

**South-Central Section Meeting of the  
Geological Society of America  
March 3-5, 2006**

**Stratigraphy and Paleontology  
of the  
Upper Mississippian Barnett Shale  
of Texas and the  
Caney Shale of  
Southern Oklahoma**

**Field-Trip Leaders:**

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Oklahoma State University**

**Jim Puckette  
Oklahoma State University**

## **Introduction**

Recent exploration activity for gas production from siliclastic mudrock reservoirs (shales and siltstones) has created widespread academic and economic interest in Mississippian strata across the southern Midcontinent and Texas. Shales that were previously of interest only to paleontologists trying to decipher Mississippian stratigraphy or petroleum geologists interested in the rocks sealing or hydrocarbon source potential, are now the objective of exploration and production programs.

Gas exploration in the Mid-continent region is primarily centered on the Woodford, Barnett, Caney and Fayetteville shales. Representative outcrops of these units occur along the margins of the Arkoma, Ardmore and Fort Worth basins where uplift associated with Pennsylvanian orogenies resulted in these sections being exposed.

Mississippian strata in Oklahoma represent shelf, starved basin and trough deposition. The outcrops in southern Oklahoma and Texas that are examined on this field trip include examples of basinal facies that have become both the source and reservoirs for natural gas production. The Sycamore Limestone and Delaware Creek (Caney) shale are examined in classic exposures along I-35 in the Arbuckle Mountains. These outcrops were described by Fay (1989) who was commissioned by the U.S. Bureau of Public Roads, through the Oklahoma Geological Survey, to “salvage anything of scientific value and to study and map new exposures of rock” (Fay, 1969, 1989). The other important exposures of Mississippian rocks in the Arbuckle Mountain region are on the margin of the Franks Graben in Pontotoc County. The Lawrence Uplift in the vicinity of the Hass G section provides the type locality for the Welden Limestone and contains excellent exposures of the Caney Shale.

This field trip is designed to introduce the participant to the stratigraphy and lithofacies of the Mississippian units in southern Oklahoma and Llano Uplift region of Texas. While the focus is on the Caney and the Barnett, understanding the stratigraphic relationship of these economically important units to other Mississippian strata, as well as adjacent beds such as the Woodford Shale, is important to reconstructing their depositional history and their genesis as gas-bearing reservoirs.

#### Stop 1 Haas G

This section along the southeast bank of the South Fork of Jackfork Creek (SE/4,SW/4, sec. 35, T3N, R6E) was first described by Hass and Huddle (1965) and later by Over & Barrick (1990), and Haywa-Branch & Barrick (1990). This locality exposes the upper 4 meters of the Woodford Shale, pre-Weldon Shale, Weldon Limestone, and basal Caney Shale (Ahloso Member).

The Devonian-Mississippian boundary is exposed .6 meters below the top of the Woodford Shale (Over & Barrick 1990). A complete section of condensed Kinderhookian strata is contained in the upper .6 meters of the Woodford Shale and pre-Weldon shale. Additionally, the entire Osagean is exposed in the Weldon Limestone and very basal Caney Shale. A thin shaly limestone exposed below a prominent siltstone ledge contains a prominent influx of *Gnathodus texanus* and marks the base of the Meramecian. This thin ledge is thought to equate with the majority of the Sycamore Limestone exposed in the Arbuckle Mountains.

#### Stop 1-South Flank Jackfork Creek Section A

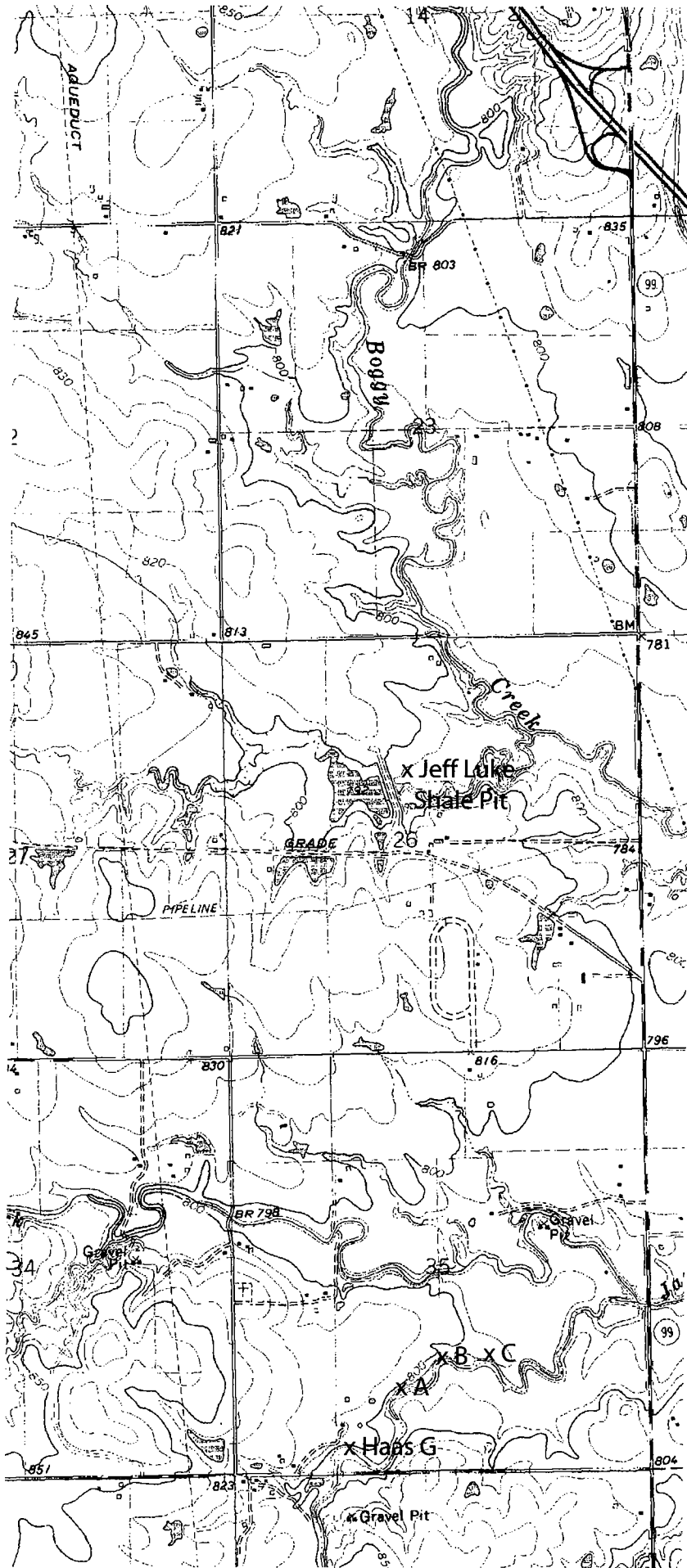
This section lies above the siltstone exposed at Haas G. This section consists of alternating siltstones and silty shales and lies within the Ahloso Member of the Caney Shale.

#### Stop 1-South Flank Jackfork Creek Section B

This section exposes the contact between the underlying Ahloso Member and Delaware Creek Member of the Caney Shale. The prominent carbonate concretions (bullions) mark the boundary. These concretions contain the ammonoid *Goniatites americanus* which correlates with the lower Moorefield of Arkansas.

#### Stop 1-South Flank Jackfork Creek Section C

This section a short stratigraphic interval above Section B contains bullion with the ammonoid *Goniatites multiliratus* allowing correlation with the upper Moorefield of Arkansas. Additionally, this level corresponds to the contact of the Meramecian and Chesterian stages.



Haas G-Large View



Weldon Limestone

pre-Weldon Shale

Woodford Shale

Haas G-Closeup



C-lower Caney (Ahloso Member)  
"Sycamore"  
Limestone



D-lower Caney (Ahloso Member)  
Siltstone Beds



B-pre-Weldon

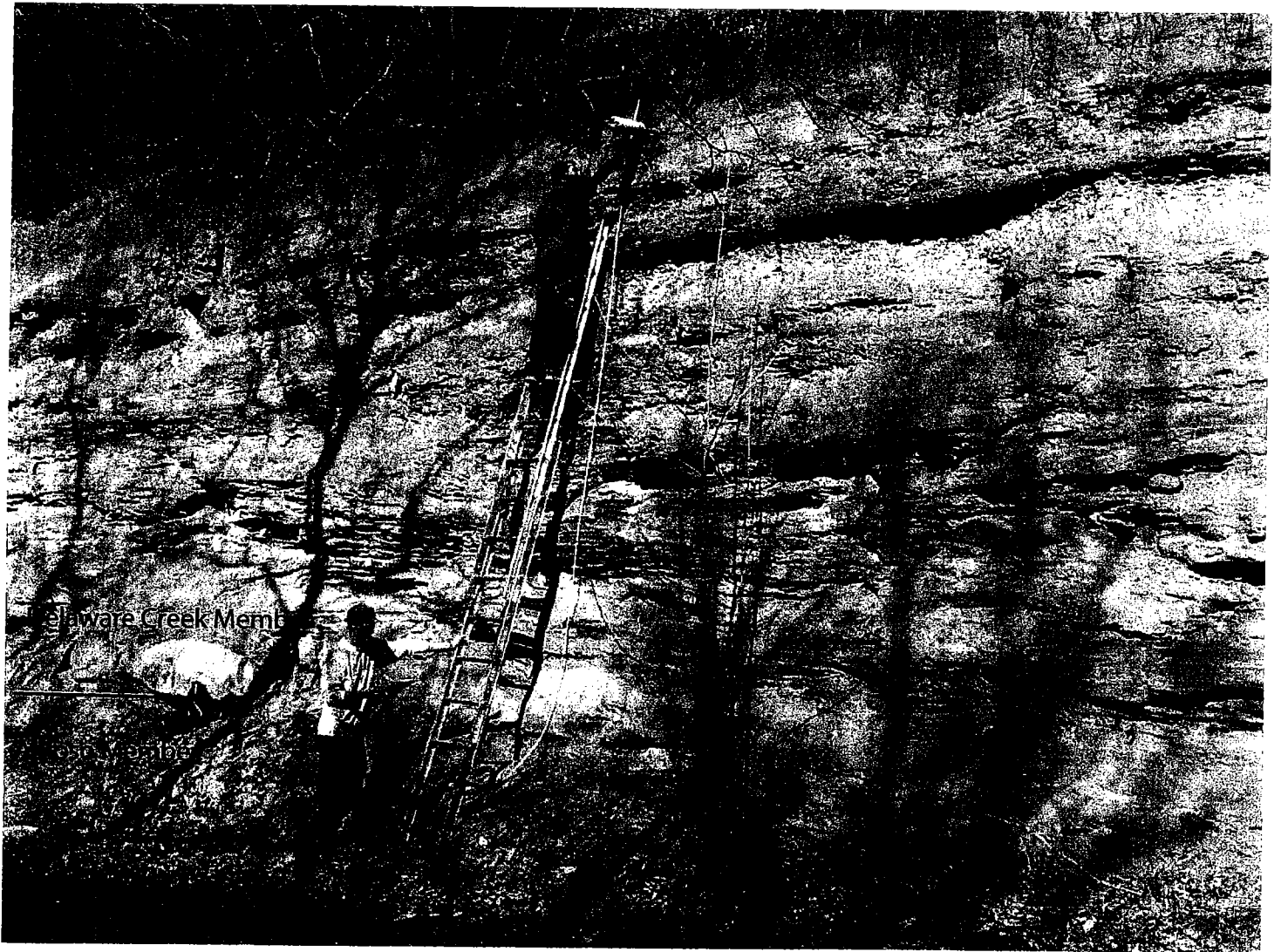


A-upper Woodford



Section A-South Fork Jackfork Creek Caney Shale (Ahloso Member)

Section B-South Fork Jackfork Creek-Caney Shale  
(top Ahloso Member, basal Delaware Creek Member)

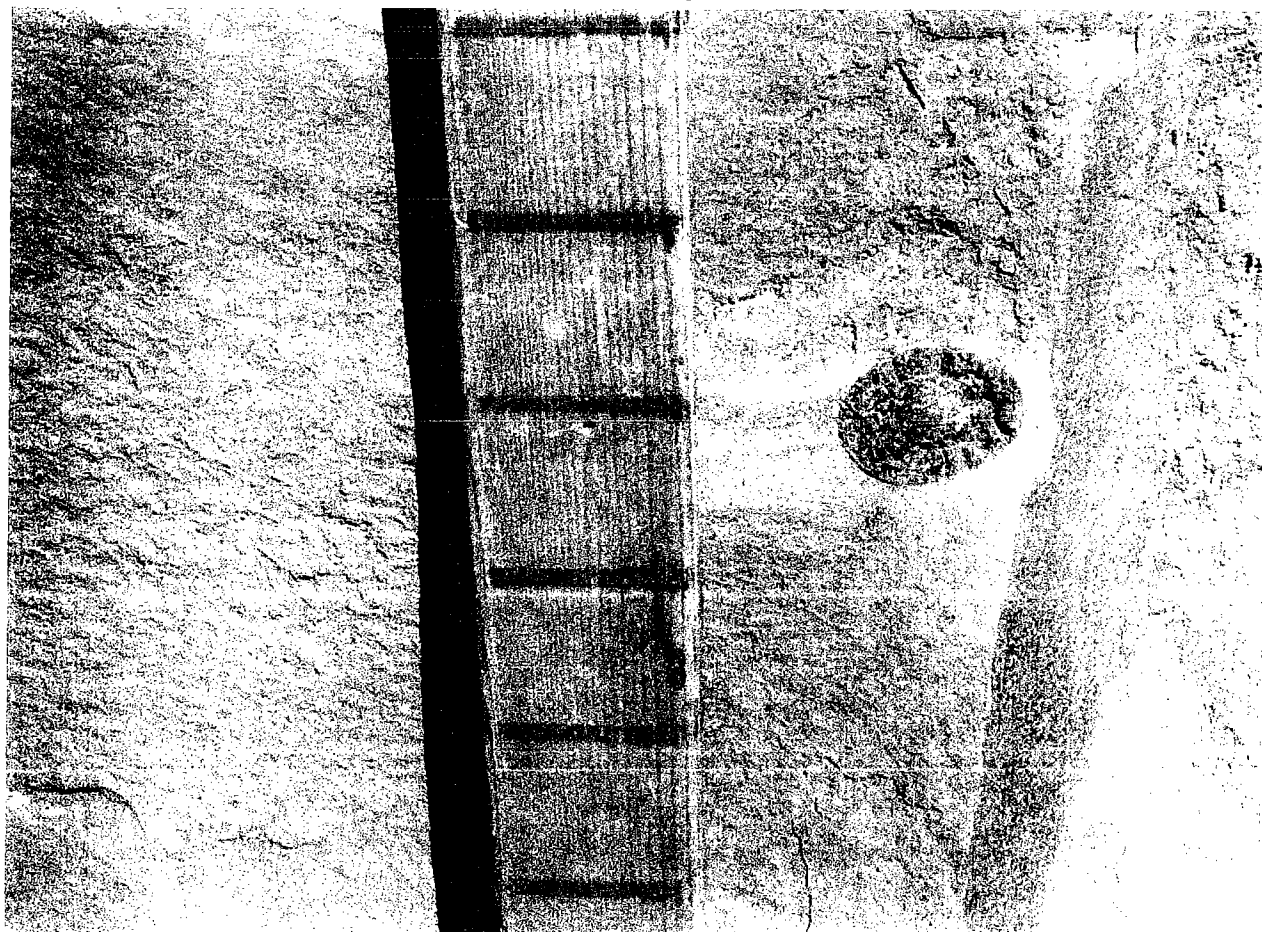




Section B-South Fork Jackfork Creek Showing Bullion at Base of Delaware Creek Member



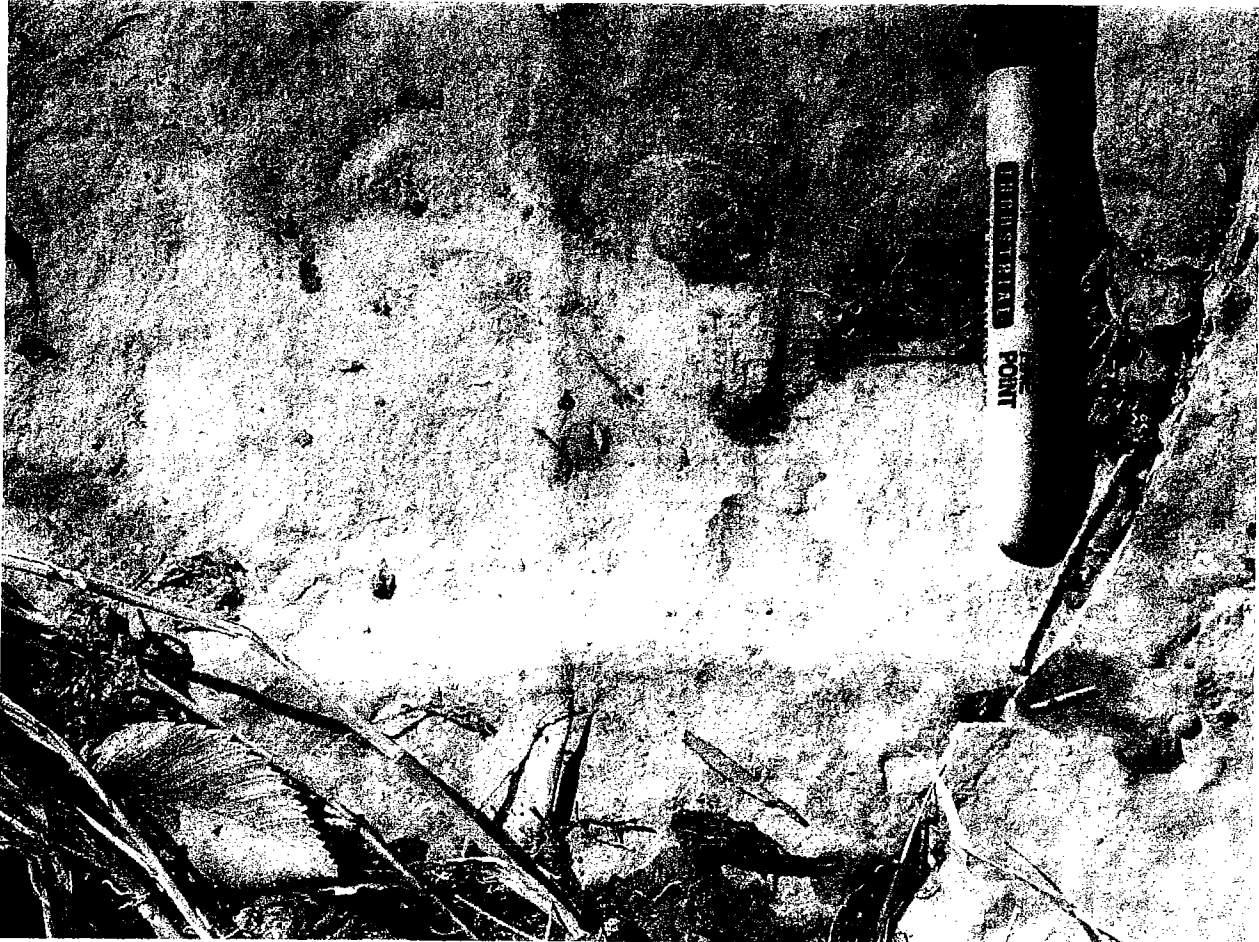
Section B-South Fork Jackfork Creek Showing *Goniatites americanus* in Bullion bed



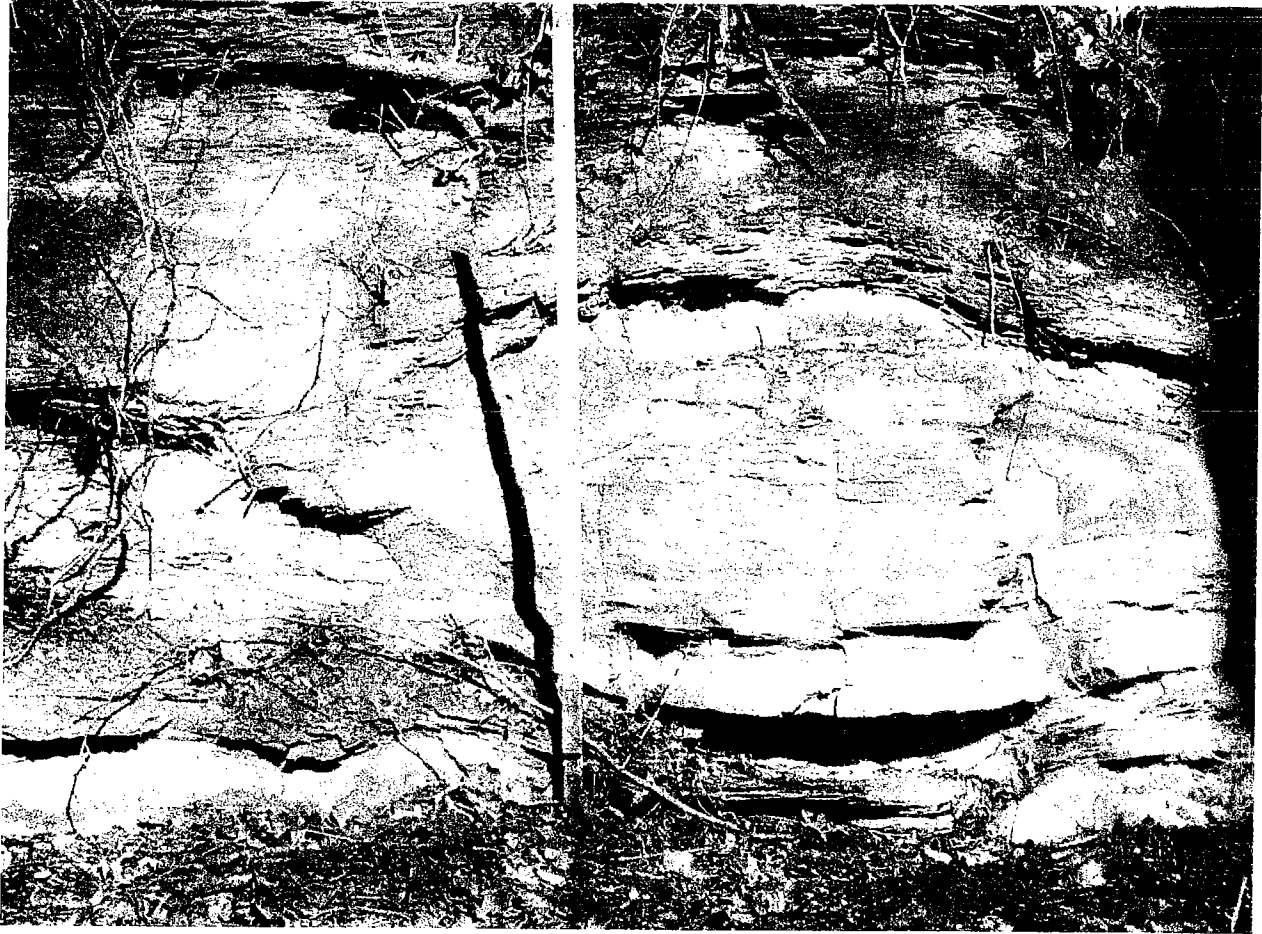
Section C-South Fork Jackfork Creek Caney Shale (Delaware Creek Member)



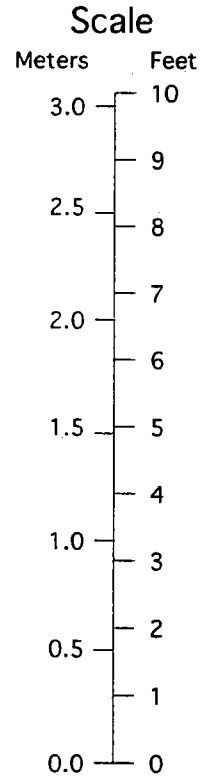
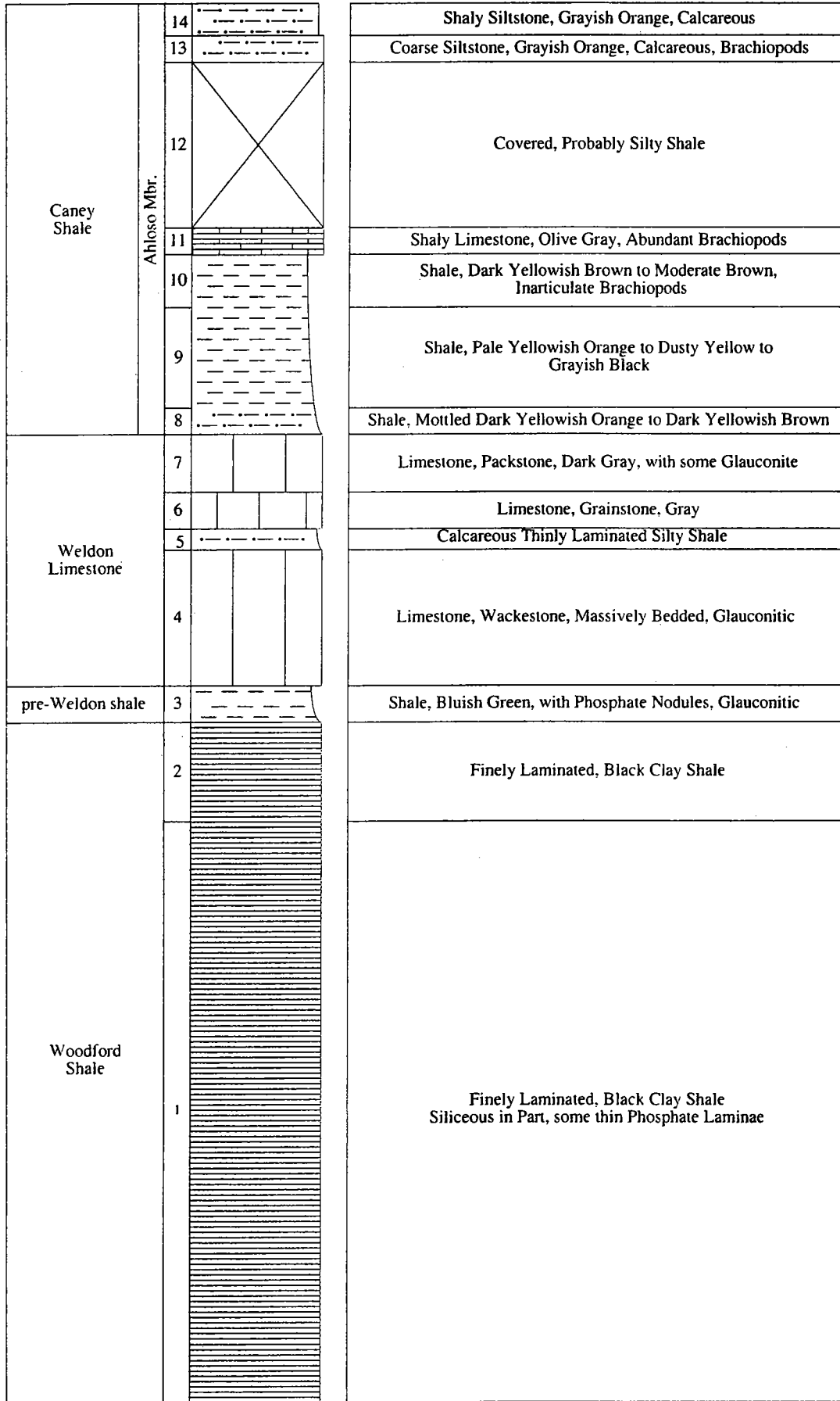
Section C South Fork Jackfork Creek-Delaware Creek Member *Goniatites multiliratus*



Section C South Fork Jackfork Creek-Delaware Creek Member Large Bullion



# Haas G



**Plate 1-Upper Woodford (Mississippian-Kinderhookian)**

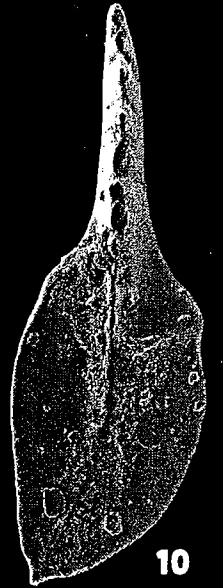
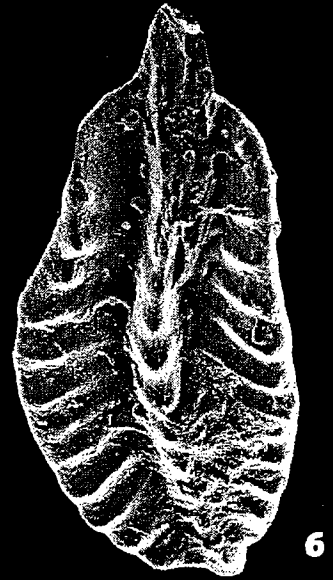
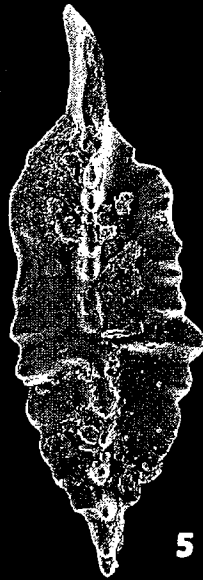
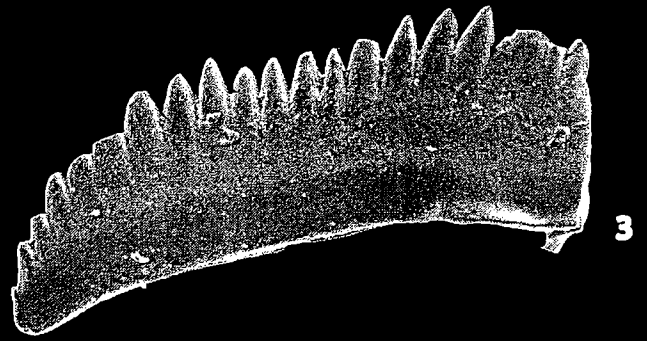
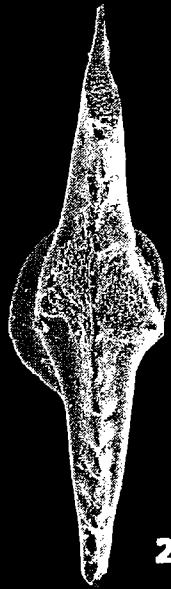
Figs. 1-2 *Bispathodus* sp.

Fig. 3 Indet.

Figs. 4-5 *Pseudopolygnathus primus*

Fig. 6 *Siphonodella sulcata*

Figs. 7-9 *Polygnathus communis*



**Plate 2-Lower pre-Weldon Shale (Mississippian-Kinderhookian)**

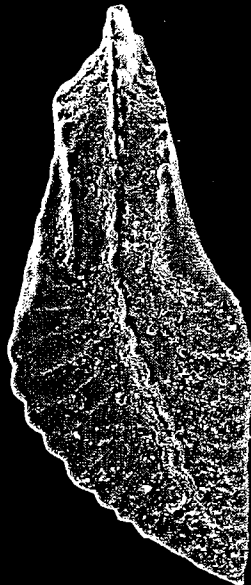
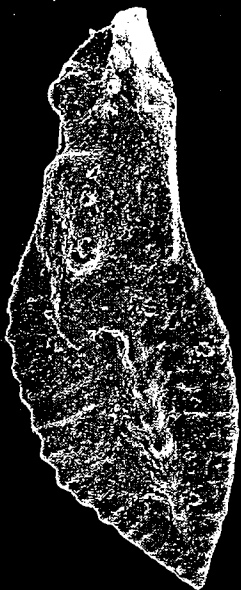
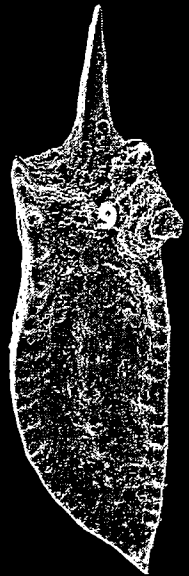
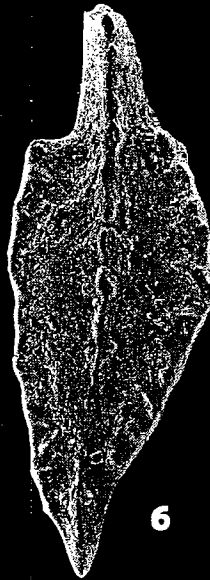
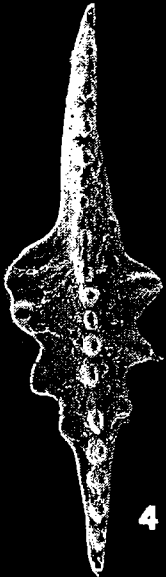
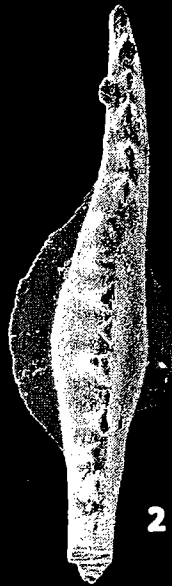
Fig. 1-Indet

Figs. 2-3 *Bispathodus*

Figs. 4-5 *Pseudopolygnathus primus*

Figs. 6-7 *Polygnathus symmetricus*

Figs. 8-10 *Siphonodella cooperi*





**Plate 3-upper pre-Weldon (Mississippian-Kinderhookian)**

Figs. 1 & 3 Indet.

Fig. 2 *Spathognathodus*

Fig. 4 *Pseudopolygnathus fusiformis*

Fig. 5 *Pseudopolygnathus crenulatus*



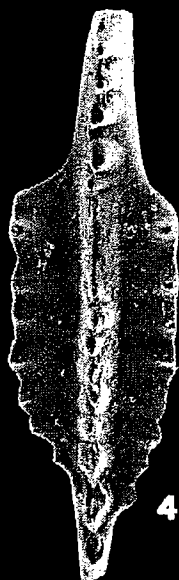
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**Plate 4-Lower Weldon Limestone (Mississippian-Osagean)**

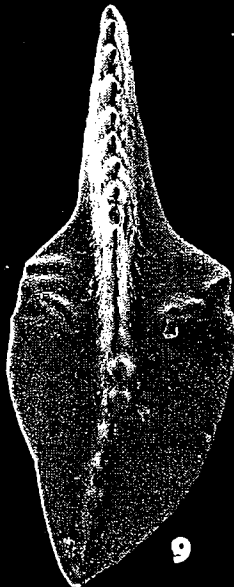
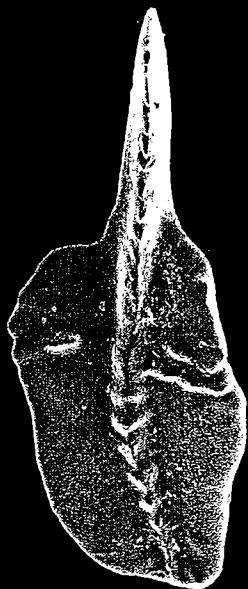
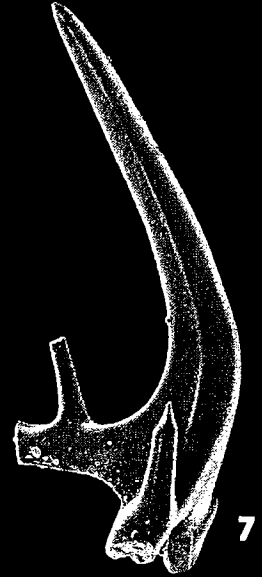
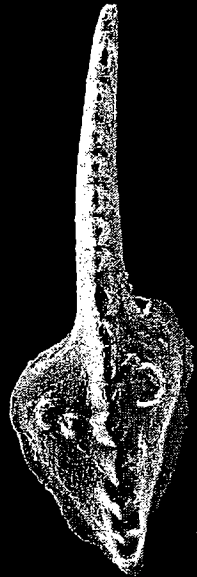
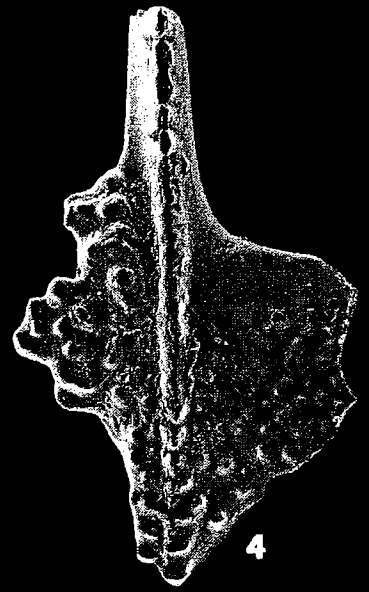
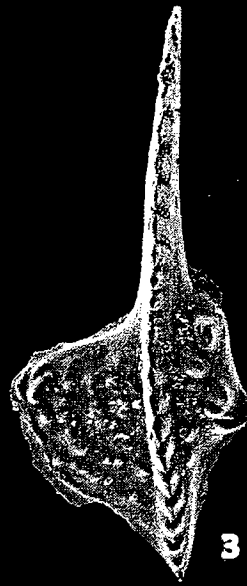
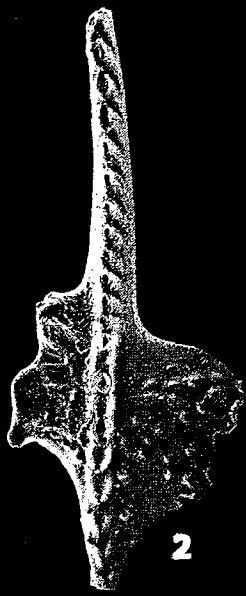
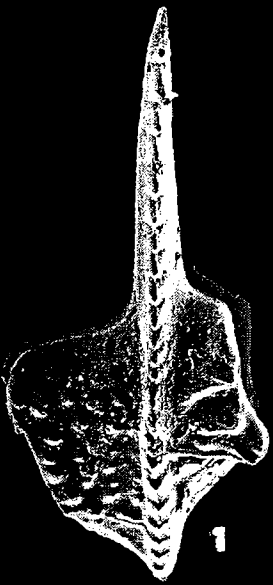
Figs. 1-4 *Gnathodus punctatus*

Fig. 5 *Gnathodus semiglaber*

Fig. 6 *Gnathodus* sp. B

Fig. 7 *Roundya* sp.

Fig. 8-9 *Polygnathus communis carina*



**Plate 5-upper Weldon (Mississippian-Osagean)**

Figs. 1-2 *Bactrognathus hamata*

Fig. 3 *Nodognathus spicata*

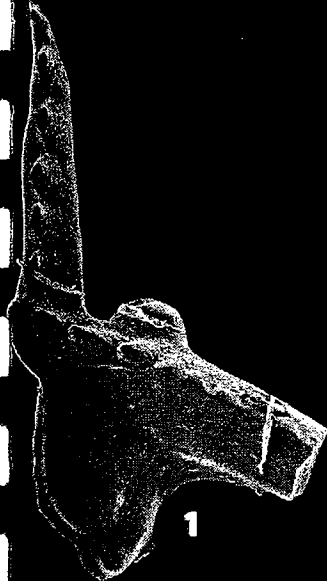
Fig. 4 *Polygnathus* sp.

Fig. 5 *Pseudopolygnathus* sp. A

Fig. 6 *Pseudopolygnathus* sp. B

Fig. 7, 9 Indet

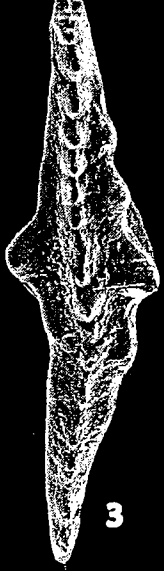
Fig. 8 *Polygnathus communis*



1



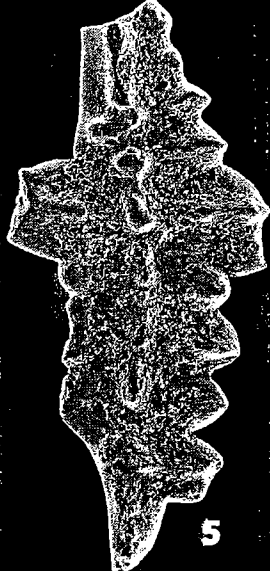
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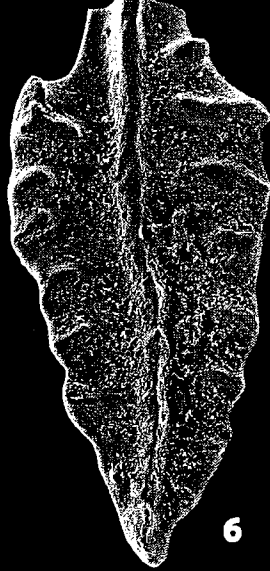
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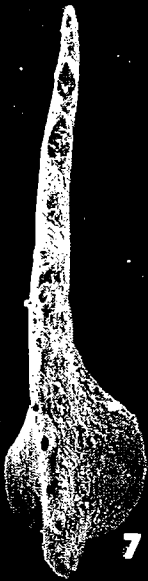
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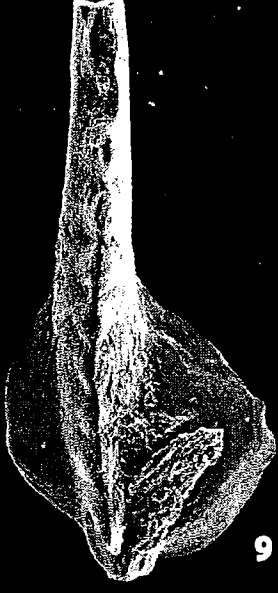
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**Plate 6-upper Weldon (Mississippian-Osagean)**

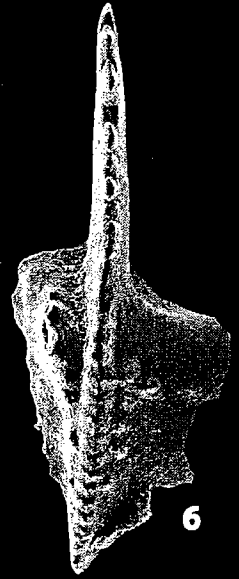
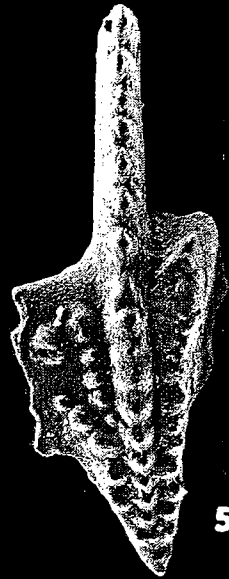
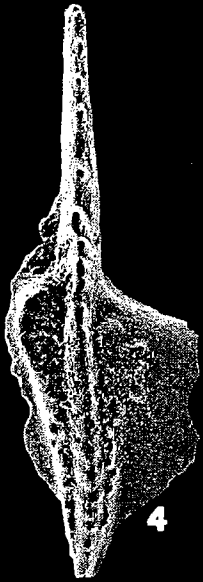
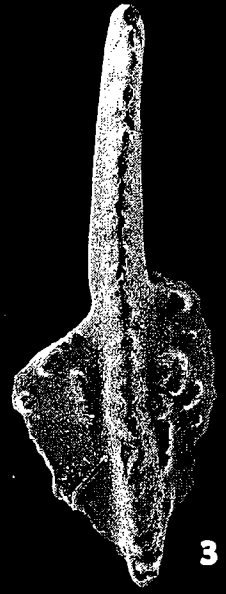
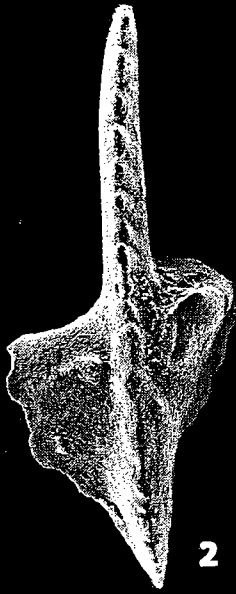
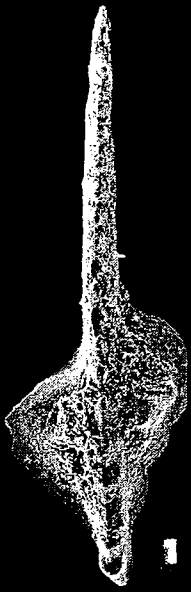
Figs. 1-2 *Gnathodus bulbosus*

Fig. 3 *Gnathodus* sp.

Fig. 4 *Gnathodus* sp.

Figs.5-8 *Gnathodus delicatus*

Fig. 9 *Gnathodus* sp.





**Plate 7 Basal Caney (Mississippian-Osagean)**

Figs. 1, 6 *Gnathodus delicatus*

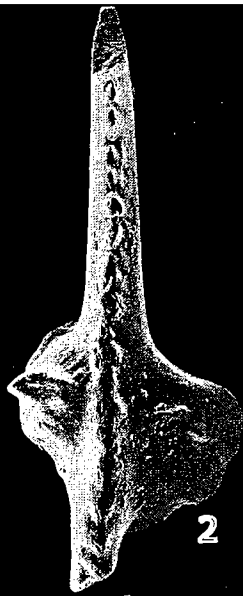
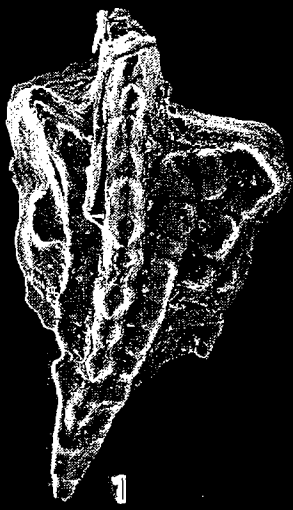
Figs 2, 7 *Gnathodus bulbosus*

Fig. 3 *Gnathodus* sp.

Figs. 4, 5 *Gnathodus texanus?*

Fig. 8 *Hibbardella*

Fig. 9 *Bactrognathus excavata*



**Plate 8-“Lawrence Uplift Sycamore”-(Mississippian-Meramecian)**

Figs. 1-2 *Rhachistognathus* sp.

Fig. 3 *Hibbardella*

Figs. 4-8 *Gnathodus texanus*

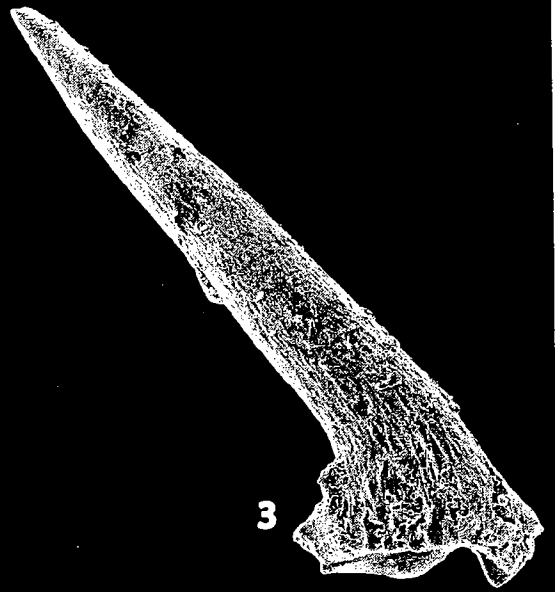
Fig. 9 *Gnathodus bilineatus*



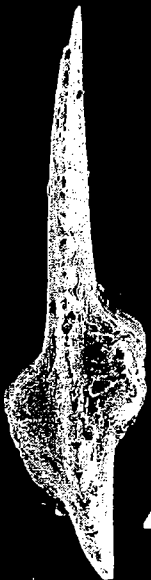
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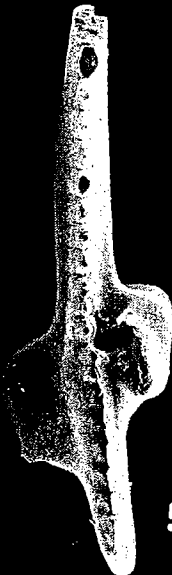
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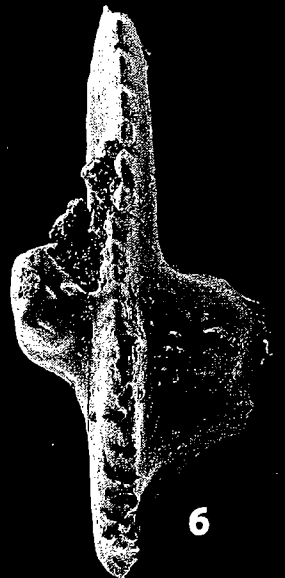
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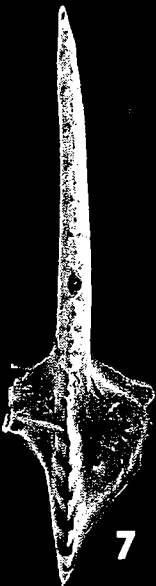
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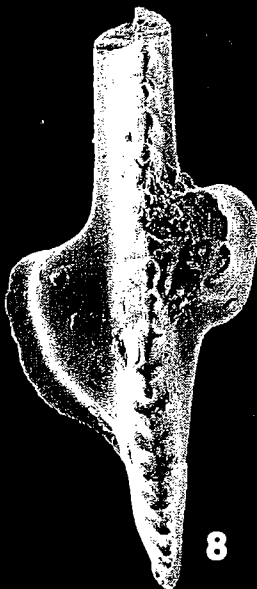
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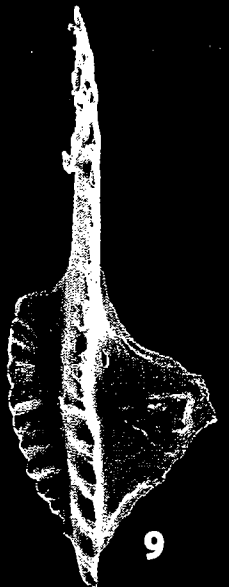
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*Southern Arbuckles/Ardmore Basin*

Lower Pennsylvanian Series	Upper Mississippian Series		Middle Mississippian Series	Lower Mississippian Series		Upper Devonian Series	
Bashkirian Stage	Serpukhovian Stage		Visean Stage	Tournaisian Stage		Fammenian Stage	Frasnian Stage
Morrowan Stage	Chesterian Stage		Meramecian Stage	Osagean Stage	Kinderhookian Stage	Fammenian Stage	Frasnian Stage
Springer Formation	Goddard Formation	Caney Shale	Sycamore Limestone			Woodford Shale	
		Delaware Creek Mbr.					

*North Flank Sycamore Ls.*

*South Flank Sycamore Ls.*

*Jeff Luke Shale Pit*

*Tulip Creek Caney*

*Jackfork Creek Section C*

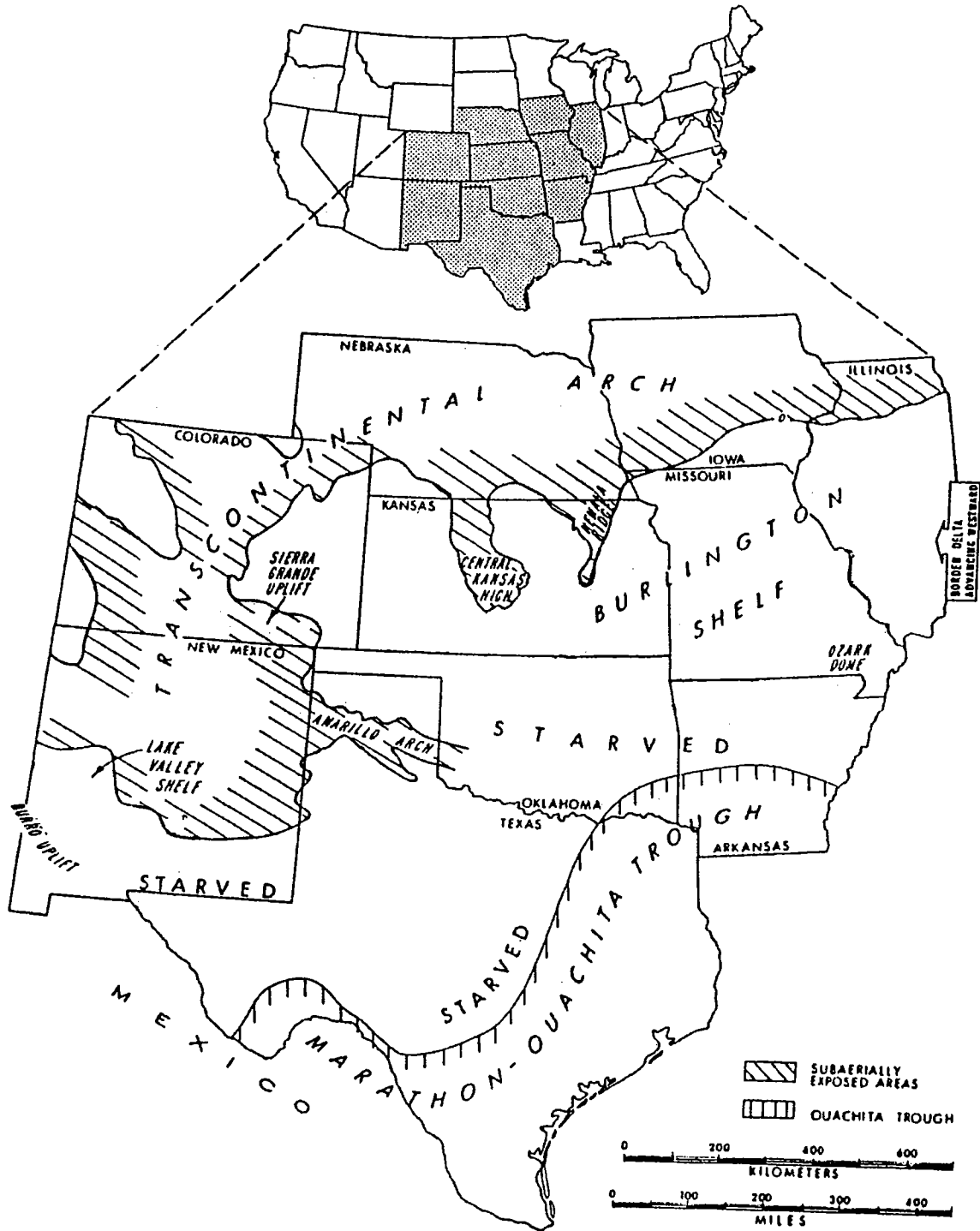
*South Branch Jackfork Creek Section B*

*South Branch Jackfork Creek Section A*

*Haas G*

*Lawrence Uplift*

Lower Pennsylvanian Series	Upper Mississippian Series	Middle Mississippian Series	Lower Mississippian Series	Upper Devonian Series	
Bashkirian Stage	Serpukhovian Stage	Visean Stage	Tournaisian Stage	Fammenian Stage	Frasnian Stage
Morrowan Stage	Chesterian Stage	Meramecian Stage	Osagean Stage	Kinderhookian Stage	Fammenian Stage
Rhoda Creek Fm.	Caney Shale	Weldon Limestone	pre-Weldon Shale	Woodford Shale	
	Delaware Creek Mbr.	Ahloso Mbr.			
	Sand Branch Mbr.				



Mississippian paleogeography of the Mid-continent area (modified from Lane and De Keyser, 1980).

## Stop 2-Jeff Luke Shale Pit-

This stop was found and described by Patrick Kamman who used this section as part of his master's thesis at Oklahoma State University. This outcrop is an abandoned shale pit on the property of Mr. Jeff Luke in section 26, T3N, R6E. This locality exposes phosphatic shales of the Caney Formation (Sand Branch Member). The carbonate concretions at the top of the hill yield a very sparse ammonoid fauna of *Cravenoceras* indicating an upper Chesterian age (Fayetteville equivalent). Conodonts from this locality are typical upper Chester age with *Gnathodus bilineatus* (advanced forms) and *Lochriea commutata*.

This section was measured in several transects across the face of the exposure. The following is based on Patrick Kamman's description.

### Top of Section

4' heavily weathered shale and carbonate bullion.

7' black fissile shale with phosphate nodules

1.6' blocky, thinly laminated, black shale with phosphate nodules

3.6' blocky, thinly laminated, black shale with common phosphate nodules

6.8' dark gray to black fissile shale with phosphate nodules

2.4' dark grey to black fissile shale no phosphate

1.6' dark grey to black thinly laminated shale no phosphate

2.15' black fissile shale some phosphate

.65' grayish black thinly laminated shale

### Base of Section

**Plate 9-Jeff Luke Shale Pit (Caney Shale-Sand Branch Member)**

Fig.1 *Hibbardella*

Fig. 2 *Lochriea commutata*

Figs. 3-5 *Gnathodus bilineatus*

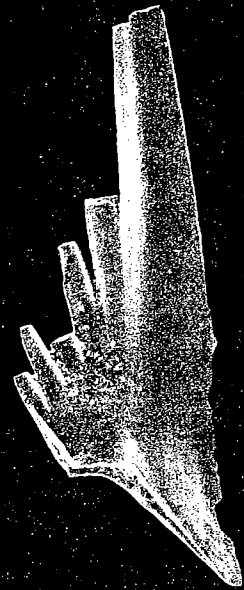
Fig. 6-7 *Lochriea commutata*

Fig. 8 *Gnathodus girtyi*

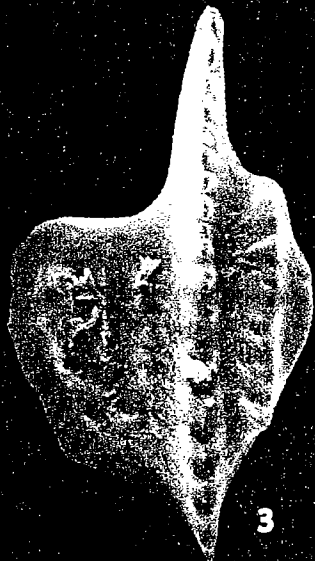




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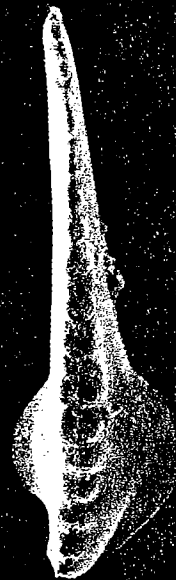
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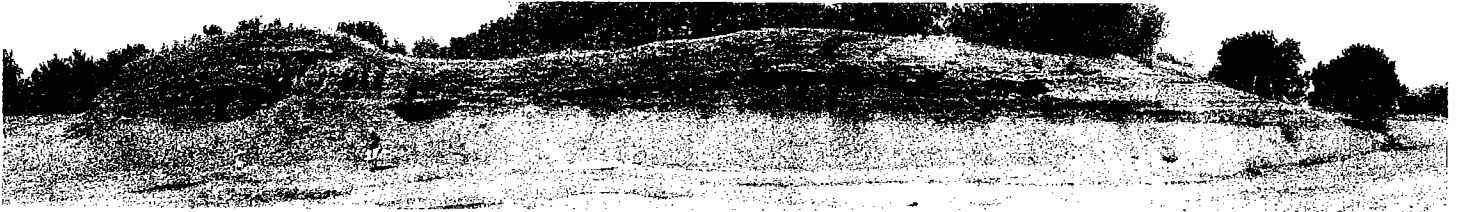


7



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Jeff Luke Shale Pit-Caney Shale (Sand Branch Member)



Jeff Luke Shale Pit-Caney Shale (Sand Branch Member) Base of Section



Jeff Luke Shale Pit-Caney Shale (Sand Branch Member) Second Offset



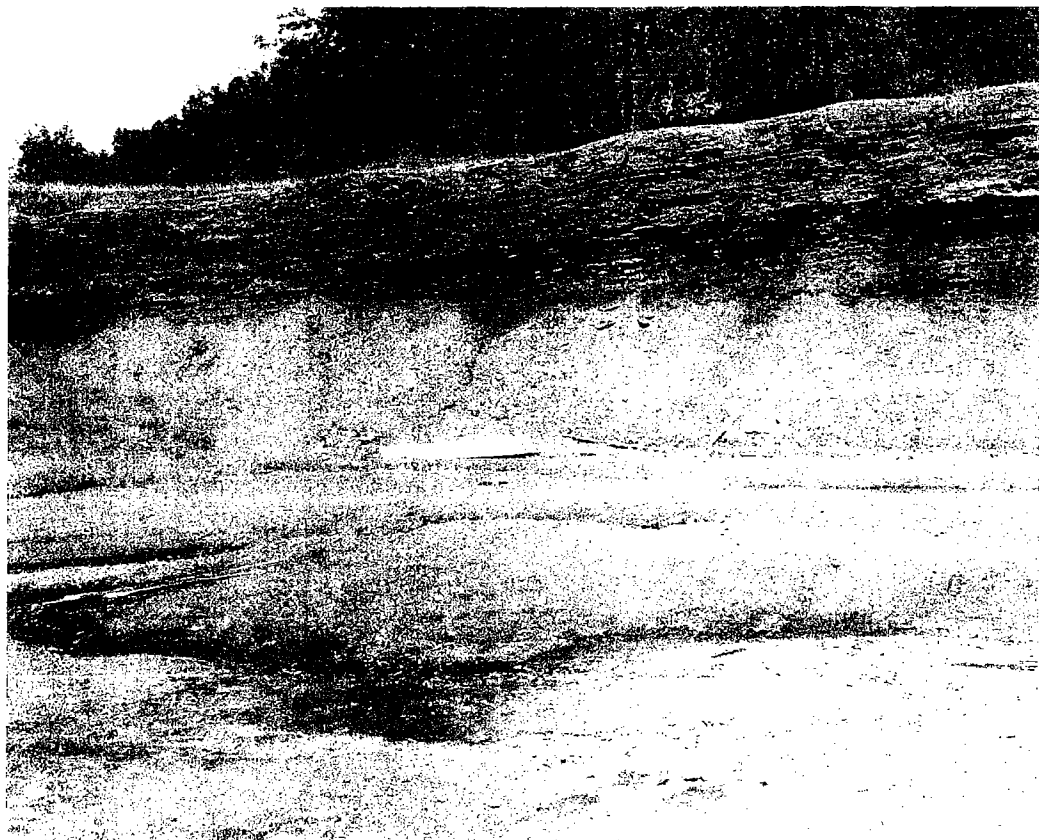
Jeff Luke Shale Pit-Caney Shale (Sand Branch Member)

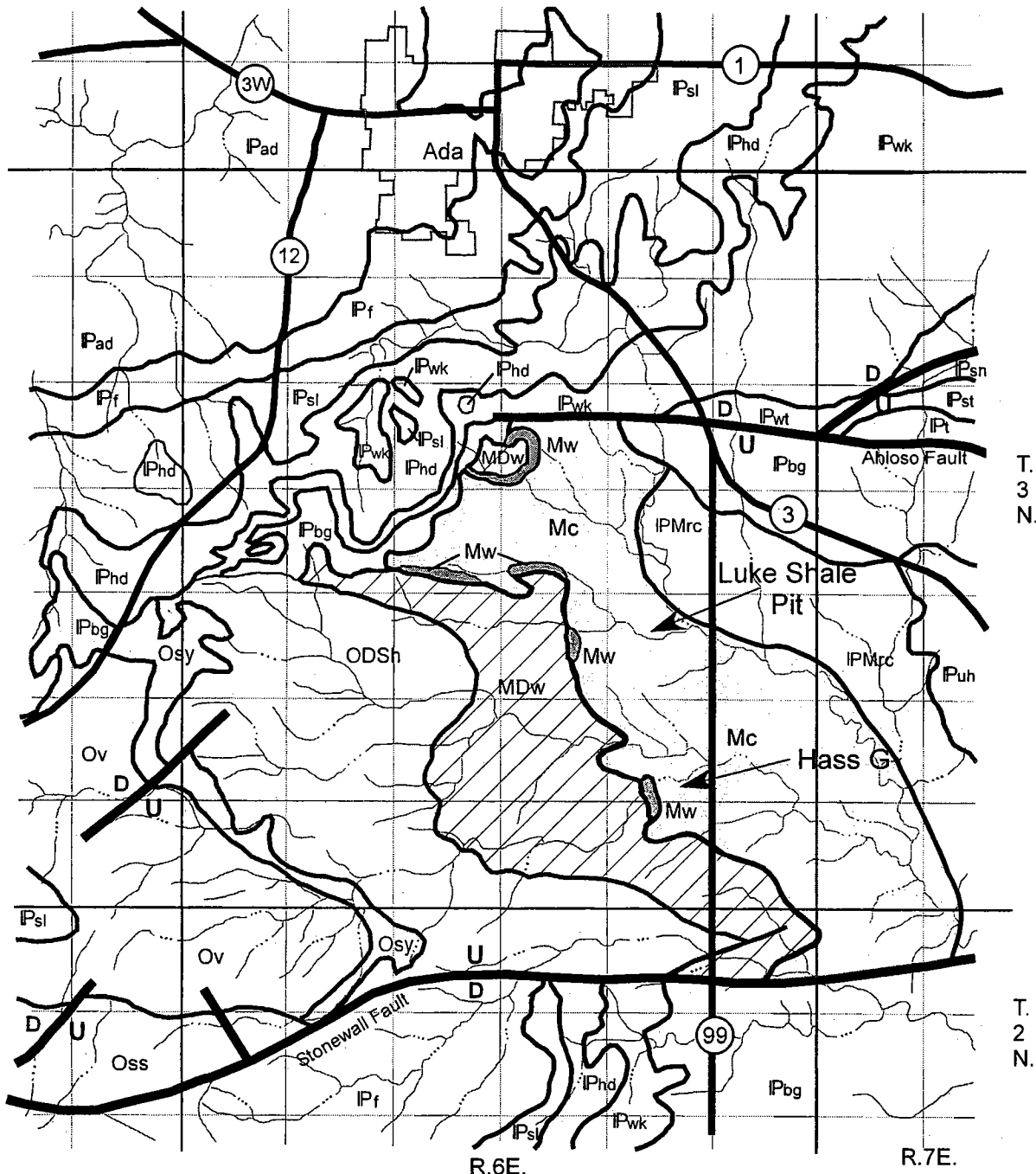


Jeff Luke Shale Pit-Caney Shale (Sand Branch Member) Top of Section



Jeff Luke Shale Pit-Caney Shale (Sand Branch Member) Third Offset





EXPLANATION OF ROCK UNITS

Pennsylvanian		Mississippian		
<b>IPad</b> Ada Fm.	<b>IPsn</b> Senora Fm.	<b>IPMrc</b> Rhoda Cr. Fm.	<b>Mc</b> Caney shale	<b>Mw</b> Welden limestone
<b>IPf</b> Francis Fm.	<b>IPst</b> Stuart shale	<b>MDw</b> Woodford shale	} Pre-Mississippian	
<b>IPsl</b> Seminole Fm.	<b>IPt</b> Thurman ss.	<b>OSDw</b> Hunton Group		
<b>IPhd</b> Holdenville Fm.	<b>IPbg</b> Boggy Fm.	<b>Osy</b> Sylvan shale		
<b>IPwk</b> Wewoka Fm.	<b>IPuh</b> Union Valley shale	<b>Ov</b> Viola Group		
<b>IPwt</b> Wetumka shale		<b>Oss</b> Simpson Group		

### Stop 3-North Flank I-35 Arbuckles Woodford & Sycamore

Description from Fay (1989). At this locality age relationships for the Sycamore Limestone and been determined by conodonts and ammonoids. Ormiston and Lane (1976) determined that the Sycamore was age equivalent To the Weldon Limestone based on typical Osagean conodont taxa. More recently Conodonts have been found in bed 28 in basal Sycamore that have older re-worked taxa but also contain conodonts typical of Meramecian age such as *Gnathodus texanus* and *Taphrognathus varians* by Anita Harris reported in Swartzapfel and Holdsworth (1996). Therefore it is concluded that the sycamore is younger than the Weldon Limestone and likely equivalent to the thin-bedded limestone at the Haas G section that was in the lower Caney. The upper shale unit of Fay (1989) contains the ammonoid *Goniatites americanus* according to Gordon in Swartzapfel and Holdsworth indicating that the upper Sycamore is equivalent to the lower Delaware Creek Member of the Caney Formation in the Lawrence Uplift.

### Sycamore Limestone (222 ft thick)

#### Upper Limestone (46ft thick)

- |   |       |
|---|-------|
| 1. Limestone, bluish-gray, fine grained, silty, massive- to thick-bedded, fossiliferous | 41.0' |
| 2. Shale, gray, silty, platy, weakly-indurated; weathering tan                          | 0.3'  |
| 3. Limestone, bluish-gray, as above, massive;   | 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   | 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 phosphate nodules, alternating with some gray shale; weathering tan to yellowish-brown | 7.0' |

#### Lower Limestone (89ft thick)

- |   |       |
|---|-------|
| 8. Limestone, gray, fine-grained, silty, argillaceous, medium-bedded, well-indurated, blocky; weathering tan along joints and bedding planes    | 15'   |
| 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 escarpment | 21.0' |
| 13. Siltstone, gray, mottled orange-brown, argillaceous, calcitic, platy,   |       |

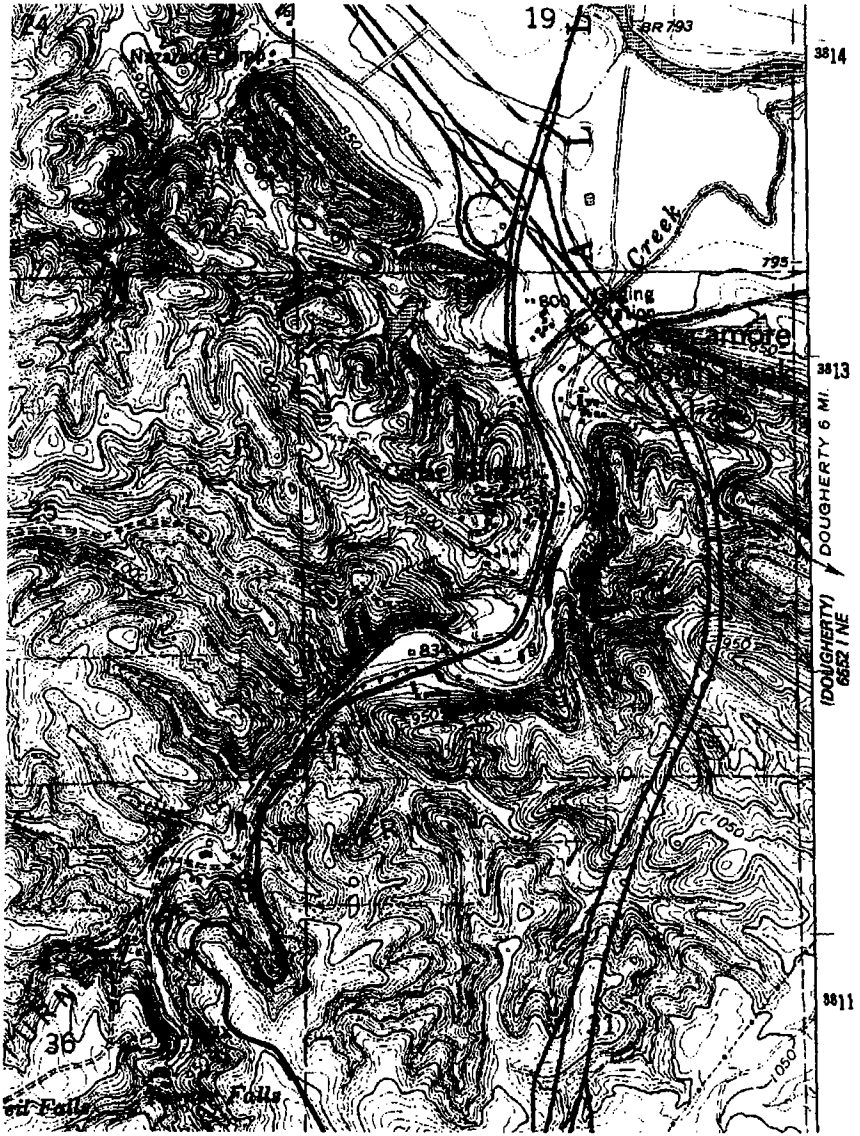
moderately-indurated	0.3'
14. Limestone, light gray to gray, fine-grained, argillaceous, silty, medium- to massive-bedded, blocky, well-indurated	2.5'
15. Siltstone, gray, fine-grained, argillaceous, calcitic, platy, moderate-indurated	0.2'
16. Limestone, gray to light gray, as above	9.0'
17. Siltstone, 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 feet	31.0'

#### **ition Zone (67 ft thick)**

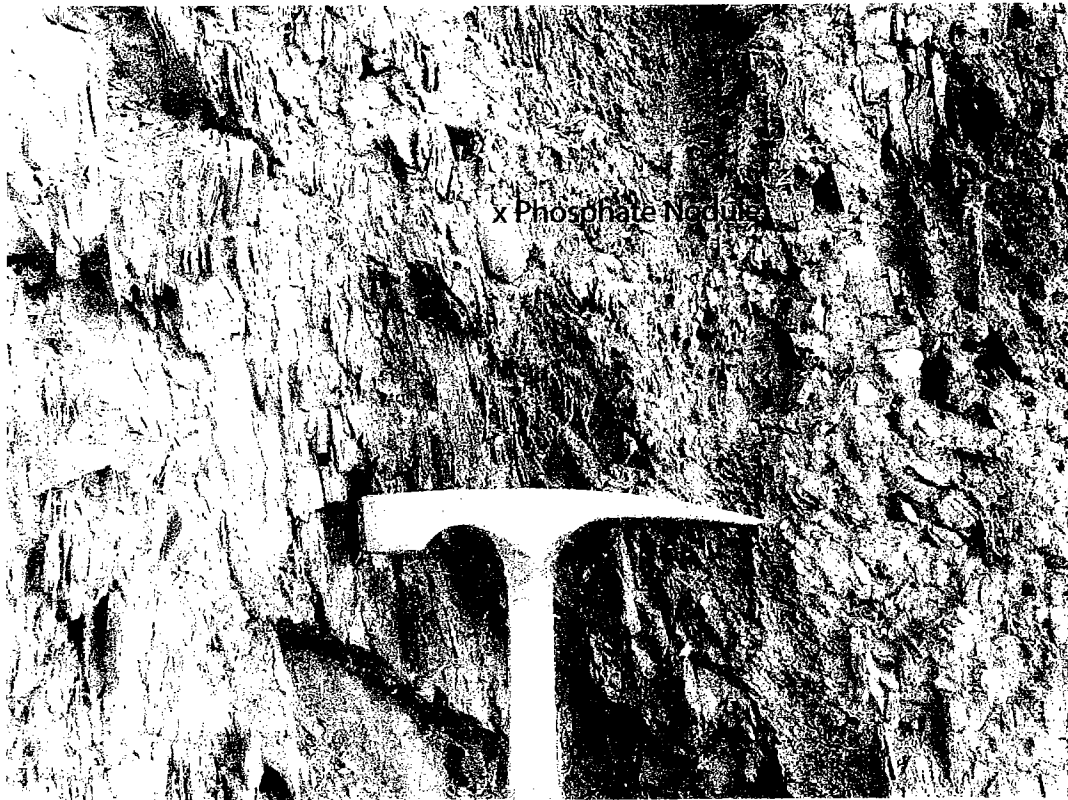
21. Shale, blue-gray, silty, platy to blocky, weakly-indurated, with some 0.5in phosphatic nodules; weathering tan;	11.0'
22. Limestone, gray, fine-grained, silty, blocky, thick-bedded, well-indurated, fossiliferous, with a cup coral found 4 ft below top and a brachiopod 3 ft below top; weathering tan, 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.; radiolarians abundant	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, eroding into a ledge. Radiolarians and conodonts occur	7.0'

#### **Woodford Shale**

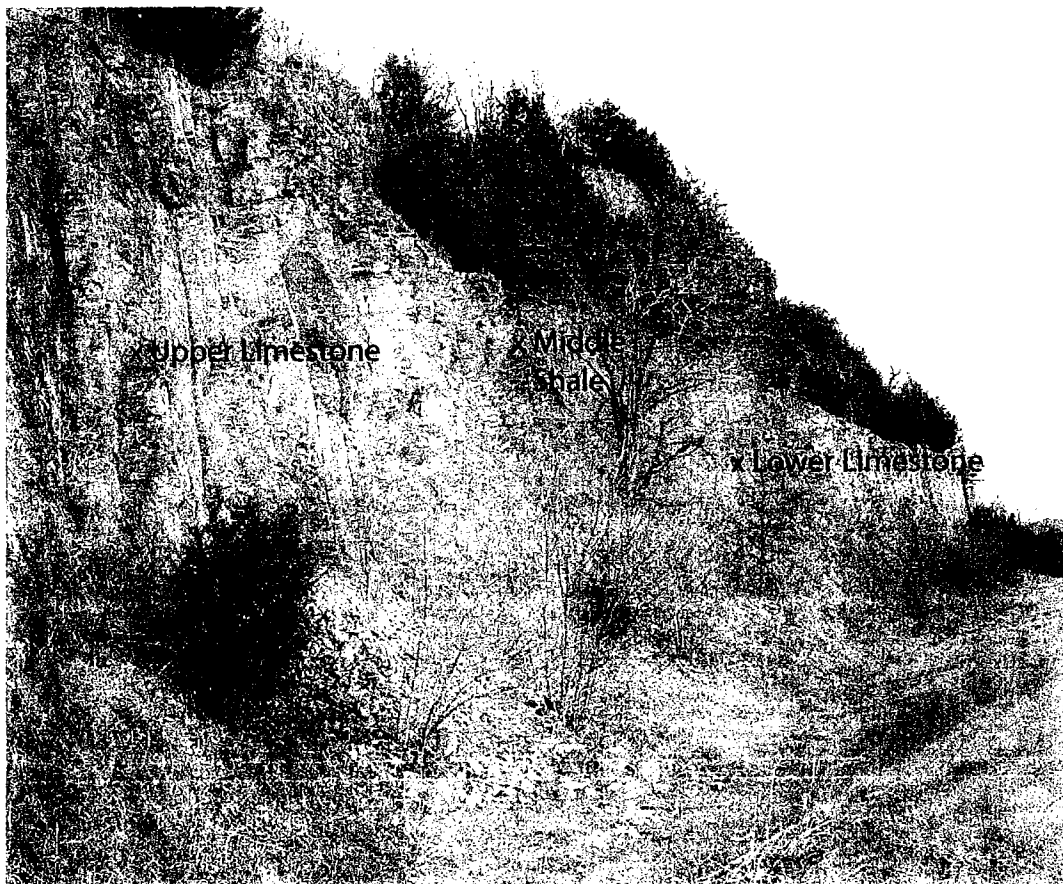
1. Shale and siltstone, gray to greenish gray, pyretic, glauconitic near middle Thin-bedded, platy, moderately to weakly indurated, with many phosphate nodules (1-2") in basal 2 ft	6.0'
--	------



Sycamore North Flank I-35  
Phosphatic Nodules in Middle Shale Member

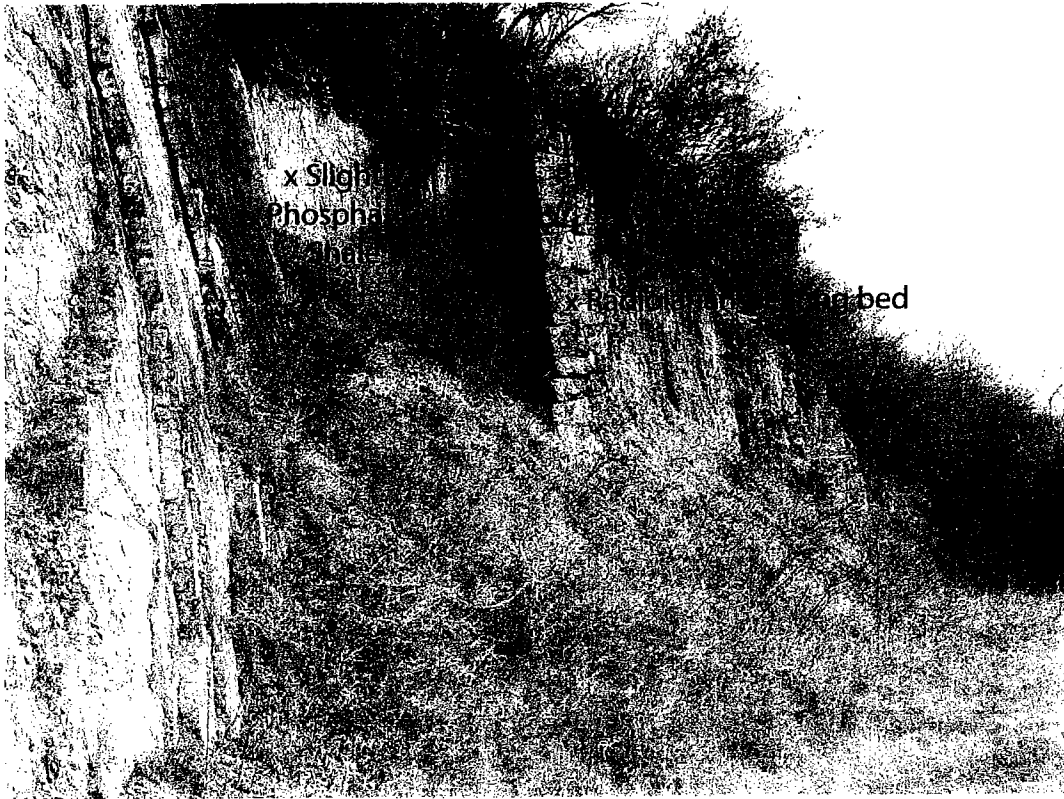


Sycamore North Flank I-35  
Lower Limestone Member/Middle Shale/Upper Limestone Member





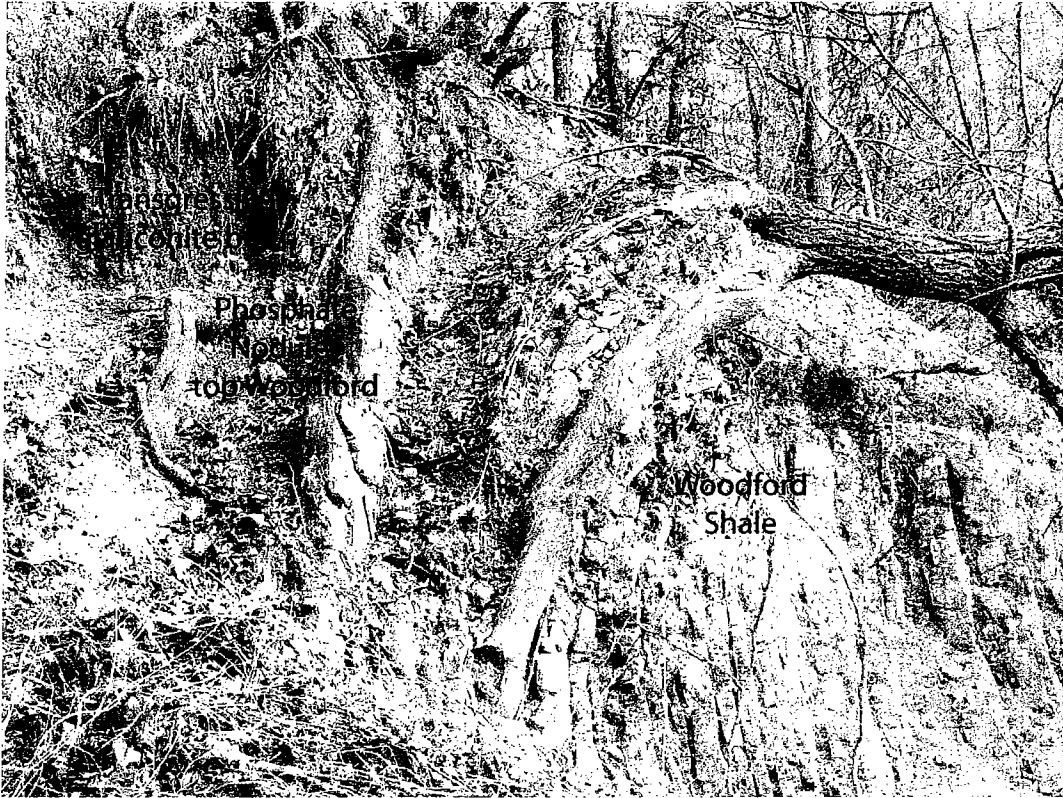
Sycamore North Flank I-35  
Transitional beds



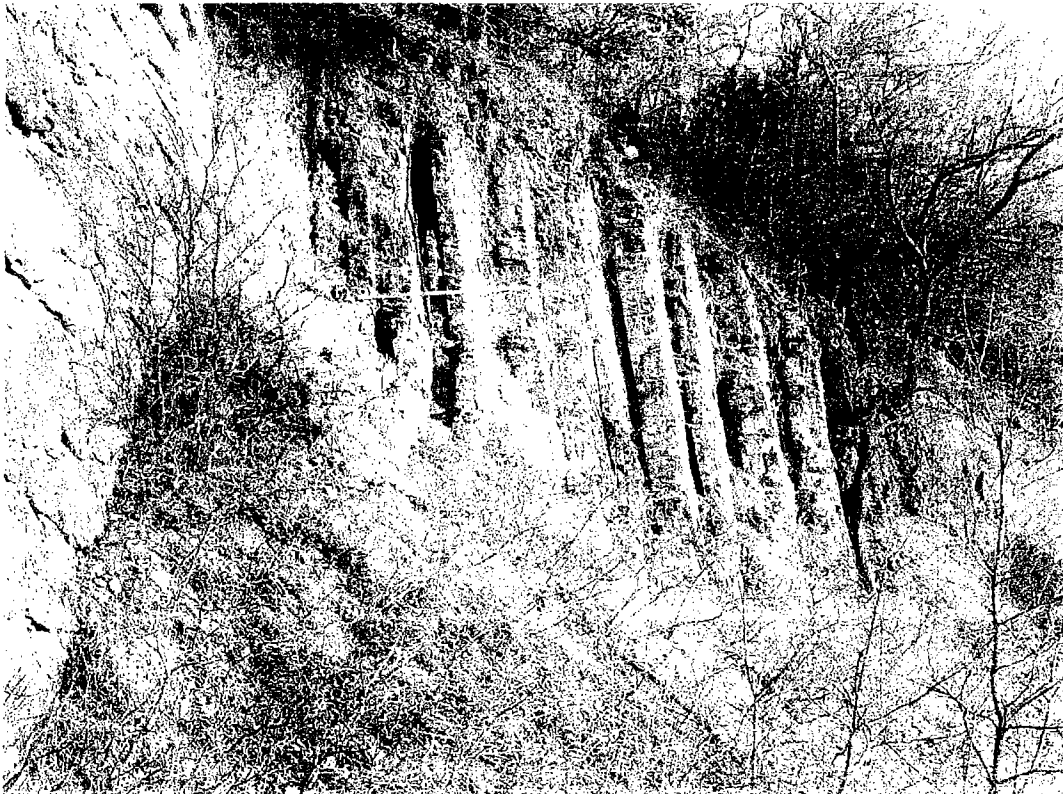
Sycamore North Flank I-35  
Lower Limestone/Middle Shale/Upper Limestone

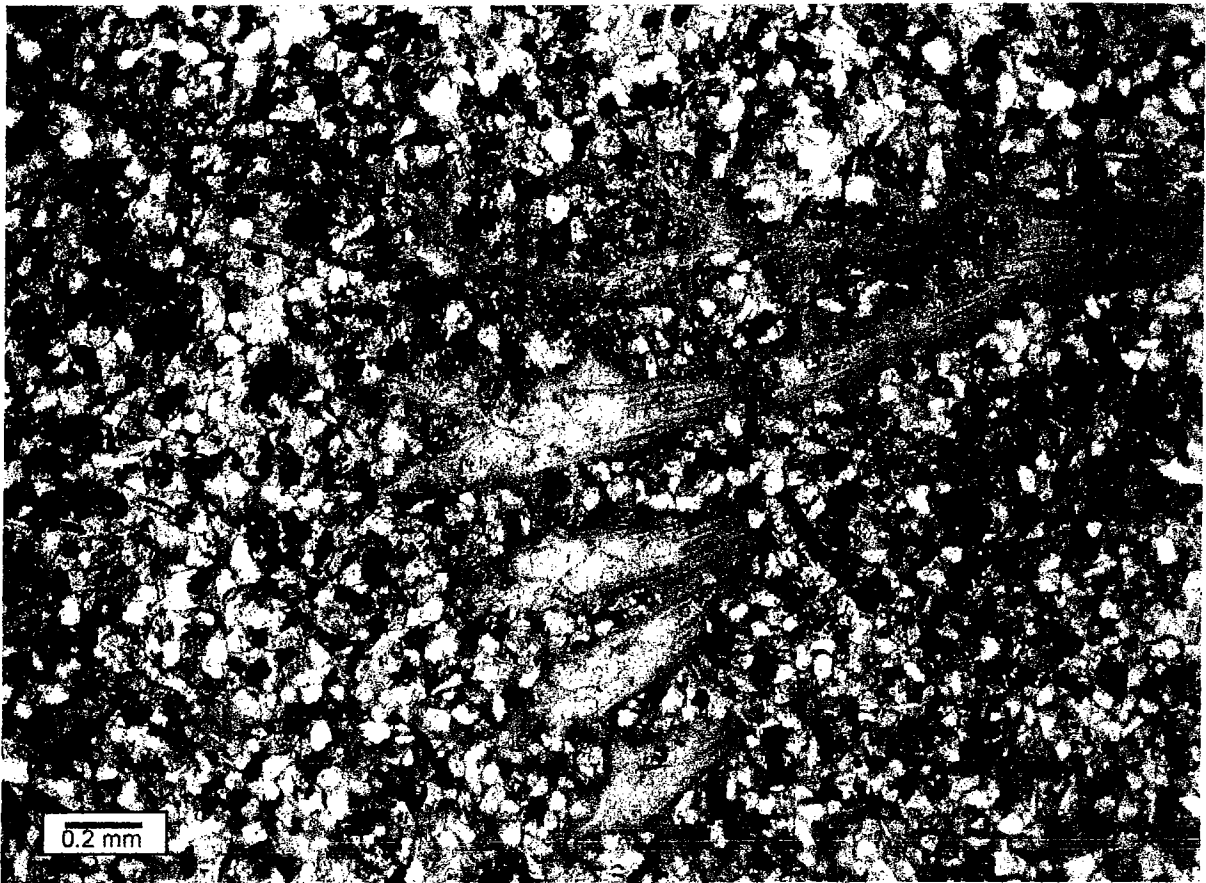


Woodford/Sycamore North Flank I-35

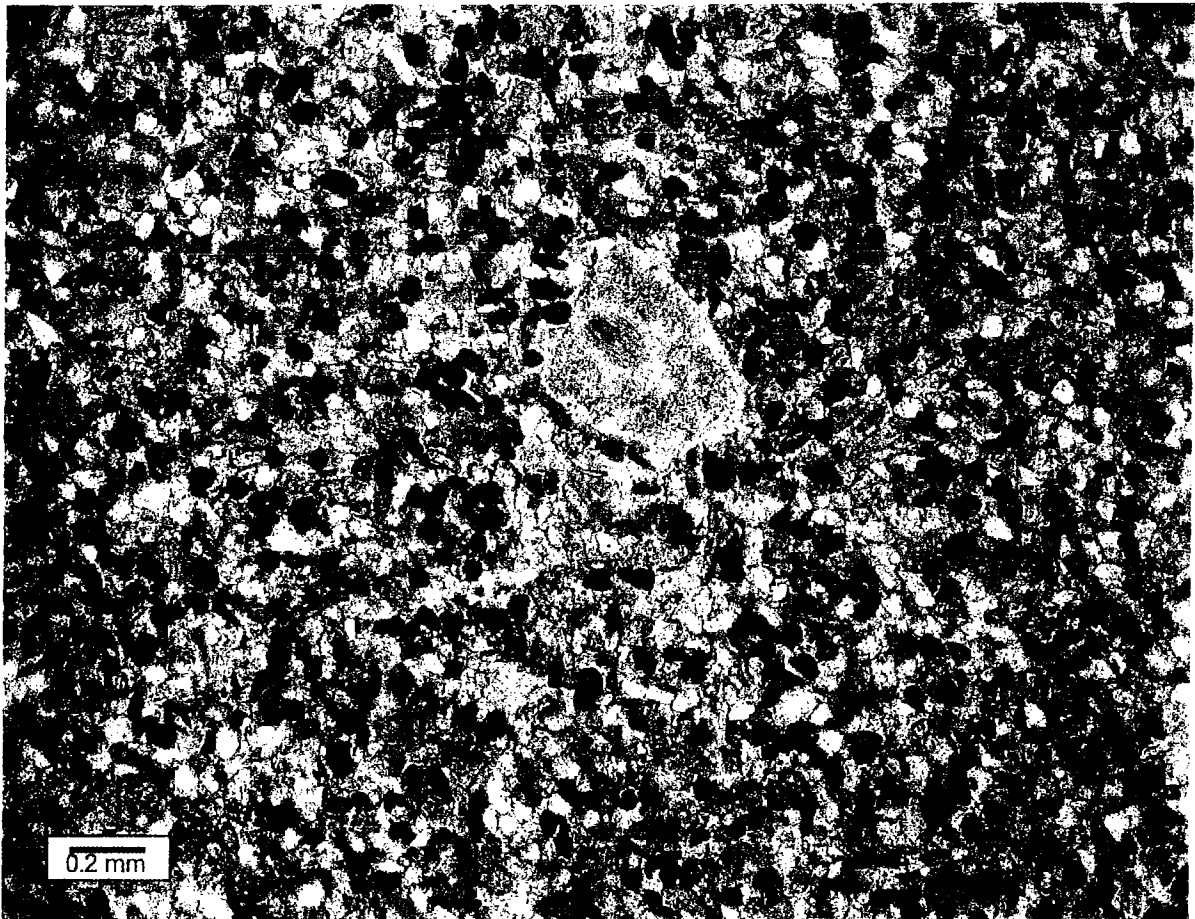


Sycamore North Flank-Transitional Facies

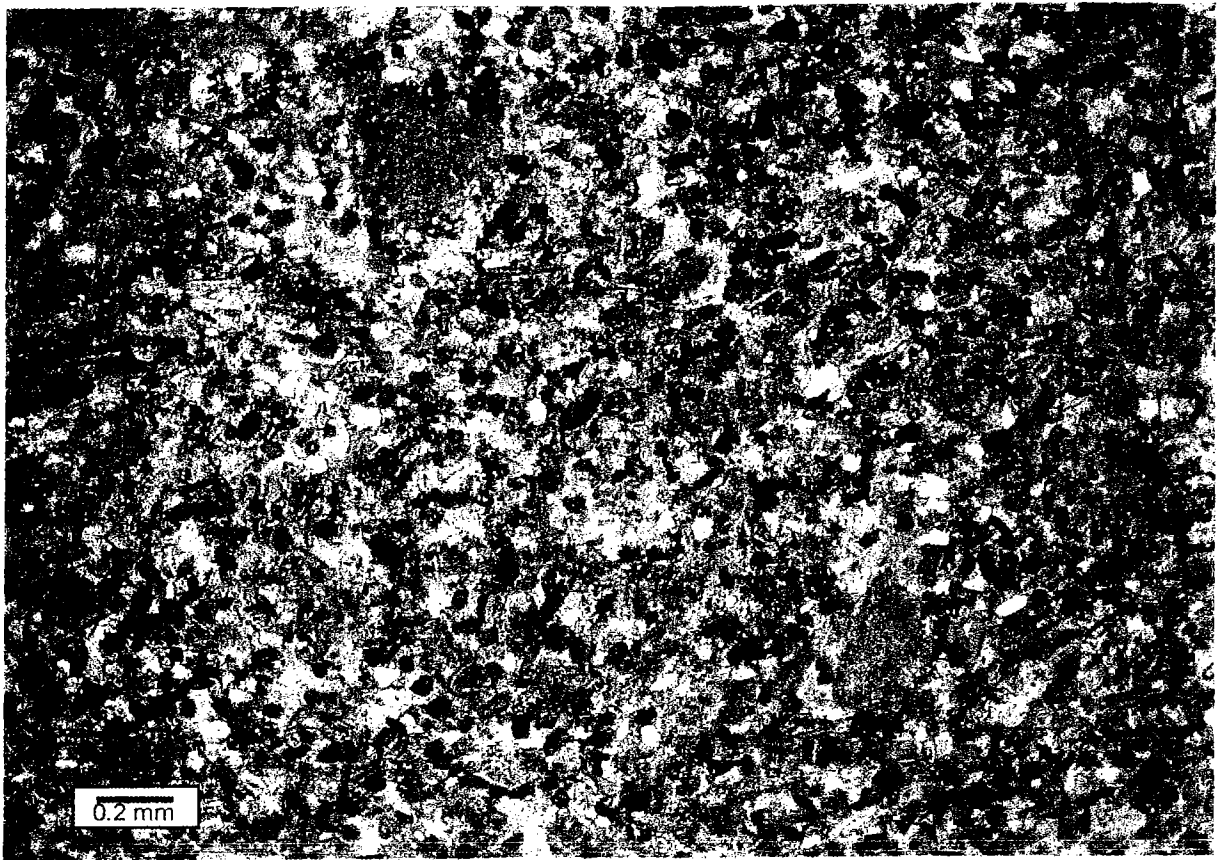




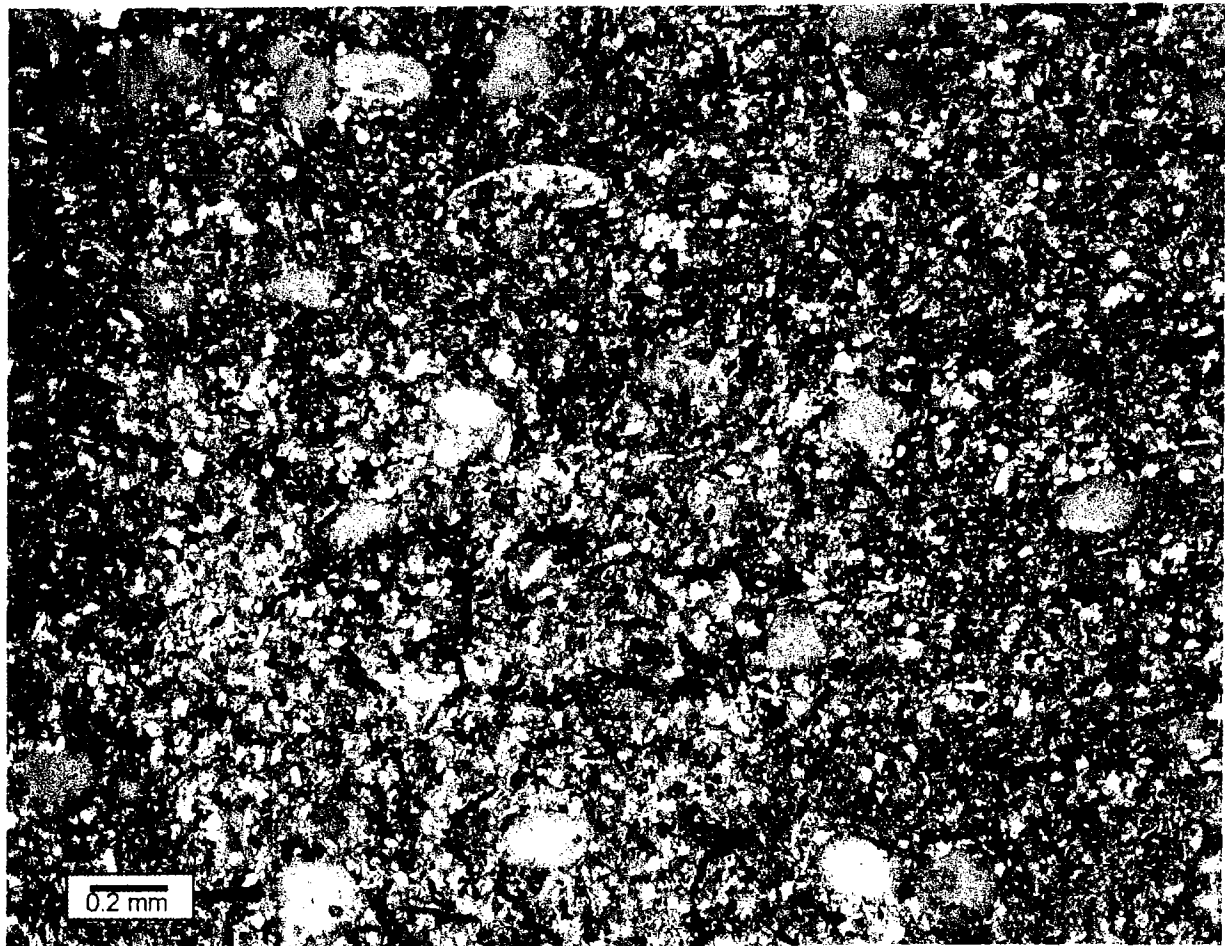
Pelmatozoan, bryozoan, and peloid wackestone-packstone with abundant silt. Sample showing bryozoan fragment. Upper Sycamore limestone (Fay, 1989), north flank of Arbuckle anticline. Plane-polarized light.



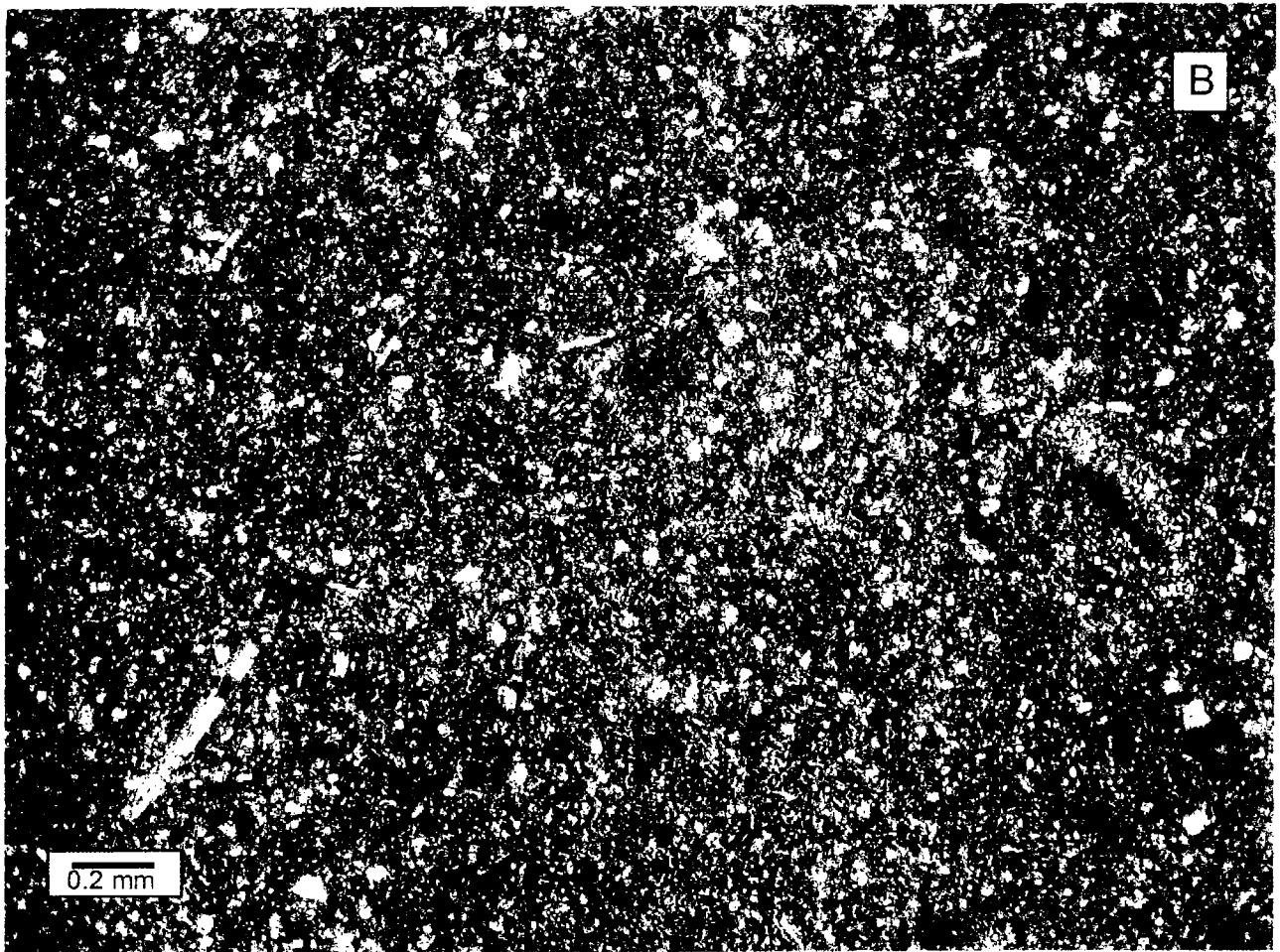
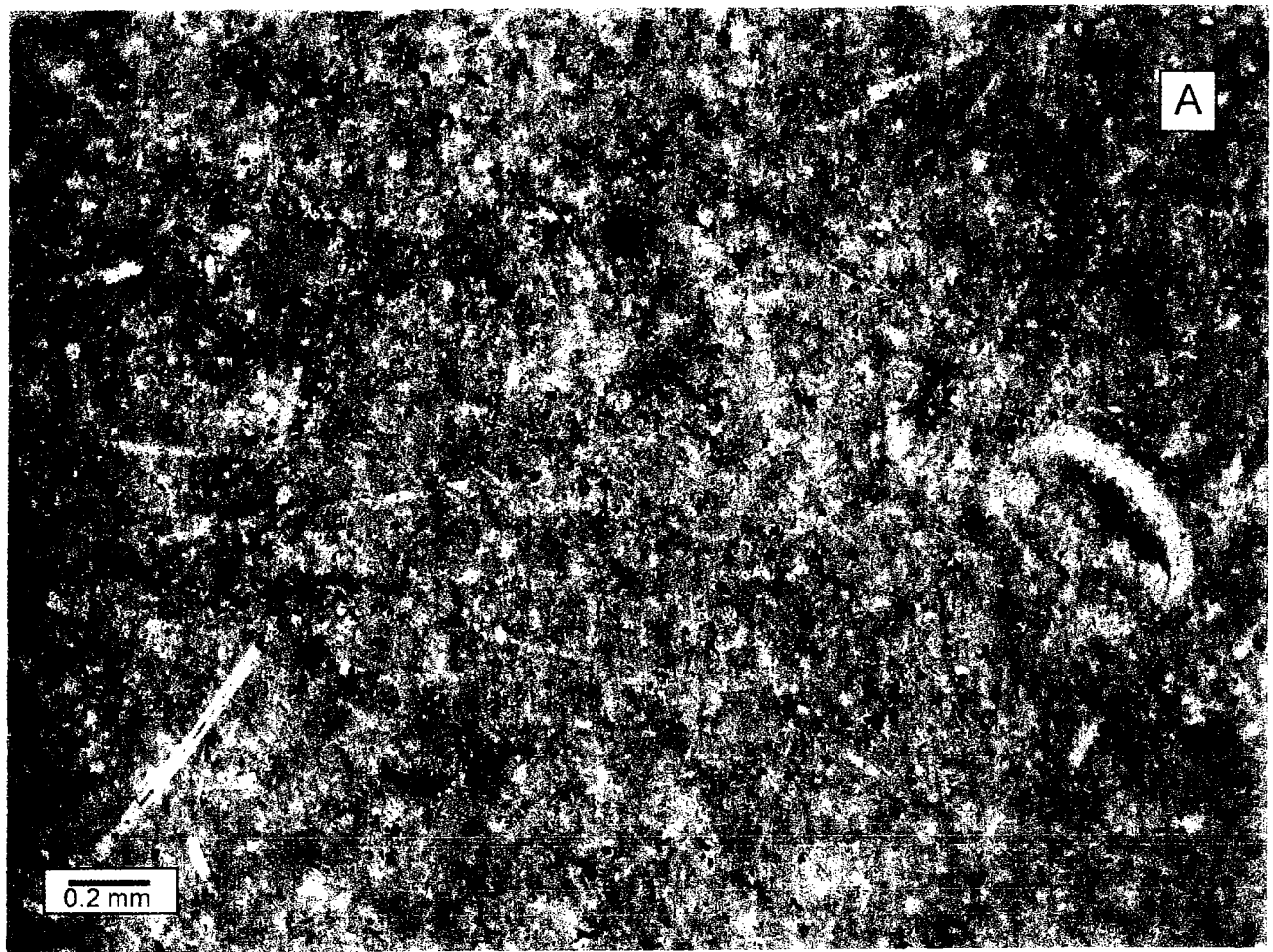
Pelmatozoan fragment, silt and peloids in the upper Sycamore limestone (Fay, 1989). North flank of the Arbuckle anticline. Plane-polarized light.



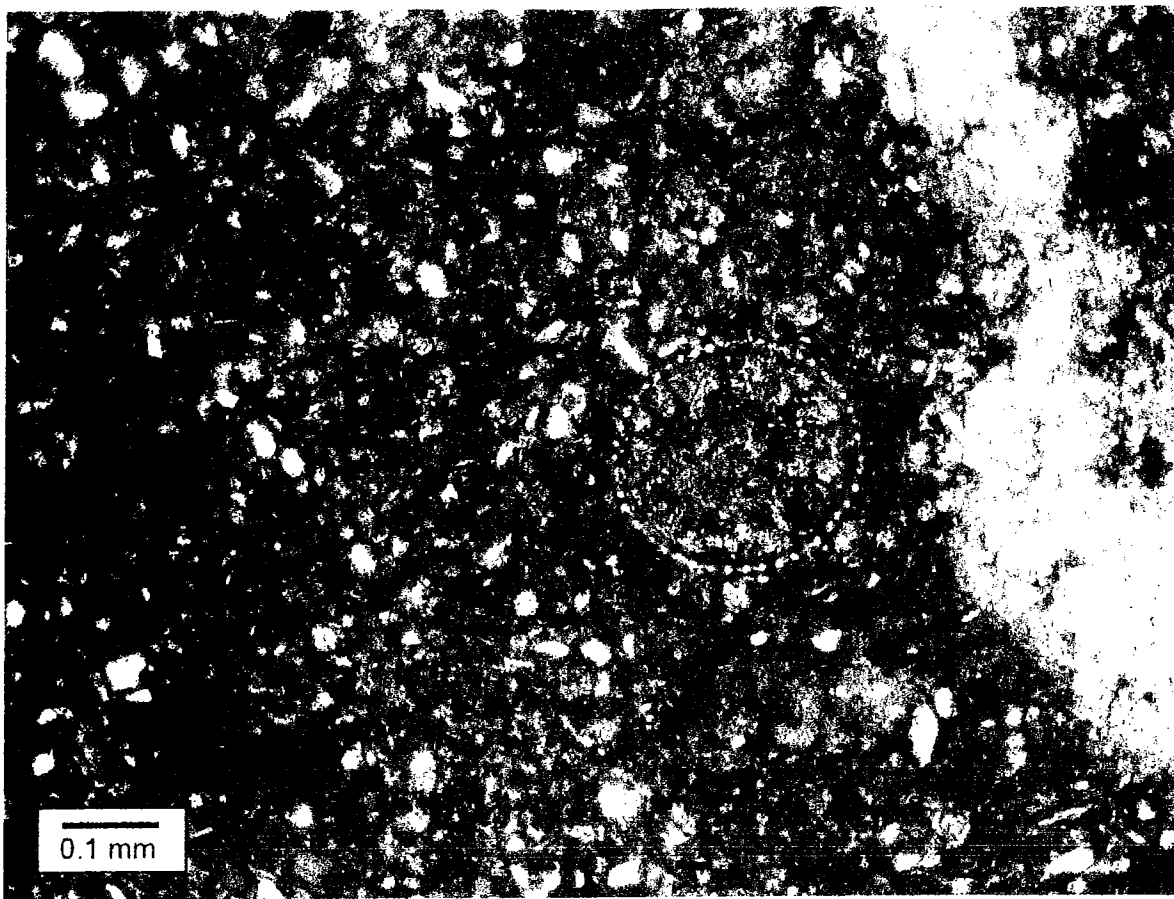
Pelmatozoan grains, silt and spicules in carbonate matrix. Upper part of lower Sycamore limestone (bed 12 of Fay, 1989), north flank of the Arbuckle anticline. Cross-polarized light.



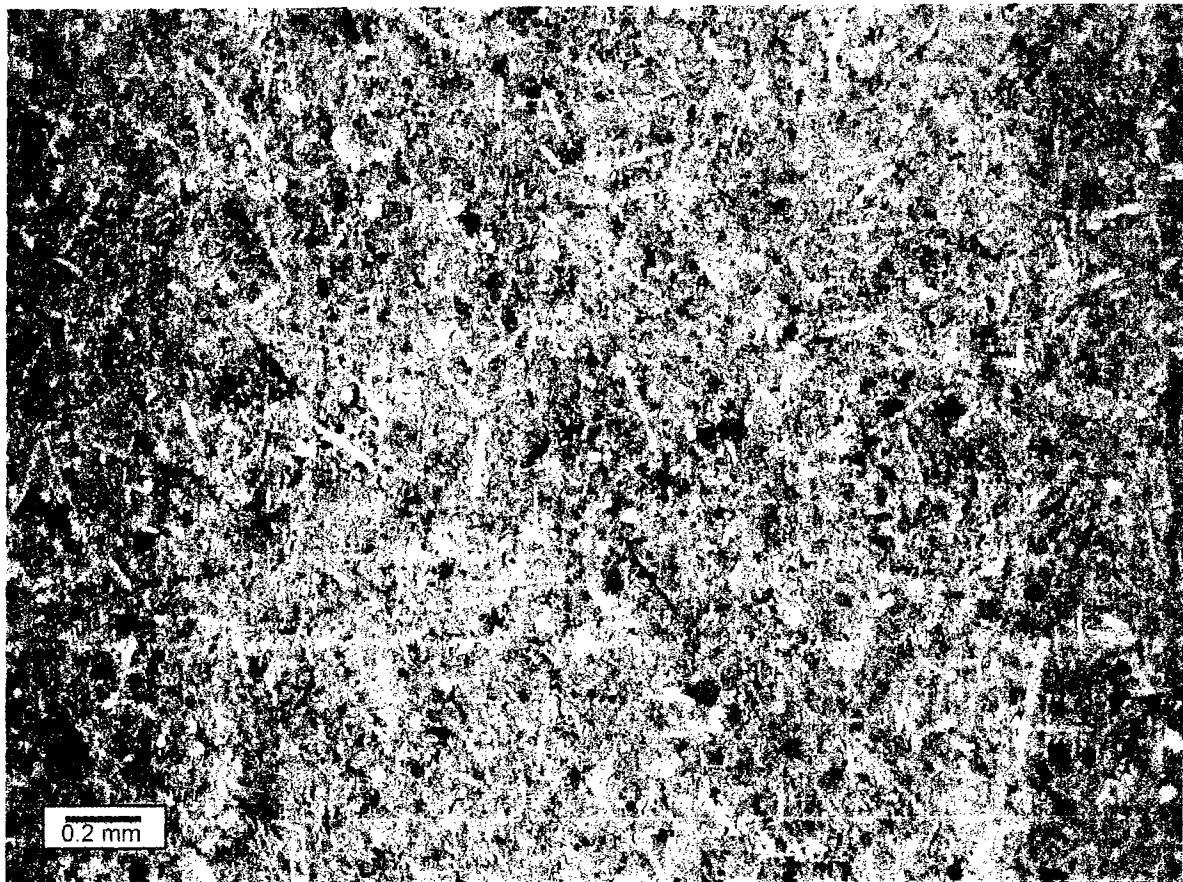
Glauconite (greenish-brown) rich, silty wackestone with ostracode fragments and spicules. lower Sycamore limestone (bed 20, Fay, 1989), north flank of Arbuckle anticline. White centers of glauconite grains are silica replacement. PPL.



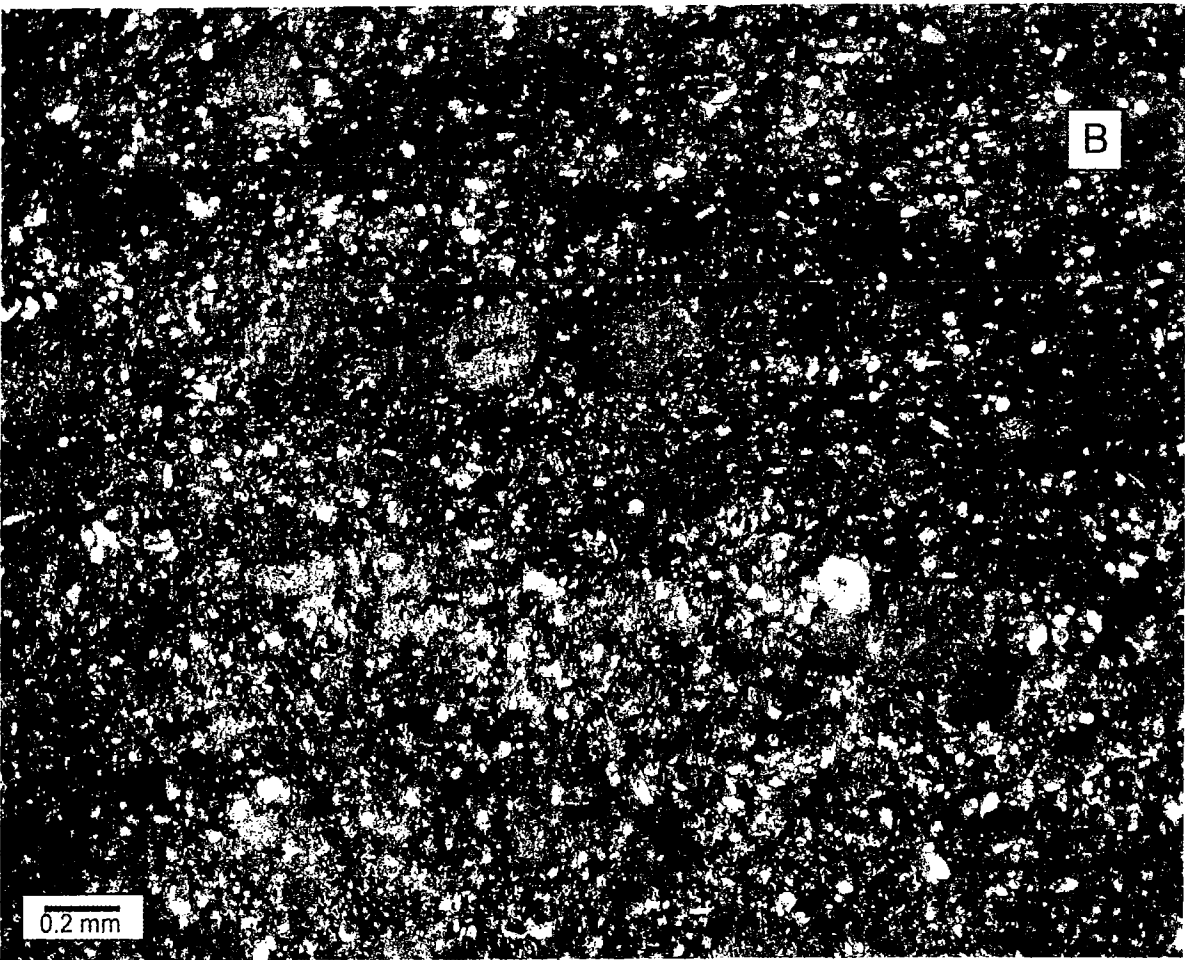
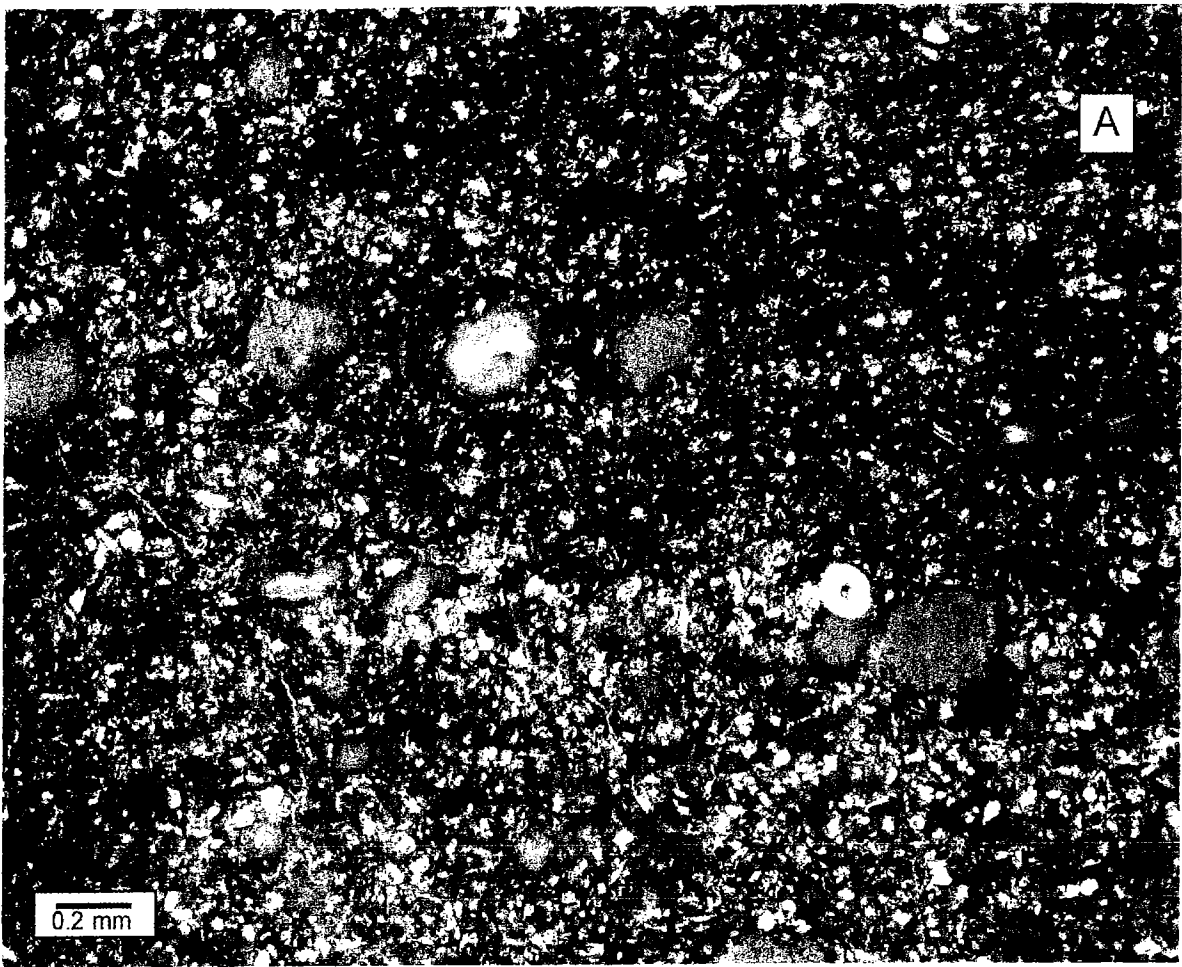
Silicified bioclasts and matrix, lower Sycamore limestone (bed 22 of Fay, 1989).  
A. Plane-polarized light. B. Cross-polarized light.



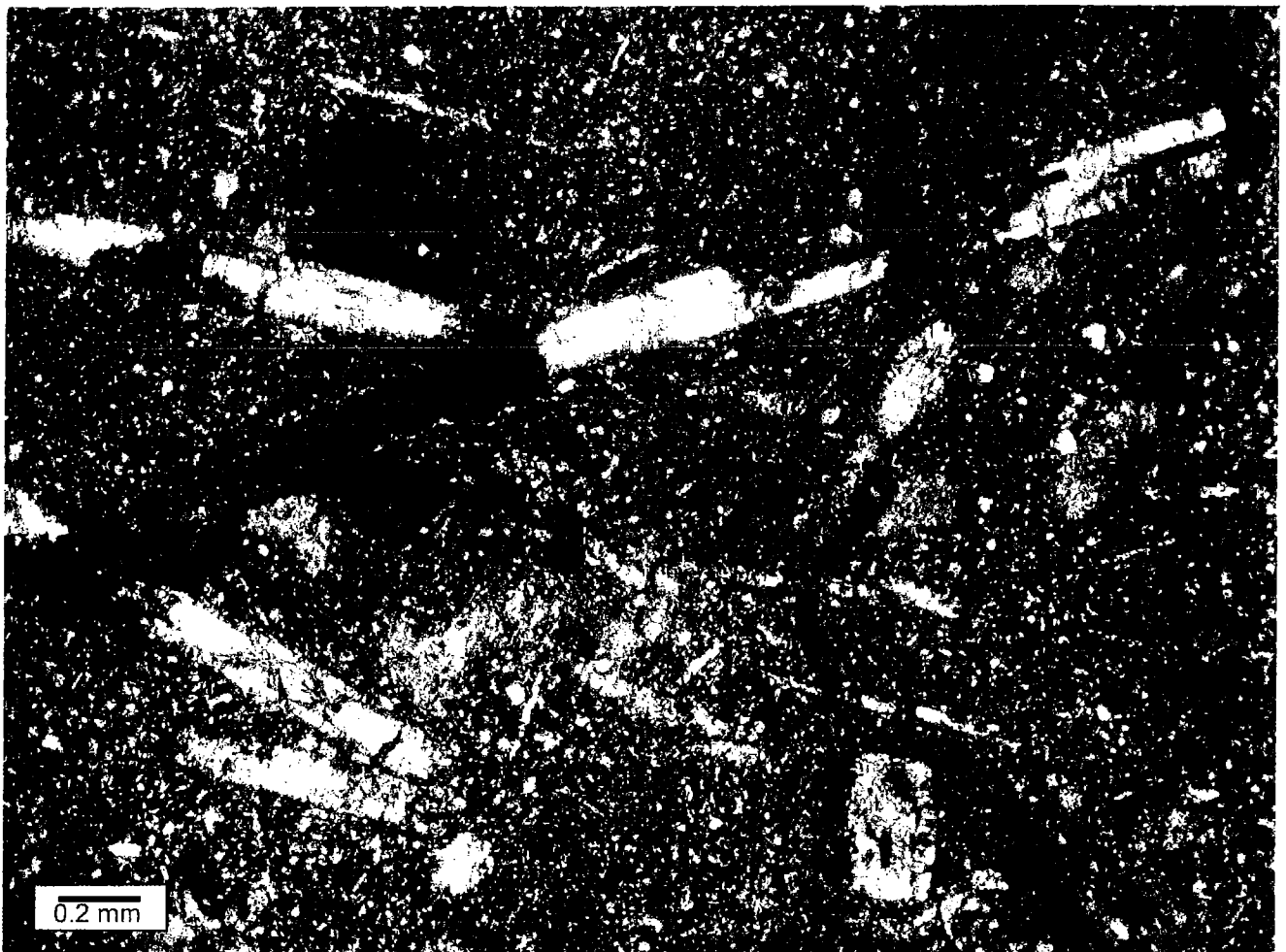
Radiolarian test in Sycamore limestone transition zone (bed 24, Fay, 1989), north flank of Arbuckle anticline. Plane-polarized light.



Photomicrograph of sample from spicular bed near the base of the Sycamore Limestone, north flank of Arbuckle anticline. Blue-stained epoxy fills pores. Silt is not abundant; carbonate is rare. Plane-polarized light.



Glauconite (green) rich, silicified carbonate, lower transition zone (Fay, 1989) Sycamore limestone, north flank of Arbuckle anticline. A. PPL B. CPL



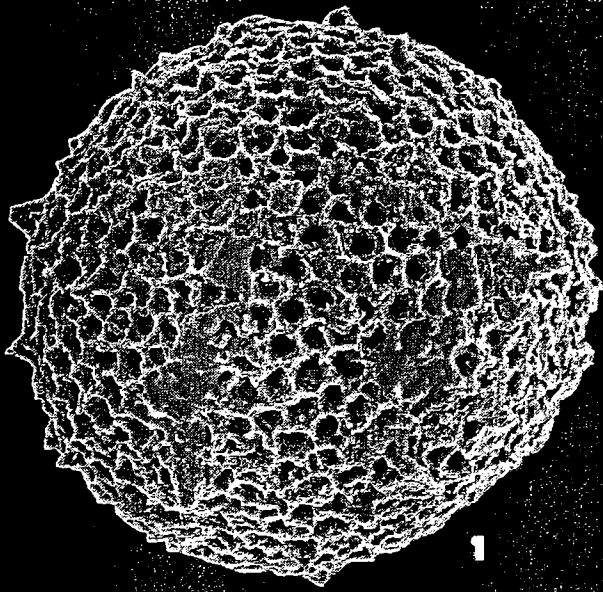
Silicified echinoderm spines, spicules and matrix from bed between the Sycamore limestone base and phosphate-nodule-bearing bed in the Woodford Shale. North flank, Arbuckle anticline. A. PPL B. CPL



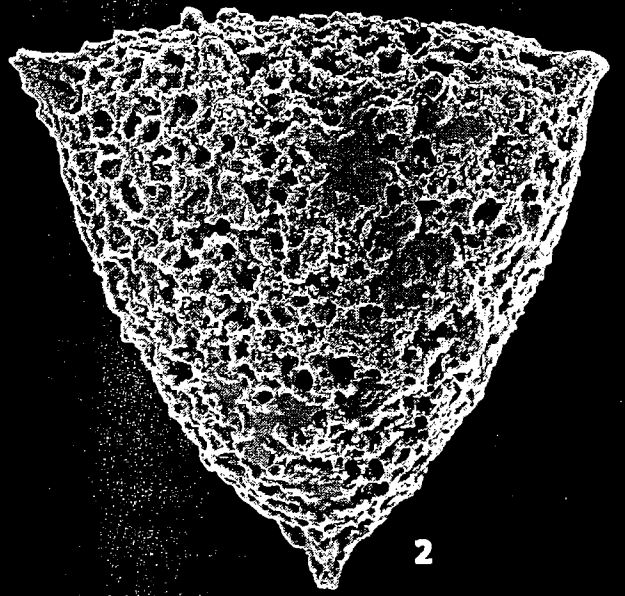
**Plate 10-Sycamore Limestone North Flank (Mississippian-Meramecian)**

Figs. 1-5 Radiolarians

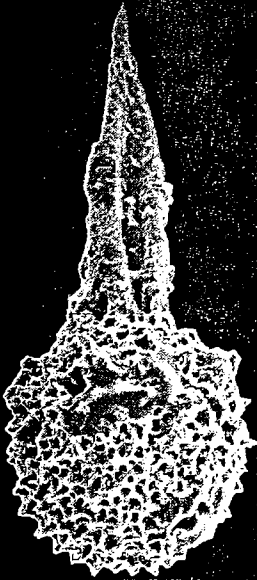
Fig. 6 *Gnathodus texanus*



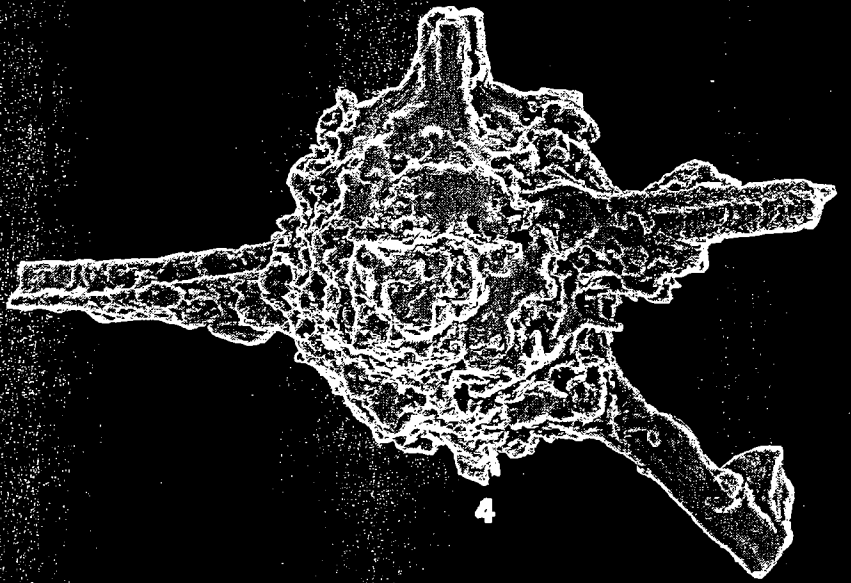
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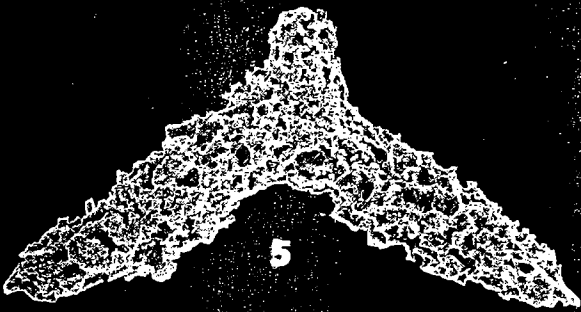
2



3



4



5



6

## Sycamore Limestone Description, South Flank, Arbuckle Anticline

The Sycamore Limestone is 358 ft thick as measured by Fay (1969, 1989) along the west side of the southbound (west) land of Interstate 35. Fay (1989) subdivided the Sycamore into six major intervals: upper limestone, upper shale, middle limestone, middle shale, lower limestone and lower transition zone. The following description is from Fay (1989).

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

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; jointed, 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 to 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
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 feet above base; gradational into siltstone; eroding into a massive ledge, forming base of upper limestone sequence . . . . . 8.4

**Upper shale (72 feet 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 . . . . . 11.0

**Middle limestone (119 ft thick)**

- 23. Limestone, gray, fine-grained, argillaceous, silty, massive, well-indurated; weathering tan, eroding into an escarpment . . . . . 5.0
- 24. Shale, black to dark-gray, silty, calcitic, platy to blocky, weakly indurated; clayey in top 4 inches . . . . . 1.4
- 25. Limestone, gray to dark-gray, fine-grained, argillaceous, silty, platy to blocky, moderately to well-indurated with shale seams; eroding into a ledge . . . . . 0.8

26. Limestone, gray, fine-grained, argillaceous, silty, blocky, medium 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 in basal 8 inches . . . . .	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, 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

- 42. Limestone, gray to tan, fine-grained, argillaceous, silty, blocky with three thin gray shale seams; weathering tan, eroding into a ledge . . . . . 4.0
- 43. Shale, gray, calcitic, silty, platy, moderately indurated; weathering greenish gray to tan . . . . . 4.6
- 44. Limestone, gray to tan, fine-grained, silty, massive, well-indurated; weathering tan, eroding into a ledge . . . . . 2.4
- 45. Shale, gray, calcitic, platy, well-indurated; gradational to limestone 0.7

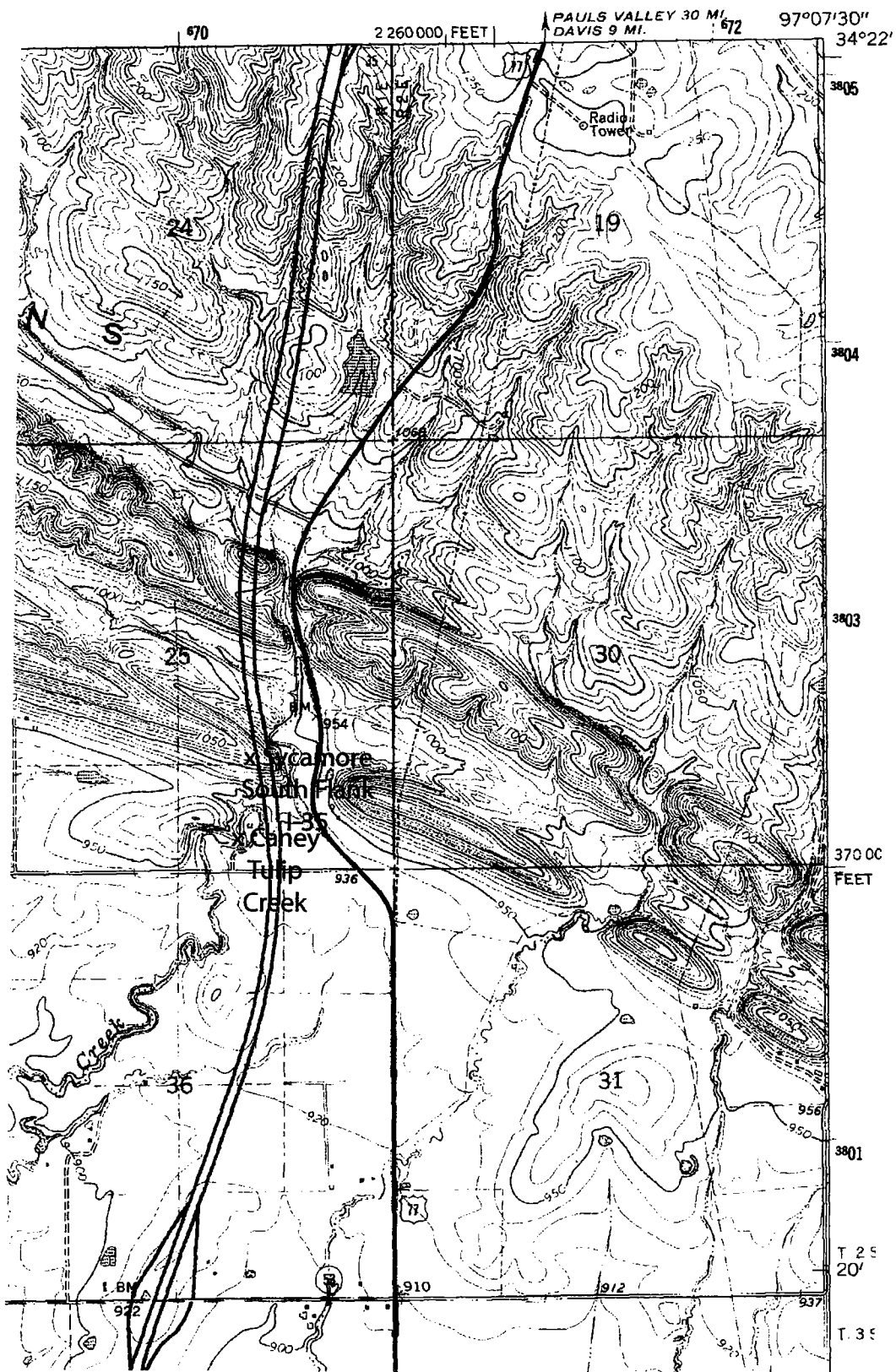
**Lower limestone (25 ft thick)**

- 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
- 47. Shale, gray to dark-gray, calcitic, platy, moderately indurated, even bedded; weathering tan . . . . . 0.8
- 48. Limestone, gray to tan, fine-grained, argillaceous, silty, massive, well-indurated, blocky; weathering tan, mappable escarpment . . . . . 1.6

**Lower transition zone (69 ft thick)**

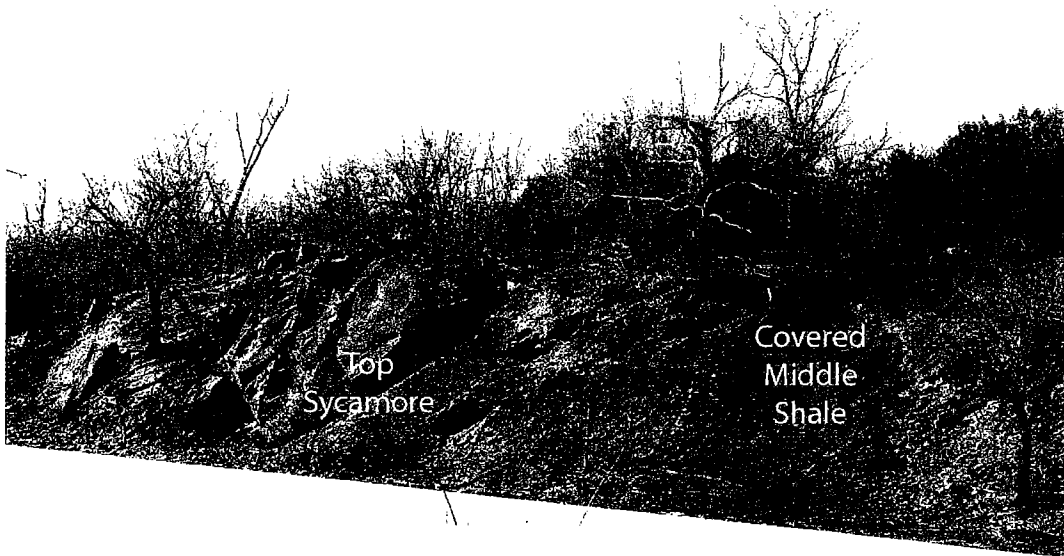
- 49. Shale, gray, calcitic, platy to blocky, moderately indurated; weathering tan to greenish gray . . . . . 7.0
- 50. Limestone, gray to tan, fine-grained, argillaceous, well-indurated, even bedded, medium-bedded, in three layers with interbedded shale; weathering greenish-gray to orange brown . . . . . 2.0
- 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
- 52. Shale, gray, calcitic, platy, thin-bedded, moderately to weakly indurated, with some limestone beds near base; weathering greenish gray to tan . . . . . 7.3
- 53. Shale, gray, calcitic, platy, weakly indurated; weathering greenish gray 2.3
- 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
56. Limestone, gray to tan, fine-grained, argillaceous, silty, well-indurated, even-bedded, medium-bedded; eroding into a ledge . . . . .	3.0
57. Shale, gray, calcitic, thin-bedded, platy, moderately to weakly indurated, even-bedded, with some 2-in. limestone beds at base . . . . .	3.0
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
59. Shale, gray, calcitic, platy, thin-bedded, moderately to weakly indurated . . . . .	1.0
60. Limestone, gray to tan, fine-grained, argillaceous, moderately to well-indurated, with cup corals and brachiopods; eroding into a ledge . . . . .	1.0
61. Shale, gray, calcitic, platy, weakly indurated, fossiliferous, with above noted corals; weathering greenish gray; base of dark-gray shale and limestone sequence . . . . .	3.0
62. Shale, light-greenish-gray, calcitic, platy, thin-bedded, weakly indurated ; weathering light-greenish-gray . . . . .	8.6
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
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
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 clay at the base . . . . .	11.4

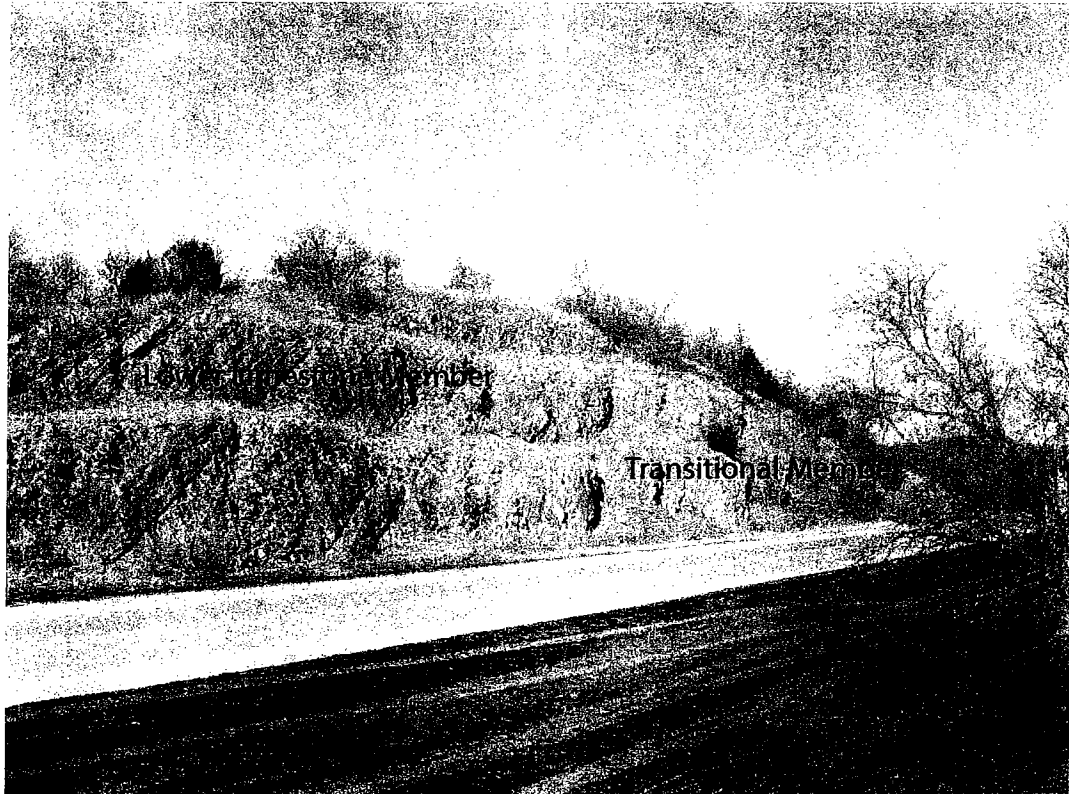




Sycamore South Flank I-35  
Top Sycamore

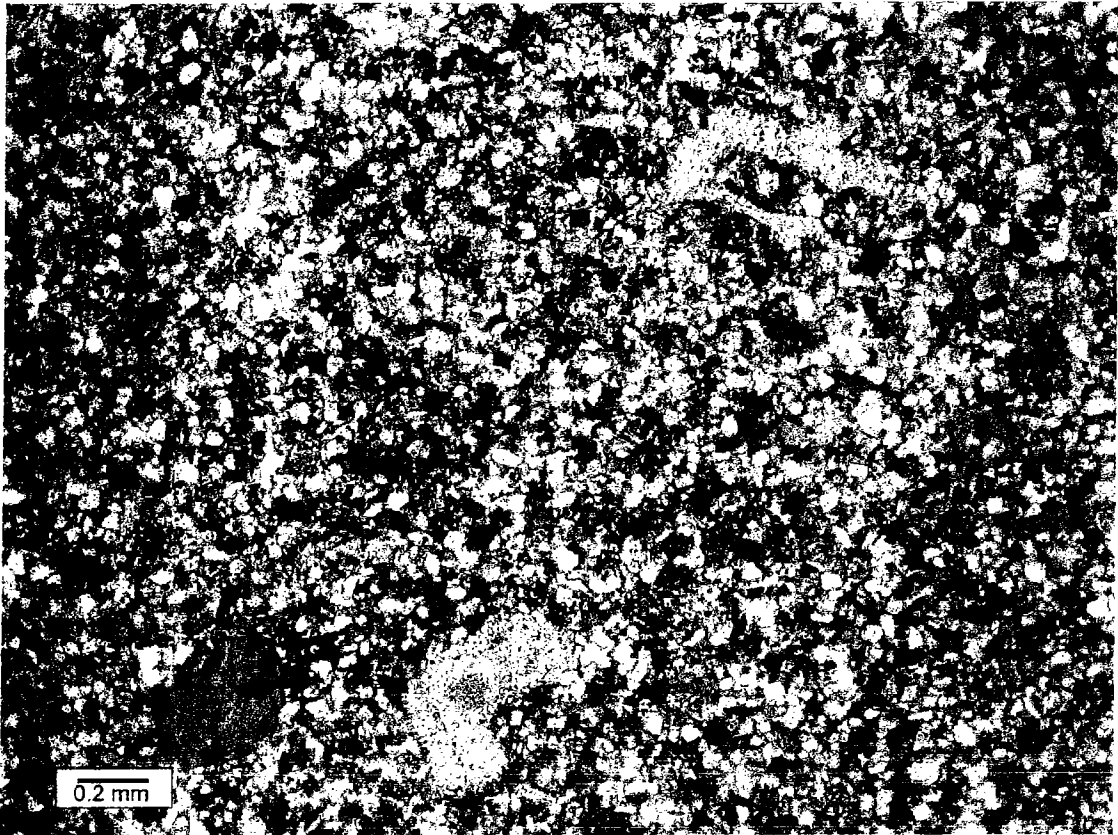


Sycamore South Flank I-35  
Transitional Member/Lower Limestone Member

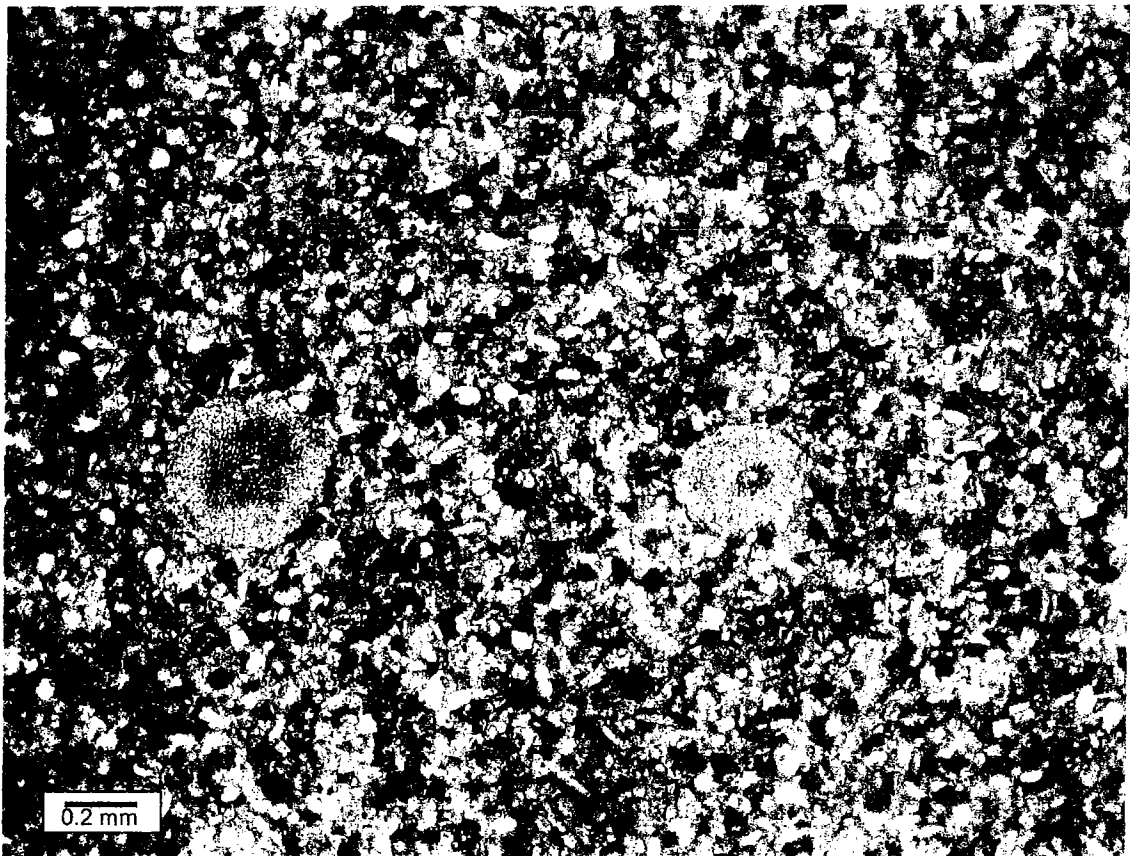


Sycamore South Flank I-35  
Transitional Member

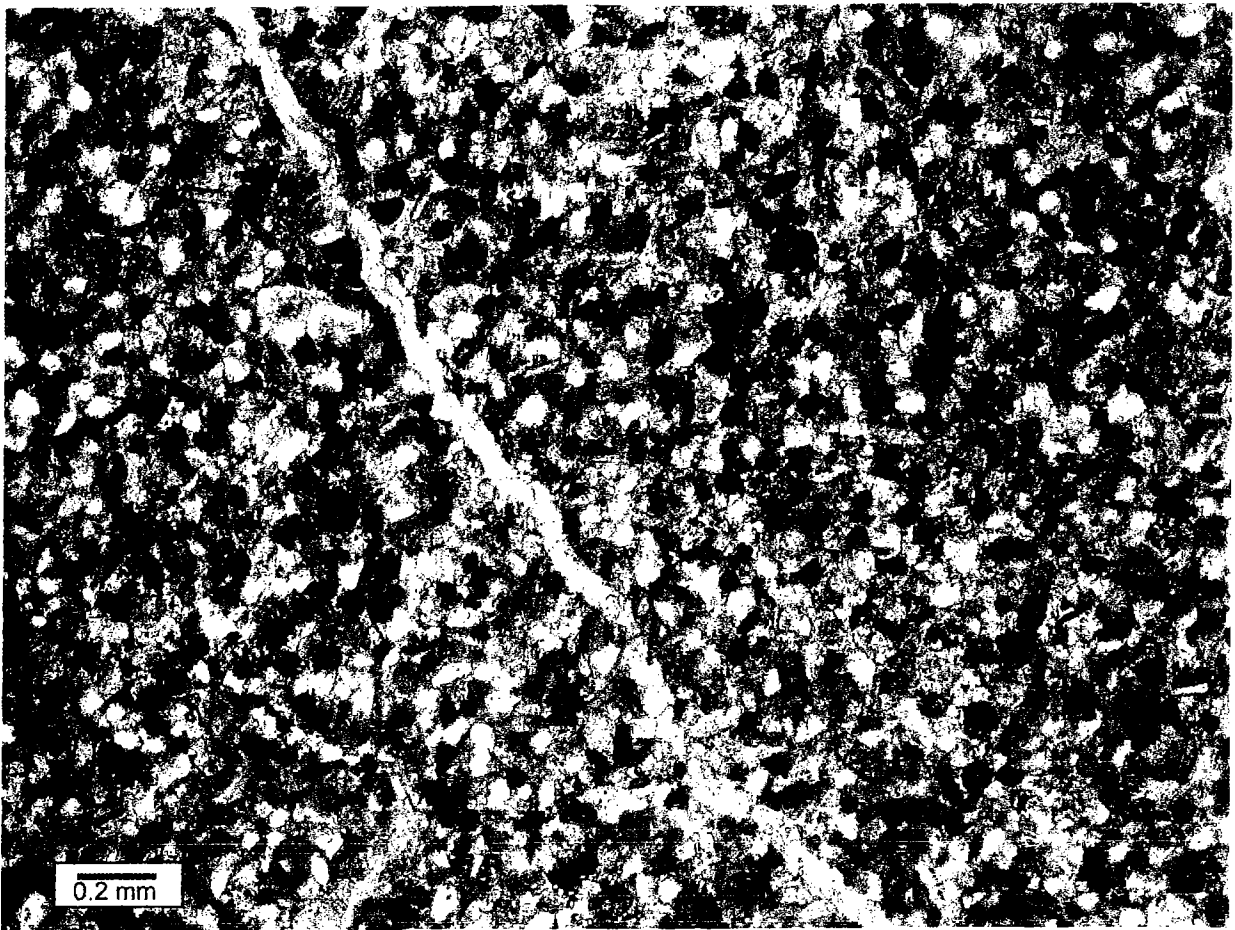




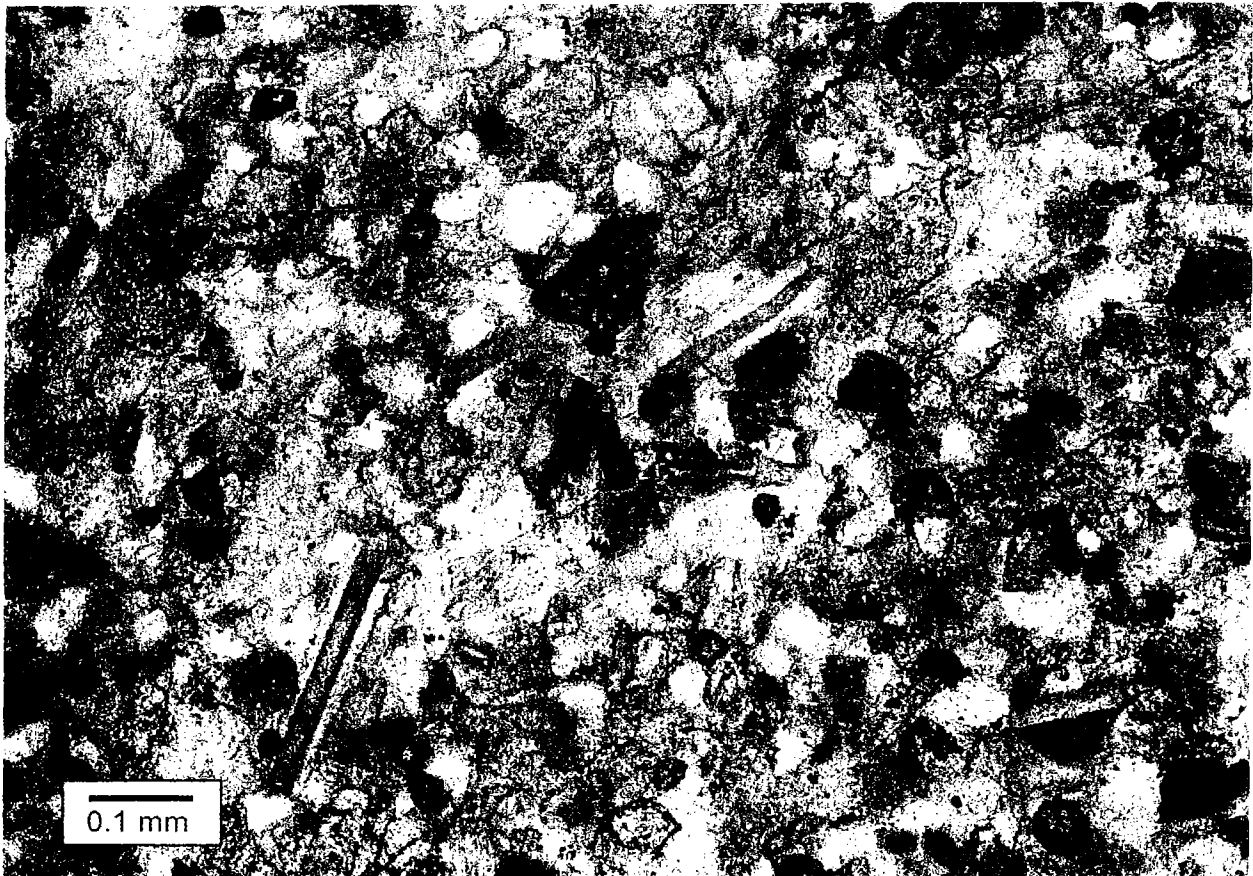
Peloidal, silty and phosphatic pelmatozoan wackestone, upper Sycamore limestone (bed 5, Fay, 1989), south flank of the Arbuckle anticline. Plane-polarized light.



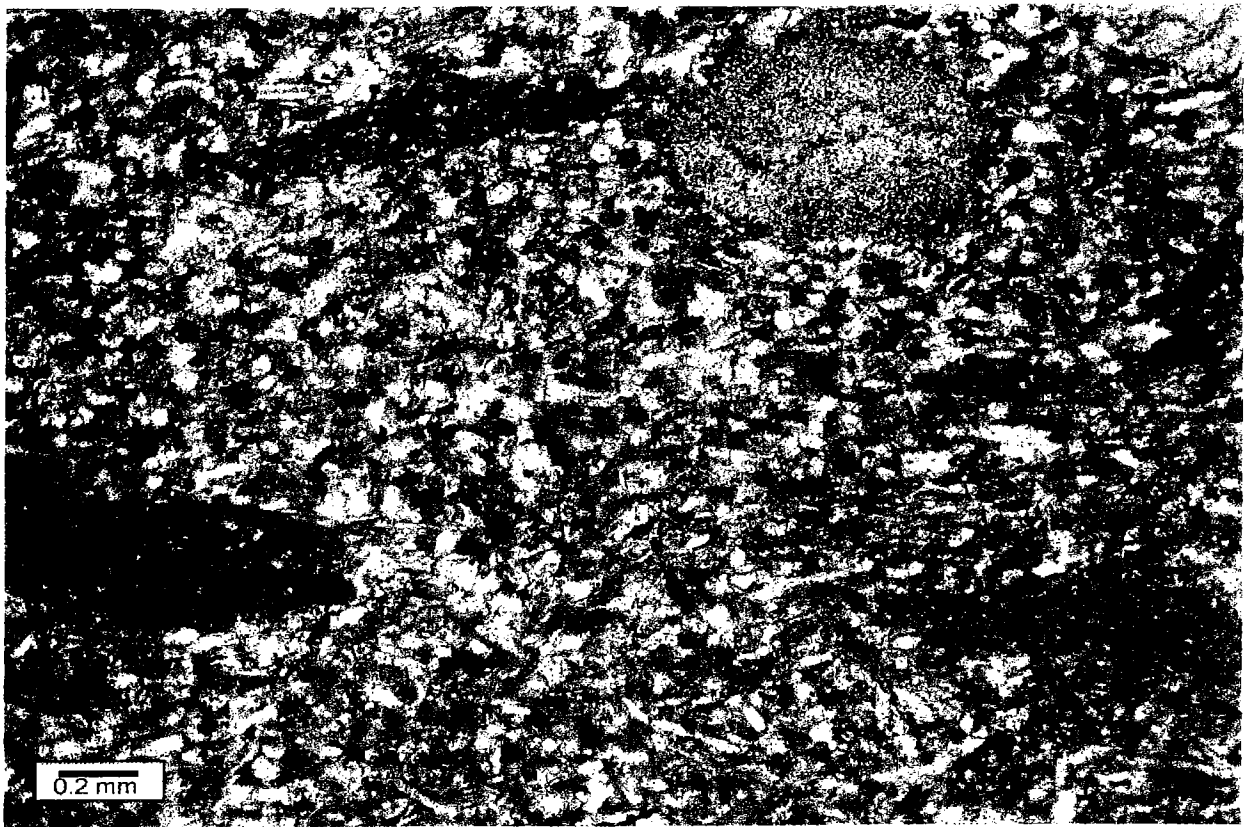
Pelmatozoan fragments, upper Sycamore limestone (bed 5, Fay, 1989). Pellets (dark) and silt (light colored) are abundant. Plane-polarized light.



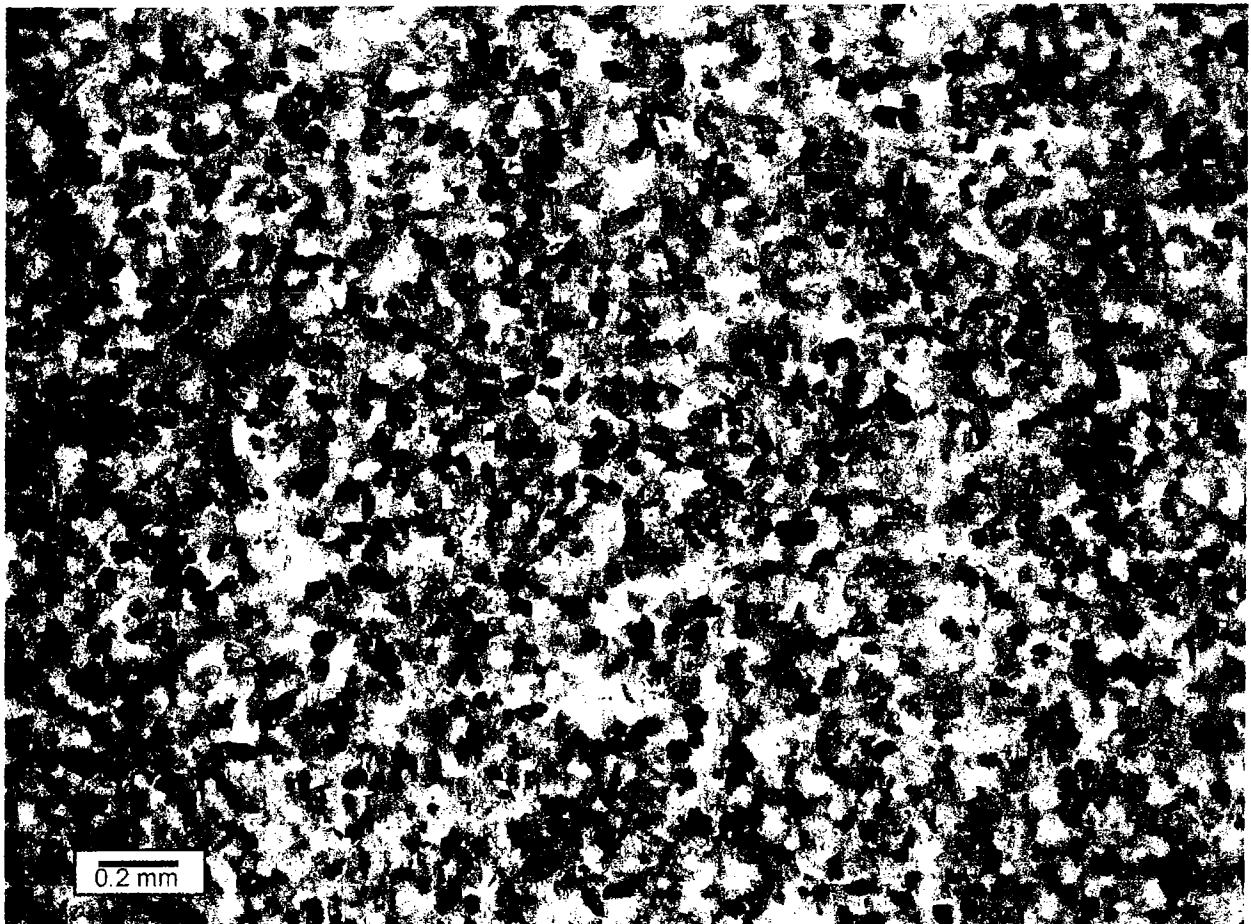
Pellet-rich and silty limestone with healed fracture. Top of middle Sycamore limestone (bed 23 of Fay, 1989) on south flank of Arbuckle anticline. Plane-polarized light.



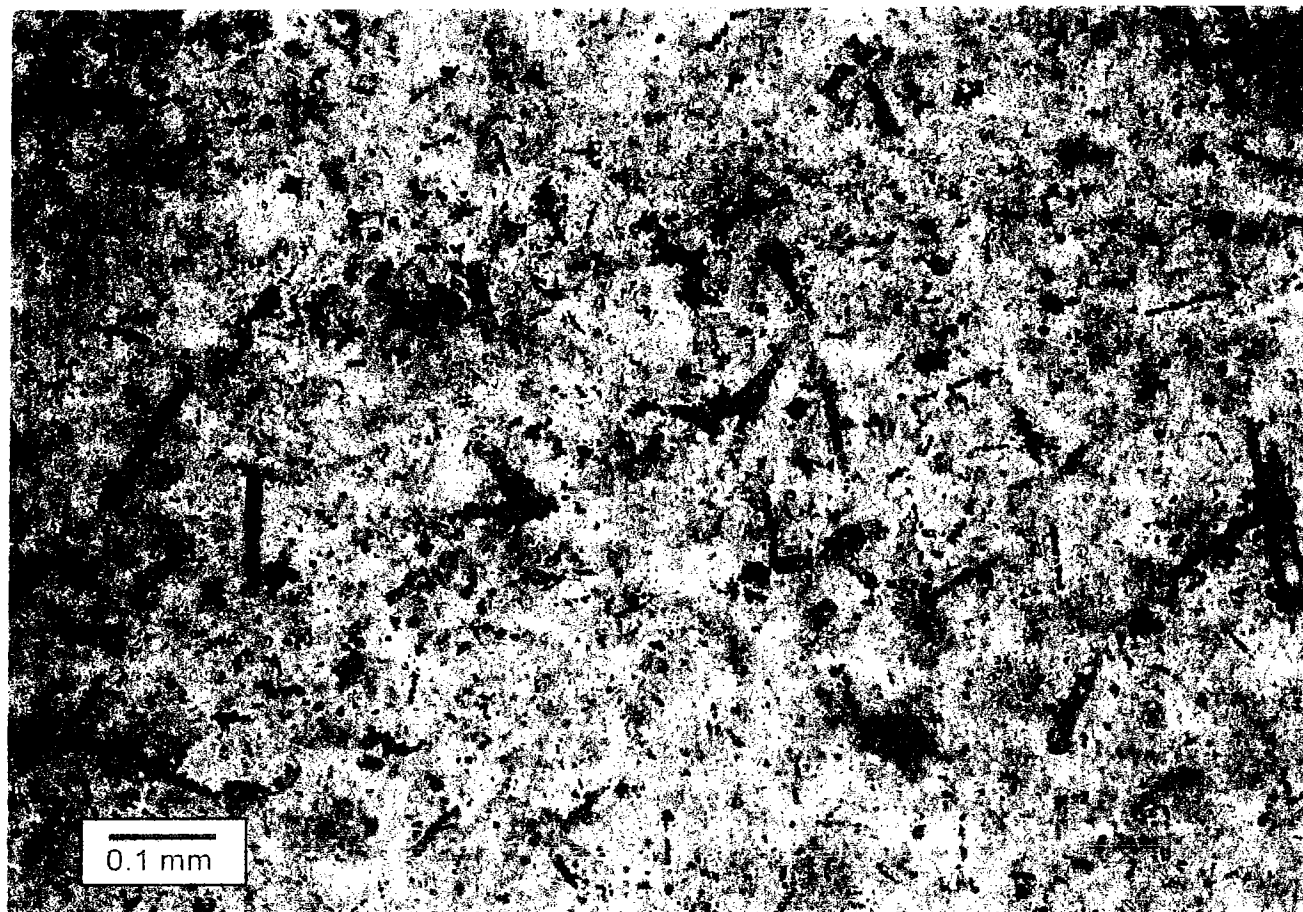
Coarse silt, pellets and echinoid spines in carbonate matrix in bed at top of middle Sycamore limestone (bed 26, Fay, 1989). South flank, Arbuckle anticline. PPL



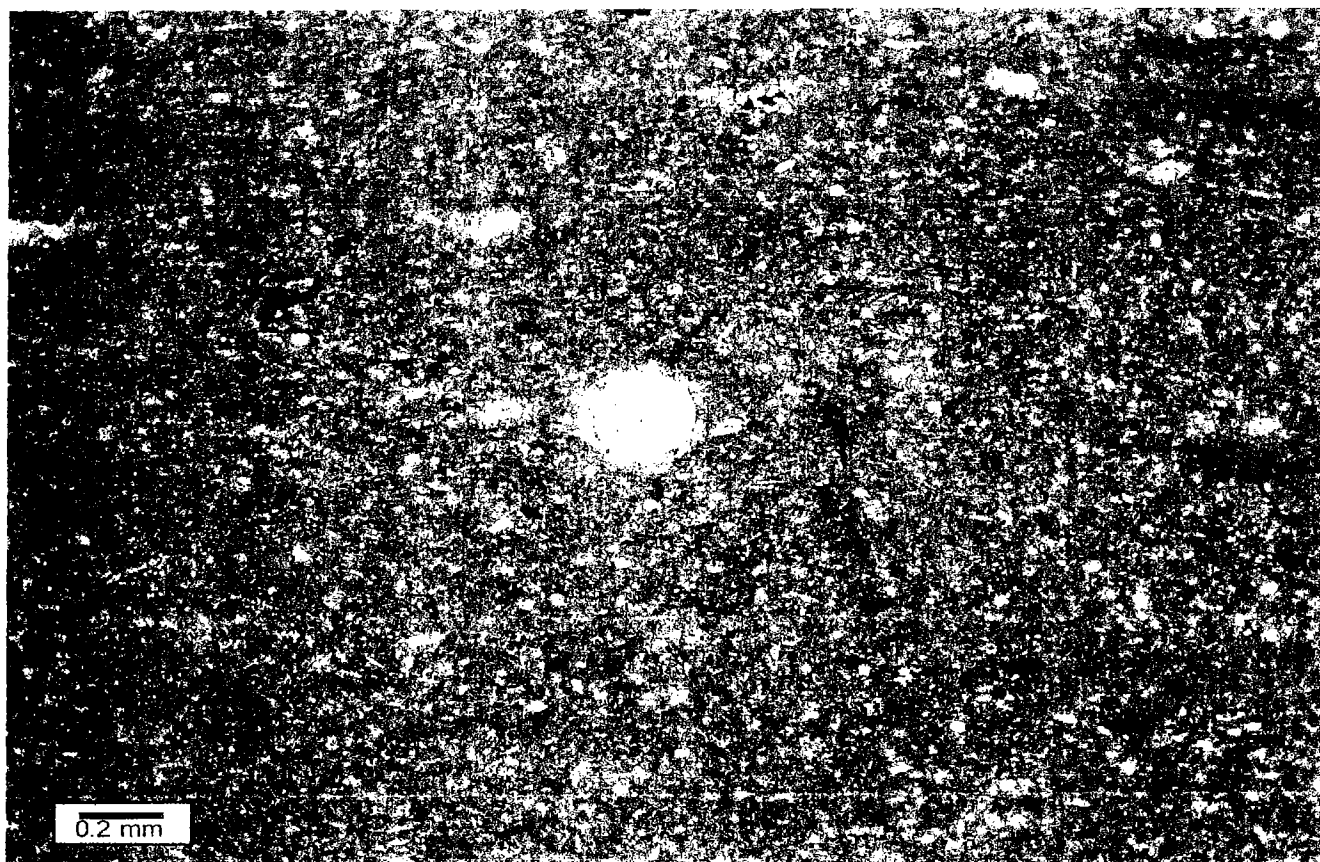
Clay clasts, pelmatozoan fragments, peloids, silt and small bioclasts exhibiting grain alignment. Middle Sycamore limestone (bed 36 of Fay, 1989), south flank, Arbuckle anticline. Plane-polarized light (PPL).



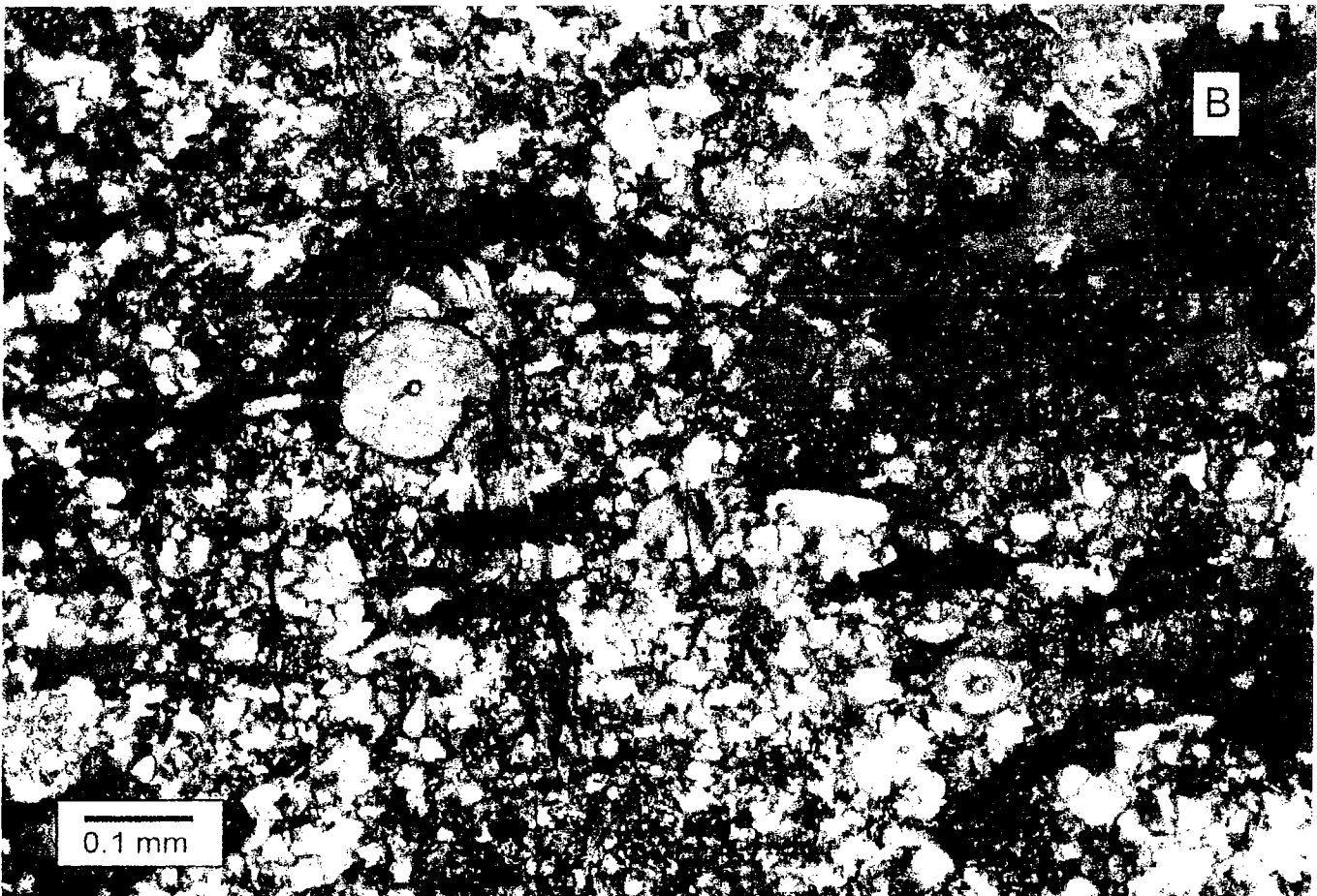
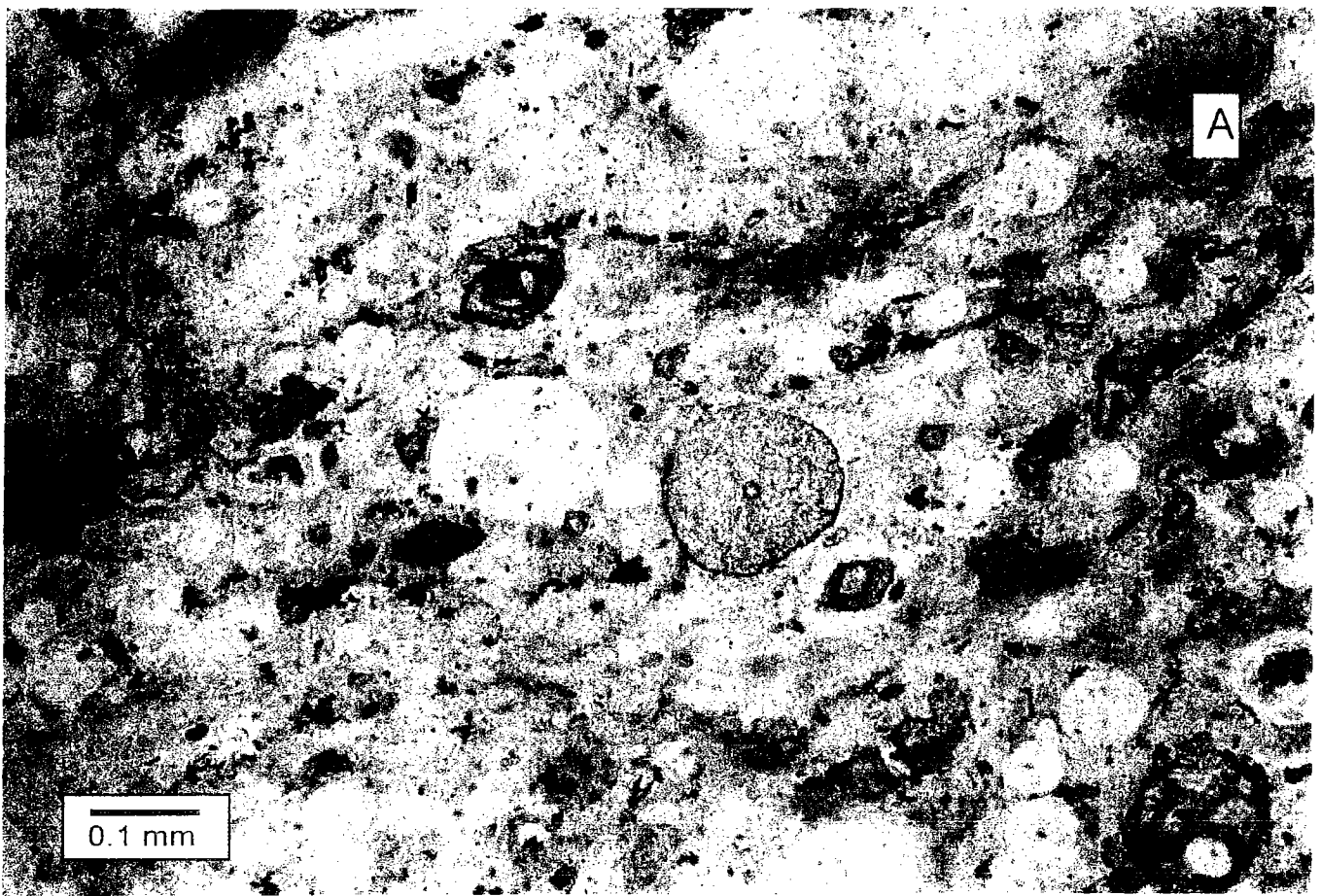
Photomicrograph of silty, peloidal wackestone-packstone. Sample is from thin limestone bed (bed 40, Fay, 1989) in middle shale, Sycamore limestone, south flank of Arbuckle anticline. Plane-polarized light.



Oxidation after replacement of sponge spicules, lower transition zone, Sycamore limestone (bed 50 of Fay, 1989). Light-colored patches indicate silica replacement of carbonate matrix. South flank of Arbuckle anticline. Plane-polarized light.



Radiolarian test in silty mudrock, lower transition zone, Sycamore limestone (bed 59 of Fay, 1989). South flank of Arbuckle anticline. Plane-polarized light.



Photomicrograph of silicified (cherty) bed near base of the lower transition zone (bed 60, Fay, 1989), Sycamore limestone, south flank of Arbuckle anticline. Echinoid spines are dominant bioclast. A. PPL B. CPL

#### Stop 4-Tulip Creek Caney Shale

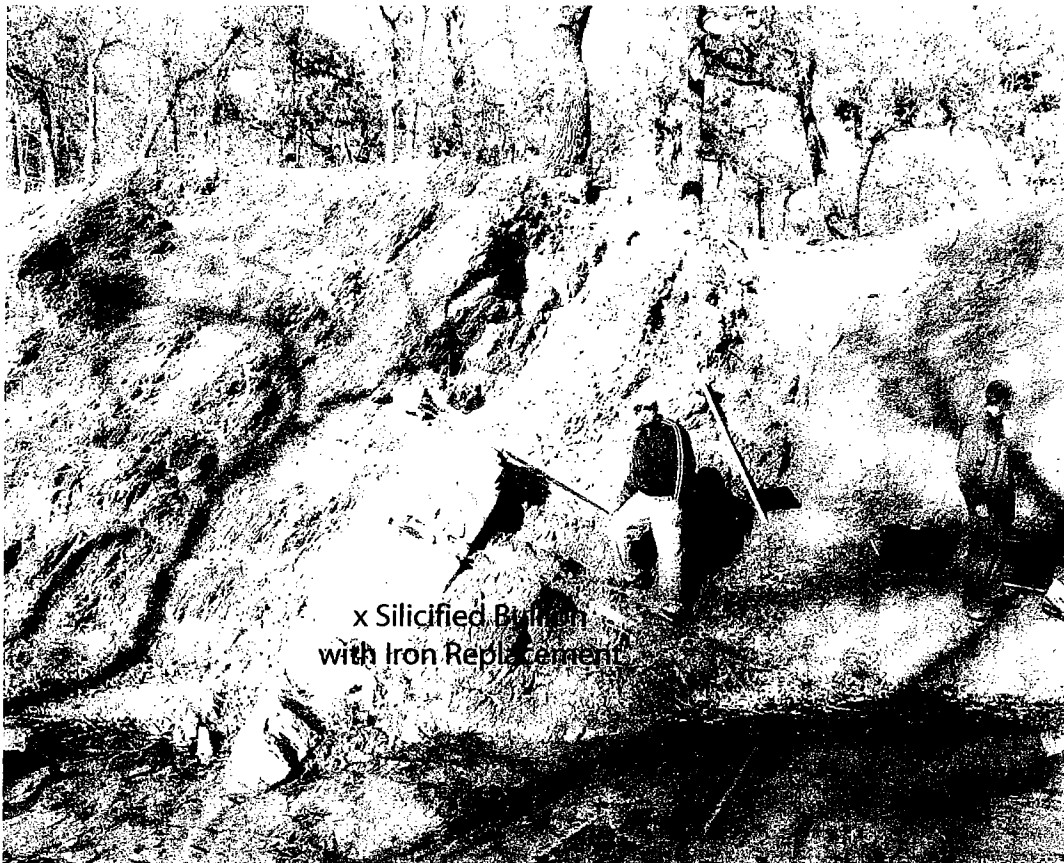
This section exposes part of the Delaware Creek Member of the Caney Shale. The section begins 135' above the Sycamore Limestone in the hillside adjacent to Tulip Creek and then along Tulip Creek.

#### Sample near top of Section

- Sample 22-Grayish Black at 334'
- Sample 21-Medium Dark Gray at 308'
- Sample 20-Limestone concretion silica replaced at 304'
- Sample 19-Grayish Black at 286'
- Sample 18-Grayish Black, fissile at 277.5'
- Sample 17-Bullion (replaced with silica & ironstone) at 275'
- Sample 16-Dark Gray, fissile at 266.5'
- Sample 15-Dark Gray Thinly laminated at 255.5
- Sample 14-Olive Gray Thinly bedded at 220'
- Sample 13-Dark Gray Thinly bedded at 220'
- Sample 12-Olive Gray minor phosphate at 215'
- Sample 11-Olive Gray-isolated phosphate at 212'
- Sample 10-Olive Gray at 187.5'
- Sample 9-Olive Gray at 183'
- Sample 8-Dark Gray to olive gray at 168'
- Sample 7-Brownish gray phosphate laminae at 167'
- Sample 6-Dark Gray to Grayish Black phosphate laminae at 166'
- Sample 5-Dark Gray Laminar Phosphate at 159'
- Sample 4-Dark Yellowish Brown at 155'
- Sample 3-Dark Yellowish Brown Phosphate Nodules at 142'
- Sample 2-Brownish Gray-Medium Gray at 140'
- Sample 1-Dark Yellowish-Moderate Brown at 139'



Tulip Creek  
Caney Shale (Delaware Creek Member)



Lower Delaware Creek Member  
Tulip Creek

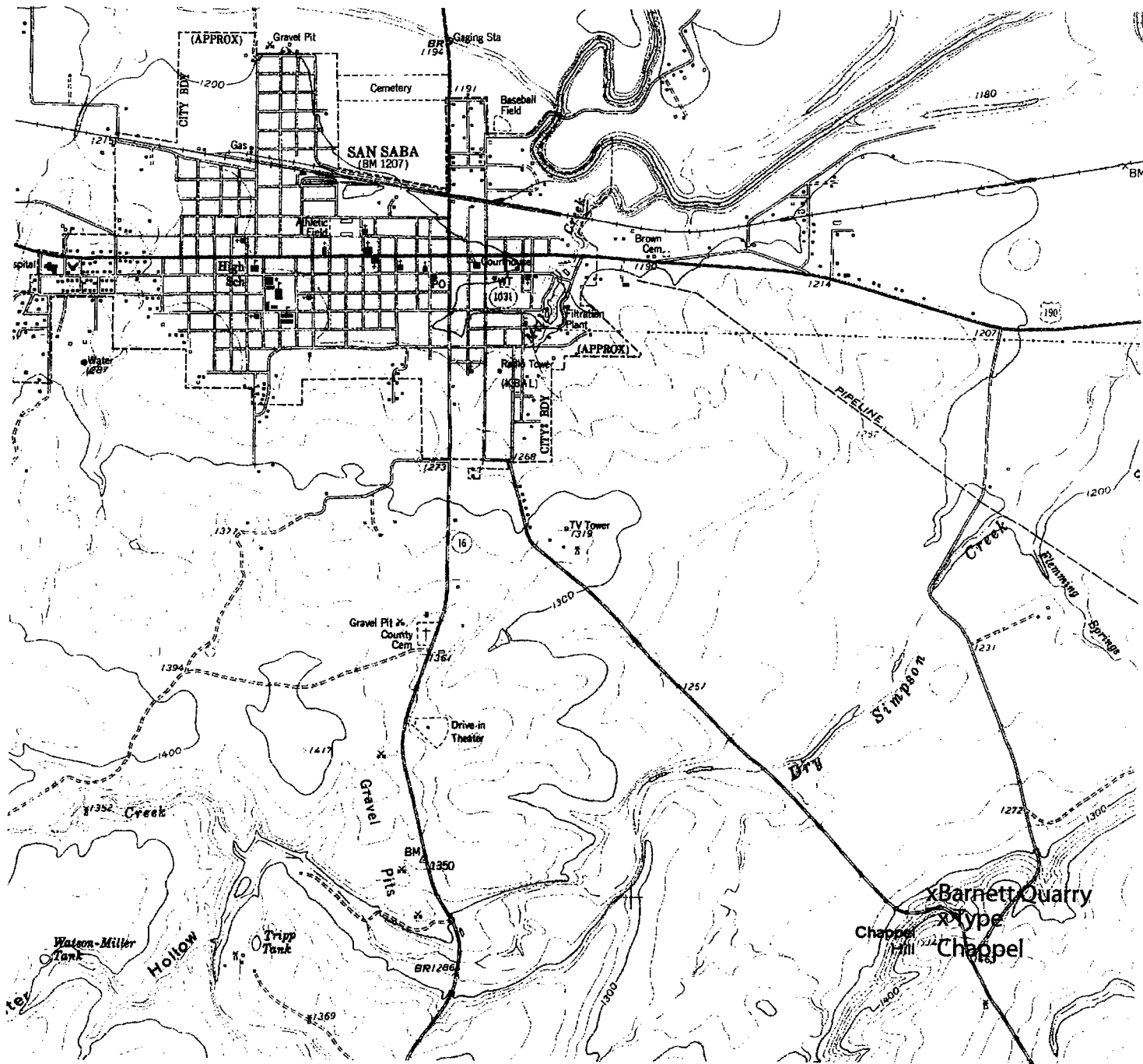


Phosphate Nodules in lower part of  
Caney Shale (Delaware Creek Member)  
Tulip Creek

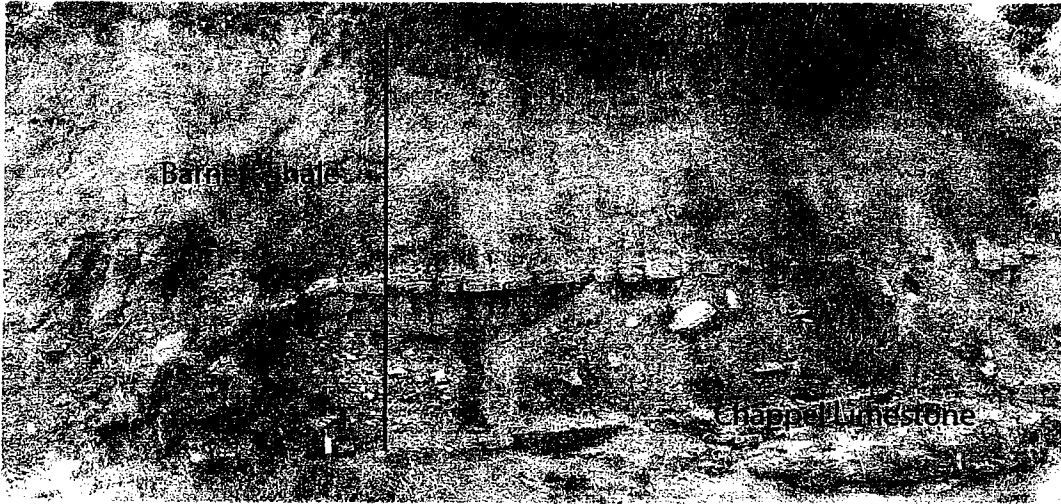


### Stop 5-Type Chappel Limestone-

This famous locality is the type section for the Chappel Limestone of Osagean age. At the base of the roadcut section is the Ordovician Ellenburger Limestone which is unconformably overlain by the enigmatic Ives Breccia. The Ives Breccia that consists of chert breccia as well as green shale and phosphatic limestones contain conodonts of Late Devonian as well as early Mississippian age (Kinderhookian), Haas, (1959). This is in turn conformably overlain by the Chappel Limestone which is Osagean in its entirety. At this locality the top of the Chappel Limestone has a well developed oxidized zone with red internal sediment indicating subaerial exposure. The base of the Barnett Shale is latest Meramecian to earliest Chesterian in age based on conodont assemblages that include *Gnathodus texanus*, *Gnathodus bilineatus*, and *Cavusgnathus*. In regions to the west of San Saba there is a lower member stratigraphically below the black shale facies of the Barnett Shale. This lower member are carbonate grainstones containing crinoids and is known as the Whites Crossing Member from its type locality at White's Crossing over the Llano River. No age data is available on this member even though Haas (1953) considered it to be older than that exposed at this locality. The top contact is not exposed at the roadcut but is exposed in a quarry across the road. The contact between the Barnett Shale is exposed on the Quarry face and was dug out in a trench for our purposes. The shale immediately below the Marble Falls Limestone is glauconitic and contains Morrowan conodonts including *Idiognathoides sinuatus*, *Declingnathodus noduliferous* as well as *Neognathodus symmetricus*. The entire interval is fossiliferous without obvious evidence of an unconformity.



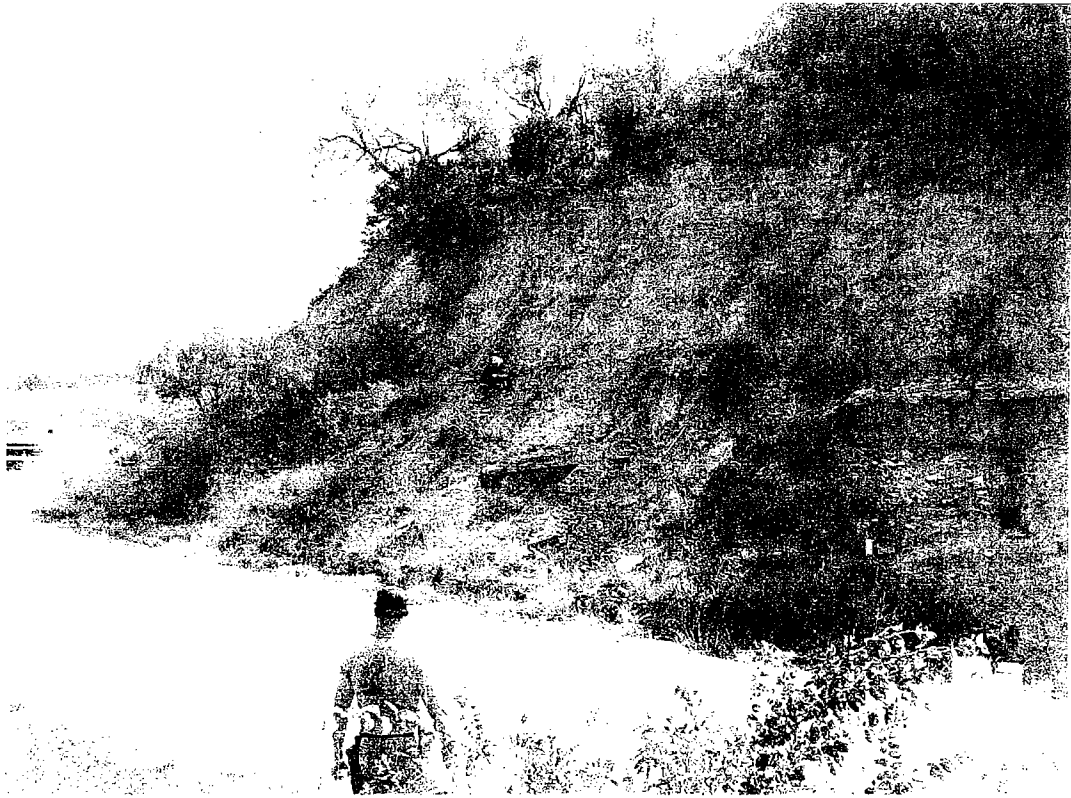
Type Chappel Limestone  
Lower Barnett Shale  
with Underlying Chappel Limestone



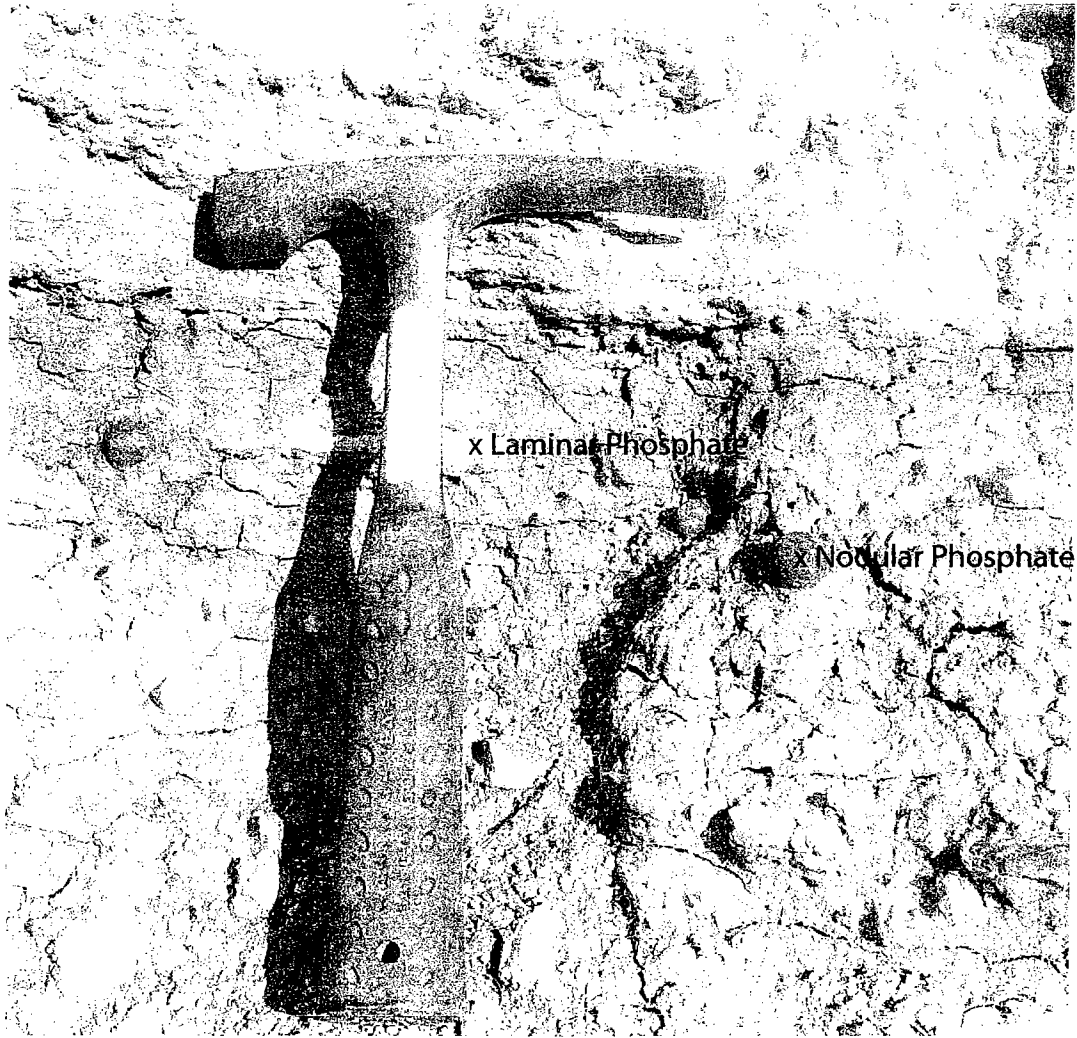
Type Chappel Limestone  
with Lower Contact of Ives Breccia  
and Upper Contact of Barnett Shale



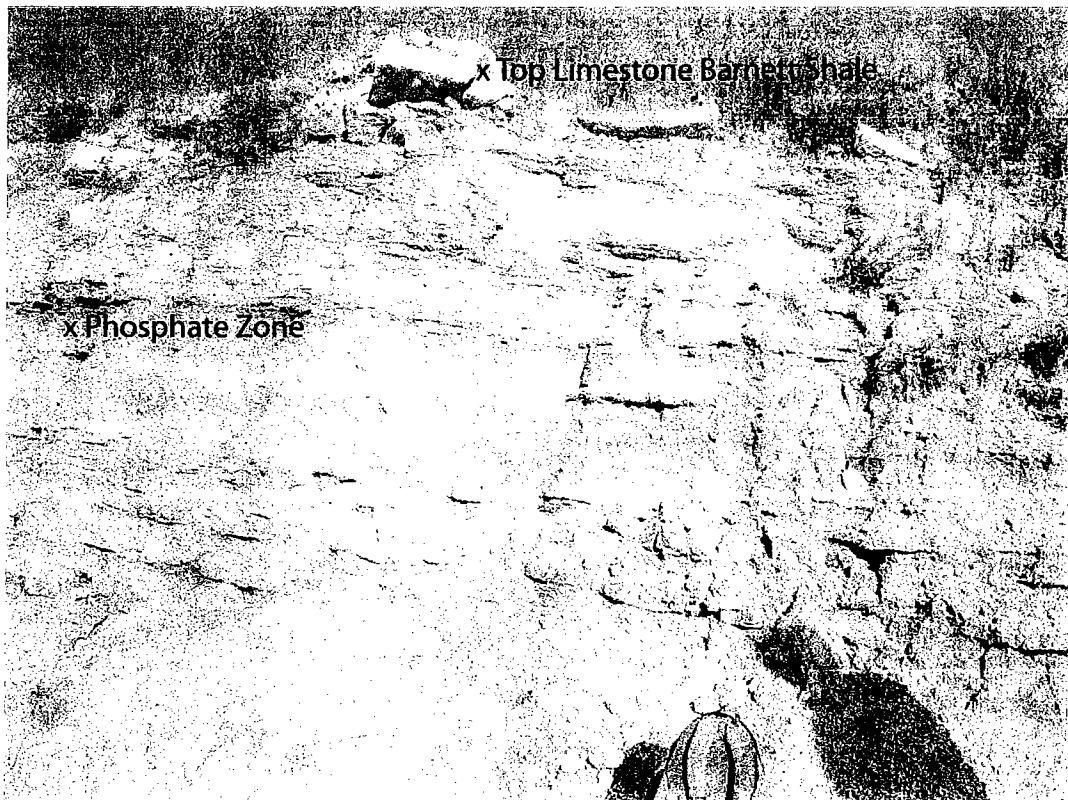
Type Chappel Limestone  
Lower & Upper Barnett Shale



Closeup of Phosphate Zone Quarry Section



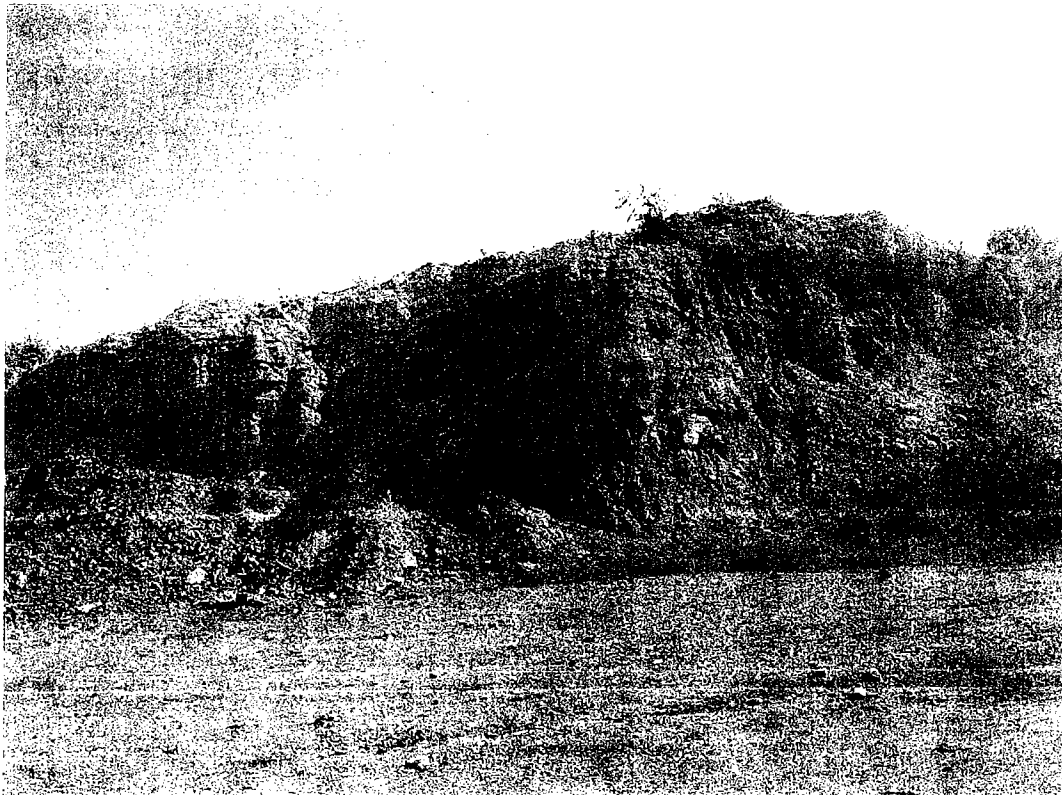
Upper Barnett Shale Quarry Section



Barnett Shale/Marble Falls Limestone Contact  
in Trench

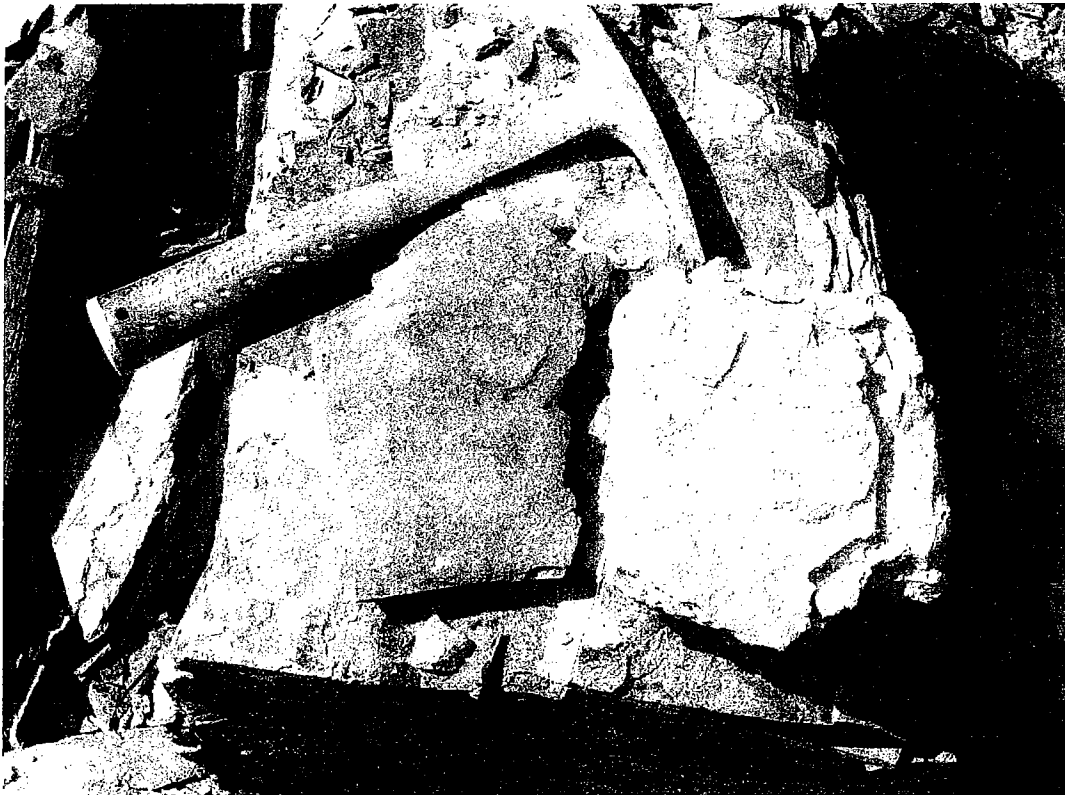


Barnett Shale Quarry Section Highwall



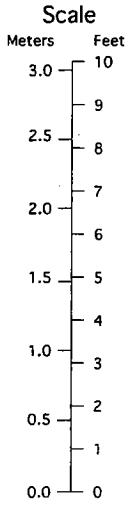


Comparison of Freshly Exposed Versus Weathered Color  
of Barnett Shale  
in Barnett Quarry



# Type Chappel

Unit Lithology



Unit	Lithology
37	Massive Bed Weathers White
36	Dark Yellowish Orange Caliche
35	Limestone Lenticular
34	Medium Gray-Medium Light Gray
33	Medium Gray-Medium Light Gray
32	Moderate Yellowish Brown
31	Limestone Variable Thickness (0.2-0.3')
30	Dark Yellowish Brown-Moderate Yellowish Brown
29	Thin bedded Limestone Upper Shaly
28	Pale Yellowish Brown
27	Pale Yellowish Brown Moderately Laminated
26	Pale Yellowish Brown
25	Dark Yellowish Brown-Moderate Yellowish Brown
24	Medium Gray
23	Dark Yellowish Orange
22	Dark Yellowish Brown-Moderate Yellowish Brown
21	Light Bluish Gray
20	Pale Yellowish Brown-Pale Yellowish Orange
19	Light Gray Fresh, Pale Yellowish Brown (W)
18	Dark Yellowish Brown
17	Medium Gray Fresh, Light Brown Weathered
16	Pale Yellowish Brown
15	Light Gray Fresh Light Brown Weathered
14	Pale Yellowish Brown
13	Dark Yellowish Brown
12	Very Pale Orange-Pelloidal
11	Light Bluish Gray
10	D. Yellowish Orange - M. Yellowish Brown
9	Nodular Limestone & Interbedded Shale
8	D. Yellowish Orange - M. Yellowish Brown
7	Reddish Brown
6	Grayish Green
5	Limestone, Top Oxidized With Solution Vugs
4	Phosphatic Limestone
3	Chert Breccia
2	Green Shale
1	Cherty Limestone Irregular Top

latest Meramecian & Chesterian

Barnett Shale

Osagean Stage

Chappel Formation

Famnenian-Kinderhookian

Ives Breccia

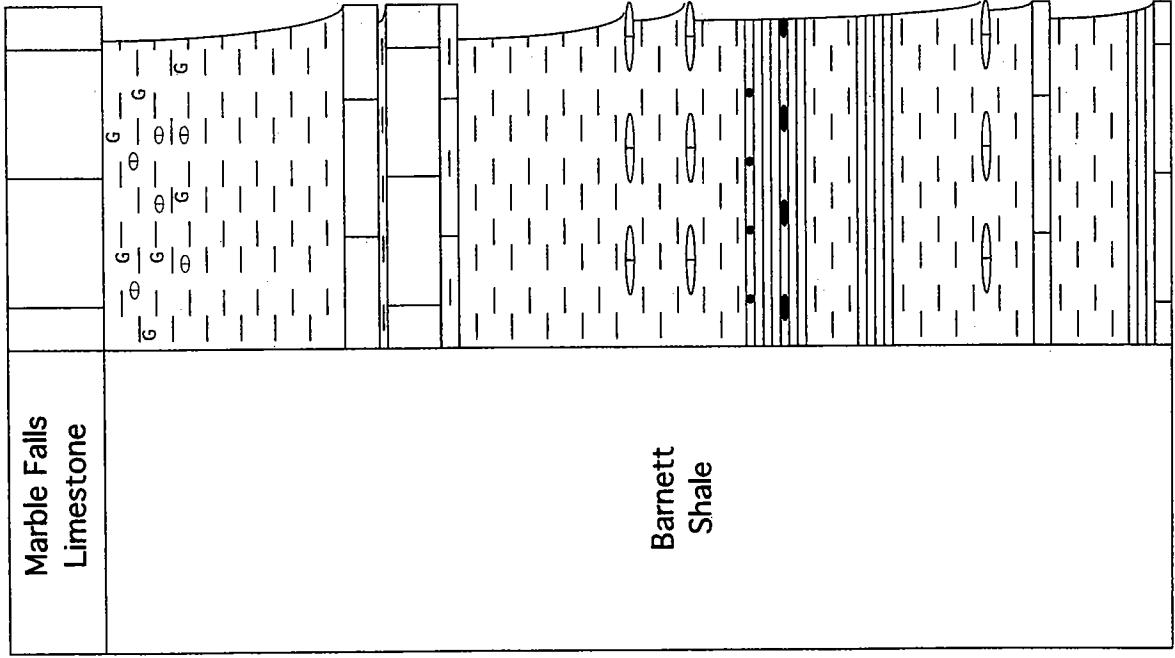
lower Ordovician

Ellenburger Formation

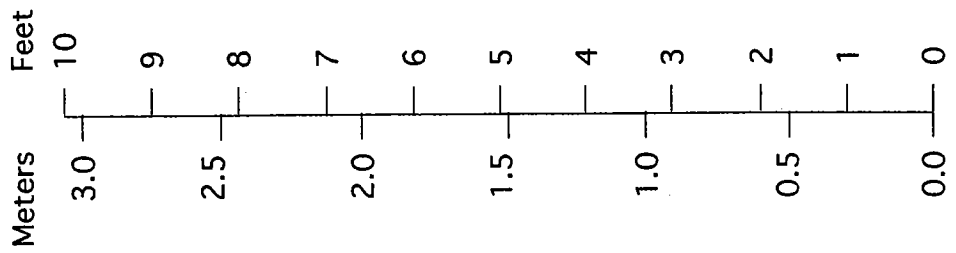
# Type Chappel Quarry

## Unit Lithology

16	Light Medium Gray-Cherty
15	Dark Yellow Brown-Light Olive Brown Glauconitic
14	Dark Yellowish Orange Heavy Caliche
13	Medium Gray With Brachiopods
12	Pale Yellowish Orange
11	Medium Gray Weathers White
10	Light Gray Limestone-Dark Yellowish Orange Sh.
9	Grayish Orange
8	Moderate Yellowish Brown With Lenticular Limestone
7	Light Gray With Phosphate Nodules
6	Pale Yellowish Orange
5	Moderate Yellowish Brown
4	Moderate Yellowish Brown With Lenticular Limestones
3	Moderate Yellowish Brown
2	Moderate Yellowish Brown-Thin Shelled Bivalves
1	Medium Gray



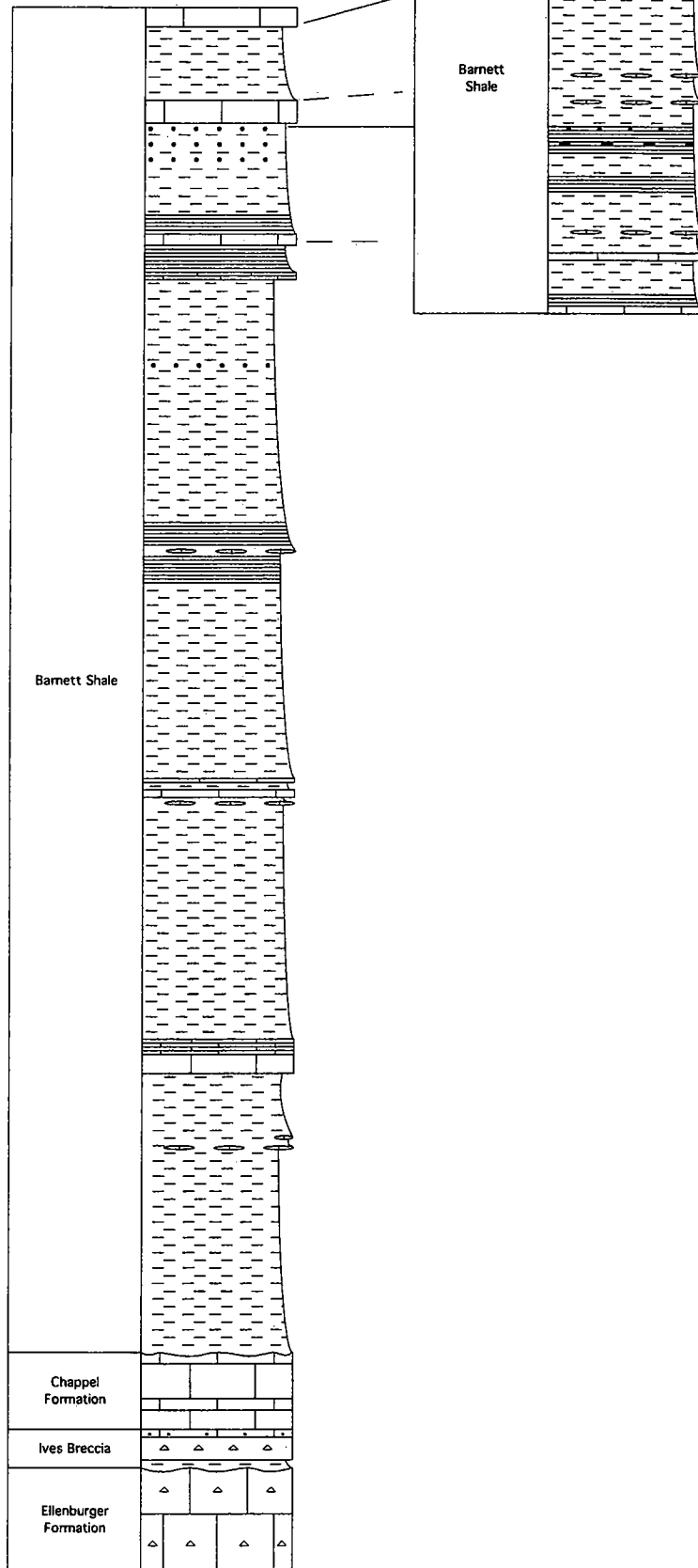
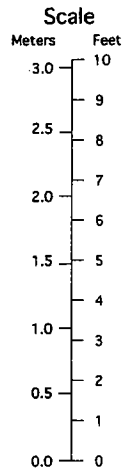
### Scale



# Type Chappel Quarry

Pennsylvanian  
—  
Mississippian

## Type Chappel Roadcut



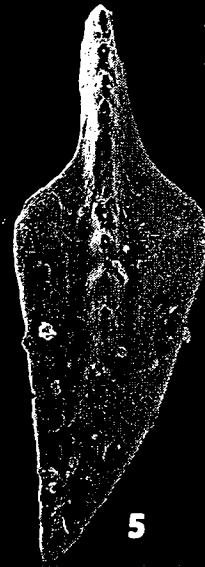
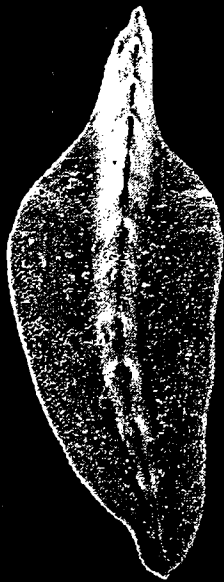
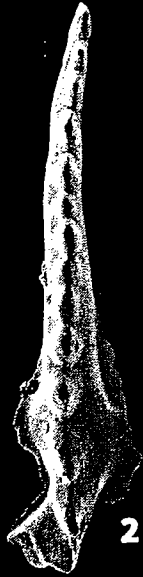
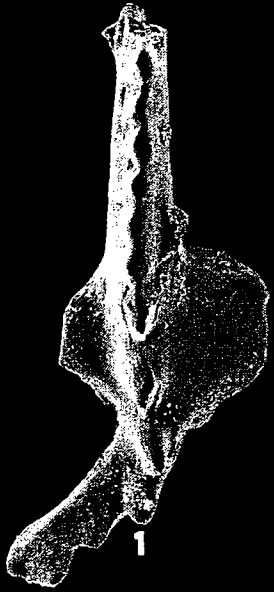
**Plate 11-Chappel Limestone (Mississippian-Osagean)**

Figs. 1-2 *Bactrognathus hamata*

Fig. 3 *Bactrognathus excavata*

Figs. 4-5 *Polygnathus communis*

Fig. 6 *Hibbardella*



**Plate 12-Chappel Limestone (Mississippian-Osagean)**

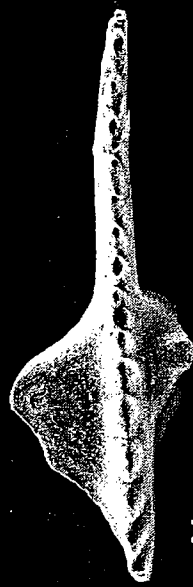
Fig. 1 *Gnathodus bulbosus*

Fig. 2 *Gnathodus* sp.

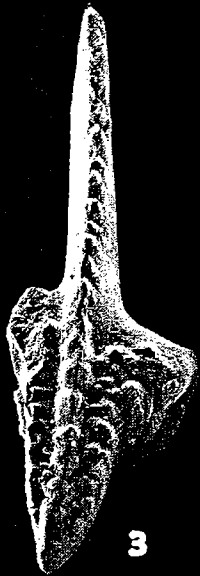
Fig. 3-9 *Gnathodus delicatus*



1



2



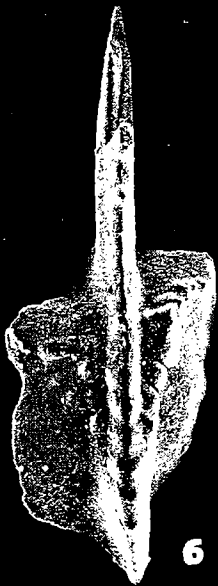
3



4



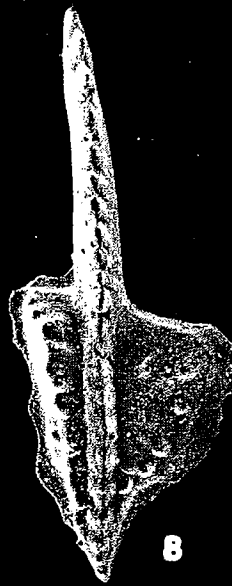
5



6



7



8



9



**Plate 13-lower Barnett Shale (Mississippian-uppermost Meramecian or  
lowermost Chesterian)**

Fig. 1 Indet.

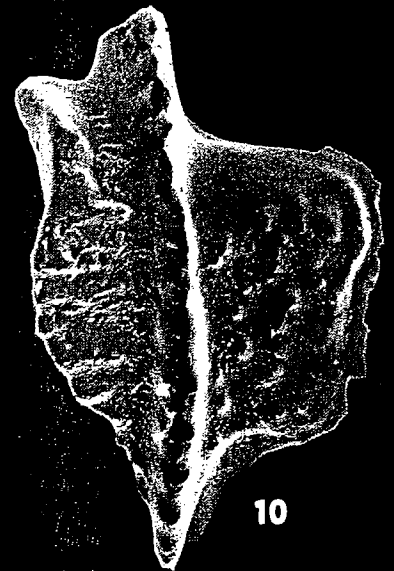
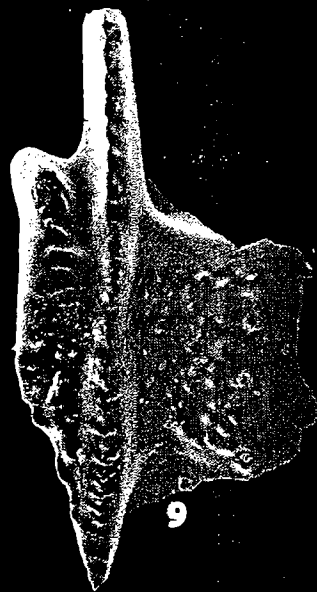
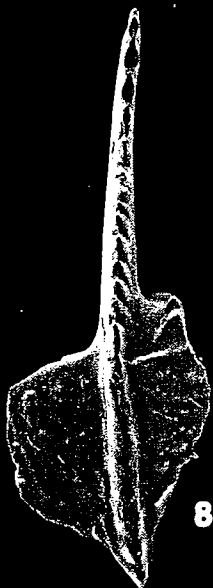
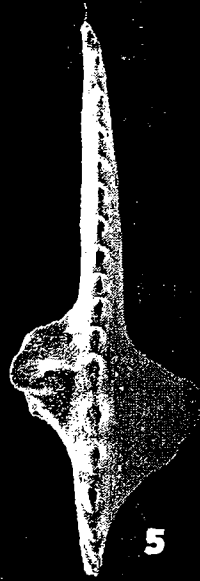
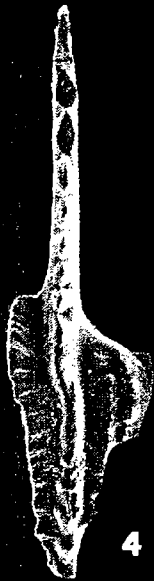
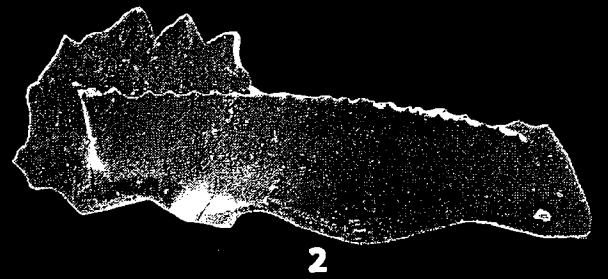
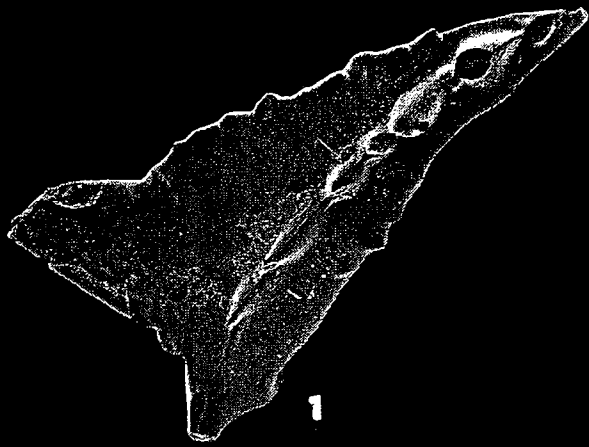
Fig. 2 *Cavusgnathus altus*

Fig. 3-4 *Gnathodus girtyi?*

Fig. 5 *Gnathodus texanus*

Figs. 6-7 *Lochriea commutata*

Figs. 8-10 *Gnathodus bilineatus*



**Plate 14 upper Barnett Shale (Mississippian-upper Chesterian)**

Fig. 1 *Cavusgnathus unicornis*

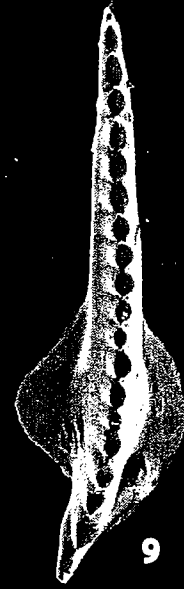
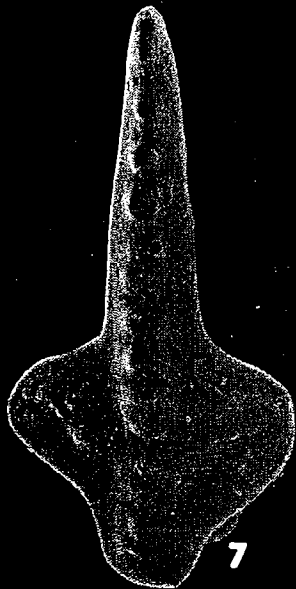
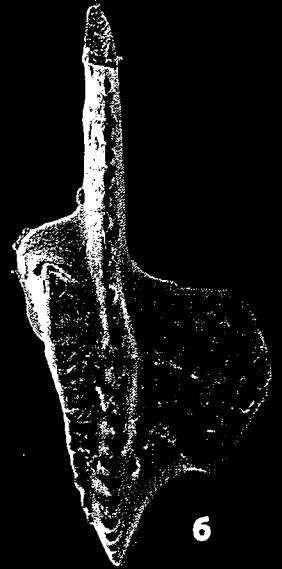
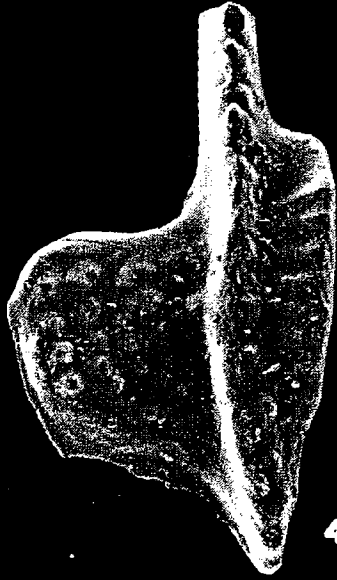
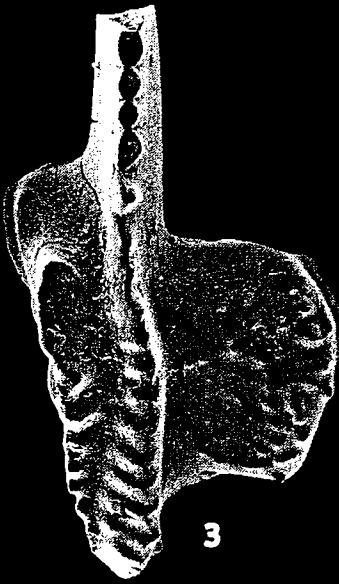
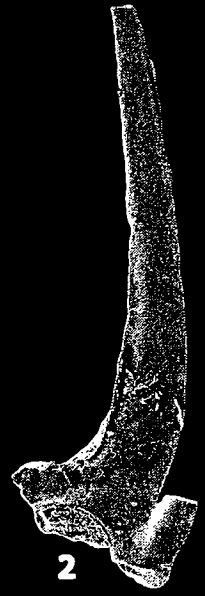
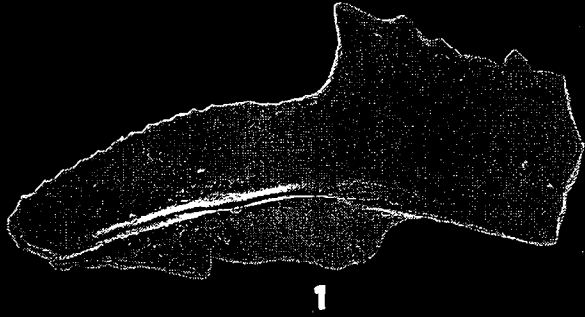
Fig. 2 *Hibbardella*

Figs. 3-6 *Gnathodus bilineatus*

Fig. 7 *Lochriea nodosus*

Fig. 8 *Lochriea commutata*

Fig. 9 *Lochriea monodosus*



**Plate 15-upper Barnett (Mississippian-upper Chesterian)**

Figs. 1 & 6 *Declinognathodus noduliferus*

Fig. 2 *Idiognathoides sinuatus*

Figs. 3-5 *Neognathodus symmetricus*

