light-olive-gray and greenish-gray mudstone

17. Mudstone, grayish-red, slightly calcareous; contains greenish-gray mudstone clasts; some sandy intervals contain highly mineralized veinlets; badly fractured

16. Sandstone, grayish-red, fine-grained, very silty, hematitic; contains mineralized veinlets

15. Loss of core



14. Sandstone, pale-red to grayish-red, very fine grained, hematitic; contains lenses of light-greenish-gray and light-bluish-gray sandstone; includes some light-greenish-gray and light-bluish-gray laminations at the base

13. Sandstone, variegated, brownish-gray, olive-gray, light-brownish-gray, and very light gray with some pale-red mottling, very fine grained, slightly hematitic; highly contorted and churned bedding

12. Siltstone and mudstone, dark-greenish-gray with mottled intervals of dusky-yellow; limonitic; contains scattered sandstone stringers

11. Shale, dark-gray to medium-bluish-gray, sandy, silty; contains scattered lenticular stringers of light-bluish-gray, very fine grained, slightly calcareous sandstone; sandy laminae produce a banded-look

Kinney Limestone Member (2.2 ft)

10. Limestone, light-bluish-gray to medium-bluish-gray, sandy; includes some stringers of slightly calcareous shale and mudstone; gradational base

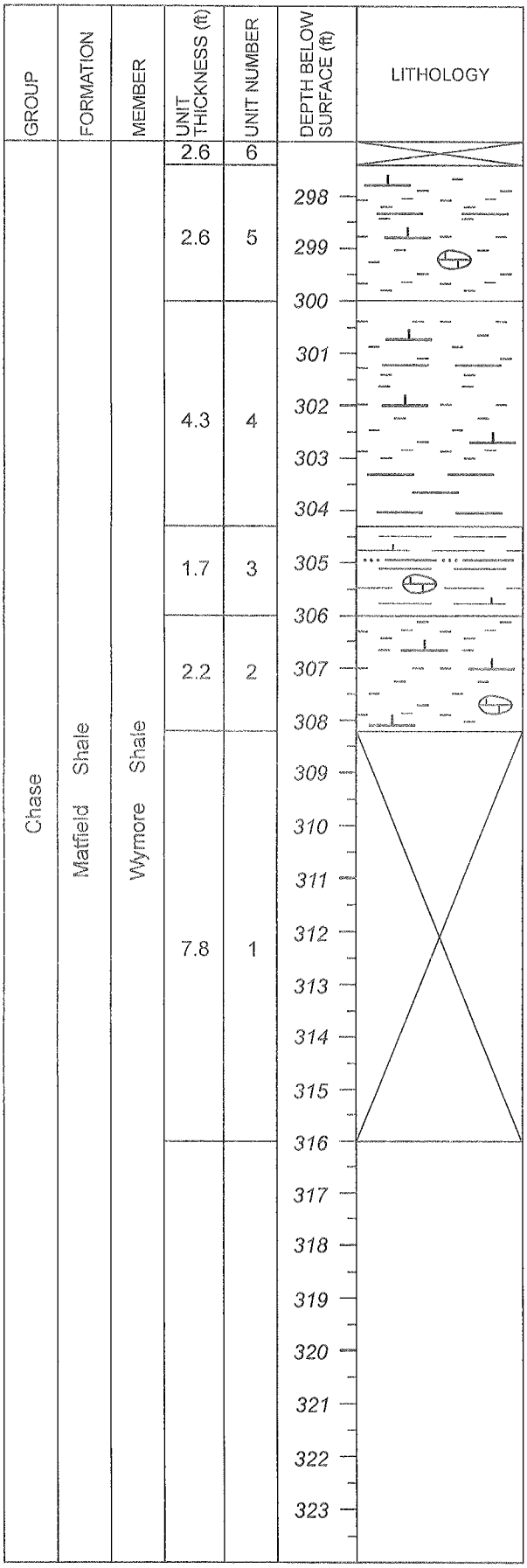
9. Limestone, medium-bluish-gray, finely crystalline, sandy; contains fractures filled with grayish-red mudstone at the top and at the base; some wavy laminations

Wymore Shale Member (28.8 ft)

8. Mudstone, grayish-red, calcareous; contains scattered lenticular sandstone laminae; mottled medium-bluish-gray in lower part

7. Mudstone, mottled grayish-red, medium-bluish-gray, and greenish-gray, calcareous; small limestone nodules scattered throughout; fracture surfaces slickensided

6. Loss of core



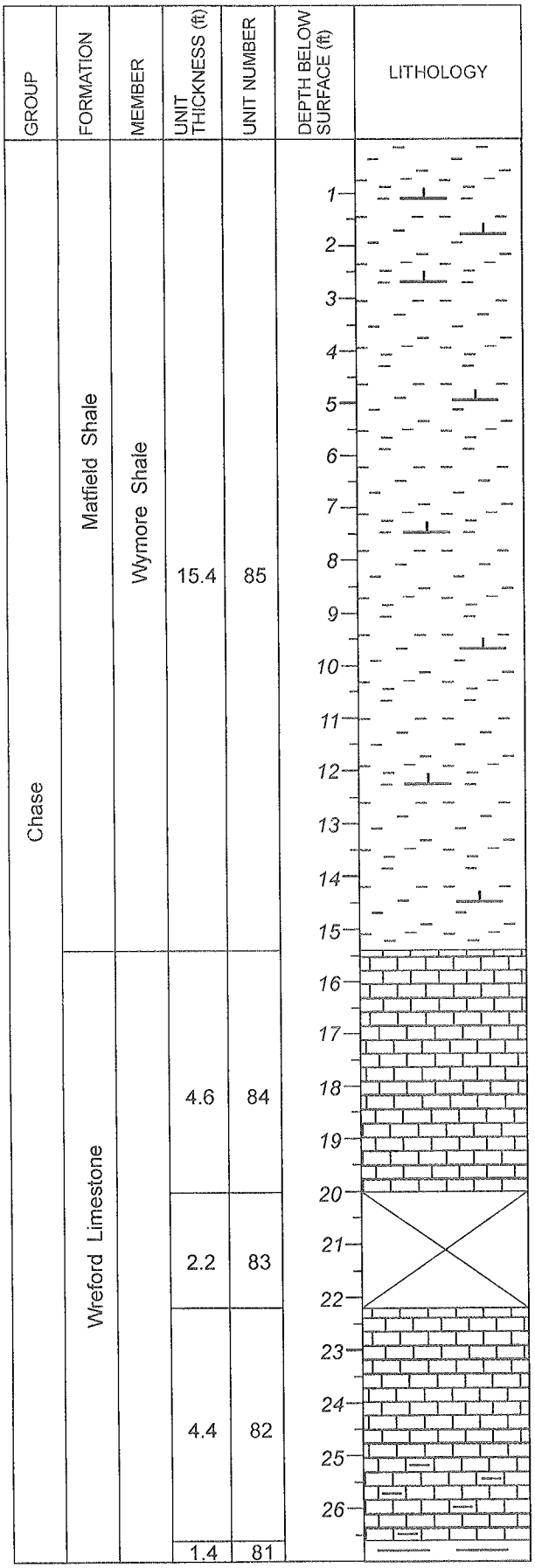
5. Mudstone, grayish-red, calcareous; contains scattered stringers of greenish-gray mudstone; includes some rare limestone nodules; fracture surfaces slickensided

4. Mudstone, pale-red to grayish-red, calcareous; includes some stringers of greenish-gray mudstone; medium-bluish-gray mudstone occurs between 303.4 and 304.3 ft; fracture surfaces slickensided

3. Mudstone, light-bluish-gray to medium-bluish-gray, calcareous, slightly silty; very small limestone nodules throughout; more indurated at the base

2. Mudstone, grayish-red mottled light-bluish-gray, calcareous; nodular limestone in lower part

1. Loss of core



Core Hole KC-3
HAMMONS RANCH

SW¼NW¼SW¼SE¼ sec. 19, T. 29 N., R. 5 E., Hardy Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey, 650 ft from north line (FNL) and 2,450 ft from east line (FEL). Surface elevation from altimeter, 1,180 ft. Spudded at base of the Matfield Shale. Field lithologic descriptions by James R. Chaplin.

CHASE GROUP

MATFIELD SHALE (15.4 ft)

Wymore Shale Member (15.4 ft)

Unit no.

85. Mudstone, dark-reddish-brown, calcareous

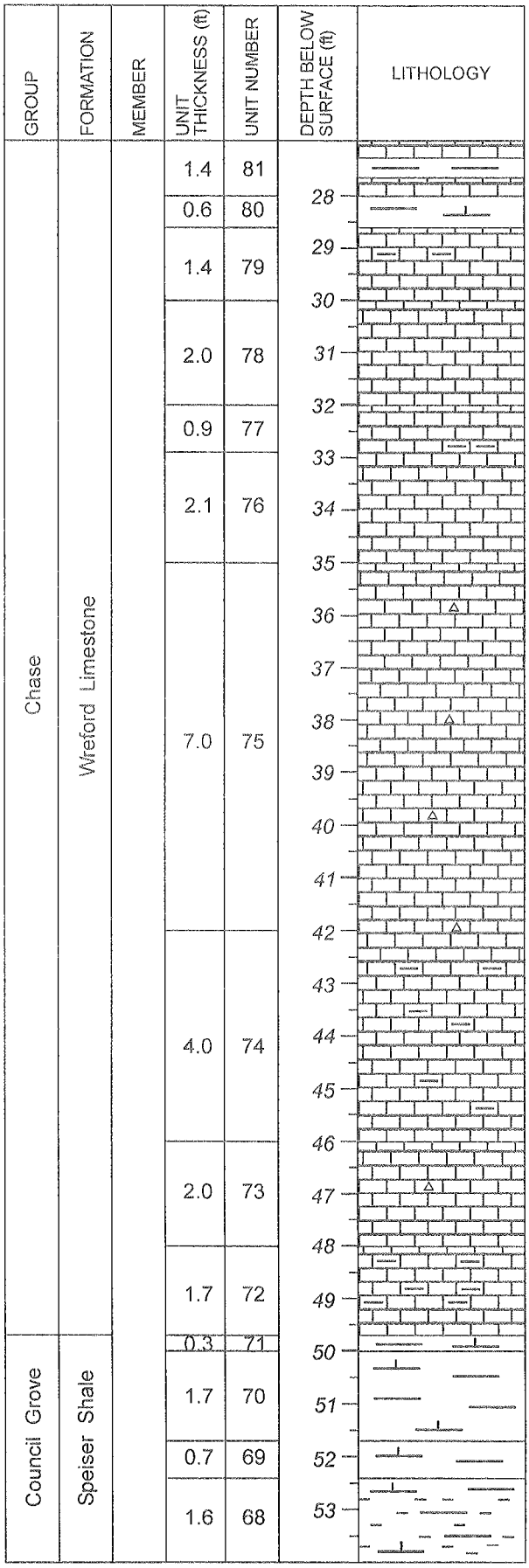
WREFORD LIMESTONE (34.3 ft)

84. Limestone, light-gray to yellowish-gray, medium-crystalline, very vuggy, fossiliferous, limonite stained; becomes finely crystalline and less vuggy at the base

83. Loss of core

82. Limestone, light-gray stained grayish-red, medium-crystalline, slightly vuggy; fossiliferous with crinoidal hash and algal grains; lower part with greenish-gray mudstone stringers and inclusions

81. Limestone and mudstone, alternating beds; limestone, light-gray, fine- to medium-crystalline; mudstone, light-bluish-gray, occurring as wavy laminae and stringers



80. Mudstone and shale, light-gray to light-bluish-gray, calcareous

79. Limestone, light-gray, fine- to medium-crystalline; contains greenish-gray mudstone stringers

78. Limestone, light-gray, finely crystalline, slightly vuggy

77. Limestone, yellowish-gray and light-gray, fine- to medium-crystalline; calcite vugs common; contains medium-bluish-gray calcareous mudstone stringers with algal-coated grains; stylolitic

76. Limestone, light-gray, finely crystalline, pitted, fossiliferous with algal filaments; contains scattered, dark-gray, carbon-lined stylolitic seams

75. Limestone, medium-dark-gray and medium-bluish-gray, medium-crystalline, pitted, fossiliferous; includes some dark-gray carbonaceous stringers; contains some small very light gray chert nodules

74. Limestone, medium-bluish-gray and dark-greenish-gray, shaly, very crinoidal and contains cross sections of brachiopod valves; wavy carbonaceous stringers common

73. Limestone, medium-bluish-gray and medium-gray, medium-crystalline, algal, carbonaceous; fossil stringers common; contains rare chert nodules; olive-gray mottling at base

72. Limestone, medium-bluish-gray and medium-gray, medium-crystalline, very shaly; highly algal with large algal-coated grains (osagid grains); very fossiliferous with cross sections of large brachiopod valves

COUNCIL GROVE GROUP

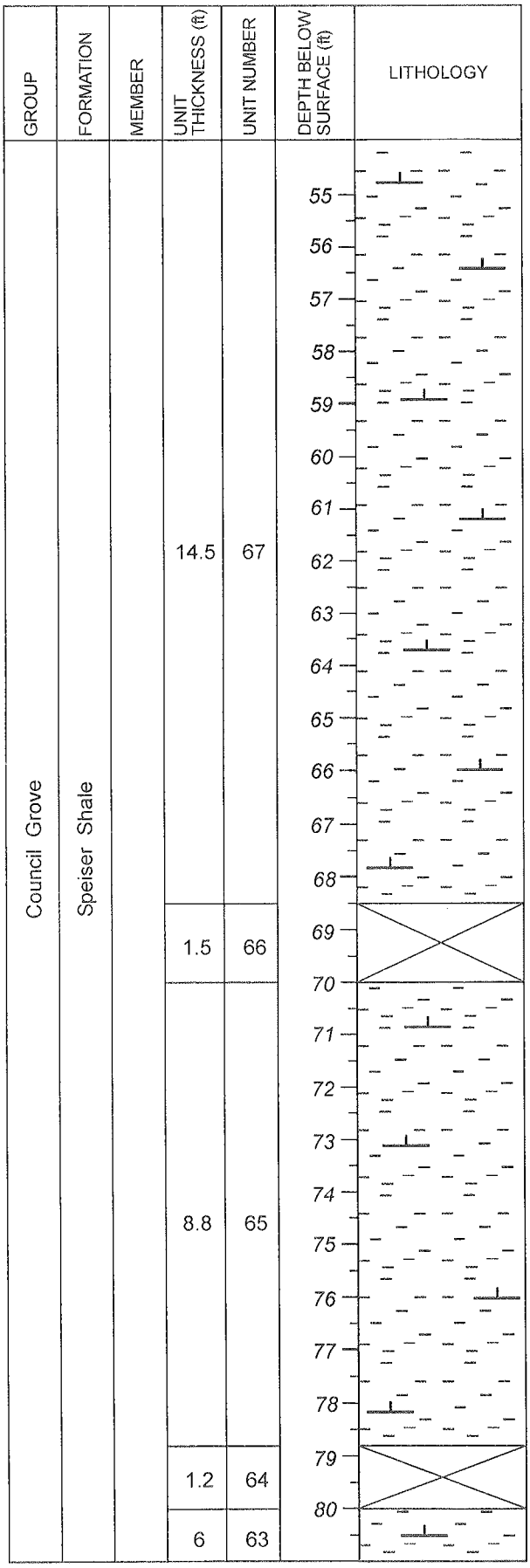
SPEISER SHALE (36.3 ft)

71. Mudstone, medium-bluish-gray to greenish-gray, calcareous

70. Mudstone, greenish-gray to light-bluish-gray, calcareous; very poor core recovery

69. Mudstone, greenish-gray to light-bluish-gray with some pale-red mottling, calcareous

68. Mudstone, mottled greenish-gray and grayish-red, calcareous

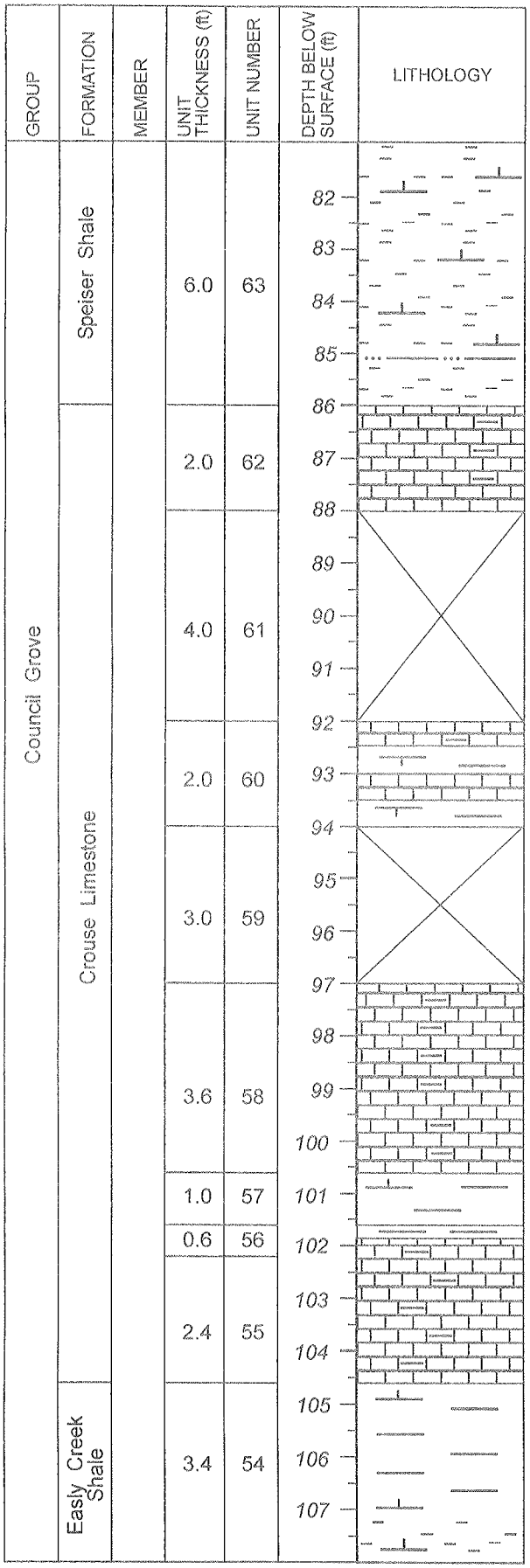


67. Mudstone, grayish-red mottled greenish-gray and medium-bluish-gray, calcareous; contains very finely crystalline limestone granules and chips in upper part

66. Loss of core

65. Mudstone, grayish-red mottled medium-bluish-gray and greenish-gray, calcareous

64. Loss of core



63. Mudstone, grayish-red mottled medium-bluish-gray, calcareous; some silty intervals near the base; very calcareous with limestone chips at base; contains some calcite-lined fractures

CROUSE LIMESTONE (18.6 ft)

62. Limestone, light-olive-gray to greenish-gray, fine- to medium-crystalline, shaly, highly algal (oncolitic); includes some rare stromatolitic wavy bedding; contains some greenish-gray mudstone

61. Loss of core

60. Limestone and mudstone; limestone, white to very light gray, finely crystalline, shaly, algal, mottled due to intraformational reworking; mudstone, light-bluish-gray to medium-bluish-gray, calcareous

59. Loss of core

58. Limestone, medium-gray and medium-light-gray, finely crystalline, shaly, algal; contains medium-dark-gray calcareous shale stringers, especially common at the base

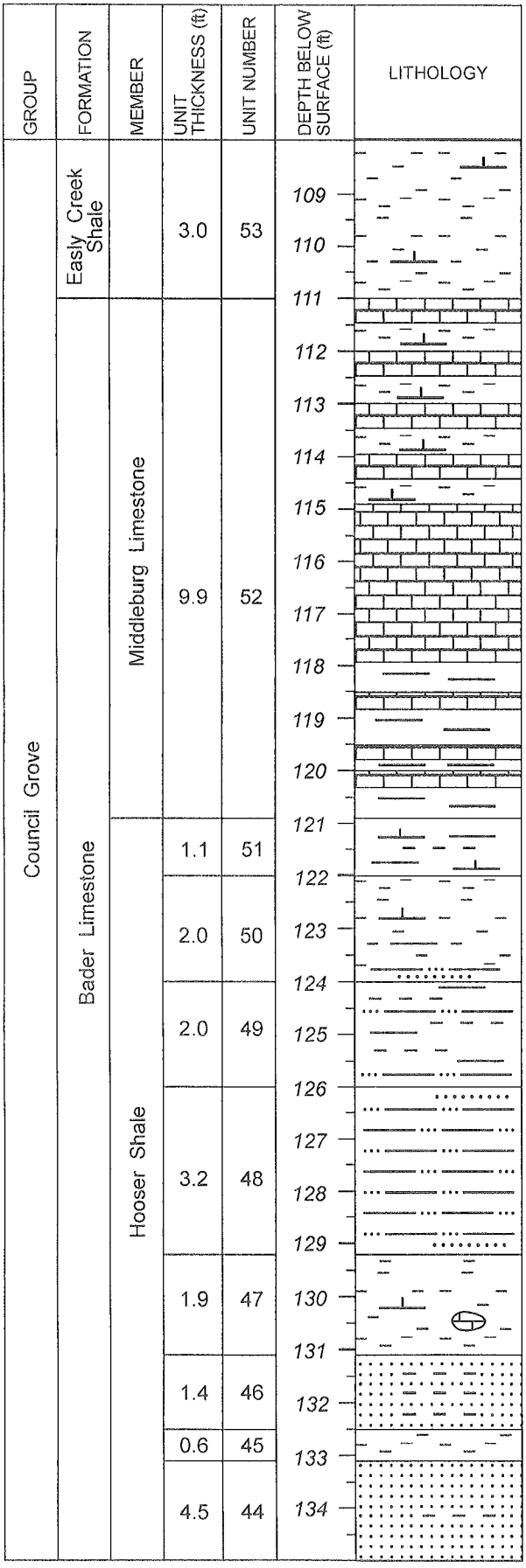
57. Shale, medium-gray to light-bluish-gray, calcareous

56. Limestone and shale, alternating beds; limestone, light-gray weathers very light gray, finely crystalline, shaly; shale, medium-dark-gray; irregularly bedded

55. Limestone, medium-light-gray to light-gray weathers to pinkish-gray, finely crystalline, shaly; wavy stringers of medium-dark-gray and dark-greenish-gray mudstone common; includes some intraformational reworking (possible subaerial exposure surface); gradational base

EASLY CREEK SHALE (6.4 ft)

54. Shale, medium-dark-gray to olive-gray to brownish-gray, becoming grayish-red at the base, calcareous



53. Shale and mudstone, grayish-red and dark-reddish-brown, calcareous; base with reworked limestone pebbles

BADER LIMESTONE (45.7 ft)

Middleburg Limestone Member (9.9 ft)

52. Limestone, pale-red and pale-red-purple weathers pinkish-gray, fine- to medium-crystalline, hematitic, algal, vuggy, recrystallized, fossiliferous with gastropods; includes some intraformational reworking at the top; basal 5 ft very algal (oncolitic); contains interbedded dark-reddish-brown calcareous mudstone in upper part; greenish-gray mudstone very common in basal 3 ft

Hooser Shale Member (24.0 ft)

51. Mudstone, greenish-gray to medium-bluish-gray, calcareous; interbedded with grayish-red mudstone; contains some scattered limestone granules

50. Mudstone, grayish-red with some medium-bluish-gray, slightly calcareous; silty to sandy at the base; includes some scattered limestone granules

49. Mudstone, grayish-red and medium-bluish-gray, very silty; some limestone pebbles throughout

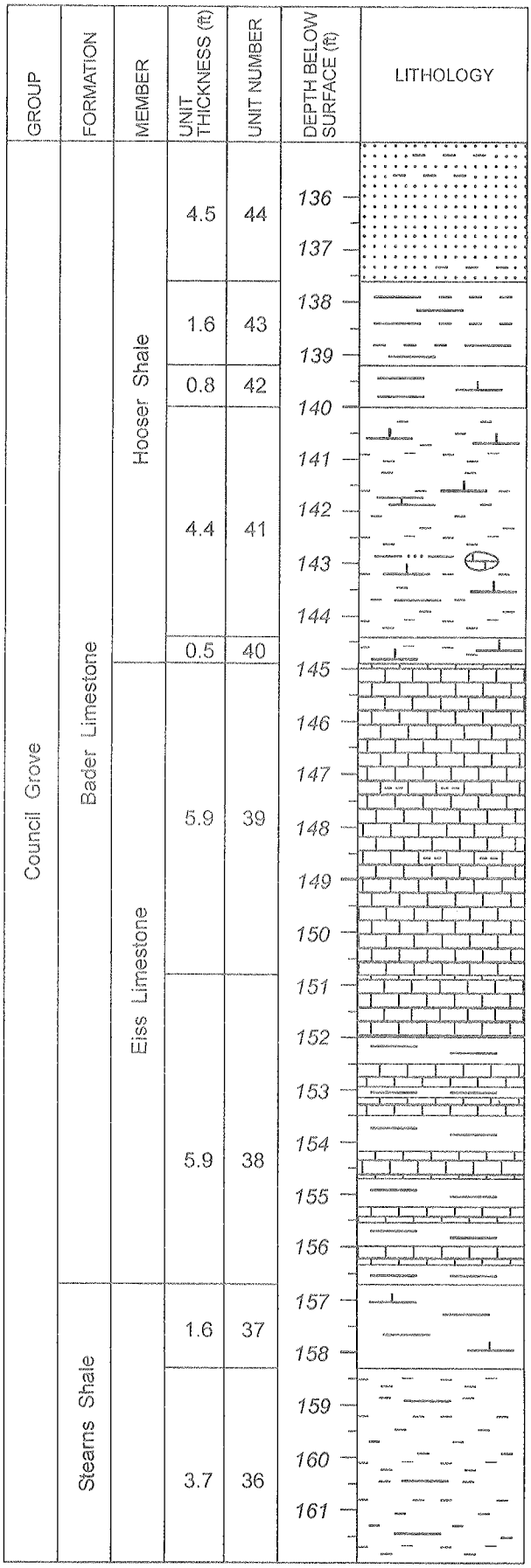
48. Siltstone, grayish-red; contains some intervals of grayish-red, very fine grained, hematitic, cross-laminated sandstone; scattered limestone granules throughout

47. Mudstone, dark-reddish-brown, slightly calcareous; contains septarian calcareous nodules; gradational base

46. Sandstone, pale-red, very fine grained, cross-laminated; interbedded with rare grayish-red sandy mudstone seams

45. Mudstone, grayish-red; gradational base

44. Sandstone, pale-red and grayish-red, very fine grained, bioturbated; strongly cross-laminated with steeply dipping laminae; contains some interbeds of grayish-red mudstone; gradational base



43. Mudstone, variegated dark-reddish-brown, grayish-red, greenish-gray, and medium-bluish-gray; contains scattered limestone granules

42. Mudstone, greenish-gray and medium-bluish-gray, calcareous

41. Mudstone, grayish-red with some medium-bluish-gray and greenish-gray, silty, very calcareous; contains scattered finely crystalline limestone nodules

40. Mudstone, dark-reddish-brown, very calcareous; includes intraformational reworking with grayish-pink finely crystalline limestone clasts; contains some scattered limestone nodules; gradational base

Eiss Limestone Member (11.8 ft)

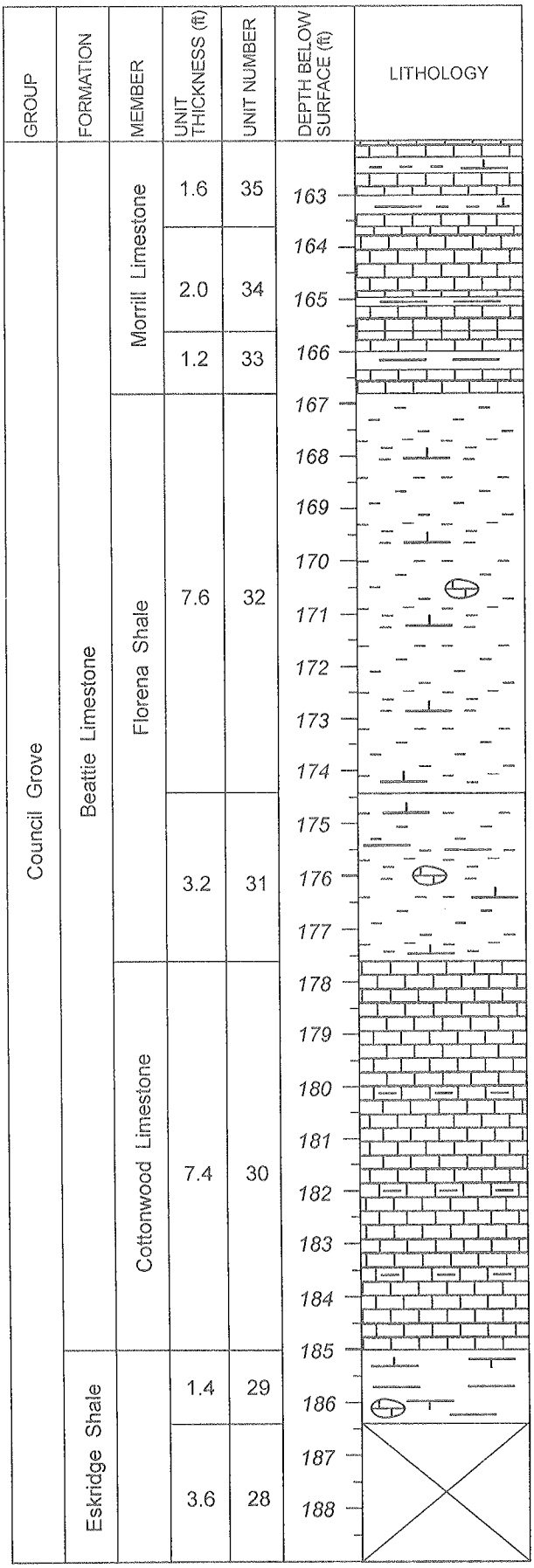
39. Limestone, pinkish-gray and grayish-pink weathers white, very finely to finely crystalline, hematitic stained, pitted, slightly silicified; includes some vugs and veinlets; veinlets and stringers of dark-reddish-brown mudstone common; banded in lower 0.8 ft

38. Limestone, pinkish-gray to grayish-pink, silicified, algal; dark-greenish-gray mudstone very common; clotted texture and very conglomeratic look (nodular) produced by interbedded limestone and mudstone in lower 2.5 ft

STEARNS SHALE (5.3 ft)

37. Mudstone, medium-bluish-gray to greenish-gray, calcareous; contains some scattered limestone chips

36. Mudstone, grayish-red to dark-reddish-brown with some medium-bluish-gray; includes scattered limestone chips



BEATTIE LIMESTONE (23.0 ft)

Morrill Limestone Member (4.8 ft)

35. Limestone and mudstone; mudstone, grayish-red to greenish-gray, calcareous with limestone clasts; limestone, medium-gray to very light gray, finely crystalline, vuggy, weathers to medium-gray, light-olive-gray, and white (chalky look)

34. Limestone, pale-red-purple to grayish-red-purple to grayish-red with interbeds of variegated mudstone, medium-crystalline, algal, coquinoid with corals, bryozoans, brachiopods, and mollusks

33. Limestone, variegated greenish-gray (especially at top) to light-olive-gray, dusky-yellow, and grayish-red-purple; interbedded with mudstone; includes some intraformational reworking

Florena Shale Member (10.8 ft)

32. Mudstone, grayish-red to dark-reddish-brown, calcareous; contains scattered limestone,nodules and granules

31. Mudstone, grayish-red, dark-reddish-brown and medium-bluish-gray, calcareous; contains scattered limestone nodules

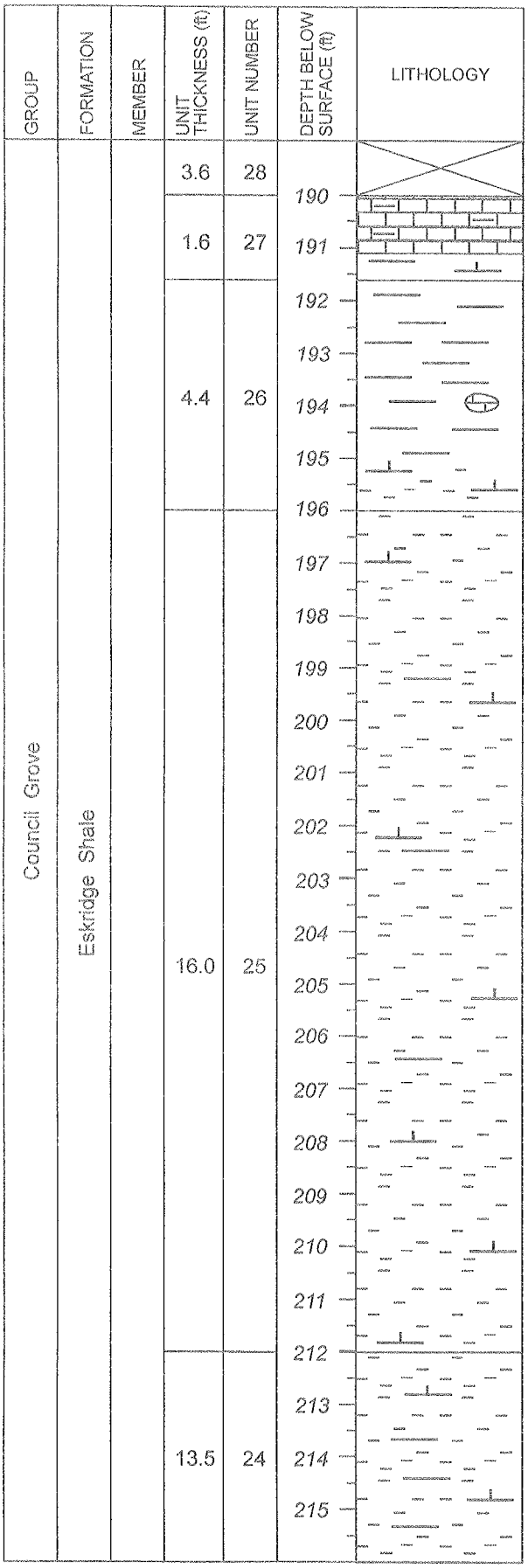
Cottonwood Limestone Member (7.4 ft)

30. Limestone, medium-light-gray to light-gray weathers white, finely crystalline at top with the basal 2.5 ft medium-crystalline, slightly pitted, vuggy, algal; contains greenish-gray mudstone stringers and medium-dark-gray stylolitic seams; includes some intraformational reworking at the top; fossiliferous with large fusulinids

ESKRIDGE SHALE (73.0 ft)

29. Mudstone, greenish-gray, very calcareous; contains some very finely crystalline limestone nodules

28. Loss of core

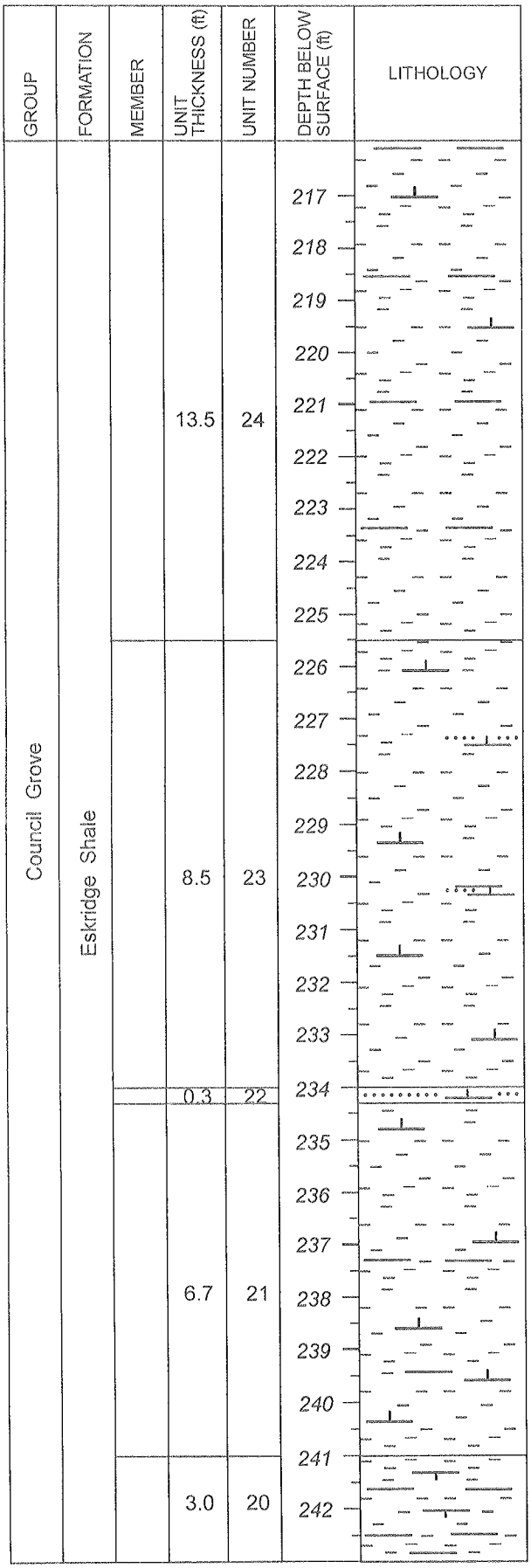


27. Limestone, light-olive-gray, dusky-yellow, and light-brownish-gray, finely crystalline, very shaly, vuggy, fossiliferous; contains tubular limestone nodules (?burrow systems); includes a calcareous shale at the base

26. Mudstone, dusky-yellowish-green to medium-bluish-gray, lower part with some grayish-red, calcareous mudstone; contains scattered very finely crystalline limestone nodules

25. Mudstone, grayish-red, some medium-bluish-gray, slightly calcareous; scattered limestone chips common

24. Mudstone, grayish-red and medium-bluish-gray, slightly calcareous; lower 2 ft predominantly grayish-red; scattered limestone chips common

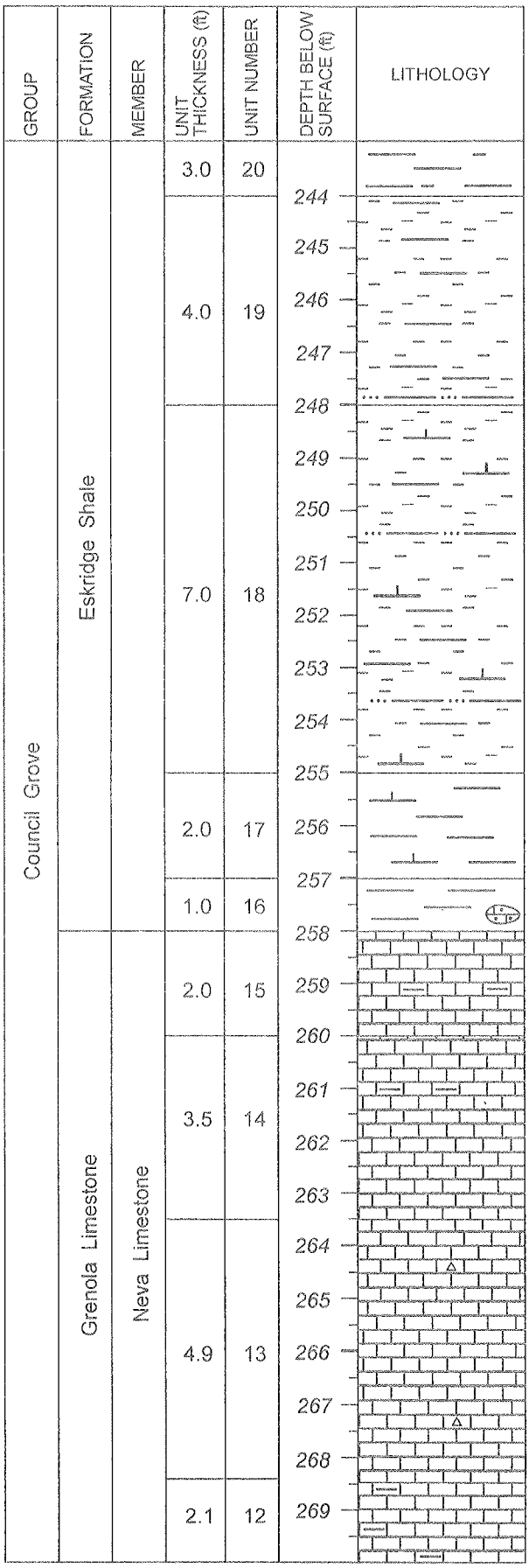


23. Mudstone, grayish-red to dark-reddish-brown, calcareous; several intervals of intraformational reworked sandy limestone and calcareous sandstone

22. Sandstone, pale-red to grayish-red, very calcareous, very fine grained, highly bioturbated

21. Mudstone, grayish-red with some medium-bluish-gray, calcareous; scattered sandy limestone chips common

20. Mudstone, medium-bluish-gray with minor grayish-red, calcareous; contains limestone chips throughout



19. Mudstone, grayish-red and medium-bluish-gray; silty at the base; limestone chips throughout

18. Mudstone and shale, grayish-red and greenish-gray, calcareous, silty

17. Mudstone, greenish-gray to medium-bluish-gray, calcareous

16. Mudstone, greenish-gray; interbedded with greenish-gray to light-olive-gray, nodular, sandy limestone

GRENOLA LIMESTONE

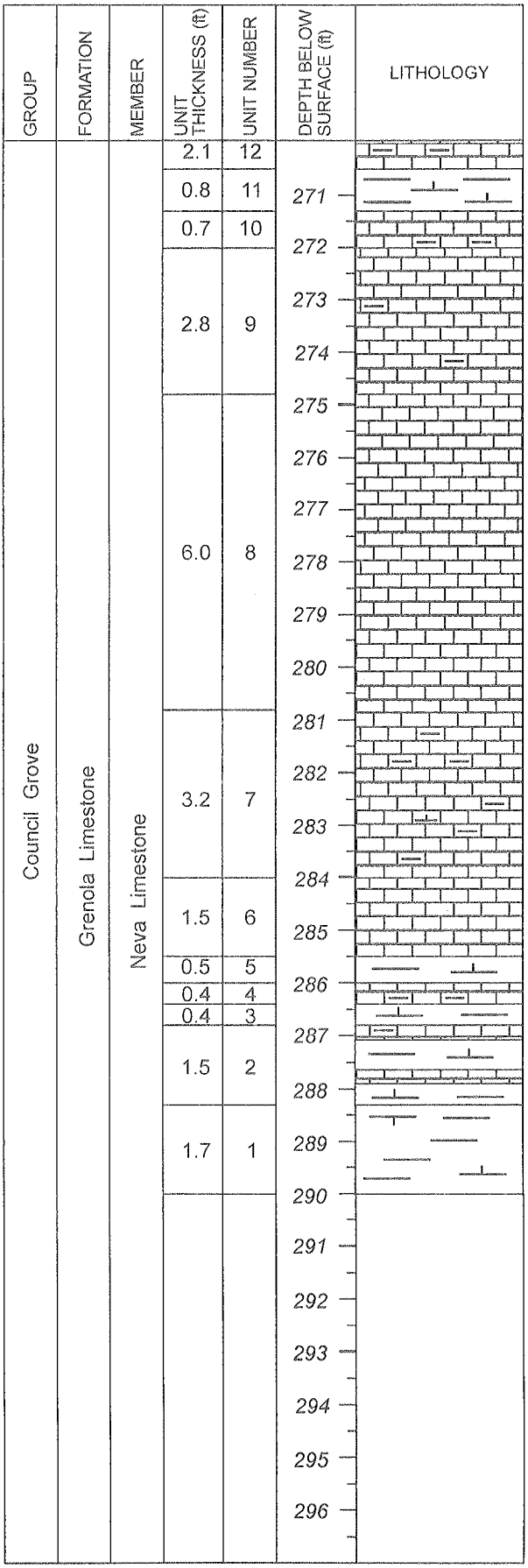
Neva Limestone Member (32.0 ft)

15. Limestone, light-olive-gray to greenish-gray, finely crystalline, algal, wavy bedding; contains stringers of greenish-gray mudstone; some evidence of intraformational reworking

14. Limestone, yellowish-gray weathers grayish-pink, finely crystalline, pitted, vuggy; contains irregular, wavy stringers of light-olive-gray mudstone

13. Limestone, pinkish-gray and light-gray, fine- to medium-crystalline, algal, fossiliferous with fusulinids; quartz-filled vugs and lined veinlets common; contains some brecciated cherty zones; includes stylolitic seams lined with dark-gray carbonaceous material

12. Limestone, light-gray and yellowish-gray, finely crystalline, shaly, fossiliferous; upper part very vuggy and pitted; contains scattered stringers of olive-gray to medium-dark-gray calcareous shale



11. Shale, dark-greenish to dark-gray and olive-gray, calcareous; contains some very thin limestone lenses

10. Limestone, medium-gray, finely crystalline; clotted texture due to silicified fusulinids; contains some silicified intervals; includes dark-greenish-gray to dark-gray calcareous shale seams; contains thin fusulinid limestone lenses

9. Limestone, light-gray to medium-dark-gray, medium-crystalline, pyritic; fossiliferous with silicified crinoidal hash and brachiopods; contains vugs and veinlets filled with euhedral quartz crystals; includes some stylolitic seams and stringers of grayish-black shale; contains some brecciated limestone with carbonaceous material

8. Limestone, medium-light-gray to medium-gray, medium-crystalline, very fossiliferous with brachiopods and fusulinids throughout; contains numerous stylolitic boundaries with carbonaceous linings; organic-rich; fusulinids closely associated with intervals of richest organic material, e.g., along stylolitic boundaries; fusulinids very common from 276.0 to 277.5 ft

7. Limestone, dark-gray to grayish-black, weathers light-gray, medium-crystalline, very shaly, very fossiliferous with cross sections of silicified brachiopod valves; includes rare calcareous shale; contains organic seams with small limestone clasts; fusulinids from 282.2 to 282.9 ft

6. Limestone, light-gray, yellowish-gray, and light-brownish-gray, lower part light-bluish-gray, finely crystalline, silicified; cross sections of silicified brachiopod valves common

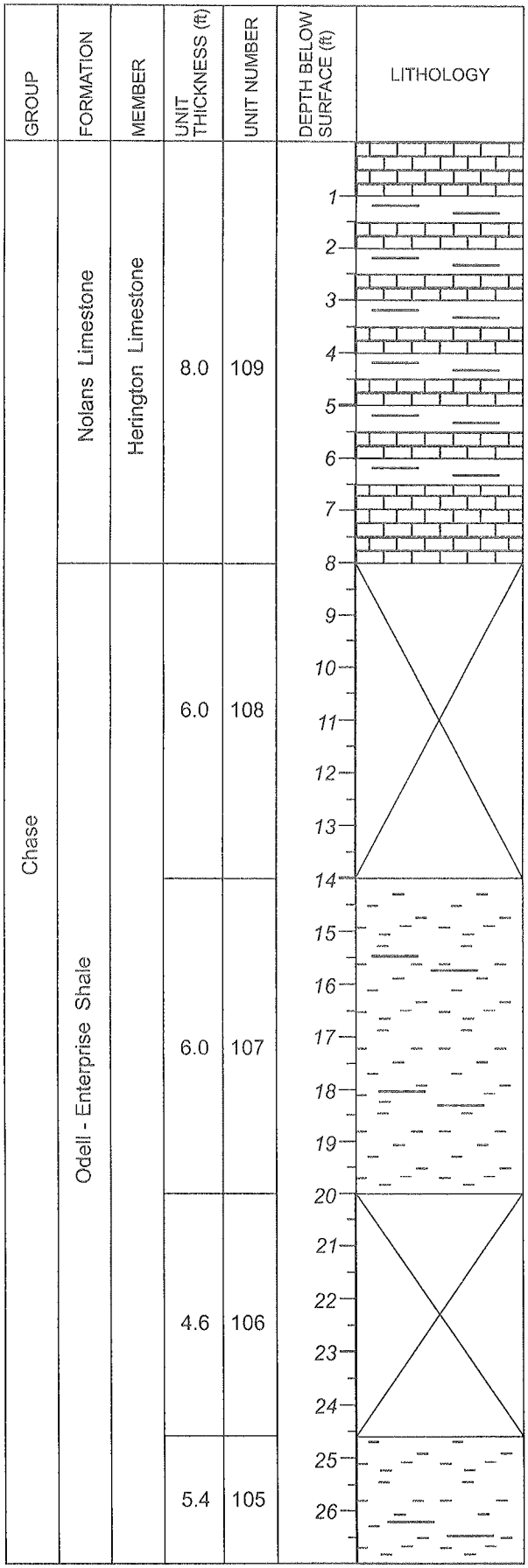
5. Shale, dark-greenish-gray to dark-gray, calcareous; includes some cross sections of brachiopods

4. Limestone, medium-gray, finely crystalline, shaly, slightly fossiliferous, silicified; contains grayish-black calcareous shale at the top and base; includes some shale inclusions; contacts gradational to highly undulatory

3. Shale, dark-greenish-gray, calcareous, fossiliferous; contains some limestone clasts

2. Limestone and shale; limestone, medium-dark-gray to medium-gray, finely crystalline, shaly, fossiliferous, slightly silicified; shale, medium-dark-gray to dark-gray, calcareous, fossiliferous; silicified base contains large tubular algal filaments; basal contact gradational to undulatory

1. Shale, greenish-gray to medium-bluish-gray, calcareous



Core Hole KC-4
MERVINE ANTICLINE

NE¼NE¼NW¼NW¼ sec. 12, T. 27 N., R. 3 E., Uncas Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey on the east flank of the Mervine Anticline. Drilled 50 ft from north line (FNL) and 1,050 ft from west line (FWL). Surface elevation from altimeter, 1,170 ft. Spudded at the base of the Wellington and Herington transitional beds. Field lithologic descriptions by James R. Chaplin.

CHASE GROUP

NOLANS LIMESTONE

Herington Limestone Member (8.0 ft)

Unit no.

109. Limestone, light-gray, fine- to medium-crystalline, thin-bedded; alternates with greenish-gray mudstone; lithology based on cuttings

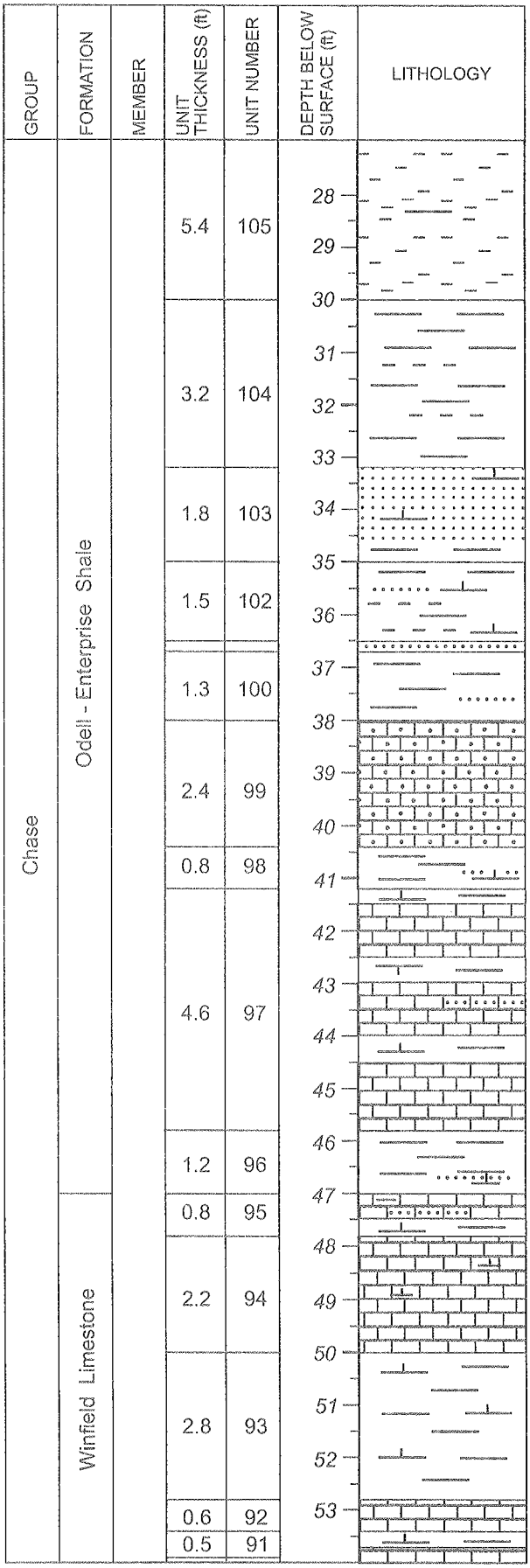
ODELL-ENTERPRISE SHALE (39.0 ft)

108. Loss of core

107. Mudstone, dark-reddish-brown with intervals of greenish-gray mudstone; contains scattered limestone granules; poorly indurated

106. Loss of core

105. Mudstone, dark-reddish-brown with intervals of greenish-gray mudstone; very poorly indurated



104. Mudstone, variegated, predominantly medium-bluish-gray, dark-reddish-brown, and grayish-red

103. Sandstone, variegated pale-red to yellowish-gray, calcareous; contains some mudstone at base; bioturbated with *Chondrites*; gradational top

102. Mudstone, variegated, light-olive-gray, greenish-gray, grayish-red-purple, and grayish-red, calcareous; includes calcareous sandstone laminae, some cross-laminated; contains some contorted bedding

101. Sandstone, pale-yellowish-brown, fine-grained, calcareous, small-scale cross-bedding

100. Mudstone, light-olive-gray to greenish-gray, slight banded appearance; contains 1–2-mm-thick sandy limestone cross-laminae; sharp basal contact

99. Limestone, brownish-gray, fine- to medium-crystalline, cross-bedded, slightly fossiliferous; sandy with wavy laminae; limonite stained

98. Mudstone, light-bluish-gray to medium-bluish-gray with calcareous sandstone cross-laminae, especially at base; bioturbated with *Chondrites*

97. Limestone and shale; limestone, light-bluish-gray to medium-bluish-gray, finely crystalline, fossiliferous; contains wavy laminations and stringers of sandy limestone; shale, dark-gray to medium-dark-gray, calcareous

96. Mudstone, dark-gray in upper part, lower part greenish-gray; contains sandy limestone stringers at the base; gradational base

WINFIELD LIMESTONE (13.4 ft)

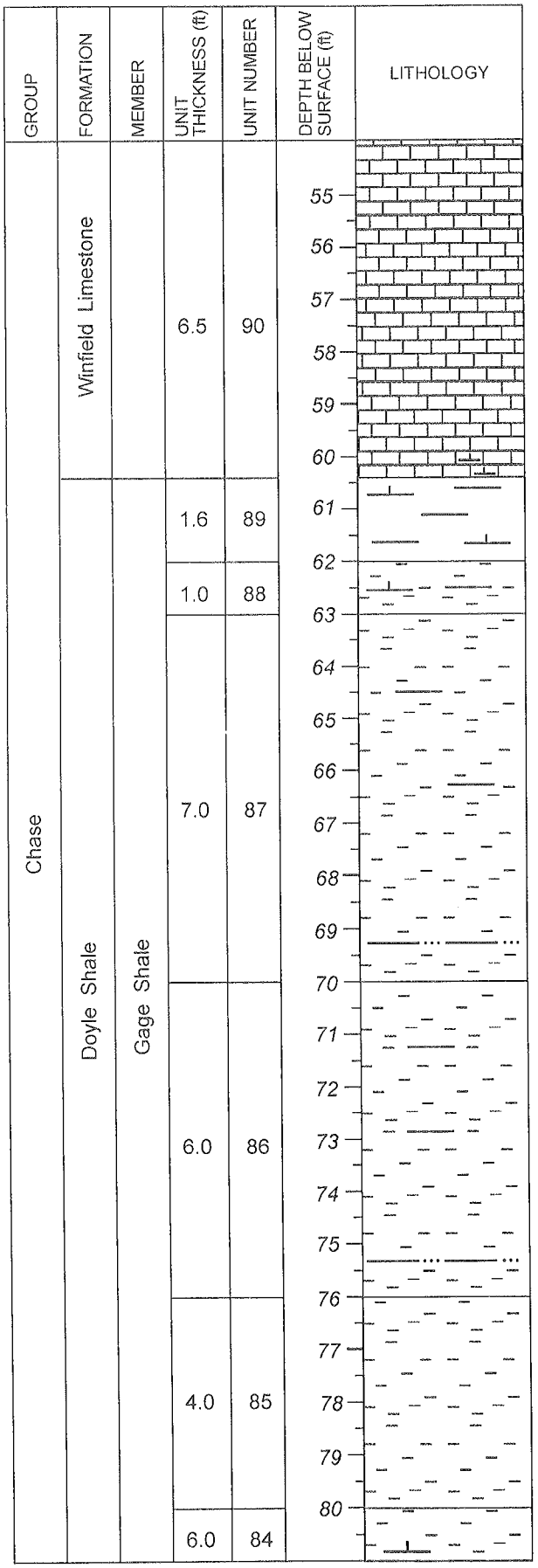
95. Limestone, very light-gray, finely crystalline, sandy, with mudstone stringers at the top; lower part consists of medium-bluish-gray to greenish-gray calcareous mudstone; gradational base

94. Limestone, very light-gray to light-bluish-gray in upper part to light-bluish-gray and medium-bluish-gray in lower part; includes some mottled intervals; contains large fossil fragments of crinoids and echinoids; lenticular calcareous mudstone stringers common

93. Shale, greenish-gray, dark-greenish-gray, medium-bluish-gray with dusky-yellow and light-olive-brown staining; very calcareous and fossiliferous with bands of crinoidal fragments and echinoid spines and plates; gradational base

92. Limestone, medium-gray to medium-bluish-gray stained dusky-yellow to light-olive-brown, fine- to medium-crystalline; fossiliferous with echinoid spines and plates; sharp base

91. Limestone and shale; limestone, medium-dark-gray to grayish-black, medium-crystalline; contains stringers of dark-gray calcareous shale; fossiliferous with echinoid spines; upper part consists of shale, dark-gray, calcareous, fossiliferous



90. Limestone, medium-light-gray to light-bluish-gray, medium-crystalline, massive, highly algal (large osagid grains at base); very fossiliferous, vuggy; some limonite stains; contains stringers of dark-gray, calcareous shale in lower 1 ft; sharp base

DOYLE SHALE (106.1 ft)

Gage Shale Member (79.8 ft)

89. Mudstone, greenish-gray to medium-bluish-gray, calcareous

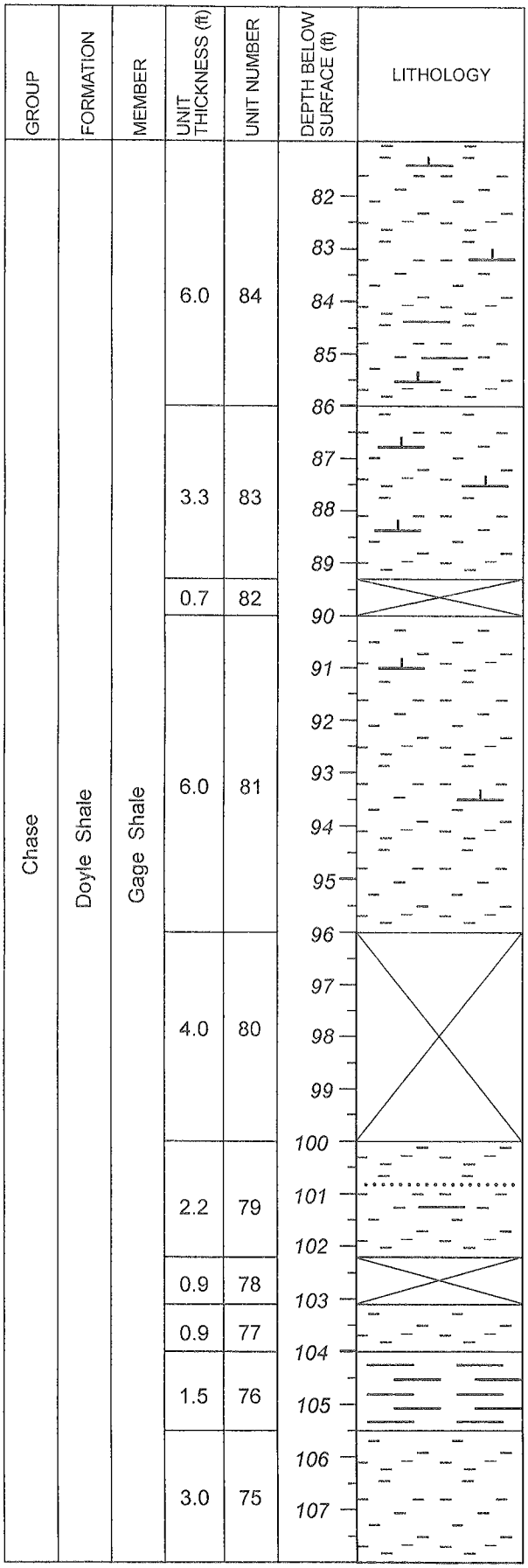
88. Mudstone, grayish-red to dark-reddish-brown with some greenish-gray to medium-bluish-gray intervals; slightly calcareous

87. Mudstone, grayish-red to dark-reddish-brown with some medium-bluish-gray intervals; contains scattered limestone granules; upper part very poorly indurated; lower part more silty and better indurated

86. Mudstone, grayish-red with some intervals of greenish-gray and medium-bluish-gray; includes scattered calcite veinlets and limestone granules; lower part more silty; poor to moderately indurated

85. Shale and mudstone, grayish-red with some medium-bluish-gray stains; contains calcite veinlets; includes pockets of brecciated limestone granules; moderate to well indurated

84. Shale and mudstone, grayish-red with intervals of medium-bluish-gray mudstone, calcareous; contains scattered very thin calcite veinlets; limestone granules common; slightly silty



83. Mudstone, grayish-red, calcareous, poorly indurated

82. Loss of core

81. Mudstone, grayish-red to dark-reddish-brown, slightly calcareous; poorly indurated; contains slickensided fracture surfaces

80. Loss of core

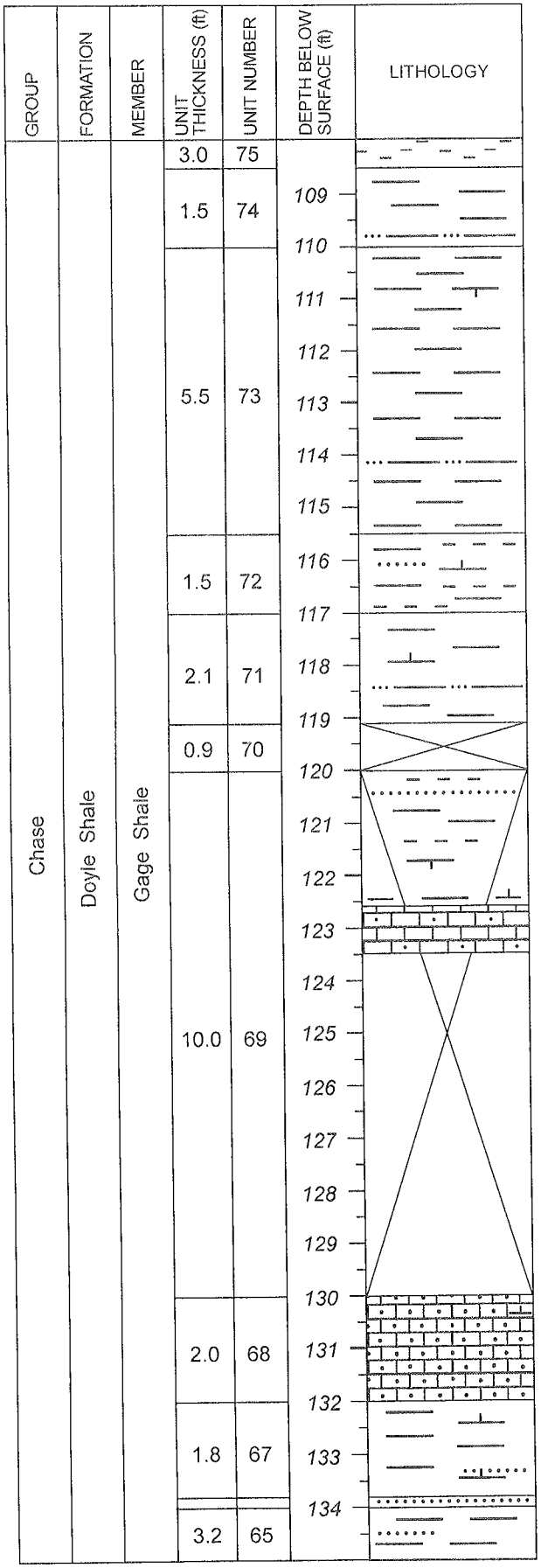
79. Mudstone, dark-reddish-brown with intervals of greenish-gray and light-bluish-gray mudstone; contains some intervals of light-greenish-gray to grayish-red, very fine grained, hematitic sandstone grading into siltstone

78. Loss of core

77. Mudstone, dark-reddish-brown with light-bluish-gray mottling

76. Mudstone, greenish-gray to light-bluish-gray with dark-reddish-brown mottling

75. Mudstone, dark-reddish-brown with light-bluish-gray to medium-bluish-gray mottling



74. Mudstone, greenish-gray to light-bluish-gray with scattered dark-reddish-brown mottled intervals; some silty intervals

73. Mudstone, light-bluish-gray to medium-bluish-gray, slightly calcareous, poorly indurated; some silty intervals

72. Mudstone, variegated, light-bluish-gray, medium-bluish-gray and dark-reddish-brown, slightly calcareous; contains cross-laminations of very fine grained sandstone; poor to moderately indurated

71. Mudstone, light-bluish-gray, medium-bluish-gray, greenish-gray with dark-reddish-brown mottled intervals, especially at the base; slightly calcareous and silty; moderately indurated

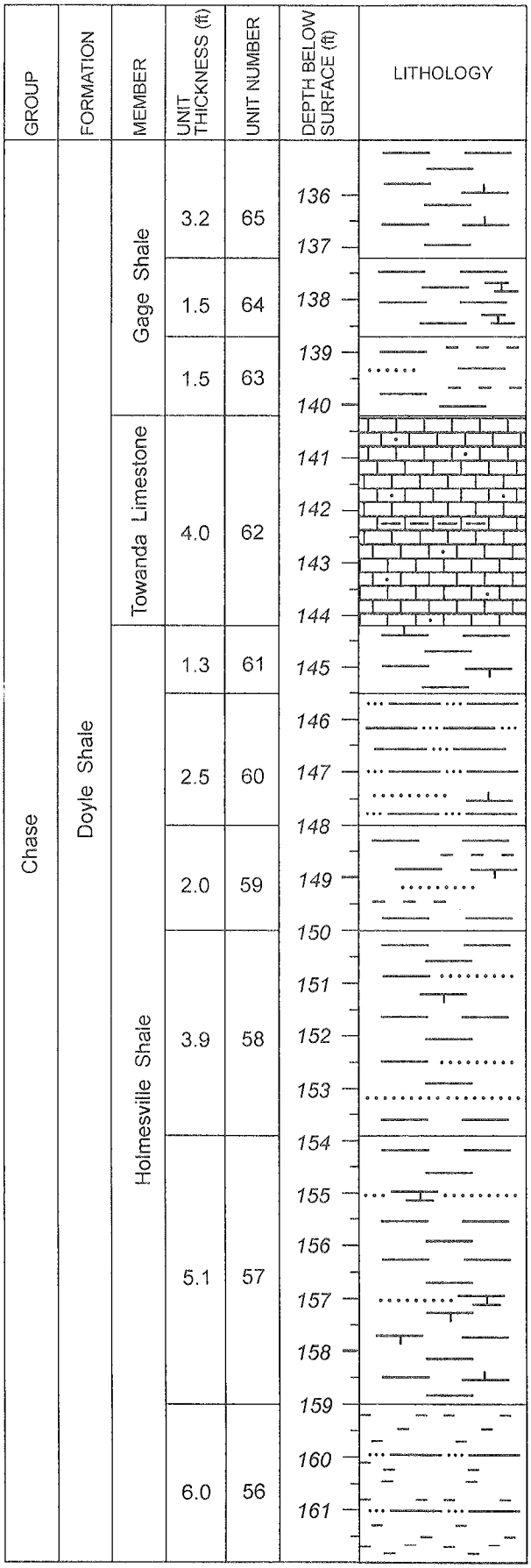
70. Loss of core

69. Partial loss of core; interval recovered consists of following lithologies; 0.6 ft of dark-reddish-brown mudstone and pale-red to very light gray, very fine grained burrowed sandstone; 1.6 ft of grayish-red and light-bluish-gray mudstone; 1.0 ft of greenish-gray calcareous shale; 1.0 ft of yellowish-gray to grayish-yellow, finely crystalline, sandy, vuggy limestone

68. Limestone, greenish-gray, finely crystalline, sandy; contains dark-greenish-gray laminations of calcareous mudstone; fractured

67. Shale, dark-greenish-gray to greenish-black, slightly calcareous; contains lenticular laminations of very fine grained, calcareous sandstone

66. Sandstone, light-bluish-gray to medium-bluish-gray, very fine grained, calcareous, cross-laminated



65. Shale, greenish-gray to medium-bluish-gray, calcareous, especially in lower part; contains numerous very fine grained calcareous sandstone lenses, especially in the upper part

64. Shale and limestone conglomerate interbedded; light-bluish-gray, medium-bluish-gray, and dark-greenish-gray

63. Shale, variegated, medium-bluish-gray, dark-greenish-gray, and grayish-red; contains scattered lenses of very fine grained sandstone

Towanda Limestone Member (4.0 ft)

62. Limestone, light-gray to light-bluish-gray, finely crystalline, sandy, very fossiliferous; contains very wavy stringers of dark-gray to dark-greenish-gray calcareous mudstone; dry surface with distinct chalky white look

Holmesville Shale Member (22.3 ft)

61. Mudstone, medium-bluish-gray to dark-greenish-gray calcareous, poorly indurated

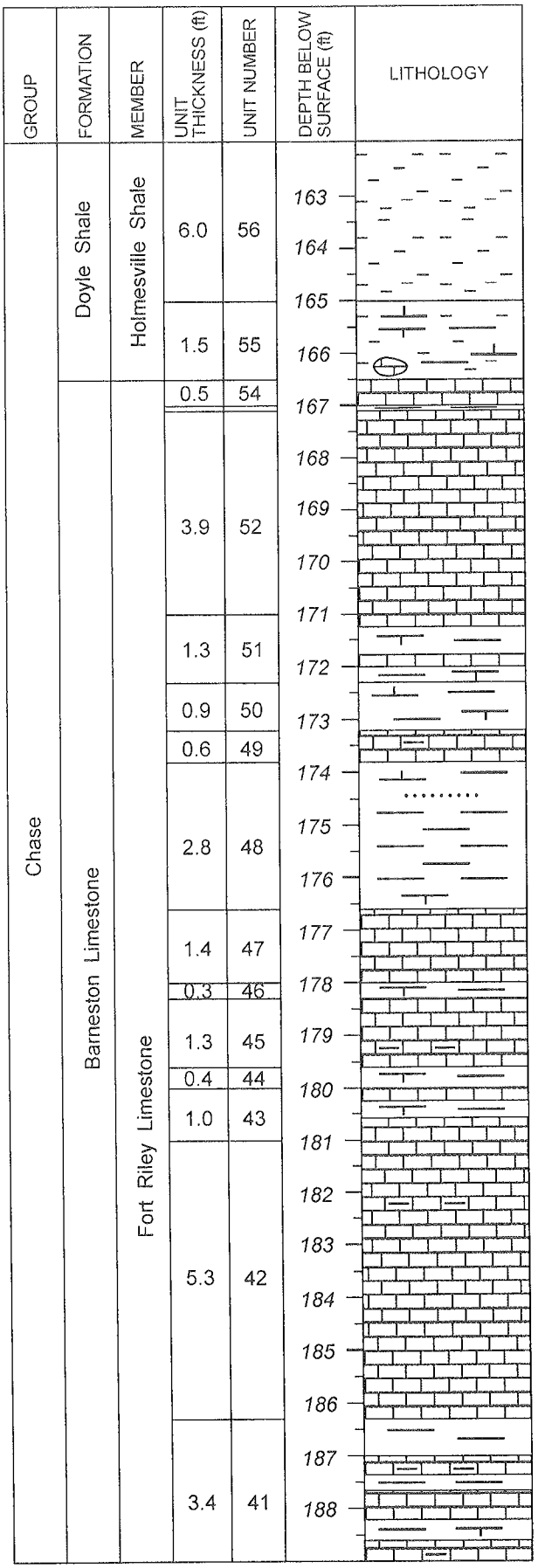
60. Siltstone, light-bluish-gray to greenish-gray and grayish-red; contains scattered lenticular lenses of pale-yellowish-brown, calcareous, very fine grained sandstone in lower part

59. Mudstone and shale, variegated, medium-bluish-gray and dark-reddish-brown; lower part with lenses of very fine grained, calcareous sandstone producing a banded look

58. Shale, dark-yellowish-brown to medium-bluish-gray with numerous stringers of slightly calcareous sandstone; contorted bedding; slight banded look; yellowish-gray to moderate-brown sandstone common in lower part

57. Shale and mudstone, brownish-gray to medium-bluish-gray with numerous laminae of limestone and calcareous sandstone; some sandstone laminae exhibit contorted bedding; lower 1.6 ft calcareous; distinct color change to grayish-red at base; contains some rare limestone granules; gradational base

56. Mudstone, grayish-red with some medium-bluish-gray mottling; silty intervals throughout but especially in upper 2–3 ft



55. Mudstone and shale, medium-bluish-gray to grayish-red, calcareous; includes some scattered medium-bluish-gray limestone nodules, especially at the top and at the base; gradational base

BARNESTON LIMESTONE (53.5 ft)

Fort Riley Limestone Member (44.8 ft)

54. Limestone, light-gray to light-bluish-gray, medium-crystalline, fossiliferous

53. Mudstone, greenish-gray, calcareous

52. Limestone, yellowish-gray, greenish-gray, and light-bluish-gray, medium-crystalline, fossiliferous, slightly vuggy, algal; contains stylolitic seams between 169.6 and 170.0 ft; lower part finely crystalline; dry surface produces a distinct chalky white appearance

51. Limestone and shale interbedded; limestone, light-gray to light-bluish-gray, medium-crystalline, fossiliferous; shale, dark-greenish-gray, calcareous

50. Shale, dark-greenish-gray, calcareous, fossiliferous

49. Limestone, very light gray to yellowish-gray, medium-crystalline, fossiliferous; contains wavy stringers of medium-dark-gray to dark-greenish-gray calcareous shale

48. Shale, dark-greenish-gray with lenticular bands of very fine grained, fossiliferous sandstone, especially in upper part; slightly calcareous in upper part and at base; sharp base

47. Limestone, medium-gray to very light gray, medium-crystalline, fossiliferous

46. Shale, medium-dark-gray, calcareous

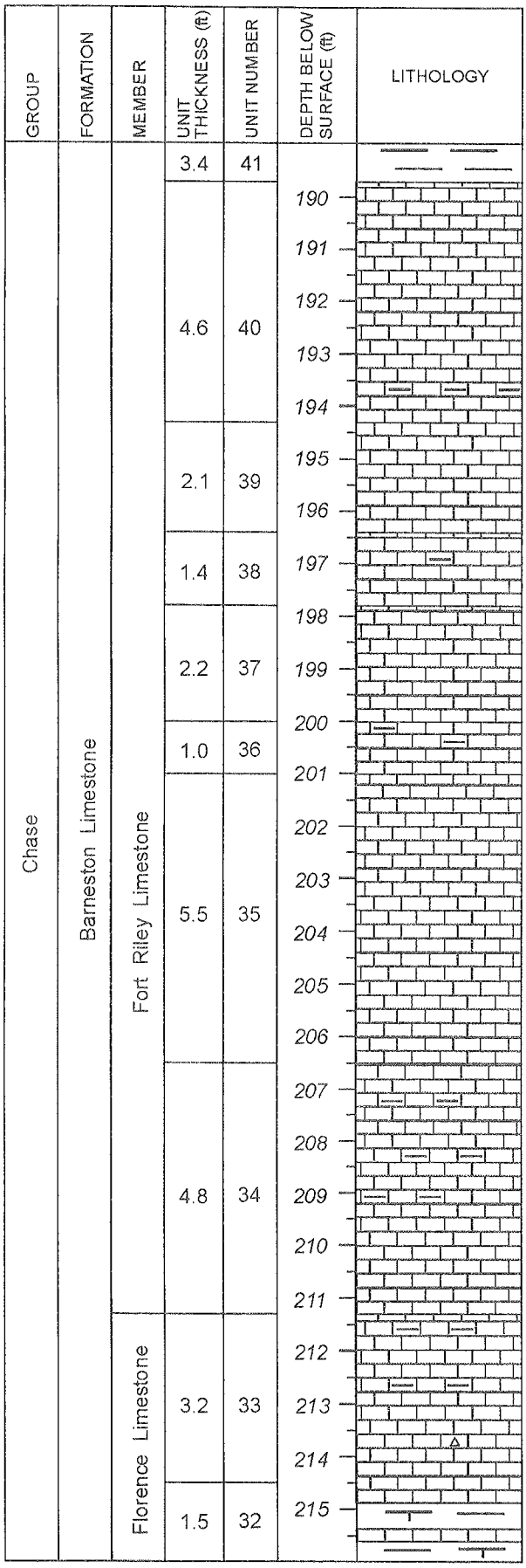
45. Limestone, light-gray, medium-crystalline, fossiliferous; contains stringers of medium-dark-gray shale

44. Shale, medium-dark-gray to medium-gray, calcareous, fossiliferous

43. Limestone and shale interbedded; limestone, medium-light-gray, medium-crystalline, fossiliferous; shale, medium-dark-gray, calcareous

42. Limestone, light-gray to very light gray, medium-crystalline, algal, vuggy; contains scattered grayish-black shale stringers throughout; dry surface with slight chalky white appearance

41. Shale and shaly limestone, medium-bluish-gray, calcareous, fossiliferous with brachiopods, bioturbated; contains very thin lenticular limestone stringers throughout



40. Limestone, light-gray to light-bluish-gray, shaly, highly algal, fossiliferous, vuggy; contains yellowish-gray to medium-dark-gray calcareous shale stringers; includes some thin, calcareous, medium-gray to light-bluish-gray shale partings, especially between 193.8 and 194.0 ft

39. Limestone, yellowish-gray, medium-crystalline, dense, highly algal, fossiliferous; distinct cream-colored appearance

38. Limestone, light-bluish-gray to light-gray, medium-crystalline, highly algal, fossiliferous; vuggy; contains scattered medium-gray shale stringers

37. Limestone, variegated, light-bluish-gray, light-gray to yellowish-gray, medium-crystalline, algal, slightly vuggy

36. Limestone, medium-gray to medium-bluish-gray, medium-crystalline, highly algal, fossiliferous; contains abundant dark-greenish-gray to medium-bluish-gray shale stringers

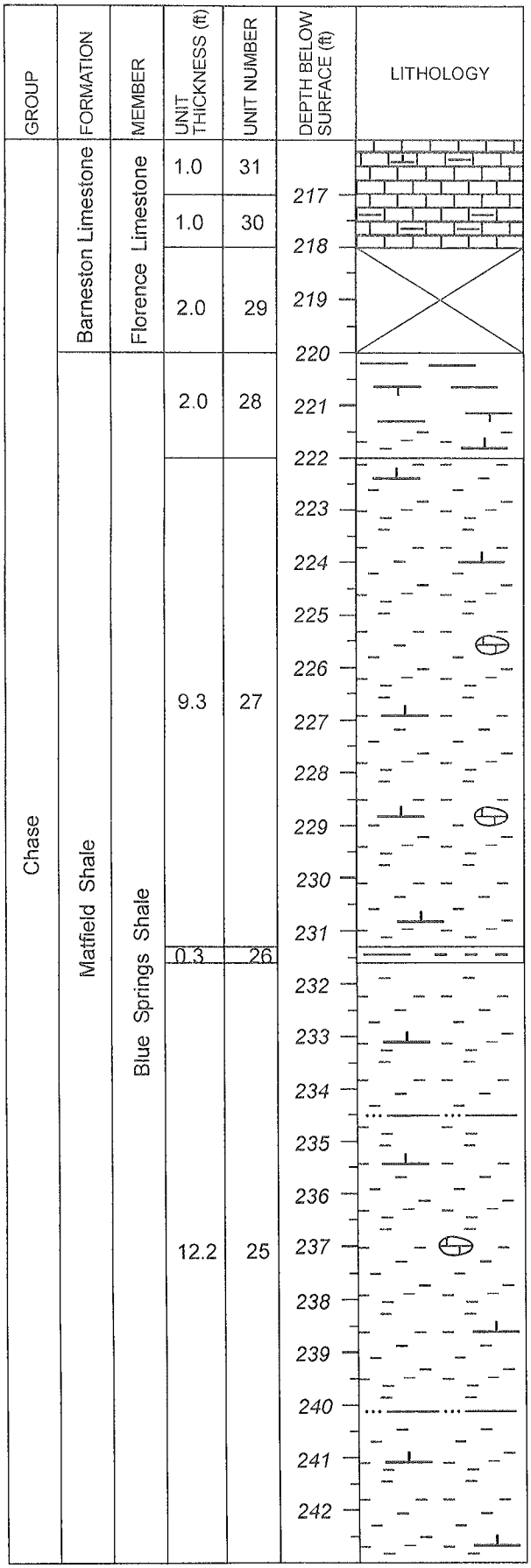
35. Limestone, medium-gray to medium-bluish-gray, medium-crystalline, dense, highly algal, fossiliferous

34. Limestone, very light gray to light-brownish-gray, medium-crystalline, algal, slightly vuggy, fossiliferous with large valves of the brachiopod *Composita*, especially between 208.3 and 208.9; contains organic-rich stylolitic partings of grayish-black shale; bioturbated

Florence Limestone Member (8.7 ft)

33. Limestone, medium-light-gray to medium-bluish-gray, medium-crystalline, slightly algal, fossiliferous; contains rare chert nodules near base; includes abundant thin dark-gray fossiliferous (crinoidal) shale stringers; carbon-filled stylolitic seams common; bioturbated

32. Limestone, medium-gray, shaly; interbedded with medium-dark-gray, calcareous shale; contains very fossiliferous (brachiopods and crinoidal hash) thin shale partings



31. Limestone, dark-gray to medium-gray, medium-crystalline, very fossiliferous with cross sections of brachiopod valves; includes scattered grayish-black, calcareous shale stringers throughout

30. Limestone, medium-gray to medium-bluish-gray, medium crystalline, highly algal (osagid grains); contains some medium-dark-gray organic-rich, calcareous shale stringers

29. Loss of core

MATFIELD SHALE (69.3)

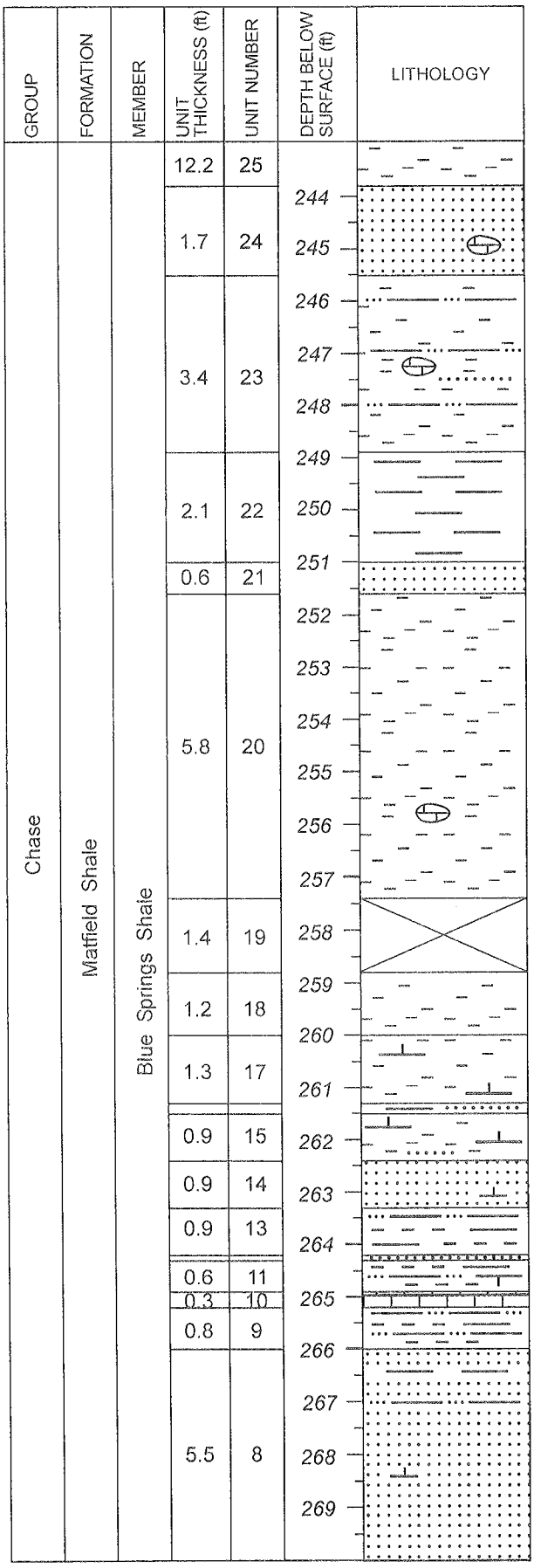
Blue Springs Shale Member (55.7 ft)

28. Mudstone, medium-bluish-gray mottled grayish-red to dark-reddish-brown at base, calcareous; includes limestone granules throughout

27. Mudstone, grayish-red to dark-reddish-brown, calcareous; limestone nodules common; fracture surfaces are slickensided

26. Mudstone, mottled medium-bluish-gray to grayish-red

25. Mudstone, grayish-red with medium-bluish-mottled intervals throughout, calcareous; silty to very silty; contains scattered small limestone nodules



24. Sandstone, grayish-red to grayish-pink, very fine grained to fine-grained, hematitic, cross-laminated; includes scattered very small calcareous nodules

23. Siltstone, and sandy mudstone, grayish-red; very small calcareous nodules common; contains streaks of grayish-pink very fine grained sandstone throughout

22. Mudstone, medium-bluish-gray, very poorly indurated

21. Sandstone, grayish-red, very fine grained, hematitic, cross-laminated; contains some very small calcareous nodules

20. Mudstone, predominantly grayish-red with some medium-bluish-gray mottled mudstone; includes scattered very small calcareous nodules; very poorly indurated

19. Loss of core

18. Mudstone, grayish-red with some medium-bluish-gray mottling; poorly indurated

17. Mudstone, grayish-red, calcareous

16. Mudstone and calcareous sandstone, medium-light-gray to medium-bluish-gray; sandstone, fine-grained and conglomeratic-like; gradational contacts

15. Mudstone, grayish-red, calcareous; sandy at base

14. Sandstone, grayish-red to yellowish-gray at base, very fine grained, hematitic, slightly calcareous

13. Siltstone and mudstone, mottled dark-reddish-brown to dark-greenish-gray, slightly sandy

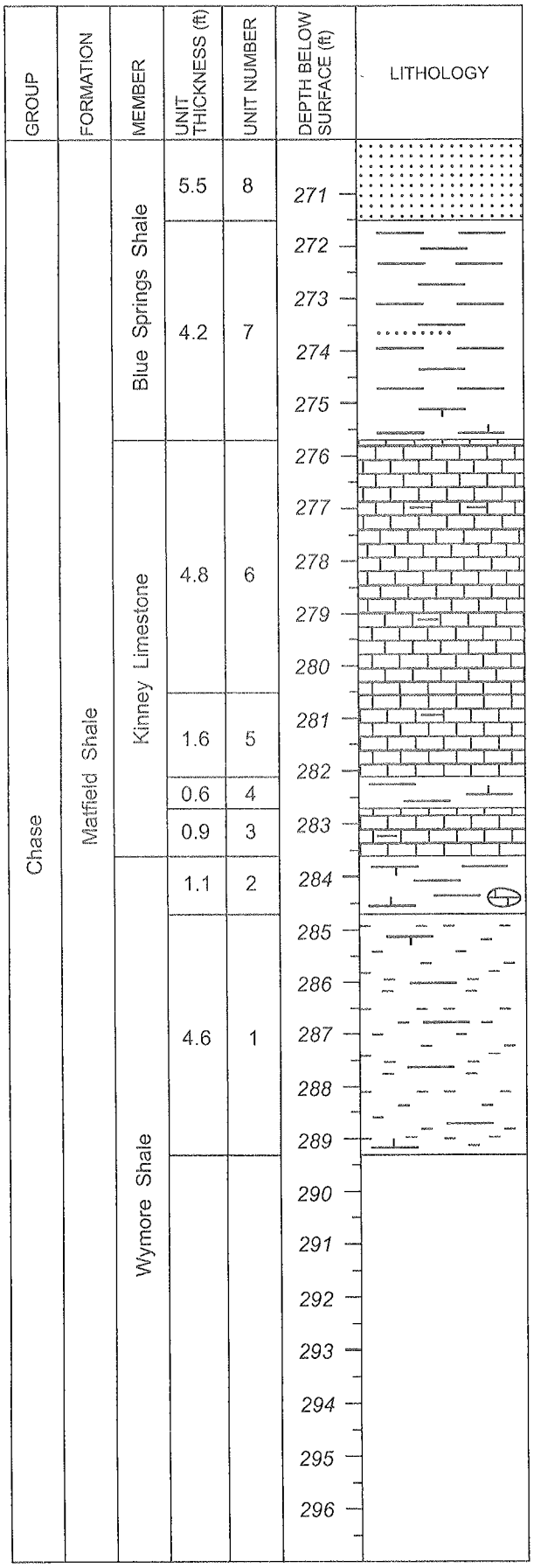
12. Sandstone, light-gray to light-bluish-gray, fine-grained, bioturbated

11. Siltstone and sandy mudstone, mottled dark-reddish-brown, dark-greenish-gray, dusky-yellow, slightly calcareous, fossiliferous; banded at top; gradational base

10. Limestone, dusky-yellow to medium-gray, sandy, fossiliferous

9. Siltstone and silty mudstone, variegated dark-reddish-brown, dusky-yellow, and medium-bluish-gray; contains rare very thin sandstone laminae; bioturbated with *Chondrites*

8. Sandstone, medium-light-gray to medium-bluish-gray, very fine grained, lenticular and churned bedding; contains some parallel and cross-laminations; highly bioturbated; includes some calcareous intervals; alternates with medium-bluish-gray mudstone and siltstone at top of the interval



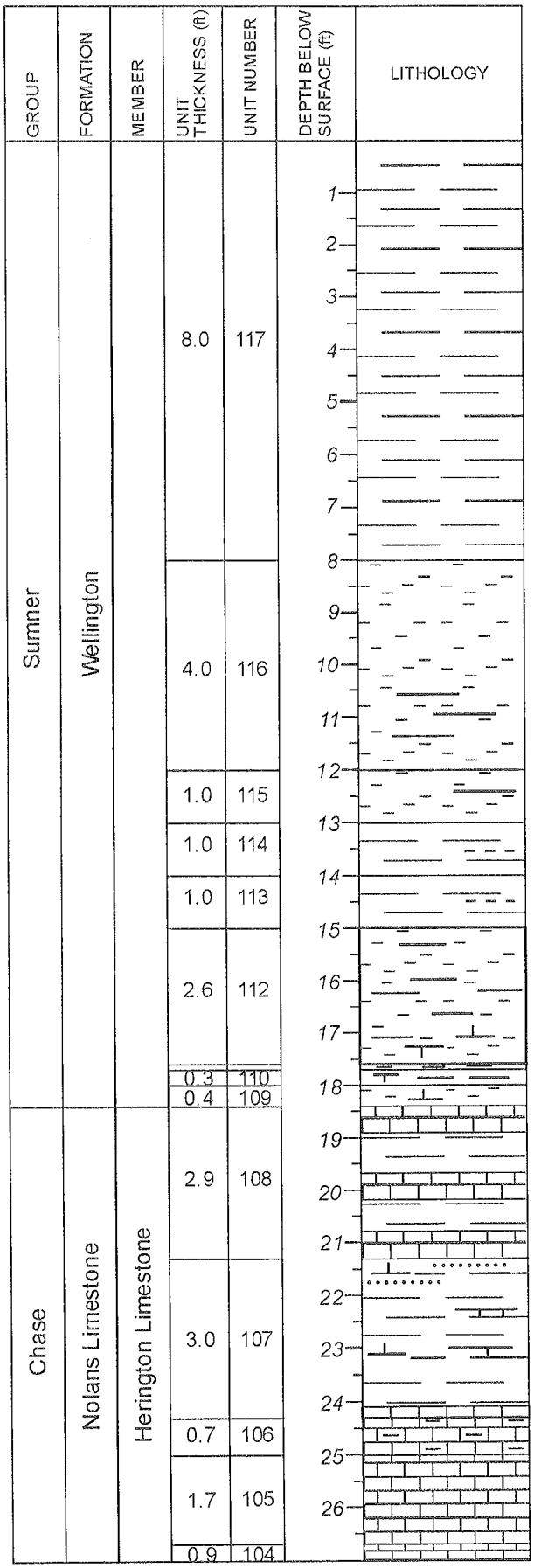
7. Mudstone, medium-bluish-gray with thin lenticular stringers of light-gray, cross-laminated, very fine grained sandstone; calcareous at base; gradational base

Kinney Limestone Member (7.9 ft)

6. Limestone, medium-light-gray to medium-bluish-gray, fine- to medium-crystalline, highly algal, very fossiliferous with large algal-coated fossil fragments; contains scattered stringers of medium-bluish-gray mudstone; includes cross fractures filled with medium-dark-gray carbonaceous material; wavy veinlets very common
5. Limestone, medium-light-gray to medium-bluish-gray, medium-crystalline, crinoidal; contains some dark-gray carbonaceous-rich mudstone
4. Shale, medium-bluish-gray, slightly calcareous, fossiliferous
3. Limestone, medium-light-gray to light-bluish-gray, fossiliferous; contains wavy stringers of dark-gray to medium-dark-gray shale and mudstone

Wymore Shale Member (5.7 ft)

2. Mudstone, medium-bluish-gray to dark-greenish-gray with some grayish-red mottling at the base, calcareous; contains scattered very small calcareous nodules
1. Mudstone, mottled grayish-red and medium-bluish-gray, calcareous



Core Hole KC-5
KAW DAM

NW¼SW¼SW¼NW¼ sec. 25, T. 26 N., R. 3 E., Charlie Creek, West Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey at south end of State Fish and Wildlife Building, 2,000 ft from north line (FNL) and 200 ft from west line (FWL). Surface elevation from altimeter, 1,140 ft. Spudded in the lower part of the Wellington Formation. Field lithologic descriptions by James R. Chaplin.

SUMNER GROUP

WELLINGTON FORMATION (18.4 ft)

Unit no.

117. Clay, moderate-brown to light-brown, sticky, lumpy, gritty

116. Clay, grayish-red to light-brown, gritty with dark-greenish-gray shale chips

115. Clay and mudstone, pale-red with some dark-greenish-gray shale chips

114. Shale and mudstone, greenish-gray with some pale-red shale chips

113. Shale and mudstone, predominantly greenish-gray with some rare grayish-red chips

112. Mudstone and shale, mottled greenish-gray to pale-red; predominantly pale-red in lower 1 ft; basal 6 in. calcareous

111. Mudstone, dark-yellowish-orange to grayish-yellow, calcareous, granular; contains stringer of "punky" limestone

110. Shale, light-olive-gray to medium-bluish-gray, calcareous

109. Mudstone, grayish-red, calcareous; gradational base

CHASE GROUP (346.3 ft)

NOLANS LIMESTONE

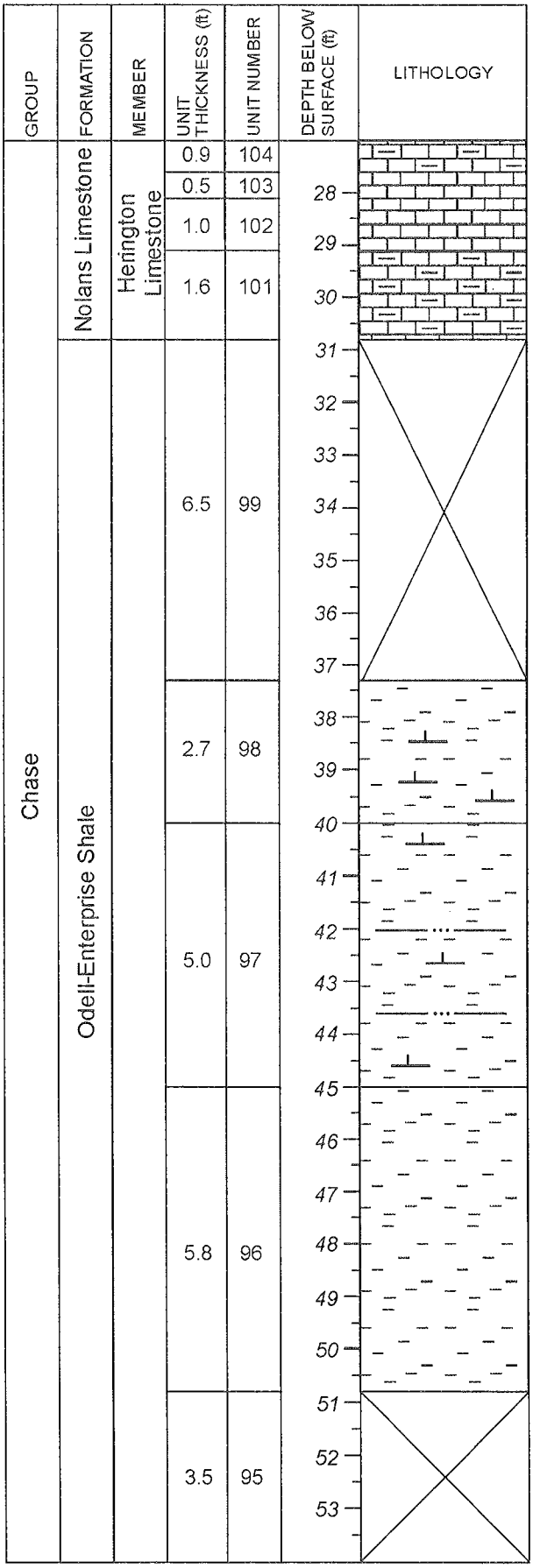
Herington Limestone Member (12.4 ft)

108. Limestone and mudstone interbedded, grayish-orange to dusky-yellow with some dark-greenish-gray bands; manganese stains common; distinct color change; gradational base

107. Shale, medium-light-gray to medium-bluish-gray, calcareous; contains thin, shaly, fossiliferous limestone intercalations; upper 6 in. sandy, non-calcareous; includes some vertical burrows; limestone increases toward the base; gradational base

106. Limestone, medium-gray to medium-bluish-gray, medium-crystalline, fossiliferous; contains medium-bluish-gray to dark-gray wavy shale stringers

105. Limestone, medium-gray to medium-bluish-gray, fossiliferous (crinoidal), medium-crystalline; slightly vuggy especially in lower 5 in.



104. Limestone, grayish-orange to light-bluish-gray, medium-crystalline, fossiliferous; contains light-bluish-gray to dark-gray wavy shale stringers

103. Limestone, medium-bluish-gray to medium-gray, medium-crystalline, fossiliferous; gradational base

102. Limestone, grayish-orange, medium-crystalline, fossiliferous, vuggy, "punky," gradational base

101. Limestone, light-bluish-gray, medium-crystalline, vuggy; contains some grayish-orange wavy shale stringers; lower 6 in. very vuggy and pitted

100. Limestone, light-bluish-gray, medium- to coarse-crystalline; large fossil fragments especially of *Myalina*; unit may be slightly thicker

ODELL–ENTERPRISE SHALE (62.2 ft)

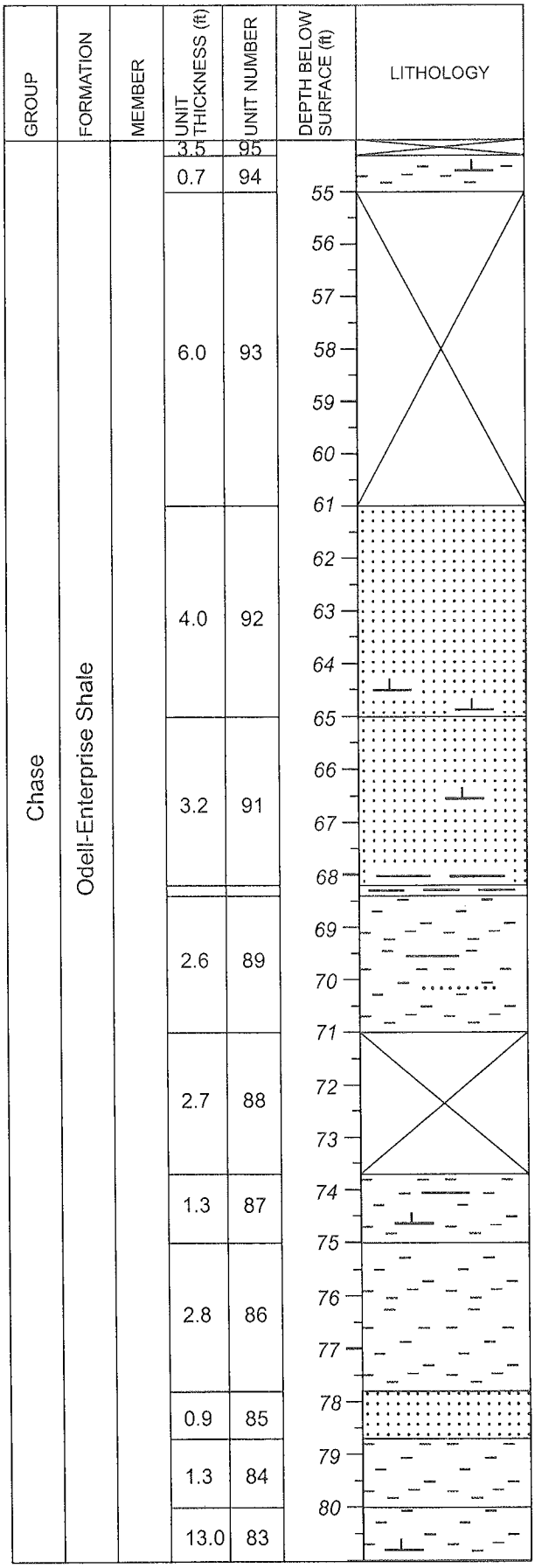
99. Loss of core

98. Mudstone, grayish-red, calcareous

97. Mudstone, grayish-red, calcareous; contains some mottled intervals of greenish-gray; includes some silty stringers throughout

96. Mudstone, grayish-red with mottled intervals of greenish-gray and light-bluish-gray; contains scattered limestone granules throughout

95. Loss of core



94. Mudstone, grayish-red, slightly calcareous; contains some limestone granules

93. Loss of core

92. Sandstone, grayish-red to dark-reddish-brown, very fine grained to fine-grained, cross-laminated; contains some slightly calcareous intervals, especially in lower 1 ft

91. Sandstone, grayish-red, very fine grained to fine-grained; includes ripple-drift cross-laminations; contains some scattered calcareous intervals; basal 0.2 ft is a sandy mudstone

90. Mudstone, grayish-red; contains calcareous sandstone chips and granules producing a conglomeratic look

89. Mudstone, grayish-red to dark-reddish-brown; includes scattered mottled intervals of greenish-gray shale; includes stringers and granules of greenish-gray very fine grained calcareous sandstone

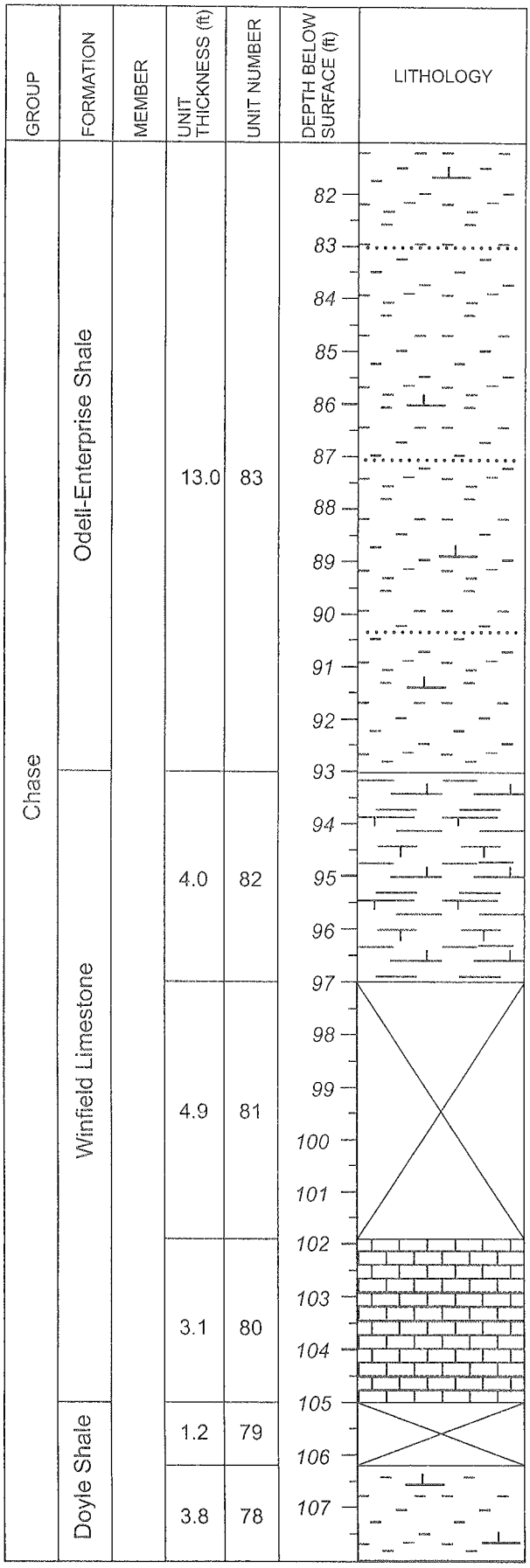
88. Loss of core

87. Mudstone, grayish-red with stringers of light-bluish-gray mudstone; some intervals are slightly calcareous

86. Mudstone, grayish-red

85. Sandstone, light-bluish-gray with some medium-bluish-gray to greenish-gray at the very top and at the base, very fine grained to fine-grained

84. Mudstone, grayish-red



83. Mudstone, grayish-red with some greenish-gray to light-bluish-gray, very fine grained sandstone in interval; calcareous; poor core recovery

WINFIELD LIMESTONE (12.0 ft)

82. Shale, medium-bluish-gray, very calcareous; contains 1–2-in.-thick bands of shaly limestone

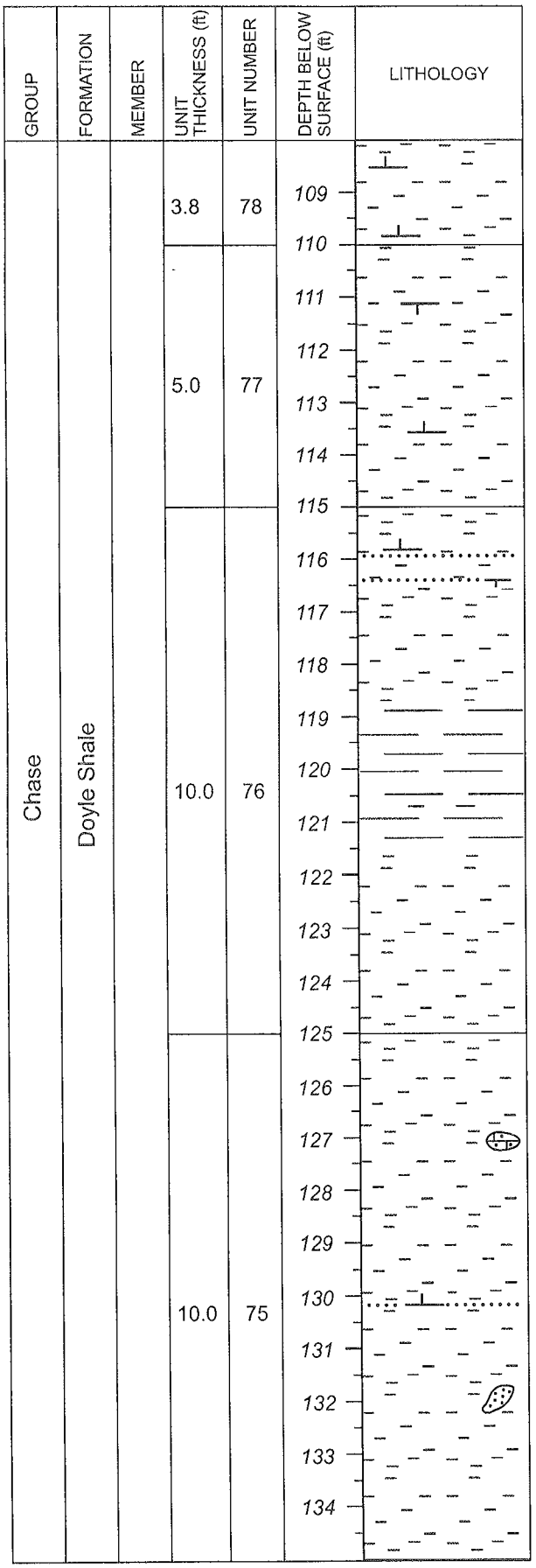
81. Loss of core

80. Limestone, medium-light-gray to light-bluish-gray, medium-crystalline, algal, fossiliferous, dense; contains large algal-coated grains (osagid grains); probably lost 1–2 ft of basal Winfield Limestone in core recovery

DOYLE SHALE (112.6 ft)

79. Loss of core

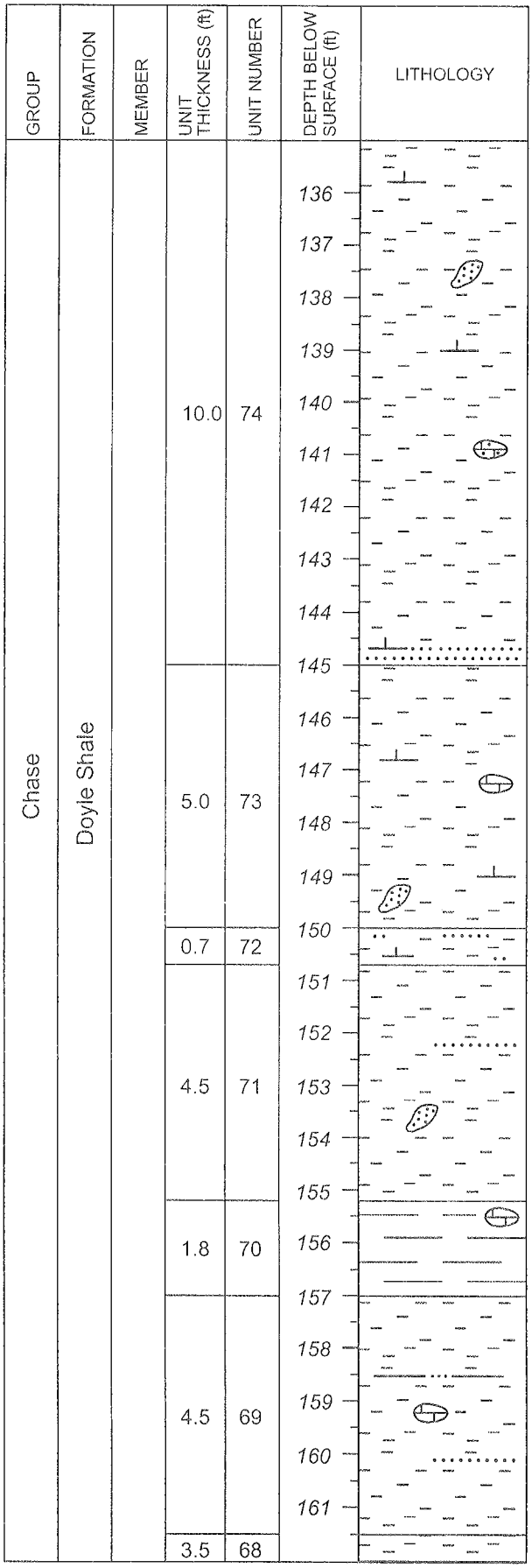
78. Mudstone, grayish-red, calcareous; contains scattered rare limestone granules



77. Mudstone, grayish-red, calcareous; includes scattered calcite veinlets and stringers; contains some rounded to sub-angular sandy limestone granules at 114.2 ft

76. Mudstone, grayish-red to light-bluish-gray which is especially common at 119.0–121.4 ft; contains bluish-white to pinkish-gray, very fine grained, calcareous sandstone granules throughout interval; includes some calcareous sandstone at 116.3–116.7 ft; most calcareous in intervals with calcareous sandstone granules

75. Mudstone, grayish-red, slightly calcareous; cross fractures filled with calcite; contains pinkish-gray to pale-red sandy limestone and calcareous, fine-grained sandstone nodules throughout; includes calcareous, very fine grained sandstone at 129.9–130.0 ft and at 134.5–134.7 ft



74. Mudstone, grayish-red, calcareous in localized intervals; cross fractures filled with calcite; contains calcareous, very fine grained sandstone and finely crystalline limestone nodules throughout; includes some pinkish-gray calcareous sandstone nodules; a vesicular-like calcareous sandstone occurs about 6 in. above the base

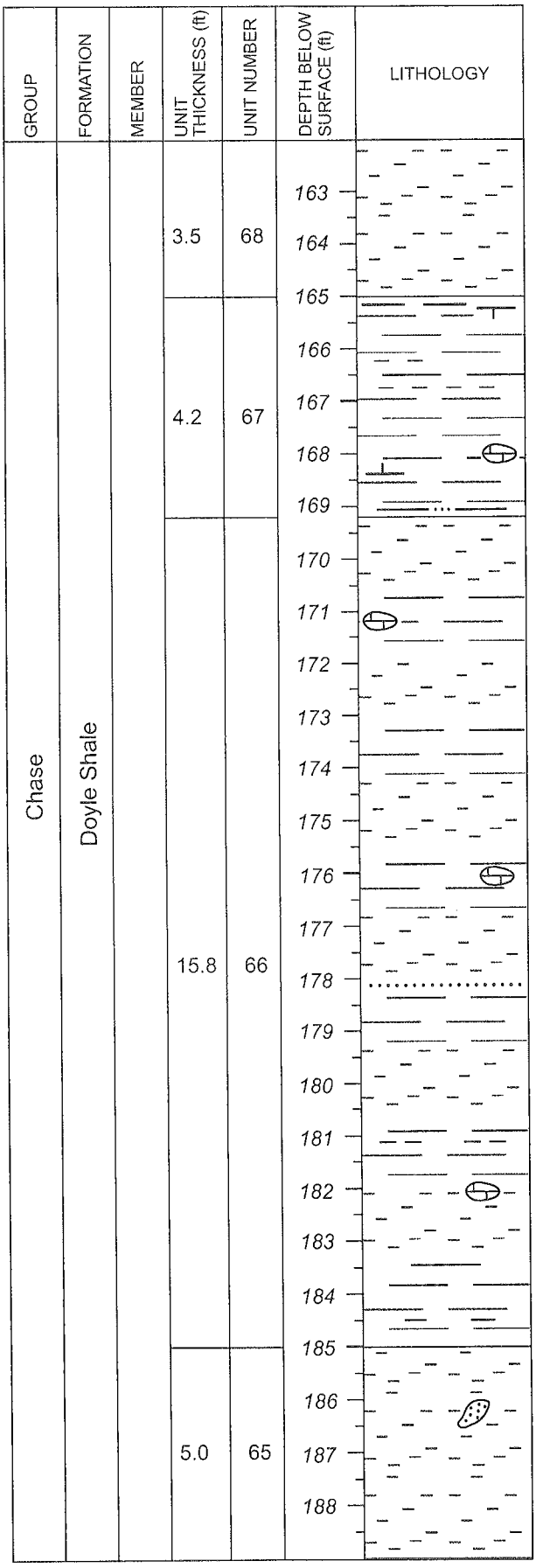
73. Mudstone, grayish-red, slightly calcareous; contains greenish-gray to light-gray, calcareous very fine grained sandstone and limestone nodules; some fracture surfaces slickensided

72. Mudstone, grayish-red, slightly sandy; includes nodules and stringers of calcareous, very fine grained sandstone

71. Mudstone, grayish-red; contains some scattered nodules of greenish-gray calcareous, very fine grained sandstone; includes some thin sandy intervals

70. Mudstone, predominantly greenish-gray to light-bluish-gray with some grayish-red mottling; scattered calcareous nodules common; fracture surfaces slickensided

69. Mudstone, grayish-red, moderately indurated; contains some slightly silty and sandy intervals; includes scattered calcareous nodules

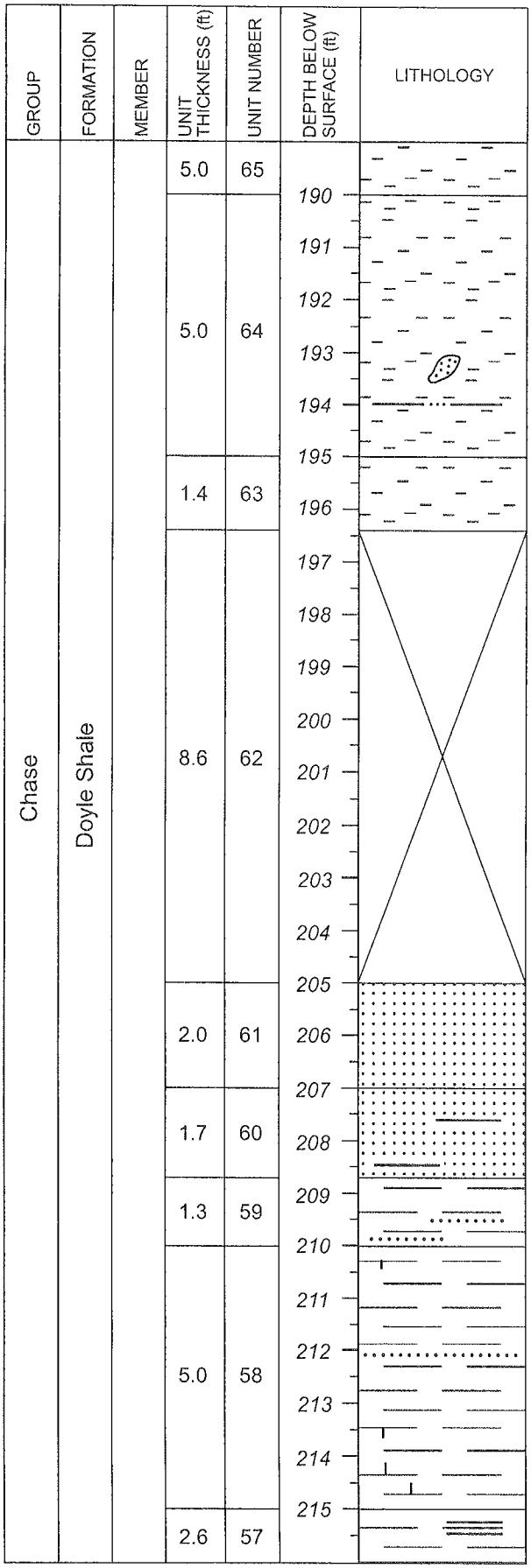


68. Mudstone, grayish-red, poorly indurated, wet, soft

67. Mudstone, mottled grayish-red, greenish-gray, light-bluish-gray, slightly calcareous; contains rare calcareous nodules; slightly silty at base

66. Mudstone, grayish-red to greenish-gray with calcareous nodules; contains stringers and lenses of very fine grained sandstone; poor core recovery

65. Mudstone, grayish-red, moderately indurated; includes scattered calcareous sandstone nodules



64. Mudstone, grayish-red; contains rare calcareous sandstone nodules; basal 1 ft slightly more silty; some fracture surfaces slickensided

63. Mudstone, grayish-red

62. Loss of core

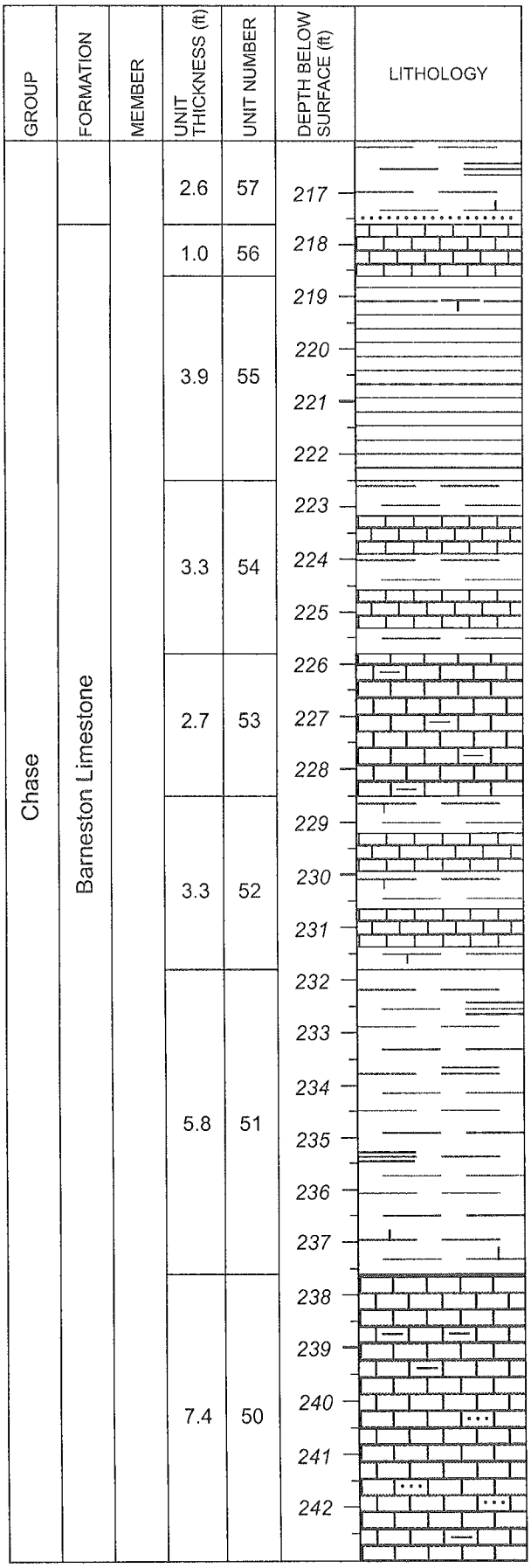
61. Sandstone, pale-red, yellowish-gray, light-greenish-gray, base grayish-yellow to dusky-yellow, very fine grained; burrowed; gastropodal

60. Sandstone, predominantly light-gray to light-olive-gray, very fine grained, lenticular; contains some medium-bluish-gray sandy shale; includes some very wispy bands of shale and sandstone

59. Shale, medium-bluish-gray; contains light-gray to light-olive-gray lenses of very fine grained sandstone

58. Shale, medium-bluish-gray; contains some slightly calcareous intervals; includes rare bands of very fine grained sandstone; very calcareous interval from 213.5 to 215.0 ft containing cross sections of shells; very gradational base

57. Shale, medium-bluish-gray to dark-gray; slightly fissile with very fine grained, medium-light-gray calcareous sandstone lenses; bioturbated; gradational base



BARNESTON LIMESTONE (35.2 ft)

56. Limestone, medium-light-gray to light-bluish-gray, medium-crystalline, fossiliferous with brachiopods, crinoid fragments, algally-coated grains, and ostracodes

55. Shale, dark-gray, fissile; slightly calcareous with shelly bands, especially at the top

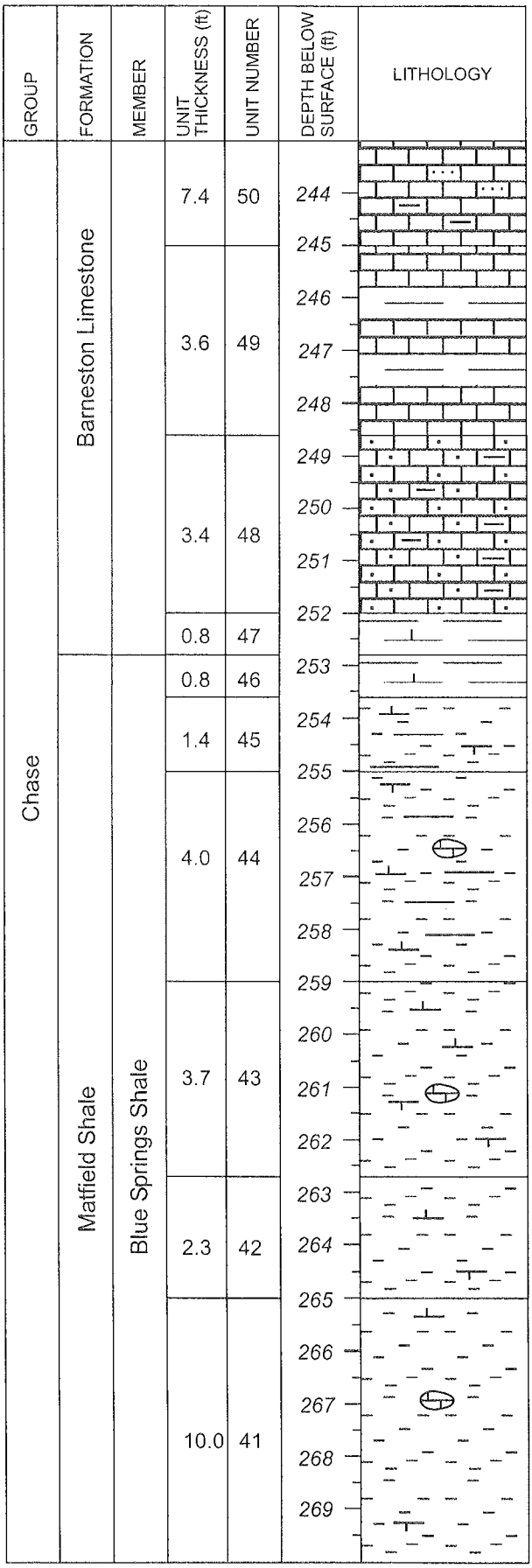
54. Shale, dark-gray alternating with medium-gray shelly bands of medium-crystalline limestone containing crinoid fragments; cross sections of large brachiopod shells filled with pink recrystallized calcite

53. Limestone, light-gray to light-bluish-gray, medium-crystalline, algal; fossiliferous with cross sections of large brachiopod shells; basal part coquinoid; contains numerous dark-gray shale stringers

52. Limestone, medium-light-gray to light-gray alternating with dark-gray to medium-bluish-gray calcareous, fossiliferous shale; limestone, medium-crystalline, fossiliferous with cross sections of large brachiopod shells filled with pink calcite; bioturbated; includes irregular to contorted bedding; contains some light-olive-brown algally coated-grains and fossil fragments

51. Shale, medium-dark-gray to dark-gray and medium-bluish-gray, dense, slightly fissile; calcareous at the base

50. Limestone, light-gray to light-bluish-gray, medium-crystalline, highly algal, crinoidal; contains some light-olive-gray lenses of burrowed, very fine grained sandstone; includes some shaly, highly algal limestone; contains some dark-gray to medium-dark-gray calcareous fossiliferous carbonaceous shale stringers and bands of osagid grains in lower part



49. Limestone, light-bluish-gray to light-gray, medium-crystalline, highly algal; contains some dark-gray carbonaceous shale stringers

48. Limestone, light-bluish-gray to light-gray, sandy, less algal than unit above; includes dark-gray carbonaceous, crinoidal-rich shale stringers

47. Shale, medium-dark-gray to dark-gray to medium-bluish-gray, highly calcareous; contains medium-light-gray limestone stringers; large algally coated grains common; gradational base

MATFIELD SHALE (89.3 ft)

Blue Springs Shale Member (50.8 ft)

46. Shale, medium-bluish-gray slightly mottled dark-reddish-brown, calcareous; gradational base

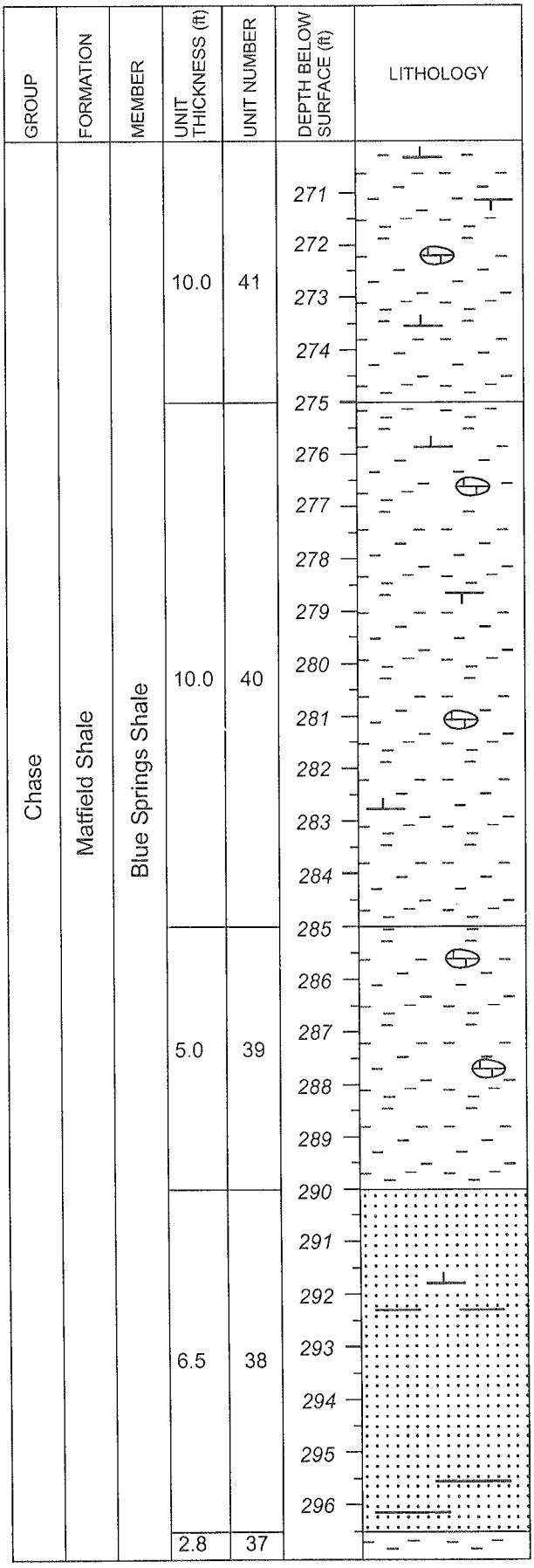
45. Mudstone, variegated medium-bluish-gray, dark-reddish-brown, dark-greenish-gray, calcareous; fracture surfaces slickensided

44. Mudstone, variegated medium-bluish-gray to grayish-red, calcareous; contains some scattered limestone nodules and very hard calcareous intervals; slickensided fracture surfaces common

43. Mudstone, slightly variegated but predominantly grayish-red to dark-reddish-brown with some medium-bluish-gray mottled intervals; very calcareous; includes scattered rare limestone nodules; some fracture surfaces slickensided

42. Mudstone, grayish-red, calcareous

41. Mudstone, grayish-red, calcareous; includes scattered limestone nodules and greenish-gray to light-bluish-gray mudstone chips; most fracture surfaces are slickensided; contains BB-size, very hard metallic-like spherical grains with white rims, especially at 271.0–273.0 ft

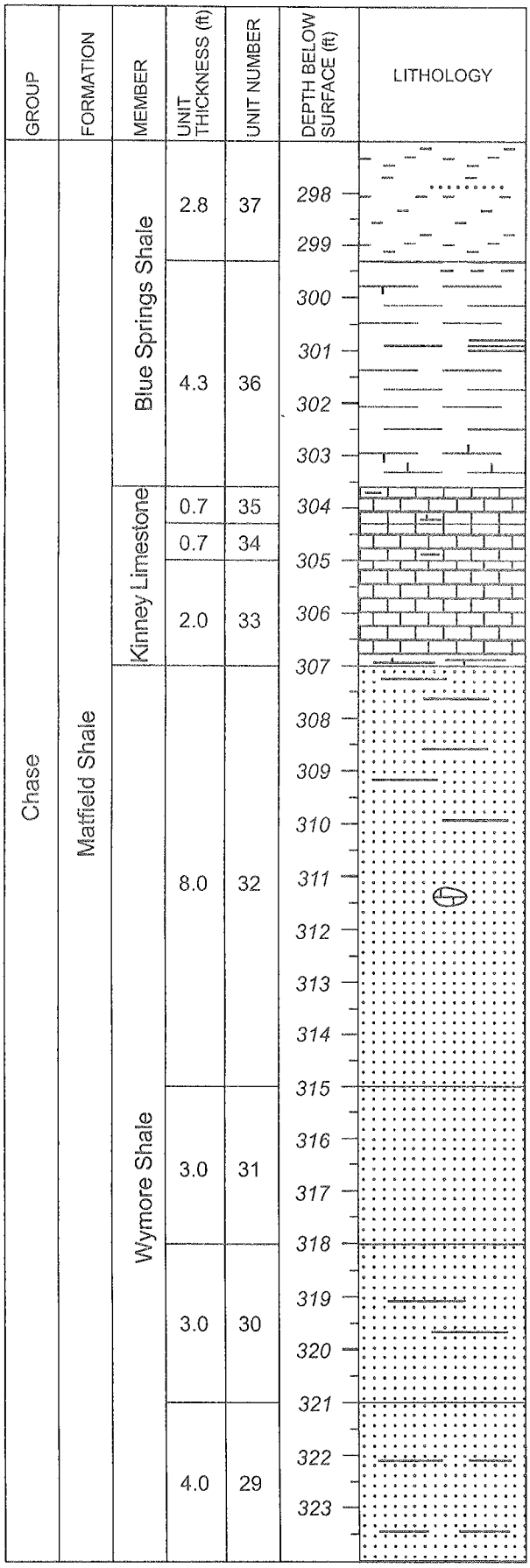


40. Mudstone, grayish-red, slightly to very calcareous; contains scattered limestone nodules, some very irregular in shape and up to 1 in. in diameter; includes some light-bluish-gray mottling; contains some BB-size metallic-like spherical grains

39. Mudstone, grayish-red to dark-reddish-brown; contains some light-bluish-gray, medium-bluish-gray to greenish-gray septarian-like calcareous sandstone nodules; fracture surfaces are slickensided

38. Sandstone, grayish-red, light-bluish-gray, very light gray to greenish-gray, very fine grained, slightly calcareous; includes intercalations of sandy mudstone; mudstone increases in lower part; bioturbated; contains some lenticular sandstone bands especially in mudstone-rich intervals; gradational base

37. Mudstone, grayish-red to pale-red; contains very thin light-gray, very fine grained lenticular sandstone laminae; slickensided fracture surfaces common; gradational base



36. Shale, light-bluish-gray to light-greenish-gray, upper few inches mottled grayish-red; slightly fissile; slightly calcareous at top to very calcareous in lower part; gradational base

Kinney Limestone Member (3.4 ft)

35. Limestone, shaly and calcareous shale, predominantly light-bluish-gray to medium-dark-gray; limestone, shaly, fossiliferous with crinoid fragments and algally coated grains; shale, calcareous, fossiliferous, slightly fissile; gradational base

34. Limestone, light-bluish-gray to light-gray, medium-crystalline, highly algal (*Osagia*), crinoidal, gastropodal; includes some stringers of dark-gray shale

33. Limestone, light-bluish-gray to light-gray, medium-crystalline with large fossil fragments, algal; lower part calcareous shale with irregular patches of light-olive-gray to yellowish-gray limestone; limestone breccia at base

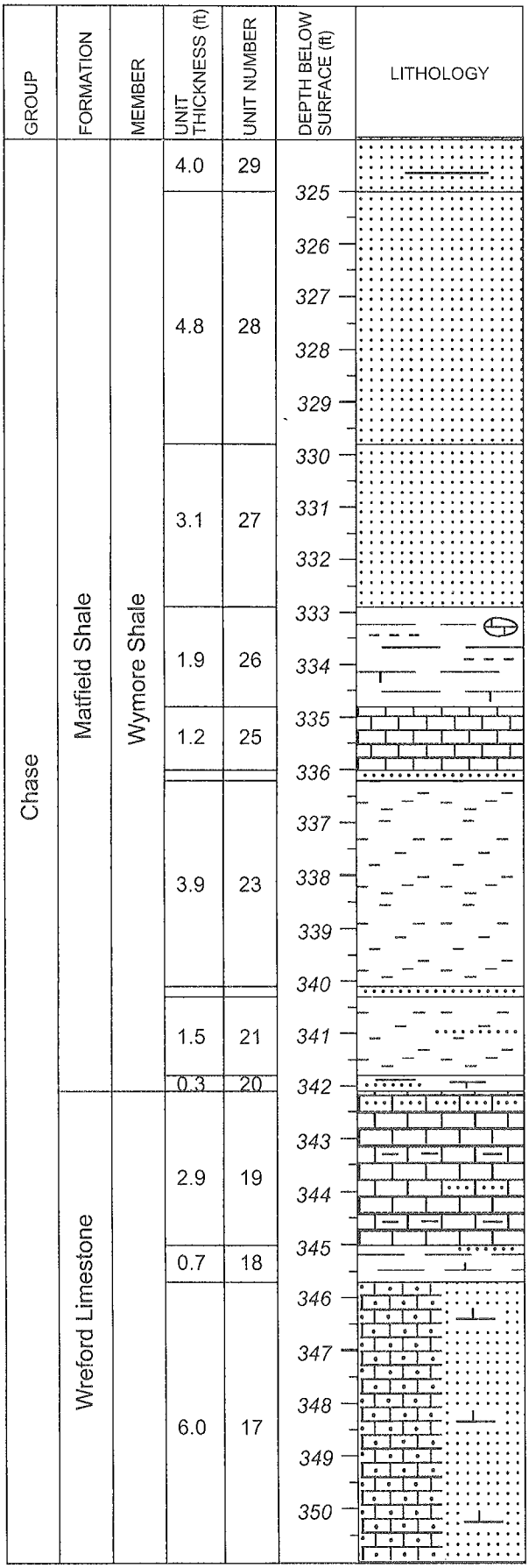
Wymore Shale Member (35.1 ft)

32. Sandstone, grayish-red with lenses of light-bluish-gray to light-gray sandstone, very fine grained; contains some sandy mudstone and shale intervals, especially at the top; includes small limestone nodules; contains some small crinoid fragments, especially between 312.0 and 315.0 ft; bioturbated

31. Sandstone, predominantly grayish-red to dark-reddish-brown with some light-bluish-gray mottled intervals, very fine grained to fine-grained, friable, micaceous

30. Sandstone, predominantly light-bluish-gray to light-gray with grayish-red mottled intervals, very fine grained to fine-grained; contains some cross-laminations; very thin stringers of medium-bluish-gray shale common

29. Sandstone, predominantly light-bluish-gray to light-gray with lenses of grayish-orange-pink sandstone, very fine grained to fine-grained, friable, cross-laminated; swirled bedding due to intensive bioturbation produces a clotted texture; some laminae display initial dip; contains stringers and laminations of medium-dark-gray to medium-gray carbonaceous material; very friable at base; some pale-yellow-orange stains



28. Sandstone, light-bluish-gray to medium-bluish-gray with grayish-orange-pink mottled intervals, fine-grained; includes some high-angle cross-laminations; contains intervals of brecciated or conglomeratic storm deposits; some intervals of medium-grained sandstone with very high angle cross-laminations; some laminations contain carbonaceous linings; upper 1 ft displays churned bedding due to intensive bioturbation; fracture surfaces lined with carbonaceous material; includes pyritic grains and vugs in middle of unit

27. Sandstone, top medium-bluish-gray to medium-dark-gray, lower part grayish-orange-pink with stringers of medium-bluish-gray sandstone; very fine grained to fine-grained with scattered layers of medium-grained sandstone; contains a storm deposit at base; fracture surfaces lined with carbonaceous material; includes some carbonaceous-rich laminae; pyrite grains throughout

26. Mudstone, mottled medium-bluish-gray, greenish-gray to grayish-red; slightly calcareous especially at the base with some limestone nodules at top; scattered fossil fragments of crinoids, especially common at the base

25. Limestone, yellowish-gray, very light gray to light-gray, stained moderate-yellowish-brown, medium-crystalline, algal, fossiliferous (crinoidal); mudstone at base; gradational base

24. Sandstone, greenish-gray to medium-bluish-gray with stringers of grayish-orange-pink, very fine grained, bioturbated

23. Shale, grayish-red with dusky-yellow to light-olive-brown stained intervals

22. Sandstone, light-olive-gray to light-brownish-gray with base stained moderate-yellowish-brown, very fine grained, bioturbated; sharp base

21. Shale, grayish-red, sandy; contains lenses of light-gray to very light-gray, very fine grained sandstone; includes some moderate-yellowish-brown stained intervals

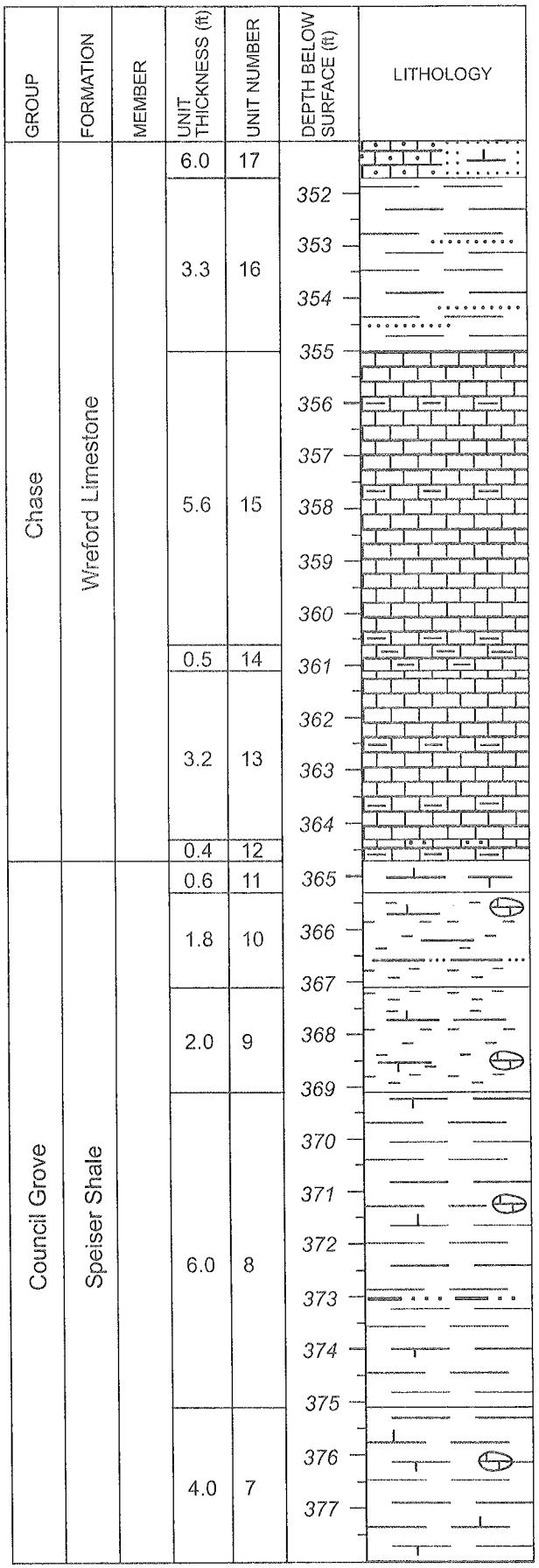
20. Mudstone and shale, light-bluish-gray to medium-bluish-gray with sandy laminae; base calcareous; sharp basal contact

WREFORD LIMESTONE (22.6 ft)

19. Limestone, light-bluish-gray to medium-light-gray, fine- to medium-crystalline, crinoidal, algal, sandy at top; contains stringers and clasts of greenish-gray to light-bluish-gray shale throughout; includes some carbonaceous shale; contains numerous sandy zones

18. Shale, medium-bluish-gray to medium-light-gray with slightly calcareous sandstone laminations; contains calcareous sandstone nodules, especially at the base

17. Limestone, light-bluish-gray to light-gray, finely crystalline, sandy; grades into calcareous sandstone; includes scattered laminae of medium-bluish-gray shale; appears silicified



16. Shale, light-bluish-gray to medium-bluish-gray with abundant very thin laminae and lenses of medium-bluish-gray to light-gray, very fine grained sandstone, especially common in lower 1.5 ft

15. Limestone, light-bluish-gray to medium-bluish-gray to light-gray, medium crystalline, algal; contains large algally coated grains; includes intervals of pink recrystallized calcite; contains stringers of medium-dark-gray, fossiliferous, carbonaceous shale; cross sections of gastropods and pelecypods common; some crinoid fragments; pitted surface

14. Limestone, medium-bluish-gray, very shaly; some calcareous shale

13. Limestone, bluish-white, light-bluish-gray, to very light-gray, fine- to medium-crystalline; basal 1 ft is finely crystalline; contains some large algally coated grains; includes numerous dark-gray carbonaceous shale stringers; some vugs filled with pink calcite; rare fossil molds; sharp basal contact

12. Limestone, medium-dark-gray to medium-gray, very shaly, slightly sandy; bioturbated; contains cross sections of brachiopod shells

COUNCIL GROVE GROUP

SPEISER SHALE (40.4 ft)

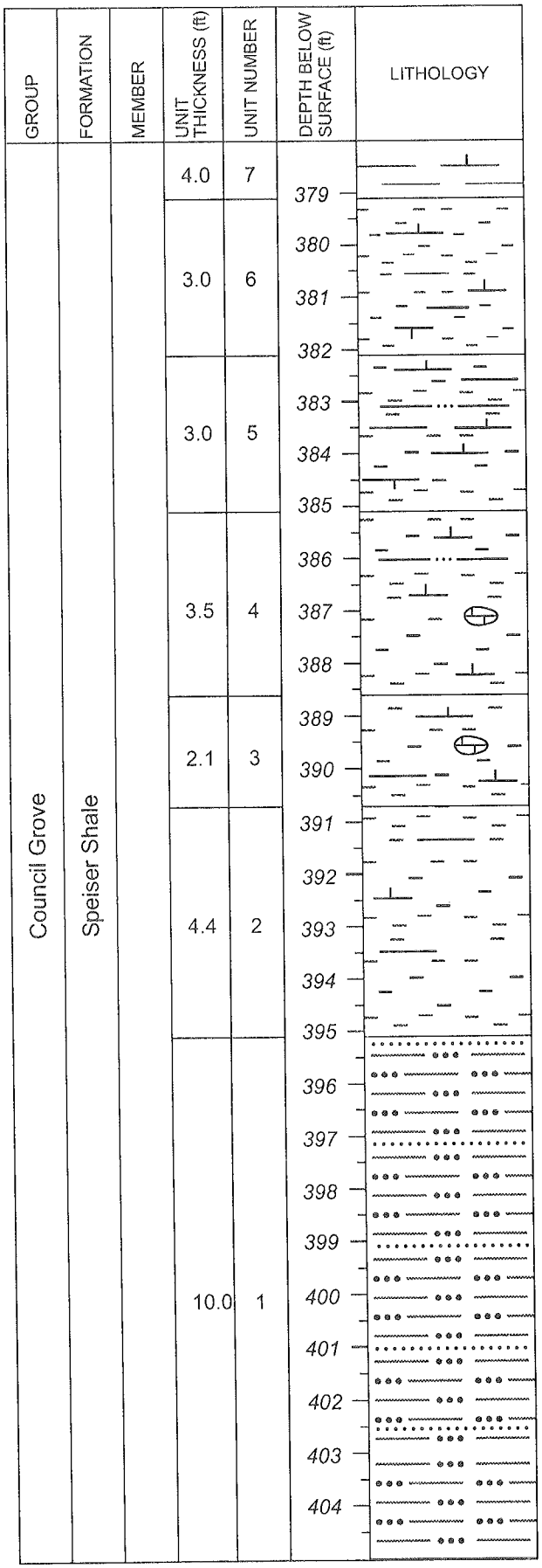
11. Mudstone, medium-bluish-gray; slightly calcareous to very calcareous in intervals containing limy stringers

10. Mudstone, mottled light-bluish-gray to pale-red, slightly calcareous, silty; contains scattered limestone nodules

9. Mudstone, light-bluish-gray to pale-red and pinkish-gray, calcareous; limestone nodules common

8. Mudstone, light-bluish-gray with some pale-red mottling, calcareous; contains pinkish-gray limestone nodules up to 2 in. in diameter; silty; fracture surfaces slickensided

7. Mudstone, predominantly light-bluish-gray to medium-bluish-gray with some grayish-red mottling, very calcareous; includes very abundant light-bluish-gray to light-gray limestone nodules; fracture surfaces slickensided



6. Mudstone, light-bluish-gray, medium-bluish-gray, grayish-red, very calcareous; limestone granules very abundant throughout; fracture surfaces are slickensided

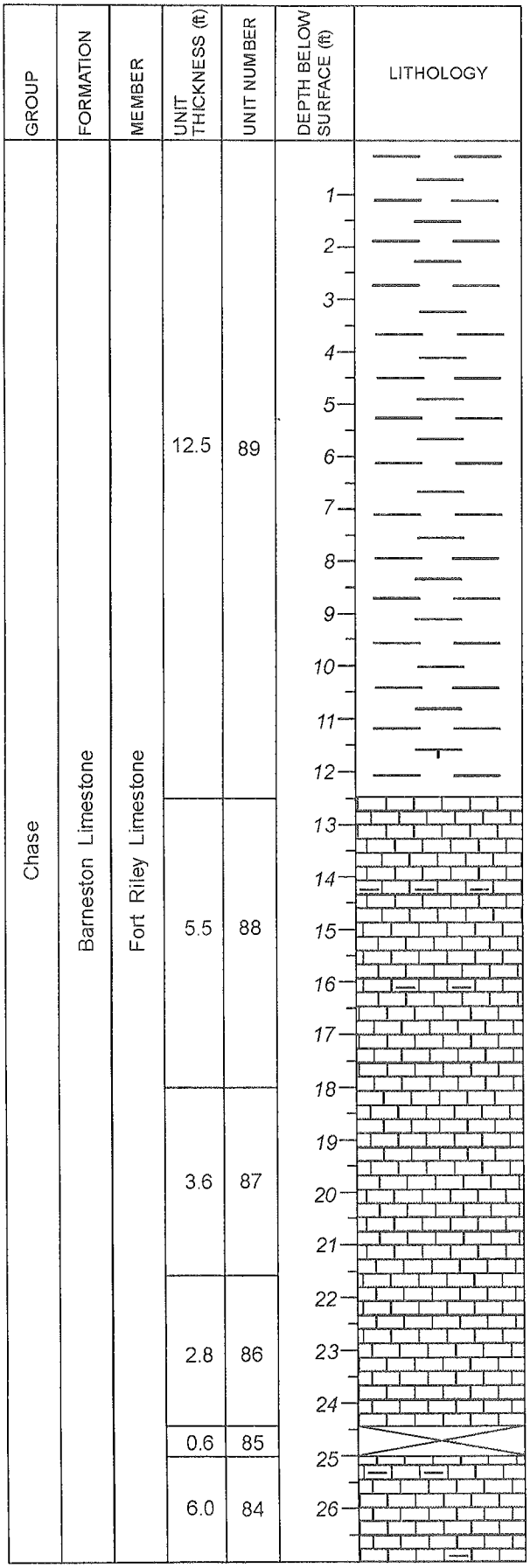
5. Mudstone, highly mottled, light-bluish-gray, medium-bluish-gray, grayish-red, very calcareous, silty; contains scattered limestone granules; fracture surfaces slickensided

4. Mudstone, grayish-red mottled light-bluish-gray to medium-bluish-gray, very calcareous; contains scattered limestone nodules, silty

3. Mudstone, grayish-red with some intervals of medium-bluish-gray to light-bluish-gray, calcareous; includes scattered limestone nodules

2. Mudstone, grayish-red with minor intervals of light-bluish-gray to medium-bluish-gray, sandy, slightly calcareous to non-calcareous; includes scattered limestone nodules

1. Siltstone, pale-red to grayish-red, sandy; contains limestone granules in basal 6 ft; contains some intervals of sandy or silty mudstone; some fracture surfaces slickensided



Core Hole KC-6
LARCHEY PIT

NE¼SW¼SE¼SW¼ sec. 35, T. 28 N., R. 3 E., Uncas Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 500 ft from south line (FSL) and 1,700 ft from west line (FWL). Surface elevation from altimeter, 1,221 ft. Spudded in the transitional beds at the top of the Barneston Limestone and base of the Doyle Shale. Field lithologic descriptions by James R. Chaplin.

CHASE GROUP (151.0 ft)

BARNESTON LIMESTONE (37.0 ft)

Fort Riley Limestone Member (31.0 ft)

Unit no.

89. Clay, moderate-brown, light-brown, and grayish-brown, very sticky, slightly calcareous at base; sharp base

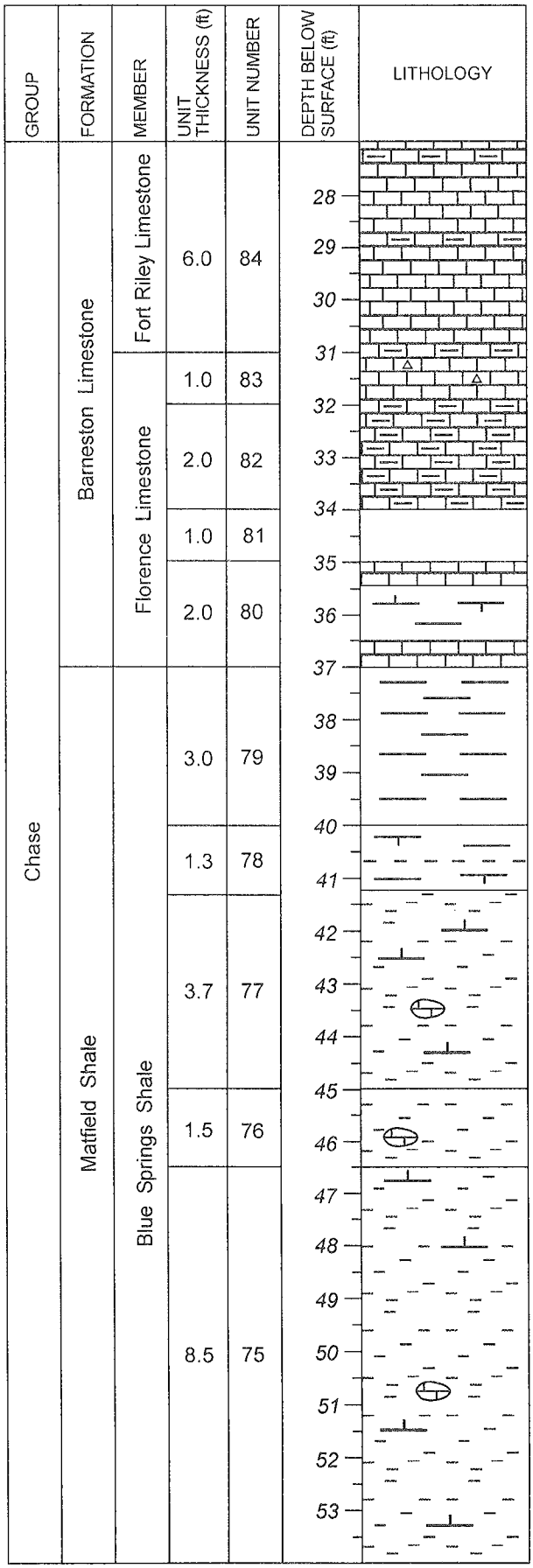
88. Limestone, light-bluish-gray to light-gray with grayish-orange staining, medium-crystalline, highly algal with large limonitic osagid grains; includes scattered very thin shale partings

87. Limestone, light-bluish-gray to light-gray, medium-crystalline, highly algal with grains having limonitic coatings; contains algal-coated fossil fragments

86. Limestone, very light gray, medium-crystalline, vuggy; contains some large algal biscuits (oncolities)

85. Loss of core

84. Limestone, light-bluish-gray to very light gray, fine- to medium-crystalline, algal; includes some limonitic staining; contains wavy, very thin light-olive-gray shale partings; surface pitted



Florence Limestone Member (6.0 ft)

83. Limestone, light-bluish-gray, finely crystalline, slightly algal and cherty; surface pitted

82. Limestone, light-bluish-gray to very light gray, finely crystalline, shaly, very crinoidal; very punky

81. Loss of core

80. Limestone and shale; limestone, medium-bluish-gray, fine- to medium-crystalline, highly algal with large algal coated grains (osagid grains); shale, medium-dark-gray, calcareous, contains scattered very irregular shale partings between limestone beds; includes some algal-coated fossil fragments; sharp but irregular base

MATFIELD SHALE (81.4 ft)

Blue Springs Shale Member (57.3 ft)

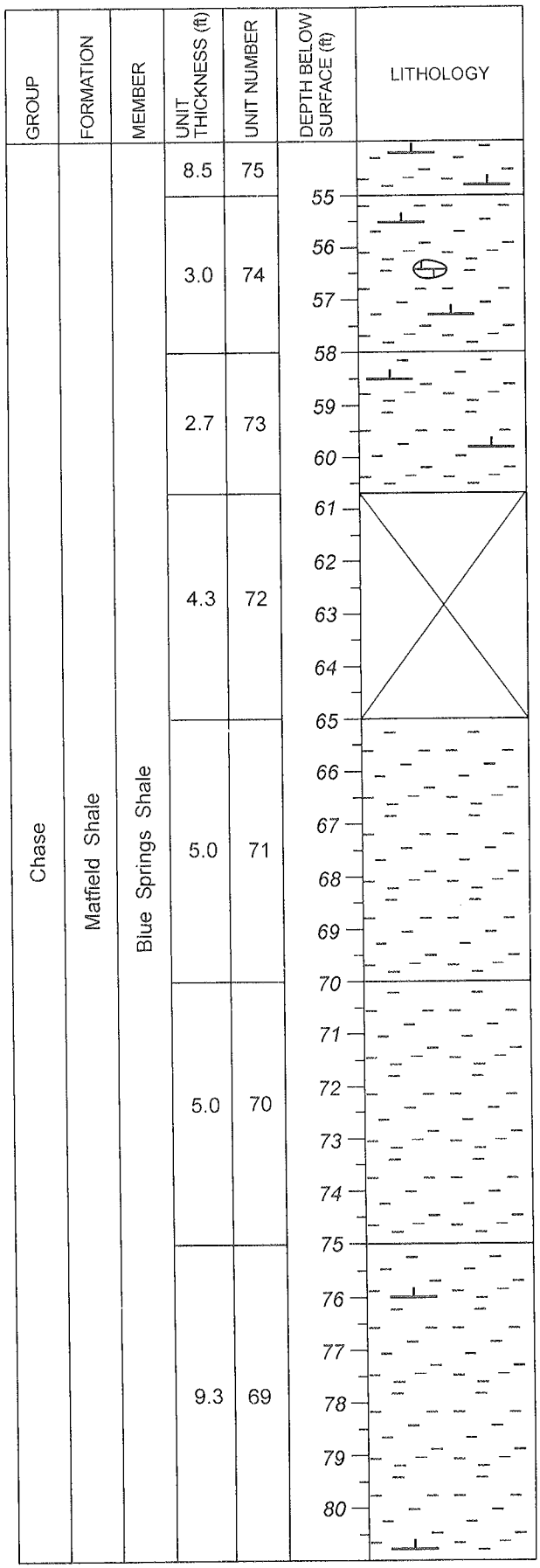
79. Mudstone, medium-bluish-gray to medium-dark-gray; contains scattered limestone granules

78. Mudstone, medium-bluish-gray to medium-dark-gray with intervals of grayish-red, calcareous; contains scattered limestone granules

77. Mudstone, grayish-red, calcareous; contains small limestone nodules

76. Mudstone, grayish-red to dark-reddish-brown; includes scattered limestone nodules

75. Mudstone, dark-reddish-brown to grayish-red, calcareous; contains scattered limestone nodules that decrease in lower 5 ft



74. Mudstone, dark-reddish-brown, calcareous; includes rare limestone nodules

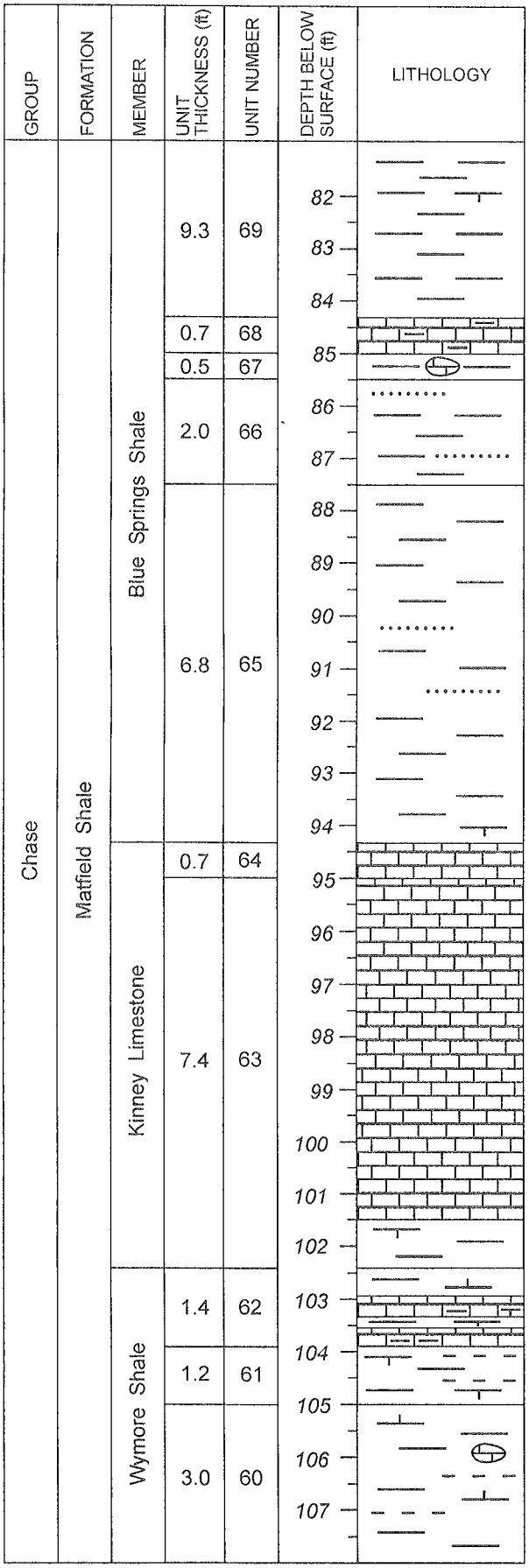
73. Mudstone, dark-reddish-brown, calcareous; very clay-rich and soft

72. Loss of core

71. Mudstone, dark-reddish-brown with mottled intervals of medium-bluish-gray mudstone; slickensided fracture surfaces common

70. Mudstone, dark-reddish-brown with some intervals mottled medium-bluish-gray

69. Mudstone, dark-reddish-brown, upper part; lower part greenish-gray, slightly calcareous



68. Limestone, light-olive-gray to greenish-gray, mottled dusky-yellow, finely crystalline, shaly

67. Shale and mudstone, dusky-yellow, light-olive-brown, medium-bluish-gray, and light-bluish-gray; contains nodules and lenses of medium crystalline, algal limestone

66. Mudstone, light-bluish-gray and medium-bluish-gray mottled dusky-yellow at top; contains lenses of light-bluish-gray to light-gray very fine to fine-grained sandstone

65. Shale, light-bluish-gray to medium-bluish-gray; basal 0.3 ft calcareous; contains some very thin stringers of light-bluish-gray to light-gray, very fine grained sandstone

Kinney Limestone Member (8.1 ft)

64. Limestone, bluish-white to light-bluish-gray, fine- to medium-crystalline, highly algal with large algal-coated grains and fossil fragments; base contains wavy stringers of dark-gray mudstone; sharp base

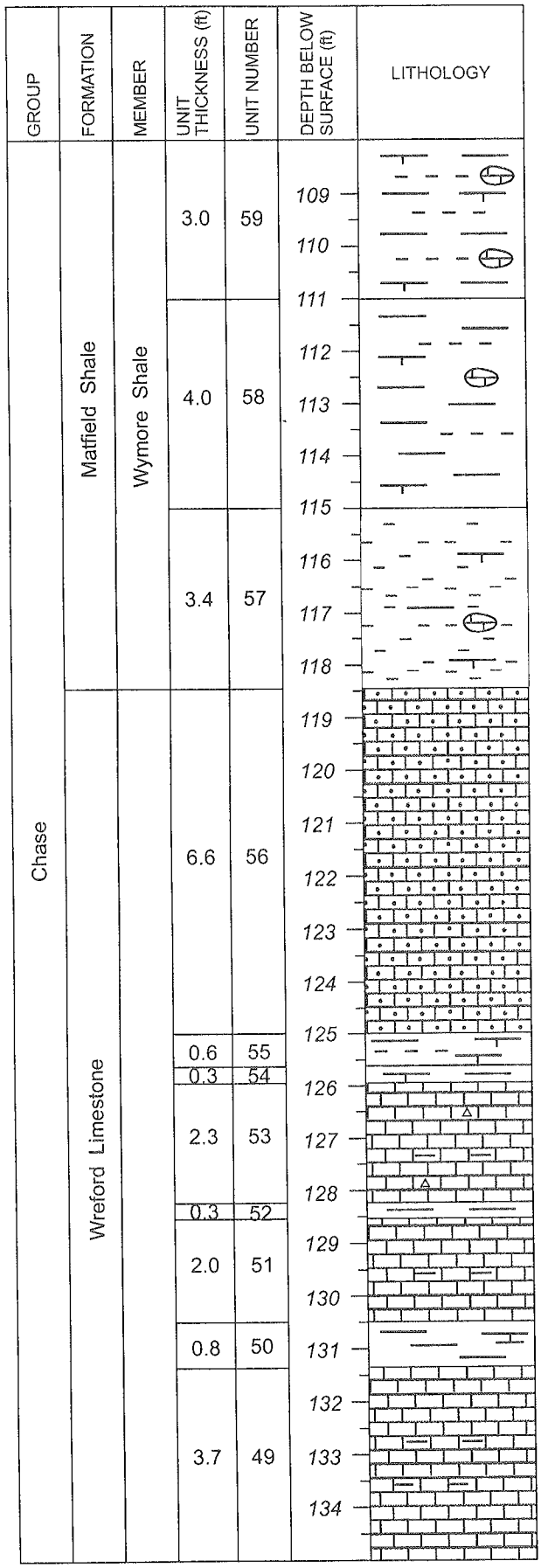
63. Limestone, light-bluish-gray to medium-light-gray, medium-crystalline, highly algal (*Osagia*); includes some algal-coated fossil fragments; contains large cross sections of fossil fragments; wavy stringers of dark-gray to medium-dark-gray, calcareous shale common, especially near base

Wymore Shale Member (16.0 ft)

62. Shale and shaly limestone, medium-bluish-gray to light-bluish-gray, very calcareous, pyritic

61. Mudstone and shale, mottled light-bluish-gray to dark-reddish-brown, calcareous

60. Mudstone, mottled dark-reddish-brown and greenish-gray, calcareous; contains scattered limestone nodules; fracture surfaces slickensided



59. Mudstone, mottled medium-bluish-gray and dark-reddish-brown, calcareous; includes abundant limestone nodules

58. Mudstone, mottled medium-bluish-gray and dark-reddish-brown, calcareous; contains rare limestone nodules

57. Mudstone, dark-reddish-brown with medium-bluish-gray mottling, calcareous; contains vertical fractures filled with medium-bluish-gray mudstone; includes scattered limestone nodules

WREFORD LIMESTONE (32.6 ft)

56. Limestone, grayish-pink to pinkish-gray stained moderate yellowish-brown, sandy; upper 0.6 ft brecciated; algal; contains stringers of dark-reddish-brown to very dusky red mudstone in lower 2 ft; vertical fractures common; surface pitted

55. Shale and mudstone, mottled dusky-red and greenish-gray, calcareous; contains small limestone nodules

54. Shale and mudstone, greenish-gray, calcareous; includes some very small light gray to very light gray limestone nodules

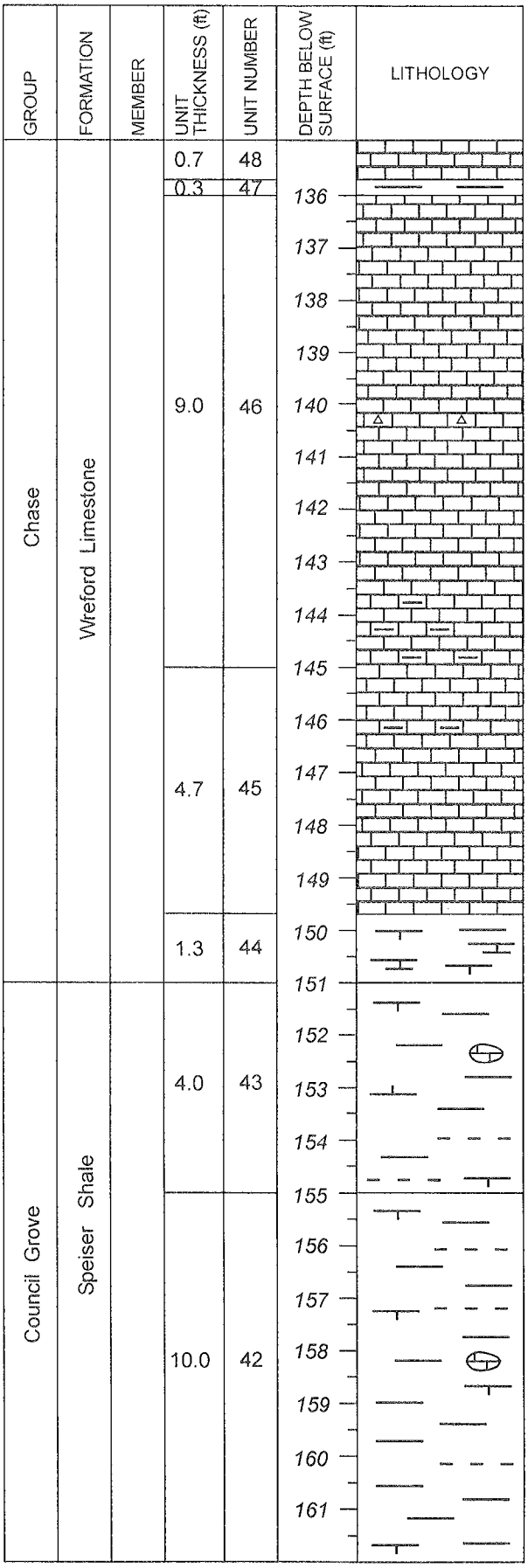
53. Limestone, bluish-white to very light gray, fine- to medium-crystalline, algal, fossiliferous, slightly cherty; contains wavy stringers of light-olive-gray to greenish-gray shale

52. Shale, dark-greenish-gray with lenses of bluish-white limestone

51. Limestone, bluish-white to very light gray, fine- to medium-crystalline, algal, fossiliferous; contains stringers of dark-greenish-gray shale

50. Shale, dark-greenish-gray to greenish-black; contains lenses of bluish-white limestone

49. Limestone, bluish-white, fine- to medium-crystalline, algal, fossiliferous; contains stylolitic seams and partings of dark-greenish-gray shale



48. Limestone, bluish-white, fine- to medium-crystalline, algal, fossiliferous; includes some partings of dark-greenish-gray shale

47. Shale, dark-greenish-gray with bluish-white, algal, fossiliferous limestone lenses

46. Limestone, bluish-white, medium-crystalline, algal; contains cross sections of large brachiopod valves; includes scattered wavy partings of dark-greenish-gray to dark-gray shale, especially at base; rare chert bands near middle of unit

45. Limestone, light-bluish-gray to medium-gray, fine- to medium-crystalline, algal; contains large spar-filled brachiopod shells; includes wavy partings of dark-greenish-gray to dark-gray shale

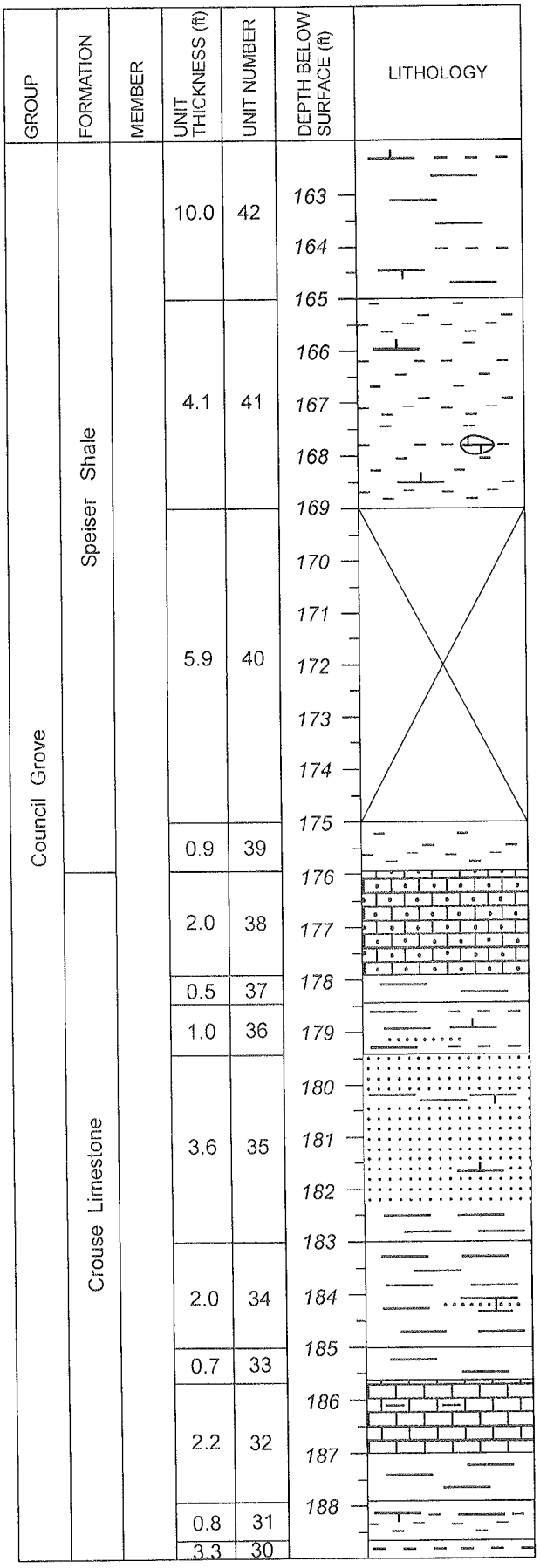
44. Shale and limestone; shale, olive-black to greenish-black, calcareous; limestone, light-bluish-gray to light-gray, fine- to medium-crystalline lenses and nodules; very fossiliferous, especially brachiopod fragments; algal, very wavy bedding, and mottled texture

COUNCIL GROVE GROUP (121.1 ft)

SPEISER SHALE (24.9 ft)

43. Mudstone, medium-bluish-gray to greenish-gray mottled in lower 1 ft to grayish-red, calcareous; contains scattered small limestone nodules

42. Mudstone, mottled medium-bluish-gray and dark-reddish-brown, slightly calcareous; contains rare limestone nodules; fracture surfaces slickensided



41. Mudstone, dark-reddish-brown, slightly calcareous; includes rare limestone nodules

40. Loss of core

39. Mudstone, very dusky-red-purple to grayish-red-purple; contains pinkish-gray to pale-purple sandy limestone clasts

CROUSE LIMESTONE (34.9 ft)

38. Limestone, pinkish-gray to very light gray, finely crystalline, very sandy; contains wavy partings and fractures filled with greenish-gray to dusky-red shale; bioturbated with churned bedding in shales

37. Mudstone, greenish-gray stained dusky-yellow to moderate-yellow; contains large very light-gray to light-gray calcareous sandstone and sandy limestone clasts

36. Mudstone and shale; shale, greenish-gray; mudstone, dusky-red; slightly calcareous; contains some dusky-yellow to moderate-yellow mottling; includes scattered sandy limestone stringers and clasts

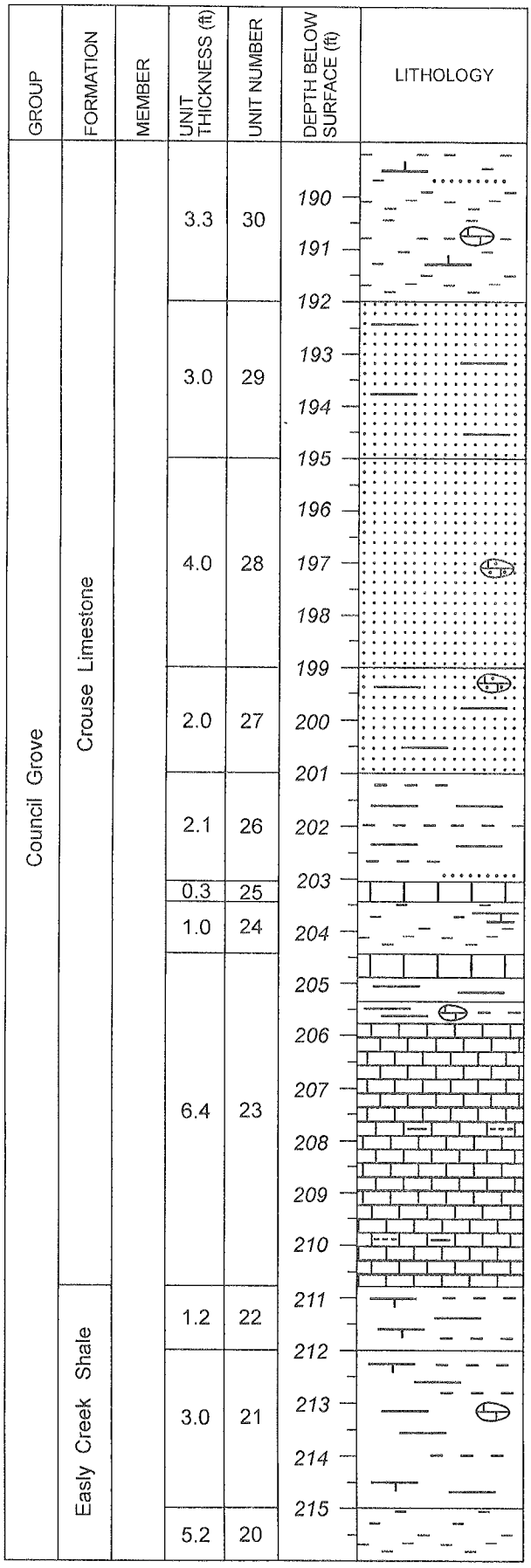
35. Sandstone, grayish-red, very fine grained, fossiliferous, calcareous; contains numerous intervals of greenish-gray shale which is bioturbated and exhibits churned bedding; shale increases in lower part; includes fractures filled with shale

34. Shale, greenish-gray with lenses and stringers of very light gray to light-gray sandy limestone; nodular bedding

33. Shale and mudstone, greenish-gray

32. Limestone, pale-purple to pale-pink, finely crystalline, nodular; contains medium-bluish-gray, greenish-gray, dusky-yellow and pale-red wavy shale stringers; becomes very shaly at base

31. Mudstone, grayish-red-purple to dark-greenish-yellow, calcareous; contains algal limestone nodules



30. Mudstone, grayish-red to dark-reddish-brown, calcareous; contains large yellowish-gray to light-greenish-gray, algal, finely crystalline limestone nodules; slightly sandy

29. Sandstone, grayish-red, very fine grained, shaly, cross-laminated

28. Sandstone, grayish-red, very fine grained, excellent cross-laminations; contains some thin intervals of mud-chip conglomerate; includes small sandy limestone nodules varying from light-olive-gray to greenish-gray; bioturbated

27. Sandstone, grayish-red, very fine grained, very shaly; mudstone lenses more common than in overlying unit; contains some large sandy limestone nodules

26. Mudstone, grayish-red, medium-bluish-gray and greenish-gray; contains thin lenses of grayish-red, very fine grained sandstone; base mottled dusky-yellow to light-olive

25. Limestone, pale-red-purple, finely crystalline, algal; brecciated texture; matrix consists of grayish-red, very fine grained sandstone

24. Mudstone, grayish-red to dark-reddish-brown; contains brecciated intervals of pale-pink, finely crystalline limestone

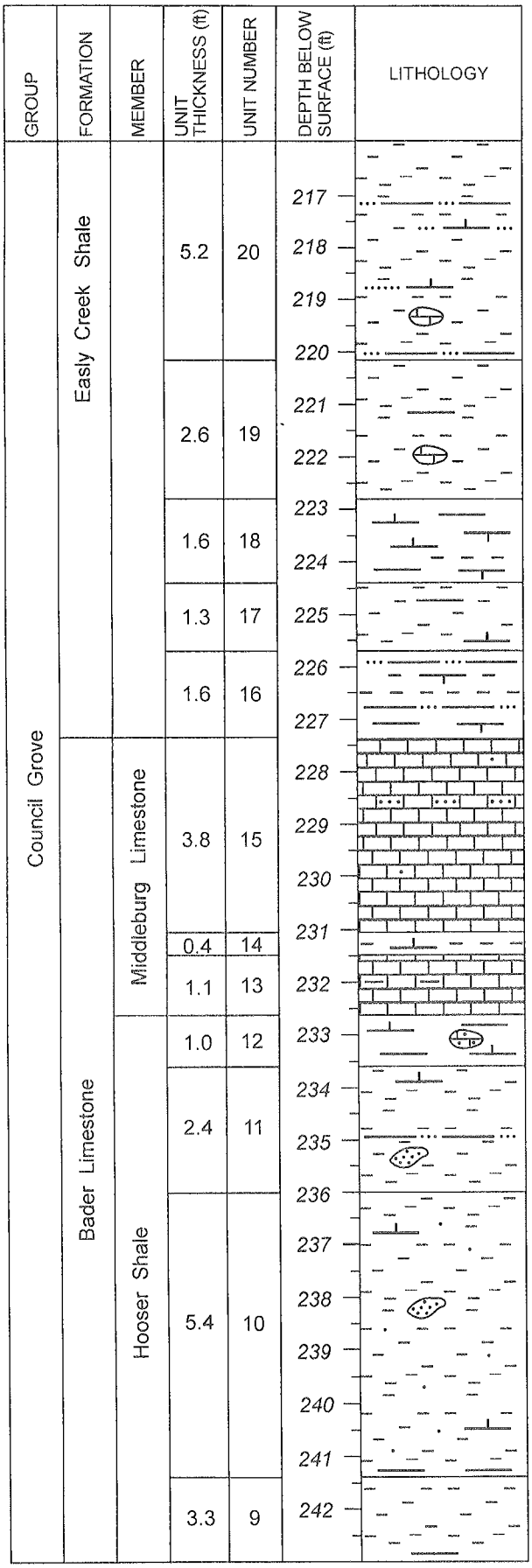
23. Limestone, white to very light gray, finely crystalline, fossiliferous with gastropods; contains very large algal-coated grains, especially in intervals with stringers of greenish-gray shale at the top of unit; includes some intervals of greenish-gray, grayish-red, dusky-yellow, and light-olive-gray wavy shale partings containing limestone nodules

EASLY CREEK SHALE (16.5 ft)

22. Mudstone, medium-bluish-gray with mottled intervals of dark-reddish-brown, calcareous

21. Mudstone, mottled medium-bluish-gray to dark-reddish-brown, calcareous; contains rare limestone nodules

20. Mudstone, dark-reddish-brown to grayish-red, silty; includes scattered limestone nodules; contains greenish-gray to medium-bluish-gray calcareous sandstone lenses throughout; some sandy beds cross-laminated



19. Mudstone, dark-reddish-brown to pale-red mottled medium-bluish-gray; contains rare small limestone nodules

18. Mudstone, medium-bluish-gray, very calcareous; contains some mottled intervals of dark-reddish-brown mudstone

17. Mudstone, dark-reddish-brown with some medium-bluish-gray mottling; slightly calcareous

16. Siltstone and mudstone, dark-reddish-brown mottled medium-bluish-gray, calcareous; includes some light-bluish-gray mudstone at base

BADER LIMESTONE (22.4 ft)

Middleburg Limestone Member (5.3 ft)

15. Limestone, bluish-white to light-bluish-gray with intervals of pale-red, finely crystalline, algal, mottled texture; top brecciated; slightly sandy; contains veinlets and fractures filled with greenish-gray mudstone

14. Mudstone, dark-reddish-brown, calcareous; contains some limestone nodules

13. Limestone, pinkish-gray to white, finely crystalline, algal; contains greenish-gray wavy shale stringers

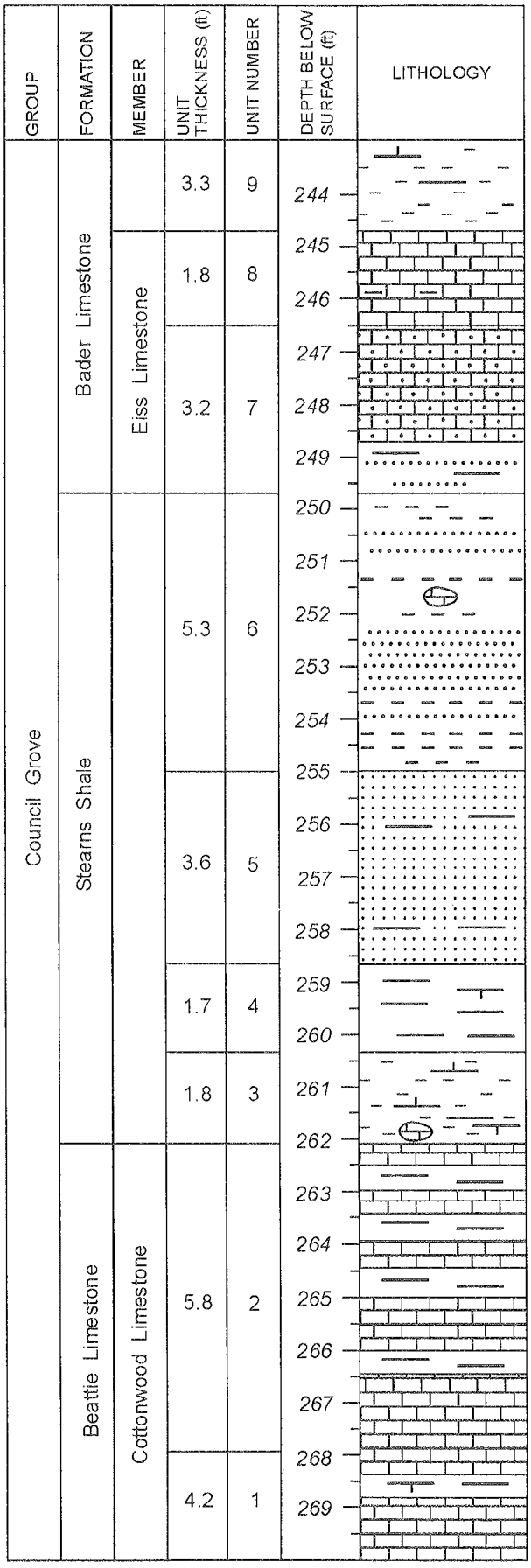
Hooser Shale Member (12.1 ft)

12. Mudstone, greenish-gray to light-bluish-gray with dusky-yellow stains, calcareous; includes some scattered sandy limestone and calcareous sandstone nodules

11. Mudstone, dark-reddish-brown, slightly calcareous, silty; contains some small calcareous sandstone nodules

10. Mudstone, grayish-red, slightly calcareous, sandy; contains light-olive-gray to greenish-gray very fine grained sandstone nodules and veinlets; includes some medium-bluish-gray mottled intervals at the base; fracture surfaces slickensided

9. Mudstone, grayish-red with some medium-bluish-gray to greenish-gray mottling; contains dusky-yellow stained slickensided fracture surfaces in the lower part; includes some rare calcareous intervals



Eiss Limestone Member (5.0 ft)

8. Limestone, bluish-white to light-bluish-gray, dry surface chalky white, finely crystalline, algal; contains stringers and veinlets of light-olive-gray to greenish-gray mudstone

7. Limestone, grayish-pink to grayish-orange-pink, finely crystalline, algal, sandy; grayish-red and pale-red very fine grained sandstone and sandy mudstone stringers common; shaly sandstone stringers in lower part produce a clotted texture with large algal coated grains floating in the matrix; dusky-yellow to light-olive-brown staining common throughout; sharp base

STEARNS SHALE (12.4 ft)

6. Sandstone and mudstone; sandstone, greenish-gray, very fine grained, wavy bedding to cross-laminated; mudstone, grayish-red, sandy; contains rare small grayish-pink limestone nodules

5. Sandstone, pale-red to grayish-red, very fine grained, cross-laminated; contains light-bluish-gray to greenish-gray mudstone lenses and stringers throughout

4. Mudstone, light-bluish-gray to greenish-gray, slightly calcareous; fracture surfaces slickensided

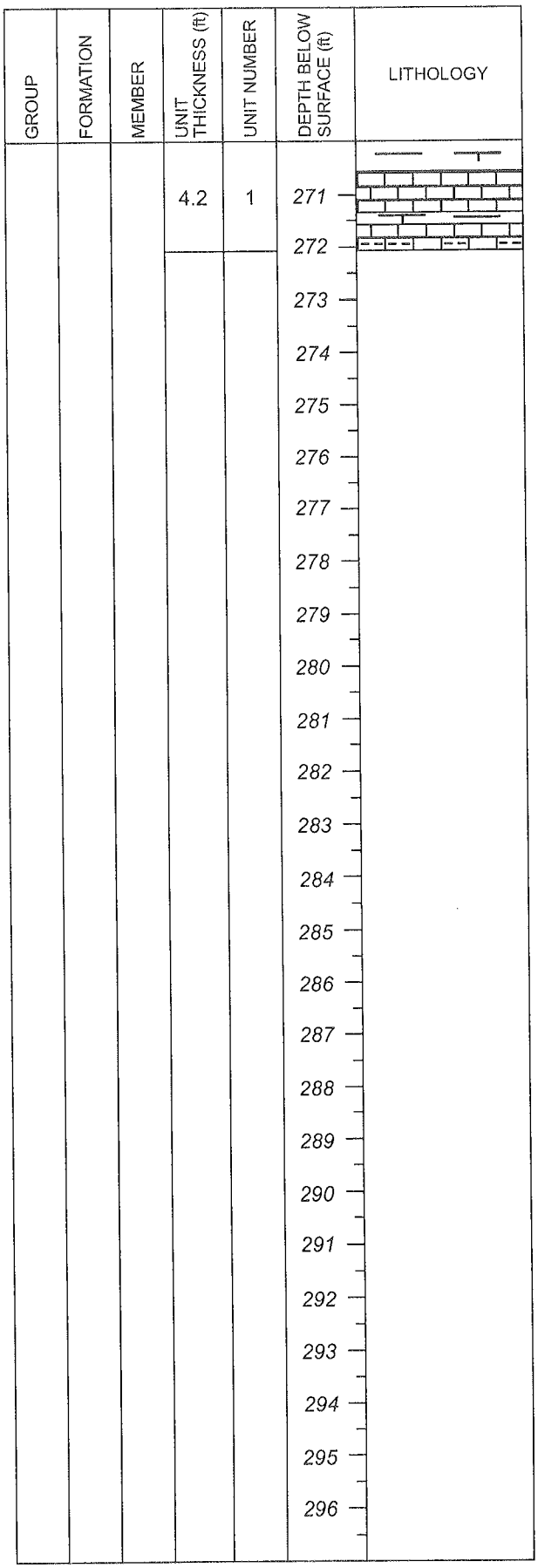
3. Mudstone and shale, variegated light-bluish-gray, grayish-red, and moderate-olive-brown, calcareous; base with pale-red limestone nodules and is more calcareous

BEATTIE LIMESTONE (10.0 ft)

Cottonwood Limestone Member (10.0 ft)

2. Limestone, bluish-white, finely crystalline, algal, fusulinids; contains light-olive-gray, greenish-gray, and dark-greenish-gray shale partings; algal grains concentrated into local intervals; upper 1 ft appears silicified; includes some bird's-eye vugs

1. Limestone, bluish-white to very light gray, finely crystalline; some intervals appear nodular; contains light-olive-gray to greenish-gray calcareous mudstone partings and stringers; lower part mottled pale-red


GROUP
FORMATION
MEMBER
UNIT THICKNESS (ft)
UNIT NUMBER
DEPTH BELOW SURFACE (ft)
LITHOLOGY
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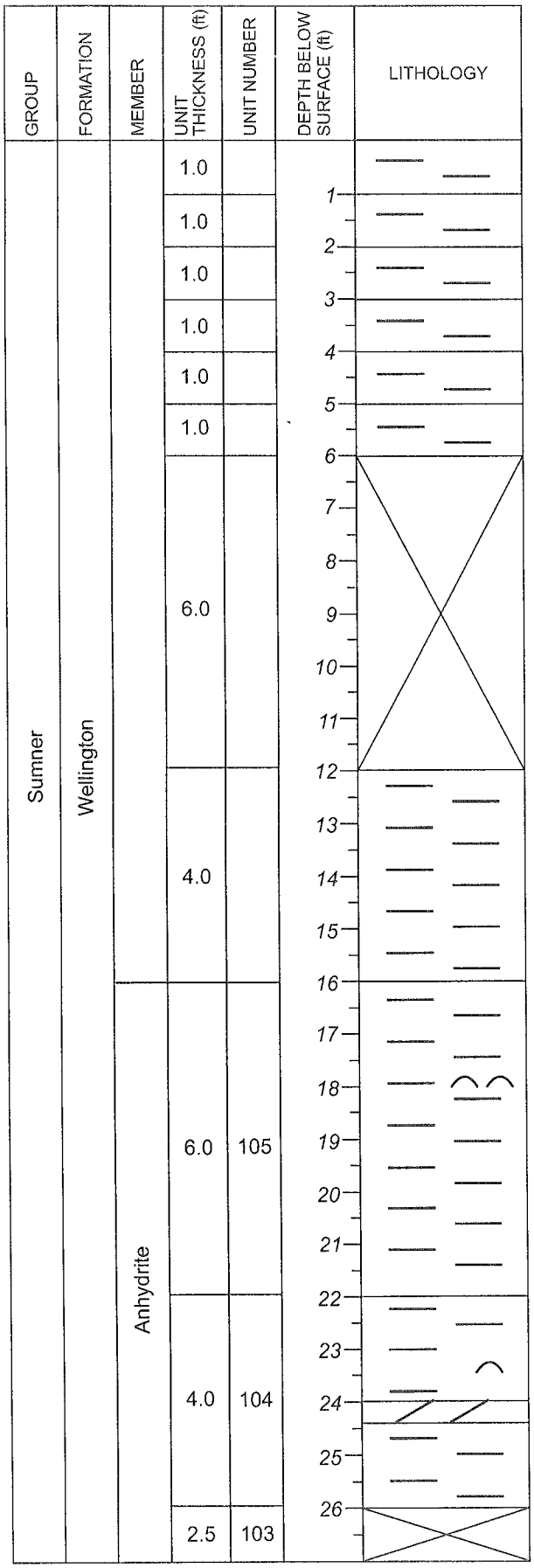


Core Hole KC-7
DUCK CREEK

SW¼NW¼NE¼SW¼ sec. 1, T. 27 N., R. 1 E., Newkirk SW Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 2,200 ft from south line (FSL) and 1,600 ft from west line (FWL). Surface elevation from altimeter, 1,079 ft. Spudded in the upper part of the Anhydrite Member of the Wellington Formation. Field lithologic descriptions by James R. Chaplin.

SUMNER GROUP

WELLINGTON FORMATION (169.0 ft)

Soil and clay mixture, grayish-black with some rootlets

Clay, brownish-black to grayish-black, slightly plastic

Clay, olive-gray to brownish-gray, slightly sticky

Clay, light-olive-gray to brownish-gray, sticky

Clay, light-brownish-gray to brownish-gray, very plastic and sticky

Clay, pale-yellowish-brown, plastic

Loss of core

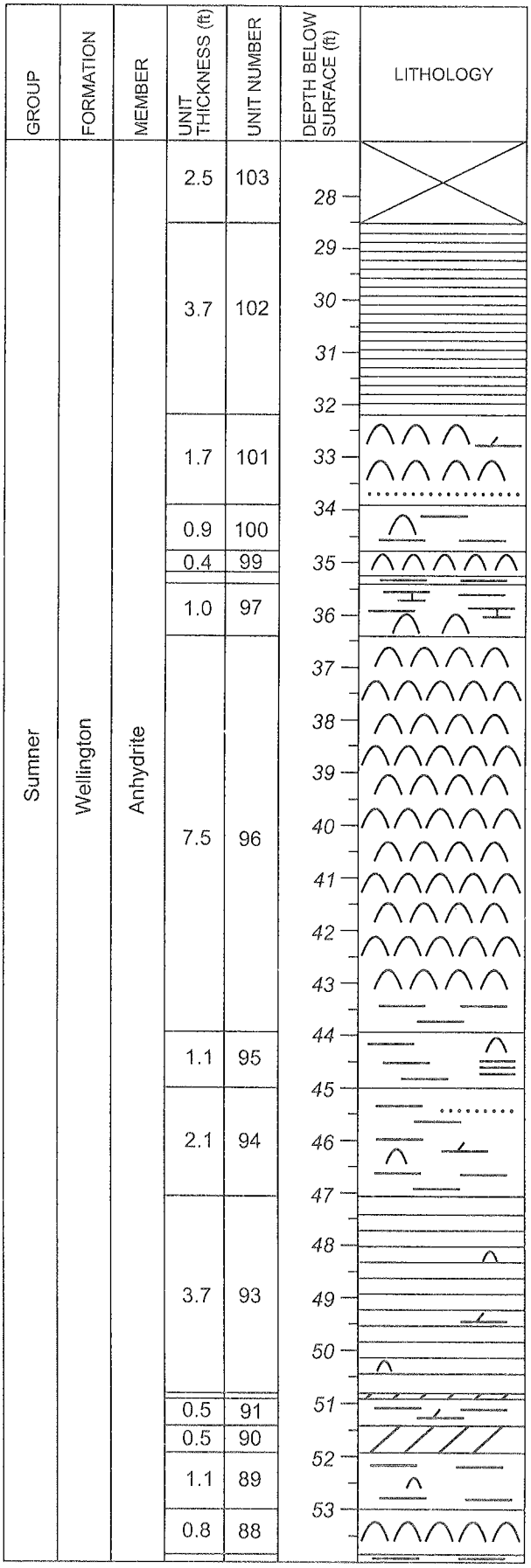
Clay and claystone, light-olive-gray to greenish-gray, soft

Anhydrite Member (Raasch, 1946) (169.0 ft)

Unit no.

105. Mudstone, grayish-green mottled light-olive-brown, very soft; upper 1 ft more indurated; contains very thin anhydrite seam

104. Mudstone, light-olive-gray; contains rare 1-mm-thick gypsum band; includes some thin dolomite laminae



103. Loss of core

102. Shale, light-bluish-gray to medium-bluish-gray; includes alternating yellowish-gray and grayish-yellow laminae that produce a varved-look; fissile, with very thin light-gray laminae at the top

101. Anhydrite and gypsum, bluish-white to light-bluish-gray; contains rare light-gray to light-brownish-gray dolomite lenses and laminae; includes some rare sandstone laminae; gradational base

100. Shale, light-olive-gray to olive-gray, slightly laminated; contains very thin anhydrite partings; vertical fracture surfaces stained dark-yellowish-orange to light-brown

99. Gypsum, bluish-white to medium-gray, massive; includes a 0.5-in.-thick satin spar gypsum band at the base

98. Shale, dark-greenish-gray, laminated

97. Mudstone, dolomitic, and dolomite, shaly, light-bluish-gray and light-gray; contains wavy laminae; bioturbated, pitted; contains a bluish-white, 5-mm-thick gypsum band at the base; gradational base

96. Gypsum, bluish-white and light-bluish-gray to very light gray, massive; lower 6 in. contains medium-gray mudstone inclusions; sharp base

95. Mudstone, medium-gray and dark-greenish-gray; grades into rare fissile shale; includes a 0.5-in.-thick gypsum band near the top; fracture surfaces are slickensided

94. Shale, medium-bluish-gray and dark-greenish-gray stained pale-brown and moderate-yellowish-brown, laminated; contains rare lenses of sandstone and/or dolomite; includes some scattered very thin gypsum partings

93. Shale, medium-bluish-gray and medium-gray, laminated, fissile; includes scattered very thin gypsum bands; contains some very thin medium-gray to medium-light-gray dolomite laminae

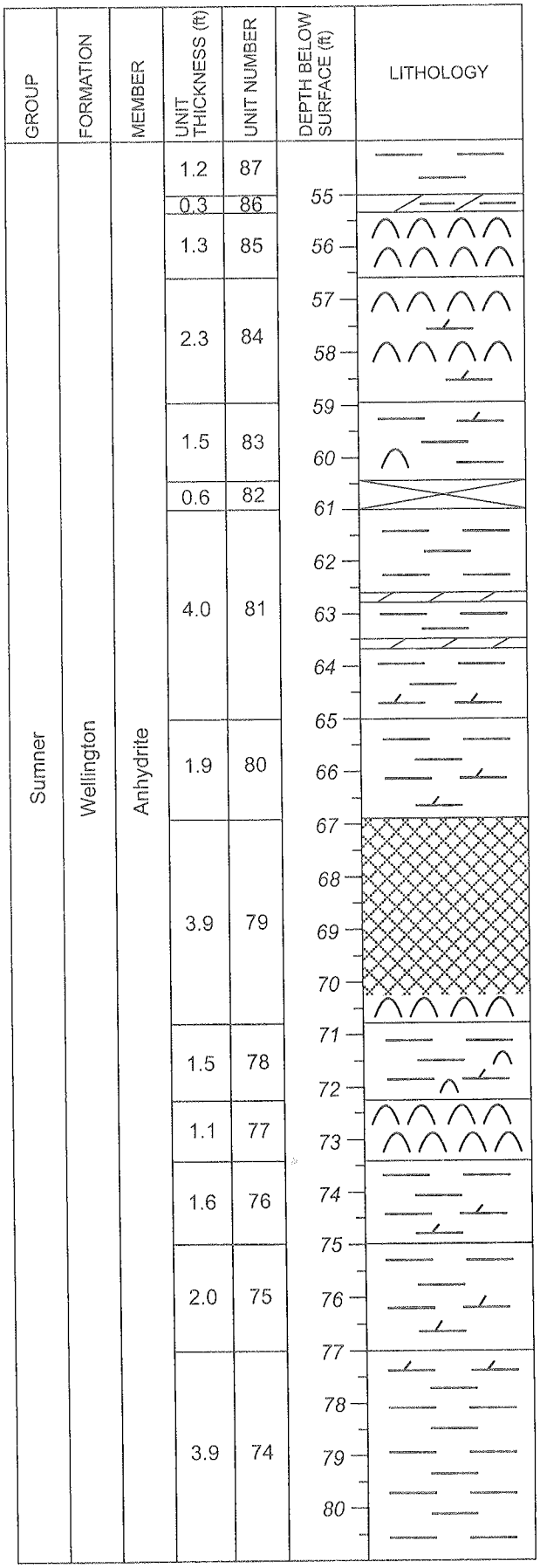
92. Dolomite, light-bluish-gray to light-gray, pitted

91. Mudstone, medium-bluish-gray to greenish-gray, slightly dolomitic

90. Dolomite, brownish-gray, slightly pitted; laminated at the top; contains dark-greenish-gray mudstone inclusions

89. Mudstone, medium-bluish-gray at top to dark-greenish-gray in lower part; contains irregular band of grayish-pink gypsum in middle; badly fractured in lower part

88. Gypsum, bluish-white to very light gray, massive; contains fracture fillings of dark-greenish-gray mudstone; includes a satin spar gypsum band at the base; gradational base



87. Mudstone, greenish-gray to dark-greenish-gray, slightly dolomitic; badly fractured

86. Mudstone and dolomite; mudstone, medium-bluish-gray to dark-greenish-gray; dolomite, light-brownish-gray; gradational base

85. Anhydrite, light-brownish-gray and light-gray, massive

84. Anhydrite and gypsum, light-bluish-gray and bluish-white; anhydrite is massive, gypsum is banded, marbled; contains bands of light-brownish-gray dolomite; wavy but sharp base

83. Shale, dark-greenish-gray and medium-dark-gray, laminated, dolomitic; contains rare light-brownish-gray dolomite; rare gypsum bands

82. Loss of core

81. Shale, dark-greenish-gray and medium-bluish-gray with grayish-red and light-olive-brown laminae; contains light-olive-brown and light-brownish-gray dolomite; lower 0.6 ft banded with light-brownish-gray dolomite laminae; shale badly fractured; rare mudstone with slickensided fracture surfaces

80. Shale, dark-greenish-gray and medium-bluish-gray, laminated; contains some light-brownish-gray dolomitic shale laminae; gradational base

79. Salt, light-gray and bluish-white, vuggy to dense; contains some interbedded gypsum; top with dark-greenish-gray shale stringers and inclusions; includes some dark-yellowish-orange staining; basal 0.8 ft consists of anhydrite; sharp base

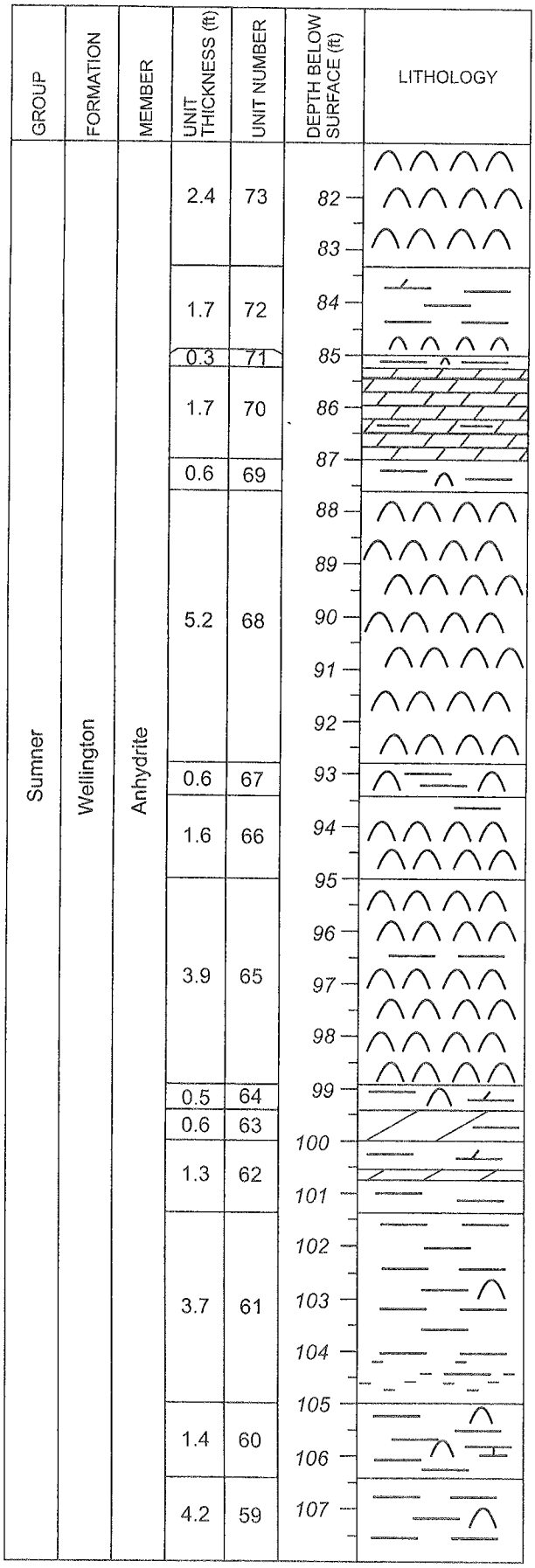
78. Shale, greenish-black and grayish-black, laminated; includes light-brownish-gray dolomitic laminae, some disrupted; contains numerous bands of fibrous gypsum; bioturbated; vertical fractures common; gradational base

77. Gypsum, bluish-white to very light gray, marbled

76. Shale, dark-greenish-gray, slightly dolomitic, dense; contains vertical fractures

75. Shale, dark-greenish-gray and medium-bluish-gray; contains scattered light-brownish-gray dolomitic laminae and lenses, especially common at the base

74. Shale, greenish-black and dark-greenish-gray; top contains wavy light-brownish-gray dolomite laminae producing a varved appearance; some intervals badly fractured; sharp base



73. Anhydrite, light-brownish-gray, light-gray, and very light gray, marbled; upper part with wavy bedding; middle marbled with clotted texture; sharp base

72. Shale, greenish-black and dark-gray, laminated, fractured; contains a moderate-orange-pink gypsum band at the base

71. Shale, greenish-black and dark-gray, laminated; contains gypsum band

70. Dolomite, pinkish-gray and light-brownish-gray, some yellowish-gray; mostly massive but some disrupted laminae; contains scattered olive-black and greenish-black shale laminae; includes some rare floating dolomite clasts in olive-black shale intervals; sharp base

69. Shale, olive-black and greenish-black, dense, fractured; gypsum-filled fractures common; contains slickensided fracture surfaces

68. Anhydrite, light-bluish-gray, light-gray, and grayish-orange-pink, laminated to marbled; sharp base

67. Anhydrite, light-gray, marbled and laminated; contains scattered fibrous gypsum bands; includes laminated olive-black shale and wavy laminae of light-brownish-gray dolomite

66. Anhydrite, light-bluish-gray, marbled; contains olive-black shale veinlets, especially at the top

65. Anhydrite, light-bluish-gray, predominantly massive, but top marbled; olive-black shale veinlets common but decrease in lower part; contains fibrous gypsum bands

64. Shale, olive-black and greenish-black, laminated; laminae consist of 1-mm-thick light-brownish-gray dolomite; contains two fibrous gypsum bands

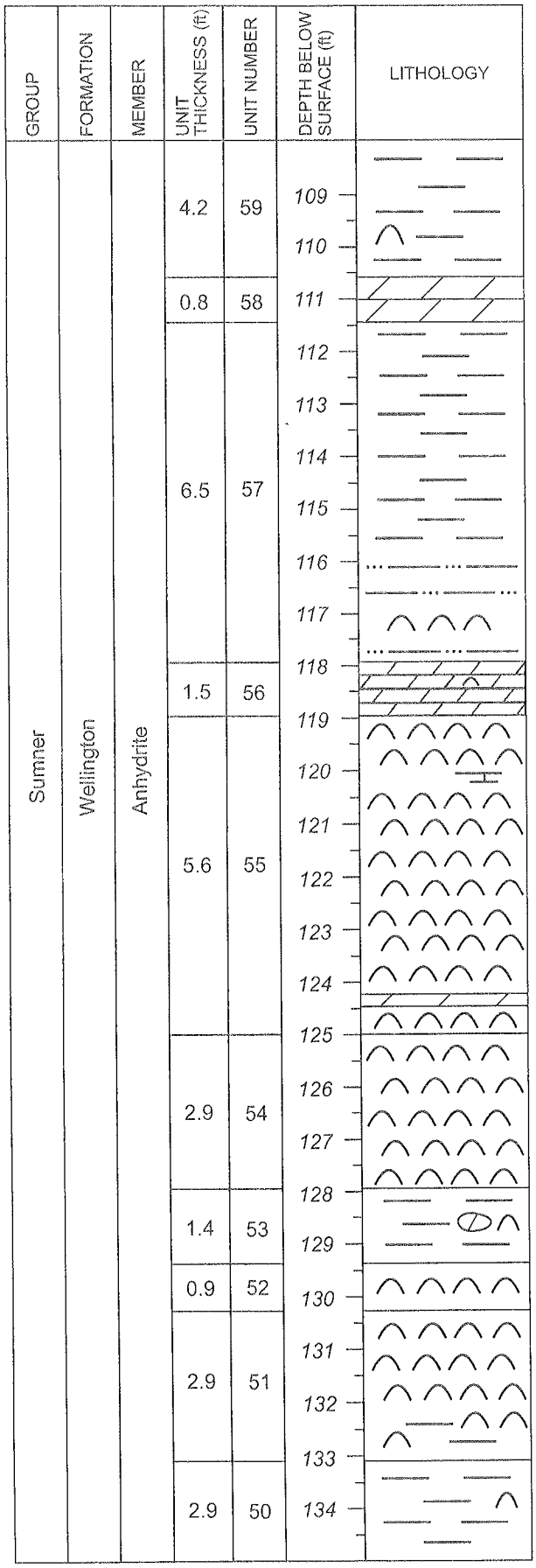
63. Dolomite, light-brownish-gray; grades into dolomitic shale; vertical fractures are gypsum-filled

62. Shale, olive-black at top to dark-greenish-gray at base, dolomitic, dense; contains abundant light-brownish-gray dolomite with disrupted laminae; churned bedding at base

61. Shale, dark-greenish-gray, mottled moderate-brown and dark-reddish-brown, especially in lower part; dense, slightly laminated; contains fibrous gypsum band

60. Shale, olive-black, greenish-black, light-bluish-gray, and pinkish-gray; contains abundant anhydrite and gypsum bands and laminae; includes some light-brownish-gray dolomite bands, especially at the base; sharp base

59. Shale, medium-bluish-gray, dark-greenish-gray, and grayish-brown, dense, laminated; includes scattered very thin gypsum bands; badly fractured; gradational base



58. Dolomite, light-brownish-gray and pale-yellowish-brown, cross-laminated; contains veinlets of dark-greenish-gray shale; badly fractured

57. Shale, top dark-greenish-gray, lower part variegated blackish-red, grayish-red, and olive-gray; dense, laminated; contains scattered fibrous gypsum bands; includes a 1-in.-thick grayish-pink anhydrite band at 117.4 ft; some beds badly fractured; sharp base

56. Dolomite, light-brownish-gray, massive; contains light-bluish-gray and medium-bluish-gray gypsum bands; pitted with granular-look; base with light-bluish-gray anhydrite nodules; gradational base

55. Anhydrite, light-bluish-gray, bluish-white, and very light gray, massive with rare marbled intervals; contains scattered veinlets of light-brownish-gray and dark-gray dolomite; includes wavy-like stromatolitic laminae of light-brownish-gray dolomite in lower 1 ft

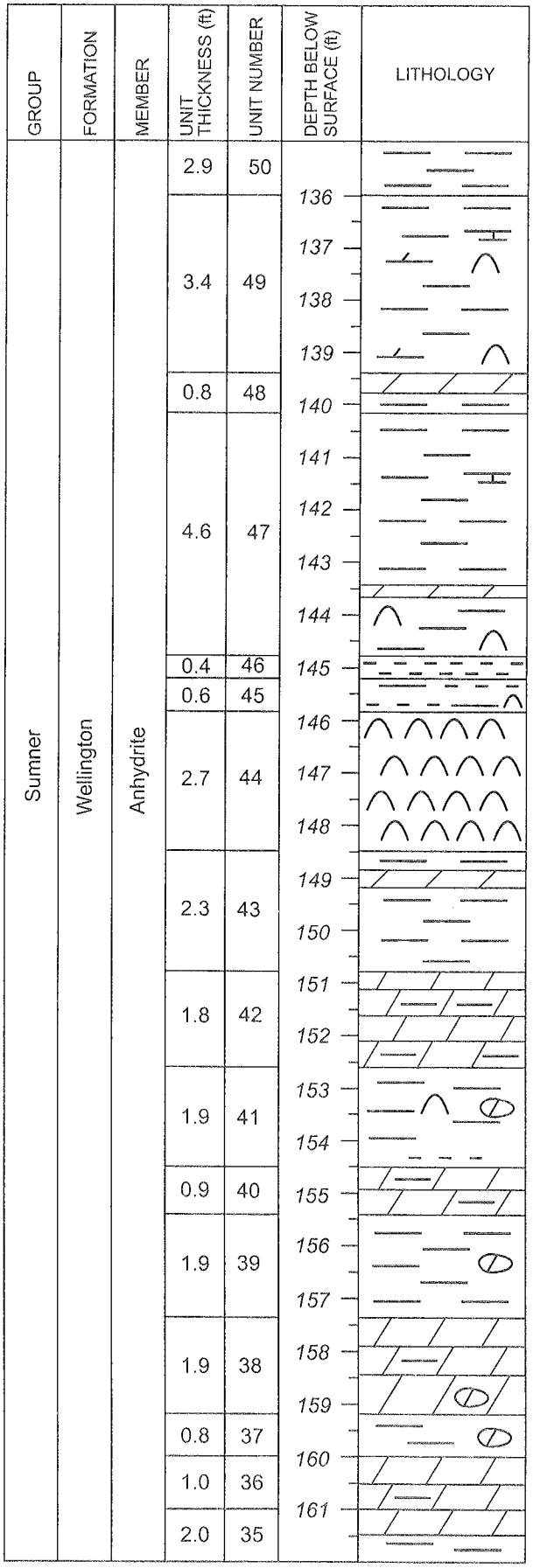
54. Anhydrite, light-bluish-gray; includes some scattered rare light-brownish-gray dolomite inclusions; contains slightly fibrous yellowish-gray gypsum at base; sharp base

53. Shale, top olive-black and greenish-black, lower part dark-greenish-gray; contains light-brownish-gray dolomite nodules; includes two fibrous gypsum bands

52. Anhydrite, light-bluish-gray and light-gray, lensoidal bedding; contains yellowish-gray fibrous gypsum; includes veinlets of dark-greenish-gray shale

51. Anhydrite, light-bluish-gray and light-gray, marbled to massive; basal part contains medium-light-gray and light-gray shale stringers; gypsum band at base.

50. Shale, dark-greenish-gray and greenish-black, base mottled medium-bluish-gray to moderate-brown; dense, slightly laminated; contains gypsum band; lower part papery



49. Shale, dark-greenish-gray and light-olive-gray, dense, dolomitic; contains some wavy laminae of light-brownish-gray dolomite, especially at the top; includes scattered bands and nodules of moderate-orange-pink gypsum

48. Dolomite and shale; alternating bands of light-brownish-gray and light-gray dolomite with dark-greenish-gray and greenish-gray shale; bioturbated; includes rare moderate-orange-pink gypsum nodules

47. Shale, medium-bluish-gray and dark-greenish-gray mottled moderate-brown; contains light-brownish-gray laminated dolomite at the top to massive below; includes vertical fractures and micro-faults throughout; lower part with olive-black and greenish-black intervals containing moderate-orange-pink gypsum veins; contains some gypsum-lined slickensided fracture surfaces

46. Shale, dark-reddish-brown

45. Shale, mottled greenish-gray and dark-reddish-brown with very thin gypsum bands

44. Anhydrite, bluish-white and very light gray; predominantly massive but with rare bands; gradational base

43. Shale, dark-greenish-gray to greenish-black, laminated; contains a 2-in.-thick light-brownish-gray dolomite band at top; vertical fractures common

42. Dolomite, light-brownish-gray and medium-light-gray; contains abundant dark-greenish-gray laminated shale; laminae disrupted at base

41. Shale, dark-greenish-gray and greenish-black; nodular (cauliflower-shaped) light-brownish-gray dolomite common; includes some moderate-orange-pink anhydrite and gypsum nodules; contains thin gypsum laminae and veins throughout; base mottled dark-reddish-brown

40. Dolomite, light-brownish-gray, shaly, badly fractured

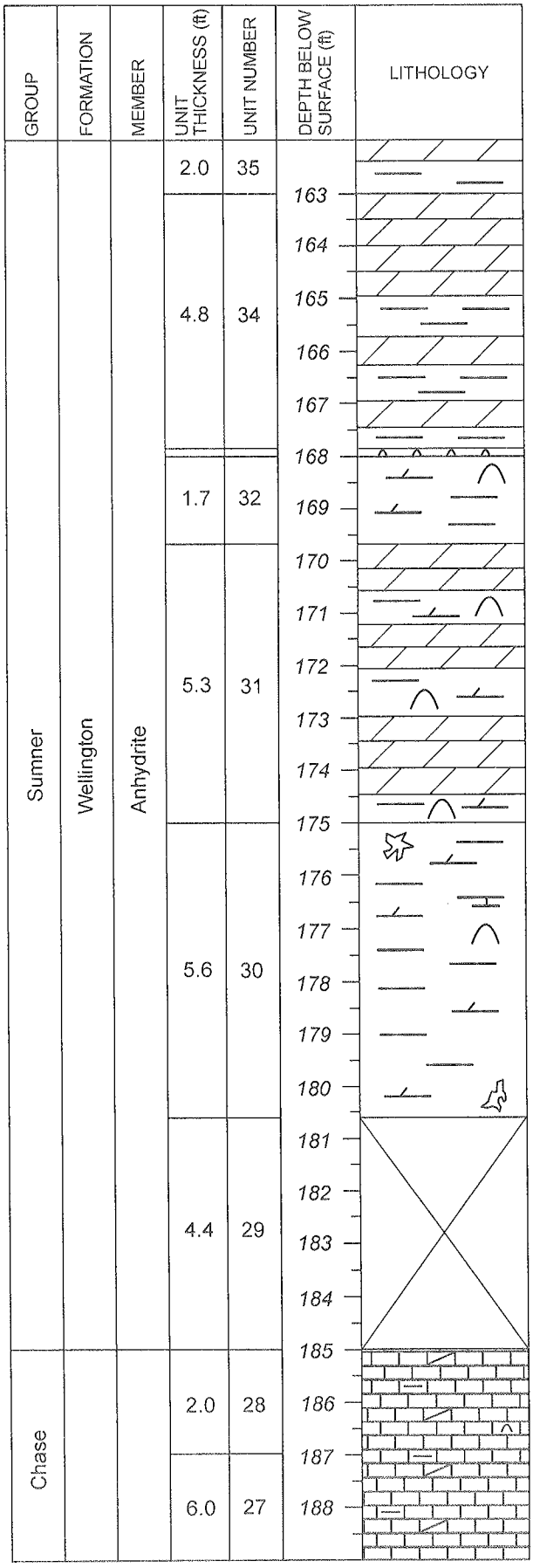
39. Shale, dark-greenish-gray and greenish-black; contains light-brownish-gray dolomite nodules

38. Dolomite, light-brownish-gray; wavy laminae common; contains greenish-black shale laminae and stringers; includes some nodular dolomite; gradational

37. Shale, olive-black and greenish-black; contains nodules and lenses of light-brownish-gray dolomite

36. Dolomite, light-brownish-gray, massive to laminated; lower part with greenish-black shale laminae

35. Dolomite and shale; alternating bands of light-brownish-gray dolomite and greenish-black to dark-greenish-gray shale producing a distinct varved bedding; contains lenses of dolomite



34. Dolomite, light-brownish-gray and medium-gray, massive; contains gypsum bands and veinlets; includes some dark-greenish-gray shale

33. Anhydrite, moderate-orange-pink and very light gray

32. Shale, dark-greenish-gray and greenish-black, dolomitic; contains scattered gypsum bands and vugs

31. Dolomite and shale; dolomite, light-brownish-gray and light-gray, dense, wavy laminae, lenses; shale, medium-bluish-gray and dark-greenish-gray, dolomitic; contains scattered gypsum veins and bands throughout; unit includes well-developed sedimentary structures

30. Shale, dark-greenish-gray and medium-bluish-gray, dolomitic; includes scattered lenses of light-brownish dolomite; contains rare 1–5-mm-thick gypsum bands; includes a moderate-orange-pink gypsum nodule at top and at the base

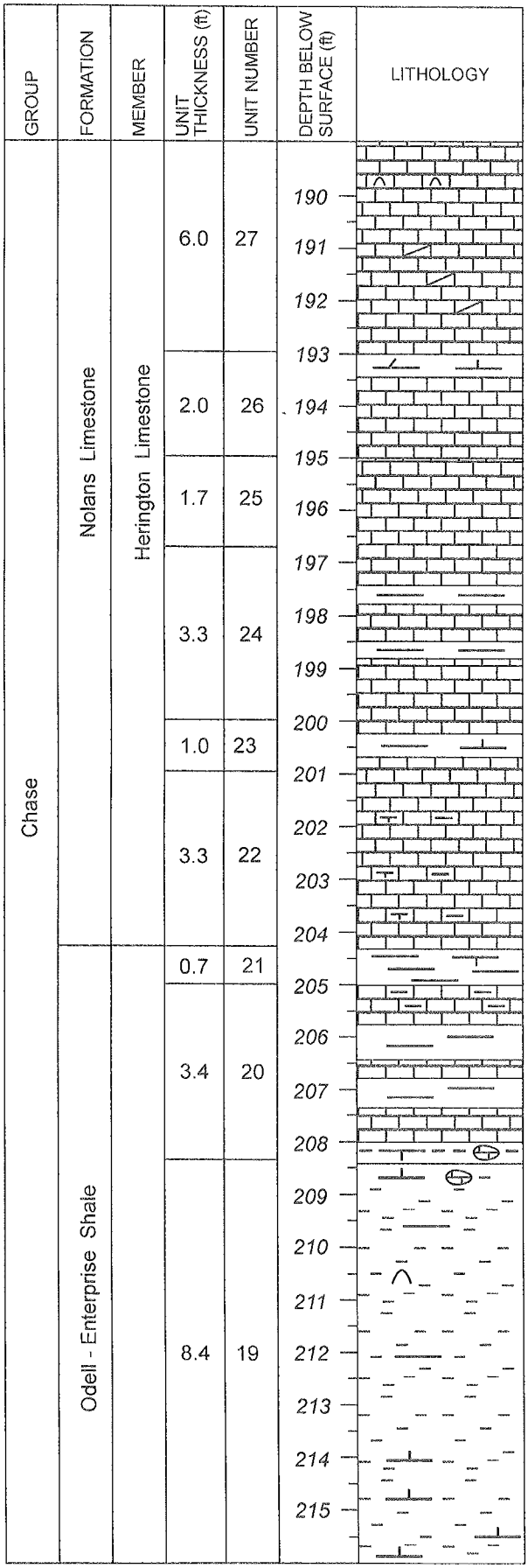
29. Loss of core

CHASE GROUP

NOLANS LIMESTONE (19.3 ft)

Herington Limestone Member (19.3 ft)

28. Limestone, light-olive-gray and light-gray, finely crystalline, dolomitic, fossiliferous, pitted, bioturbated; contains stringers and partings of medium-dark-gray shale; includes some small gypsum-filled vertical fractures



27. Limestone, medium-bluish-gray and medium-light-gray, finely crystalline, dolomitic; contains scattered lenses of crinoidal hash; includes some gypsum bands; a micro-faulted gypsum band is found at 189.7 ft

26. Limestone, medium-bluish-gray and medium-dark-gray, finely crystalline, crinoidal; contains dolomitic to calcareous shale at the top

25. Limestone, medium-gray and medium-light-gray, medium-crystalline, crinoidal, very fossiliferous; contains rare algal-coated grains

24. Limestone, medium-gray and medium-light-gray, medium-crystalline, highly algal with large algal coated grains, especially at the top; very fossiliferous; contains numerous dark-gray and medium-dark-gray shale partings

23. Limestone and shale in alternating beds; limestone, medium-gray, medium-crystalline, fossiliferous with large *Composita* brachiopods at the top; shale, dark-gray, calcareous, fossiliferous

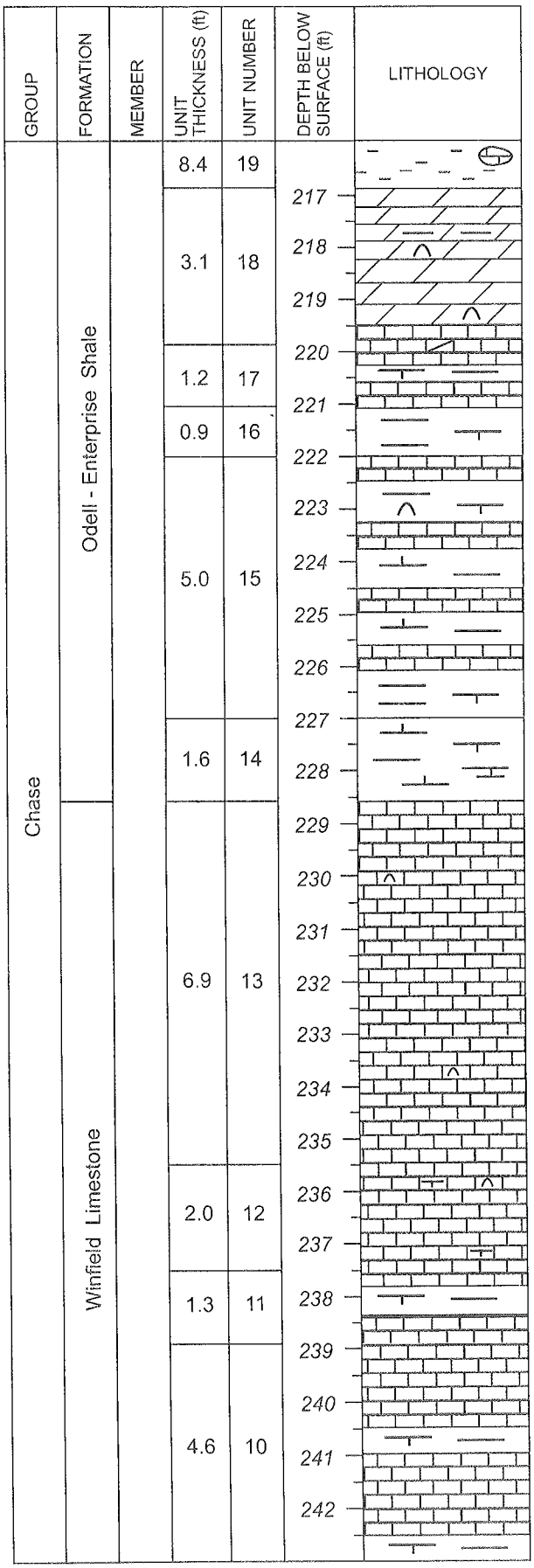
22. Limestone, medium-light-gray and light-gray, medium-crystalline, highly fossiliferous with cross sections of large fossil fragments (*Myalina*), very crinoidal; contains wavy stringers and partings of dark-gray calcareous shale

ODELL-ENTERPRISE SHALE (24.3 ft)

21. Mudstone, medium-bluish-gray and greenish-gray, calcareous

20. Shale and limestone in alternating beds; limestone, light-gray and light-brownish-gray, finely crystalline, shaly, nodular bedded; shale, greenish-gray, base variegated with dark-reddish-brown calcareous mudstone containing small limestone nodules, calcareous

19. Mudstone, dark-reddish-brown mottled greenish-gray, calcareous, poorly indurated, slickensided fracture surfaces; contains light-gray finely crystalline limestone nodules throughout, but especially at the top and at the base; some fracture surfaces with very thin gypsum linings, some of which are transparent; very calcareous between 213.7 and 215.0 ft; sharp base



18. Dolomite, light-gray and very light gray, dense; upper 6 in. brecciated; includes scattered very thin gypsum bands; contains veins and fractures of medium-bluish-gray shale; some small vugs; contains dolomitic limestone in lower part

17. Limestone, light-gray, finely crystalline, dense; interbedded with medium-gray and greenish-gray calcareous shale; limestone occurs as lenses; gradational base

16. Shale, medium-dark-gray and medium-bluish-gray, calcareous; gradational base

15. Limestone and shale interbedded; limestone, light-gray and light-bluish-gray, finely crystalline, dense; occurs as lenses that produce a cross bedded appearance; contains some very wavy disrupted limestone laminae; some bands of grayish-orange-pink lenticular limestone and gypsum, especially at top; contains small-scale scour features; shale, olive-gray and dark-gray, calcareous

14. Shale, medium-dark-gray and medium-bluish-gray, very calcareous; grades into shaly limestone

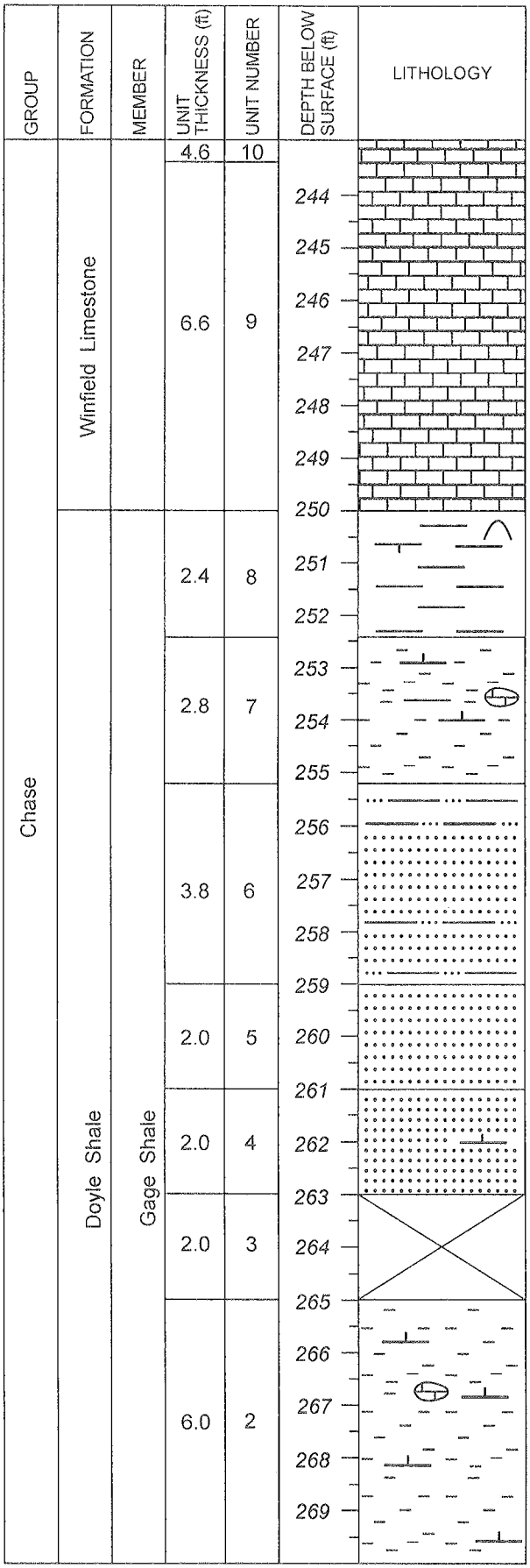
WINFIELD LIMESTONE (21.4 ft)

13. Limestone, medium-dark-gray and dark-gray, finely crystalline, dense; contains laminae of diminutive shell hash; includes rare very thin gypsum bands; cross sections of fossil fragments and crinoidal hash are common

12. Limestone, light-gray and light-brownish-gray, very finely crystalline; includes some steeply dipping laminae bands; contains medium-gray and medium-dark-gray calcareous shale laminae; includes rare gypsum laminae; vertical fractures common; exhibits excellent sedimentary structures

11. Limestone and shale; limestone, medium-light-gray and light-brownish-gray, very finely crystalline, crinoidal; shale, dark-gray, calcareous with some limestone lenses

10. Limestone, medium-dark-gray and medium-gray, fine- to medium-crystalline, crinoidal; contains some large brachiopod shells, especially in lower part; includes stylolitic seams and veins in lower part; some brachiopod molds filled with recrystallized calcite; contains some intervals with wavy calcareous, crinoidal, dark-gray and medium-dark-gray shale and light-brownish-gray limestone lenses; base is stylolitic



9. Limestone, light-gray and light-bluish-gray, medium-crystalline, highly algal, fossiliferous; contains crinoid hash recrystallized to pink calcite; includes algal-coated fossil fragments and grains; medium-dark-gray stylolitic seams are common; sharp base

DOYLE SHALE (23.5 ft)

Gage Shale Member

8. Mudstone, dark-greenish-gray and medium-bluish-gray, slightly calcareous; contains gypsum band at the top

7. Mudstone, dark-reddish-brown with medium-bluish-gray and dark-greenish-gray mottling, calcareous; contains rare small very finely crystalline limestone nodules

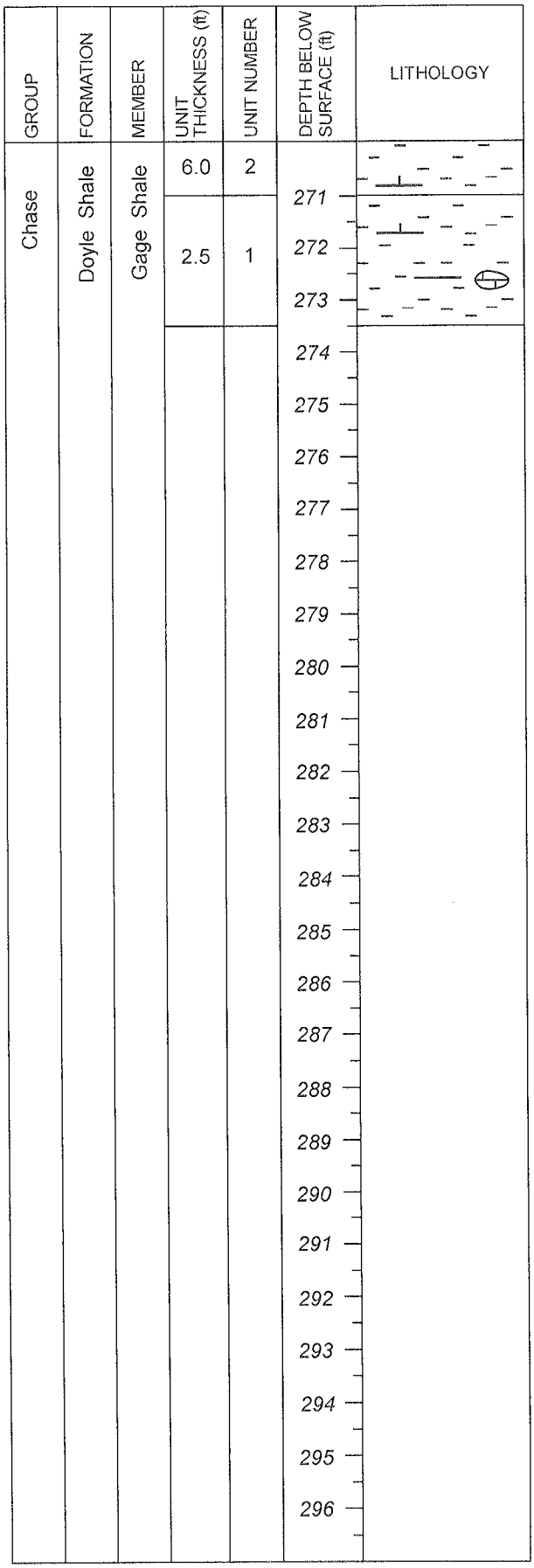
6. Siltstone and sandstone, dark-reddish-brown and grayish-red with rare dark-bluish-gray mottling; sandstone, very fine grained

5. Sandstone, dark-reddish-brown and grayish-red, very fine grained, slightly cross bedded

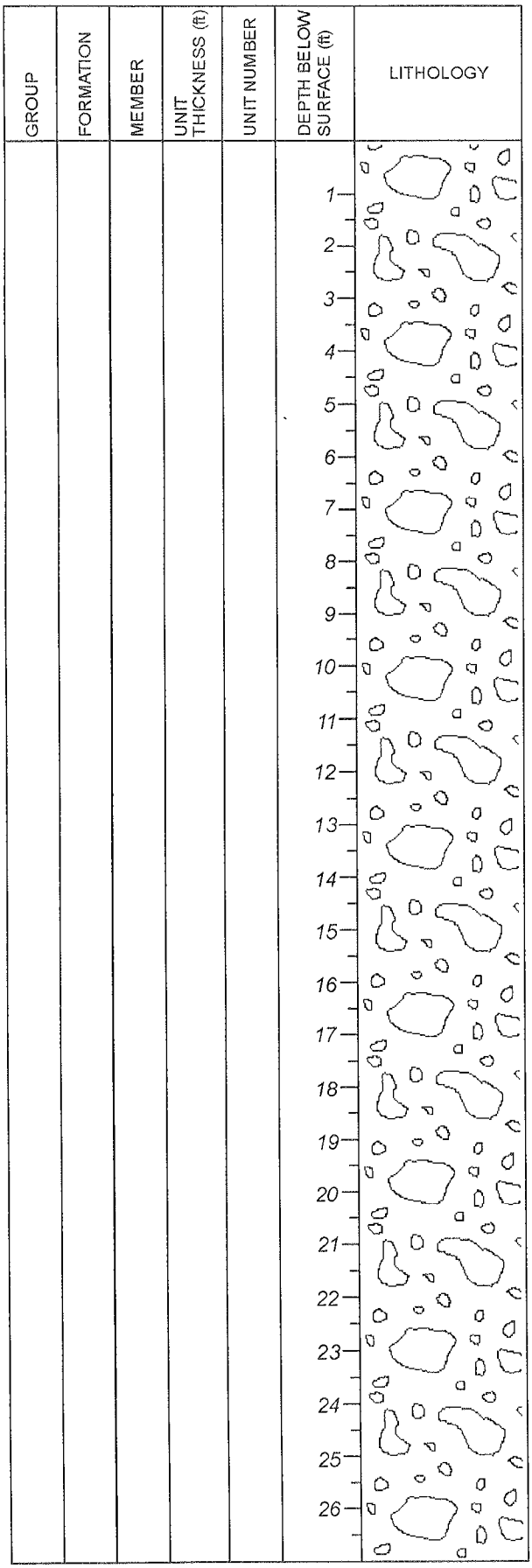
4. Sandstone, dark-reddish-brown and grayish-red, very fine grained, low-angle trough cross bedding, especially in lower 1 ft; contains rare calcareous intervals

3. Loss of core

2. Mudstone, grayish-red, calcareous; contains rare finely crystalline limestone nodules; includes some dark-bluish-gray mottling



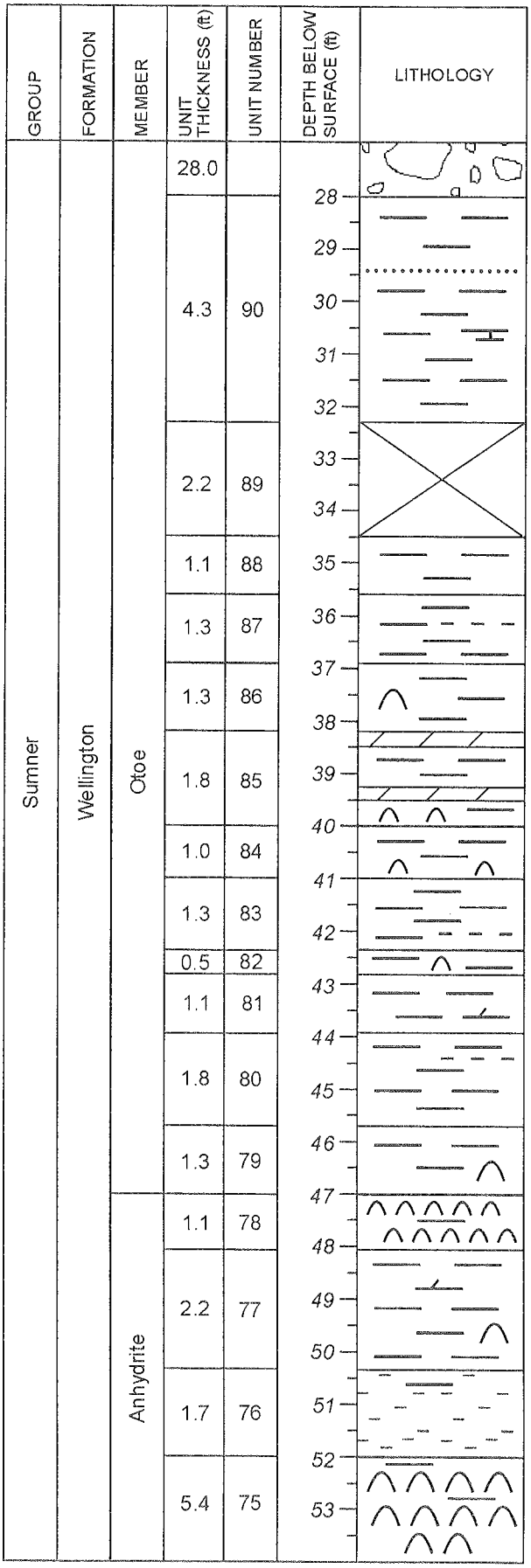
1. Mudstone, grayish-red mottled dark-bluish-gray, slightly calcareous; includes rare very finely crystalline limestone nodules and granules



Core Hole KC-8
BELL RANCH

NW¼SE¼NE¼SE¼ sec. 10, T. 28 N., R. 1 W., Braman Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 1,700 ft from south line (FSL) and 500 ft from east line (FEL). Surface elevation from altimeter, 1,058 ft. Spudded in the basal part of the Otoe Member of the Wellington Formation. Field lithologic descriptions by James R. Chaplin.

Terrace gravels and sands saturated with water



SUMNER GROUP

WELLINGTON FORMATION (185.8 ft)

Otoe Member (19 ft)

Unit no.

90. Shale, greenish-black, medium-dark-gray, and dark-gray; contains medium-light-gray and light-brownish-gray dolomite laminations and bands; includes some medium-light-gray bioturbated sandstone lenses with churned bedding; some vertical fractures and rare microfaults

89. Loss of core

88. Mudstone, dark-greenish-gray and medium-bluish-gray; contains vertical fractures

87. Mudstone and shale, mottled dark-reddish-brown, medium-bluish-gray, dark-greenish-gray to moderate-brown; waxy feel

86. Mudstone, dark-greenish-gray with very thin gypsum bands; very soft

85. Dolomite and shale; dolomite, medium-light-gray to light-gray, occurs in irregular bands; shale, dark-gray; contains gypsum band at base

84. Mudstone, greenish-gray; includes a 0.5-in.-thick white fibrous gypsum band at the base

83. Mudstone, mottled greenish-gray and dark-reddish-brown, very soft

82. Mudstone and gypsum interbedded; mudstone, dark-greenish-gray; gypsum, moderate-orange-pink

81. Shale, dark-greenish-gray, slightly dolomitic, laminated; bioturbated with distinct churned bedding; contains some vertical fractures

80. Shale, mottled to banded, dark-greenish-gray, dark-reddish-brown, and moderate-brown

79. Shale, slightly mottled dark-greenish-gray with rare dark-reddish-brown stains; contains some very thin gypsum bands; gradational into anhydrite below

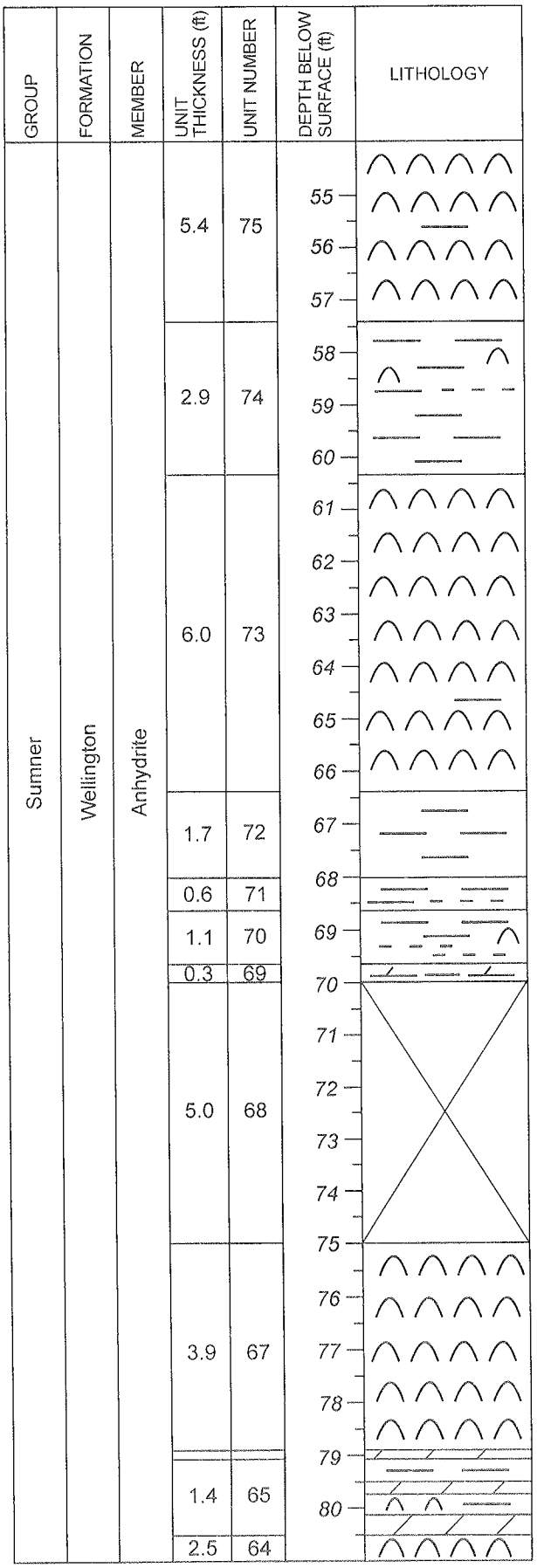
Anhydrite Member (166.8 ft)

78. Anhydrite, white and moderate-orange-pink; contains stringers of dark-greenish-gray shale

77. Shale, dark-greenish-gray to greenish-black, slightly dolomitic; contains vertical fractures lined with moderate-orange-pink gypsum; badly fractured

76. Mudstone, dark-reddish-brown with some dark-greenish-gray; sharp base

75. Anhydrite, light-gray to very light gray with massive stringers of greenish-gray and grayish-yellowish-green shale throughout; shale stringers very abundant at the top; basal 2.4 ft with brownish-gray and grayish-orange-pink wavy laminations producing a tiger stripe look; sharp base



74. Shale, greenish-gray to dark-greenish-gray, slightly laminated; includes some rare dark-reddish-brown mottling; contains large gypsum veins in upper part; includes some very thin gypsum laminae; gradational to anhydrite below

73. Anhydrite, medium-light-gray and very light gray, massive to rare marbled (brecciated look) intervals; contains rare greenish-gray shale stringers; two bands of fibrous gypsum occur at the base

72. Shale, olive-black and greenish-black, laminated, fractured

71. Shale, dark-greenish-gray mottled dark-reddish-brown at base, slightly laminated

70. Mudstone, dark-reddish-brown becoming dark-greenish-green at top; two gypsum bands occur at the top

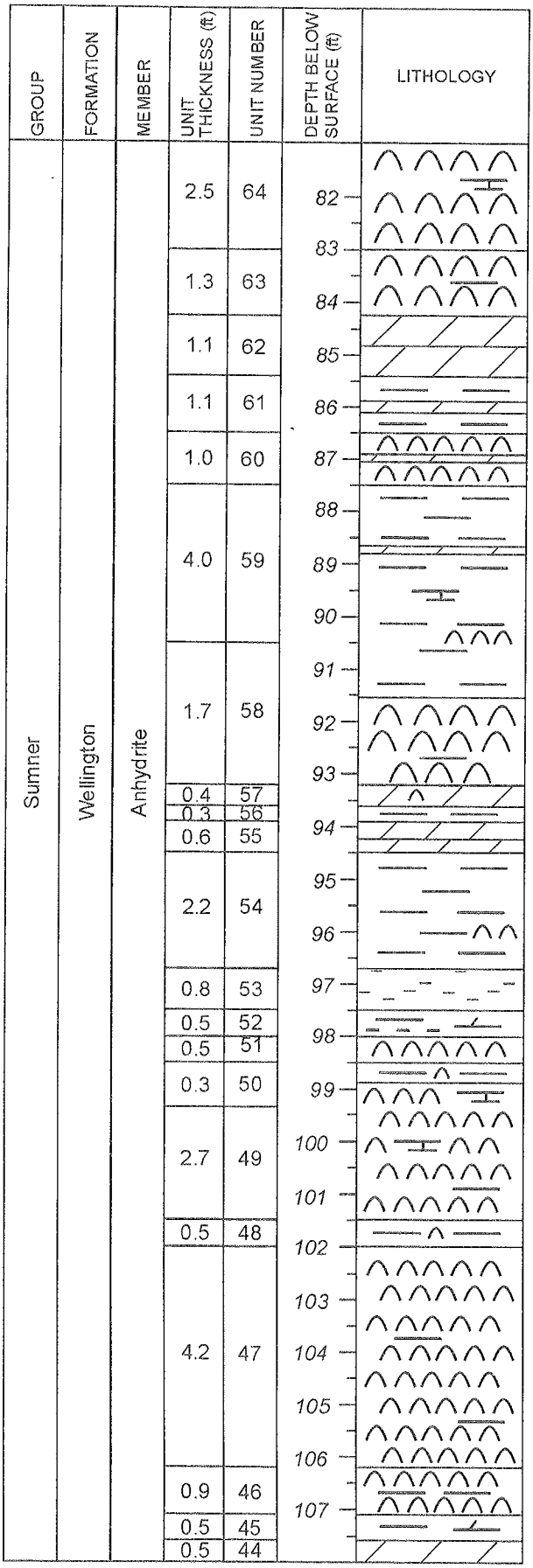
69. Shale, greenish-black, dolomitic; shale alternates with yellowish-gray and light-brownish-gray dolomitic bands; dolomite bands often disrupted by bioturbation

68. Loss of core

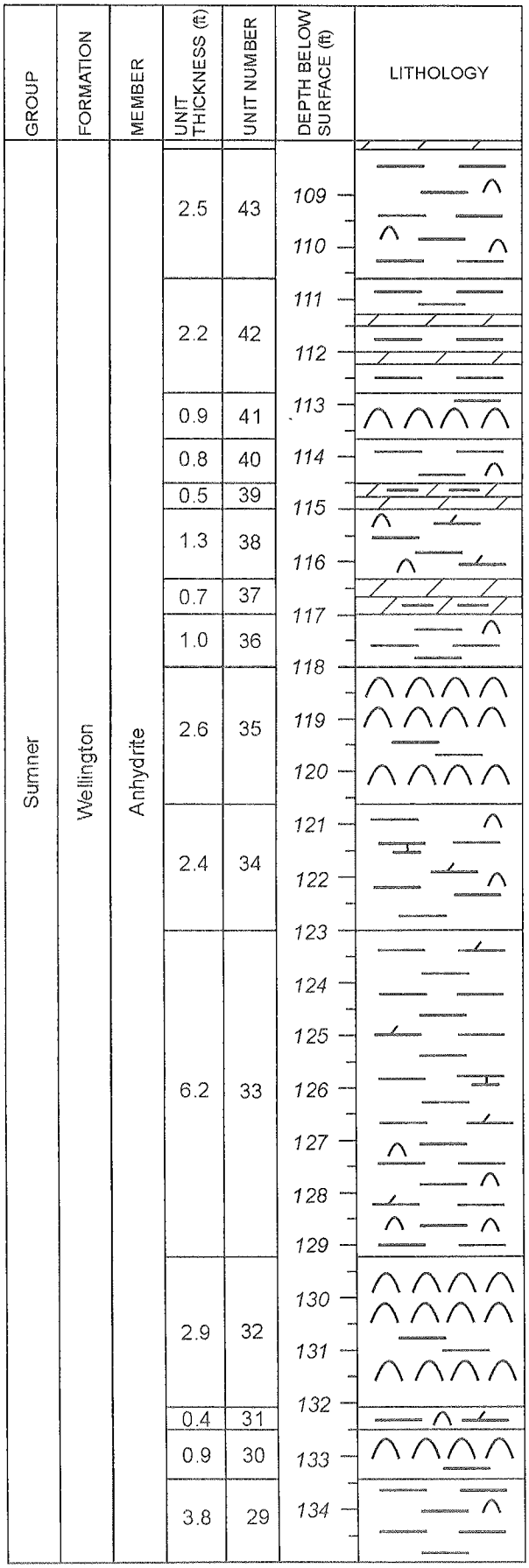
67. Anhydrite, light-gray to very light gray, marbled to slightly laminated, especially in lower 1.5 ft; lower 1 ft is finely crystalline and dense

66. Dolomite, light-brownish-gray

65. Dolomite and shale; dolomite, light-brownish-gray, occurs in bands; shale, olive-black to greenish-black with dark-reddish-brown laminations, fractured; dolomite bands often disrupted; contains a 0.5-in.-thick fibrous gypsum band at 80.0 ft



64. Anhydrite, medium-light-gray to light-gray; top predominantly laminated but with some marbled intervals; contains some rare dolomite bands
63. Anhydrite, medium-gray to light-gray; contains stringers, bands, and laminations of olive-black and greenish-black shale
62. Dolomite, light-gray to light-brownish-gray; includes very wavy laminations (stromatolitic) in lower 0.4 ft
61. Dolomite and shale; dolomite, light-olive-gray to light-brownish-gray; shale, olive-black to greenish-black at top becoming dark-greenish-gray at the base, laminated, fractured
60. Anhydrite and dolomite, light-gray to light-bluish-gray, banded, laminated; contains stringers and veinlets of olive-black shale
59. Shale, olive-black to dark-greenish-black, laminated; contains wavy laminae and lenses of light-gray and light-brownish-gray dolomite; some dolomite laminae are disrupted; includes some very thin gypsum and anhydrite bands; sharp base
58. Anhydrite, medium-light-gray to light-bluish-gray, laminated; lower part with wavy olive-black shale stringers and bands; contains gypsum bands at the base
57. Dolomite, light-gray to light-brownish-gray with 1–2-mm-thick anhydrite and gypsum bands at the base; includes some wavy bands of dolomite
56. Shale, greenish-gray and dark-greenish-gray
55. Dolomite, light-gray to light-brownish-gray, slightly laminated
54. Shale, dark-greenish-gray, slightly laminated; contains fracture planes lined with moderate-orange-pink gypsum bands
53. Shale, grayish-red with rare dark-greenish-gray mottling; badly fractured
52. Shale, dark-greenish-gray and rare grayish-red, dolomitic; badly fractured
51. Anhydrite, very light gray to light-bluish-gray; mottled with veins of olive-black shale
50. Shale, olive-black and greenish-black; contains irregular gypsum veins; badly fractured
49. Anhydrite, very light gray to light-bluish-gray, laminated at top to slightly marbled below; lower part with abundant light-brownish-gray dolomite granules and disrupted bands; top contains light-brownish-gray, very irregular and broken bands of dolomite; includes some very thin olive-black shale veins in lower part
48. Shale, olive-black and greenish-black with 1–2-mm-thick gypsum veins; badly fractured
47. Anhydrite, light-bluish-gray and light-gray, slightly marbled; contains veins of olive-black shale
46. Anhydrite, very light gray and light-bluish-gray; interbedded with olive-gray to medium-dark-gray laminated shale; contains anhydrite with dark-gray shale veinlets; fibrous gypsum bands occur at the top
45. Shale, dark-greenish-gray and medium-dark-gray, laminated, slightly dolomitic



44. Dolomite, light-brownish-gray, laminated; olive-black shale laminae common; includes gypsum-lined fracture planes at the base

43. Shale, dark-greenish-gray mottled moderate-yellowish-brown to moderate-brown, laminated; gypsum bands common throughout; badly ribbed and fractured

42. Shale and dolomite; shale, olive-black and greenish-black, dolomitic; dolomite, light-brownish-gray, laminated to massive; contains gypsum-lined fracture surfaces; top badly fractured

41. Anhydrite, medium-light-gray and light-bluish-gray, banded; contains fracture fillings of olive-black shale at the top

40. Shale, greenish-black and dark-greenish-black; includes gypsum-lined fracture planes

39. Dolomite, light-brownish-gray, laminated with some steeply dipping laminae; contains intercalations of greenish-black and olive-black dolomitic shale; some shale stringers with floating grains

38. Shale, olive-black and greenish-black, dolomitic; contains a 0.5-in.-thick fibrous gypsum band at base and a 1-in.-thick anhydrite band at the top; fractured

37. Dolomite, light-brownish-gray, laminated with some laminae wavy and disrupted; includes intercalations of olive-black laminated shale

36. Shale, olive-black and greenish-black, slightly laminated; contains a fibrous gypsum band at the base; fractured

35. Anhydrite, very light gray to light-bluish-gray, massive; contains veins of olive-black and greenish-black shale throughout; shale veinlets produce a clotted or nodular texture for the anhydrite

34. Shale, dark-greenish-gray and greenish-black, slightly dolomitic; includes very thin gypsum bands and veins; upper 1 ft ribbed; slightly laminated; contains rare very thin light-brownish-gray dolomite laminae and stringers

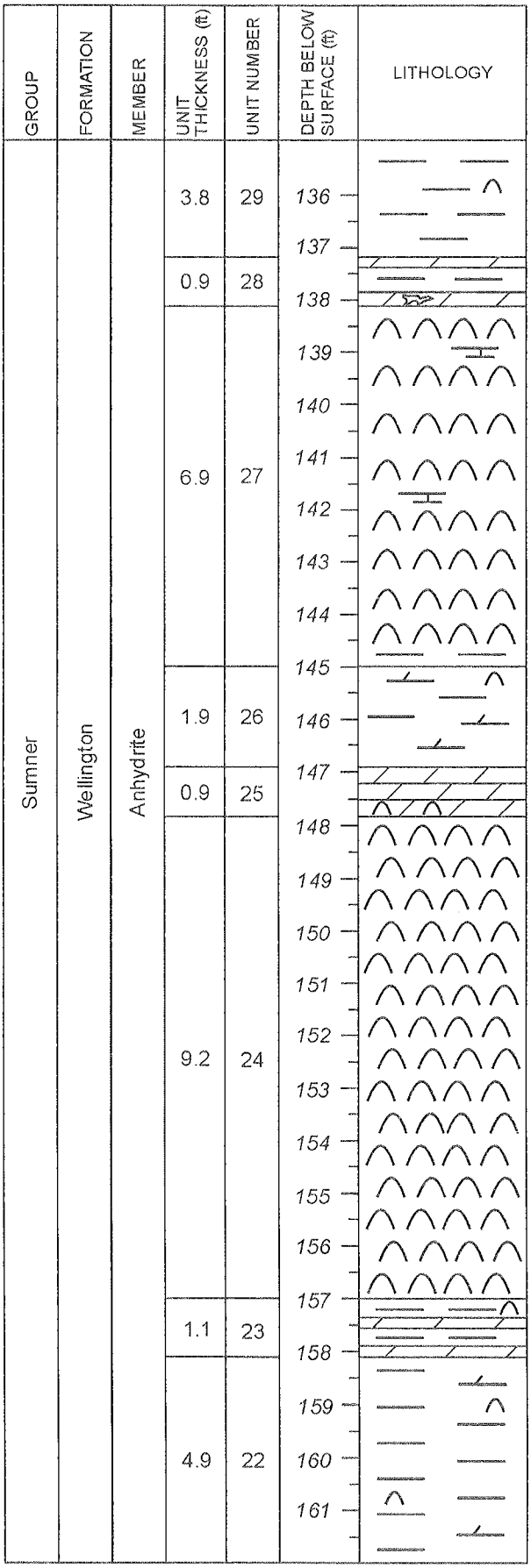
33. Shale, greenish-black, dark-greenish-gray, and olive-black, dolomitic; contains some intervals with very wavy and very thin light-brownish-gray dolomite laminae; some laminae disrupted; includes rare dolomite lenses; some laminae produce a varved bedding style; lower 2 ft with thin gypsum band and stringers; some dolomite beds brecciated; contains vertical fractures; gradational base

32. Anhydrite, very light gray and light-bluish-gray; upper part massive to slightly marbled; slightly banded in lower part; contains stringers of olive-black shale; sharp base

31. Shale, olive-black, dolomitic, laminated; contains a fibrous gypsum band; sharp base

30. Anhydrite, light-bluish-gray to very light gray; olive-black shale bands and stringers very common; sharp but irregular base

29. Shale, dark-greenish-black, slightly laminated; contains rare very thin gypsum laminae; includes some slickensided fracture surfaces



28. Shale and dolomite; shale, olive-black and greenish-black, dolomitic; dolomite, light-gray and light-brownish-gray; laminated with a varved look; contains anhydrite nodules at the base; sharp base

27. Anhydrite, light-gray and light-bluish-gray; laminated in upper part; lower part consists of crenulated (tiger-striped) pale-yellowish-brown laminae; dolomite, greenish-gray and dark-greenish-gray, laminated, with gypsum band; fibrous gypsum band occurs near base; olive-black laminated shale at base

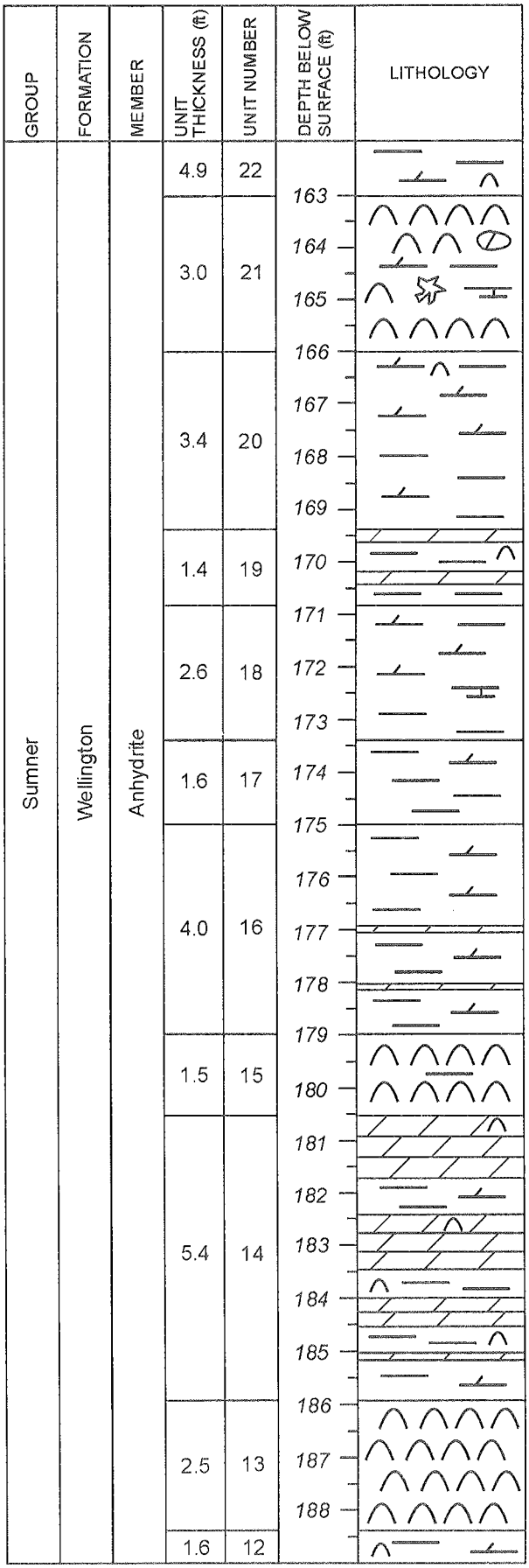
26. Shale, brownish-gray to olive-black, dolomitic; laminated with very thin gypsum bands

25. Dolomite, grayish-orange-pink and yellowish-gray; contains veins of olive-black shale; brecciated texture; gypsum band at base

24. Anhydrite, light-bluish-gray and light-gray with grayish-orange-pink dolomite clasts producing a very clotted texture; contains veins and stringers of olive-black shale; predominantly marbled texture with some laminated beds; gradational base

23. Shale and dolomite; shale, olive-black and greenish-black, dolomitic, laminated; dolomite, light-brownish-gray, banded to laminated; contains a 3-in.-thick anhydrite band at top

22. Shale, dark-greenish-gray, slightly dolomitic, laminated; gypsum bands throughout; contains some gypsum-lined fracture surfaces



21. Anhydrite, light-bluish-gray and medium-light-gray, upper 2 in. grayish-orange-pink and moderate-orange-pink; upper part with light-olive-gray dolomite nodules and stringers; some intervals of dark-greenish-gray and greenish-black dolomitic shale produce a marbled texture; contains scattered gypsum bands; includes rare light-brownish-gray dolomite bands and laminae containing anhydrite nodules; lower 1 ft marbled

20. Shale, dark-greenish-gray and greenish-black, dolomitic, slightly laminated; contains gypsum bands at top; especially dolomitic at the top

19. Dolomite and shale; dolomite, light-brownish-gray; shale, olive-black and greenish-gray; distinct banded bedding; contains some lenses, laminae, and bands of dolomite; very thin gypsum bands are common throughout

18. Shale, dark-greenish-gray, dolomitic, laminated; contains some light-gray to light-brownish-gray dolomite bands near base

17. Shale, dark-greenish-gray, laminated, slightly dolomitic

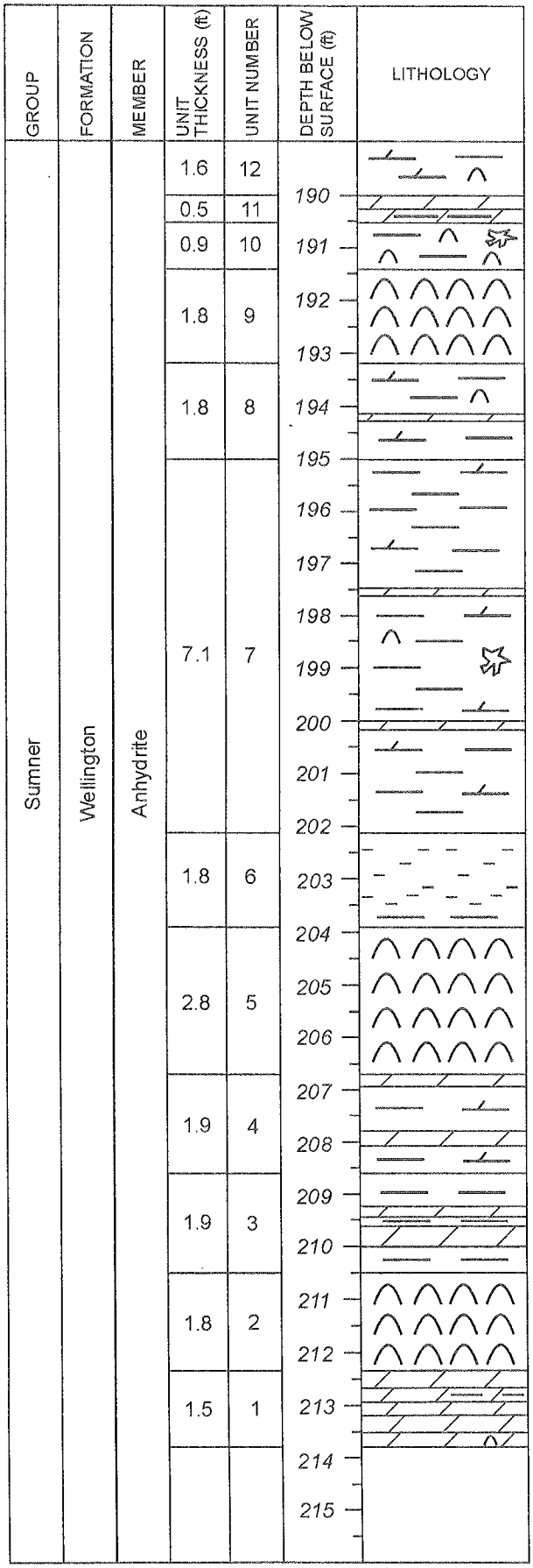
16. Shale, dark-greenish-gray and greenish-black, dolomitic, laminated; includes some intervals of light-brownish-gray laminated dolomite; gypsum bands are very common; contains olive-black and greenish-black shale in lower part; sharp base

15. Anhydrite, very light gray and light-bluish-gray, laminated; contains fibrous gypsum bands; includes partings and undulatory stringers of olive-black shale

14. Dolomite, light-brownish-gray and brownish-gray with intervals of olive-black laminated shale; some laminae steeply dipping; contains anhydrite-filled vugs and veins; gypsum and anhydrite bands common throughout; middle of unit consists of massive dolomite veins filled with anhydrite crystals; basal 1 ft consists of distinctly laminated dolomitic shale and dolomite

13. Anhydrite, bluish-white and light-bluish-gray, laminated to marbled; marbling produced by greenish-black and dark-greenish-gray shale veinlets and stringers; contains moderate-orange-pink fibrous gypsum at the top and bottom; sharp base

12. Shale, dark-greenish-gray, dolomitic, laminated; gypsum bands common; gradational base



11. Dolomite, light-brownish-gray and yellowish-gray; top slightly brecciated; contains dark-greenish-gray shale laminae; gradational base

10. Gypsum and anhydrite; occurs as nodules and veins in matrix of olive-black shale; shale badly fractured along gypsum veins and bands; gradational base

9. Anhydrite, bluish-white and light-bluish-gray; contains large veins of olive-gray and greenish-gray shale; includes rare olive-black shale and gypsum veins; fibrous gypsum veins at top and at the base; sharp base

8. Shale, olive-black, dolomitic, laminated; contains bands of light-brownish-gray dolomite; some dolomite bands and laminae disrupted; vertical fractures common; rare gypsum bands

7. Shale, greenish-gray and dark-greenish-gray, dolomitic, distinctly laminated with probably some gypsum laminae; includes some scattered intervals of light-brownish-gray laminated dolomite with wavy, often disrupted laminae; contains some moderate-orange-pink and very pale orange gypsum and anhydrite nodules; rare gypsum bands; some dolomite beds bioturbated; sharp base

6. Mudstone and shale, reddish-brown to moderate-brown, fractured; contains dark-greenish-gray shale at base; sharp base

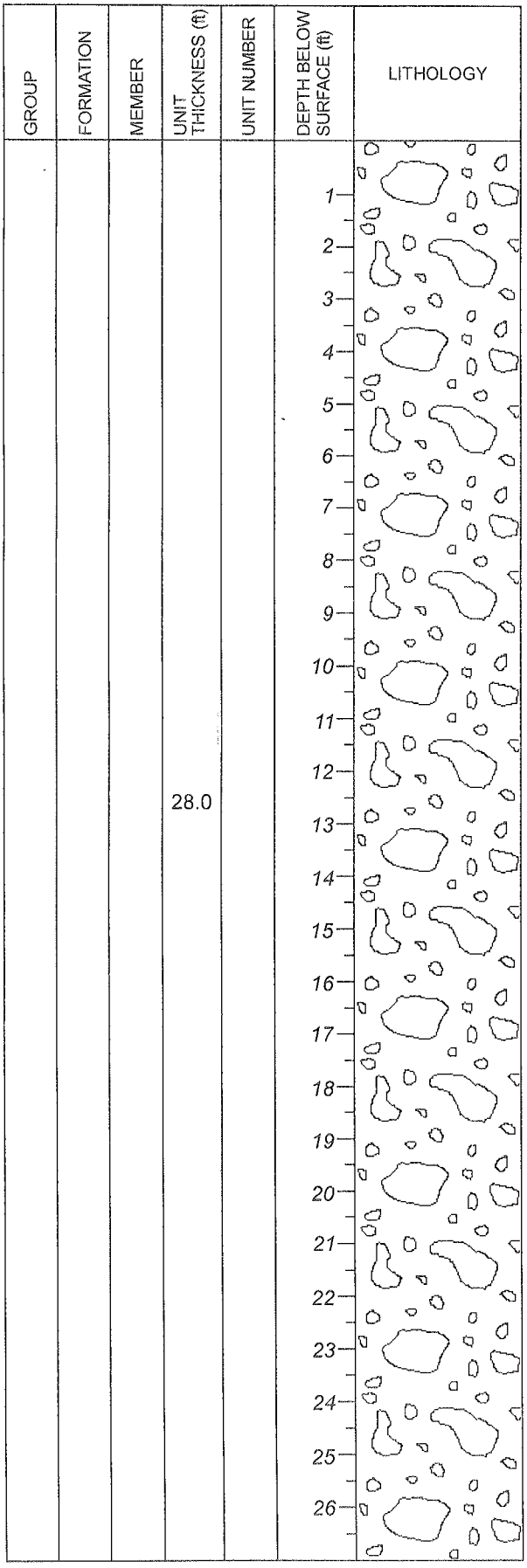
5. Anhydrite, bluish-white and light-bluish-gray, laminated; top slightly fibrous

4. Shale and dolomite; shale, greenish-black, dolomitic, laminated; dolomite, light-brownish-gray with some light-gray, pitted; gradational base

3. Shale, greenish-gray and dark-greenish-gray, laminated; lower part consists of olive-black laminated shale with light-brownish-gray dolomite; contains light-brownish-gray dolomitic intervals throughout; sharp base

2. Anhydrite, bluish-white with olive-black shale stringers; gradational base

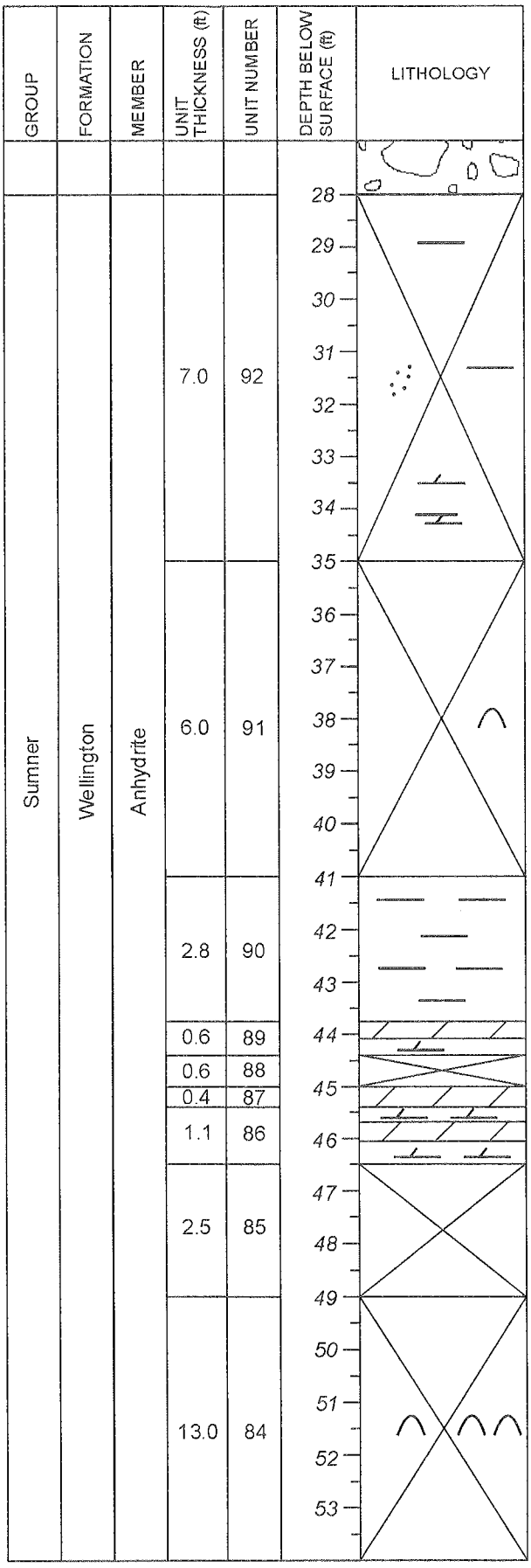
1. Dolomite, light-brownish-gray with olive-black shale bands and stringers; lower part with fenestral texture (bird's eye); contains rare gypsum bands



Core Hole KC-9
PRATT RANCH

SE¼NW¼NE¼SW¼ sec. 31, T. 29 N., R. 1 E., Peckham Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 2,000 ft from south line (FSL) and 1,700 ft from west line (FWL). Surface elevation from altimeter, 1,070 ft. Spudded in the basal part of the Wellington Formation. Field lithologic descriptions by James R. Chaplin.

Terrace deposits consist of light-olive-gray clay, silt, and well-sorted frosted sand grains; clay very sticky and plastic; some sand grains rounded



SUMNER GROUP

WELLINGTON FORMATION (87.9 ft)

Anhydrite Member (87.9 ft)

Unit no.

92. Loss of core; recovered some light-olive-gray and pale-yellowish-orange clay with medium- to coarse-grained sands; some medium-light-gray to medium-bluish-gray laminated dolomitic shale

91. Loss of core; recovered about 0.5 ft of anhydrite from interval

90. Mudstone, greenish-gray to olive-black at top; sharp base

89. Dolomite, upper part light-brownish-gray; lower part greenish-gray dolomitic shale

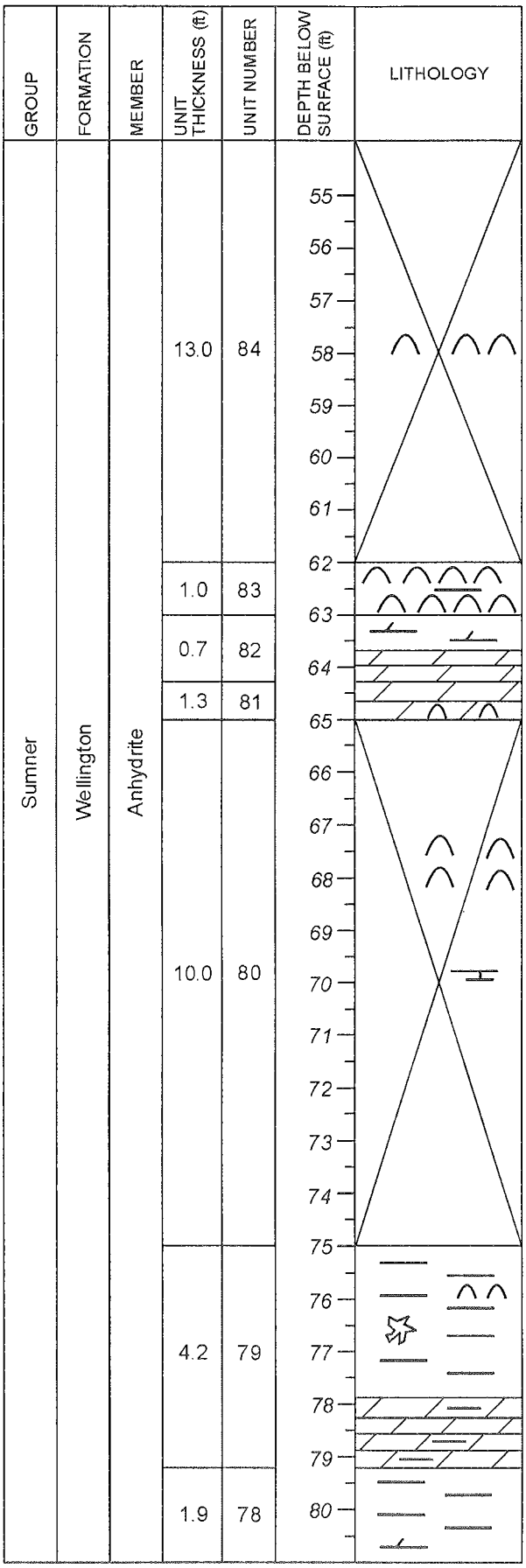
88. Loss of core

87. Dolomite, medium-light-gray to light-gray, vertical fractures common; base consists of soft clay

86. Dolomite and shale; shale, dark-greenish-gray, dolomitic; dolomite, light-brownish-gray to light-gray with dark-greenish-gray stringers of shale; laminated in lower part; some vertical fractures

85. Loss of core

84. Loss of core; recovered about 1.5 ft of anhydrite from interval



83. Anhydrite, very light gray to light-gray; contains olive-black shale stringers

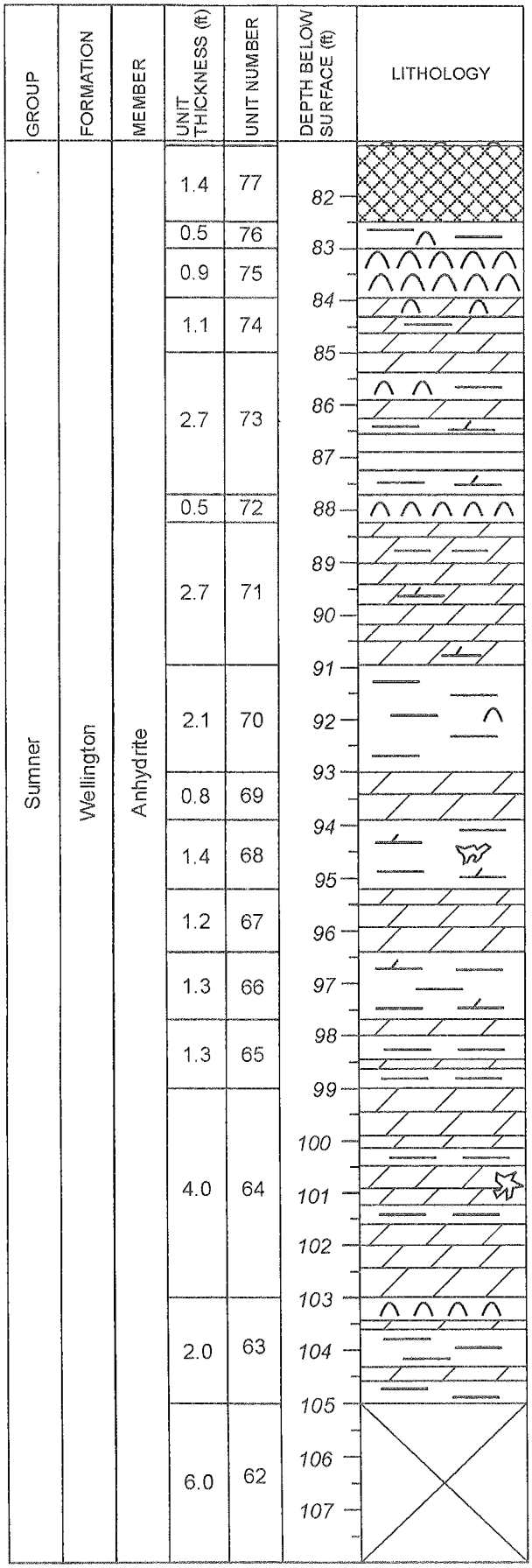
82. Shale, light-olive-gray to dark-greenish-gray, very dolomitic, dense, laminated

81. Dolomite, light-olive-gray to greenish-gray, pitted; contains gypsum bands at base

80. Loss of core; recovered about 2.0 ft of anhydrite and 0.6 ft of stromatolitic dolomite from this interval

79. Shale, greenish-gray with some light-brownish-gray to light-gray dolomite laminations; contains some bluish-white gypsum bands; includes some moderate-orange-pink vuggy gypsum nodules; lower 1.6 ft contains light-olive-gray to light-gray dolomite with shale laminations

78. Shale, dark-greenish-gray to olive-black with some light-brownish-gray dolomitic shale at base; slightly papery at the top; mottled medium-dark-gray to greenish-gray shale at base; contains a very thin gypsum band at the base



77. Salt and gypsum, pinkish-gray to very light gray, very vuggy and soluble, especially in the lower 0.6 ft; contains stringers of dark-greenish-gray shale

76. Shale, dark-greenish-gray; contains clasts of olive-gray that produce a brecciated look; includes some veins and bands of gypsum at base

75. Anhydrite, bluish-white with thin bands of bluish-white gypsum; contains olive-black shale at the top

74. Dolomite, light-brownish-gray to brownish-gray, laminated; contains a 1-in.-thick anhydrite band near the top; olive-black shale and a very thin gypsum band occur near the top

73. Dolomite and shale, light-gray to light-brownish-gray, laminated, stromatolitic, top pitted; dolomite at base is stromatolitic with greenish-black shale intercalations; distinctly laminated; shale, dark-greenish-gray, dolomitic; some intervals of brecciated edgewise dolomite clasts; includes a very thin gypsum band about 0.9 ft below the top; gradational base with dolomitic shale intercalations grading into gypsum below

72. Gypsum, bluish-white to very light gray; moderate-brown at the top and bottom; translucent; sharp base

71. Dolomite, light-olive-gray, laminated with some laminations disrupted, stromatolitic; contains some greenish-black shale intercalations; bioturbated; includes some dark-greenish-gray to olive-black dolomitic shale; dolomite at base is pitted; gradational base

70. Shale, dark-greenish-gray to greenish-black, slightly laminated, fractured; contains rare very thin transparent gypsum bands; gradational base

69. Dolomite, light-brownish-gray, pitted; includes rare greenish-gray shale stringers; gradational base

68. Shale, greenish-gray and dark-greenish-gray to greenish-black at base; dolomitic, slightly laminated; contains bluish-white to grayish-orange gypsum nodules

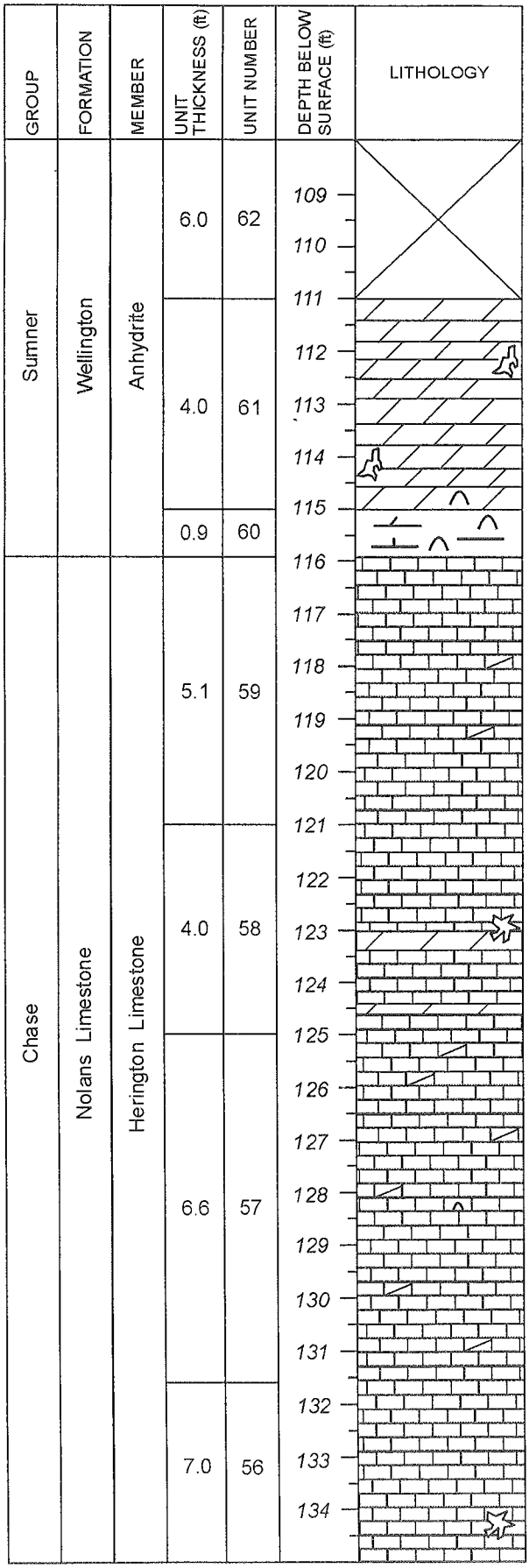
67. Dolomite, light-brownish-gray with greenish-black to dark-greenish-gray dolomitic shale laminations; includes some dark-greenish-gray shale veinlets

66. Shale, light-olive-gray, greenish-gray, and dark-greenish-gray, dolomitic, laminated

65. Dolomite, light-brownish-gray to brownish-gray alternating with laminations of dark-greenish-gray and greenish-black shale; some laminations lenticular, disrupted, or crenulated; starved ripples rare

64. Dolomite, yellowish-gray to light-brownish-gray, pitted at top; contains intervals of greenish-black laminated shale and dolomite; includes some intervals of bluish-white to grayish-orange nodular gypsum throughout; some chicken-wire texture noted; rare gypsum bands but some elongated fibrous gypsum crystals; gradational base

63. Dolomite and shale; dolomite, light-brownish-gray with gypsum and shale laminations; contains edgewise clasts of dolomite; includes some laminations of greenish-black and dark-greenish-gray dolomitic shale; surface pitted; upper part massive; basal 0.8 ft consists of stromatolitic dolomite with disrupted laminations forming edgewise conglomerate; contains two very thin transparent gypsum bands in upper 0.5 ft



62. Loss of core

61. Dolomite, light-brownish-gray with lower 3 ft light-brownish to olive-black, laminated, pitted; contains gypsum bands and nodular anhydrite throughout; includes some very small blebs of quartz

60. Shale, olive-black, dolomitic to calcareous; base calcareous; slightly laminated; contains two anhydrite bands

CHASE GROUP (229.1 ft)

NOLANS LIMESTONE (25.0 ft)

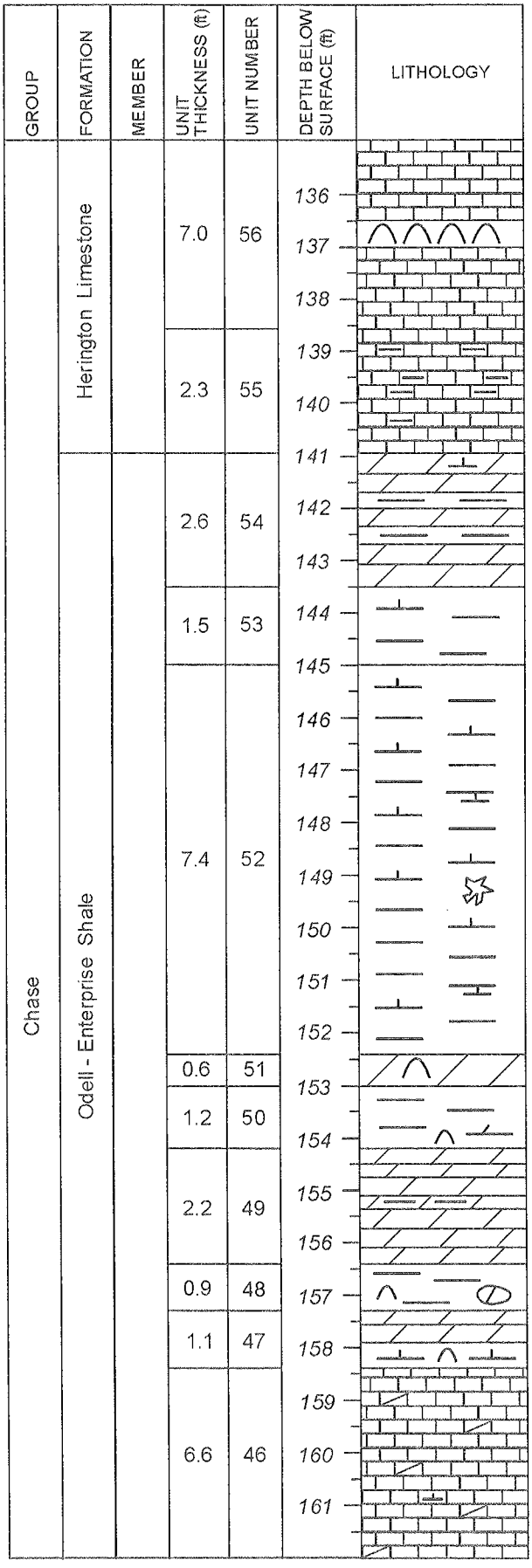
Herington Limestone Member (25.0 ft)

59. Limestone, medium-light-gray to light-gray, medium-crystalline, pitted with fossil molds; contains scattered irregular bands of light-brownish-gray dolomite

58. Limestone, white to bluish-white, sandy, finely crystalline with thin intervals of light-gray to light-brownish-gray dolomite; contains some nodular anhydrite; brachiopod molds common; includes rare olive-gray shale laminae

57. Limestone, medium-dark-gray to light-gray, finely crystalline, dolomitic, laminated; contains scattered lenses of shell material; includes rare fibrous medium-bluish-gray gypsum bands; contains rare very thin gypsum laminae; bioturbated, especially at the top

56. Limestone, medium-gray to dark-gray, fine- to medium-crystalline, fossiliferous (crinoidal); contains rare anhydrite nodules; includes a transparent gypsum band at 136.7 ft; basal 2 ft with large algal coated grains (osagid grains) in localized pockets



55. Limestone, medium-gray, medium-crystalline, shaly, fossiliferous (crinoidal); contains olive-black shale stringers; base brecciated and contains light-gray to light-brownish-gray micritic limestone clasts and dark-greenish-gray shale stringers; dolomitic at base

ODELL-ENTERPRISE SHALE (38.9 ft)

54. Dolomite, light-brownish-gray to light-gray, laminated to banded; contains intercalations of olive-black shale; slightly calcareous at top; laminations very wavy (stromatolitic) and often broken; contains some clasts and rare very thin gypsum laminations; bioturbated with vertical burrows

53. Shale, dark-greenish-gray to greenish-black; upper part calcareous

52. Shale, greenish-gray to dark-greenish-gray, calcareous, laminated; includes intervals of light-brownish-gray dolomite, some nodular; contains scattered pockets of fossil fragments, predominantly crinoidal; contains veins and nodules of moderate-orange-pink gypsum; some rare very thin gypsum and dolomite laminations; lower part badly fractured

51. Dolomite, light-brownish-gray with dark-greenish-gray shale stringers; some shale inclusions; slightly brecciated-appearance at base; top with moderate-reddish-orange gypsum band

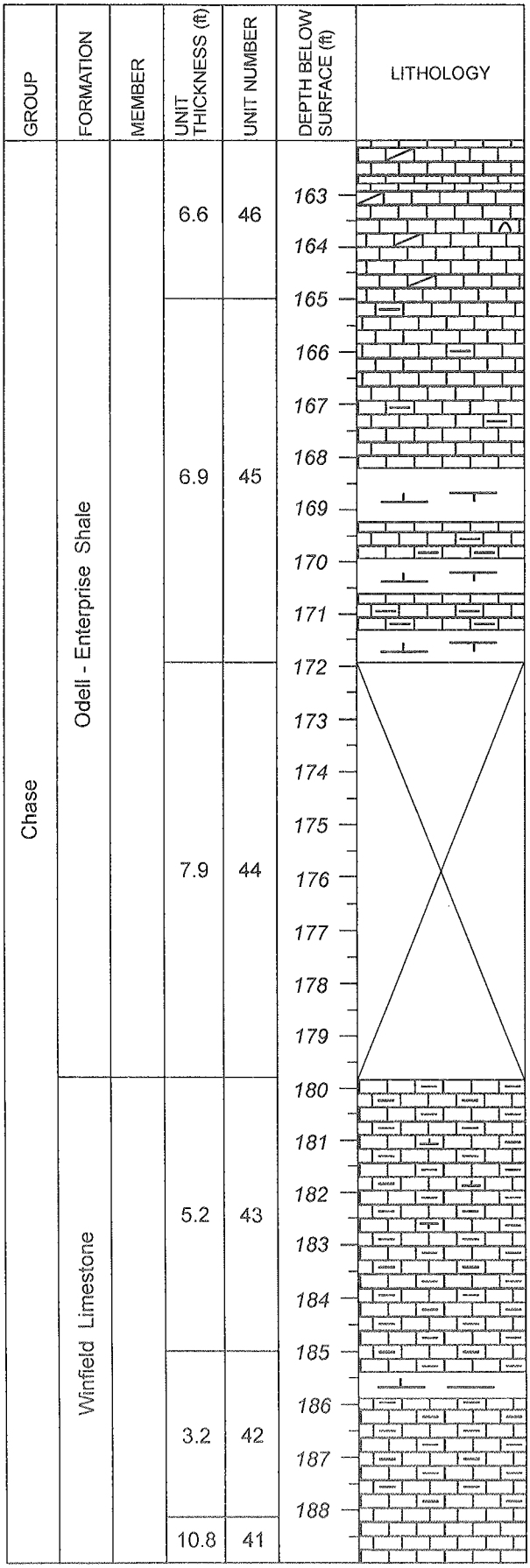
50. Shale, greenish-black to olive-black, dolomitic at base; contains a very thin gypsum band at base

49. Dolomite, yellowish-gray with abundant greenish-gray to dark-greenish-gray shale stringers; clasts of dolomite produce a clotted texture

48. Shale, dark-greenish-gray to grayish-purple to very dusky purple; contains light-brownish-gray to light-olive-gray dolomite clasts and nodules; includes rare gypsum bands

47. Dolomite, light-brownish-gray, stromatolitic, bird's-eye texture; contains some transparent gypsum bands; includes rare moderate-orange-pink gypsum bands; stromatolitic domal structures disrupted by growth of gypsum bands; base contains abundant greenish-gray calcareous shale and moderate-orange-pink gypsum nodules

46. Limestone, light-gray, greenish-gray, and light-olive-gray, finely crystalline, dolomitic, banded; contains calcareous shale and dolomite laminations; laminations are lensoidal; lenticular bedding; starved ripples; contains some very thin gypsum laminations, some disrupted; includes intercalations of olive-gray to olive-black distinctly laminated calcareous shale



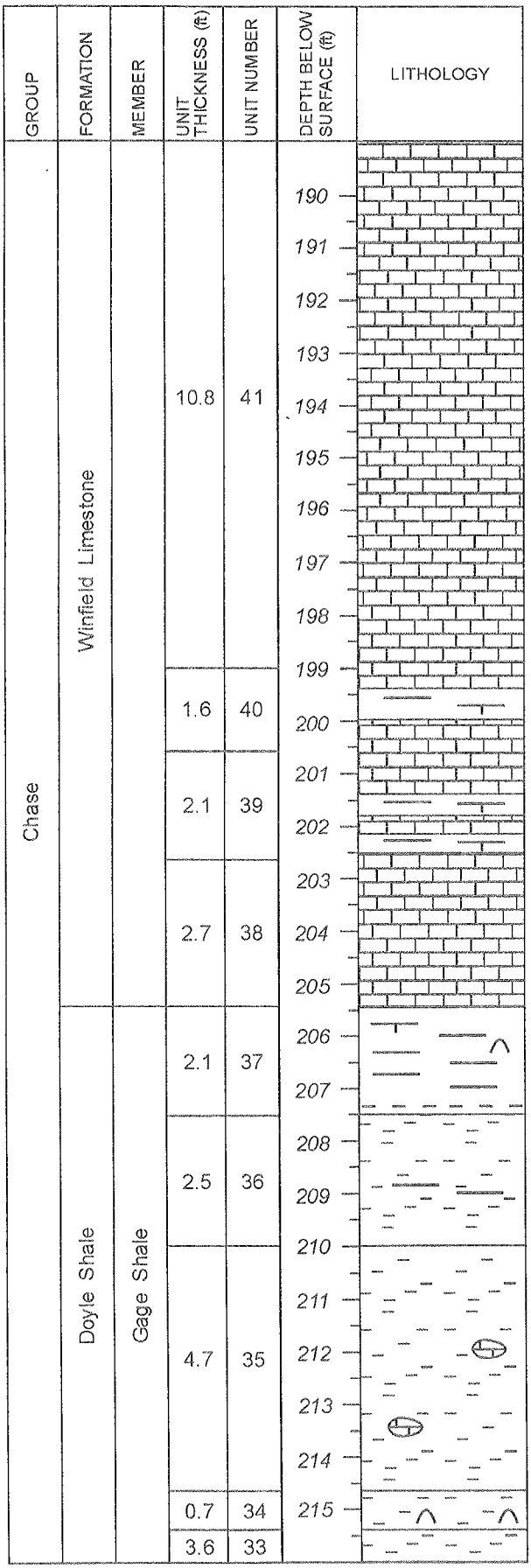
45. Limestone, and shale; limestone, medium-light-gray to light-gray, finely crystalline, shaly; contains very irregular lenses of dark-gray shale; most laminations highly irregular; lenticular bedding; bioturbated, especially in lower part; lower 3.6 ft consists of dark-gray to medium-dark-gray very calcareous shale and shaly limestone

44. Loss of core

WINFIELD LIMESTONE (25.6 ft)

43. Limestone, medium-light-gray to medium-gray, finely crystalline, shaly, very fossiliferous with crinoidal hash, algal grains, and echinoid spines; contains rare medium-dark-gray calcareous shale stringers; slightly laminated and more shaly in upper part

42. Limestone and shale; limestone, medium-light-gray to light-gray, finely crystalline, shaly, crinoidal; medium-dark-gray to dark-gray fossiliferous, calcareous shale occurs as stringers and as cavity fillings; includes medium-dark-gray calcareous, brachiopod-bearing beds, especially *Composita* at the base



41. Limestone, light-gray, medium-crystalline, algal, crinoidal, massive bed; pitted; contains very large algal coated (osagid) grains, especially from 194.0 to 196.0 ft; gradational base

40. Limestone, light-gray, fine- to medium-crystalline, with very large algal coated grains; contains irregular stringers of dark-gray crinoidal, calcareous shale; gradational base

39. Limestone, light-gray to light-brownish-gray, finely crystalline; contains intercalations of grayish-black to dark-gray laminated calcareous shale; sharp base

38. Limestone, medium-light-gray, medium-crystalline; includes very abundant medium-bluish-gray to dark-gray algal coated grains that produce a conglomeratic-looking texture; sharp base

DOYLE SHALE (74.0 ft)

Gage Shale Member (48.6 ft)

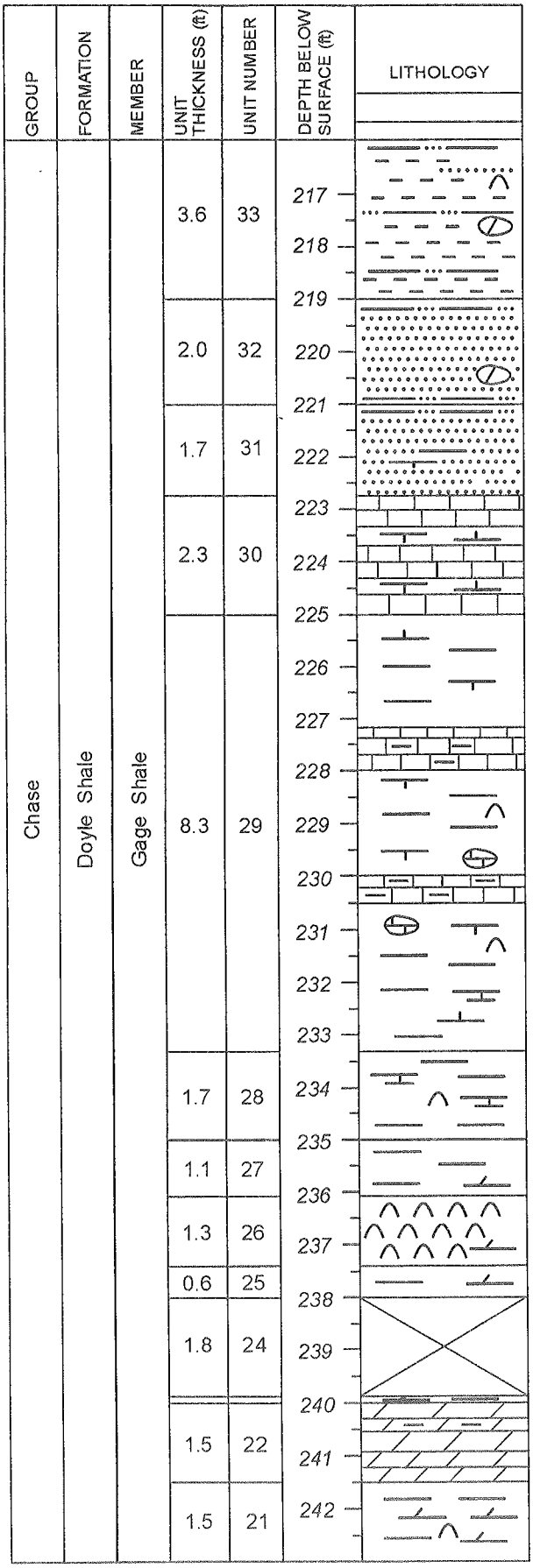
37. Mudstone, greenish-gray to dark-reddish-brown at base; slightly calcareous; contains rare gypsum bands

36. Mudstone, dark-reddish-brown with greenish-gray to medium-bluish-gray mudstone intercalations

35. Mudstone, dark-reddish-brown with rare greenish-gray to medium-bluish-gray mudstone interbeds; contains scattered pale-red micritic limestone nodules, especially common from 212.0 to 214.0 ft

34. Mudstone, dark-reddish-brown with abundant moderate-orange-pink gypsum nodules

33. Mudstone, dark-reddish-brown, very silty; contains rare very fine grained sandstone lenses; includes pale-reddish-brown to light-olive-gray dolomite nodules, some vesicular; rare gypsum bands



32. Siltstone and sandstone; sandstone, dark-reddish-brown with pale-reddish-brown to light-olive-gray dolomite nodules, very fine grained

31. Siltstone and sandstone; sandstone, dark-reddish-brown, very fine grained; interbedded with siltstone; contains medium-light-gray to light-gray laminations alternating with pale-red laminae; some laminations disrupted; slightly calcareous in local intervals

30. Limestone and shale; limestone, greenish-gray to medium-bluish-gray interbedded with calcareous shale; contains some very light gray laminations; top brecciated; vertical fractures common; base contains crinoidal hash

29. Shale, dark-greenish-gray tinted grayish-red, calcareous; contains some shaly limestone; includes large algal limestone nodules from 229.7 to 231.6 ft; contains scattered gypsum bands; some rare yellowish-gray dolomitic limestone with disrupted laminations

28. Shale, olive-black, greenish-black, and light-olive-gray, laminated; contains some thin finely crystalline limestone and gypsum bands; includes olive-black to grayish-black shale bands in lower part; contains rare light-brownish-gray to light-gray dolomite bands; fractured

27. Shale, olive-black to grayish-black, laminated; contains light-gray to light-brownish-gray dolomite bands; some rare calcareous laminations

26. Anhydrite, bluish-white, moderate-orange-pink, and very pale orange; contains stringers and veins of medium-dark-gray to dark-gray shale; includes an olive-black dolomitic shale band with gypsum band at base; sharp base

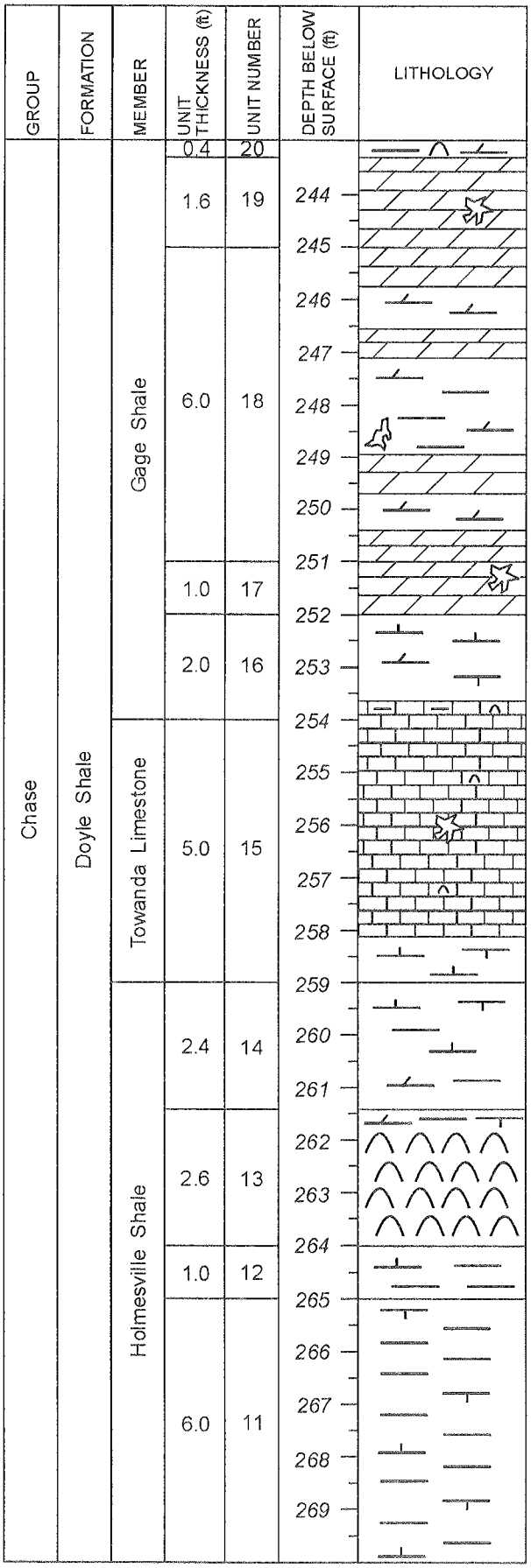
25. Shale, dark-greenish-gray to greenish-gray, slightly dolomitic

24. Loss of core

23. Shale, dark-greenish-gray, slightly dolomitic; contains very thin gypsum band at the base

22. Dolomite, light-gray to light-olive-gray with stringers of dark-greenish-gray shale; contains rare gypsum laminations; pitted; brecciated look, nodular at the top

21. Shale, light-olive-gray to greenish-gray, very dolomitic; contains rare gypsum bands



20. Shale, olive-black to greenish-black, very dolomitic; contains a gypsum band

19. Dolomite, light-brownish-gray to very light gray; upper part laminated, lower part vuggy and pitted; contains some stromatolitic structures; includes scattered anhydrite nodules and gypsum bands, some fibrous

18. Dolomite and shale; dolomite, light-brownish-gray, light-olive-gray, and yellowish-gray, laminated to massive; some intervals of olive-gray to olive-black dolomitic shale and shaly dolomite; contains scattered very pale-orange-anhydrite nodules; some rare bluish-white to medium-bluish-white fibrous gypsum bands; many dolomite laminations disrupted

17. Dolomite, medium-light-gray, slightly calcareous, pitted, fenestral texture; contains laminations at base and very pale orange nodular anhydrite at the top

16. Shale, light-olive-gray to light-brownish-gray, very calcareous, laminated; some slightly dolomitic intervals; contains olive-gray calcareous shale laminations; base consists of shaly limestone containing a fibrous gypsum band

Towanda Limestone Member (5.0 ft)

15. Limestone, medium-gray to medium-light-gray with some yellowish-gray mottling, finely crystalline, fossiliferous; includes some medium-bluish-gray fibrous gypsum bands; contains scattered anhydrite nodules with light-bluish-gray siliceous nuclei and very pale orange outer rinds; slightly sandy appearance; lower part consists of olive-gray to olive-black calcareous shale stringers and bands

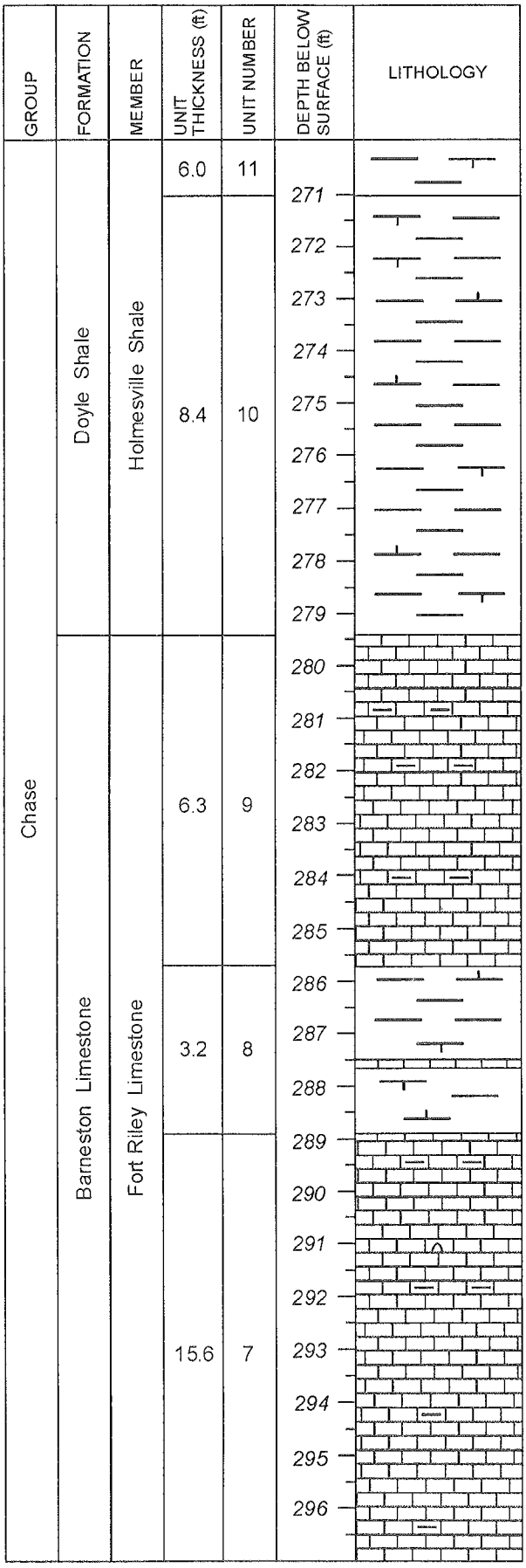
Holmesville Shale Member (20.4 ft)

14. Shale, light-brownish-gray to brownish-gray, laminated, very calcareous, slightly dolomitic

13. Anhydrite, bluish-white with brownish-gray to olive-gray dolomitic and calcareous shale stringers at top; slightly "marbled" texture due to stringers of greenish-gray to olive-gray shale

12. Shale, olive-gray to olive-black with rare calcareous bands

11. Shale, medium-light-gray, light-gray, and light-olive-gray, calcareous, laminated; laminations inclined to wavy with some cross-laminations; very light gray calcareous shale lenses common; bioturbated with churned bedding



10. Shale, olive-gray to medium-gray, very calcareous, massive; basal 0.6 ft packed with pelecypod (*Pecten*) molds

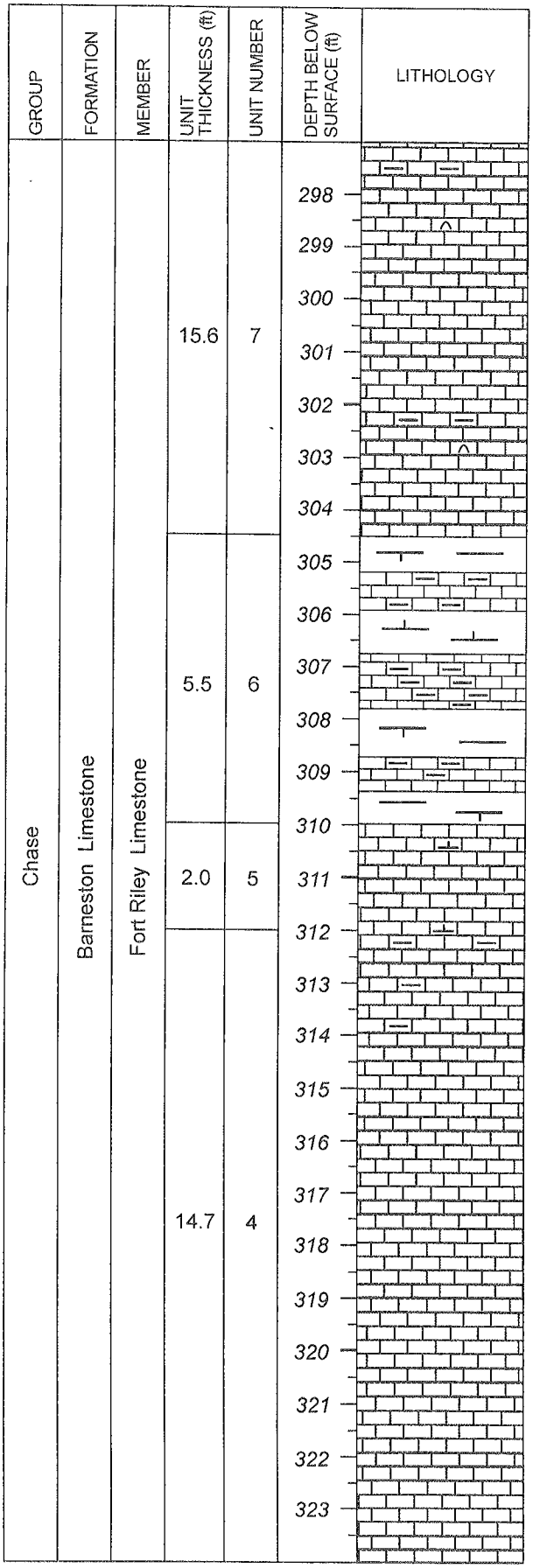
BARNESTON LIMESTONE (65.6 ft)

Fort Riley Limestone Member (47.3 ft)

9. Limestone, light-gray to yellowish-gray, very finely crystalline; contains greenish-gray and olive-gray calcareous shale stringers and bands; rare laminations; bioturbated with churned bedding, especially in lower 4 ft; fossils rare

8. Shale, olive-black to dark-gray, very calcareous; contains bands of light-gray to light-brownish-gray finely crystalline limestone; laminated, especially in basal 2 ft; contains scattered pockets and bands of fossil hash

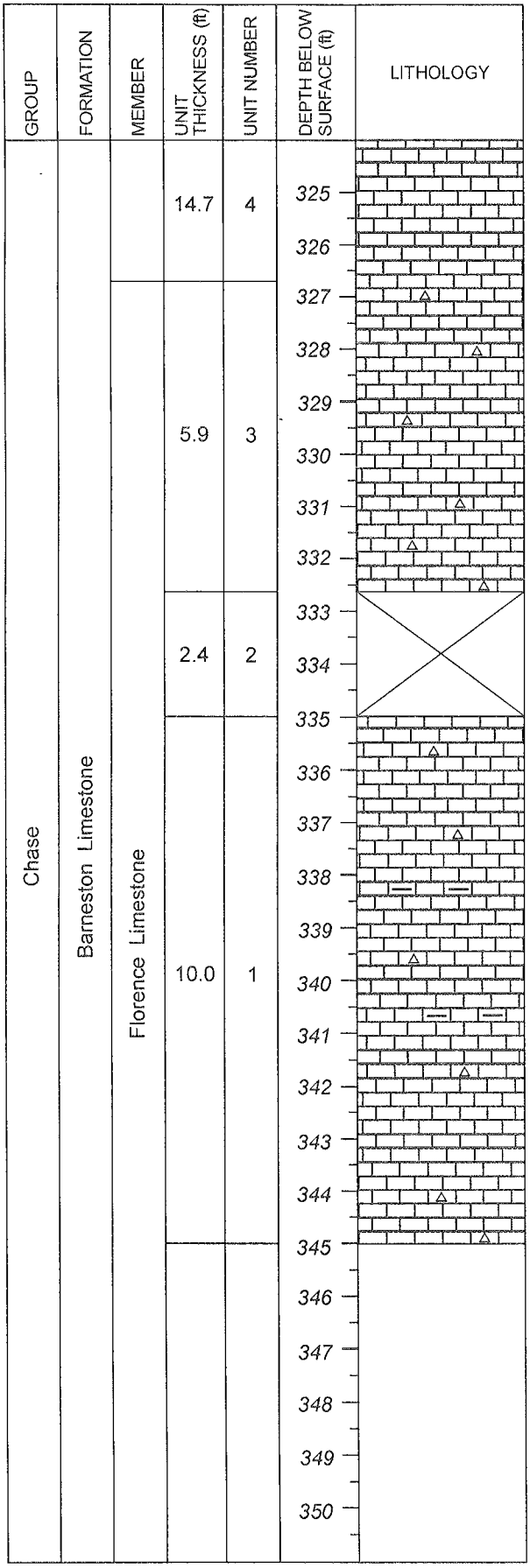
7. Limestone, medium-gray to medium-dark-gray, fine- to medium-crystalline, fossiliferous (crinoidal); contains scattered stringers of dark-gray shale; includes some cross sections of brachiopod valves (*Composita*); includes some intervals of shell hash; rare sponge spicules; gypsiferous



6. Shale and limestone; shale, olive-black to greenish-black, calcareous, slightly laminated; limestone, finely crystalline, very shaly; contains some laminations and bands of shell hash; basal 1 ft very crinoidal

5. Limestone, medium-gray to medium-dark-gray, fine- to medium-crystalline, algal, crinoidal; contains stringers of dark-gray and grayish-black calcareous shale

4. Limestone, medium-light-gray, medium-gray, and light-bluish-gray, medium-crystalline, algal; contains stringers of grayish-black calcareous shale, especially in upper 2 ft; some stylolitic seams; slightly vuggy; fossiliferous, especially crinoidal and rare very small gastropods; rare fusulinids between 320.0 and 322.0 ft; many fossil fragments with algal coatings; bioturbated

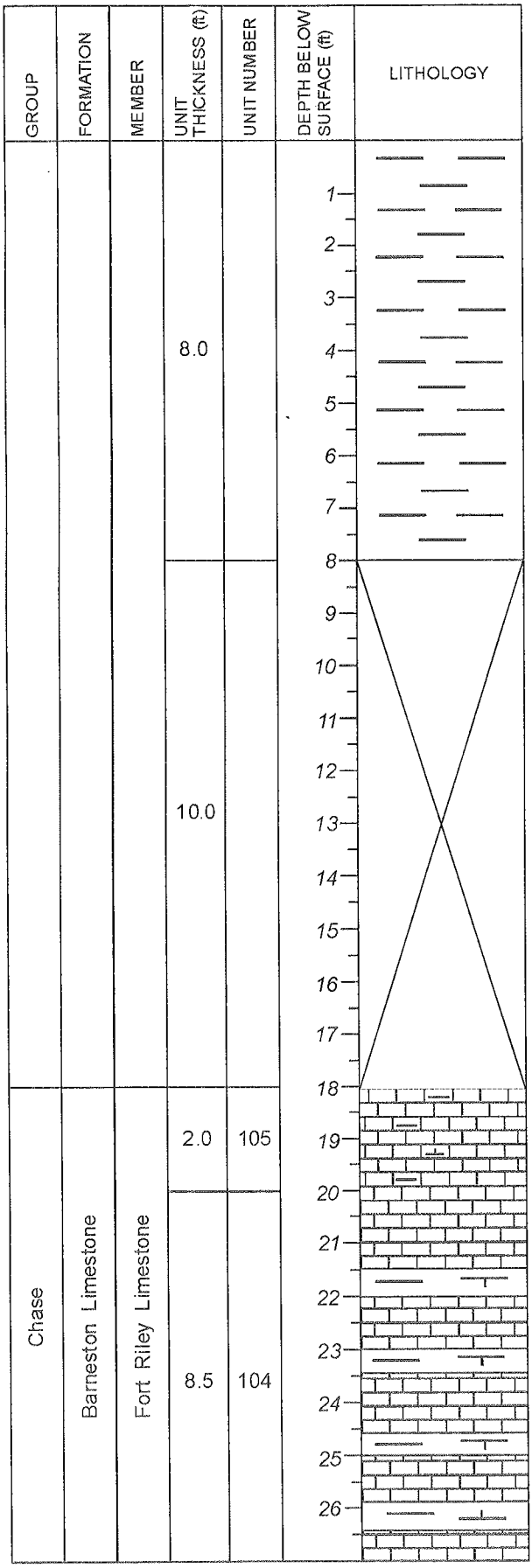


Florence Limestone Member (18.3 ft)

3. Limestone, light-gray to medium-light-gray with some light-bluish-gray mottling, finely crystalline; contains light-gray chert nodules; includes some stylolitic seams filled with grayish-black carbonaceous material; rare sponge spicules; very abundant large fusulinids

2. Loss of core

1. Limestone, light-olive-gray to yellowish-gray, finely crystalline; contains chert nodules; includes some scattered stringers of grayish-black shale; some stylolitic seams; pitted, very vuggy; contains very abundant large fusulinids



Core Hole KC-10
LANE RANCH

SE¼NW¼NW¼SW¼ sec. 18, T. 29 N., R. 4 E., Kaw City NW Quadrangle, Kay County. Drill cored by Oklahoma Geological Survey 2,000 ft from south line (FSL) and 350 ft from west line (FWL). Surface elevation from altimeter, 1,168 ft. Spudded on top of the Fort Riley Limestone Member of the Barneston Limestone. Field lithologic descriptions by James R. Chaplin.

Clay, moderate-brown; lower 3 ft very sticky and plastic

Loss of core

CHASE GROUP (160 ft)

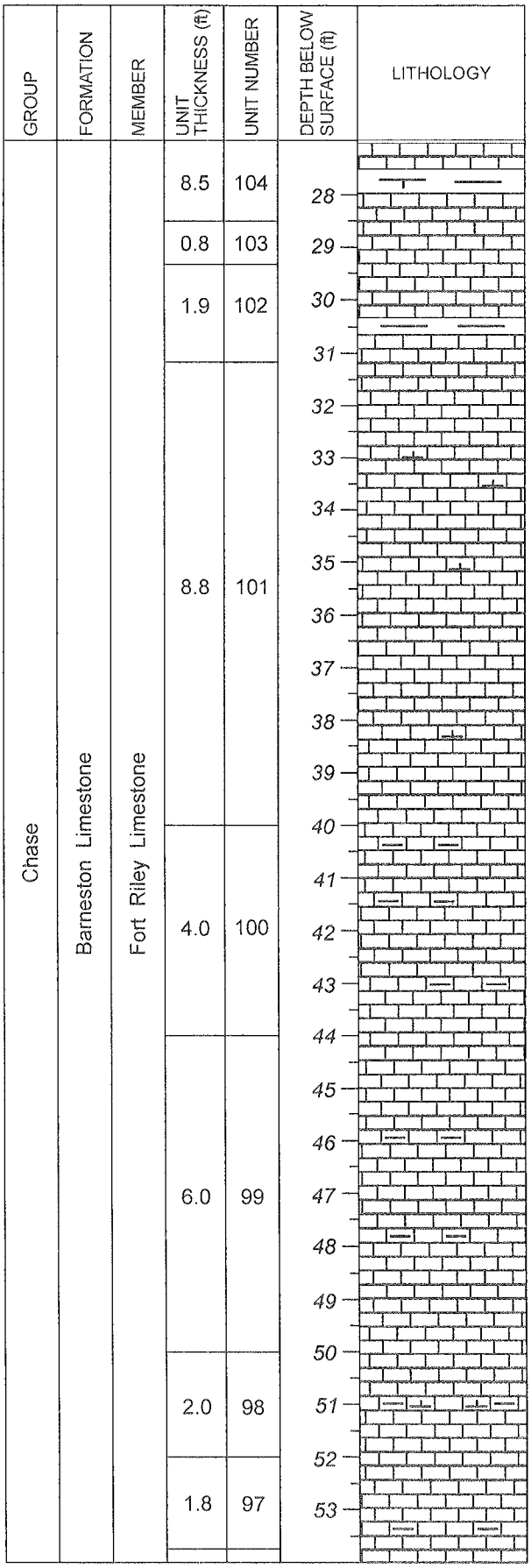
BARNESTON LIMESTONE (65.0 ft)

Fort Riley Limestone Member (44.0 ft)

Unit no.

105. Limestone, grayish-yellow, finely crystalline, shaly; contains partings of grayish-yellow calcareous shale; some limonite staining

104. Limestone, grayish-yellow to yellowish-gray, fine- to medium-crystalline, algal, fossiliferous; pitted with vesicular texture; contains partings and stringers of soft grayish-yellow calcareous shale; several intervals of soft punky limestone; crinoidal



103. Limestone, medium-light-gray to medium-bluish-gray, medium-crystalline, fossiliferous (crinoidal hash and brachiopods); contains stringers and veinlets of medium-dark-gray to dark-gray shale; base becomes grayish-yellow; bioturbated

102. Limestone, medium-light-gray to medium-bluish-gray, medium-crystalline, fossiliferous, especially crinoidal; includes stringers and partings of medium-dark-gray shale; some intervals of soft grayish-yellow to grayish-orange fossiliferous limestone; bioturbated

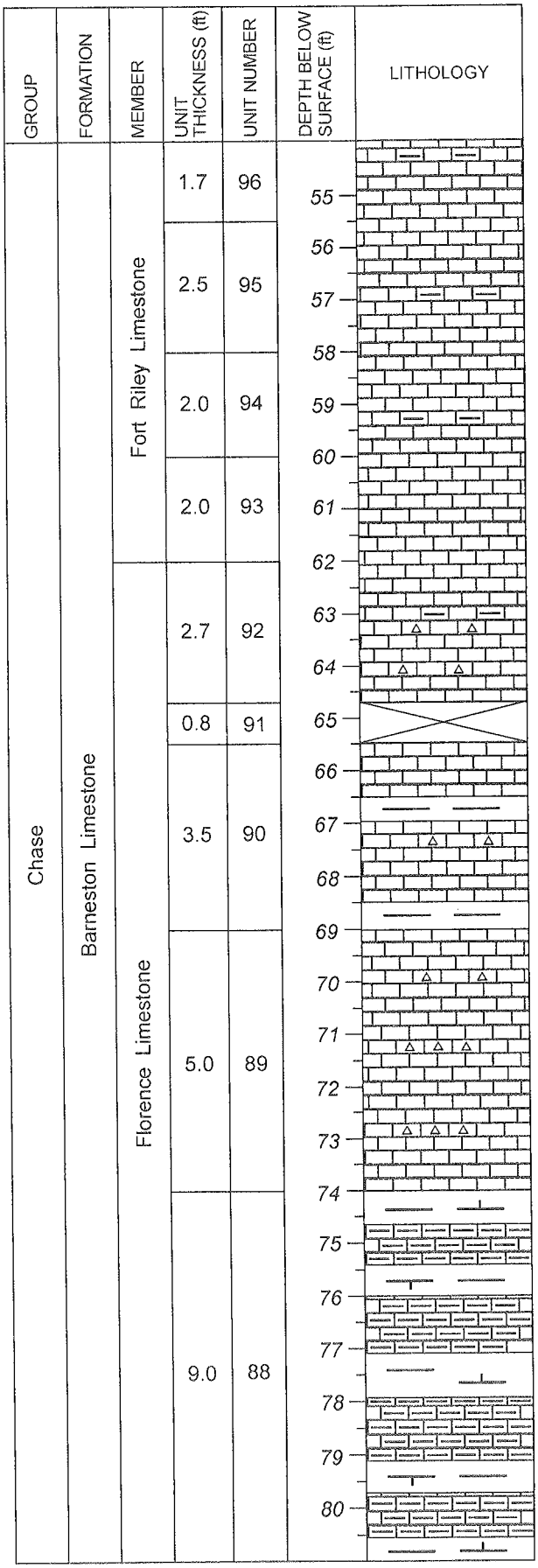
101. Limestone, medium-light-gray to medium-bluish-gray, fine- to medium-crystalline, very fossiliferous with brachiopods, crinoid fragments, and algae; contains stringers and veinlets of dark-gray, fossiliferous calcareous shale; includes some pockets and lenses of fossil hash; highly bioturbated with *Thalassinoides* systems

100. Limestone, bluish-gray, fine-crystalline, algal, very fossiliferous; contains numerous medium-dark-gray shale stringers; bioturbated with burrows filled with algally coated grains and fossil fragments; some vuggy intervals; predominantly an osagite limestone

99. Limestone, medium-bluish-gray, medium-crystalline, algal (osagite), fossiliferous; contains some medium-dark-gray shale stringers

98. Limestone, light-bluish-gray, medium-crystalline, algal, very fossiliferous (crinoidal); includes some medium-dark-gray calcareous shale stringers; some stringers are stylolitic

97. Limestone, yellowish-gray, medium-crystalline, vuggy, limonitic stained; contains rare shale stringers



96. Limestone, medium-bluish-gray, medium-crystalline, algal, fossiliferous; contains medium-dark-gray stylolitic shale stringers

95. Limestone, light-bluish-gray to medium-bluish-gray, finely crystalline, algal, pitted, slightly vuggy; fossiliferous with rare solitary coals; includes some medium-dark-gray, slightly pyritic, stylolitic shale seams

94. Limestone, yellowish-gray, finely crystalline, fossiliferous with crinoidal hash and fusulinids; contains some medium-dark-gray stylolitic shale seams

93. Limestone, yellowish-gray, finely crystalline, slightly pitted; contains a few large clay-lined stylolitic seams

Florence Limestone Member (21.0 ft)

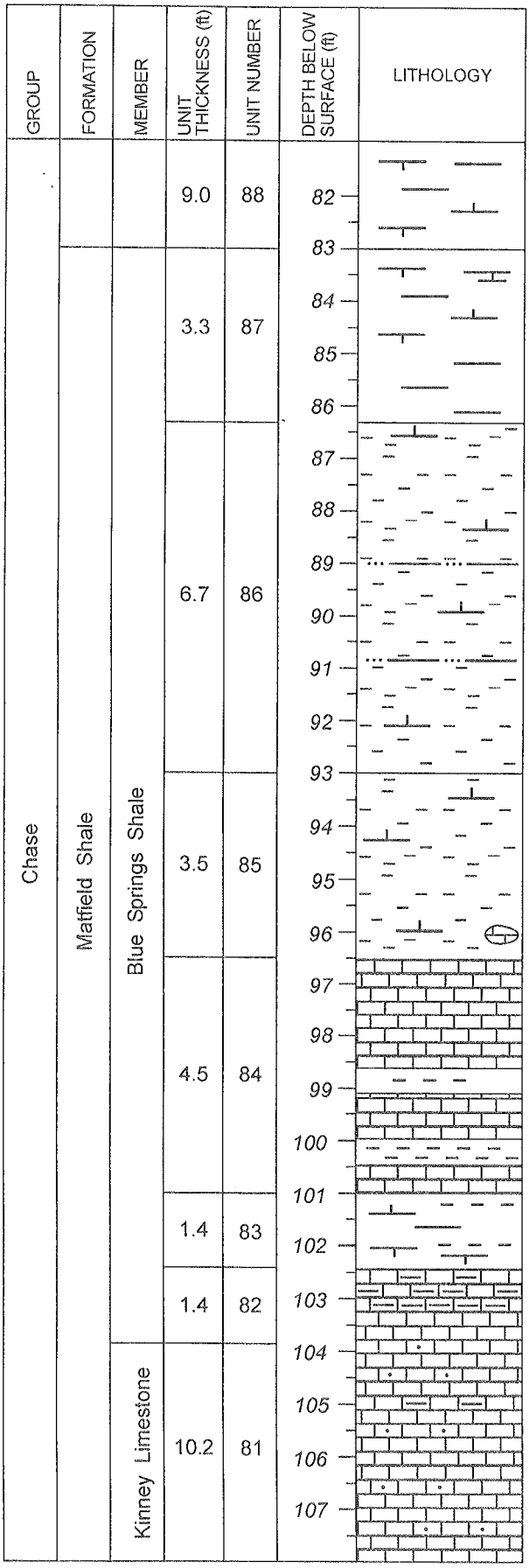
92. Limestone, light-bluish-gray, pitted, very vuggy; granular to sandy appearance and feel; contains scattered stringers and seams of medium-dark-gray clay shale; includes some large stylolitic seams; fracture surfaces lined with carbonaceous films; fossils include rare solitary corals and cross sections of large brachiopods; contains some cherty bands

91. Loss of core

90. Limestone, light-bluish-gray, finely crystalline, very vuggy, fossiliferous; contains rare chert bands; includes some medium-dark-gray shale stringers, some of which are stylolitic; fossils include solitary corals and cross sections of brachiopod valves; base mottled yellowish-gray

89. Limestone, yellowish-gray to grayish-yellow, finely crystalline, very vuggy, fossiliferous; siliceous with light-gray to very light gray chert bands packed with fusulinids; upper 1 ft less siliceous; gradational base

88. Limestone and shale, light-bluish-gray, very fossiliferous with brachiopods and rare solitary corals; upper part consists of very fossiliferous (crinoidal) calcareous shale alternating with shaly limestone beds containing rare solitary corals; contains stringers of medium-dark-gray to medium-gray shale throughout; some vugs, pyritic; lower 3 ft predominantly calcareous fossiliferous shale with medium-light-gray bands; some intervals bioturbated; gradational base



MATFIELD SHALE (59.6 ft)

Blue Springs Shale Member (20.8 ft)

87. Mudstone, greenish-gray, calcareous; contains thin fossiliferous limestone lenses in the upper part

86. Mudstone, dark-reddish-brown with some greenish-gray mottling at the top, calcareous; contains some silty intervals; fracture surfaces are slickensided

85. Shale, dark-reddish-brown, calcareous; basal 0.5 ft contains grayish-pink finely crystalline limestone nodules; fracture surfaces are slickensided

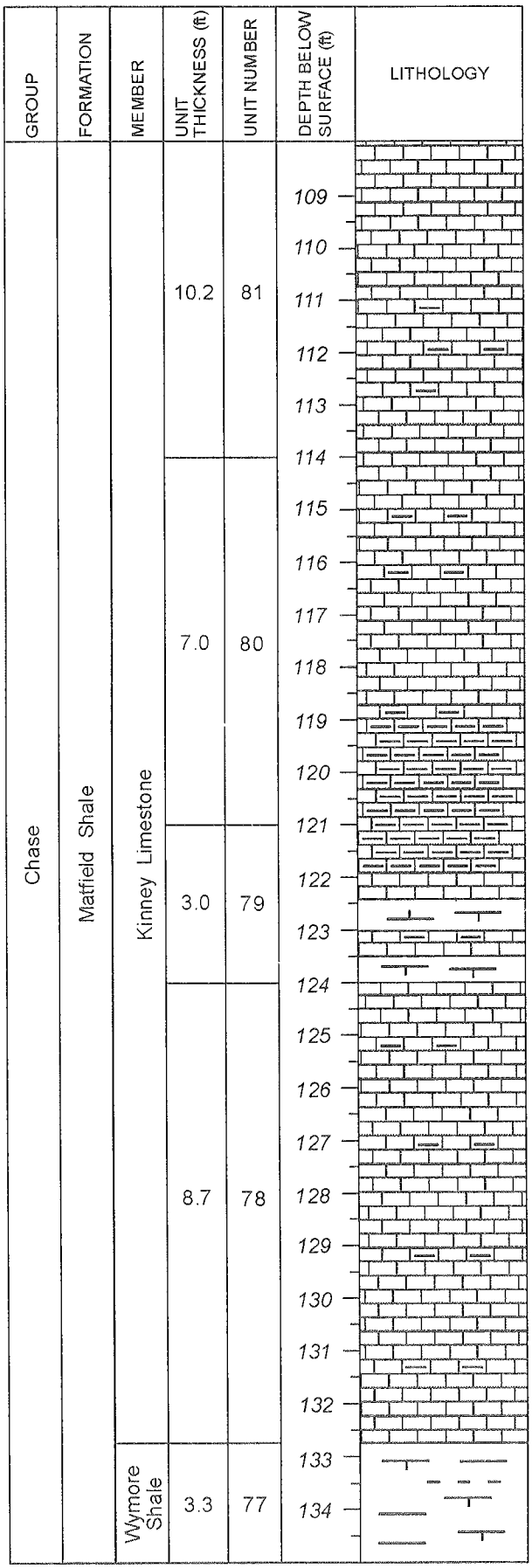
84. Limestone, grayish-pink to pale-red, finely crystalline, algal; nodular bedding contains grayish-red to dark-reddish-brown shale stringers throughout; bioturbated with *Chondrites*

83. Shale, medium-gray to grayish-pink, calcareous; includes grayish-red veinlets of shale; bioturbated with very abundant *Chondrites*; some disrupted, wavy to inclined laminations

82. Limestone, medium-light-gray to light-gray, finely crystalline, shaly, top laminated; contains stringers and veinlets of dark-greenish-gray to greenish-black shale

Kinney Limestone Member (28.9 ft)

81. Limestone, light-gray to yellowish-gray, fine- to medium-crystalline, algal, slightly pitted, fossiliferous; granular to sandy, especially in the upper 4 ft; contains rare medium-gray shale stringers in upper 6 ft that increase in lower part; vesicular texture; more finely crystalline in lower 4 ft



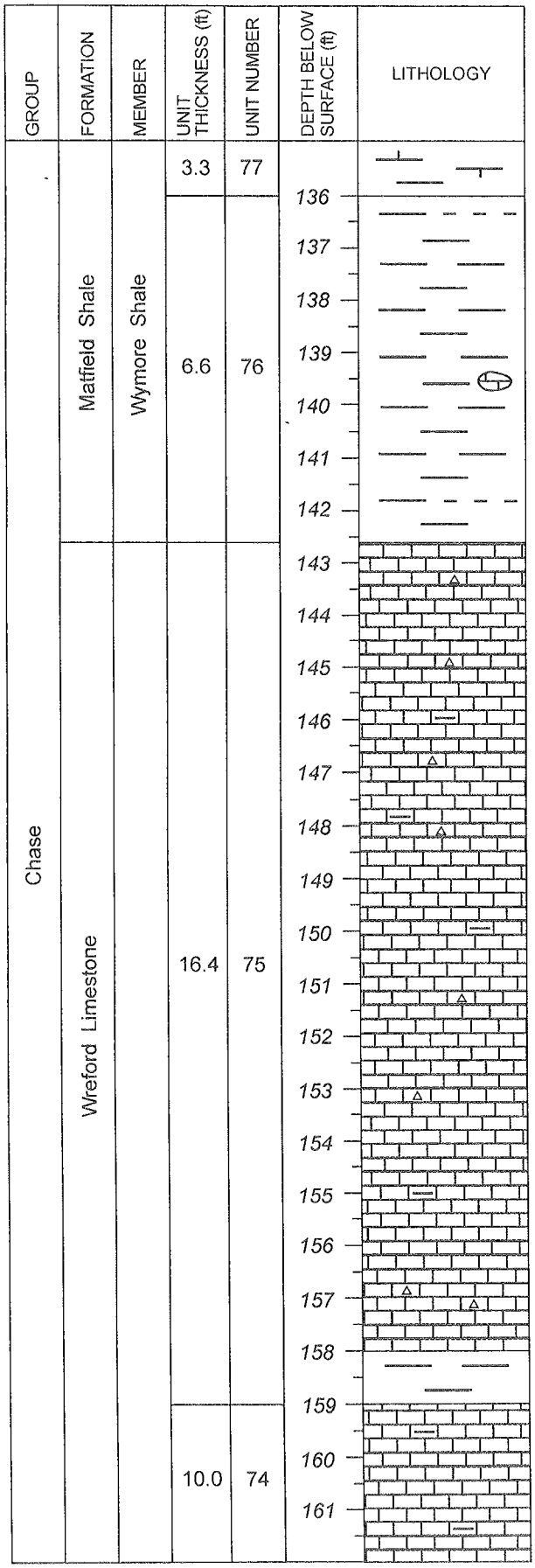
80. Limestone, medium-light-gray to light-gray, finely crystalline; some intervals laminated; contains numerous stringers of medium-dark-gray to dark-greenish-gray shale; fossils rare; lower part more shaly and fossiliferous

79. Limestone, medium-light-gray to light-gray, finely crystalline, shaly; medium-gray to dark-greenish-gray calcareous shale very common

78. Limestone, light-gray to medium-light-gray, very finely crystalline, algal coated grains common; very fossiliferous with large brachiopod valves in cross section; contains very abundant veinlets, some stylolitic, of dark-gray to grayish-black shale; very large algal coated grains (osagid grains) in interval from 128.0 to 132.7 ft; sharp base

Wymore Shale Member (9.9 ft)

77. Mudstone, greenish-gray to medium-bluish-gray with some rare dark-reddish-brown mottling, calcareous

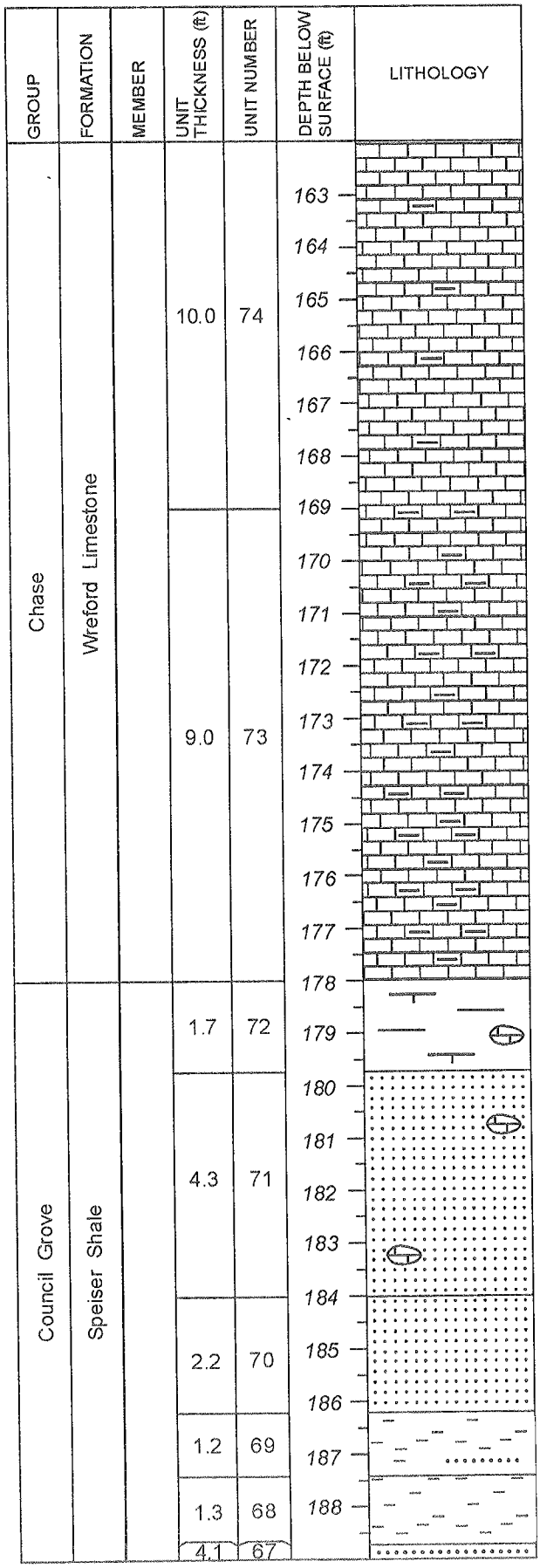


76. Mudstone, mottled greenish-gray, medium-bluish-gray, and dark-reddish-brown in upper 1 ft; basal 1 ft mottled as in upper 1 ft; contains rare small limestone nodules; sharp base

WREFORD LIMESTONE (35.4 ft)

75. Limestone, very light gray to light-gray, finely crystalline, algal, pitted, fossiliferous; contains very light gray to light-gray chert nodules; includes some veinlets of medium-dark-gray, greenish-gray and dark-greenish-gray shale; fine vesicular texture; some rare quartz-filled vugs; base with dark-gray to grayish-black shale seams

74. Limestone, medium-light-gray to medium-gray, finely crystalline, large brachiopod valves; contains scattered stringers and veinlets of dark-greenish-gray, dark-gray, and olive-black shale; includes some discoloration pockets of rounded clasts with sponge spicules; some vugs, pitted



73. Limestone, medium-light-gray to medium-gray, very finely crystalline, very shaly, very fossiliferous with large fossil fragments; some dark-greenish-gray to greenish-black, calcareous shale with cross sections of large fossil fragments; shale contains medium-light-gray rounded clasts of finely crystalline limestone; veinlets of dark-greenish-black to greenish-black shale common

COUNCIL GROVE GROUP (212.3 ft)

SPEISER SHALE (33.0 ft)

72. Mudstone, medium-bluish-gray to dark-greenish-gray, calcareous; contains scattered finely crystalline limestone nodules and granules

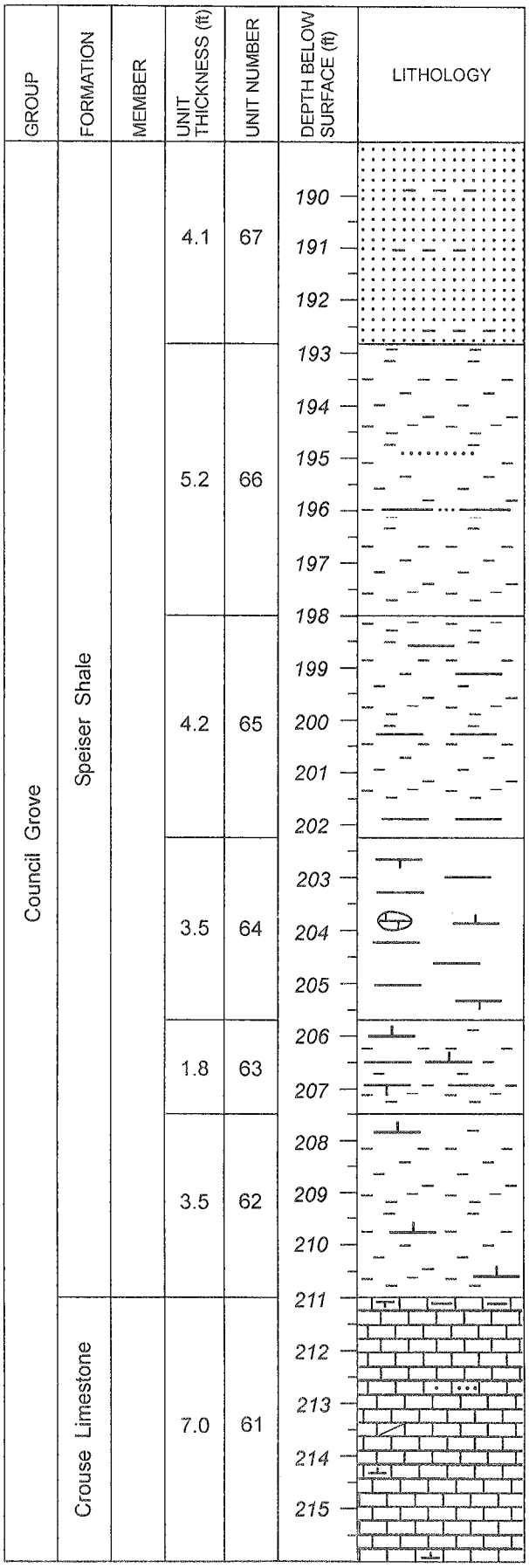
71. Sandstone, grayish-red to pale-red, very fine grained, cross-laminated; contains small very light gray limestone nodules throughout; laminations very churned, irregular, and inclined; includes some veinlets and fracture fillings of grayish-red shale; vertical fractures common

70. Sandstone, grayish-red to pale-red, fine-grained, cross-laminated; laminations highly churned; contains some veinlets of grayish-red shale; some fractures

69. Mudstone, dark-reddish-brown to grayish-red; contains very abundant lenses of very fine grained sandstone in a mudstone matrix

68. Mudstone, dark-reddish-brown to grayish-red

67. Sandstone, pale-red, very fine grained, some cross-laminations; contains veinlets and partings of grayish-red mudstone and shale; some light-gray to light-bluish-gray mottled intervals; mudstone increases in basal 1 ft



66. Mudstone, grayish-red to dark-reddish-brown with rare mottled intervals of light-bluish-gray; contains some siltstone and cross-laminated sandstone lenses

65. Mudstone, dark-reddish-brown with light-bluish-gray to medium-bluish-gray; fracture surfaces slickensided

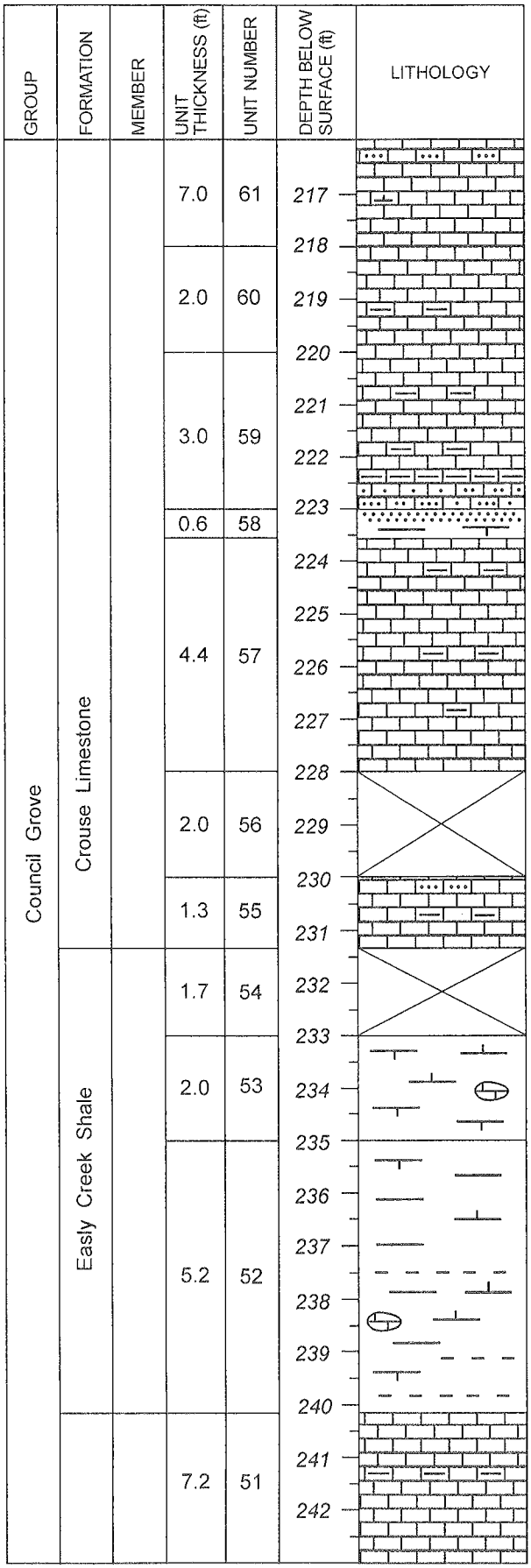
64. Mudstone, predominantly light-bluish-gray with some medium-bluish-gray, and rare dark-reddish-brown mottling, calcareous; contains scattered very small limestone nodules; some fracture surfaces lined with carbonaceous films

63. Mudstone, dark-reddish-brown, medium-bluish-gray, and light-bluish-gray, calcareous; contains rare small pale-red finely crystalline limestone granules

62. Mudstone, dark-reddish-brown with rare medium-bluish-gray and light-bluish-gray mottling, calcareous; includes some large algal limestone nodules about 1 ft above the base

CROUSE LIMESTONE (20.3 ft)

61. Limestone, very light gray to pale-pink, algal, nodular bedding; top 0.5 ft brecciated and consists of greenish-gray calcareous shale and shaly limestone; slightly dolomitic; contains very wavy stringers of pale-purple, pale-red-purple, grayish-purple, and greenish-gray calcareous shale; very clotted texture produced by nodular algal limestone; slightly sandy; includes some dark-yellowish-orange nodules; gradational base



60. Limestone, light-gray to pale-pink, very finely crystalline, slightly nodular; contains wispy stringers of medium-dark-gray, very dusky purple, dark-greenish-gray shale and mudstone; includes some ghosts of gastropod shells

59. Limestone, light-gray to very light gray, finely crystalline, nodular, algal; brownish-black shale common; basal 0.6 ft consists of sandy limestone

58. Sandstone, medium-gray to medium-light-gray stained dusky-yellow, very fine grained, slightly calcareous, laminated; lower part very shaly

57. Limestone, light-gray, very finely crystalline, nodular, algal; contains wispy olive-black, brownish-black, greenish-black, dark-greenish-gray shale stringers and veinlets; base predominantly olive-black

56. Loss of core

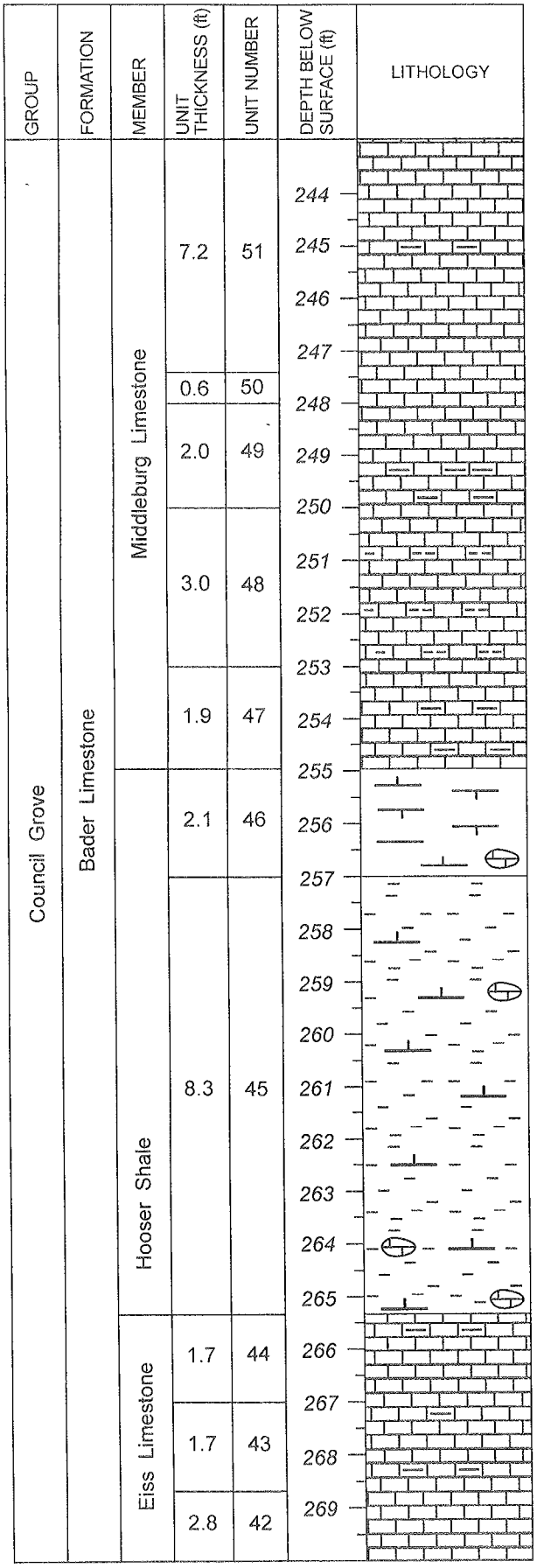
55. Limestone, light-gray, finely crystalline, slightly sandy; contains medium-light-gray shale stringers

EASLY CREEK SHALE (8.9 ft)

54. Loss of core

53. Shale, medium-gray to medium-bluish-gray, very calcareous; contains very small nodules of finely crystalline limestone

52. Shale, medium-bluish-gray to dark-reddish-brown, top predominantly medium-bluish-gray with dusky-yellow staining, very calcareous; contains rare light-gray to white finely crystalline limestone nodules



BADER LIMESTONE (37.2 ft)

Middleburg Limestone Member (14.7 ft)

51. Limestone, bluish-white to pale-pink, very finely crystalline, brecciated; contains veinlets and stringers of grayish-purple to dark-reddish-brown shale; includes desiccation features of an exposure surface; contains some medium-bluish-gray to dark-greenish-gray shale clasts; dry surface has a distinct chalky white color

50. Limestone, light-gray with dark-reddish-brown shale stringers and veinlets

49. Limestone, pale-pink, finely crystalline, algal; contains some intervals of very dusky purple, dusky-yellow, and dark-greenish-yellow mottling; very clotted texture; includes very abundant very dusky purple to dark-reddish-brown mudstone stringers

48. Limestone, light-gray, finely crystalline, very algal; upper part brecciated; includes scattered stringers of dark-reddish-brown to very dusky purple shale; some light-brown mineralization noted in upper 2 ft

47. Limestone, medium-light-gray to bluish-white, very finely crystalline, nodular, algal; contains very abundant wavy stringers and veinlets of greenish-black to moderate-olive-brown shale; floating algal grains very common in shale stringers

Hooser Shale Member (10.4 ft)

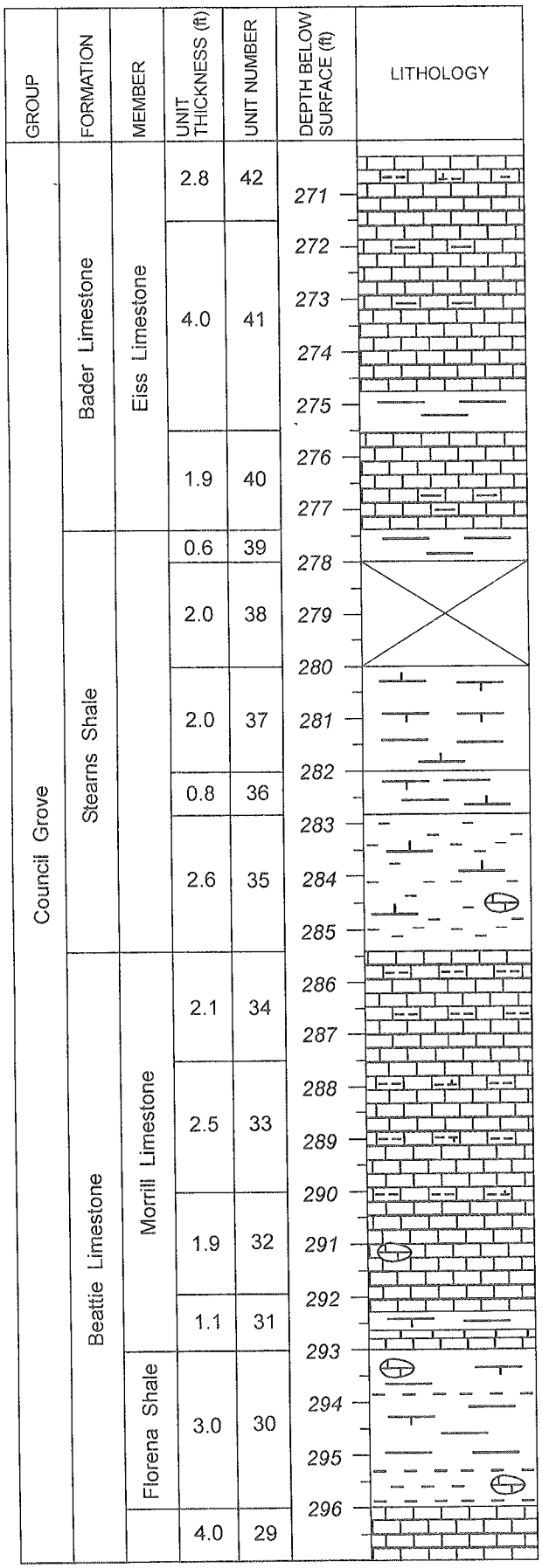
46. Shale, medium-bluish-gray to dark-greenish-gray with light-olive-brown mottling, very calcareous, contains rare finely crystalline limestone nodules in lower part; gradational base

45. Shale, predominantly grayish-red with rare medium-bluish-gray mottling, very calcareous; finely crystalline limestone nodules rare in upper part but increase near base; sharp base

Eiss Limestone Member (12.1 ft)

44. Limestone, grayish-pink, pale-red, and pale-pink, very finely crystalline, nodular, pitted, algal at top; greenish-gray shale common in nodular limestone interval at top; contains veinlets of dark-reddish-brown shale

43. Limestone, dark-reddish-brown with pale-red, very finely crystalline clasts; brecciated-look with some algal limestone nodules; contains stringers of greenish-gray shale; very brecciated-look in lower part; badly fractured



42. Limestone, grayish-pink, grayish-orange-pink, and pale-pink, very finely crystalline; contains rare veinlets of dark-reddish-brown calcareous shale

41. Limestone, pale-pink to grayish-pink, highly algal; algal coated grains very common in shale stringers; contains dark-reddish-brown to pale-pink shale veinlets; some shale stringers appear stromatolitic; basal 0.6 ft has mottled intervals of light-olive-brown to dusky-yellow shale; gradational base

40. Limestone, bluish-white to very light gray with mottled intervals of dusky-yellow to light-olive-brown calcareous shale; some medium-light-gray shale beds

STEARNS SHALE (8.0 ft)

39. Mudstone, medium-bluish-gray to dark-greenish-gray; top mottled dusky-yellow and light-olive-brown

38. Loss of core

37. Mudstone, medium-bluish-gray to dark-greenish-gray; upper 1 ft calcareous, lower 1 ft slightly calcareous

36. Mudstone, medium-bluish-gray with some dark-reddish-brown mottling, calcareous, rare limestone granules

35. Mudstone, dark-reddish-brown mottled medium-bluish-gray; contains scattered light-gray to light-bluish-gray limestone granules and very small nodules; calcareous, fracture surfaces slickensided

BEATTIE LIMESTONE (18.6 ft)

Morrill Limestone Member (7.6 ft)

34. Limestone, grayish-pink to pale-red, very finely crystalline, algal, slightly nodular, fenestral texture; includes stringers and veinlets of dark-reddish-brown shale; dry surfaces have a distinct chalky white look

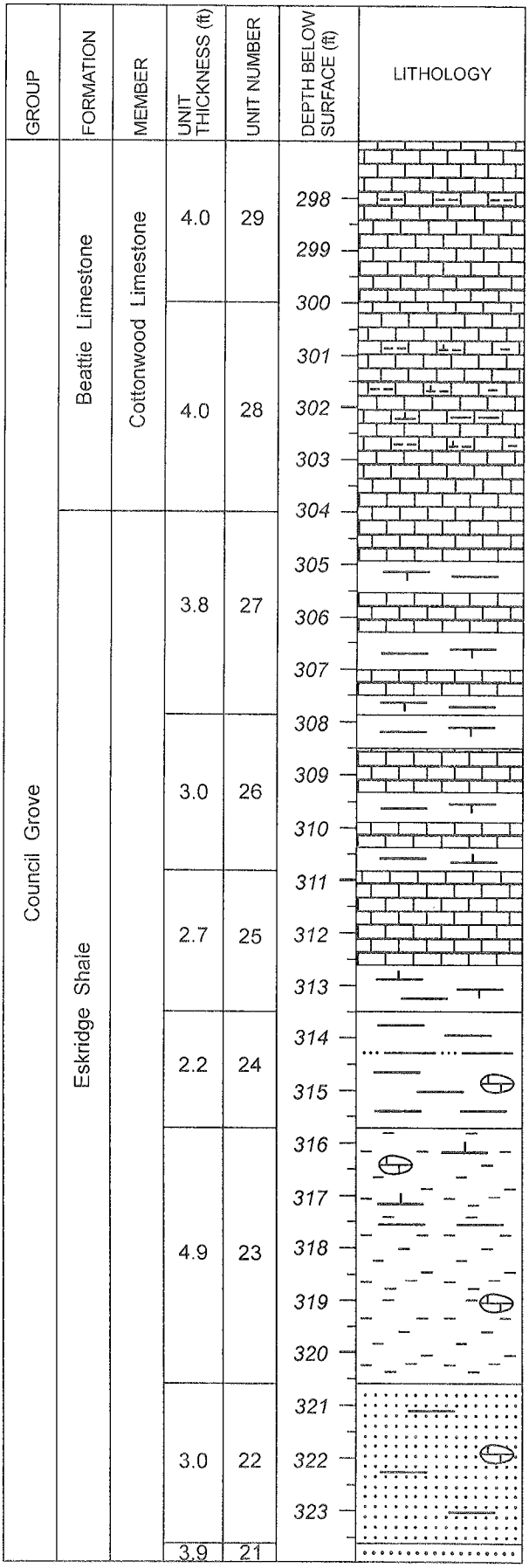
33. Limestone, pale-red to grayish-red, very finely crystalline, fossiliferous with crinoidal hash, fusulinids, rare solitary corals, and bryozoans; contains grayish-red calcareous, fossiliferous shale stringers; calcareous shale more common at base

32. Limestone, dark-reddish-brown to dusky-red, very finely crystalline, very fossiliferous, rare solitary corals, and bryozoans; includes some pale-olive finely crystalline limestone nodules; gradational base

31. Limestone, medium-light-gray, mottled dusky-yellow to light-olive-brown, very finely crystalline, algal, fossiliferous; contains intercalations of medium-bluish-gray to medium-gray calcareous shale; some shale mottled dusky-yellow to light-olive-brown; some rare dark-reddish-brown mottled shale beds; sharp base

Florena Shale Member (3.0 ft)

30. Mudstone and shale, medium-bluish-gray and dark-reddish-brown, calcareous; lower part predominantly dark-reddish-brown; contains scattered very finely crystalline limestone nodules; sharp base



Cottonwood Limestone Member (8.0 ft)

29. Limestone, bluish-white to light-bluish-gray to pinkish-gray, very finely crystalline; nodular bedding look due to wavy veinlets and stringers of dark-reddish-brown shale; upper 1 ft brecciated

28. Limestone, yellowish-gray to grayish-yellow, very finely crystalline; includes dusky-red to dark-reddish-brown fossiliferous, calcareous shale stringers and partings packed with algal coated grains and fusulinids; contains some medium-bluish-gray, calcareous, algal shale veinlets and stringers; lower 1 ft with dusky-yellow to light-olive-brown calcareous shale stringers

ESKRIDGE SHALE (74.2 ft)

27. Limestone and shale; limestone, light-gray to yellowish-gray, very finely crystalline, nodular, algal; shale, very dusky purple, dusky-yellow, and light-olive-brown, calcareous, fossiliferous; shale beds packed with algal coated grains and cross sections of brachiopods and bryozoans; some fossil fragments recrystallized to pink calcite

26. Limestone and shale; limestone, light-gray to light-bluish-gray, finely crystalline, very fossiliferous, especially crinoidal; includes some cross sections of large brachiopods; some fossil fragments recrystallized to pink calcite; shale, medium-dark-gray to medium-gray, calcareous

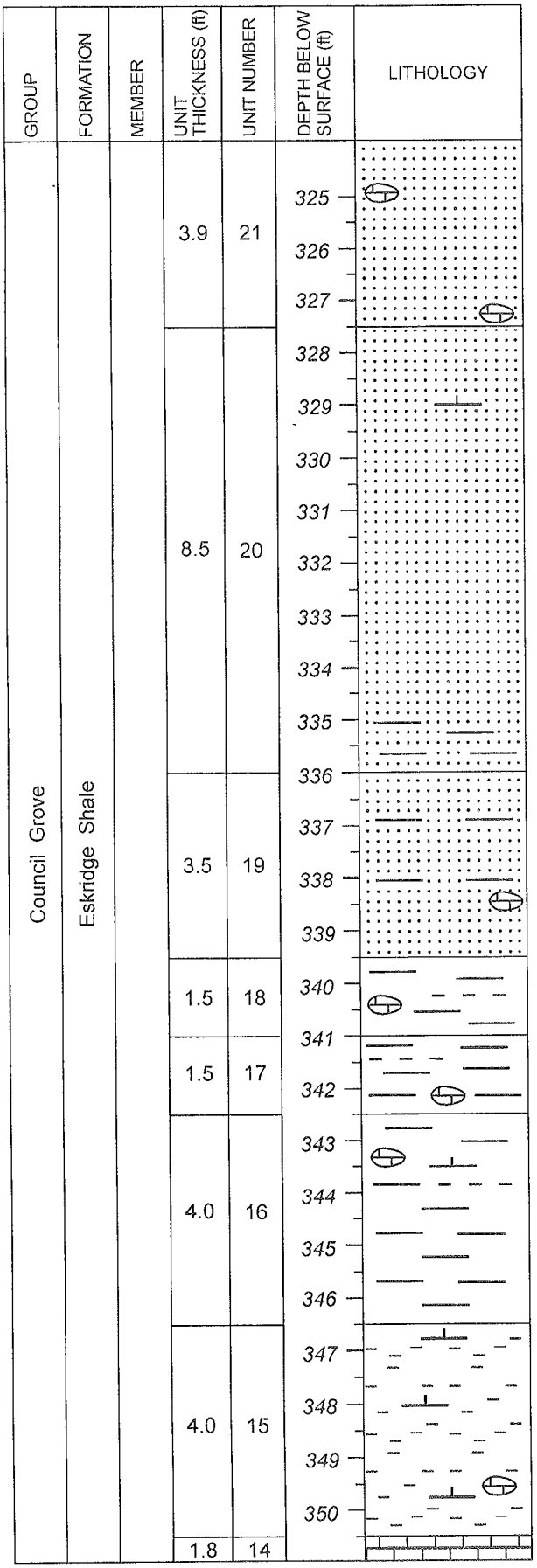
25. Limestone, medium-light-gray to light-gray with some very finely crystalline, fossiliferous (crinoidal); contains some moderate-red inclusions and some light-gray limestone clasts with moderate-red linings; lower part with greenish-gray and dark-greenish-gray, very calcareous, fossiliferous shale; some dusky-yellow to light-olive-brown mottling; wispy and/or undulatory stringers of calcareous shale common; tubular burrows; gradational base

24. Shale, dark-greenish-gray mottled light-olive-brown to dusky-yellow in upper part; lower part dark-greenish-gray and greenish-black; silty; contains some small very finely crystalline limestone nodules; sharp base

23. Mudstone, dark-reddish-brown some medium-bluish-gray mottling; top slightly calcareous, base noncalcareous; contains scattered nodules of finely crystalline limestone

22. Sandstone, dark-reddish-brown to grayish-red with some medium-bluish-gray mottling, fine-grained, shaly; includes scattered very small finely crystalline limestone nodules and granules

21. Sandstone, grayish-red to moderate-orange-pink with lenses of light-olive-gray to greenish-gray, very fine grained, lenticular bedding; cross-laminations rare; contains some small tubular blebs of finely crystalline limestone; includes rare finely crystalline limestone nodules with vesicular texture



20. Sandstone, predominantly light-olive-gray and greenish-gray with some grayish-red mottling, fine-grained, pyritic, strongly cross-laminated; contains rare calcareous sandstone laminations; some blebs of finely crystalline limestone; basal 1 ft contains mudstone beds; bioturbated

19. Sandstone, grayish-red, greenish-gray, and medium-bluish-gray, very fine grained; contains mudstone intercalations; some cross-laminations noted; bedding very churned due to bioturbation; contains scattered very small finely crystalline limestone nodules

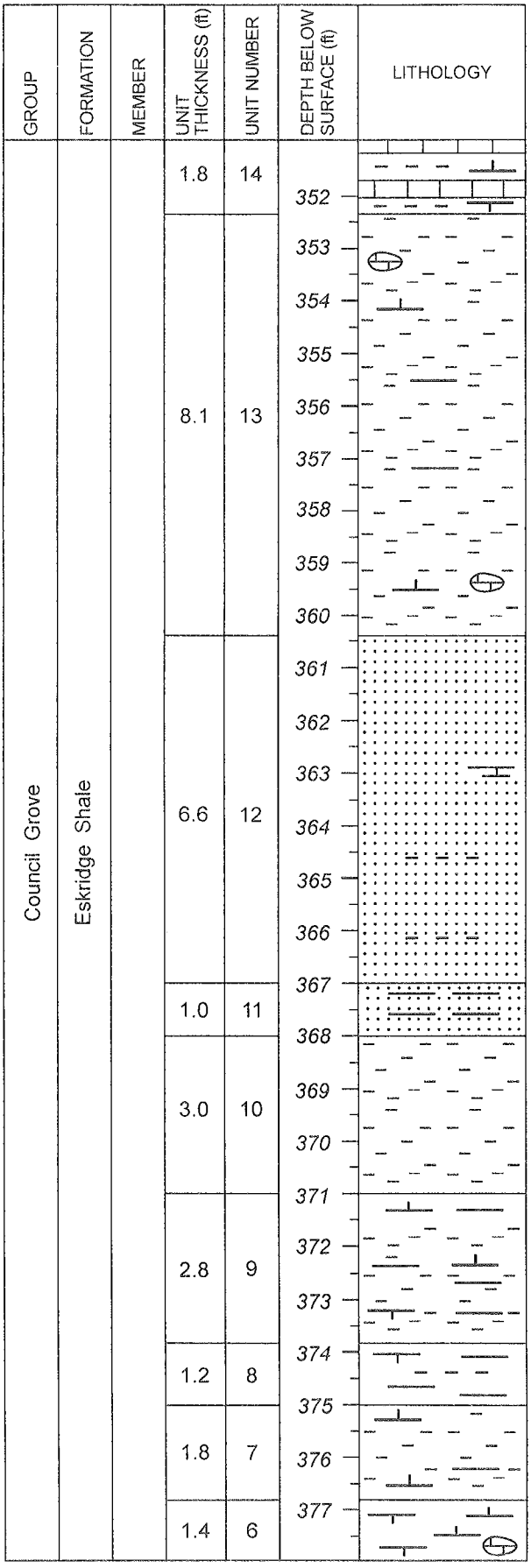
18. Mudstone, mottled medium-bluish-gray and dark-reddish-brown; includes scattered finely crystalline limestone nodules; fracture surfaces slickensided

17. Mudstone, medium-bluish-gray and dark-greenish-gray with some dark-reddish-brown; contains scattered finely crystalline limestone nodules

16. Mudstone, medium-bluish-gray with rare dark-reddish-brown mottling; slightly calcareous; some finely crystalline limestone nodules; fracture surfaces slickensided

15. Mudstone, dark-reddish-brown with common medium-bluish-gray mottling; very calcareous; includes some small finely crystalline limestone nodules

14. Limestone, light-bluish-gray and pale-pink interbedded with dark-reddish-brown veinlets and stringers of calcareous mudstone; limestone, very finely crystalline, nodular brecciated texture



13. Mudstone, dark-reddish-brown with medium-bluish-gray mottling, slightly calcareous; some scattered finely crystalline limestone nodules; fracture surfaces slickensided; sharp base

12. Sandstone, greenish-gray and medium-bluish-gray, very fine grained, churned bedding; dark-reddish-brown mudstone matrix; some rare mudstone clasts; contains very thin, irregular limestone laminations; some light-olive-gray sandstone beds; lower part with dark-reddish-brown sandstone inclusions; lower 2 ft contains very irregular undulatory sandstone bands interbedded with sandy mudstone stringers; sandstone bands often broken and disrupted; strongly bioturbated; sharp base

11. Sandstone, dark-reddish-brown interbedded with sandy mudstone; sandstone, very fine grained with some greenish-gray mudstone clasts; sharp base

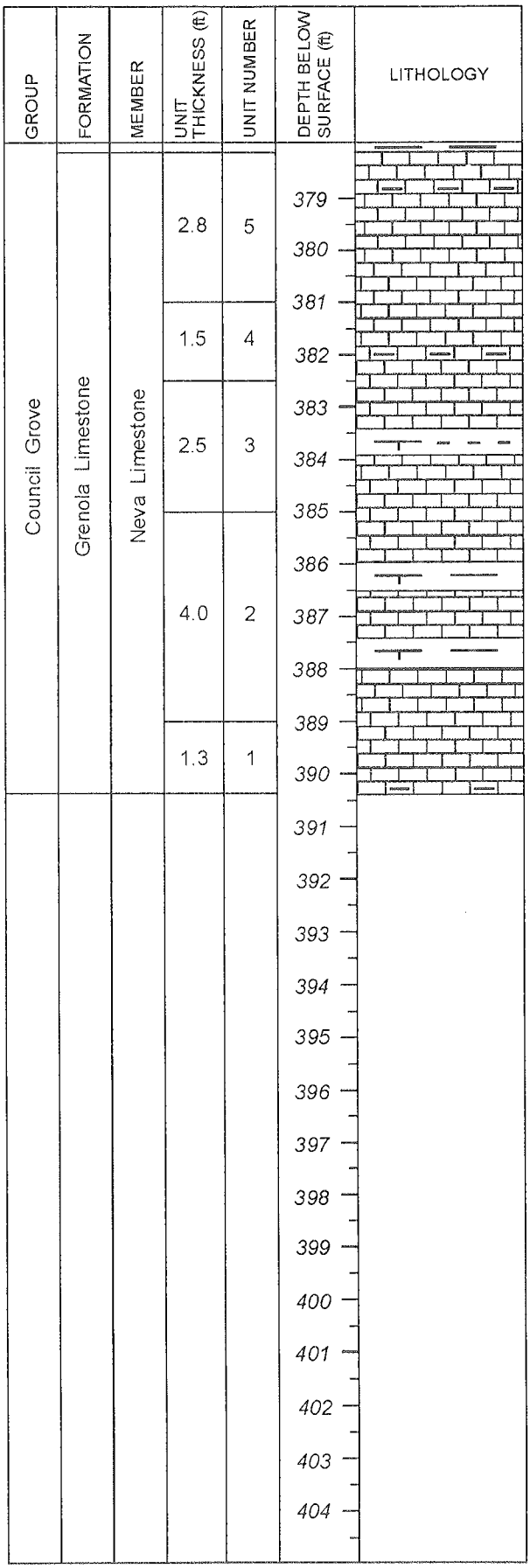
10. Mudstone, dark-reddish-brown with dusky-yellow and light-olive-brown mottling

9. Mudstone, mottled dark-reddish-brown and medium-bluish-gray, calcareous; includes some small finely crystalline limestone granules; fracture surfaces slickensided and lined with carbonaceous films

8. Mudstone, medium-bluish-gray with dark-reddish-brown mottling, calcareous; slickensided fracture surfaces covered with carbonaceous films

7. Shale, dark-reddish-brown mottled medium-bluish-gray, calcareous; slickensided fracture surfaces lined with carbonaceous films; sharp base

6. Shale, medium-bluish-gray and greenish-gray, very calcareous, fossiliferous; calcareous shale beds are bioturbated; lower part calcareous mudstone containing fossiliferous, finely crystalline limestone nodules; gradational base



GRENOLA LIMESTONE (12.1 ft)

Neva Limestone Member (12.1 ft)

5. Limestone, light-gray to very light gray, very finely crystalline, fossiliferous; silicified look; contains veinlets of greenish-gray calcareous mudstone that produce a brecciated look at the top; includes tubular burrows and borings; fusulinids common

4. Limestone, light-olive-gray and greenish-gray, finely crystalline; contains some greenish-gray shale veinlets; nodular bedding; packed with fusulinids

3. Limestone, greenish-gray and grayish-red-purple, highly variegated; nodular bedding produces a clotted texture; contains very dusky purple, grayish-red-purple, and greenish-gray calcareous shale laminations and stringers; slightly algal; packed with fusulinids

2. Limestone and shale; limestone, light-gray, finely crystalline, nodular; shale, greenish-gray and dark-greenish-gray with some grayish-red-purple mottling throughout, calcareous; fusulinids occur throughout but are especially abundant at 388.0–389.0 ft, occurring in limestone lenses and clasts; basal part with greenish-black and olive-black shale stringers and light-gray finely crystalline limestone bands

1. Limestone, light-gray to light-brownish-gray, very finely crystalline, silicified; bird's-eye fenestral texture; contains rare light-olive-gray and greenish-gray shale veinlets with fusulinids