

**GEOLOGY OF THE ARBUCKLE MOUNTAINS  
ALONG INTERSTATE 35,  
CARTER AND MURRAY COUNTIES, OKLAHOMA**

*Robert Oran Fay*



STRATIGRAPHIC SECTION EXPOSED ON I-35 THROUGH  
THE ARBUCKLE ANTICLINE AND MAPPED AREA

SYSTEM		GROUP, FORMATION AND MEMBER	MAP SYMBOL	THICKNESS (ft)	
				SOUTH FLANK	NORTH FLANK
QUATERNARY		Alluvium and Terrace deposits	Qat		
PERMIAN - PENNSYLVANIAN		~ UNCONFORMITY ~ Pontotoc Group <i>undifferentiated</i>	Po/IPp		
		~ UNCONFORMITY ~ Collings Ranch Conglomerate	IPcr		3000 estimated
MISSISSIPPIAN		~ UNCONFORMITY ~ Goddard Shale	Mg	2500	
		Delaware Creek Shale (formerly "Caney" Shale)	Md	425	
		Sycamore Limestone	Ms	358	221
DEVONIAN	Hunton Group (DSOh)	Woodford Shale	MDw	290	274
		Bois d'Arc Limestone	★	9	19
		Haragan Formation	★	25	16
SILURIAN	Chimneyhill Subgroup	Henryhouse Formation	★	191	72
		Clarita Limestone	★	12	16
		Cochrane Limestone	★	13	4+
ORDOVICIAN	Simpson Group	Keel Limestone	★		7
		Sylvan Shale	Os	305	275
		Viola Group	Ov	684	710
		Bromide Formation	Obr	420	346
		Poolville Limestone Member	★	120	80
		Mountain Lake Member	★	300	266
		Tulip Creek Formation	Otc	395	297
		McLish Formation	Oml	475	397
	Upper Arbuckle Gp	Oil Creek Formation	Ooc	747	
		Joins Formation	Oj	294	
		West Spring Creek Formation	Ow	1515	
		Kindblade Formation	Ok	1410	
		Cool Creek Formation	Occ	1300	
		McKenzie Hill Formation	Omh	900	
		Butterly Dolomite	Ob	297	
CAMBRIAN	Lower Arbuckle Group	Signal Mountain Formation	€sm	415	
		Royer Dolomite	€ry	717	
		Fort Sill Limestone	€fs	155	
	Timbered Hills Group	Honey Creek Limestone	€hc	105	
		Reagan Sandstone	€r	240	
		Colbert Rhyolite	€c	4500 drilled	7500 estimated

★ Formation or member shown only on cross section



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**Robert Oran Fay**

**Prepared in cooperation with  
Ardmore Geological Society  
Ardmore, Oklahoma**

An earlier version of this guidebook was released in 1969 under the same title by the Ardmore Geological Society as a guide to an AGS field trip directed by Robert O. Fay. The original guidebook being sold out, the Oklahoma Geological Survey and the AGS agreed to jointly reissue this revised and expanded version of the original guidebook as OGS Guidebook 26.

**The University of Oklahoma  
Norman**

**1989**



### **Front Cover**

*Top*—Tulip Creek sandstone on McLish limestone, east side of east lane, looking southeast; strike N. 55° W., dip 75° S, overturned; station 2649 + 70' on contact of sandstone on greenish shale to right; SE¼SW¼NE¼SE¼ sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.

*Bottom*—Viola limestone—Pooleville limestone—Mountain Lake shale cut, 156 ft deep, east side of east lane, looking southeast; strike N. 55° W., dip 75° S, overturned; station 2658 + 60' on base of Viola; station 2657 + 40' at base of Pooleville; SE¼NW¼NE¼SE¼ sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.

### **Back Cover**

*Top*—Collings Ranch Conglomerate, edge of graben and unconformity on overturned Bromide Formation, west lane, looking west; strike N. 60° W., dip 61° SW on Bromide; station 2629 on graben fault; SW¼NE¼NW¼NE¼ sec. 31, T. 1 S., R. 2 E., Murray County, Oklahoma.

*Bottom*—Syncline in Collings Ranch Conglomerate, east side of west lane, looking east; strike on axis N. 80° W., dip 10° toward axis; station 2610 + 12' on axis; SW¼SW¼SW¼NE¼ sec. 31, T. 1 S., R. 2 E., Murray County, Oklahoma.





### **Dr. Robert Oran Fay**

Dr. Fay was born in St. Louis, Missouri, on March 4, 1927. He graduated from Washington University, St. Louis, with a Bachelor of Arts degree in 1949. Later he received his Doctorate from the University of Kansas in 1961.

He served with the U.S. Army (surgery) with 279th Station Hospital attached to the 78th Lightning Division and 101st Airborne in Germany from 1945 to 1946, ending in Berlin. Between 1953 and 1954 he was employed by the Canadian Geological Survey, working at the North Pole (Cornwallis Island) and British Columbia (Anahim Lake area) and was with The California Company in 1955, working the western Wyoming thrust belt. He joined the staff of the Oklahoma Geological Survey in 1956, his present affiliation. Dr. Fay is the author of more than 125 articles on geology and paleontology.

The United States Bureau of Public Roads funded a two-year project, directed by Dr. Fay, primarily for salvage of anything of scientific value along Interstate-35 cuts through the Arbuckle Mountains. The project was administered through the Oklahoma Department of Highways and carried out by the Oklahoma Geological Survey from September 1967 through September 1969. This is the second project of this type in the United States.



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1. Geologic map and cross section along Interstate 35,  
    through Arbuckle Anticline ..... pocket





# ROAD LOG

South miles	North miles	Station no.	Marker no.	Lane* W-C-E-77	
0	7.3	2312 + 83'		C	Bridge—On Goddard Formation
		2316		W	Goddard Formation—Delaware Creek (Caney) Shale contact
0.15	7.15	2320 + 75'		W	Delaware Creek (Caney) Shale outcrop on west side (Fig. 1)
		2323 + 20'		C	<b>44 Mile Post</b>
0.2	7.1	2323 + 25'		W	Delaware Creek (Caney) Shale—Sycamore Limestone contact (Fig. 2)
		2323 + 80'	①	W	<b>Marker No. 1.</b> —Sycamore Limestone, 13 ft below top
0.3	7.0	2329 + 52'		W	Sycamore Limestone—Woodford Shale contact (Figs. 3–5)
		2329 + 70'	②	W	<b>Marker No. 2.</b> —Woodford Shale, 9 ft below top
0.4	6.9	2333 + 83'		W	Woodford Shale—Hunton Group contact (Fig. 6)
		2333 + 98'	③	W	<b>Marker No. 3.</b> —Bois d'Arc Limestone, 1 ft below top
0.5	6.8	2337 + 80'		W	Hunton Group—Sylvan Shale contact
		2337 + 80'	④	W	<b>Marker No. 4.</b> —Cochrane Limestone of Chimneyhill Subgroup of Hunton Group, 3 ft above base
0.6	6.7	2342 + 70'		W	Sylvan Shale—Viola Group contact
		2342 + 91'	⑤	W	<b>Marker No. 5.</b> —Viola Group, 15 ft below top
0.65	6.65	2345 + 23'		W	Oil seep in Viola Group, east side of west lane (Fig. 7)
0.8	6.5	2352 + 10'		W	Viola Group—Pooleville Limestone contact
		2353 + 15'	⑥	W	<b>Marker No. 6.</b> —Pooleville Limestone Member of Bromide Formation, Simpson Group, 1 ft below top
0.9	6.4	2359 + 30'		C	Center of bridge over rural road
1.2	6.1	2370 + 25'		E	Basal McLish sandstone—Oil Creek limestone contact
		2376		C	<b>45 Mile Post</b>
		2378 + 59'	⑦	E	<b>Marker No. 7.</b> —Oil Creek Formation, 49 ft above base (Fig. 8)
1.34	5.96	2379 + 25'		E	Oil Creek Formation—Joins Formation contact
1.45	5.85	2383 + 35'		E	Joins Formation—Arbuckle Group West Spring Creek Formation contact
		2383 + 90'		E	Algal bed in West Spring Creek Formation, beginning of West Spring Creek road cut on east side of east lane
		2384 + 15'	⑧	E	<b>Marker No. 8.</b> —West Spring Creek Formation of Arbuckle Group, 67 ft below top
		2387 + 37'	⑨	E	<b>Marker No. 9.</b> —West Spring Creek Formation, C-D-P Zone, or <i>Ceratopea</i> – <i>Diparelasma</i> – <i>Pomatotrema</i> Zone, 284 ft below top
1.5	5.8	2387 + 48'		E	Sandstone bed below C-D-P Zone—top of red bed sequence in West Spring Creek Formation (Figs. 9–10)
1.65	5.65	2395 + 06'		E	Graptolite bed, <i>Didymograptus protobifidus</i> , in bluish-gray limy shale a few inches thick (marker for dating West Spring Creek Formation as Early Ordovician in United States) (Fig. 11)
1.8	5.5	2401 + 15'		E	Base of red beds in West Spring Creek Formation
1.85	5.45	2404 + 40'		E	West Spring Creek Formation—Kindblade Formation contact, tan dolomitic siltstone on gray limestone (Fig. 12)
		2404 + 42'	⑩	E	<b>Marker No. 10.</b> —Kindblade Formation, 2 ft below top
2.2	5.1	2423 + 15'	⑪	E	<b>Marker No. 11.</b> —Axis of anticline in lower Kindblade Formation, 100 ft above base (Fig. 13)
2.25	5.05	2425 + 30'		E	Fault contact between Kindblade Formation and Cool Creek Formation
		2428 + 80'		C	<b>46 Mile Post</b>
2.45	4.85	2435 + 80'		W	Lower Cool Creek Formation outcrop
		2437 + 05'	⑫	W	<b>Marker No. 12.</b> —Cool Creek Formation, about 700 ft below top
2.6	4.7	2444 + 80'		W	Cool Creek Formation—McKenzie Hill Formation contact

\*W = West Lane, generally west side; C = Center of Median between four lanes; E = East Lane, generally east side; 77 = U.S. Highway 77.

South miles	North miles	Station no.	Marker no.	Lane* W-C-E-77	
2.9	4.4	2459 + 40'		W	McKenzie Hill Formation—Butterly Dolomite contact
3.0	4.3	2466 + 90'		W	Butterly Dolomite—Signal Mountain Formation contact
3.2	4.1	2474 + 30'	(20)	W	<b>Marker No. 20.</b> —Signal Mountain Formation—Royer Dolomite, just above contact
		2481 + 60'		C	<b>47 Mile Post</b>
		2483 + 15'	(21)	W	<b>Marker No. 21.</b> —Royer Dolomite, 150 ft above base
3.45	3.85	2485 + 80'		W	Royer Dolomite—Fort Sill Limestone contact, on slope south of ditch
3.48	3.82	2488 + 50'		W	Chapman Ranch thrust fault—covered and cannot be seen—Fort Sill Limestone on Royer Dolomite; approximate position is at fence line
3.7	3.6	2505		C	Bridge, above Highway 77, Cattle Pens Interchange
		2534 + 40'		C	<b>48 Mile Post</b>
4.3	3.0	2534 + 80'		W	Royer Dolomite—Fort Sill Limestone contact—highly distorted beds
		2535 + 20'	(22)	W	<b>Marker No. 22.</b> —Fort Sill Limestone, 9 ft below top (Fig. 14)
		2541	(23)	E	<b>Marker No. 23.</b> —Royer Dolomite, 2 ft above base
4.4	2.9	2542 + 20'		W	Fault—Fort Sill Limestone—Royer Dolomite
4.7	2.6	2560 + 20'		W	Royer Dolomite starts to dip north
4.9	2.4	2564 + 80'		W	Fault—Royer Dolomite—Signal Mountain Formation
		2566 + 80'	(24)	W	<b>Marker No. 24.</b> —Signal Mountain Formation
4.95	2.35	2569 + 20'		W	Fault—Signal Mountain Formation—Butterly Dolomite—part of Washita Valley fault system
		2570	(25)	E	<b>Marker No. 25.</b> —Butterly Dolomite
5.07	2.23	2575 + 30'		W	Fault—Butterly Dolomite—Cool Creek Formation
5.15	2.15	2579 + 50'		W	Cool Creek Formation—Kindblade Formation contact; Cool Creek is a massive oolitic zone
		2581	(26)	W	<b>Marker No. 26.</b> —Lower Kindblade Formation
		2587 + 20'		C	<b>49 Mile Post</b>
5.35	1.95	2590 + 60'		W	Kindblade Formation, dipping steeply northward (normal)
5.4	1.9	2592 + 50'		W	Kindblade Formation—Displacement of drill holes shows evidence of recent movements; see fold on east side of west lane
		2596 + 50'	(27)	E	<b>Marker No. 27.</b> —Kindblade Formation, 25 ft below top, on east turnout, west side of north end
5.5	1.8	2598 + 55'	(28)	W	<b>Marker No. 28.</b> —Kindblade Formation, 52 ft below top, on west turnout, west side of south end—tectonic breccia in Kindblade (Fig. 20)
5.55	1.75	2599 + 30'		W	Kindblade Formation—West Spring Creek Formation contact, on west turnout, west side of south end, just north of Marker No. 28 about 75 ft
5.6	1.7	2603 + 80'		W	Fault—West Spring Creek Formation—Collings Ranch Conglomerate, on west turnout, west side of north part, north of road to geologic sign
		2604 + 50'	(29)	W	<b>Marker No. 29.</b> —Collings Ranch Conglomerate, 70 ft north of fault, on west turnout, west side of north part
5.7	1.6	2610	(30)	E	<b>Marker No. 30.</b> —Collings Ranch Conglomerate, synclinal axis (back cover, bottom)
		2628 + 75'	(16)	W	<b>Marker No. 16.</b> —Collings Ranch Conglomerate, 25 ft south of fault
6.1	1.2	2629		W	Fault—Collings Ranch Conglomerate—Bromide Formation; Collings Ranch dips 11° S—Bromide overturned, dipping south about 61°—Collings Ranch flat on top of Bromide (back cover, top)
		2629 + 22'	(19)	W	<b>Marker No. 19.</b> —Mountain Lake Member of Bromide Formation, fault contact, 126 ft below Viola Group
		2630 + 14'	(17)	W	<b>Marker No. 17.</b> —Pooleville Limestone Member of Bromide Formation, 36 ft below Viola Group, faulted
6.15	1.15	2630 + 50'		W	Bromide Formation Pooleville Limestone Member—Viola Group contact—vertical dip with Collings Ranch Conglomerate resting unconformably above synclinal axis in Viola Group
6.2	1.1	2633 + 50'		W	<b>Marker No. 18.</b> —Viola Group, 175 ft above base
		2633 + 70'	(18)	W	Viola Group—Bromide Formation Pooleville Limestone Member contact
6.25	1.05	2637 + 20'		W	



South miles	North miles	Station no.	Marker no.	Lane* W-C-E-77	
		2638 + 50'	③①	E	<b>Marker No. 31.</b> —Bromide Formation Pooleville Limestone Member, 15 ft below top
6.3	1.0	2639		W	Bromide Formation Pooleville Limestone Member—Mountain Lake Member contact
		2639 + 80'	③②	E	<b>Marker No. 32.</b> —Mountain Lake Member of Bromide Formation, 6 ft below top
		2640		C	<b>50 Mile Post</b>
6.4	0.9	2643		W	Mountain Lake Member of Bromide Formation, lower sandstone beds
		2643 + 50'	③③	E	<b>Marker No. 33.</b> —Mountain Lake Member of Bromide Formation, lower sandstone, 53 ft above base (Fig. 19)
6.45	0.85	2644 + 50'		E	Fault zone, in valley, basal McLish sandstone to east, against Bromide and Tulip Creek Formations to west (Fig. 18)
		2649 + 68'	③④	E	<b>Marker No. 34.</b> —McLish Formation, 2 ft below top
6.5	0.8	2649 + 70'		E	McLish Formation—Tulip Creek Formation contact (front cover, top)
6.6	0.7	2653		E	Tulip Creek Formation—Bromide Formation contact in valley
6.7	0.6	2657 + 10'		E	Bromide Formation Mountain Lake Member Pooleville Limestone Member contact
6.75	0.55	2658 + 60'		E	Bromide Formation Pooleville Limestone Member—Viola Group contact (front cover, bottom)
		2658 + 62'	③⑤	E	<b>Marker No. 35.</b> —Viola Group, overturned, 2 ft above base
6.8	0.5	2664 + 60'		W	Viola Group—fault zone splinters, ending in sharp anticline
6.9	0.4	2668 + 30'		W	Viola Group—Sylvan Shale contact, covered; go west to U.S. Highway 77 to see contact, where <b>Marker No. 13</b> is in the Viola, 24 ft below top
			③⑬	77	
6.95	0.35	2672		W	Sylvan Shale—Hunton Group contact, covered; go west to U.S. Highway 77 to see contact, where <b>Marker No. 14</b> is in the Keel Limestone of the Chimneyhill Subgroup of the Hunton Group, 2 ft above the base (Fig. 17)
			③⑭	77	
7.0	0.3	2675		C	Bridge over Highway 77-D; Haragan Limestone on west side of bridge; Woodford Shale on east side of bridge, north side 77-D
7.05	0.25	2677 + 80'		W	Hunton Group Haragan Limestone—Woodford Shale contact
7.15	0.15	2679 + 50'		E	Woodford Shale—Sycamore Limestone contact (Fig. 16)
		2681 + 55'	③⑯	E	<b>Marker No. 36.</b> —Sycamore Limestone, 71 ft above base; on Highway 77 to west is <b>Marker No. 15</b> , about 110 ft above the base of the Sycamore Limestone
			③⑰	77	
7.25	0.05	2685		W	Sycamore Limestone—Delaware Creek (Caney) Shale contact
7.3	0.00	2692 + 80'		C	<b>51 Mile Post</b> —West end of bridge across Honey Creek
		2703 + 33'		C	Bridge—U.S. Highway 77 overpass above U.S. I-35



# GEOLOGY OF THE ARBUCKLE ANTICLINE

## INTRODUCTION

The purpose of the Interstate-35 project in the Arbuckle Mountains was to salvage anything of scientific value and to study and map new exposures of rocks. The project began on September 1, 1967, and was completed on September 1, 1969. A geologic map was prepared on a topographic base map (scale 1:12,000), and a geologic cross section was completed at the same scale (see Pl. 1, in pocket). A large amount of new information on structures and stratigraphy was added.

Approximately 400 sacks of fossils, minerals, and rocks were collected for future study by geologists. Of practical importance, the study was helpful in spotting areas of collapsed structures and slides, and in one instance was helpful for treatment of a cave-in (Nov. 22, 1968: Station 2540 + 50') along the west lane near the top of the mountains.

Thousands of geologists have visited this area and have expressed enthusiasm over the educational value of the map and cross section. Field trips have been conducted for many geological societies and for many educational, governmental, and industrial groups and organizations.

## GEOLOGIC HISTORY

The geologic history of the area consists of a story on the origin of the mountains revealed from a study of the rocks and associated structures. Rocks can be formed either from molten magma or lava, or from sediments deposited in water. Rocks are formed at different times and in chronologic or stratigraphic succession, with the oldest rocks on the bottom of a natural sequence. Rock formations are given formal geographic names and are grouped into larger divisions, called groups and systems, the system being the major geologic division. The systems along Interstate 35 in the Arbuckle Mountains are named, in ascending order, Cambrian (550 million years old), Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian (250 million years old).

The oldest rocks in the area were formed from Middle Cambrian volcanic flows that covered an ancient land surface. The region then began to buckle downward into a deep trough or geosyncline, and many thousands of feet of Cambrian-Ordovician sediments were deposited in the sea that covered the area.

The younger Silurian, Devonian, and Early Mississippian rocks show that the geosyncline was filled with sediments, and it is known that many unconformities (surfaces of erosion or nondeposition of sediments) were developed in this region during this time.

During Late Mississippian and Pennsylvanian time, a geosyncline was established again. In Late Pennsylvanian time, the area was uplifted many thousands of feet, and the Arbuckle anticline and associated structures were formed. Many faults and many synclines were formed. Along the north flank of the Arbuckle anticline, a large graben was formed, and much material eroded from the uplifted mountains was deposited in the graben. Slight movements oc-

curred again, causing these Late Pennsylvanian conglomerates to be faulted.

After Pennsylvanian time, the mountains were mostly emergent above sea level and have been progressively worn down by erosion and weathering. The highest elevation in the region is 1,377 ft in the East Timbered Hills just west of Interstate 35, but during Pennsylvanian time these mountains may have been many thousands of feet higher.

## STRATIGRAPHY

A short summary of each rock formation of each system, from oldest to youngest, follows:

**Cambrian.**—The oldest rock in the area occurs at the top of the mountains in the East Timbered Hills just west of Interstate 35, where maximum uplift occurred. The rock, the Colbert Rhyolite, has been isotopically dated at 525 million years (Middle Cambrian). It is formed from a volcanic flow believed to be almost 7,500 ft thick. It is a fine-grained, reddish-orange aluminum silicate rock with phenocrysts of feldspar and quartz (Fig. 15).

Unconformably above is the Upper Cambrian Reagan Sandstone (240 ft thick), which is feldspathic and glauconitic and is exposed on the south side of the East Timbered Hills. The overlying Honey Creek Limestone (105 ft thick) is also exposed on the south side of the East Timbered Hills, dipping southward underground. The Reagan and Honey Creek belong to the Timbered Hills Group of rocks and together with the underlying Colbert Rhyolite are cut off from Interstate 35 by a large fault zone. The top of the Colbert Rhyolite occurs about 700 ft underground where old U.S. Highway 77 crosses Interstate 35. Overlying the Honey Creek are rocks of the lower Arbuckle Group, named, in ascending order, Fort Sill Limestone (155 ft), Royer Dolomite (717 ft), and Signal Mountain Formation (415 ft). These rocks are exposed for about a mile along the crest of the mountains and contain many sinkhole deposits. The Fort Sill and Signal Mountain are bluish gray in color, whereas the Royer is pink to yellowish gray and more massive.

**Ordovician.**—Overlying the Signal Mountain are several thousand feet of Lower Ordovician carbonates of the upper Arbuckle Group. These formations are, in ascending sequence, Butterly Dolomite (297 ft), McKenzie Hill Formation (900 ft), Cool Creek Formation (1,300 ft), Kindblade Formation (1,410 ft), and West Spring Creek Formation (1,515 ft). These rocks occur on both flanks of the Arbuckle anticline but are filled over or faulted out in many places.

Above the Arbuckle Group is the Middle Ordovician Simpson Group, consisting of the Joins (294 ft), Oil Creek (747 ft), McLish (475 ft), Tulip Creek (395 ft), and Bromide (420 ft) Formations (ascending order). Each of the Simpson formations above the Joins typically has a basal sandstone, a middle greenish-gray shale, and an upper limestone. The Bromide is subdivided into a lower shale-sandstone unit, the Mountain Lake Member (300 ft), and an upper, dense limestone, the Pooleville Limestone Member (120 ft). On the north flank of the mountains, some of these and other units may be thinner and have a different facies (change in type of rock). The overlying Viola Group (684 ft) is the uppermost Middle Ordovician unit. It forms steep, resistant ridges in the area and has the deepest cuts in the mountains (134–156 ft deep on north flank) (front cover, bottom).



The Upper Ordovician consists of the Sylvan Shale (305 ft), which is dark greenish gray, with unconformities at the base and top. It erodes into valleys. The overlying Keel Limestone (0–2 ft) is now classed as Ordovician in age. Next above the Sylvan is the Hunton Group (134–250 ft) of Silurian and Lower Devonian rocks.

**Silurian.**—The Silurian rocks on the south flank are represented by about 215 ft or more of limestone and shales termed Cochrane Limestone (13 ft), Clarita Limestone (12 ft), and Henryhouse Formation (191 ft). The Silurian section contains many unconformities, and these units are thinner on the north flank. These units erode into low ridges.

**Devonian.**—The Lower Devonian on the south flank consists of the Haragan Limestone (25 ft) and the overlying Bois d'Arc Limestone (9 ft), with unconformities above and below each unit. These units erode into a ridge.

The Upper Devonian Woodford Shale (274–290 ft) is black, contains much chert, and is gradational into the overlying Sycamore Limestone. The Woodford erodes into valleys.

**Mississippian.**—The Mississippian on the south flank consists of the Sycamore Limestone (358 ft) and overlying Delaware Creek Shale (425 ft) and Goddard Shale (2,500 ft). The Sycamore erodes into the first steep ridges seen on both flanks of the mountains. The Delaware Creek is mostly covered in the flats on either side of the mountains. Many thousands of feet of Upper Mississippian and Pennsylvanian rocks occur on the flanks of the mountains in the adjoining basins but have been eroded from the mountains.

**Pennsylvanian.**—The only rocks of this system exposed along Interstate 35 are those termed Collings Ranch Conglomerate (3,000 ft thick), of Late Pennsylvanian age. The Collings Ranch is a reddish-brown conglomerate with individual pebbles which range in type from the Reagan Sandstone upward. Apparently the Colbert Porphyry was not exposed at the time the Collings Ranch formed. The Collings Ranch crops out along the turnouts on the north flank of the mountains (back cover, top and bottom).

## COLLECTIONS

The collections consist of approximately 400 bags of samples as well as larger specimens of minerals, fossils, and microfossil samples.

**Minerals.**—Abundant calcite crystals were collected from the Viola Limestone. In one area, natural asphalt or tar was associated with the calcite. Some pyrite crystals were collected from the Woodford Shale and Viola Group. Some limonite was collected from the lower part of the Butterfly Dolomite.

**Fossils.**—Corals, bryozoans, brachiopods, trilobites, and echinoderms were collected from the Sycamore Limestone, Bois d'Arc Limestone, Haragan Limestone, Henryhouse Formation, and Simpson Group. Graptolites were collected from the Viola Group (lower) and West Spring Creek Formation (middle). Cephalopods, ostracodes, and gastropods were collected from the Oil Creek Formation. A fossil bone was collected from the Bois d'Arc Limestone.

**Microfossils.**—Bulk microfossil samples were taken from the shales in the Delaware Creek, Sycamore, Woodford, Bois d'Arc, Haragan, Henryhouse, Sylvan, Viola, and lower stratigraphic units.

## MEASURED SECTIONS

Beginning at the top of the section on the south side of the Arbuckle Mountains and proceeding northward, down section, along the west side of the west (left, southbound) lane of Interstate Highway 35, station numbers are designated every 100 ft, beginning with 0 at the Red River and proceeding northward, measured along the center line of the median. With reference to measured sections, a station number is given for each contact or zone, measured at the base of the cliff face, at right angles to the center line of the median. For instance, the Delaware Creek–Sycamore contact is at Station 2323 + 25' or 232,325 ft north of the Red River, measured at the base of the cliff on the west side of the west lane at a right angle to the center-line tangent. The beds from Oil Creek through Kindblade were measured on the east side of the east lane, and the Cool Creek through Fort Sill beds were measured on the west lane. On the north side of the mountains, the beds from Sycamore through McLish were measured along the east lane.

## Description of Brass Markers

In 1984 and 1985, Mr. Robert Allen and George Ramsey, of Ardmore, and Robert Fay, of Norman, Oklahoma, put in 4-in. brass markers along Interstate Highway 35 and U.S. Highway 77 through the Arbuckle Mountains. These are described below and appear in the text. Most of the markers are about eye height and are cemented in orange fiberglass. We were not allowed to put up signs because they would be a distraction to drivers according to the Oklahoma Department of Public Safety. Station numbers are points 100 ft apart, beginning with 0 at the south bank of the Red River and proceeding northward along Interstate Highway 35, measured along the center of the median. Marker No. 1 is Station No. 2323 + 80' or 232,380 ft north of the south bank of the Red River along the cut in the west side of the west lane, as projected at right angles to the median. E—means east lane, W—means west lane, and 77—means west side of U.S. Highway 77 just south of Exit 51 on the north side of the Arbuckles.

Marker no.	Location	Station no.	Formation
①	W	2323 + 80'	Sycamore Limestone, 13 ft below top
②	W	2329 + 70'	Woodford Shale, 9 ft below top
③	W	2333 + 98'	Bois d'Arc Limestone, 1 ft below top
④	W	2337 + 80'	Cochrane Limestone of Chimneyhill Subgroup of Hunton Group, 3 ft above base
⑤	W	2342 + 91'	Viola Group, 15 ft below top
⑥	W	2353 + 15'	Pooleville Limestone Member of Bromide Formation, Simpson Group, 1 ft below top

Marker no.	Location	Station no.	Formation	Marker no.	Location	Station no.	Formation
⑦	E	2378 + 59'	Oil Creek Formation, 49 ft above base	③②	E	2639 + 80'	Mountain Lake Member of Bromide Formation, 6 ft below top
⑧	E	2384 + 15'	West Spring Creek Formation, Arbuckle Group, 67 ft below top	③③	E	2643 + 50'	Mountain Lake Member of Bromide Formation, 53 ft above base
⑨	E	2387 + 37'	West Spring Creek Formation, C-D-P Zone, 284 ft below top	③④	E	2649 + 68'	McLish Formation, 2 ft below top
⑩	E	2404 + 42'	Kindblade Formation, 2 ft below top	③⑤	E	2658 + 62'	Viola Group, overturned, 2 ft above base
⑪	E	2423 + 15'	Kindblade Formation, 100 ft above base	③⑥	E	2681 + 55'	Sycamore Limestone, 71 ft above base
⑫	W	2437 + 05'	Cool Creek Formation, 700 ft below top				
⑬	77		Viola Group, 24 ft below top				
⑭	77		Keel Limestone of Chimneyhill Subgroup, Hunton Group, 2 ft above base				
⑮	77		Sycamore Limestone, 110 ft above base				
⑯	W	2628 + 75'	Collings Ranch Conglomerate, 25 ft south of fault				
⑰	W	2630 + 14'	Bromide Formation, 36 ft below Viola Group, faulted				
⑱	W	2633 + 70'	Viola Group, 175 ft above base				
⑲	W	2629 + 22'	Mountain Lake Member of Bromide Formation, fault contact, 126 ft below Viola Group				
⑳	W	2474 + 30'	Signal Mountain Formation above Royer Dolomite				
㉑	W	2483 + 15'	Royer Dolomite, 150 ft above base				
㉒	W	2535 + 20'	Fort Sill Limestone, 9 ft below top				
㉓	E	2541	Royer Dolomite, 2 ft above base				
㉔	W	2566 + 80'	Signal Mountain Formation, middle part				
㉕	E	2570	Butterly Dolomite, middle part				
㉖	W	2581	Kindblade Formation, lower part				
㉗	E	2596 + 50'	Kindblade Formation, 25 ft below top				
㉘	W	2598 + 55'	Kindblade Formation, 52 ft below top				
㉙	W	2604 + 50'	Collings Ranch Conglomerate, 70 ft north of fault				
③⑩	E	2610	Collings Ranch Conglomerate, synclinal axis				
③⑪	E	2638 + 50'	Pooleville Limestone Member of Bromide Formation, 15 ft below top				

### South Flank of Arbuckle Anticline

#### Mississippian

**Delaware Creek Shale** (425 ft thick): Thickness (ft)

Shale, dark-gray, fissile, platy; many phosphatic concretions; a 2-ft, fine-grained limestone bed at top; mostly covered, but well exposed along Philips (Tulip) Creek and hills to west; best seen at Station 2320 + 75', on west side along Philips (Tulip) Creek (Fig. 1) ..... 425.0

**Sycamore Limestone** (358 ft thick) (Station 2323 + 25' west side, west lane) (Figs. 2-5)

*Upper limestone* (48 ft thick): (Strike N. 60° W., dip 45° SW)

1. Siltstone, bluish-gray to tan, quartzose, calcitic, well-indurated, even-bedded, medium- to thick-bedded, with some interbedded silty tan shale; gradational into silty limestone; joints strike N. 20° W., dip 42° NE and strike N. 30° E., dip 62° NW, with limonitic and tan stains following joints and bedding planes; partly covered, eroding into an escarpment ..... 5.5
2. Limestone, bluish-gray, mottled tan, fine-grained, silty, quartzose, well-indurated, massive; eroding into a ledge ..... 2.4
3. Shale, tan, silty, platy, weakly indurated; gradational into siltstone ..... 0.2
4. Siltstone and shale, tan, moderately indurated; eroding into a slope ..... 1.8
5. Limestone, bluish-gray, fine-grained, silty, blocky, well-indurated, massive, mottled tan; gradational into siltstone; eroding into a ledge ..... 0.8
6. Shale, dark-gray to black, silty, platy, laminated; gradational into siltstone above; weathering gray ..... 1.0
7. Siltstone, tan, argillaceous, blocky, weakly indurated; gradational into clay shale .... 0.4

8. Limestone, bluish-gray, mottled tan, fine-grained, silty, well-indurated, massive; gradational into siltstone; eroding into a ledge ..... 4.3

**Marker No. ①**

**Station 2323 + 80', 13 ft below top of Sycamore**

9. Siltstone and shale, tan, calcitic, platy, moderately to weakly indurated; mostly covered in talus slope. .... 2.8
10. Limestone, bluish-gray, mottled tan, fine-grained, silty, massive, with some tan shale partings; gradational into siltstone; eroding into a ledge ..... 9.7
11. Siltstone, tan, argillaceous, thin-bedded, platy, weakly indurated; gradational into shale ..... 0.8
12. Limestone, bluish-gray, as above; eroding into a massive ledge. .... 9.8
13. Siltstone, tan, argillaceous, laminated, weakly indurated. .... 0.3
14. Limestone, bluish-gray, mottled tan, fine-grained, silty, massive, well-indurated, with intraclasts 2.8 ft above base; gradational into siltstone; eroding into a massive ledge, forming base of upper limestone sequence; Station 2324 + 18' on base. .... 8.4

*Upper shale (72 ft thick):*

15. Shale, tan to dark-gray, silty, platy to blocky, weakly indurated. .... 1.0
16. Shale, dark-gray to black, silty, platy, weakly indurated; weathering tan to gray. .... 4.7
17. Shale, dark-gray to black, silty, platy, well-indurated, with some tan siltstone lenses and phosphatic layers; weathering light gray ..... 8.3
18. Shale, dark-gray to black, silty, platy to blocky, weakly indurated; weathering gray to greenish gray to tan ..... 13.8
19. Shale, dark-gray to black, silty, calcitic, moderately to well-indurated, platy to blocky, with some light-colored streaks and small phosphatic nodules; weathering gray to tan ..... 12.0
20. Shale, dark-gray to black, silty, platy to blocky, weakly indurated; weathering tan to gray ..... 12.5
21. Shale, dark-gray to black, silty, calcitic, thin-bedded, platy to blocky, well-indurated; gradational into calcitic siltstone in middle; weathering tan to gray ..... 8.8
22. Shale, dark-gray to black, silty, platy, blocky, weakly indurated, with some small calcitic nodules at base; weathering gray to tan, with a small spring or seep at base; Station 2325 + 35' on base. .... 11.0

*Middle limestone (119 ft thick):*

23. Limestone, gray, fine-grained, argillaceous, silty, massive, well-indurated; weathering tan, eroding into an escarpment, with a small spring at base ..... 5.0
24. Shale, black to dark-gray, silty, calcitic, platy to blocky, weakly indurated; clayey in top 4 in. .... 1.4
25. Limestone, gray to dark-gray, fine-grained, argillaceous, silty, platy to blocky, moderately to well-indurated, with some gray shale seams; eroding into a ledge ..... 0.8
26. Limestone, gray, fine-grained, argillaceous, silty, blocky, medium-bedded, even-bedded, well-indurated; weathering tan, eroding into a mappable escarpment. .... 16.0
27. Limestone, as above, with three laminated layers each 3-4 in. thick ..... 1.3
28. Limestone, gray, fine-grained, argillaceous, silty, blocky, well-indurated, even-bedded, medium- to thick-bedded; weathering tan, eroding into a mappable escarpment ..... 24.0
29. Shale, dark-gray, calcitic, platy, thin-bedded, well-indurated; weathering greenish gray ..... 0.5
30. Limestone, gray, as above, medium- to thick-bedded ..... 23.0
31. Shale, gray, calcitic, platy, moderately indurated, with interbedded lenticular silty limestone; weathering greenish gray ..... 0.5
32. Limestone, gray, as above, medium-bedded ..... 6.5
33. Shale, gray, as above; weathering greenish gray ..... 0.4
34. Limestone, gray, as above, medium-bedded ..... 7.3
35. Shale, gray, as above; weathering greenish gray ..... 0.5
36. Limestone, gray, as above, medium- to thick-bedded, with some thin gray shale beds and with *caudi-galli?* in basal 8 in.; Station 2327 + 33' on base of main limestone sequence ..... 32.1

*Middle shale (25 ft thick):*

37. Shale, gray, calcitic, platy to blocky, moderately indurated, with speckled phosphatic(?) spots in lower part ..... 4.0
38. Limestone, gray to tan, fine-grained, silty, argillaceous, blocky, well-indurated; eroding into a ledge. .... 0.7
39. Shale, gray, calcitic, platy, thin-bedded, moderately indurated, with some thin, impure, silty limestone stringers and a cup coral and linguloid brachiopods near middle; weathering greenish gray to tan ..... 7.3
40. Limestone, gray to tan, as above ..... 0.3



41. Shale, gray, calcitic, thin-bedded, platy, moderately indurated . . . . .	1.2	56. Limestone, gray to tan, fine-grained, argillaceous, silty, well-indurated, even-bedded, medium-bedded; eroding into a ledge . . . . .	3.0
42. Limestone, gray to tan, fine-grained, argillaceous, silty, blocky, with three thin gray shale seams; weathering tan, eroding into a ledge . . . . .	4.0	57. Shale, gray, calcitic, thin-bedded, platy, moderately to weakly indurated, even-bedded, with some 2-in. limestone beds at base . . . . .	3.0
43. Shale, gray, calcitic, silty, platy, moderately indurated; weathering greenish gray to tan . . . . .	4.6	58. Limestone, gray to tan, fine-grained, argillaceous, cherty (brown), well-indurated, laminated, wavy-bedded; weathering tan; first chert noted in section below the top . . . . .	1.0
44. Limestone, gray to tan, fine-grained, silty, massive, well-indurated; weathering tan, eroding into a ledge . . . . .	2.4	59. Shale, gray, calcitic, platy, thin-bedded, moderately to weakly indurated. . . . .	1.0
45. Shale, gray, calcitic, platy, well-indurated; gradational into limestone . . . . .	0.7	60. Limestone, gray to tan, fine-grained, argillaceous, moderately to well-indurated, with cup corals and brachiopods; eroding into a ledge . . . . .	1.0
<i>Lower limestone (25 ft thick):</i>		61. Shale, gray, calcitic, platy, weakly indurated, fossiliferous, with above-noted corals found on slope (possibly came from here); weathering greenish gray; base of dark-gray shale and limestone sequence . .	3.0
46. Limestone, gray, fine-grained, silty, well-indurated, even-bedded, medium- to thick-bedded, with some thin shale seams; weathering tan, eroding into a ledge. . . . .	23.0	62. Shale, light-greenish-gray, calcitic, platy, thin-bedded, weakly indurated; weathering light greenish gray . . . . .	8.6
47. Shale, gray to dark-gray, calcitic, platy, moderately indurated, even-bedded; weathering tan. . . . .	0.8	63. Limestone, gray to tan, fine-grained, argillaceous, medium-bedded, with some thin shale seams at base; gradational into shale; weathering orange brown . . . . .	3.8
48. Limestone, gray to tan, fine-grained, argillaceous, silty, massive, well-indurated, blocky; weathering tan, at base of mappable limestone escarpment; Station 2328 + 21' on base . . . . .	1.6	64. Limestone, gray to tan, fine-grained, cherty (white to light-gray), well-indurated, even-bedded, medium-bedded, with some thin greenish-gray shale seams; weathering orange brown and greenish gray . . . . .	3.0
<i>Lower transition zone (69 ft thick):</i>		65. Shale, gray to greenish-gray, clayey, platy, weakly indurated, with some 6-in. pyritic lenses and greenish glauconitic layers, a 6-in. clay seam 3 ft below the top, and a brown lignitic clay at base; Station 2329 + 52' on base of Sycamore . . . . .	11.4
49. Shale, gray, calcitic, platy to blocky, moderately indurated; weathering tan to greenish gray, with small spring near top . . . . .	7.0	<b>Devonian</b>	
50. Limestone, gray to tan, fine-grained, argillaceous, well-indurated, even-bedded, medium-bedded, in three layers with interbedded shale; weathering greenish gray and orange brown. . . . .	2.0	<b>Woodford Shale (290 ft thick): (Station 2329 + 52' west side, west lane) (Figs. 4-6)</b>	
51. Limestone, tan to gray, fine-grained, argillaceous, well-indurated, even-bedded, thick-bedded, with some thin shale seams; weathering tan, eroding into a ledge. . . . .	5.5	Shale, dark-gray to black, thin-bedded, even-bedded, with much dark-gray to black chert and many phosphatic nodules; weathering into a slope and valley; upper 102 ft and lower 51 ft exposed, with middle 137 ft covered between Stations 2331 and 2333; basal part greenish-gray shale . . . . .	
52. Shale, gray, calcitic, platy, thin-bedded, moderately to weakly indurated, with some limestone beds near base; weathering greenish gray to tan. . . . .	7.3	<b>Marker No. ②</b>	
53. Shale, gray, calcitic, platy, weakly indurated; weathering greenish gray. . . . .	2.3	<b>Station 2329 + 70', 9 ft below top of Woodford</b>	
54. Limestone, gray, fine-grained, argillaceous, well-indurated, even-bedded, medium-bedded, with some interbedded shale; weathering tan to orange brown, eroding into a ledge . . . . .	4.0		
55. Shale, gray, calcitic, platy, moderately to weakly indurated, even-bedded; weathering greenish gray. . . . .	2.0		

**Hunton Group (250 ft thick) (Fig. 6)****Bois d'Arc Limestone (9 ft thick): (Station 2333 + 83' west side, west lane)**

1. Limestone, dark-tan, fine-grained, argillaceous, cherty, thin-bedded, well-indurated, fossiliferous, with lemon-yellow marly shale in middle part; strike N. 60° W., dip 46° SW ..... 0.7
2. Limestone, tan to light-bluish-gray, fine-grained, well-indurated, fossiliferous, with some lemon-yellow shale partings, in three beds 0.3, 1, and 1.4 ft thick; eroding into an escarpment ..... 2.7

**Marker No. ③****Station 2333 + 98', 1 ft below top of Bois d'Arc**

3. Limestone, light-tan, fine-grained, argillaceous, thin-bedded, moderately indurated, fossiliferous, rubbly, with some interbedded marly shale layers; eroding into a recess ..... 3.6
4. Limestone, tan to light-bluish-gray, fine-grained, well-indurated, fossiliferous, medium-bedded, in four beds; eroding into a ledge ..... 1.8

**Haragan Limestone (25 ft thick):**

1. Limestone, tan, fine-grained, argillaceous, rubbly, thin-bedded, well-indurated, fossiliferous, with abundant fossils in lower 2 ft; alternating with marly shale beds; eroding into a recess ..... 6.6
2. Limestone, tan, as above, with less shale, in 1- to 4-in. beds; eroding into small ledges ..... 9.5
3. Limestone, tan to light-bluish-gray, fine-grained, well-indurated, thick-bedded, fossiliferous; eroding into a ledge ..... 9.0

**Silurian****Henryhouse Formation (191 ft thick): (Station 2334 + 40' west side, west lane)**

1. Shale, light-tan, calcitic, platy, weakly indurated, fossiliferous; eroding into a recess ..... 5.3
2. Limestone, light-tan, fine-grained, well-indurated, medium- to thick-bedded; eroding into a ledge ..... 2.0
3. Shale, tan, calcitic, thin-bedded, platy, weakly indurated, fossiliferous ..... 1.0
4. Limestone, tan, fine-grained, argillaceous, medium-bedded, well-indurated, fossiliferous; eroding into a ledge ..... 2.8
5. Shale, tan, calcitic, thin-bedded, platy, weakly indurated, fossiliferous ..... 0.5
6. Limestone, tan, fine-grained, thin-bedded,

well-indurated, fossiliferous; alternating with calcitic shale ..... 3.0

7. Limestone, tan to light-gray, fine-grained, medium- to thick-bedded, well-indurated, fossiliferous; eroding into a mappable escarpment ..... 12.0
8. Shale, tan, calcitic, thin-bedded, weakly indurated, fossiliferous, with some 3- to 6-in. limestone beds; eroding into a recess .... 19.0
9. Shale, tan, as above, with 6-in. limestone at top and one at base ..... 6.5
10. Shale, tan, as above, with many thin-bedded argillaceous limestone beds and some large *Flexicalymene*-type trilobites . 8.0
11. Limestone, tan, fine-grained, well-indurated, thin-bedded, fossiliferous; eroding into a ledge ..... 1.3
12. Shale, tan, calcitic, as above, weakly indurated ..... 4.0
13. Limestone, tan to light-gray, fine-grained, well-indurated, medium-bedded, fossiliferous; alternating with some calcitic shale layers; eroding into a ledge ..... 3.3
14. Shale, tan, calcitic, as above ..... 1.5
15. Limestone, tan, fine-grained, argillaceous, thin-bedded, moderately indurated, fossiliferous, with *Flexicalymene*-type trilobites; alternating with much tan calcitic shale ..... 7.0
16. Limestone, tan, fine-grained, argillaceous, well-indurated, thick-bedded; eroding into a ledge ..... 2.0
17. Shale, tan, calcitic, thin-bedded, fossiliferous; alternating with many fine-grained, thin-bedded limestones; eroding into a flat bench ..... 16.0
18. Limestone, gray to tan, fine-grained, thin-bedded, well-indurated, fossiliferous, with interbedded calcitic gray shale; eroding into several ledges ..... 4.5
19. Shale, tan, calcitic, thin-bedded, weakly indurated, fossiliferous, with some thin-bedded rubbly limestone ..... 4.0
20. Limestone, reddish-brown, mottled-tan, fine-grained, argillaceous, well-indurated, thin- to medium-bedded, fossiliferous; eroding into a ledge ..... 2.4
21. Shale, tan, calcitic, platy, rubbly, weakly indurated ..... 1.0
22. Limestone, tan to gray, fine-grained, well-indurated, thin-bedded, fossiliferous, with interbedded shale; eroding into ledges ... 14.0
23. Interval covered from Station 2336 + 32' to 2337 + 45'; estimated to be mostly shale with some limestone as above; eroding into a bench ..... 70.0

**Chimneyhill Subgroup** (25 ft thick): (Station 2337 + 45' west side, west lane)

**Clarita Limestone** (12 ft thick):

Limestone, light-tan to gray, fine-grained, medium-bedded, well-indurated, fossiliferous; eroding into small ledges ..... 12.0

**Cochrane Limestone** (13 ft thick):

Limestone, white to light-tan, mottled-greenish-gray to pink, medium- to coarsely crystalline, echinodermal, well-indurated, medium- to massive-bedded; eroding into a prominent mappable escarpment; base may be covered; Keel Limestone below not seen, but about 2 ft thick on Highway 77 ..... 13.0

**Marker No. ④**

**Station 2337 + 80', 3 ft above base of Cochrane**

### Ordovician

**Sylvan Shale** (305 ft thick): (Station 2337 + 82' west side, west lane)

Shale, greenish-gray, blocky to platy, weakly indurated; mostly covered, with about 20 to 25 ft exposed at top and at base; basal 6 ft brown, limonitic, thinly laminated, and weakly indurated; strike N. 60° W., dip 53° SW on base ..... 305.0

**Viola Group** (684 ft thick): (Station 2342 + 66' west side, west lane)

1. Limestone, gray, medium-grained, well-indurated, medium-bedded, conglomeratic at top, cherty (light-gray), vuggy, with large calcite crystals on east side of west lane; fossiliferous; weathering tan, eroding into a ledge ..... 2.0
2. Limestone, gray, fine- to medium-grained, medium- to thick-bedded, well-indurated, fossiliferous with many brachiopods, with calcite crystals in vugs on east side of west lane; weathering tan, eroding into a ledge ..... 11.0
3. Limestone, tan, fine- to medium-grained, argillaceous, thin-bedded, well-indurated, fossiliferous; eroding into a recess ..... 0.5
4. Limestone, bluish-gray, fine-grained to medium-granular, massive, well-indurated, fossiliferous; eroding into a ledge ..... 4.8

**Marker No. ⑤**

**Station 2342 + 91', 15 ft below top of Viola**

5. Limestone, gray, coarsely granular, well-indurated, medium-bedded, fossiliferous, echinodermal; eroding into a ledge ..... 2.0

6. Limestone, gray, fine-grained, argillaceous, lenticular, well-indurated, wavy-bedded, thin-bedded, cherty (gray), alternating with coarsely granular fossiliferous echinodermal limestone; eroding into ledges ..... 4.2
7. Limestone, gray, fine-grained, well-indurated, medium- to thick-bedded, with much nodular gray chert, conglomeratic in places, with pyritic specks; with some interbedded argillaceous limestone and dark-gray nodular limestone, brown at base; eroding into ledges ..... 3.5
8. Limestone, tan, fine-grained, argillaceous, cherty, well-indurated, wavy-bedded, thin-bedded; gradational into gray limestone .. 1.0
9. Limestone, gray, fine-grained, well-indurated, cherty (light-gray), nodular, alternating in lenses and layers with light-gray argillaceous limestone, fossiliferous, with thin tan layer in middle and at base; eroding into a ledge ..... 7.0
10. Limestone, gray, as above, slumped and fractured in places, with asphaltic stains ..... 40.0
11. Limestone, gray, fine-grained, argillaceous, well-indurated, thin-bedded to massive, wavy-bedded, cherty (white) in middle, conglomeratic, stained brown with many weathered pyrite specks, fossiliferous, alternating with medium-grained limestone; eroding into a ledge ..... 13.0
12. Limestone, gray, fine-grained, argillaceous, thin- to thick-bedded, wavy-bedded, well-indurated, cherty, fossiliferous, with some medium-grained limestone, slumped in places; eroding into a ledge ..... 28.0
13. Limestone, gray, medium-granular, wavy-bedded, thin- to medium-bedded, well-indurated, alternating with fine-grained argillaceous limestone, fossiliferous, with many *Lichenaria*-type trilobites; eroding into a ledge ..... 14.0
14. Limestone, gray, fine-grained, thin-bedded to massive, well-indurated, fossiliferous, alternating with light-gray argillaceous layers; eroding into massive ledges ..... 21.0
15. Limestone, gray, fine-grained, cherty, massive, well-indurated, fossiliferous, nodular, alternating with light-gray argillaceous limestone, with calcite vugs about 10 ft above base; eroding into a ledge; Station 2345 + 77' on base ..... 39.0

On the east side of the west lane at Station 2345 + 20', a 2-ft tar seep occurs associated with calcite crystals and gray clay, about 10 ft below above unit, or about 201 ft below top of Viola; section extrapolated to east side of east lane, at Station 2344 + 10' (Fig. 7)

16. Limestone, gray, fine-grained, argillaceous, crinkly-bedded, medium-bedded to massive, well-indurated, nodular, fossiliferous, with some gray chert nodules, with much dark-gray medium- to fine-grained limestone; eroding into a ledge . . . . . 13.0
17. Shale, gray to tan, calcitic, platy, asphaltic, crinkly-bedded, weakly indurated . . . . . 0.2
18. Limestone, gray, fine-grained to coarsely granular, argillaceous, well-indurated, thin-bedded to massive, nodular, fossiliferous, with many dark-gray nodular beds; weathering tan, eroding into a ledge; Station 2345 + 65' at base. . . . . 101.0
19. Interval partly covered, probably same as above; section extrapolated to west side of west lane to Station 2348 + 33' at base of interval . . . . . 55.0
20. Limestone, gray, fine- to medium-grained, argillaceous, medium-bedded, crinkly-bedded, alternating with light-gray argillaceous limestone, nodular, fossiliferous, with some thin shale beds; weathering tan, eroding into low ledges along a slope . . . . . 96.0
21. Limestone, gray, fine-grained, argillaceous, well-indurated, thin- to medium-bedded, crinkly-bedded, nodular, with some medium-grained limestone, alternating with many thin limy shale beds, fossiliferous, with some graptolites, with 3-in. yellow-brown shale at base; weathering tan, eroding into ledges; Station 2351 + 48' on base . . . . . 115.0
22. Limestone, gray, fine-grained, argillaceous, laminated, cherty, thin-bedded, well-indurated, alternating with light-gray argillaceous limestone, crinkly-bedded, fossiliferous, with many graptolites; basal 1 in. pyritic, limonitic, stained brown; weathering tan, eroding into a grass-covered hill . . . . . 113.0

### **Simpson Group (2,331 ft thick):**

#### **Bromide Formation (420 ft thick):**

*Pooleville Limestone Member (120 ft thick): (Station 2353 + 10' west side, west lane)*

- Limestone, tan to gray, fine-grained, dense, well-indurated, massive, fossiliferous, with many brachiopods, thin-bedded in lower 5 ft, with much sparry calcite; eroding into a massive tan to gray ledge . . . . . 16.0

#### **Marker No. ⑥**

**Station 2353 + 15', 1 ft below Pooleville top**

Limestone, tan to gray, fine-grained, medium-bedded, well-indurated, even-

bedded, fossiliferous; eroding into a ledge; about 10 ft is exposed, the remainder of the unit covered but well exposed in hill west of fence, along with underlying Mountain Lake Member . . . . . 104.0

#### *Mountain Lake Member (300 ft thick):*

Mostly shale, greenish-gray, with some fossiliferous limestone; with some interbedded sandstone in basal 100 ft, and 30 ft of sandstone at base; interval covered, but exposed just west of fence. . . . . 300.0

#### **Tulip Creek Formation (395 ft thick):**

Mostly shale in the upper part, with about 175 ft of sandstone in the lower part; the sandstone eroding into a tree-covered ridge; interval covered, but exposed in creeks near the highway. . . . . 395.0

#### **McLish Formation (475 ft thick):**

Mostly shale with interbedded limestone, with about 75 ft of fine- to medium-grained, quartzose sandstone at base; the basal few feet are covered, but the sandstone erodes into a tree-covered ridge, and the contact can be approximated at Station 2370 + 2' along east fence line of east lane . . . . . 475.0

#### **Oil Creek Formation (747 ft thick): (measured along east side, east lane)**

1. Shale, gray to tan, with some coarsely crystalline limestone; strike N. 55° W., dip 74° SW, changing to 60° SW near middle of exposures farther north; interval mostly covered with grass, to Station 2372 + 35' at base of cut, east side of east lane . . . . . 173.0
2. Shale, olive-green, platy, weakly indurated, thin- to medium-bedded, with some medium- to coarsely granular tan echinodermal limestone, fossiliferous; eroding into a slope . . . . . 10.0
3. Shale, olive-gray to green to tan, platy, thin-bedded, weakly indurated, with some thin dark-gray to tan medium- to coarsely grained fossiliferous limestone . . . . . 46.0
4. Limestone, gray to tan, coarse-grained, thin- to medium-bedded, well-indurated, biohermal, with many bryozoans, echinoderm parts, trilobites, and gastropods; eroding into ledges . . . . . 1.5
5. Shale, olive-green to tan, platy, weakly indurated. . . . . 4.0
6. Limestone, as above, biohermal . . . . . 2.0
7. Alternating shale and limestone, as above, in 1- to 1.5-ft beds, with 1.5-ft limestone at base . . . . . 20.0

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|--|------|--|------|
| 8. Shale, olive-green to gray to tan, platy, thin-bedded, with some nodular limestone and some 1- to 4-in. gray coarsely crystalline fossiliferous limestone beds; eroding into low ledges; Station 2373 + 55' on base ..          | 28.0 | and base, thick-bedded in middle, with some 1- to 2-in. shale seams; eroding into a ledge .....  | 4.0  |
| 9. Limestone, gray to tan, medium- to coarsely crystalline, thin-bedded, well-indurated, fossiliferous, echinodermal, with interbedded 2- to 4-in. tan to greenish-gray shale beds, moderately indurated; eroding into ledges..... | 3.5  | 24. Shale, greenish-gray, platy, weakly indurated, with some 1-in. nodular coarse-grained gray limestone beds .....  | 2.0  |
| 10. Limestone, gray, coarsely granular, medium-bedded, well-indurated, crinkly-bedded, fossiliferous, echinodermal; eroding into a ledge.....  | 2.5  | 25. Limestone, gray, coarse-grained, well-indurated, echinodermal, medium-bedded, with some greenish-gray shale; eroding into ledges .....   | 7.0  |
| 11. Shale, greenish-gray, weakly indurated, thin-bedded, with interbedded gray to tan coarsely granular echinodermal limestone; eroding into small ledges.....   | 15.0 | 26. Shale, greenish-gray, bluish-gray where fresh, platy, weakly indurated, with some 1- to 3-in. coarse-grained gray limestone beds; eroding into a grassy bench .....  | 10.0 |
| 12. Limestone, gray, as above, thin-bedded, with some 1- to 6-in. greenish-gray shale beds; eroding into ledges .....  | 7.0  | 27. Limestone, gray, coarse-grained, well-indurated, medium-bedded, with some 1-in. greenish-gray shale beds .....   | 2.5  |
| 13. Shale, greenish-gray, platy, weakly indurated, with 6-in. coarse-grained echinodermal limestone in middle .....  | 6.0  | 28. Shale, greenish-gray to bluish-gray, weakly indurated, with many 1- to 3-in. gray limestone beds 0.5 to 1 ft apart; eroding into a grassy bench .....  | 15.0 |
| 14. Limestone, gray, coarse-grained, thin-bedded, well-indurated, crinkly-bedded, fossiliferous, echinodermal, with some interbedded 1- to 2-in. greenish-gray shale beds; eroding into a ledge .....                              | 2.5  | 29. Limestone, gray, coarse-grained, well-indurated, fossiliferous, with 2- to 4-in. shale seams in middle; eroding into a ledge .....   | 2.5  |
| 15. Shale, greenish-gray, as above, with alternating 1- to 2-in. gray limestone beds; eroding into small ledges.....   | 11.0 | 30. Shale, bluish-gray to greenish-gray, with many 1- to 3-in. gray coarse-grained echinodermal limestones; weathering tan, eroding into small ledges .....  | 43.0 |
| 16. Alternating greenish-gray shale and gray limestone, as above, in 0.5- to 1-ft beds; eroding into small ledges.....   | 10.0 | 31. Shale, bluish-gray, platy, weakly indurated, with some 1-in. nodular limestone beds, and some 1- to 2-in. tan limestones near base; eroding into a grassy bench; Station 2375 + 60' on base .....  | 6.0  |
| 17. Alternating shale and limestone, as above, in 1-in. beds, with 1-ft gray massive limestone at base; eroding into a ledge at base .....   | 6.0  | 32. Alternating bluish-gray to greenish-gray shale, with gray coarsely crystalline nodular crinkly-bedded limestone, fossiliferous, medium-bedded, echinodermal; eroding into ledges.....  | 12.0 |
| 18. Shale, greenish-gray, platy, weakly indurated; weathering tan .....  | 1.5  | 33. Limestone, bluish-gray, coarse-grained, massive, well-indurated, fossiliferous, echinodermal; eroding into a ledge.....  | 1.0  |
| 19. Limestone, gray, medium- to coarse-grained, massive, well-indurated, echinodermal; eroding into a ledge .....  | 0.8  | 34. Shale, bluish-gray, platy, weakly indurated, with many 1- to 4-in. beds of fine-grained argillaceous nodular limestone and gray coarsely crystalline fossiliferous limestone, with many bryozoans, gastropods, and echinoderms; weathering tan, eroding into ledges..... | 36.0 |
| 20. Shale, greenish-gray, thin-bedded, with many 1- to 2-in. medium- to coarse-grained limestone beds, some of which are iron-stained red-brown in middle part; eroding into ledges.....   | 10.0 | 35. Limestone, gray, coarse-grained, massive, well-indurated, echinodermal, with many bryozoans and brachiopods; weathering tan, eroding into a ledge .....  | 1.5  |
| 21. Limestone, gray, coarse-grained, well-indurated, medium-bedded, echinodermal; eroding into a ledge .....   | 2.0  | 36. Shale, greenish-gray, platy, with many 1- to 3-in. beds of fine-grained gray to tan iron-stained argillaceous limestone and some gray coarsely crystalline fossiliferous limestone with gastropods and some echinoderms; eroding into ledges.....                        | 30.0 |
| 22. Shale, greenish-gray to tan, platy, weakly indurated, with some 1- to 2-in. coarse-grained gray limestone near top .....   | 2.5  |  |      |
| 23. Limestone, gray, coarse-grained, well-indurated, fossiliferous, thin-bedded at top .....   |      |  |      |



37. Alternating greenish-gray shale and bluish-gray coarsely crystalline echinodermal limestones, medium-bedded, fossiliferous; eroding into ledges . . . . .	9.0	some limonitic ironstone beds 1-2 in. thick in lower 20 ft; eroding into ledges; Station 2378 + 60' on base . . . . .	60.0
38. Shale, greenish-gray, platy, weakly indurated, with some 1-in. nodular limestones in middle and near base; eroding into a recess . . . . .	3.0	<i>Lower transition zone (50 ft thick):</i>	
39. Limestone, gray, coarsely crystalline, echinodermal, thin- to medium-bedded, with some 1- to 4-in. greenish-gray shale beds; eroding into a ledge . . . . .	3.0	53. Limestone, bluish-gray, coarsely crystalline, arenaceous, massive, cross-bedded, echinodermal; gradational into calcitic quartzose sandstone; eroding into a ledge (Fig. 8) . . . . .	2.0
40. Shale, greenish-gray, platy, weakly indurated . . . . .	3.0	<b>Marker No. ⑦</b> <b>Station 2378 + 59', 49 ft above base of Oil Creek</b>	
41. Limestone, gray, as above, medium-bedded, eroding into a ledge . . . . .	3.0	54. Alternating bluish-gray arenaceous limestone and greenish-gray platy shale, in 1- to 6-in. beds; eroding into small ledges . . . .	10.0
42. Alternating shale, greenish-gray, platy, weakly indurated, and limestone, gray, coarse-grained, echinodermal, well-indurated, medium-bedded, fossiliferous; eroding into ledges . . . . .	8.0	55. Shale, gray to tan, platy, silty, weakly indurated . . . . .	2.0
43. Limestone, gray, coarsely crystalline, thin- to medium-bedded, crinkly-bedded, echinodermal, with some thin shale seams; eroding into a ledge . . . . .	1.5	56. Limestone, gray to tan, medium-grained, arenaceous, well-indurated, fossiliferous, medium-bedded, alternating with tan to gray arenaceous shales; eroding into ledges . . . . .	3.0
44. Alternating greenish-gray shale and bluish-gray coarsely crystalline limestone, medium-bedded, fossiliferous; eroding into ledges . . . . .	10.0	57. Sandstone, dark-gray, fine-grained, quartzose, silty, calcitic, fossiliferous, with some interbedded gray shale and limestone, nodular, weakly indurated; more massive and tan toward base, with 2-in. dark-gray shale at base; eroding into a slope . . . . .	12.0
45. Shale, greenish-gray, platy, weakly indurated . . . . .	2.0	58. Sandstone, tan, fine-grained, quartzose, calcitic, nodular, thin- to medium-bedded, and moderately indurated; gradational into arenaceous limestone in places; eroding into ledges . . . . .	21.0
46. Alternating shale and limestone; shale greenish-gray, platy, weakly indurated, 1- to 8-in. beds; limestone bluish-gray, coarsely crystalline, echinodermal; with 2-ft shale at base; eroding into small ledges . . . . .	16.0	<b>Joins Formation (294 ft thick): (Station 2379 + 25' on top, east side, east lane)</b>	
47. Limestone, gray, coarsely crystalline, well-indurated, fossiliferous, echinodermal, thin- to medium-bedded, with some greenish-gray platy shale; eroding into ledges . . . . .	22.0	Limestone, light-gray, fine- to coarse-grained, well-indurated, thin-bedded, fossiliferous, nodular; mostly covered; eroding into low ledges; exposed . . . . .	10.0 +
48. Shale, greenish-gray, platy, weakly indurated . . . . .	2.0	Basal conglomerate not exposed, but occurs about 42 ft above a prominent algal bed in the West Spring Creek Formation, at approximately Station 2383 + 35' along east fence line of east lane.	
49. Limestone, bluish-gray, coarsely crystalline, echinodermal, massive; eroding into a ledge . . . . .	0.8	<b>Upper Arbuckle Group</b>	
50. Alternating greenish-gray platy shale and bluish-gray coarsely crystalline echinodermal limestone, in 1- to 6-in. beds, fossiliferous; eroding into ledges . . . . .	12.0	(o = oolite; r = red beds; s = sandstone.)	
51. Limestone, gray to tan, fine- to coarse-grained, nodular, medium-bedded, crinkly-bedded, fossiliferous; eroding into a ledge . . . . .	4.0	<b>West Spring Creek Formation (1,515 ft thick)</b>	
52. Alternating shale, bluish-gray to tan, platy, weakly indurated, in 1-in. to 1-ft beds, and limestone, bluish-gray, coarsely crystalline, echinodermal, in 1- to 6-in. beds; with		<i>Upper zone (288 ft thick): (Station 2383 + 35' east fence line, east lane)</i>	
		1. Limestone, fine-grained, argillaceous, fossiliferous, well-indurated, covered; regional strike N. 50° W., dip 55° SW . . . .	42.0

2. Limestone, gray, fine-grained, well-indurated, medium-bedded, fossiliferous, with many large 0.5- to 1-ft algal-like concentric structures; eroding into a ledge; top is at Station 2383 + 85' on east side of east lane ..... 2.0
3. Limestone, gray, coarse-grained, arenaceous, conglomeratic, pelletal, medium-bedded, well-indurated; gradational into sandstone below; eroding into a ledge ... 2.0
4. Limestone, yellow-brown, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated, with laminated algal-like structures in lower foot; eroding into a grassy flat. .... 6.0
5. Limestone, gray, mottled yellow-brown, fine-grained, well-indurated, medium-bedded, with algal-like structures in upper part and gastropods in lower part; eroding into a ledge ..... 5.0
6. Limestone, gray to yellow-brown, fine-grained, argillaceous, dolomitic, laminated, well- to moderately indurated; eroding into a slope ..... 5.0
7. Limestone, gray, coarse-grained, pelletal, well-indurated, massive to medium-bedded, arenaceous in middle with algal-like structures; eroding into a ledge ..... 5.0

**Marker No. ⑧**

**Station 2384 + 15', 67 ft below top of West Spring Creek**

8. Limestone, yellow-brown, fine-grained, argillaceous, dolomitic, laminated, weakly indurated, alternating with yellow-brown shale layers; eroding into a recess. .... 2.0
9. Limestone, gray, fine- to coarse-grained, pelletal, laminated, medium-bedded, well-indurated, fossiliferous, silty in top 3 in.; eroding into an escarpment ..... 2.0
10. Limestone, tan, fine-grained, argillaceous, dolomitic, thin-bedded, moderately indurated; eroding into a grassy flat. .... 4.0
- 11s. Limestone, gray, medium-grained, arenaceous, pelletal, medium- to thick-bedded, well-indurated; gradational into a quartzose medium-grained sandstone; eroding into a ledge. .... 2.0
12. Limestone, gray to tan, fine-grained, argillaceous, dolomitic, laminated, medium-bedded, moderately indurated; eroding into a grassy flat. .... 8.0
13. Limestone, gray, fine-grained, pelletal, massive, well-indurated; eroding into a ledge ..... 3.0
14. Limestone, light-gray to tan, fine-grained, argillaceous, dolomitic, laminated to

medium-bedded, moderately to weakly indurated, with some white chert at base, alternating with thin shale beds; eroding into a grassy flat (approximate paleontologic position of Lower Ordovician–Middle Ordovician boundary by Derby, 1969; this is also the approximate position of the Joins–Arbuckle contact on electric logs by some petroleum geologists); Station 2384 + 82' at base, east side, east lane ..... 18.0

- 15s. Limestone, light-gray to tan, fine- to medium-grained, arenaceous, laminated, massive; crinkly-bedded, algal in upper part; cross-bedded quartzose calcitic medium-grained sandstone in middle; eroding into a ledge. .... 4.5
16. Limestone, gray to tan, fine-grained, argillaceous, dolomitic, laminated, medium-bedded, moderately to well-indurated, with some 1- to 3-in. beds of coarse-grained limestone and many greenish-gray shale laminae in lower 7 ft; eroding into a grassy slope ..... 15.0
- 17s. Sandstone, tan to light-gray, fine- to medium-grained, quartzose, calcitic, laminated, well-indurated; gradational into limestone; eroding into a ledge; Station 2385 + 10' on top of bed east side, east lane ..... 1.0
18. Limestone, light-gray, fine-grained, argillaceous, arenaceous, silty, dolomitic, thin-bedded, moderately to weakly indurated; eroding into a slope ..... 6.5
19. Limestone, gray to pink, fine- to coarse-grained, pelletal, dolomitic, massive, well-indurated; eroding into a ledge ..... 2.0
20. Limestone, light-gray, fine-grained, argillaceous, laminated, moderately indurated; alternating with coarse-grained light-pink, medium-bedded, well-indurated limestone; eroding into ledges ..... 2.0
- 21s. Sandstone, brown to light-gray, fine- to medium-grained, quartzose, calcitic at top, argillaceous and dolomitic in middle, well-indurated; eroding into a recess in middle ..... 3.0
22. Limestone, gray, fine-grained, medium-bedded, well-indurated; eroding into a ledge ..... 2.5
23. Shale, gray, platy, calcitic, weakly indurated; Station 2385 + 35' on base, east side of east lane ..... 0.5
24. Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, well-indurated, with some 1- to 2-in. limy shale layers; eroding into a ledge ..... 2.0
25. Limestone, gray to tan, fine-grained, argillaceous, dolomitic, thin- to medium-bedded, well-indurated, with some white chert nodules in upper 5 ft; silty in basal 3 ft, with 6-in. bed of gray to white chert and

shale at base; Station 2385 + 70' on base, east side, east lane .....		20.0	ledge; Station 2387 + 40' on base, east side, east lane .....		1.0
26s.	Sandstone, tan to light-gray, fine-grained, quartzose, silty, calcitic, dolomitic, thin-bedded, well-indurated; gradational into limestone in the upper 6 in.; eroding into a ledge .....	6.0	<i>Middle zone</i> (1,003 ft thick): (contains an 8-ft sandstone at top, 40 red-bed intervals, and 10 oolitic limestones) (Figs. 9-10)		
27.	Limestone, gray to yellow-brown, fine-grained, argillaceous, dolomitic, laminated, well-indurated, with some 1- to 4-in. shale beds; with stylolite-pyrite zone 20 ft below top; weathering tan, eroding into ledges .....	26.0	37s.	Sandstone, white to tan, fine-grained, quartzose, calcitic, well-indurated, thin- to thick-bedded, stained with many brown limonite and pyrite specks; argillaceous and more laminated in lower 2 ft, with symmetrical ripple marks in middle and basal parts that strike N. 35° W.; Station 2387 + 52' on base, east side of east lane .....	8.0
28.	Limestone, gray to dark-gray, mottled tan, fine- to medium-grained, argillaceous, dolomitic, nodular to brecciated, thick-bedded to massive, with some laminated layers; eroding into ledges .....	33.0	38.	Limestone, tan, fine-grained, argillaceous, dolomitic, rubbly, with much gray chert .....	1.0
29.	Limestone, dark-gray, fine-grained, argillaceous, thin-bedded, nodular, well-indurated, mottled tan, alternating with many crinkly-bedded limy bluish-gray shale layers, with 6-in. tan shale at base; eroding into a grassy bench .....	13.0	39r.	Limestone, red-brown, fine- to medium-grained, argillaceous, pelletal, nodular, mottled tan, crinkly-bedded, moderately to weakly indurated, with some red-brown shale; eroding into a grassy bench .....	2.0
30.	Limestone, gray to dark-gray, mottled tan, argillaceous, massive, well-indurated, thin- to medium-bedded at top; eroding into a ledge .....	14.0	40.	Limestone, light-greenish-gray to lavender, fine-grained, argillaceous, laminated, moderately to well-indurated, crinkly-bedded, with a 6-in. greenish-gray shale at top; eroding into a grassy bench .....	5.0
31.	Limestone, bluish-gray to gray, mottled tan, fine-grained, argillaceous, dolomitic, nodular, laminated, moderately indurated, massive in middle 2 ft; gradational into shale; eroding into a recess .....	12.0	41r.	Limestone, red-brown, fine-grained, argillaceous, moderately indurated, thinly laminated, with much greenish-gray to red-brown shale in upper part .....	1.5
32.	Limestone, gray, fine-grained, massive, well-indurated; eroding into a ledge .....	3.0	42.	Limestone, yellow-brown to greenish-gray, fine-grained, argillaceous, dolomitic, moderately to well-indurated, mottled red-brown, massive at top, thin-bedded below, with gray to tan chert at base; eroding into a bench .....	2.0
33.	Limestone, gray to tan, fine-grained, dolomitic, medium-bedded, well-indurated; eroding into a grassy bench .....	2.5	43.	Limestone, gray, fine-grained, argillaceous, laminated, medium-bedded, well-indurated; eroding into small ledges .....	5.5
34.	Limestone, gray, fine- to medium-grained, argillaceous, cherty (brown), pelletal, nodular, medium- to thick-bedded, well-indurated, with many brown silicified brachiopods at top, fossiliferous, with <i>Ceratopea</i> and many <i>Pomatotrema</i> and <i>Diparelasma</i> in top and middle; eroding into a ledge .....	10.0	44r.	Limestone, red-brown, fine-grained, argillaceous, laminated, moderately to weakly indurated, mottled yellow-brown, with some interbedded shale at top and bottom .....	2.0
<b>Marker No. ⑨</b> <b>Station 2387 + 37', 284 ft below top of West Spring Creek, in C-D-P zone of Ham</b>			45o.	Limestone, gray, fine-grained, oolitic, crinkly-bedded, medium-bedded to massive, well-indurated; eroding into a ledge .....	3.0
35.	Shale, tan, calcitic, laminated, weakly indurated; gradational into limestone above; eroding into a recess .....	2.0	46r.	Limestone, red-brown, fine-grained, argillaceous, laminated, weakly indurated, with interbedded red-brown to tan shale; eroding into a recess .....	3.0
36.	Limestone, gray, fine-grained, dense, well-indurated; medium-bedded, with interbedded brown to white chert; eroding into a		47.	Limestone, light-greenish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated; eroding into a recess .....	1.0
			48r.	Limestone, red-brown, fine-grained, argillaceous, laminated, well-indurated at	

	top, weakly indurated below; gradational into shale; eroding into a recess . . . . .	1.7	62s. Limestone, light-gray to tan, fine-grained, silty, dolomitic, laminated, medium-bedded, with some fine-grained tan sandstone in middle, well-indurated; eroding into ledges . . . . .	6.0
49o.	Limestone, gray, fine- to coarse-grained, oolitic, pelletal, well-indurated, massive; eroding into a ledge; Station 2387 + 93' on top of bed east side, east lane . . . . .	1.5	63. Limestone, bluish-gray, fine-grained, argillaceous, laminated, moderately to well-indurated, alternating with dark-gray medium-grained limestone; eroding into ledges . . . . .	2.5
50r.	Limestone, red-brown, fine-grained, argillaceous, laminated, moderately to weakly indurated, mottled tan to greenish-gray in upper 1 ft, with some interbedded shale; eroding into a grassy bench . . . . .	6.8	64. Limestone, tan, fine-grained, argillaceous, dolomitic, laminated, arenaceous at base, moderately indurated; eroding into a recess . . . . .	3.8
51.	Limestone, gray, fine-grained, laminated, well-indurated, medium- to thick-bedded, with white to tan chert in upper 2 in.; eroding into a ledge . . . . .	6.0	65. Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, brecciated, moderately indurated, with some interbedded medium-grained limestone; eroding into a grassy bench . . . . .	7.0
52o.	Limestone, gray, fine- to medium-grained, oolitic, pelletal, medium-bedded, well-indurated; eroding into a ledge . . . . .	0.9	66. Limestone, gray to tan, fine-grained, argillaceous, dolomitic, laminated, medium- to thick-bedded, well-indurated; eroding into ledges . . . . .	7.0
53r.	Limestone, red-brown, fine-grained, argillaceous, laminated, weakly indurated, mottled yellow-brown below; gradational into shale; eroding into a recess . . . . .	1.2	67. Limestone, gray, coarse-grained, pelletal, medium-bedded, well-indurated; eroding into a ledge . . . . .	1.6
54.	Limestone, gray, fine-grained, argillaceous, laminated, pelletal, well-indurated, with some oolitic layers; eroding into ledges . . . . .	3.5	68. Limestone, tan, fine-grained, silty, arenaceous, dolomitic, moderately to weakly indurated; eroding into a recess . . . . .	1.5
55r.	Limestone, red-brown, fine-grained, argillaceous, laminated, moderately to weakly indurated, with some interbedded shale, and light-gray lenticular limestone in middle; eroding into a recess . . . . .	12.5	69s. Sandstone, tan, fine-grained, quartzose, calcitic, dolomitic, thin- to medium-bedded, weakly to moderately indurated; eroding into a recess; Station 2389 + 43' on top of bed, east side, east lane . . . . .	1.0
56.	Limestone, tan to greenish-gray, fine-grained, argillaceous, dolomitic, rubbly, massive, brecciated, well-indurated; eroding into a ledge . . . . .	4.5	70s. Shale and limestone, tan, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated, with a 1-ft tan sandstone 11-12 ft below top; eroding into a recess . . . . .	18.5
57r.	Limestone, red-brown, fine-grained, argillaceous, laminated, pelletal, moderately indurated, mottled tan in lower 1 ft, with some interbedded shale; eroding into a bench; base of red-bed sequence Station 2388 + 52' east side, east lane . . . . .	5.0	71. Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, medium-bedded to massive, well-indurated, with some dark-gray medium-grained limestone; eroding into ledges . . . . .	7.0
58.	Limestone, gray to bluish-gray, mottled tan, fine-grained, argillaceous, dolomitic, thin- to medium-bedded, moderately to well-indurated, with some small pyrite crystals and limonitic stains; eroding into a recess . . . . .	20.0	72o. Limestone, gray, medium-grained, oolitic, pelletal, medium-bedded to massive, well-indurated; eroding into a ledge . . . . .	1.8
59.	Limestone, tan, fine-grained, argillaceous, dolomitic, rubbly, weakly indurated, with interbedded shale; eroding into a recess . . . . .	2.0	73. Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, well-indurated, thin-bedded, with some interbedded medium-grained dark-gray limestone; eroding into a grassy bench . . . . .	18.0
60.	Limestone, light-bluish-gray to tan to dark-gray, fine-grained, dolomitic, laminated, thin- to thick-bedded, with some medium-grained limestone; arenaceous, cherty in lower 1 ft; eroding into small ledges . . . . .	11.5	74. Limestone, tan, fine-grained, silty, dolomitic, laminated, medium-bedded to massive, moderately to well-indurated, mottled bluish-gray at top; eroding into a grassy bench . . . . .	2.5
61s.	Sandstone, white to light-tan, fine-grained, quartzose, calcitic, medium-bedded, well-indurated; eroding into a ledge; Station 2389 on top of bed, east side, east lane . . . . .	1.0	75r. Limestone, red-brown, mottled tan, fine-grained, argillaceous, dolomitic, lami-	



Figure 1. Delaware Creek Shale, west side of west lane, looking west, on north side of Tulip Creek; strike N. 60° W., dip 45° SW; station 2320 + 75' in middle; SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 2. Upper Sycamore Limestone, west lane, looking west; strike N. 65° W., dip 44° SW; station 2323 + 30' on top of upper limestone; NW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.





Figure 3. Main Sycamore Limestone, west lane, looking west, with Woodford Shale on north slope; strike N. 65° W., dip 44° SW; station 2325 + 35' on top of massive limestone; near CSE $\frac{1}{4}$  sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 4. Lower Sycamore Limestone on Woodford Shale, west side of west lane, looking northwest, contact near bushes on right; strike N. 60° W., dip 44° SW; station 2327 + 33' on base of main limestone; station 2328 + 21' on lower limestone base; station 2329 + 50' on Sycamore–Woodford contact; SW $\frac{1}{4}$  SE $\frac{1}{4}$  NW $\frac{1}{4}$  SE $\frac{1}{4}$  sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 5. Sycamore Limestone–Woodford Shale contact (middle of bushes near middle), west side of west lane, looking west; strike N. 60° W., dip 44° SW; station 2329 + 50' on contact; SW¼SE¼NW¼SE¼ sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 6. Woodford Shale on Hunton Group (Bois d'Arc 8.8 ft, Haragan 25 ft, Henryhouse on right, below thick limestone), west side of west lane, looking west; strike N. 60° W., dip 46° SW; station 2333 + 85' on base of Woodford; SW¼NE¼NW¼SE¼ sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



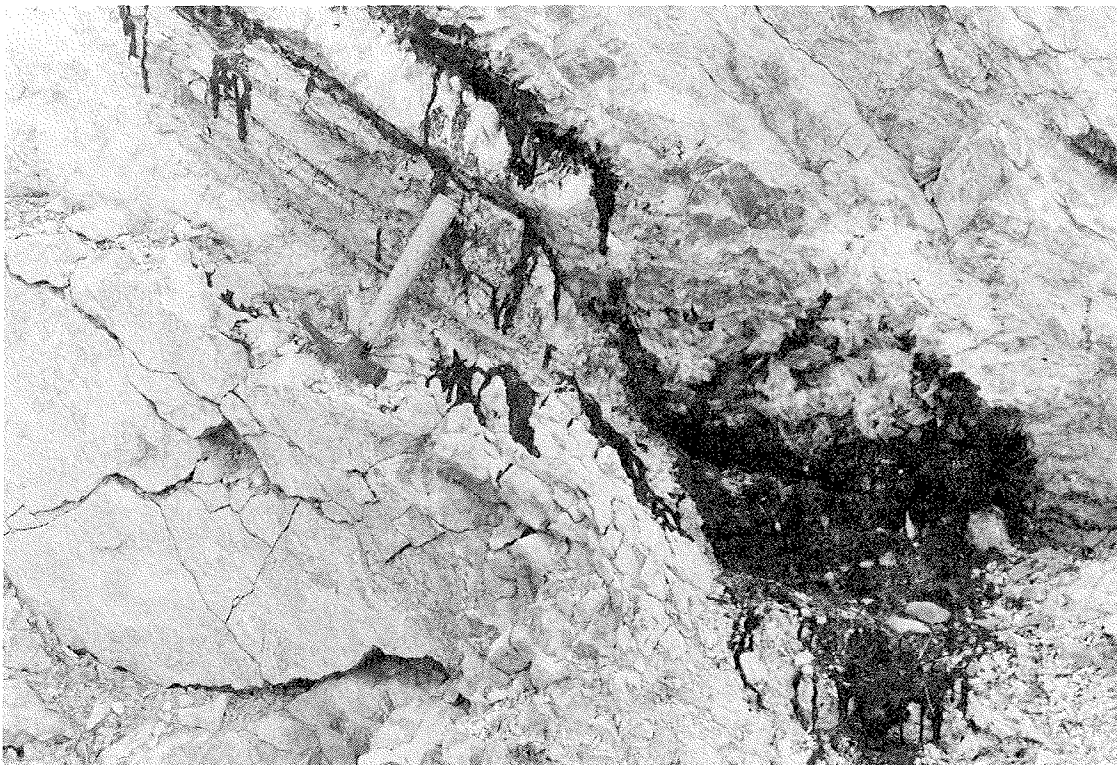


Figure 7. Upper Viola limestone, ~200 ft below top, asphalt, clay, and calcite, east side of west lane; strike N. 62° W., dip 43° SW; station 2345 + 27' on seam; NW¼SE¼SW¼NE¼ sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 8. Lower Oil Creek Formation, lower sandstone on right (thick bed) at top of sandstone sequence, east lane, looking east; strike N. 60° W., dip 58° SW; station 2378 + 59' on top of sandstone to right; NW¼NW¼SE¼SE¼ sec. 24, T. 2 S., R. 1 E., Carter County, Oklahoma.

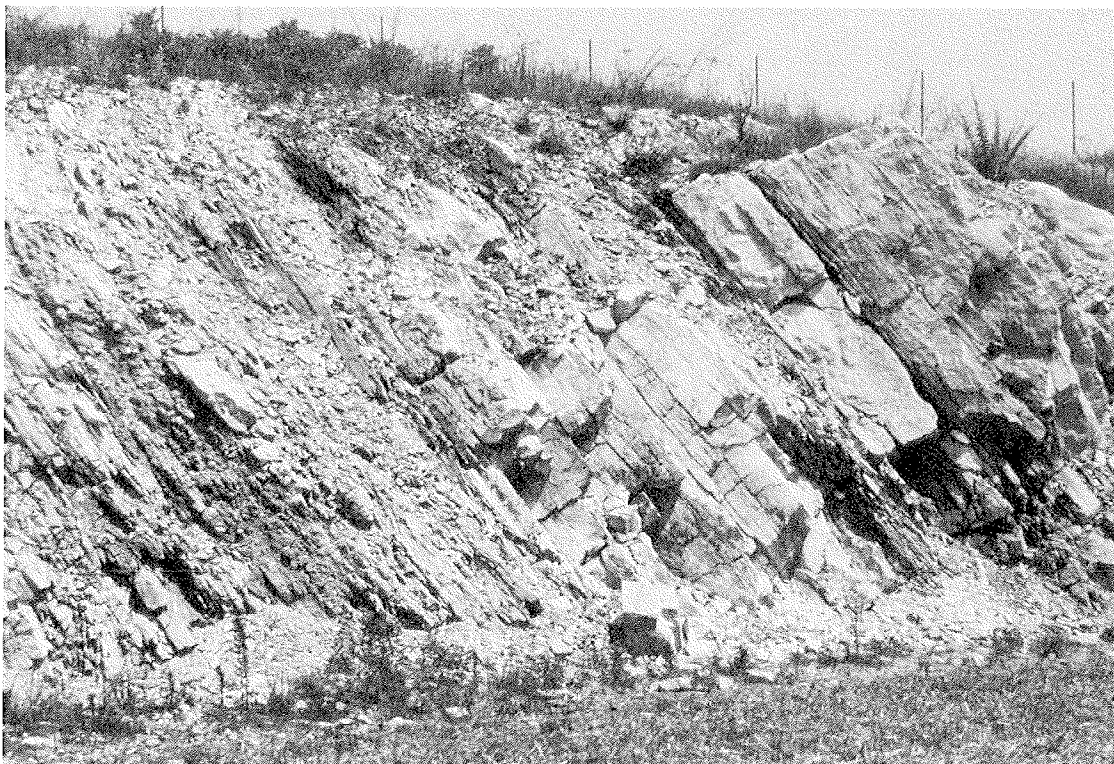


Figure 9. Upper West Spring Creek sandstone, 9 ft thick, east lane, looking east; strike N. 50° W., dip 55° SW; station 2387 + 38' on top of sandstone; SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 24, T. 2 S., R. 1 E., Carter County, Oklahoma.



Figure 10. Upper West Spring Creek limestone, with red-brown beds and oolites, east lane, looking east; strike N. 50° W., dip 55° SW; station 2388 + 50' on base of red sequence; SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 24, T. 2 S., R. 1 E., Carter County, Oklahoma.





Figure 11. Middle West Spring Creek Formation, *Didymograptus protobifidus* zone of gray shale in middle; strike N. 50° W., dip 60° SW; station 2395 + 12' on base; SE¼SW¼SE¼NE¼ sec. 24, T. 2 S., R. 1 E., Carter County, Oklahoma.

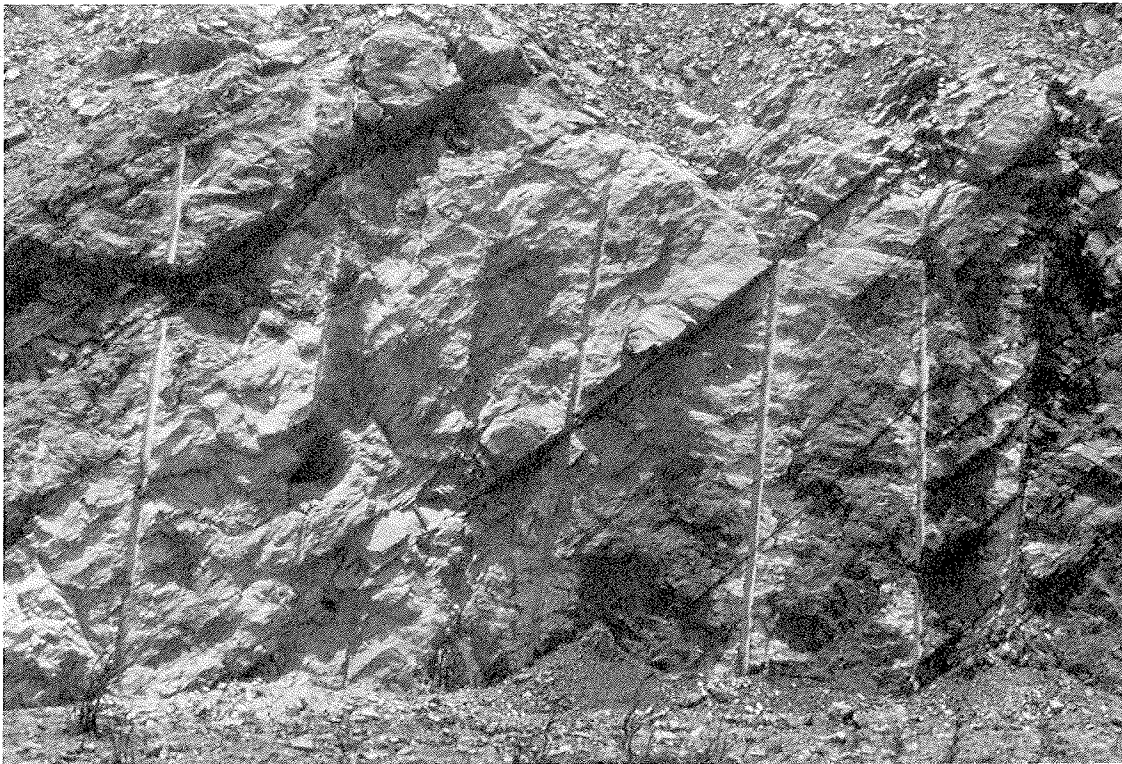


Figure 12. West Spring Creek limestone–Kindblade limestone contact, west lane, looking west; strike N. 50° W., dip 50° SW; station 2405 + 95' on contact; SE¼SW¼NE¼NE¼ sec. 24, T. 2 S., R. 1 E., Carter County, Oklahoma.

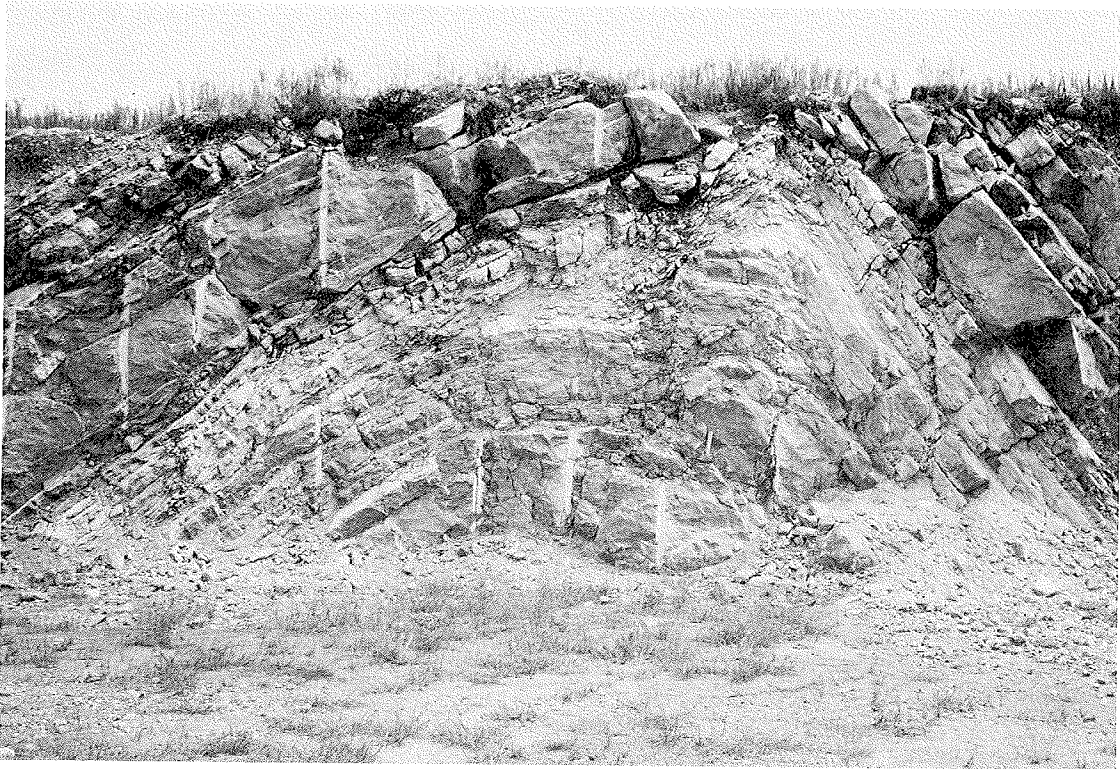


Figure 13. Anticline in lower Kindblade limestone, east lane, looking east; strike N. 50° W., dip 18–50° away from axis; station 2423 + 20' on axis; SE¼SE¼SE¼ sec. 13, T. 2 S., R. 1 E., Murray County, Oklahoma.



Figure 14. Fort Sill Limestone, west lane, looking west, faulted and folded zone; strike mostly N. 70° W.; station 2536 + 85' on axis of middle syncline; near CNE¼SW¼SW¼ sec. 6, T. 2 S., R. 2 E., Murray County, Oklahoma.





Figure 15. Reagan Sandstone on Colbert Rhyolite Porphyry, dip S; view looking west; station 2521 (projected on cut face of Reagan on side of hill; NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 12, T. 2 S., R. 1 E., Murray County, Oklahoma.



Figure 16. Sycamore Limestone, transition zone at base, east side of east lane, looking southeast; strike N. 65° W., dip 70° S, overturned; station 2681 + 49' on base of massive limestone to left, and station 2679 + 42' on base of fourth limestone to right; SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.



Figure 17. Cochrane Limestone (on left) below Clarita Limestone (right) at shale contact, west side of old Highway 77, looking west; strike N. 68° W., dip vertical; SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.

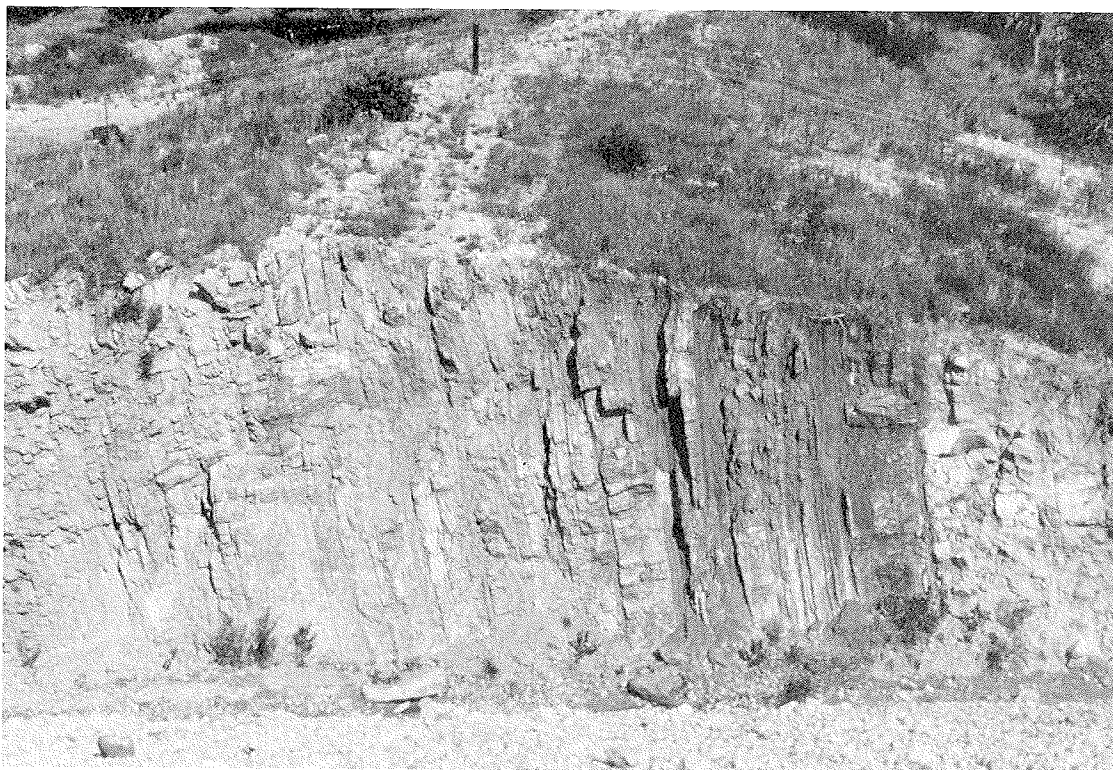


Figure 18. McLish Formation, limestone and shale on basal sandstone (right), east ditch of east lane, looking southeast; strike N. 55° W., dip 75° SW, overturned; station 2645+35' on top of basal sandstone; SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.





Figure 19. Mountain Lake Member below Pooleville Member of Bromide Formation, east side of east lane, looking southeast; strike N. 60° W., dip 32° SW; station 2641 + 50' at base of slumped upper sandstone on left; NW¼SW¼SE¼SE¼ sec. 30, T. 1 S., R. 2 E., Murray County, Oklahoma.



Figure 20. Upper Kindblade limestone, contact with tectonic breccia, west turnout, looking west; strike N. 70° W., dip 56° NE; station 2598 + 50' on contact; NE¼SE¼NE¼SW¼ sec. 31, T. 1 S., R. 2 E., Murray County, Oklahoma.



	nated, weakly to moderately indurated; gradational into shale below; eroding into a recess; Station 2390 + 14' on top of bed, east side, east lane . . . . .	1.7		indurated; eroding into ledges . . . . .	21.7
76.	Limestone, gray to greenish-gray, fine-grained, crinkly-bedded, thin-bedded to massive, well-indurated, with white chert nodules; eroding into a ledge . . . . .	2.5	89.	Limestone, tan, fine-grained, argillaceous, silty, dolomitic, laminated, weakly indurated; gradational into shale . . . . .	3.5
77r.	Shale, red-brown, calcitic, platy, laminated, weakly indurated; gradational into fine-grained limestone, with greenish-gray shale below; eroding into a recess . . . . .	1.0	90.	Limestone, gray, mottled tan, fine-grained, argillaceous, dolomitic, laminated, well-indurated, medium-bedded to massive; eroding into ledges . . . . .	13.0
78.	Limestone, light-gray to tan, fine-grained, argillaceous, dolomitic, silty, laminated, medium-bedded, moderately indurated, with some white chert in middle; eroding into a recess . . . . .	3.0	91.	Limestone, tan, fine-grained, silty, dolomitic, laminated, moderately to well-indurated, mottled gray in places; eroding into ledges along a slope; partly covered along old road; Station 2391 + 43' on middle of old road, east side of east lane . . .	72.0
79r.	Limestone, red-brown, mottled tan, fine-grained, argillaceous, moderately to weakly indurated; gradational into shale; eroding into a recess . . . . .	1.0	92.	Limestone, gray to bluish-gray, fine-grained, argillaceous, laminated, medium-bedded to massive, well-indurated, pelletal in places; eroding into ledges on a slope. .	15.0
80.	Limestone, gray, fine-grained, argillaceous, dolomitic, well-indurated, medium- to thick-bedded, with some brown chert in middle, mottled tan to red-brown in lower 3 ft; eroding into ledges . . . . .	6.2	93.	Limestone, tan, fine-grained, argillaceous, silty, dolomitic, laminated, thin- to medium-bedded, moderately to weakly indurated, with some limonitic stains, with some shale and much white chert in basal part; eroding into a recess . . . . .	4.7
81.	Shale, greenish-gray to tan, calcitic, platy, weakly indurated . . . . .	0.4	94.	Limestone, gray, fine-grained, laminated, well-indurated, medium- to thick-bedded, with some white to gray chert nodules; eroding into ledges . . . . .	6.0
82.	Limestone, gray, mottled red-brown, fine-grained, argillaceous, dolomitic, laminated, thin-bedded, well-indurated; eroding into a grassy bench . . . . .	2.5	95.	Shale, tan to bluish-gray, calcitic, dolomitic, platy, moderately to weakly indurated; eroding into a recess . . . . .	1.8
83r.	Limestone, red-brown, fine-grained, argillaceous, laminated, thin-bedded, moderately indurated; eroding into a recess . .	0.7	96.	Limestone, gray, fine-grained, algal(?), laminated, well-indurated, medium- to thick-bedded; eroding into a ledge . . . . .	3.0
84.	Limestone, gray to greenish-gray, fine-grained, argillaceous, laminated, crinkly-bedded, well-indurated, with chalcedonic chert; eroding into a recess . . . . .	0.8	97.	Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, well-indurated, with some interbedded tan shale in lower part; eroding into ledges . . . . .	23.0
85r.	Limestone, mottled red-brown to tan to light-gray, fine-grained, argillaceous, dolomitic, laminated, moderately indurated; eroding into a recess; Station 2390 + 45' on base of red-bed sequence, east side of east lane . . . . .	2.5	98.	Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated, with much interbedded shale; eroding into a recess . .	5.4
86.	Limestone, gray, fine-grained, argillaceous, dolomitic, dense, medium-bedded, well-indurated, mottled red-brown in upper 1 ft; eroding into ledges . . . . .	3.4	99.	Limestone, gray, fine-grained, argillaceous, medium- to thick-bedded, well-indurated, with white brecciated chert in lower 3 in.; eroding into ledges . . . . .	6.0
87.	Limestone, light-gray to tan, fine-grained, argillaceous, silty, dolomitic, laminated, moderately to weakly indurated, cross-bedded in upper part; eroding into a recess; Station 2390 + 60' at base, east side of east lane . . . . .	6.8	100.	Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, crinkly-bedded, moderately to weakly indurated; gradational into shale; eroding into a recess	7.5
88.	Limestone, bluish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, medium-bedded to massive, well-		101.	Limestone, gray, fine-grained, argillaceous, laminated to dense, thin- to thick-bedded, mottled tan, with some 6-in. shale beds; eroding into ledges . . . . .	24.0
			102.	Limestone, tan above to bluish-gray below, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated, with much shale; eroding into a recess . .	11.0

- |  |      |   |      |
|--|------|---|------|
| 103. Limestone, gray, fine-grained, argillaceous, dolomitic, laminated, well-indurated, thin- to thick-bedded, nodular in places, mottled bluish-gray to tan; eroding into ledges; Station 2393 + 80' on base, at top of red-bed sequence, east side, east lane  | 35.0 | bedded, well-indurated, with interbedded coarse-grained pelletal limestone; eroding into ledges . . . . .   | 5.5  |
| 104r. Limestone, mottled red-brown to gray to bluish-gray, fine-grained, dolomitic, laminated, well-indurated, medium- to thick-bedded, with black graptolite-like markings 20 ft below top; eroding into light-reddish-brown ledges . . . . .   | 27.0 | 114r. Limestone, mottled red-brown and gray, fine-grained, argillaceous, nodular, medium-bedded to massive, well-indurated, with red-brown matrix; weathering red brown; eroding into ledges . . . . .  | 6.0  |
| 105r. Limestone, red-brown to gray, medium-grained, oolitic, pelletal, mottled greenish-gray, thin-bedded to massive, well-indurated; eroding into a ledge; marking top of lower West Spring Creek of Ham (1955), with more laminated dolomites above and more cherty massive limestones below; Station 2394 + 15' on top of bed, east side of east lane . . . . . | 1.5  | 115r. Limestone, mottled red-brown and gray, as above, weathering gray . . . . .  | 7.0  |
| 106r. Limestone, mottled red-brown to gray, fine-grained, argillaceous, well-indurated, thick-bedded, nodular, with tan chert nodules, with some interbedded pelletal limestone; weathering tan to reddish brown, eroding into ledges . . . . .  | 17.5 | 116r. Limestone, mottled red-brown to bluish-gray to tan, fine-grained, argillaceous, thin-bedded, moderately to well-indurated, with graptolite-like material in upper 1 ft, with red-brown matrix crossing bedding planes; weathering red brown; Station 2395 + 50' at base, east side of east lane . . . . .                     | 2.5  |
| 107r. Limestone, mottled red-brown to tan to bluish-gray, fine-grained, argillaceous, dolomitic, thin-bedded, moderately indurated; weathering red brown, eroding into a recess . . . . .  | 2.6  | 117r. Limestone, mottled red-brown to gray to tan, fine-grained, thin- to thick-bedded, well-indurated, with some pelletal limestone, with red-brown matrix; eroding into massive ledges; base of red-bed sequence  | 22.0 |
| 108. Limestone, gray, coarse-grained, pelletal, well-indurated, massive, eroding into a ledge . . . . .  | 1.0  | 118. Shale, greenish-gray to bluish-gray, calcitic, laminated, weakly indurated, rubbly, crinkly-bedded, with interbedded fine-grained dolomitic-limestone nodules and beds, fossiliferous (gastropods and trilobites), mottled tan at base; eroding into a recess . . . . .  | 9.8  |
| 109r. Limestone, mottled red-brown and gray, fine-grained, argillaceous, nodular, well-indurated, medium-bedded to massive, with some interbedded medium-grained pelletal limestone; eroding into red-brown ledges; base of red-bed portion 23 ft below top at Station 2394 + 75' east side of east lane . .   | 30.0 | 119. Limestone, dark-gray, fine- to medium-grained, well-indurated, massive, with some intraclasts; eroding into a ledge . . .  | 4.5  |
| 110. Limestone, gray, fine-grained, argillaceous, dolomitic, massive, well-indurated, nodular, with some thin-bedded limestone and shale near base; eroding into ledges .  | 13.0 | 120. Limestone, gray, fine-grained, argillaceous, silty, well-indurated, medium- to thick-bedded, mottled tan; eroding into ledges . . . . .  | 7.7  |
| 111. Limestone, gray, fine-grained, massive, well-indurated, with some interbedded pelletal limestone and many tan chert nodules; eroding into ledges . . . . .  | 5.0  | 121. Shale, tan, calcitic, silty, platy, weakly indurated; eroding into a recess . . . . .  | 0.4  |
| 112. Limestone, bluish-gray, fine-grained, argillaceous, dolomitic, laminated, moderately indurated, crinkly-bedded, with interbedded shale; <i>Didymograptus protobifidus</i> noted 1.5 ft below top (862 ft below top of West Spring Creek) at Station 2395 + 6' on east side of east lane (Fig. 11)   | 4.0  | 122. Limestone, dark-gray, fine- to medium-grained, argillaceous, well-indurated, thin- to thick-bedded, with many intraclasts and some interbedded bluish-gray to tan shale; eroding into ledges . . . . .   | 10.0 |
| 113. Limestone, bluish-gray to gray, fine-grained, argillaceous, thin- to medium-  |      | 123. Limestone, dark-gray, mottled light-gray, fine-grained, dense, argillaceous, medium- to thick-bedded, well-indurated with some intraclasts and some tan to bluish-gray shale; weathering gray to tan; eroding into ledges . . . . .  | 26.0 |
|  |      | 124. Limestone, bluish-gray, mottled tan, fine-grained, argillaceous, dolomitic, nodular, thin-bedded, moderately indurated, with interbedded shale and dark-gray medium- to thick-bedded intraclast limestones and fine-grained limestones; eroding into ledges and recesses; Station 2397 at base, east side, east lane . . . . . | 31.0 |
|  |      | 125. Limestone, gray, fine-grained, thick-  |      |

	bedded, fossiliferous, mottled with many dark-gray irregular patches; eroding into ledges . . . . .	9.0		eroding into ledges . . . . .	3.0
126.	Limestone, gray, fine-grained, argillaceous, laminated, thin-bedded, moderately to well-indurated; eroding into a grassy bench . . . . .	11.5	139.	Shale, tan to bluish-gray, calcitic, platy, laminated, weakly indurated; eroding into a recess . . . . .	0.4
127.	Limestone, gray, medium-grained, pelletal, well-indurated, medium-bedded; eroding into ledges . . . . .	4.0	140r.	Limestone, red-brown to gray, fine-grained, argillaceous, well-indurated, thin-bedded to massive; eroding into a ledge . .	1.3
128r.	Limestone, light-red-brown to tan, fine-grained, argillaceous, laminated, moderately indurated; eroding into a recess; Station 2397 + 35' at top . . . . .	1.0	141.	Limestone, gray, fine-grained, massive, well-indurated; eroding into a ledge . . . . .	2.5
129.	Limestone, light-gray, fine-grained, argillaceous, laminated, well-indurated, massive; gradational into greenish-gray argillaceous laminated limestone and shale below; eroding into a recess . . . . .	1.0	142r.	Siltstone, light-red-brown, fine-grained, argillaceous, dolomitic, laminated, mottled tan; eroding into a ledge . . . . .	1.0
130.	Limestone, gray, fine-grained, algal, well-indurated, crinkly-bedded, thick-bedded to massive, cherty (gray to white) in top 1 ft; eroding into a ledge . . . . .	3.3	143.	Siltstone, tan, fine-grained, argillaceous, dolomitic, laminated, well-indurated; eroding into small ledges . . . . .	3.0
131r.	Limestone, red-brown, mottled greenish-gray, fine-grained, argillaceous, thin-bedded, moderately to weakly indurated, pelletal in places; gradational into shale; eroding into a recess . . . . .	4.6	144r.	Siltstone, red-brown, fine-grained, argillaceous, dolomitic, laminated, well-indurated; eroding into a ledge . . . . .	0.8
132.	Limestone, gray, fine-grained, well-indurated, massive, cherty (white and black) and brecciated in upper 3 in.; eroding into a massive ledge . . . . .	3.0	145r.	Limestone, gray to bluish-gray, mottled red-brown in upper 1 ft, fine-grained, argillaceous, laminated, moderately to well-indurated; eroding into ledges . . . . .	5.8
133r.	Limestone, red-brown, mottled tan, fine-grained, argillaceous, thin- to medium-bedded, moderately to well-indurated; eroding into small ledges; Station 2397 + 60' on base, east side, east lane . . . . .	3.8	146.	Limestone, tan, fine-grained, argillaceous, dolomitic, massive, well-indurated; eroding into a ledge . . . . .	1.2
134.	Limestone, tan, fine-grained, argillaceous, thin-bedded, crinkly-bedded, well-indurated, with interbedded pelletal limestone; eroding into ledges . . . . .	2.0	147r.	Siltstone, light-red-brown, fine-grained, argillaceous, dolomitic, laminated, massive, well-indurated, mottled tan; eroding into ledges . . . . .	2.7
135o.	Limestone, gray, medium-grained, oolitic, well-indurated, massive, with some fine-grained patches; eroding into a ledge; Ham's F-563 zone; Station 2397 + 75' at base, east side, east lane . . . . .	6.5	148.	Limestone, gray, fine-grained, medium-bedded to massive, well-indurated, with some oolitic limestone and a 1-in. greenish-gray shale in middle; eroding into ledges . .	7.2
136r.	Limestone, light-gray to tan, mottled red-brown below, fine-grained, massive, well-indurated, pelletal in places; eroding into a ledge . . . . .	3.0	149r.	Limestone, light-red-brown, fine-grained, argillaceous, laminated, crinkly-bedded, with some shale and medium-grained limestone; eroding into a recess . . . . .	0.7
137r.	Shale, bluish-gray to tan, mottled red-brown, calcitic, laminated, weakly indurated, with some interbedded fine-grained argillaceous limestone; eroding into a recess . . . . .	2.5	150.	Limestone, gray, fine-grained, thick-bedded, well-indurated; eroding into ledges	5.3
138r.	Limestone, light-red-brown to gray, fine-grained, thick-bedded, well-indurated;		151r.	Limestone, light-red-brown, fine-grained, argillaceous, silty, laminated, massive, well-indurated; eroding into a ledge . . . . .	1.2
			152.	Limestone, light-gray, fine-grained, argillaceous, rubbly, medium-bedded, well-indurated; eroding into a ledge . . . . .	1.0
			153r.	Limestone, light-red-brown, fine-grained, argillaceous, thin-bedded, well-indurated, mottled gray below; eroding into ledges . .	2.0
			154r.	Limestone, gray, mottled with red-brown matrix, fine-grained, medium- to thick-bedded, well-indurated; eroding into ledges	4.0
			155r.	Limestone, red-brown, fine-grained, argillaceous, laminated, massive, well-indurated; eroding into a ledge . . . . .	1.0
			156.	Limestone, gray, fine-grained, thin- to thick-bedded, well-indurated, mottled with	

	red-brown patches; eroding into ledges ..	10.0	171. Limestone, dark-gray, medium-grained, pelletal, massive, well-indurated, laminated at base; eroding into a ledge .....	1.0
157s.	Sandstone breccia, fine-grained, quartzose, moderately indurated, with many pebbles and cobbles of white to gray chert, gray fine-grained limestone, light-gray limestone, and greenish-gray shale; seemingly collapsed and cutting across beds; eroding into a recess; Station 2398 + 60' on base, east side, east lane .....	4.5	172. Limestone, bluish-gray, fine-grained, argillaceous, laminated, thin-bedded below to massive above, moderately to weakly indurated, with interbedded tan silty limestone 1-2 ft below top; eroding into a recess .....	6.7
158.	Limestone, gray, fine-grained, cherty (white, nodular), laminated, massive, crinkly-bedded, well-indurated; eroding into a ledge .....	1.0	173. Limestone, gray to bluish-gray, fine-grained, thick-bedded to massive, well-indurated, with some coarse-grained pelletal limestone in basal 3 in.; eroding into ledges .....	3.5
159.	Limestone; gray, fine-grained, dense, laminated, crinkly-bedded, thin- to medium-bedded, well-indurated; eroding into ledges .....	2.5	174. Limestone, bluish-gray, fine-grained, argillaceous, laminated, moderately indurated, mottled tan, with interbedded coarse-grained gray limestone; eroding into a recess .....	4.0
160r.	Limestone, red-brown, fine-grained, argillaceous, brecciated, cherty (white), with many gray fine-grained limestone pebbles; gradational into gray limestone breccia; eroding into a ledge .....	0.8	175. Limestone, dark-gray, fine-grained, dense, massive, well-indurated; eroding into a ledge .....	4.2
161.	Limestone, gray, fine-grained, dense, medium-bedded, well-indurated; eroding into ledges .....	1.3	176. Shale, bluish-gray, mottled tan, calcitic, platy, laminated, weakly indurated; eroding into a recess .....	0.5
162r.	Limestone, red-brown, fine-grained, dense, laminated, massive, well-indurated; eroding into a ledge .....	1.5	177. Limestone, dark-gray, mottled with gray patches, fine-grained, massive, well-indurated; eroding into a ledge .....	8.0
163.	Limestone, gray, fine-grained, dense, thick-bedded, well-indurated .....	4.0	178. Limestone, bluish-gray, mottled tan, fine-grained, argillaceous, laminated, thin- to medium-bedded, moderately indurated, with some medium-grained dark-gray limestone, nodular at top; eroding into a recess .....	1.5
164r.	Limestone, red-brown and gray, fine-grained, dense, rubbly, thin-bedded, argillaceous at top; eroding into a recess ..	0.7	179. Limestone, gray, fine-grained, dense, mottled with light-gray patches, medium- to thick-bedded, well-indurated, argillaceous 6-7 ft below top, mottled red-brown and tan in basal 1 ft; eroding into ledges .....	11.8
165.	Limestone, light-gray, fine-grained, dense, massive; eroding into a ledge .....	4.4	180r. Shale, red-brown, calcitic, platy, laminated, weakly indurated; eroding into a recess .....	0.4
166r.	Limestone, red-brown, mottled tan, fine- to medium-grained, cherty (white) in places, massive; eroding into a ledge .....	1.5	181. Limestone, gray, fine-grained, dense, well-indurated, thick-bedded, with some interbedded dark-gray medium-grained limestone, and some bluish-gray argillaceous limestone 6-7 ft below top and at base; eroding into ledges .....	10.7
167r.	Limestone, mottled red-brown and dark-gray, fine-grained, thin- to thick-bedded, moderately to well-indurated, argillaceous at top and base; weathering red brown, eroding into ledges; Station 2398 + 85' on base, east side, east lane .....	7.2	182o. Limestone, light-gray, medium-grained, oolitic, well-indurated, massive, becoming pelletal and fine-grained toward base; eroding into a ledge .....	6.8
168.	Limestone, dark-gray, mottled with light-gray patches, mottled red-brown in basal 6 ft, fine-grained, well-indurated, thin-bedded to massive; eroding into ledges ..	21.5	183. Limestone, gray, fine-grained, dense, massive, well-indurated; eroding into a ledge .....	3.0
169.	Limestone, light-gray, fine-grained, dense, massive, well-indurated; eroding into ledges .....	3.5	184o. Limestone, light-gray, fine- to medium-grained, oolitic, massive, well-indurated; eroding into a ledge; Station 2400 + 15' on base, east side, east lane .....	4.0
170.	Limestone, bluish-gray, fine-grained, argillaceous, laminated, thin-bedded to massive, rubbly, moderately indurated, with some medium-grained dark-gray limestone, nodular at top and base; eroding into a recess .....	2.0	185. Limestone, gray, fine-grained, dense, rub-	

	bly, medium-bedded, well-indurated; eroding into ledges . . . . .	6.8	199.	Limestone, gray, fine- to medium-grained, laminated to massive, well-indurated, mottled tan and pink in places, with some pyrite specks; eroding into ledges . . . . .	7.8
186r.	Limestone, red-brown, fine-grained, argillaceous, laminated, moderately indurated, cherty (white) at base; eroding into a recess . . . . .	1.0	200.	Limestone, light-greenish-gray to pink, fine- to medium-grained, argillaceous, pyritic, laminated, thin-bedded, moderately to weakly indurated, shaly below; eroding into a recess . . . . .	0.5
187.	Limestone, gray, fine-grained, nodular, mottled with red-brown patches in middle, medium- to thick-bedded, well-indurated, with white chert nodules 2–3 ft above base; eroding into ledges . . . . .	8.0	201.	Limestone, dark-gray, fine-grained, massive, well-indurated; eroding into a ledge . . . . .	1.2
188o,r.	Limestone, light-gray, mottled red-brown at base, medium-grained, oolitic, arenaceous, thin-bedded, well-indurated; eroding into a recess; Station 2400 + 34' at base, east side, east lane . . . . .	0.3	202.	Limestone, light-gray to tan, mottled pink, fine-grained, dense, well-indurated, massive, with some pyrite specks; eroding into a ledge . . . . .	1.0
189.	Siltstone, yellow-brown, fine-grained, argillaceous, dolomitic, cherty (white), laminated, moderately to weakly indurated, with interbedded greenish-gray shale; eroding into a recess . . . . .	4.3	203.	Shale, greenish-gray, calcitic, platy, weakly indurated, with many large calcite crystals; eroding into a recess . . . . .	0.3
190.	Limestone, gray, fine-grained, argillaceous, dense, laminated, crinkly-bedded, moderately to weakly indurated, algal in places, with some white chert nodules 3–4 ft below top, argillaceous at base; eroding into ledges at top . . . . .	5.5	204.	Limestone, gray, fine-grained, dense, cherty (white), nodular to brecciated, massive, well-indurated; eroding into an escarpment. . . . .	2.5
191o.	Limestone, gray, medium-grained, oolitic, medium-bedded, well-indurated, cherty (white), with some pyrite cubes; eroding into a ledge; Station 2400 + 50' at base, east side, east lane . . . . .	1.3	205r.	Shale, red-brown, calcitic, platy, weakly indurated, crinkly-bedded; eroding into a recess. . . . .	0.5
192.	Limestone, gray, fine-grained, dense, laminated, medium- to thick-bedded, well-indurated; eroding into ledges . . . . .	3.5	206.	Limestone, dark- to light-gray, fine-grained, massive, well-indurated, pyritic in upper 2 ft; eroding into a ledge. . . . .	5.0
193r.	Limestone, red-brown and light-gray, fine-grained, laminated, crinkly-bedded, well-indurated; eroding into a ledge . . . . .	0.7	207r.	Limestone, red-brown, fine-grained, argillaceous, mottled greenish-gray and tan, thin-bedded, moderately to weakly indurated; eroding into a recess . . . . .	1.0
194.	Limestone, greenish-gray, coarse-grained, argillaceous, pelletal, moderately to weakly indurated, laminated; gradational into shale below; eroding into a recess . . . . .	0.3	208r.	Limestone, gray, mottled red-brown, fine- to coarse-grained, pyritic, pelletal, brecciated, moderately to well-indurated; eroding into a ledge . . . . .	1.5
195.	Limestone, gray, fine-grained, dense, massive, well-indurated, mottled with tan patches, with many pyrite specks; eroding into a ledge . . . . .	2.0	209r.	Shale, red-brown, calcitic, platy, laminated, mottled greenish-gray, weakly indurated; eroding into a recess; Station 2401 + 6' at base of red-bed sequence, east side, east lane . . . . .	0.5
196.	Limestone, light-gray, fine- to medium-grained, massive, well-indurated, mottled pink, with some pyrite specks; eroding into a ledge. . . . .	2.0	<i>Lower zone (224 ft thick): (mostly gray to tan limestones with three oolitic limestones)</i>		
197.	Limestone, dark-gray, fine-grained, algal, laminated, crinkly-bedded, well-indurated, massive, with some pyrite specks; eroding into a ledge . . . . .	0.6	210.	Limestone, dark-gray, fine-grained, brecciated, pyritic, cherty (white), well-indurated, massive; eroding into a ledge . .	4.5
198r.	Siltstone, tan, fine-grained, argillaceous, calcitic, medium-bedded, moderately to weakly indurated, mottled red-brown in basal 1 ft; eroding into a recess. . . . .	3.8	211.	Limestone, gray to dark-gray, fine-grained, dense, rubbly, well-indurated, massive; eroding into several ledges . . . . .	4.5
			212.	Limestone, greenish-gray, fine-grained, argillaceous, laminated, massive, moderately to weakly indurated, with much pyrite at base; eroding into a recess . . . . .	1.0
			213.	Limestone, gray, fine-grained, dense, laminated, massive, well-indurated, with much pyrite at top; eroding into a ledge. .	4.2

214.	Limestone, greenish-gray, fine-grained, argillaceous, laminated, moderately to weakly indurated, with some interbedded shale and many pyrite crystals; eroding into a recess .....	2.5	laminated, medium-bedded, well-indurated; eroding into ledges .....	8.7
215o.	Limestone, light-gray, medium-grained, oolitic, massive, well-indurated; eroding into a ledge .....	3.0	230. Limestone, tan to light-gray, fine-grained, dense, laminated, moderately to well-indurated, cherty (white) in upper 2 in.; eroding into a recess .....	1.0
216.	Limestone, gray, coarse- to fine-grained, dense, pelletal, well-indurated, massive, with much white to gray chert in lower 1 ft; eroding into ledges .....	9.0	231. Limestone, dark-gray, fine-grained, dense, rubbly, well-indurated, thick-bedded; eroding into a ledge .....	3.5
217.	Limestone, tan to greenish-gray, fine-grained, argillaceous, laminated, moderately to weakly indurated, medium-bedded; eroding into a recess .....	2.3	232. Limestone, tan, fine-grained, argillaceous, dolomitic, medium-bedded, well-indurated; eroding into a ledge .....	1.2
218.	Limestone, tan, fine-grained, massive, well-indurated; eroding into a ledge .....	2.0	233. Limestone, dark-gray, as above; eroding into a ledge .....	5.5
219.	Limestone, gray, fine-grained, dense, well-indurated, massive, with some medium-grained limestone and many thin calcite veins; eroding into a ledge .....	1.0	234. Limestone, tan, as above; eroding into a recess .....	0.3
220.	Siltstone, yellow-brown, fine-grained, argillaceous, dolomitic, calcitic, massive, well-indurated, with some stylolites; eroding into a ledge .....	6.3	235. Limestone, dark-gray, as above; eroding into a ledge .....	3.0
221.	Limestone, gray, fine-grained, argillaceous, well-indurated, alternating with dark-gray medium-grained limestone; eroding into ledges .....	9.0	236. Limestone, tan, as above; eroding into a recess .....	2.7
222o.	Limestone, dark-gray, medium-grained, oolitic, well-indurated, medium- to thick-bedded; eroding into a ledge .....	2.0	237. Limestone, dark-gray, as above; eroding into a ledge .....	7.0
223.	Limestone, bluish-gray, fine-grained, argillaceous, thin-bedded, moderately to weakly indurated, with some medium-grained limestone; eroding into a recess ..	0.5	238. Limestone, tan, as above .....	1.0
224.	Limestone, dark-gray, fine- to medium-grained, well-indurated, thick-bedded to massive; eroding into a ledge .....	9.0	239. Limestone, dark-gray, as above .....	0.3
225.	Limestone, bluish-gray to gray, fine-grained, argillaceous, laminated, thin-bedded, crinkly-bedded, weakly indurated, with interbedded shale; eroding into a recess ..	0.8	240. Limestone, tan, as above .....	1.7
226.	Limestone, dark-gray, fine-grained, massive, well-indurated; eroding into a ledge ..	2.5	241. Limestone, dark-gray to gray, as above ..	3.5
227.	Limestone, gray to light-gray, alternating fine- and medium-grained, algal, laminated, crinkly-bedded, cherty (white) with 3-in. chert bed 2 ft below top, medium- to thick-bedded; eroding into ledges .....	8.2	242. Limestone, tan, as above; eroding into a clay seam .....	2.0
228.	Siltstone, yellow-brown, fine-grained, argillaceous, calcitic, dolomitic, laminated, medium-bedded, moderately indurated, with much white chert in top 4 in.; eroding into a recess .....	1.5	243. Limestone, dark-gray, as above, mottled red-brown at top .....	6.7
229.	Limestone, gray, fine-grained, rubbly,		244. Limestone, tan, as above .....	1.2
			245. Limestone, dark-gray to gray, as above ..	4.6
			246. Limestone, tan, as above .....	2.3
			247. Limestone, dark-gray to gray, as above ..	4.6
			248. Siltstone, yellow-brown, fine-grained, calcitic, moderately indurated; eroding into a recess .....	0.7
			249. Limestone, light-bluish-gray, fine-grained, cherty (white), brecciated, irregularly bedded, moderately indurated; eroding into a recess .....	3.0
			250. Limestone, tan, as above, with interbedded gray cherty (white) limestone 2-4 ft below top; eroding into a recess .....	11.0
			251. Limestone, gray, fine- to medium-grained, well-indurated, massive; eroding into a ledge .....	3.5
			252. Siltstone, yellow-brown, fine-grained, dolomitic, argillaceous, laminated, medium-bedded to massive, moderately to well-indurated; gradational into light-gray limestone below; eroding into a recess; Station 2403 + 47' at base, east side, east lane ..	6.4
			253. Limestone, dark-gray, fine-grained, rub-	

bly, well-indurated, thick-bedded to massive; eroding into ledges . . . . .	12.5	Station 2405 + 73' on base, east side, east lane . . . . .	2.5
254o. Limestone, light-gray, medium-grained, oolitic, cherty (white) at base and top, massive, well-indurated, with some fine-grained gray limestone patches; eroding into a ledge . . . . .	4.0	5. Limestone, gray, medium- to coarse-grained, pelletal, massive, well-indurated, fossiliferous; eroding into a ledge . . . . .	9.5
255. Limestone, dark-gray to gray, fine- to medium-grained, rubbly, medium- to thick-bedded, cherty (white) at base; eroding into ledges . . . . .	8.5	6. Limestone, greenish-gray to tan, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated, algal in top 1 ft; eroding into a recess; Station 2405 + 98' at base, east side, east lane . . . . .	5.5
256. Siltstone, yellow-brown, fine-grained, argillaceous, dolomitic, laminated to medium-bedded, moderately to weakly indurated; eroding into a recess . . . . .	3.0	7. Limestone, dark-gray, fine-grained, thin- to medium-bedded, well-indurated, with some medium-grained limestone; eroding into ledges . . . . .	13.0
257. Limestone, dark-gray, fine-grained, medium-bedded, well-indurated; eroding into ledges . . . . .	14.0	8o. Limestone, gray, medium-grained, oolitic, pelletal, cherty, well-indurated, massive, fossiliferous; eroding into a ledge . . . . .	2.0
258. Limestone, light-gray, fine- to medium-grained, silty, laminated, medium-bedded; eroding into a recess . . . . .	1.2	9. Limestone, gray, fine- to medium-grained, thin- to medium-bedded, well-indurated; eroding into a ledge . . . . .	4.0
259. Limestone, dark-gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with some interbedded laminated argillaceous gray limestone; eroding into ledges . . . . .	14.0	10o. Limestone, light-gray, medium- to coarse-grained, oolitic, pelletal, algal, massive, well-indurated; eroding into a ledge . . . . .	2.0
260s. Sandstone, yellow-brown, fine-grained, quartzose, silty, argillaceous, dolomitic, laminated, moderately to weakly indurated; gradational into siltstone; eroding into a recess; Station 2404 + 40' on base of West Spring Creek, east side, east lane (Fig. 12) . . . . .	8.0	11s. Sandstone, tan to light-gray, fine-grained, quartzose, cherty, moderately to well-indurated, medium-bedded, oolitic at top, argillaceous in middle; eroding into a recess . . . . .	1.0
<b>Kindblade Formation</b> (1,410 ft measured, base faulted; total thickness 1,440 ft)		12. Limestone, light-greenish-gray, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated; eroding into a recess; Station 2406 + 39' at base, east side, east lane . . . . .	4.5
<i>Upper Kindblade</i> (193 ft thick): (contains five oolitic limestones)		13. Limestone, dark-gray, fine- to medium-grained, cherty (gray), rubbly, medium-bedded, well-indurated; eroding into ledges . . . . .	10.0
1. Limestone, gray, fine- to medium-grained, medium- to thick-bedded, well-indurated, fossiliferous, with some algal-like crinkly-bedded structures; eroding into ledges . . . . .	33.0	14. Limestone, gray, fine- to medium-grained, algal near base, thin-bedded to massive, well-indurated; eroding into ledges . . . . .	13.0
<b>Marker No. ⑩</b>		15o. Limestone, light-gray, medium-grained, oolitic, massive, well-indurated . . . . .	1.0
<b>Station 2404 + 42', 2 ft below top of Kindblade</b>		16. Limestone, gray, fine- to medium-grained, thin- to thick-bedded, oolitic, pelletal, and algal in middle 1 ft; eroding into ledges . . . . .	4.5
2. Limestone, gray, fine-grained, rubbly, thin- to thick-bedded, well-indurated, with some 2- to 4-in. gray-blue argillaceous limestone layers and some medium-grained limestone; eroding into ledges . . . . .	54.0	17. Limestone, gray, fine-grained, algal, massive, cherty, crinkly-bedded, well-indurated; eroding into ledges . . . . .	5.0
3. Limestone, gray, fine-grained, algal, crinkly-bedded, medium-bedded, well-indurated, with some medium-grained limestone; eroding into ledges . . . . .	7.0	18. Limestone, light-greenish-gray, fine-grained, argillaceous, laminated to medium-bedded, moderately to well-indurated; eroding into ledges . . . . .	3.0
4o. Limestone, light-gray, fine- to medium-grained, oolitic, algal, pelletal, well-indurated, massive; eroding into a ledge;		19. Limestone, gray, fine-grained, cherty, thin- to medium-bedded, well-indurated, medium-grained in places; eroding into ledges . . . . .	2.5
		20o. Limestone, light-gray, fine- to coarse-grained, oolitic, algal, pelletal, cherty	



	(gray), well-indurated, massive; eroding into a ledge . . . . .	1.3		into a ledge . . . . .	1.2
21.	Limestone, gray, fine-grained, thin- to medium-bedded, well-indurated, pelletal and medium-grained in lower part; eroding into ledges . . . . .	6.5	36.	Limestone, gray, fine- to medium-grained, rubbly, medium- to thick-bedded, well-indurated, argillaceous in lower part; eroding into ledges . . . . .	7.5
22.	Limestone, tan, fine- to medium-grained, silty, dolomitic, medium-bedded to massive, well- to moderately indurated; eroding into a recess . . . . .	2.5	37o.	Limestone, gray to dark-gray, medium-grained, oolitic, pelletal, massive, well-indurated; eroding into a ledge; Station 2408 + 13' on base, east side, east lane . .	3.0
23.	Limestone, light-greenish-gray, fine-grained, algal, brecciated, crinkly-bedded, moderately indurated; eroding into a recess . . . . .	3.0	38.	Limestone, dark-gray, fine- to medium-grained, rubbly, pelletal, thin- to medium-bedded, well-indurated; eroding into ledges . . . . .	5.0
24.	Limestone, light-greenish-gray, fine-grained, argillaceous, dolomitic, laminated, moderately indurated, with some medium-grained limestone in basal 1 ft; eroding into a recess; Station 2407 + 20' on base, east side, east lane . . . . .	2.5	39.	Limestone, greenish-gray to tan, fine- to medium-grained, argillaceous, dolomitic, rubbly, massive; eroding into a ledge . . . .	2.0
<i>Middle Kindblade (643 ft thick): (contains 12 oolitic limestones)</i>			40.	Limestone, dark-gray, fine-grained, rubbly, as above . . . . .	2.0
25.	Limestone, gray, fine-grained, rubbly, massive, well-indurated; eroding into a ledge . . . . .	2.0	41.	Limestone, greenish-gray to tan, as above . . . . .	3.8
26o.	Limestone, gray, medium- to coarse-grained, oolitic, pelletal, massive, well-indurated; eroding into a ledge . . . . .	1.0	42.	Limestone, gray, fine- to medium-grained, rubbly, medium-bedded to massive, well-indurated, pelletal in places; eroding into ledges . . . . .	18.0
27.	Limestone, gray, fine-grained, rubbly, well-indurated, thick-bedded to massive, with some medium-grained pelletal limestone; eroding into ledges and recesses . . . . .	17.0	43.	Limestone, tan to bluish-gray, fine-grained, argillaceous, rubbly, moderately to weakly indurated; eroding into a recess . . . . .	0.8
28.	Limestone, tan to greenish-gray, fine-grained, argillaceous, dolomitic, medium-bedded, well-indurated; eroding into ledges . . . . .	2.5	44.	Limestone, gray, rubbly, as above . . . . .	37.0
29.	Limestone, gray to tan, fine- to medium-grained, argillaceous, crinkly-bedded, thin- to medium-bedded, moderately to well-indurated; eroding into ledges . . . . .	2.0	45.	Limestone, light-gray, fine-grained, argillaceous, thin- to medium-bedded, well-indurated, with some medium-grained limestone; eroding into a recess . . . . .	12.0
30.	Limestone, dark-gray, fine-grained, rubbly, massive, well-indurated; eroding into a ledge . . . . .	7.0	46.	Limestone, tan to bluish-gray, fine-grained, argillaceous, rubbly, moderately to weakly indurated; eroding into a recess; Station 2409 + 35' at base, east side, east lane . . .	2.0
31.	Limestone, gray, fine- to medium-grained, argillaceous, medium- to thick-bedded, well-indurated; eroding into ledges . . . . .	8.0	47.	Limestone, gray, fine- to medium-grained, rubbly, thin- to thick-bedded, well-indurated, argillaceous at base; eroding into ledges . . . . .	19.0
32.	Limestone, gray, fine- to medium-grained, rubbly, massive to thick-bedded, well-indurated; eroding into ledges . . . . .	10.0	48o.	Limestone, gray, medium- to coarse-grained, oolitic, pelletal, massive, well-indurated, with white oolitic chert at base; eroding into a ledge; Station 2409 + 66' at base, east side, east lane . . . . .	4.0
33o.	Limestone, gray, fine- to medium-grained, oolitic, pelletal, massive, well-indurated; eroding into a ledge . . . . .	1.0	49.	Limestone, gray, fine- to medium-grained, rubbly, medium-bedded to massive, well-indurated; eroding into a ledge . . . . .	2.5
34.	Limestone, gray, fine- to coarse-grained, argillaceous, medium-bedded, well-indurated; eroding into ledges . . . . .	4.0	50o.	Limestone, gray, medium- to coarse-grained, oolitic, pelletal, thick-bedded, well-indurated; eroding into ledges . . . . .	3.0
35o.	Limestone, gray, medium-grained, oolitic, pelletal, massive, well-indurated; eroding . . . . .		51.	Limestone, gray, fine- to medium-grained, medium-bedded to massive, rubbly to pelletal in places; eroding into ledges . . . . .	16.0
			52o.	Limestone, gray, medium- to coarse-grained, oolitic, pelletal, laminated to massive, well-indurated; eroding into ledges; Station 2410 at base, east side, east lane . . . . .	2.0

53. Limestone, gray, fine- to medium-grained, rubbly, medium- to thick-bedded, well-indurated, pelletal in places, with oolitic chert zone 4 ft above base; eroding into ledges . . . . .	41.0	eroding into ledges . . . . .	52.0
54. Limestone, bluish-gray, fine-grained, argillaceous, rubbly, thin-bedded, moderately indurated; eroding into a recess . .	2.3	69. Limestone, gray, fine- to medium-grained, rubbly, well-indurated, medium-bedded, mottled with some tan argillaceous laminae; eroding into ledges . . . . .	16.0
55o. Limestone, gray, medium-grained, oolitic, pelletal, well-indurated, massive, fossiliferous; eroding into a ledge; Station 2410 + 61' at base, east side, east lane . .	2.0	70. Limestone, tan and gray, fine-grained, argillaceous, thin-bedded, moderately to weakly indurated; eroding into a recess . .	1.2
56. Limestone, gray to tan, fine-grained, rubbly, medium-bedded, well-indurated; eroding into ledges . . . . .	1.0	71. Limestone, gray, fine- to medium-grained, medium- to thick-bedded, well-indurated, pelletal in places, with some tan argillaceous laminae; eroding into ledges; Station 2413 + 78' on base, east side, east lane; section extrapolated to west side of east lane at Station 2414 + 45' . . . . .	30.0
57o. Limestone, gray, fine- to medium-grained, oolitic, pelletal, medium-bedded, well-indurated, fossiliferous; eroding into ledges	1.5	72. Limestone, dark-gray, mottled bluish-gray, fine-grained, argillaceous, rubbly, thin-bedded, well-indurated; eroding into a recess . . . . .	5.0
58. Limestone, gray, mottled with tan argillaceous matrix, fine-grained, rubbly, medium- to thick-bedded, well-indurated, fossiliferous, pelletal and medium-grained in places; eroding into ledges . . . . .	17.0	73. Limestone, gray, fine-grained, argillaceous, pelletal, massive, well-indurated, mottled tan at base; eroding into a ledge	0.7
59o. Limestone, light-gray, medium-grained, oolitic, pelletal, massive, well-indurated; eroding into a ledge . . . . .	1.8	74. Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with some medium-grained limestone and tan argillaceous laminae, mottled bluish-gray . . . . .	47.0
60. Limestone, gray, mottled tan, as above . .	33.5	75. Limestone, bluish-gray to tan, fine-grained, argillaceous, thin-bedded, moderately to weakly indurated; eroding into a recess . .	0.8
61. Limestone, light-gray, fine- to coarse-grained, algal, pelletal, brecciated, well-indurated, massive, fossiliferous, with white chert in basal 2 ft; eroding into a ledge	4.0	76. Limestone, gray to bluish-gray, fine-grained, rubbly, medium- to thick-bedded, fossiliferous, with some medium-grained limestone, mottled with tan argillaceous laminae; eroding into ledges . . . . .	4.0
62. Limestone, gray, mottled tan, rubbly, as above . . . . .	14.0	77. Limestone, bluish-gray to tan, as above . .	4.0
63o. Limestone, gray, fine- to medium-grained, oolitic, pelletal, medium-bedded, well-indurated, mottled light-red-brown in middle; eroding into ledges; Station 2411 + 65' at base, east side, east lane . . . . .	4.5	78. Limestone, gray to bluish-gray, as above	21.0
64. Limestone, gray, mottled tan, rubbly, as above . . . . .	10.0	79. Limestone, bluish-gray to tan, as above . .	0.5
65. Limestone, gray and tan, fine-grained, argillaceous, thin-bedded, moderately indurated; eroding into a recess . . . . .	1.5	80. Limestone, gray to bluish-gray, as above	75.0
66. Limestone, gray, fine-grained, rubbly, thin- to thick-bedded, well-indurated, with some medium-grained limestone, mottled with tan argillaceous streaks; eroding into ledges	33.0	81. Limestone, gray to tan, fine-grained, argillaceous, thin-bedded, moderately to well-indurated; eroding into ledges and recesses . . . . .	4.0
67. Limestone, bluish-gray to gray, fine-grained, argillaceous, rubbly, medium-bedded, well-indurated, with some medium-grained limestone, with 3-in. light-red-brown zone at base; eroding into ledges	17.0	82o. Limestone, gray, medium- to coarse-grained, oolitic, pelletal, massive, well-indurated; eroding into a ledge; Station 2416 + 90' on base, west side, east lane . .	2.2
68. Limestone, gray, mottled light-red-brown and tan, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with some medium-grained and pelletal limestones and some thin argillaceous red-brown laminae;		<i>Lower Kindblade (574 ft thick):</i>	
		83. Limestone, gray, fine-grained, medium-bedded, well-indurated; eroding into ledges	8.5
		84. Limestone, tan to bluish-gray, fine-grained, argillaceous, dolomitic, thin-bedded, moderately to weakly indurated; eroding into a recess . . . . .	2.0

85. Limestone, gray, fine-grained, rubbly, well-indurated, medium- to thick-bedded, with some medium-grained pelletal limestone, tan argillaceous laminae, and tan chert. ....	45.0	104. Limestone, gray, fine-grained, argillaceous, rubbly, medium- to thick-bedded, well-indurated; eroding into ledges. ....	11.0
86. Limestone, tan and bluish-gray, fine-grained, rubbly, thin-bedded, moderately to weakly indurated; eroding into a recess. .	3.5	105. Limestone, gray and tan, fine-grained, argillaceous, thin-bedded, moderately to weakly indurated, with some well-indurated medium-grained limestone in middle; eroding into a recess with middle ledges. ....	8.0
87. Limestone, gray, fine- to medium-grained, medium-bedded, well-indurated, with some tan argillaceous laminae; eroding into ledges. ....	8.5	106. Limestone, gray, medium- to thick-bedded, as above. ....	4.0
88. Limestone, gray and tan, fine-grained, argillaceous, thin- to medium-bedded, moderately to well-indurated; eroding into ledges. ....	8.0	107. Limestone, tan and gray, thin-bedded, as above. ....	4.0
89. Limestone, gray, fine- to medium-grained, rubbly, medium- to thick-bedded, well-indurated, pelletal in places; eroding into ledges. ....	26.5	108. Limestone, gray, as above. ....	3.5
90. Limestone, tan and bluish-gray, fine-grained, argillaceous, rubbly, thin-bedded, moderately to weakly indurated; eroding into ledges and recesses. ....	2.5	109. Limestone, tan and gray, as above. ....	0.5
91. Limestone, gray, fine- to medium-grained, argillaceous, moderately to weakly indurated, medium-bedded, with some tan argillaceous laminae; eroding into ledges and recesses. ....	7.5	110. Limestone, gray, as above. ....	3.5
92. Limestone, gray, fine- to medium-grained, well-indurated, massive to medium-bedded, pelletal in places; eroding into ledges. ....	22.0	111. Limestone, tan and gray, as above. ....	2.0
93. Limestone, tan to gray, fine-grained, rubbly, thin-bedded, moderately indurated; eroding into a recess. ....	0.8	112. Limestone, gray, as above. ....	3.5
94. Limestone, gray, as above. ....	4.5	113. Limestone, tan and gray, as above. ....	0.5
95. Limestone, tan to gray, as above. ....	0.3	114. Limestone, gray, as above, with some white chert nodules. ....	4.0
96. Limestone, gray, as above, with some algal structures; eroding into a pitted surface. .	12.5	115. Limestone, tan and gray, as above. ....	2.5
97. Limestone, tan to gray, as above. ....	0.3	116. Limestone, gray, as above. ....	1.5
98. Limestone, gray, as above. ....	6.5	117. Limestone, tan and gray, as above. ....	1.0
99. Limestone, tan to gray, as above. ....	0.5	118. Limestone, gray, as above. ....	14.0
100. Limestone, gray, as above, with some light-gray chert. ....	53.0	119. Limestone, tan and gray, as above. ....	3.5
101. Limestone, tan to gray, as above, weakly indurated; eroding into a recess; Station 2420 at top, west side, east lane; section extrapolated back to east side of east lane, Station 2419 + 43'. ....	4.0	120. Limestone, gray, as above. ....	14.0
102. Limestone, gray, fine-grained, argillaceous, rubbly, thin- to medium-bedded, moderately to well-indurated, with some medium-grained limestone, mottled tan; eroding into ledges. ....	88.0	121. Limestone, tan and gray, as above. ....	0.5
103. Limestone, tan and gray, fine-grained, thin-		122. Limestone, gray, as above. ....	6.0
		123. Limestone, tan and gray, as above. ....	0.8
		124. Limestone, gray, as above. ....	1.5
		125. Limestone, tan and gray, as above. ....	4.0
		126. Limestone, gray, as above. ....	3.0
		127. Limestone, tan and gray, as above. ....	0.4
		128. Limestone, gray, as above, with some gray-blue chert; Station 2422 + 39' on base, east side, east lane. ....	21.0
		129. Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, moderately indurated; eroding into ledges. ....	6.5
		130. Limestone, light-gray, fine-grained, argillaceous, dolomitic, rubbly, thin-bedded, moderately to weakly indurated; eroding into a recess. ....	2.5
		131. Limestone, gray, fine-grained, rubbly, medium-bedded, well-indurated; eroding into a ledge. ....	2.0
		132. Limestone, light-gray, fine-grained, argillaceous, dolomitic, rubbly, laminated, weakly indurated; eroding into a recess. .	1.5

133. Limestone, gray, fine-grained, rubbly, medium-bedded, with bluish-gray chert at base; eroding into ledges ..... 6.0
134. Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, crinkly-bedded, moderately to weakly indurated; eroding into a recess ..... 1.3
135. Limestone, gray, fine-grained, rubbly, massive, with some tan chert at base; eroding into a ledge ..... 5.5
136. Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, cherty (tan, gray, and black), moderately to weakly indurated; eroding into a recess ..... 2.5
137. Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with some gray chert nodules; eroding into ledges ..... 14.0
138. Limestone, light-gray, fine-grained, laminated, moderately to weakly indurated; eroding into a recess; folded into a prominent anticline; Station 2423 + 2' at base, east side, east lane ..... 1.5
139. Limestone, gray, fine-grained, thin- to medium-bedded, well-indurated; eroding into ledges ..... 2.3
140. Limestone, gray, fine- to medium-grained, medium- to thick-bedded, well-indurated; exposed at base of anticline with small thrust fault dipping southwestward 70° through bed; Station 2423 + 15' on anticlinal axis and Station 2433 + 45' on adjacent synclinal axis, east side, east lane (Fig. 13) ..... 3.2

**Marker No. ⑪****Station 2423 + 15', 100 ft above base of Kindblade, on anticlinal axis**

141. Limestone, light-gray, fine-grained, laminated, moderately to weakly indurated, with some tan, black, and gray chert; eroding into a recess; Station 2423 + 70' on top, east side, east lane ..... 7.0
142. Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated; eroding into ledges ..... 9.5
143. Limestone, light-gray, fine-grained, laminated to rubbly, moderately to weakly indurated; eroding into a recess ..... 7.0
144. Limestone, gray, fine-grained, rubbly, thin- to medium-bedded, well-indurated; eroding into ledges ..... 8.0
145. Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, weakly indurated; gradational into shale; eroding into a recess ..... 24.0

146. Limestone, gray, fine-grained, rubbly, cherty, massive, well-indurated; eroding into a ledge ..... 4.0
147. Limestone, light-gray, as above ..... 5.0
148. Limestone, gray, massive, as above ..... 4.0
149. Limestone, light-gray, mottled red-brown, as above ..... 8.0
150. Limestone, gray, cherty (gray), as above ..... 2.0
151. Limestone, light-gray, mottled red-brown, as above ..... 7.0
152. Limestone, gray, as above, partly covered ..... 8.0
153. Limestone, light-gray, as above; appears to be vertical to overturned at Station 2425 + 25'; the remainder of the section (about 10 ft) is faulted down on the south side and is covered; exposed ..... 5.0 +

**Cool Creek Formation (1,300 ft thick):** (lower 564 ft exposed from Station 2435 + 85' to Station 2442 + 94' on west side, west lane; contains 25 red-bed units, 23 sandy beds, and 14 oolitic limestones)

1. Limestone, dark-gray, fine-grained, well-indurated, medium- to thick-bedded; eroding into ledges; strike N. 50° W., dip 52° SW ..... 9.0 +
2. Limestone, gray to dark-gray, fine-grained, rubbly, well-indurated with calcite vugs at top; eroding into a ledge ..... 1.5
3. Limestone, gray, fine-grained, cherty (white to light gray), thin-bedded, crinkly-bedded, well-indurated; eroding into a recess ..... 1.0
4. Limestone, gray to dark-gray, fine-grained, rubbly, cherty (white to gray), well-indurated, massive, algal in places; eroding into a ledge ..... 6.0
- 5r. Limestone, gray, mottled red-brown, fine-grained, cherty (gray to white), laminated, moderately indurated; eroding into a recess ..... 2.3
6. Limestone, gray, fine-grained, rubbly, well-indurated, medium- to thick-bedded, with much chert (gray, light-orange, white); eroding into ledges ..... 8.5
- 7r. Limestone, tan and red-brown, fine-grained, dolomitic, rubbly, laminated, crinkly-bedded, well-indurated, massive; eroding into a ledge ..... 2.5
8. Limestone, dark-gray, fine-grained, medium-bedded, well-indurated, pelletal at base; eroding into ledges ..... 3.5
- 9r. Limestone, tan and red-brown, fine-grained, dolomitic, cherty (white to gray), laminated, well-indurated; eroding into ledges ..... 2.0
- 10r. Limestone, gray, mottled red-brown, fine-

	to medium-grained, thin-bedded, well-indurated, with varicolored chert in basal 2 ft; eroding into ledges . . . . .	6.8		nated, cherty (orange, gray, and white), crinkly-bedded, moderately indurated; eroding into recesses and ledges . . . . .	3.0
11.	Limestone, gray, fine- to medium-grained, massive, well-indurated; eroding into a ledge . . . . .	1.5	25o,s.	Limestone, gray to tan, fine- to medium-grained, oolitic, arenaceous, cherty (gray), laminated, well-indurated, dolomitic in middle, mottled maroon; eroding into ledges; Station 2437 + 78' on base, west side, west lane . . . . .	3.5
12.	Limestone, tan, fine-grained, dolomitic, cherty (gray to white), brecciated, medium-bedded, well-indurated; eroding into a recess . . . . .	7.0	26.	Limestone, dark-gray, fine-grained, thin- to medium-bedded, well-indurated; eroding into ledges . . . . .	8.5
13.	Limestone, gray, fine-grained, algal, cherty (white to gray), laminated, well-indurated; eroding into a recess . . . . .	4.5	27s.	Limestone, gray, coarse-grained, arenaceous, pelletal, cherty, massive, well-indurated; gradational into conglomerate; eroding into a ledge . . . . .	0.9
14.	Limestone, tan, fine-grained, dolomitic, cherty (gray to tan) in top 1 ft, laminated, moderately indurated; eroding into a recess . . . . .	4.3	28r.	Limestone, maroon and tan, fine-grained, dolomitic, thin-bedded, moderately indurated, argillaceous at top; eroding into a recess . . . . .	0.8
15r.	Limestone, gray, mottled maroon, fine-grained, argillaceous, thin-bedded, crinkly-bedded, moderately to weakly indurated; eroding into a recess . . . . .	3.0	29.	Limestone, gray, fine-grained, rubbly, laminated, thin-bedded, well-indurated; eroding into ledges . . . . .	3.3
16.	Limestone, gray, fine-grained, rubbly, well-indurated, medium- to thick-bedded; eroding into ledges . . . . .	5.0	30.	Limestone, light-gray, fine-grained, algal, cherty (orange and white), crinkly-bedded, massive; eroding into a ledge . . . . .	1.0
17.	Limestone, gray, mottled with tan laminae, fine-grained, thin-bedded, well-indurated; eroding into ledges . . . . .	5.5	31.	Limestone, dark-gray, fine-grained, thin- to medium-bedded, well-indurated; eroding into ledges . . . . .	5.0
18.	Limestone, light-gray, mottled tan, fine-grained, argillaceous, dolomitic, rubbly, moderately to weakly indurated; eroding into a recess . . . . .	3.5	32.	Limestone, gray and tan to light-gray, fine-grained, dolomitic, cherty (gray to tan), laminated, crinkly-bedded, well-indurated; eroding into ledges . . . . .	7.0
19.	Limestone, gray, fine-grained, rubbly, medium-bedded, well-indurated; eroding into ledges . . . . .	3.4	33.	Limestone, dark-gray, fine-grained, laminated, well-indurated, massive, eroding into a ledge . . . . .	4.0
20.	Limestone, light-gray, fine- to medium-grained, argillaceous, thin-bedded, moderately indurated, rubbly at top; eroding into a recess . . . . .	4.0	34s.	Limestone, gray, mottled tan and red-brown, fine-grained, dolomitic, cherty (gray, white, black), thin- to medium-bedded, well-indurated, arenaceous and pelletal in basal 1 ft; eroding into ledges . . . . .	12.0
21.	Limestone, dark-gray, fine-grained, rubbly, medium-bedded, well-indurated; eroding into ledges . . . . .	7.0	35.	Limestone, light-gray, mottled tan and maroon, fine-grained, argillaceous, dolomitic, cherty (gray, white, black), laminated, crinkly-bedded, moderately indurated; eroding into recesses and ledges . . . . .	10.0

**Marker No. ⑫****Station 2437 + 05', 700 ft below top of Cool Creek**

22.	Limestone, gray to light-gray, fine-grained, cherty (orange, black, red-brown, gray, white), algal, laminated to medium-bedded, crinkly-bedded, well-indurated; with some arenaceous oolitic pelletal lenses, mottled tan and dolomitic in basal 2 ft; eroding into ledges and recesses . . . . .	21.0	36r.	Limestone, maroon and tan, fine-grained, argillaceous, dolomitic, pelletal, cherty (gray), laminated, well-indurated; eroding into ledges . . . . .	4.0
23.	Limestone, dark-gray, fine-grained, thin- to medium-bedded, well-indurated, mottled red-brown, with some light-gray chert; eroding into ledges . . . . .	13.0	37.	Limestone, dark-gray, fine-grained, laminated to medium-bedded, well-indurated, arenaceous and medium-grained in basal 1 ft; eroding into ledges . . . . .	9.0
24r.	Limestone, gray to tan and red-brown, fine-grained, dolomitic, argillaceous, lami-		38s.	Limestone, light-gray, fine- to medium-grained, arenaceous, pelletal, thin-bedded, well-indurated; eroding into ledges . . . . .	1.8

39.	Limestone, gray, fine-grained, algal, cherty (gray), medium-bedded, well-indurated; eroding into ledges . . . . .	3.5	to medium-bedded, well-indurated; eroding into ledges . . . . .	3.5
40o,s.	Limestone, gray, medium-grained, oolitic, arenaceous, pelletal, massive, well-indurated; eroding into a ledge; Station 2438 + 84' on base, west side, west lane . . . . .	1.0	56o,s. Limestone, gray, medium-grained, oolitic, arenaceous, pelletal, cherty (gray to orange-brown), massive, well-indurated; eroding into a ledge . . . . .	0.5
41r.	Limestone, light-gray to maroon, fine-grained, argillaceous, cherty (gray to tan), thin-bedded, crinkly-bedded, moderately indurated; eroding into a recess . . . . .	2.0	57r. Limestone, maroon and tan, fine-grained, dolomitic, argillaceous, brecciated, cherty (white, gray), thin-bedded, crinkly-bedded, moderately indurated; gradational into gray limestone below; eroding into a recess . . . . .	2.5
42.	Limestone, dark-gray, fine-grained, medium-bedded, well-indurated; eroding into ledges . . . . .	3.0	58. Limestone, gray, fine-grained, rubbly, well-indurated, massive; eroding into a ledge . . . . .	1.0
43o,s.	Limestone, dark-gray, medium-grained, oolitic, arenaceous, pelletal, massive, well-indurated; eroding into a ledge . . . . .	0.8	59. Limestone, tan, fine-grained, dolomitic, massive, well-indurated; eroding into a ledge . . . . .	0.7
44.	Limestone, gray to dark-gray, fine-grained, rubbly, cherty (tan to gray), thin- to medium-bedded, well-indurated; eroding into ledges . . . . .	8.0	60o,s. Limestone, tan to gray, medium-grained, arenaceous, dolomitic, oolitic, pelletal, massive, well-indurated; eroding into a ledge . . . . .	0.8
45r.	Limestone, maroon and tan, fine-grained, dolomitic, algal, massive, well-indurated; eroding into a ledge . . . . .	2.0	61r. Limestone, gray, mottled red-brown and tan, argillaceous, dolomitic, laminated, thin-bedded, moderately indurated; eroding into ledges . . . . .	2.0
46.	Limestone, dark-gray, fine-grained, rubbly, algal, laminated, medium-bedded to massive, well-indurated; eroding into ledges . . . . .	6.0	62. Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with some tan dolomitic limestone laminae and beds; eroding into ledges . . . . .	21.0
47o,s.	Limestone, gray to maroon, medium-grained, oolitic, arenaceous, pelletal, crinkly-bedded, moderately indurated; eroding into a recess . . . . .	0.7	63r. Limestone, light-red-brown to tan, fine-grained, dolomitic, laminated to massive, well-indurated; eroding into a recess . . . . .	6.5
48.	Limestone, light-gray to tan, fine-grained, dolomitic, laminated, massive; eroding into ledges . . . . .	3.5	64. Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated, with tan laminae; eroding into ledges . . . . .	6.0
49o,s.	Limestone, dark-gray, fine- to medium-grained, oolitic, arenaceous, pelletal, well-indurated, massive; eroding into a ledge . . . . .	0.9	65r. Limestone, maroon and tan, fine-grained, dolomitic, argillaceous, laminated, crinkly-bedded, moderately to weakly indurated; eroding into a recess . . . . .	6.5
50r.	Limestone, maroon and tan, fine-grained, dolomitic, cherty (gray), laminated, massive, well-indurated; eroding into a ledge . . . . .	0.4	66. Limestone, gray, fine-grained, medium-bedded, well-indurated; eroding into ledges . . . . .	6.0
51.	Limestone, dark-gray, fine-grained, rubbly, crinkly-bedded, thin- to medium-bedded, well-indurated; eroding into ledges . . . . .	4.0	67o,s. Limestone, tan to gray, medium-grained, arenaceous, oolitic, pelletal, crinkly-bedded, thin-bedded, well-indurated; eroding into a ledge . . . . .	0.3
52r.	Limestone, maroon and tan, fine-grained, dolomitic, cherty (light-gray), laminated, crinkly-bedded, moderately indurated; eroding into a recess; Station 2439 + 38' on base, west side, west lane . . . . .	1.5	68r. Limestone, red-brown to tan, fine-grained, dolomitic, cherty (gray and orange-brown), medium-bedded to massive, well-indurated; eroding into ledges . . . . .	2.0
53.	Limestone, gray, fine-grained, rubbly, massive, well-indurated; eroding into a ledge . . . . .	1.0	69s. Limestone, gray to tan, fine- to medium-grained, dolomitic, laminated to medium-bedded, well-indurated, with tan oolitic arenaceous limestone at base; eroding into ledges . . . . .	3.5
54.	Limestone, tan, fine-grained, dolomitic, argillaceous, massive, well-indurated, mottled maroon; eroding into a ledge . . . . .	2.0	70r. Limestone, maroon and tan, fine-grained, argillaceous, silty, dolomitic, laminated,	
55.	Limestone, gray and tan, fine-grained, thin-			

	medium-bedded, moderately to weakly indurated; eroding into a recess . . . . .	1.5	85.	Limestone, gray to tan, fine-grained, cherty (tan, orange-brown, and gray), medium-bedded, well-indurated; eroding into ledges	3.0
71.	Limestone, gray, fine-grained, medium-bedded, well-indurated, mottled with tan and orange-brown laminae; eroding into ledges . . . . .	4.5	86o,s.	Limestone, tan, medium-grained, oolitic, arenaceous, thin-bedded, moderately indurated; gradational into sandstone; eroding into a recess . . . . .	0.4
72o,s.	Limestone, gray, medium-grained, oolitic, arenaceous, medium-bedded, well-indurated, with some fine-grained limestone; eroding into ledges . . . . .	1.0	87r.	Limestone, maroon and tan, fine-grained, argillaceous, dolomitic, laminated, moderately indurated; eroding into a recess . .	1.3
73o,r,s.	Limestone, light-red-brown to tan, medium-grained, oolitic, arenaceous, thin-bedded, moderately indurated; eroding into a recess . . . . .	0.6	88.	Limestone, gray, fine-grained, algal, medium-bedded, well-indurated; eroding into ledges . . . . .	3.0
74r.	Limestone, tan to light-red-brown, fine-grained, cherty (gray to white), brecciated, well-indurated, massive; eroding into a ledge . . . . .	1.3	89.	Limestone, light-gray, fine-grained, argillaceous, laminated, crinkly-bedded, mottled tan below, moderately indurated; eroding into a recess . . . . .	2.0
75.	Limestone, tan, fine-grained, laminated, massive, well-indurated, mottled light-red-brown; eroding into a ledge . . . . .	2.0	90.	Limestone, tan, fine-grained, dolomitic, massive, well-indurated; eroding into a ledge . . . . .	1.0
76.	Limestone, gray to tan, fine-grained, thin-bedded, well-indurated; eroding into ledges	2.0	91.	Limestone, gray, mottled tan, fine- to medium-grained, rubbly, algal, massive, well-indurated; eroding into ledges . . . . .	8.0
77o,s.	Limestone, gray, medium-grained, oolitic, arenaceous, thin-bedded, well-indurated; eroding into ledges . . . . .	0.5	92s.	Sandstone, tan, medium-grained, quartzose, calcitic, thin-bedded, moderately indurated; eroding into a recess . . . . .	2.0
78.	Limestone, light-gray, fine-grained, algal, cherty (orange and white), crinkly-bedded, massive, well-indurated; eroding into a ledge . . . . .	0.6	93r.	Limestone, maroon and tan, fine-grained, argillaceous, dolomitic, laminated to medium-bedded, moderately to well-indurated; eroding into a recess . . . . .	1.0
79r.	Limestone, light-gray, mottled red-brown and tan, fine-grained, argillaceous, laminated, crinkly-bedded, moderately indurated, with gray algal limestone lenses, and with some medium-grained oolitic limestone near base; eroding into a recess	2.0	94.	Limestone, gray, fine-grained, algal, cherty (bluish-gray and white), massive, well-indurated; eroding into a ledge . . . . .	1.0
80r,s.	Limestone, tan to red-brown, fine- to medium-grained, arenaceous, dolomitic, laminated to medium-bedded, crinkly-bedded, well-indurated, cherty (tan) at base; eroding into a ledge . . . . .	1.0	95.	Limestone, dark-gray, fine-grained, thin-bedded, well-indurated; eroding into ledges	2.3
81.	Limestone, gray, fine-grained, rubbly, cherty (light-gray) at base, thin-bedded, well-indurated; eroding into ledges . . . . .	5.5	96.	Limestone, light-gray, mottled tan to maroon, fine-grained, laminated, moderately indurated; eroding into ledges and recesses	1.5
82.	Limestone, light-gray, fine-grained, algal, arenaceous, massive, well-indurated; eroding into a ledge . . . . .	0.7	97.	Limestone, gray, fine-grained, rubbly, laminated, medium- to thick-bedded, well-indurated; eroding into ledges . . . . .	5.5
83o,s.	Limestone, light-gray to tan, medium-grained, arenaceous, oolitic, cherty (tan and white), moderately to well-indurated; gradational into sandstone; eroding into a recess . . . . .	1.5	98s.	Sandstone, light-gray to tan, fine-grained, quartzose, calcitic, cherty (light-gray), thin-bedded, moderately indurated; eroding into a recess . . . . .	1.5
84r,s.	Limestone, maroon to tan, fine- to medium-grained, silty, arenaceous, dolomitic, laminated, moderately indurated; eroding into a recess; Station 2440 + 80' at top, west side, west lane . . . . .	2.0	99r.	Limestone, light-maroon to tan, fine-grained, argillaceous, dolomitic, laminated to medium-bedded, moderately indurated; eroding into a recess . . . . .	2.5
			100.	Limestone, gray, fine-grained, algal, crinkly-bedded, medium- to thick-bedded, cherty (gray), well-indurated; eroding into ledges . . . . .	5.0
			101.	Limestone, tan, fine-grained, laminated, massive, well-indurated, mottled maroon; eroding into a ledge . . . . .	1.5

102.	Limestone, gray, as above.....	2.0	ditch or Station 2445 about 75 ft south of culvert below west turnout; approximate thickness .....	100.0 +
103.	Limestone, gray to light-gray to tan, fine-grained, dolomitic, rubbly, laminated, crinkly-bedded, moderately indurated; eroding into recesses and ledges .....	4.0	<b>McKenzie Hill Formation</b> (900 ft thick; covered, not measured):	
104.	Limestone, gray, fine-grained, rubbly, cherty (light-gray to tan), medium- to thick-bedded, well-indurated; eroding into ledges .....	15.0	Mostly dark-gray fine-grained limestone with some chert nodules. The oldest chert-bearing formation of the Arbuckle Group. Station 2459 + 40' on base (approximately), west side, west lane.	
105.	Limestone, light-gray, fine-grained, argillaceous, dolomitic, laminated, moderately to weakly indurated; eroding into a recess .....	4.0	<b>Butterfly Dolomite</b> (297 ft thick; covered, not measured):	
106.	Limestone, gray, fine-grained, rubbly, laminated, medium- to thick-bedded, well-indurated, arenaceous in places; eroding into ledges .....	8.0	Mostly gray medium- to coarsely crystalline sandy dolomite with some fine-grained limestone. The formation contains milky quartz and locally sphalerite, with many ironstone concretions and limonite in basal part. Station 2466 + 90' on base (approximately), west side, west lane.	
107o,s.	Limestone, gray, medium-grained, oolitic, arenaceous, pelletal, cherty (gray), massive, well-indurated; gradational into sandstone; eroding into a ledge .....	1.5	<b>Upper Cambrian</b> (the Cambrian–Ordovician boundary is 90–250 ft below the top of the Signal Mountain Limestone, according to Stitt, 1969)	
108.	Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated; eroding into ledges .....	6.0	<b>Lower Arbuckle Group</b>	
109.	Limestone, light-gray to tan, fine-grained, well-indurated, rubbly in places; eroding into ledges .....	6.5	<b>Signal Mountain Formation</b> (415 ft thick; lower 61 ft exposed):	
110s.	Sandstone, tan to maroon, fine- to medium-grained, quartzose, thin-bedded, moderately indurated; eroding into a recess; Station 2442 + 25' on base, west side, west lane .....	2.5	Limestone, dark-gray, fine- to medium-grained, laminated to medium-bedded, well-indurated, fossiliferous, mottled tan; eroding into ledges; strike N. 50° W., dip 41° SW; Station 2472 + 98' on top of 61-ft exposure; Station 2474 + 30' on contact with underlying Royer Dolomite, west side, west lane .....	
111r.	Limestone, tan to maroon, fine-grained, argillaceous, dolomitic, laminated, moderately indurated; eroding into a recess ..	2.0	61.0	
112.	Limestone, gray, fine-grained, rubbly, laminated, medium-bedded, well-indurated; eroding into ledges .....	3.0	<b>Marker No. 20</b>	
113r.	Limestone, light-gray, mottled maroon, fine-grained, argillaceous, dolomitic, laminated, moderately indurated; eroding into a recess .....	6.0	<b>Station 2474 + 30', Signal Mountain–Royer contact</b>	
114.	Limestone, gray, fine-grained, rubbly, medium- to thick-bedded, well-indurated; eroding into ledges; partly covered .....	20.0	<b>Royer Dolomite</b> (717 ft thick):	
115.	Limestone, light-gray to tan, fine-grained, argillaceous, dolomitic, laminated to medium-bedded, well-indurated; eroding into ledges .....	3.0	1. Dolomite, tan to light-gray, mottled orange-brown, fine- to coarse-grained, medium-bedded, lenticular, well-indurated, brecciated in places, with many joint patterns normal to bedding and striking at various angles from west to southwest; eroding into ledges .....	
116.	Limestone, gray, fine-grained, rubbly, cherty (tan), medium-bedded, well-indurated; eroding into ledges; partly covered; Station 2442 + 94' at base, west side, west lane; exposed .....	9.0	26.0	
117.	Limestone, gray, as above, covered; contact with underlying McKenzie Hill Formation approximately at Station 2444 + 50' along		2. Dolomite, gray to tan, medium-grained, sucrosic, medium-bedded to massive, well-indurated; eroding into ledges .....	
			7.0	
			3. Dolomite, gray and tan, fine- to medium-grained, medium-bedded to massive, well-indurated, brecciated and fractured along joints in many places; eroding into ledges .....	
			55.0	
			4. Dolomite, tan to light-gray, mottled orange-brown, coarse-grained, brecciated, massive, well-indurated, fractured along joints; eroding into ledges .....	
			25.0	



5. Dolomite, light-gray to tan, fine- to medium-grained, medium-bedded, well-indurated, fractured along joints that strike S. 55° W., dip 66° NW, and strike N. 25° W., dip 45° NE; eroding into ledges . . .	13.0	indurated . . . . .	0.5
6. Dolomite, tan to light-gray, mottled orange, fine- to medium-grained, vuggy, brecciated, sucrosic, massive, well-indurated, fractured along joints, caved in places . .	37.0	25. Dolomite, pink, as above. . . . .	3.0
7. Dolomite, light-gray to tan, fine-grained, laminated, medium-bedded, well-indurated; eroding into a recess. . . . .	6.0	26. Shale, greenish-gray, as above . . . . .	0.3
8. Dolomite, pink to light-gray, coarse-grained, vuggy, massive, well-indurated; eroding into a ledge . . . . .	1.0	27. Dolomite, pink, as above. . . . .	7.0
9. Limestone, light-gray, fine-grained, stylolitic, massive, well-indurated, with some pink dolomite stringers and many solution cavities; eroding into ledges and recesses	35.0	28. Shale, greenish-gray, as above; Station 2479 + 85' on base, west side, west lane; section appears to be slumped above, and shale may be traced to about Station 2480 + 39' . . . . .	0.5
10. Dolomite, pink, coarse-grained, vuggy, massive, well-indurated, with many solution cavities; eroding into a recess . . . . .	7.0	29. Dolomite, pink, as above. . . . .	34.0
11. Shale, greenish-gray, clayey, weakly indurated; eroding into a recess . . . . .	1.0	30. Shale, greenish-gray, as above . . . . .	0.5
12. Dolomite, pink, as above. . . . .	4.0	31. Dolomite, pink, mottled tan, coarse-grained, vuggy, brecciated, massive, well-indurated; eroding into ledges and cavities	38.0
13. Shale, greenish-gray, as above . . . . .	6.0	32. Dolomite, pink and light-gray, medium- to coarse-grained, vuggy, medium- to thick-bedded, well-indurated, with some greenish-gray shale laminae; eroding into ledges	10.5
14. Dolomite, pink and tan, coarse-grained, vuggy, brecciated, massive, well-indurated, fractured along joints; eroding into solution cavities and a recess. . . . .	24.0	33. Dolomite, pink to tan, coarse-grained, vuggy, massive, well-indurated; a fault occurs here, with gray to tan sucrosic dolomite on north (right) side, which is down-dropped about 5 ft, the fault plane striking N. 55° E., dip 81° SE; Station 2481 + 65' on fault, west side, west lane . . . . .	26.0
15. Dolomite, tan, fine- to medium-grained, thin-bedded, well-indurated, blocky; eroding into a recess . . . . .	2.5	34. Dolomite, gray to tan, mottled pink, fine- to coarse-grained, stylolitic, vuggy, medium- to thick-bedded, well-indurated; eroding into ledges. . . . .	27.0
16. Shale, greenish-gray, platy, weakly indurated, with some interbedded pink dolomite; eroding into a recess. . . . .	1.5	35. Shale, gray, platy, weakly indurated, with interbedded fine-grained, thin-bedded dolomite; eroding into a recess. . . . .	1.0
17. Dolomite, pink to tan, coarse-grained, vuggy, brecciated, massive, fractured along joints, with some greenish-gray shale spots; eroding into ledges and recesses . . . . .	31.0	36. Dolomite, gray to tan, as above . . . . .	6.0
18. Dolomite, light-greenish-gray to pink, coarse-grained, stylolitic, medium-bedded, well-indurated, with some greenish-gray shale laminae; eroding into ledges . . . . .	2.0	37. Dolomite, gray to tan, mottled pink, medium- to coarse-grained, arenaceous, quartzose, sucrosic, moderately to well-indurated; eroding into a recess. . . . .	6.0
19. Dolomite, pink, coarse-grained, vuggy, brecciated, massive, well-indurated; eroding into ledges and recesses with many solution cavities. . . . .	29.0	38. Shale, greenish-gray, platy, weakly indurated, with interbedded medium-grained arenaceous gray dolomite; eroding into a recess. . . . .	0.3
20. Shale, greenish-gray, platy, weakly indurated; eroding into a recess . . . . .	0.2	39. Dolomite, gray to tan, medium-grained, arenaceous, medium-bedded, well-indurated; eroding into ledges . . . . .	2.5
21. Dolomite, pink, as above. . . . .	1.0	40. Shale, greenish-gray, as above . . . . .	0.2
22. Shale, greenish-gray, as above; Station 2479 + 40' on base, west side, west lane	0.2	41. Dolomite, gray to tan, mottled pink, medium- to coarse-grained, medium-bedded to massive, well-indurated; eroding into ledges. . . . .	8.0
23. Dolomite, pink, as above. . . . .	11.0	42. Dolomite, pink to tan, medium- to coarse-grained, arenaceous, sucrosic, massive, moderately indurated; eroding into a recess	2.0
24. Shale, greenish-gray, clayey, platy, weakly		43. Dolomite, gray to tan, mottled pink, medium- to coarse-grained, medium-bedded to massive, well-indurated,	

arenaceous and sucrosic in many places, fractured along joints; eroding into ledges; Station 2484 + 25' on base, west side, west lane ..... 98.0

**Marker No. ②①**

**Station 2483 + 15', 150 ft above base of Royer**

44. Interval covered, probably dolomite with some shale as above; Station 2486 + 60' on Fort Sill contact at west fence line, or about 2485 + 80' along line of cuts, west side, west lane ..... 120.0

**Fort Sill Limestone** (155 ft thick; upper 48 ft exposed):

1. Siltstone, tan to greenish-gray, argillaceous, calcitic, laminated, weakly indurated, with some interbedded fine-grained gray limestone; eroding into a grassy bench; mostly covered ..... 12.0
2. Limestone, gray, fine-grained, rubbly, massive, well-indurated; eroding into ledges ..... 2.0
3. Siltstone, as above, with interbedded limestone ..... 14.0
4. Limestone, gray, as above ..... 4.0
5. Siltstone, as above, with interbedded limestone; well exposed in ditch near fence, lower part covered; strike N. 45° W., dip 46° SW; exposed ..... 16.0 +

The Chapman Ranch bedding-plane thrust fault occurs along west fence line approximately at Station 2488 + 50'; strike and dip on the fault plane parallel the Fort Sill-Royer contact. The next 4,590 linear ft is in the Royer, with Fort Sill faulted to the surface again at Station 2534 + 40' (approximately milepost 48) to Station 2542 + 50'. The Fort Sill is about 20 ft thick here, and folded and faulted complexly upon southward-dipping Royer (strike N. 85° W., dip 17° S) (Fig. 14). The Royer reverses dip northward (normal) at about Station 2560 + 50', and the overlying Arbuckle Group is again exposed for the next 4,250 linear ft, where Collings Ranch Conglomerate is faulted down against the West Spring Creek Formation at Station 2603 (back cover, bottom).

**Marker No. ②②**

**Station 2535 + 20', 9 ft below top of Fort Sill, west side of west lane (Fig. 14)**

**Marker No. ②③**

**Station 2541, 2 ft above base of Royer, east side of east lane**

**Marker No. ②④**

**Station 2566 + 80', middle Signal Mountain, west side of west lane**

**Marker No. ②⑤**

**Station 2570, middle Butterly, east side of east lane**

**Marker No. ②⑥**

**Station 2581, lower Kindblade, west side of west lane**

**Marker No. ②⑦**

**Station 2596 + 50', 25 ft below top of Kindblade, east turnout, west side**

**Marker No. ②⑧**

**Station 2598 + 55', 52 ft below top of Kindblade, west side of west turnout (Fig. 20)**

**Timbered Hills Group** (345 ft thick; not measured; exposed about one-quarter mile northwest of bridge over relocated U.S. Highway 77)

**Honey Creek Limestone** (105 ft thick; not exposed):

Mostly brown to gray to greenish-gray, fine- to coarse-grained silty glauconitic limestone.

**Reagan Sandstone** (240 ft thick; not exposed):

Mostly quartzose, feldspathic, glauconitic fine- to coarse-grained buff to red-brown sandstone with quartz cement, poorly sorted, weakly indurated, irregularly bedded, with rhyolite-porphyry conglomerate at base; thickness ranges from 0 to 460 ft, and the base is unconformable with the underlying Colbert Rhyolite; exposed in East Timbered Hills about one-quarter mile west of the highway, dipping southward (Fig. 15).

## Middle Cambrian

**Colbert Rhyolite** (4,500 ft, drilled thickness):

Rhyolite porphyry, massive to flow-banded, with welded glassy tuffs, agglomerates, and water-laid tuffs; with phenocrysts of perthite (6%), albite (3%), and quartz (2%) in a red-brown devitrified groundmass. A chemical analysis: 74.71% SiO<sub>2</sub>, 12.25% Al<sub>2</sub>O<sub>3</sub>, 3.99% Na<sub>2</sub>O, 4.40% K<sub>2</sub>O, and 2.28% Fe<sub>2</sub>O<sub>3</sub>. Isotopically dated at 525 million years old. The flow-banding shows that the beds are dipping southwestward at about the same angle of dip as the overlying beds (Fig. 15).

## North Flank of Arbuckle Anticline

(The author recommends approaching the north flank from the north, in accordance with the following sequence.)

### Mississippian

**Sycamore Limestone** (222 ft thick) (Station 2684 + 93' east side, east lane)

*Upper limestone* (46 ft thick): (Strike N. 73° W., dip 78° SW, overturned)

1. Limestone, bluish-gray, fine-grained, argillaceous, silty, massive to thick-bedded, well-indurated, blocky, with some disseminated pyrite, fossiliferous; joints strike N. 27° E., dip 86° NW, and strike N. 10° W., dip 20° NE; weathering tan, eroding into an escarpment ..... 41.0
2. Shale, gray, silty, platy, weakly indurated; weathering tan. .... 0.3
3. Limestone, bluish-gray, as above, massive; Station 2683 + 85' at base, east side, east lane ..... 5.0

*Middle shale* (19 ft thick):

4. Shale, gray, silty, calcitic, platy, weakly indurated ..... 2.0
5. Limestone, gray, fine-grained, silty, argillaceous, blocky, well-indurated, with some fluted structures and disseminated pyrite; eroding into a ledge ..... 0.8
6. Shale, gray to dark-gray, silty, platy, weakly indurated; weathering tan; eroding into a recess. .... 9.0
7. Shale, dark-gray, pyritic, fissile, weakly indurated, with some 1-in. phosphatic nodules, alternating with some gray shale; weathering tan to yellowish brown; Station 2683 + 55' on base, east side, east lane .. 7.0

*Lower limestone* (89 ft thick):

8. Limestone, gray, fine-grained, silty, argillaceous, medium-bedded, well-indurated, blocky; weathering tan along joints and bedding planes; eroding into an escarpment ..... 15.0
9. Shale, gray, silty, calcitic, blocky, weakly indurated; weathering tan. .... 1.0
10. Limestone, gray, fine-grained, silty, argillaceous, massive, well-indurated, blocky, eroding into a ledge ..... 1.0
11. Shale, gray, as above. .... 1.5
12. Limestone, gray, fine-grained, silty, argillaceous, blocky, medium- to thick-bedded, well-indurated; weathering tan; eroding into an escarpment ..... 21.0
13. Siltstone, gray, mottled orange-brown, argillaceous, calcitic, platy, moderately indurated. .... 0.3
14. Limestone, light-gray to gray, fine-grained, argillaceous, silty, medium- to massive-bedded, blocky, well-indurated; eroding into an escarpment ..... 2.5
15. Siltstone, gray, fine-grained, argillaceous, calcitic, platy, moderately indurated. .... 0.2
16. Limestone, gray to light-gray, as above .. 9.0

### Marker No. 15

**Old Hwy. 77, west side of new cut, about 110 ft above base of Sycamore**

17. Siltstone, gray, mottled orange-brown to yellow-brown, fine-grained, argillaceous, calcitic, platy, moderately indurated. .... 0.2
18. Limestone, gray to light-gray, as above .. 6.0
19. Shale, gray, silty, calcitic, platy, weakly indurated ..... 0.3
20. Limestone, gray to light-gray, as above, mottled dark-gray, pyritic to limonitic in lower 4 ft; Station 2681 + 45' at base, east side, east lane ..... 31.0

### Marker No. 36

**Station 2681 + 55', 71 ft above base of Sycamore, east side of east lane**

*Transition zone* (68 ft thick; includes four limestones) (Fig. 16):

21. Shale, blue-gray, silty, platy to blocky, weakly indurated, with some 0.5-in. phosphatic nodules; weathering tan; Station 2681 + 15' at base, east side, east lane... 11.0
22. Limestone, gray, fine-grained, silty, blocky, thick-bedded, well-indurated, fossiliferous, with a cup coral found 4 ft below top and a brachiopod 3 ft below top; weathering tan; eroding into a ledge. .... 6.0
23. Shale, greenish-gray, platy, weakly indurated, with some gray to tan calcitic siltstone beds, and some greenish-gray to brown blocky, medium-bedded, moderately indurated, fine-grained argillaceous siltstone beds; gradational into limestone in upper 1 ft and lower 3 ft; weathering tan; eroding into a slope ..... 13.0
24. Limestone, gray, fine-grained, silty, blocky, medium- to thick-bedded, well-indurated, fossiliferous, argillaceous in middle 3 in.; eroding into a ledge 0-1 ft above base of #24; radiolarians collected here, and described by Ormiston and Lane (1976); Station 2680 + 55' on base, east side, east lane ..... 3.0
25. Shale and siltstone, greenish-gray to yellow-brown, fine-grained, thin- to medium-bedded, blocky, moderately to weakly indurated, with many small phosphatic specks; eroding into a slope. .... 20.0
26. Limestone, gray, fine-grained, silty, argillaceous, massive, well-indurated; weathering yellow brown; eroding into a ledge ..... 2.0
27. Shale and siltstone, as above. .... 6.0
28. Limestone, light-gray to tan, fine-grained, silty, cherty, with much black chert at top

and in middle, thick-bedded, well-indurated, with *caudi-galli* structures; eroding into a ledge; Ormiston and Lane (1976) correlate this bed with the Welden Limestone, using conodonts; radiolarians also occur here; Station 2679 + 42' at base, east side, east lane . . . . . 7.0

## Devonian

### Woodford Shale (274 ft thick):

1. Shale and siltstone, gray to greenish-gray, pyritic, glauconitic near middle, thin-bedded, platy, moderately to weakly indurated, with many 1- to 2-in. phosphatic nodules in basal 2 ft. . . . . 6.0
2. Shale, dark-gray, thin-bedded, platy, weakly indurated, well-indurated where cherty, with many 1- to 3-in. beds of light-gray to tan chert and many 1- to 2-in. phosphatic nodules; partly covered in lower 10 ft; eroding into a slope. . . . . 28.0
3. Shale, dark-gray, thin-bedded, platy, weakly indurated, crinkly-bedded, alternating with 1- to 2-in. beds of gray to tan moderately to well-indurated chert, with 2- to 3-in. pyrite nodules in lower 60 ft; covered from 60 to 75 ft below top; eroding into a slope; the upper 160 ft was measured on the east side of east lane to Station 2675 + 75' and then extrapolated to west side of west lane to Station 2679 + 50' at top of the lower 67 ft. . . . . 227.0
4. Shale, greenish-gray to dark-gray, mottled lavender, cherty, thin-bedded, platy, weakly indurated. . . . . 11.0
5. Shale, greenish-gray to lavender, glauconitic, well-indurated, conglomeratic, with small angular pieces of tan to greenish-gray arenaceous limestone; Station 2677 + 75' at unconformable contact with underlying Haragan Formation, west side, west lane . . . . . 2.0

### Hunton Group (134 ft thick)

#### Bois d'Arc Limestone (Cravatt Member) (19 ft thick):

Section extrapolated to Highway 77D, east of bridge over highway, at first turn in road; strike N. 52° W., dip 65° SW, overturned; section exposed on east side of 77D.

1. Limestone, light-yellow-brown, fine-grained, argillaceous, medium-bedded, weakly indurated, alternating with yellow-brown shale. . . . . 2.0
2. Limestone, light-yellow-brown, fine-grained, with much light-tan to gray chert, medium-bedded, massive, well-indurated, conglomeratic in places, with much brown to pink medium- to coarse-grained limestone with much sparry calcite, fossilifer-

ous; fossil bone found 8 ft below top; basal 6 in. greenish gray, argillaceous, glauconitic(?), with some small limonitic ironstone concretions; eroding into an escarpment. . . . . 17.0

#### Haragan Limestone (16 ft thick, unconformable above and below):

Limestone, light-yellow-brown, fine-grained, argillaceous, medium-bedded, well-indurated, alternating with thin layers of yellow-brown shale, fossiliferous (crinoids, corals, trilobites, brachiopods) with *Camarocrinus* at base; eroding into an escarpment . . . . . 16.0

## Silurian

### Henryhouse Formation (72 ft thick):

1. Limestone, yellow-brown, fine-grained, argillaceous, well-indurated, alternating with thin yellow-brown shale layers, greenish-gray in lower 4 ft; eroding into an escarpment . . . . . 58.0
2. Shale, yellow-brown, calcitic, thin-bedded, blocky, with some interbedded yellow-brown to greenish-gray argillaceous limestone . . . . . 7.0
3. Limestone, yellow-brown, fine-grained, argillaceous, medium-bedded, moderately indurated, alternating with yellow-brown weakly indurated shale; eroding into a slope; section extrapolated to west side of Highway 77D . . . . . 7.0

### Chimneyhill Subgroup (Fig. 17)

#### Clarita Limestone (16 ft thick, unconformable above and below):

Limestone, light-gray, mottled pink to greenish-gray, fine-grained, medium-bedded, well-indurated, fossiliferous; eroding into an escarpment. . . . . 14.5

#### Prices Falls Shale Member (1.5 ft thick):

Shale, greenish-gray, calcitic, glauconitic, cherty (lavender), weakly indurated . . . . . 1.5

#### Cochrane Limestone (4+ ft thick):

Limestone, light-gray, mottled pink to greenish-gray, coarse-grained, echinodermal, medium-bedded, well-indurated, blocky, fossiliferous; eroding into an escarpment; exposed . . . . . 4.0+

## Ordovician

#### Keel Limestone (7 ft thick; not seen, but described on Highway 77):

Limestone, light-gray to pale-brown,

medium- to coarse-grained, oolitic, echinodermal, thick-bedded; unconformable above and below; now classed as Ordovician in age. . . . . 7.0

**Marker No. ⑭**

**Old Hwy. 77, west side of new cut, 2 ft above base of Keel**

**Sylvan Shale** (275 ft thick on Highway 77; here covered, not measured):

Mostly olive-green to greenish-gray plastic to fissile clay shale; contact with underlying Viola Group near Station 2667 + 93' along east fence of east lane.

**Viola Group** (710 ft thick) (front cover, bottom):

Beginning at top of section along Highway 77D where it curves back to the east above Interstate 35 and measuring down 263 stratigraphic ft to Station 2665 + 65' on east side of east lane of Interstate 35; strike N. 65° W., dip 70° SW, overturned.

1. Limestone, yellow-brown, fine-grained, argillaceous, thin-bedded, weakly indurated; eroding into a slope . . . . . 9.0
2. Limestone, gray, medium- to coarse-grained, echinodermal, cherty, medium- to thick-bedded, well-indurated, alternating with fine-grained limestone, fossiliferous; eroding into an escarpment . . . . . 122.0

**Marker No. ⑬**

**Old Hwy. 77, west side, 24 ft below top of Viola**

3. Limestone, gray, fine- to medium-grained, crinkly-bedded, thin- to medium-bedded, well-indurated, fossiliferous, with some chert, alternating with coarse-grained limestone and fine-grained dark limestone nodules and argillaceous limestone laminae, brecciated 45–62 ft below top; eroding into an escarpment . . . . . 62.0
4. Limestone, gray, medium- to coarse-grained, medium- to thick-bedded, well-indurated, fossiliferous, echinodermal; eroding into a ledge . . . . . 32.0
5. Limestone, gray, fine- to medium-grained, cherty (dark-gray), medium- to thick-bedded, well-indurated, fossiliferous, alternating with dark-gray fine-grained limestone nodules and argillaceous limestone laminae; eroding into ledges . . . . . 38.0

Section extrapolated from cliff on west side of 77D to the east lane of Interstate 35 at Station 2665 + 65'.

6. Limestone, gray, fine-grained, nodular, crinkly-bedded, thin- to medium-bedded,

well-indurated, fossiliferous, with some dark-gray chert, alternating with light-gray fine-grained argillaceous-limestone laminae; eroding into an escarpment . . . . . 127.0

7. Interval covered, probably same as above, but more argillaceous; eroding into a valley . . . . . 70.0
8. Limestone, light-gray, fine-grained, argillaceous, medium-bedded, well-indurated, with graptolite zone 33 ft below top; eroding into a slope . . . . . 47.0
9. Limestone, light-gray, fine-grained, argillaceous, medium-bedded, well-indurated, alternating with medium- to coarse-grained echinodermal limestone . . . . . 14.0
10. Limestone, as above, with many pyrite specks and nodules . . . . . 15.0
11. Limestone, gray, fine-grained, nodular, crinkly-bedded, medium-bedded, well-indurated, fossiliferous, cherty (dark-gray), with graptolite zone 52 ft below top, alternating with argillaceous limestone laminae; eroding into ledges . . . . . 77.0
12. Limestone, gray to dark-gray, fine-grained, argillaceous, laminated, medium- to thick-bedded, well-indurated, nodular, cherty (dark-gray), alternating with dark-gray fine-grained limestone, graptolitic, with 2-in. pyritic-ironstone-stained zone at base; eroding into a prominent ridge . . . . . 97.0

**Marker No. ⑮**

**Station 2658 + 62', 2 ft above base of Viola, east side of east lane**

**Simpson Group**

**Bromide Formation** (346 ft thick) (Station 2658 + 60' on top, east side, east lane) (front cover, bottom)

**Pooleville Limestone Member** (80 ft thick): (Strike N. 60° W., dip 70° SW, overturned):

1. Limestone, light-gray, fine-grained, fossiliferous, thick-bedded to massive, even-bedded, well-indurated, with some greenish-gray argillaceous laminae; weathering tan, eroding into an escarpment . . . . . 7.0
2. Limestone, light-gray, fine-grained, thin- to medium-bedded, crinkly-bedded, well-indurated, fossiliferous, with many light-greenish-gray argillaceous laminae; weathering tan, eroding into an escarpment . . . . . 6.0
3. Limestone, light-gray to tan, fine-grained, fossiliferous, massive, well-indurated; eroding into an escarpment . . . . . 7.0

**Marker No. ⑯**

**Next outcrop to south, east side, east lane; Station 2638 + 50', 15 ft below top of Pooleville**



- |   |                         |  |                                     |
|---|-------------------------|--|-------------------------------------|
| <p>4. Limestone, light-gray to tan, fine-grained, fossiliferous, medium- to thick-bedded, well-indurated, with some argillaceous laminae in lower 13 ft; eroding into an escarpment . . . . .</p> <p>5. Limestone, tan, fine-grained, medium-bedded, well-indurated, fossiliferous, with many light-greenish-gray argillaceous laminae, with some tan to bluish-gray to greenish-gray medium- to coarse-grained echinodermal limestones; eroding into an escarpment; Station 2657 + 40' at base, east side, east lane . . . . .</p> | <p>23.0</p> <p>37.0</p> | <p>medium-bedded shales; eroding into a slope . . . . .</p> <p>9. Interval covered, probably same as above; eroding into a slope . . . . .</p> <p>10. Sandstone, yellow-brown, fine- to medium-grained, quartzose, moderately indurated, interbedded with greenish-gray platy shale, with an 11-ft massive sandstone at base; mostly covered; base of section is about Station 2654 + 60' on west fence line of west lane, or Station 2653 + 25' on east fence line of east lane . . . . .</p> | <p>10.0</p> <p>61.0</p> <p>90.0</p> |
|---|-------------------------|--|-------------------------------------|

*Mountain Lake Member* (266 ft thick):

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|--|-------------|
| <p>1. Shale, bluish-gray, calcitic, platy, laminated, weakly indurated, fossiliferous, alternating with tan to bluish-gray medium-bedded coarsely crystalline echinodermal limestone, with a brecciated pocket of tan fine-grained dense limestone 6–8 ft below top, with <i>Platycystites</i> found 2 and 25–26 ft below top and <i>Oklahomacystis</i> found at top and 1, 5, 11, 16, and 22 ft below top; eroding into a slope, with lower 8 ft formed into a slide area . . . . .</p> | <p>31.0</p> |
|--|-------------|

**Marker No. ③②**

**Next outcrop to south, east side of east lane, Station 2639 + 80', 6 ft below top of Mountain Lake**

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|---|--|--|-------------------------------------|
| <p>2. Limestone, gray, fine- to medium-grained, massive, well-indurated, fossiliferous; weathering tan, eroding into a massive ledge . . . . .</p> <p>3. Limestone, gray, fine-grained, argillaceous, nodular, fossiliferous, thin- to medium-bedded, well-indurated, alternating with bluish-gray to tan calcitic shale beds; weathering tan, eroding into a slope . . . . .</p> <p>4. Limestone, gray, fine- to coarse-grained, fossiliferous, echinodermal, well-indurated, massive; weathering tan, eroding into an escarpment . . . . .</p> <p>5. Shale, bluish-gray to tan, calcitic, platy, weakly indurated, with many bryozoans. . . . .</p> <p>6. Limestone, gray, fine- to medium-grained, fossiliferous, massive, well-indurated, with thin-bedded nodular argillaceous crinkly-bedded limestone and shale in middle 1.5 ft; eroding into an escarpment . . . . .</p> <p>7. Limestone, gray, fine-grained, argillaceous, nodular, thin-bedded, crinkly-bedded, well-indurated, with some tan shale laminae; eroding into a slope; Station 2655 + 85' at base, east side, east lane . . . . .</p> <p>8. Limestone, gray to tan, fine- to coarse-grained, fossiliferous, echinodermal, alternating with laminated to thin- to</p> | <p>4.0</p> <p>50.0</p> <p>8.0</p> <p>4.0</p> <p>5.0</p> <p>3.0</p> | <p>medium-bedded shales; eroding into a slope . . . . .</p> <p>9. Interval covered, probably same as above; eroding into a slope . . . . .</p> <p>10. Sandstone, yellow-brown, fine- to medium-grained, quartzose, moderately indurated, interbedded with greenish-gray platy shale, with an 11-ft massive sandstone at base; mostly covered; base of section is about Station 2654 + 60' on west fence line of west lane, or Station 2653 + 25' on east fence line of east lane . . . . .</p> | <p>10.0</p> <p>61.0</p> <p>90.0</p> |
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**Marker No. ③③**

**Next outcrop to south, east side of east lane, Station 2643 + 50', sandstone of Mountain Lake, 53 ft above base of Bromide (Fig. 19)**

**Tulip Creek Formation** (297 ft thick):

- |   |   |
|---|---|
| <p>1. Shale, greenish-gray, calcitic, platy, fossiliferous, weakly indurated, with some medium-bedded, bluish-gray to tan, coarse-grained, well-indurated echinodermal limestone beds; weathering tan, eroding into a slope . . . . .</p> <p>2. Sandstone, light-greenish-gray to tan, fine- to medium-grained, quartzose, thin- to medium-bedded, cross-bedded, moderately indurated, calcitic in upper 5 ft; weathering tan, eroding into a slope; Station 2652 at top, at mouth of box along side of ditch, east side, east lane . . . . .</p> <p>3. Limestone, light-gray, fine-grained, argillaceous, thin-bedded, well-indurated, fossiliferous, alternating with some tan platy shale; eroding into small ledges . . . . .</p> <p>4. Sandstone, tan, fine- to medium-grained, quartzose, thin-bedded, weakly indurated, alternating with some greenish-gray platy shale; eroding into a recess . . . . .</p> <p>5. Sandstone, light-tan, fine- to medium-grained, quartzose, thin- to medium-bedded, cross-bedded, moderately to well-indurated, with some 1- to 2-in. greenish-gray shale laminae; eroding into a low escarpment . . . . .</p> <p>6. Shale, greenish-gray, platy, weakly indurated, with a 1-ft tan sandstone 1 ft below top . . . . .</p> <p>7. Sandstone, tan, massive, as above . . . . .</p> <p>8. Shale, greenish-gray, as above . . . . .</p> <p>9. Sandstone, tan to bluish-gray, fine- to medium-grained, quartzose, calcitic, thin-bedded to massive, cross-bedded, well-indurated, speckled with dark-brown oil(?) stains, with some crystalline echinodermal limestone in places; eroding into an escarpment; Station 2649 + 70' on base, east side, east lane . . . . .</p> | <p>98.0</p> <p>48.0</p> <p>14.0</p> <p>4.0</p> <p>45.0</p> <p>5.0</p> <p>3.0</p> <p>1.5</p> <p>78.0</p> |
|---|---|

**McLish Formation** (397 ft measured, base not exposed):  
(front cover, top; Fig. 18)

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|---|-----|
| 1. Shale, greenish-gray, platy, crinkly-bedded, weakly indurated; eroding into a recess; strike N. 55° W., dip 75° SW, overturned . . . . . | 1.0 |
| 2. Sandstone, tan to gray, fine- to medium-grained, calcitic, well-indurated, blocky; weathering tan, eroding into a ledge . . . . .        | 2.0 |

**Marker No. 34**

**Station 2649 + 68', 2 ft below top of McLish**

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| 3. Shale, bluish-gray, calcitic, platy, weakly indurated, with some fine-grained limestone nodules; weathering tan, eroding into a recess . . . . .  | 2.0  |
| 4. Sandstone, light-gray to tan, fine- to medium-grained, calcitic, medium- to thick-bedded, well-indurated; gradational into limestone; eroding into an escarpment . . . . .  | 8.0  |
| 5. Shale, bluish-gray, calcitic, platy, arenaceous, weakly indurated; eroding into a recess . . . . .  | 0.5  |
| 6. Limestone, greenish-gray to blue-gray to dark-blue-gray, fine- to coarse-grained, echinodermal, medium- to thick-bedded, well-indurated; eroding into a ledge . . . . .   | 14.0 |
| 7. Limestone, tan to bluish-gray, coarse-grained, arenaceous, thin- to medium-bedded, cross-bedded, with much greenish-gray shale in lower 2 ft; eroding into ledges . . . . .   | 10.0 |
| 8. Sandstone, tan, fine- to medium-grained, calcitic, rubbly or burrowed, medium-bedded, well-indurated, with some interbedded coarsely crystalline echinodermal limestone; Station 2649 + 05' at base, east side, east lane . . . . . | 25.0 |
| 9. Interval covered, probably same as above, interbedded limestone and greenish-gray shale . . . . .   | 25.0 |
| 10. Limestone, tan, coarse-grained, arenaceous, echinodermal, thin-bedded, moderately indurated; eroding into ledges . . . . .   | 7.0  |
| 11. Interval covered, probably greenish-gray shale with some echinodermal limestone as exposed in lower 4 ft . . . . .   | 54.0 |
| 12. Limestone, gray, fine- to medium-grained, arenaceous, massive, cross-bedded, well-indurated; weathering tan, eroding into a ledge . . . . .  | 5.0  |
| 13. Interval covered, probably greenish-gray shale, with some interbedded fossiliferous coarse-grained echinodermal limestone; eroding into a creek valley . . . . .   | 52.0 |
| 14. Limestone, bluish-gray, coarse-grained, echinodermal, argillaceous, thin- to   |      |

medium-bedded, well-indurated, with some thin greenish-gray shale laminae; eroding into a ledge . . . . .

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|--|--------|
| 15. Shale, bluish-gray, calcitic, platy, weakly indurated, with some interbedded coarse-grained nodular limestone; eroding into a recess . . . . .   | 36.0   |
| 16. Limestone, bluish-gray, coarse-grained, echinodermal, thin- to medium-bedded, well-indurated; eroding into a ledge . . . . .   | 3.0    |
| 17. Limestone, bluish-gray, coarse-grained, echinodermal, thin- to medium-bedded, well-indurated; eroding into a ledge . . . . .   | 5.0    |
| 17. Shale, bluish-gray to greenish-gray, calcitic, thin-bedded, weakly indurated, with some interbedded coarse-grained limestone . . . . .   | 3.0    |
| 18. Limestone, bluish-gray, as above, with some interbedded shale . . . . .  | 8.0    |
| 19. Shale, greenish-gray, platy, weakly indurated, with some 1- to 2-in. flattened fine-grained gray limestone nodules . . . . .   | 11.0   |
| 20. Limestone, bluish-gray, as above . . . . .   | 2.0    |
| 21. Shale, greenish-gray, as above . . . . .   | 7.0    |
| 22. Shale and limestone, interbedded, as above, thin-bedded, weakly indurated . . . . .  | 21.0   |
| 23. Limestone, bluish-gray to tan, coarse-grained, echinodermal, thin- to thick-bedded, well-indurated, with some interbedded greenish-gray shale; eroding into an escarpment . . . . .  | 22.0   |
| 24. Sandstone, bluish-gray to tan, fine- to medium-grained, quartzose, calcitic, medium-bedded, well-indurated; gradational into arenaceous limestone; eroding into a ledge . . . . .  | 5.0    |
| 25. Shale, bluish-gray, platy, weakly indurated; eroding into a recess . . . . .   | 1.0    |
| 26. Sandstone, light-gray to tan, fine- to medium-grained, thin-bedded, calcitic, well-indurated; eroding into a ledge . . . . .   | 1.5    |
| 27. Shale, bluish-gray, platy, weakly indurated; eroding into a recess . . . . .   | 1.5    |
| 28. Sandstone, light-gray to tan, as above, massive . . . . .  | 2.0    |
| 29. Sandstone and shale, alternating, as above, thin- to medium-bedded, weakly indurated . . . . .   | 5.0    |
| 30. Sandstone, tan to light-greenish-gray, quartzose, thin-bedded to massive, moderately to well-indurated; eroding into a low escarpment; upper 57 ft exposed, base covered, probably another 20 ft is covered to Oil Creek contact (Fig. 18) . . . . . | 57.0 + |
- Station 2644 + 50' on contact, east fence of east lane

The underlying Oil Creek Formation occurs in the creek to the east, and the Bromide Formation is in fault contact with the Oil Creek beginning at about Station 2644 on east side of east lane. The Mountain Lake Member, overlain by the

Pooleville, dips 25° to 32° southwestward, striking N. 60° W. on the west (downthrown) side of the fault. The overlying Viola Group shows reversal of dip at about Station 2633 + 70', west side, west lane, and is vertical at Station 2633, west side, west lane, with Bromide Formation at faulted contact seen again at about Station 2630 + 50' in a clay-filled sink below the Collings Ranch Conglomerate. The Collings Ranch is flat-lying above the vertical Viola-Bromide from Station 2632 + 30' to Station 2629, where the Collings Ranch is in fault contact with the Bromide. The Bromide is overturned, with 61° dip to the southwest, and the fault plane dips 87° SW, with a strike of N. 60° W. The Collings Ranch dips about 11° SW on the southwest side of the fault (back cover, top and bottom).

**Marker No. ⑩**

**Station 2628 + 75', west side of west lane,  
Collings Ranch Conglomerate, 25 ft south  
of fault contact with Bromide**

**Marker No. ⑪**

**Station 2630 + 14', west side of west lane,  
faulted Bromide, 36 ft below Viola**

**Marker No. ⑫**

**Station 2633 + 70', west side of west lane,  
175 ft above base of Viola**

**Marker No. ⑬**

**Station 2629 + 22', west side of west lane,  
faulted Bromide, 126 ft below Viola**

The Collings Ranch Conglomerate is estimated to be about 3,000 ft thick, composed of pebbles and cobbles reworked mostly from beds ranging in age from the West Spring Creek to the Reagan Sandstone. After uplift of the mountains in late

Pennsylvanian (mid-Virgilian) time, the conglomerate was deposited. The large graben then formed, and the conglomerate was down-dropped and preserved in the graben. It is possible that the graben was formed before or at the same time deposition was taking place. Later movements have taken place after the graben was formed, as evidenced by a fault at Station 2614 + 25', west side, west lane, and a syncline at approximately Station 2610 + 10' in the Collings Ranch (back cover, top and bottom).

**Marker No. ⑭**

**Station 2604 + 50', west side of west turnout,  
Collings Ranch Conglomerate, 70 ft north  
of fault contact with Arbuckle Group**

**Marker No. ⑮**

**Station 2610, east side of east lane, Collings  
Ranch Conglomerate, synclinal axis**

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