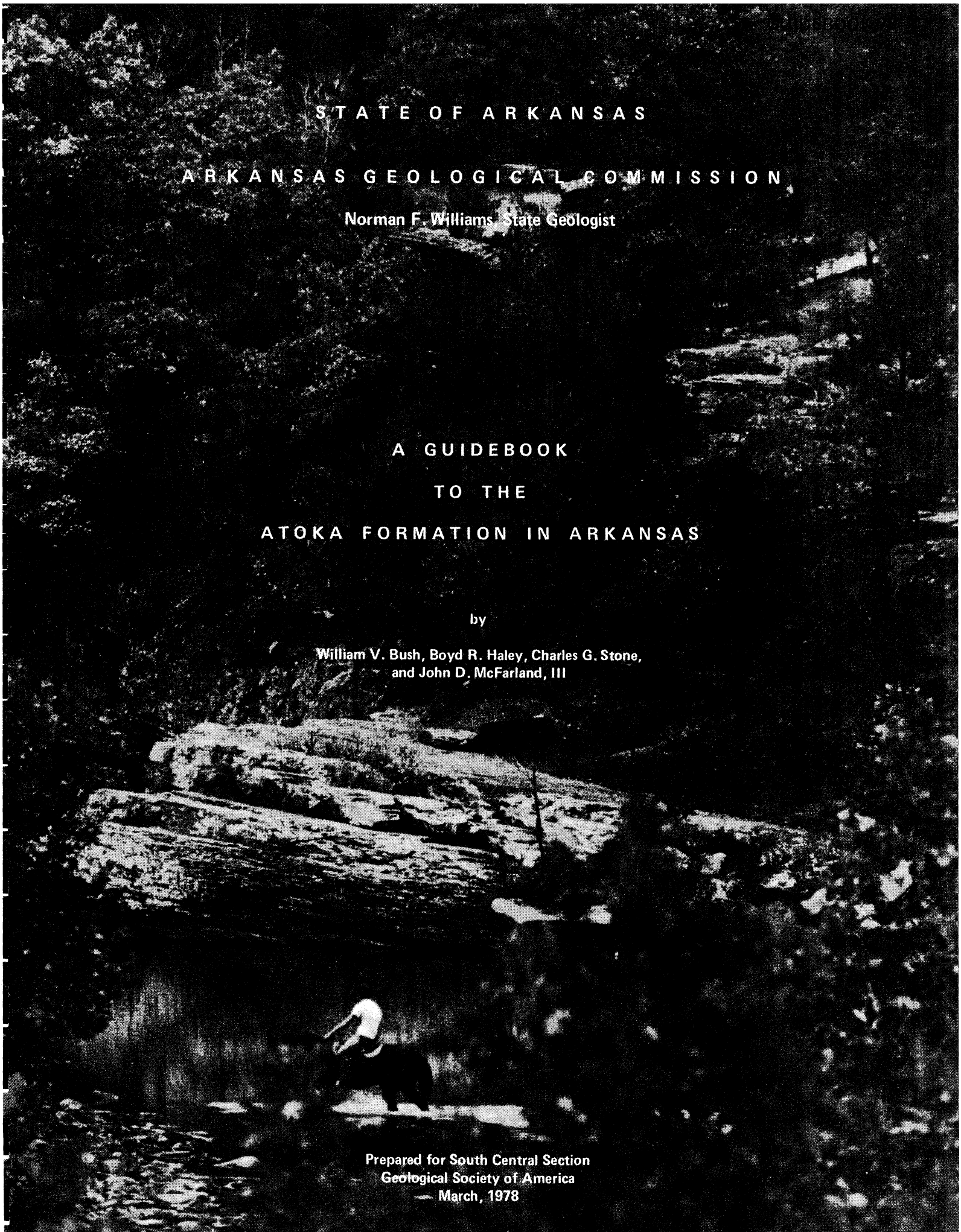

STATE OF ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION

Norman F. Williams, State Geologist

A GUIDEBOOK TO THE ATOKA FORMATION IN ARKANSAS

by

William V. Bush, Boyd R. Haley, Charles G. Stone,
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Prepared for South Central Section
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GUIDEBOOK 78-1

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PREFACE

This guidebook has been prepared to provide geologic information on the Atoka Formation in Arkansas. The route for the field trip has been divided into two days. The first day begins at Fayetteville in the Ozarks and ends at Fort Smith in the Arkansas Valley, and the second day extends from Ft. Smith into the frontal Ouachita Mountains.

The maps presented were compiled during the mapping program for the new State Geologic Map of Arkansas during the years 1968 to 1974.

It is the primary purpose of this field trip to examine the different parts of the Atoka Formation and encompassing formations, to determine the depositional environments of the rocks, and to discuss the regional changes in these depositional environments as we progress southward across the area. The Atoka Formation ranges from about 3,500 feet of shallow-water clastics in the Boston Mountains in the Ozarks to over 25,000 feet of mostly deep-water slope and troughal (flysch) deposits in the southern Arkansas Valley and the frontal Ouachita Mountains.

In the past, workers have tended to classify the rocks that we will examine during the first part of this trip as being deposited in an off-shore, nearshore, or continental depositional environment, with the silty and sandy zones being deposited near the shoreline during trangressions or regressions of sea level. Some recent workers are beginning to classify the silty and sandy zones as parts of a deltaic depositional environment. It is difficult, at least for us, to place the rocks at every outcrop into its proper niche of this model.

Undoubtedly, part of our difficulties stem from inexperience; therefore, we welcome constructive comments from more knowledgeable people, and even from less knowledgeable people if any are present.

The nomenclature cited in this road log does not necessarily conform to that of the U. S. Geological Survey.

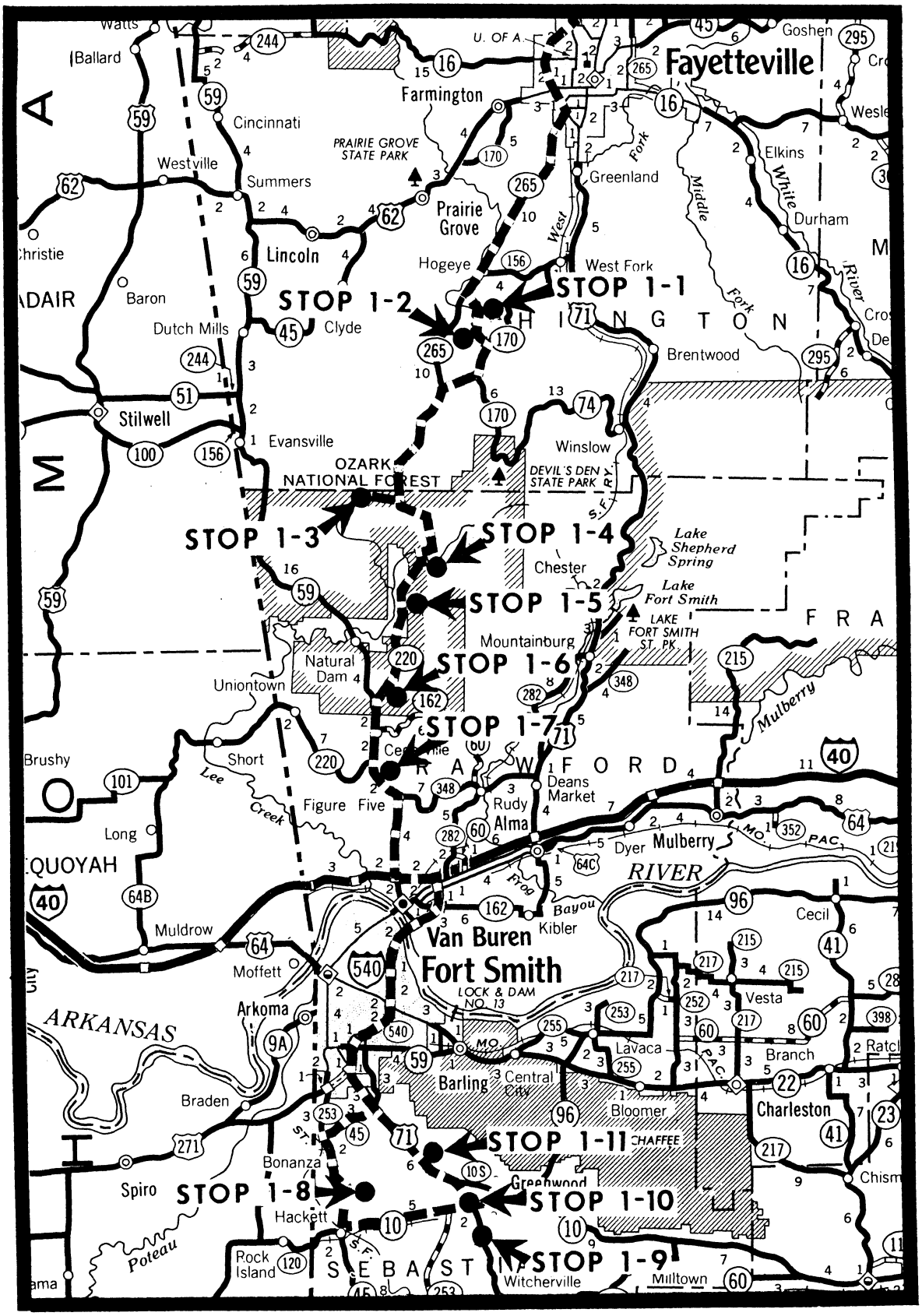

FIGURE 1 INDEX MAP OF FIRST DAY ROAD LOG

MILES 0 5 10 15 20 25

Route STOP 1-1

CORRELATION OF CARBONIFEROUS ROCKS IN THE OZARK, ARKANSAS VALLEY, AND OUACHITA MOUNTAIN REGIONS, ARK.

AGE			OZARK - ARKANSAS VALLEY SECTION		MAP SYM.	OUACHITA MTN. SECTION		MAP SYM.
CARBONIFEROUS SYSTEM	PENNSYLVANIAN	DES MOINES	Boggy Fm.		$\mathbb{P}_{by}$	Missing		
			Savanna Fm.		$\mathbb{P}_{sv}$			
			Mc Alester Fm.		$\mathbb{P}_{ma}$			
			Hartshorne Sandstone		$\mathbb{P}_{hs}$			
		ATOKA	Atoka Fm.		$\mathbb{P}_a$	Atoka Fm.		$\mathbb{P}_a$
		MORROW		Kessler Ls. Mbr.	$\mathbb{P}_{bk}$			
			Bloyd Shale	Woolsey Mbr.	$\mathbb{P}_{bw}$	Johns Valley Shale		$\mathbb{P}_{jv}$
				Brentwood Ls. Mbr.	$\mathbb{P}_{bb}$			
			Hale Fm.	Prairie Grove Mbr.	$\mathbb{P}_{hp}$	Jackfork Fm.		$\mathbb{P}_j$
				Cane Hill Mbr.	$\mathbb{P}_{hc}$			
	MISSISSIPPIAN	UPPER	Pitkin Limestone		Mp		Chickasaw Creek Mbr.	Ms
			Fayetteville Shale	Wedington SS Mbr.	Mf	Stanley Shale		
			Batesville Sandstone	Hindsville Ls. Mbr.	Mbh			
			Ruddell Shale		Mr		Hatton Tuff	
			Moorefield Fm.		Mm		Hot Springs SS Mbr.	
		LOWER	Boone Fm.	Short Creek Oolite Mbr.	Mb	Arkansas Novaculite	Upper Div.	MDa
				St. Joe Ls. Mbr.				

GENERAL LITHOLOGIC DESCRIPTION OF UNITS

OZARK MOUNTAINS ARKANSAS VALLEY	Max. Thickness	OUACHITA MOUNTAINS	Max. Thickness
Pennsylvanian System		Pennsylvanian System	
Des Moinesian Series		Des Moinesian Series	
Boggy Formation Savanna Sandstone—sandstone and shale	850		
McAlester Formation—shale, sandstone, and coal	1,000	"missing"	
Hartshorne Sandstone—massive sandstone	180		
Atokan Series		Atokan Series	
Atoka Formation—sandstone and shale	6,500	Atoka Formation—shale and sandstone	27,500±
Morrowan Series		Morrowan Series	
Bloyd Shale—shale, sandstone, limestone, and minor coal	350	Johns Valley Shale—shale, minor sandstone and limestone, and erratic boulders	1,500±
Hale Formation—shale, sandstone, and limy sandstone	250	Jackfork Sandstone—sandstone and shale	6,000
Mississippian System		Mississippian System	
Chesterian Series			
Pitkin Limestone—massive limestone and shale	200	Stanley Shale—shale, sandstone, and some chert	8,500
Fayetteville Shale—black shale with minor limestone and sandstone	350		
Batesville Sandstone—sandstone and limestone	75		
Kinderhookian—Osagean—Meramecian Series		Upper and upper portion of the Middle Divisions of the Arkansas Novaculite—novaculite and shale	130
Boone Formation—limestone and chert	400		

Figure 2

ROAD LOG – FIRST DAY

OZARK MOUNTAINS – ARKANSAS VALLEY

by

William V. Bush*, Boyd R. Haley**, Charles G. Stone*
and John D. McFarland, III*

Mileage	Description
0.0	Start at Ramada Inn, Fayetteville, Arkansas and *turn right (south)* onto U. S. Hwy. 71. You are riding on Fayetteville Shale of Chesterian (upper Mississippian) age.
	The Fayetteville Shale is generally a black, fissile, concretion-bearing, petroliferous, marine shale exposed along the Boston Mountain Escarpment. A prominent sandstone called the Wedington Sandstone Member is present near the top of the formation in the west. In the central and eastern Ozarks of Arkansas, exposures of black micritic and fossiliferous limestones are interbedded with the upper shale. The Fayetteville varies in thickness from 10 to 400 feet, with the thicker sections generally occurring toward the south and the thinner sections representing truncations due to the Mississippian-Pennsylvanian erosional surface. The Fayetteville shale is Chesterian in age and is characterized by the cephalopods *Tumulities varians* McCaleb, Quinn, and Furnish, *Eumorphoceras plummeri* Miller and Youngquist, and *Cravenoceras fayettevillae* Gordon.
0.3	Stay to the right on U.S. Hwy. 71 Bypass.
1.3	Outcrop of Boone Limestone in the creek.
	The Boone Formation, of Osagean and lower Meramecan (lower Mississippian) age, consists of limestone, limestone and nodular chert, interbedded limestone and chert, and in some exposures just chert. It is widely exposed in southern Missouri, northeastern Oklahoma, and northern Arkansas commonly capping the Springfield Plateau surface. The Boone is 300-400 feet thick, probably thinning slightly to the south. Marine fossils, mostly crinoids and brachiopods occur throughout the unit.
1.4	Junction with Johnson Road.
2.5	Junction with Ark. Hwy. 112.
2.7	Fault, downthrown side to the north.
2.9	Riding on the Boone Formation.
4.4	Exit to Ark. Hwy. 16, continue on Hwy. 71 Bypass.
4.8	Boone - Fayetteville contact (north of small building to the east).
5.4	Fayetteville shale crops out to the east.
6.0	Exit to Ark. Hwy. 62, continue on Hwy. 71 Bypass.
7.1	Outcrop of Fayetteville Shale to the west (fossil locality). Junction with Ark. Hwy 16.

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* Arkansas Geological Commission.

** U. S. Geological Survey.

Mileage	Description
7.8	Junction with Ark. Hwy. 265, *turn right (south)* onto Hwy. 265.
9.2–9.4	Outcrop of Wedington Sandstone Member of the Fayetteville Shale to the west. A fault is present under the road. The Wedington Sandstone Member of the Fayetteville Shale is a gray to brown sandstone, generally well-sorted, fine to medium grained, commonly cross-bedded, and in some places calcareous. The unit is thickest in northwest Washington County and thins to the south and east. The Wedington Sandstone appears to be a nearshore, marine deposit formed from stream-carried sediment derived from the north. Marine and plant fossils are present within the unit.
10.1	Outcrop of the Prairie Grove Member of the Hale Formation to the east. The Hale Formation constitutes the basal portion of the Morrowan series in this region and is divided into two members. The underlying Cane Hill Member consists of interbedded siltstone, shale, and fine-grained sandstone with scattered calcite cemented sandstone lenses and, in northwest Arkansas, a basal conglomerate that marks the Mississippian-Pennsylvanian unconformity. The everlying Prairie Grove Member is made up of lithologies that vary from a carbonate-cemented sandstone to a sandy calcarenite. The Hale Formation is exposed along the edge of the Boston Mountain Escarpment and averages 100 feet in thickness in northwest Arkansas. Studies are needed to determine whether deltaic-carbonate bank models apply to the deposition of the Hale in this area.
11.5	Wedington Sandstone is exposed to the east.
12.9	Outcrop of Wedington Sandstone to the east.
14.4	Wedington Sandstone is exposed to the west.
14.6	Another exposure of Wedington Sandstone to the east.
14.9	Mountain to the west is capped by lower Atoka sandstones.
15.6	Outcrop of Wedington Sandstone to the east.
16.8	A fossil plant horizon occurs in the outcrop of Fayetteville Shale.
17.0	Wedington Sandstone crops out in the creek.
17.4	Billingsly Church in downtown Hogeye, Arkansas.
17.8	Junction with Ark. Hwy. 156, *turn right (west)* continue on Ark. 256.
17.9	Turn *left (south)* onto Ark. Hwy. 265 in downtown Moffit, Arkansas.
19.1	Howell Cemetery, and exposure of Bloyd Shale. The Bloyd Formation constitutes the upper part of the Morrowan series. This formation is divided into five members. In ascending order they are: The Brentwood Limestone - a ledge forming sandy limestone alternating with dark shale; The Woolsey - a shaly to silty sandstone of continental origin with a coal bed near or at the top; The Dye Shale - a dark gray to black shaly siltstone or claystone with a ledge forming, conglomeratic, calcareous sandstone "caprock" overlying the Woolsey coal at its base; The Kessler Limestone - a gray, oolitic limestone containing algal-foraminiferal concretions; and The Trace Creek Shale - a gray to black silty shale. The Bloyd Formation outcrops along the north side of the Boston Mountain Plateau where it varies from 150 - 300 feet thick.
19.4	Junction with dirt road, *turn left (east).*
19.7	Outcrop of Bloyd Shale to the west.
19.8	Normal fault with downthrown side to the west.

Mileage	Description
19.9	Prairie Grove Member and the Hale Formation crops out to the north.
20.0	Bridge over creek.
20.2	**STOP 1-1 -- Big Spring Minnow Farm.** Plate 1, Figures 3, 4. Unload at the base of the hill and walk up the road to mile 20.5. This stop provides for an examination of the Morrowan rocks including: the Prairie Grove Member of the Hale Formation; the Brentwood Limestone, Woolsey Shale and Baldwin Coal, Kessler Limestone and Dye Shale Members of the Bloyd Shale; and the basal Atoka Formation. The depositional history of the rocks in the vicinity of this stop can be briefly summarized as follows: deposition of Mississippian age limestones; regression of the sea; erosion; trangression of the sea with the deposition of the Cane Hill Member; regression of the sea; erosion; transgression of the sea with successive deposition of the Prairie Grove Member, Brentwood Limestone and marine shale; regression of the sea; deposition of the Baldwin Coal and its caprock; trangression of the sea with deposition of the Kessler Limestone and marine shale; regression of the sea with deposition of a sandstone unit that is the base of the Atoka Formation. This sandstone unit could be classified as representing a prograding delta deposit.
20.3	Outcrop of the Brentwood Limestone Member of the Bloyd Shale.
20.4	Exposure with two thin coal beds in the Baldwin Coal. Elsewhere in Arkansas where the Baldwin Coal is exposed, normally only one coal bed is present.
20.45	Kessler Limestone beneath road to east.
20.5	Base of the Atoka Formation.
20.8	Bottom sandstone unit of the double ledge sandstone in the lower Atoka Formation. The double ledge character of this sandstone persists to Clinton, Arkansas a distance of 120 miles. (Figure 5)
21.6	Junction with dirt road from the west, continue on same road.
22.4	Outcrop of lower Atoka shale to the west. Entrance to Dripping Springs Ranch.
22.8-22.9	**STOP 1-2 -- Onda, Lower Atoka.** Plate 2, Figure 6. Good exposure of Atoka. Walk up hill to the sandstone. Where do these rocks fit in a delta?
23.4	Transformer site to the west. Caution - steep hill before stop!
23.5	Junction with Ark. Hwy. 170, *turn right (west).*
24.0	Outcrop of Atoka shale and sandstone to the west.
24.2	Outcrop of Atoka sandstone to the west.
24.4	Junction Ark. Hwys. 170 and 265, *turn left (west)* onto Hwy. 265.

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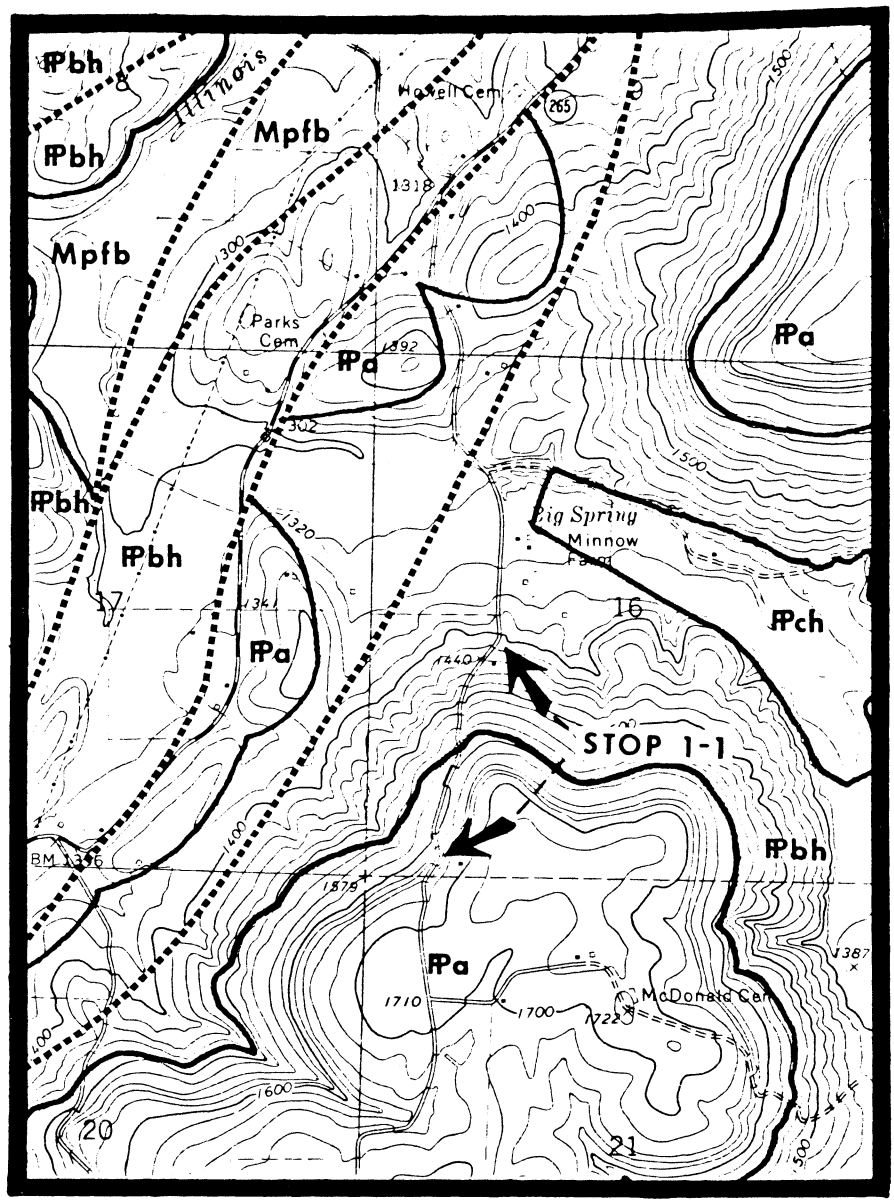

PLATE I. BIG SPRING MINNOW FARM – STOP 1-1.

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Geology by Boyd R. Haley

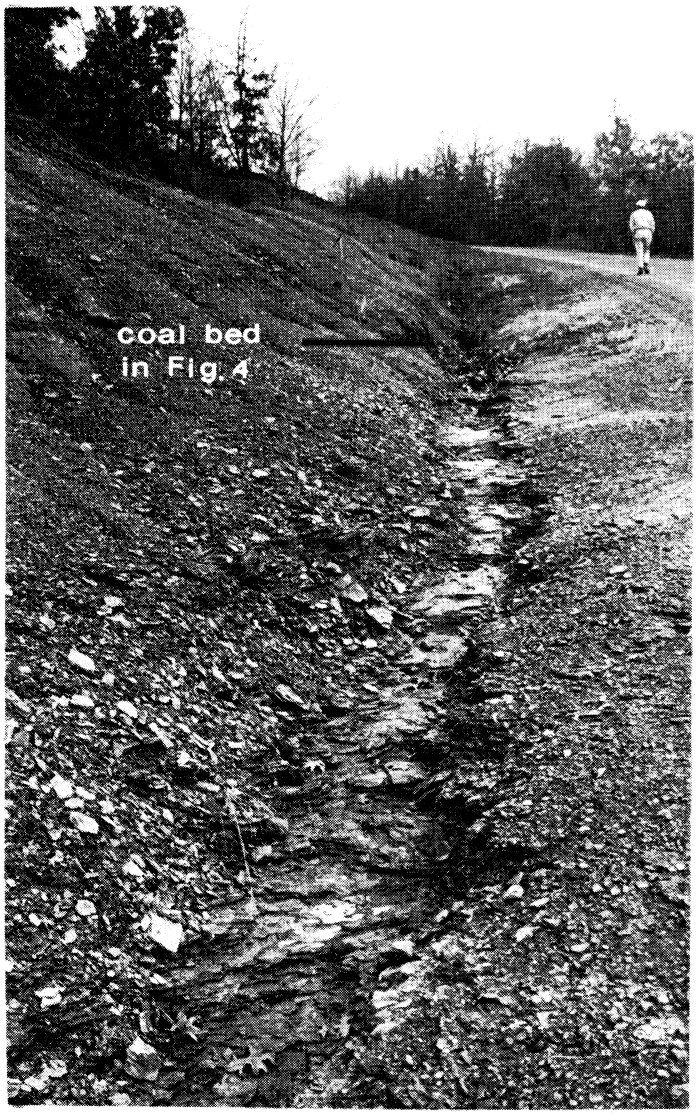

Figure 3. STOP 1-1. Woolsey Member of the Bloyd Shale. Two coal beds are exposed in the roadcut. Elsewhere in Arkansas where the Baldwin coal is exposed, normally only one coal bed is exposed.

Figure 4. STOP 1-1. Upper coal bed of the Baldwin coal near the top of the Woolsey Member.

Figure 5. Exposure of the bottom sandstone unit of a "double ledge" sandstone in the Atoka Formation at mileage 20.8. The "double ledge" sandstone and the basal sandstone of the Atoka Formation extends eastward for more than 120 miles.

Figure 6. STOP 1-2. Sandstone in the Atoka Formation.

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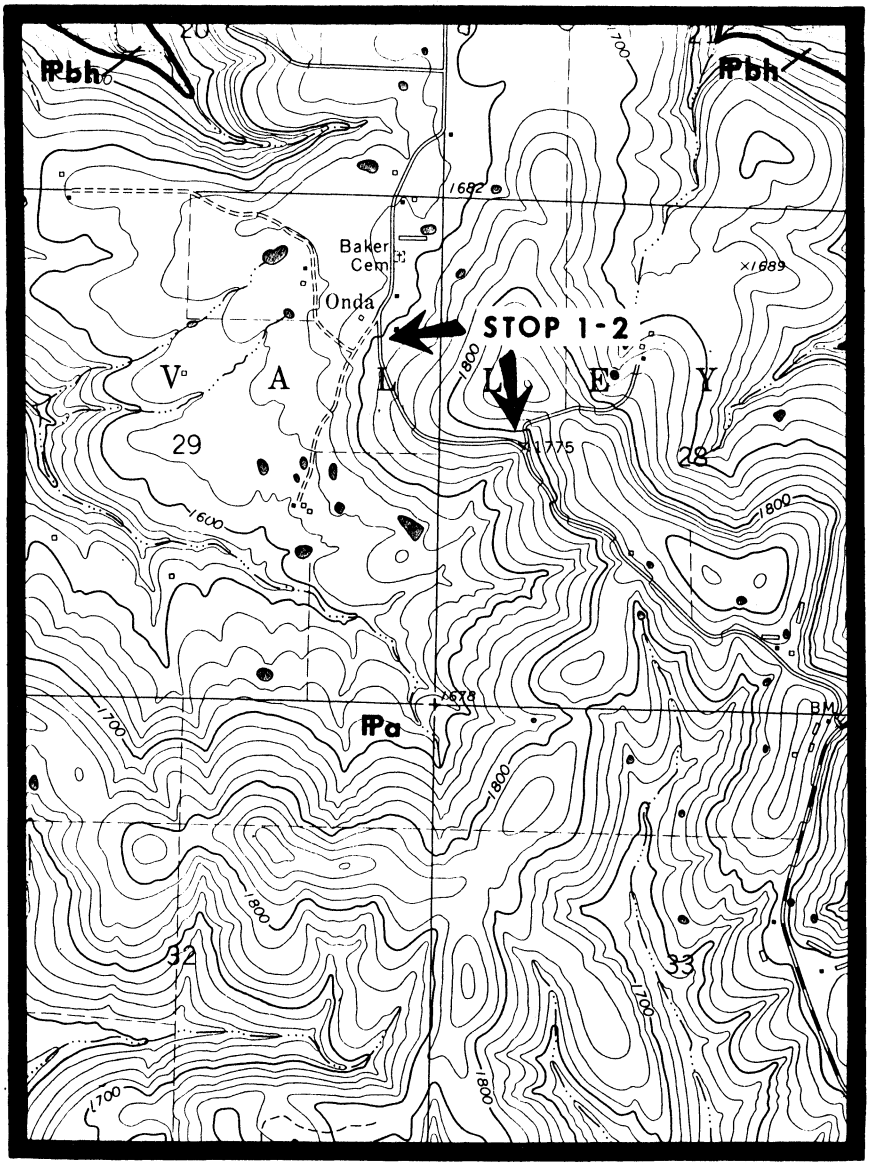

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PLATE 2. ONDA, LOWER ATOKA – STOP 1-2.

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

Mileage	Description
25.0	Entrance to SEFOR to east. Experimental Breeder Reactor site.
26.9	Strickler, Arkansas. Falls Creek Freewill Baptist Church to the north.
27.0	*Turn left (southwest)* on dirt road west of Falls Creek.
27.8	Almosta Ranch on the west.
28.6	Good exposure of Atoka to the west.
31.1	Bug Scuffle Community Church to the east.
34.1	Junction with Forest Service Road, *turn right (west).*
35.5	**STOP 1 - 3 -- Switchback Lake.** Plate 3, Figures 7, 8. Two sequences of Atoka sandstone are exposed and each can be classified as a part of a prograding delta. The lower sequence is capped distributary channel deposits, and the upper sequence is capped by either off-shore bar or river mouth deposits. Note the mound of travertine under the cliff, also the abundant brachiopods near the base of the cliff-forming sandstone. *Turn around* and go east.
36.9	Junction with road, continue southeast.
37.5	Power line
41.2	Junction with road from the east, continue south.
41.9	Bridge over Lee Creek.
42.1	**STOP 1 - 4 -- Lee Creek.** Plate 4, Figure 9, 10. Junction with road from the east. Atoka sandstone with plant and marine fossils. Park buses and walk to the outcrop on stream. Fringe deposits with the more sandy parts being deposited closer to the delta front (shoreline). If all the sediments exposed at this stop are fringe deposits, then delta front never reached this area. However, the plant fragments would seem to indicate its nearby presence.
43.0	Outcrop of Atoka sandstone to the east.
43.4	Junction with dirt road, stay on Hwy. 220.
46.9	Dip, low-water bridge.
47.6 - 48.2	**STOP 1 - 5.** Plate 5, Figures 11, 12. Atoka shale, siltstone and sandstone to the east. Excellent exposure of distributary channel deposits and the underlying fringe deposits (Figures 11 and 12). Is the cross-bedded limy sandstone at the top of Figure 11 part of the channel deposits, or is it beach sand or off-shore bar deposits?
49.8	Outcrop of Atoka shale and sandstone to the west.

R 32 W

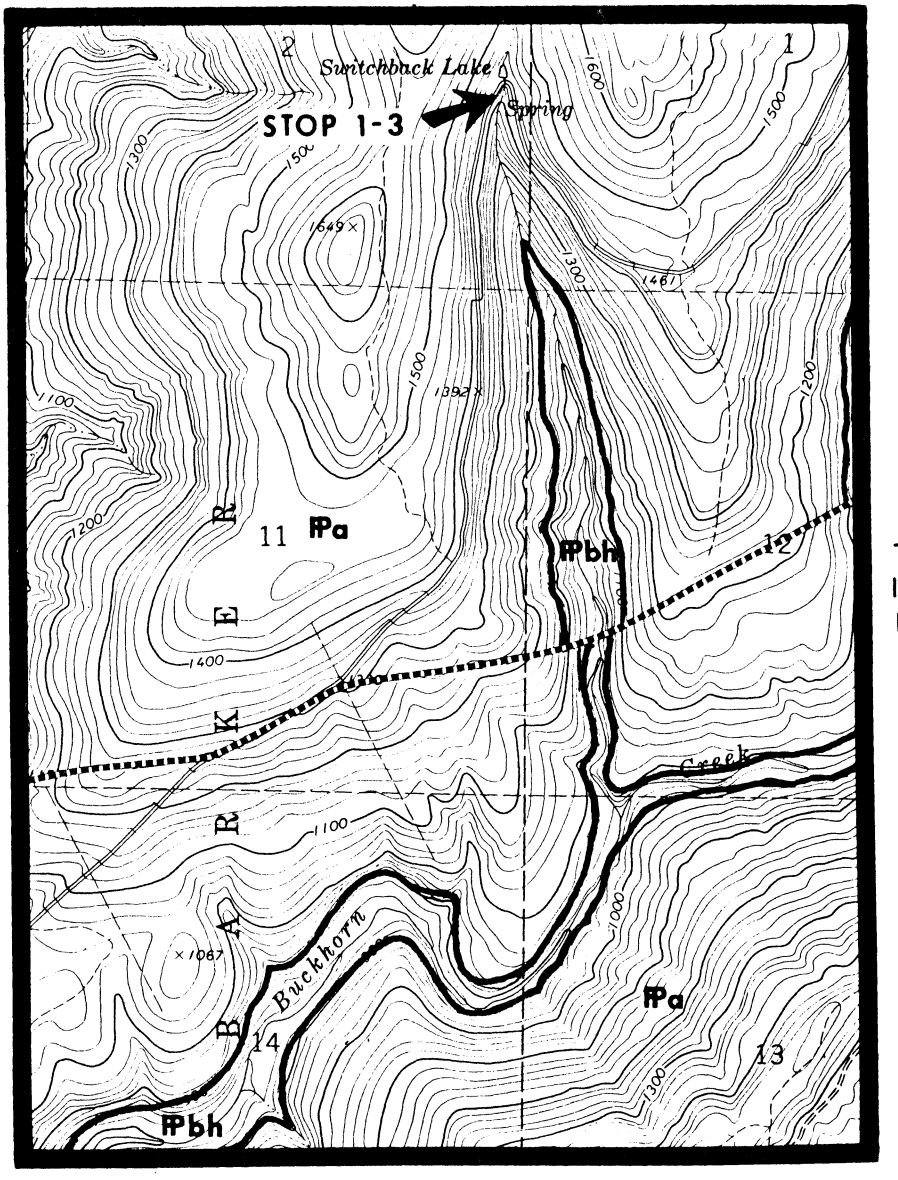

PLATE 3. SWITCHBACK LAKE – STOP 1-3.

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

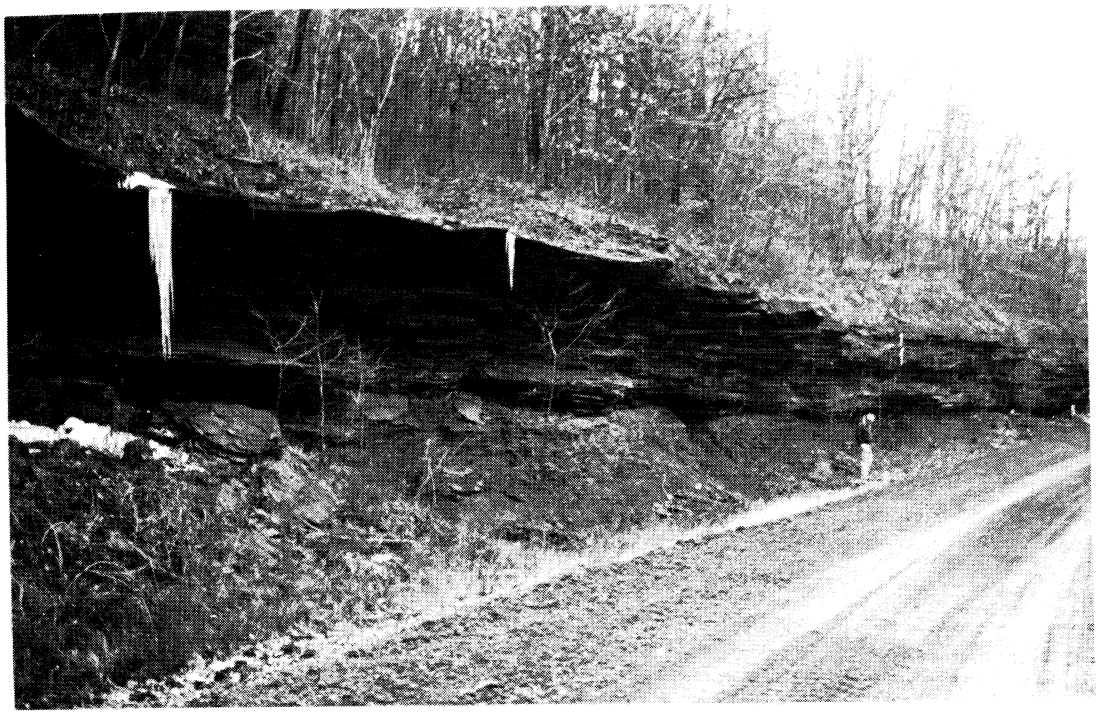

Figure 7. STOP 1-3. Switchback Lake, Atoka Formation. Delta fringe deposits overlain by distributary channel deposits (line of icicles).

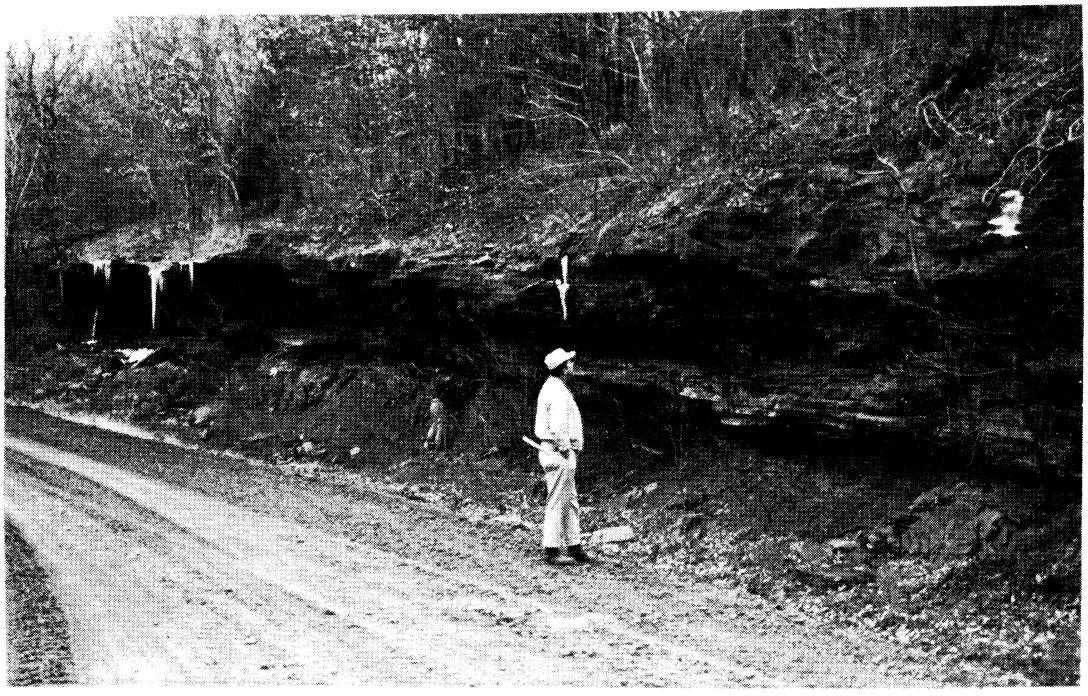

Figure 8. STOP 1-3. Switchback Lake. Fringe deposits overlain by cross-bedded distributary channel deposits.

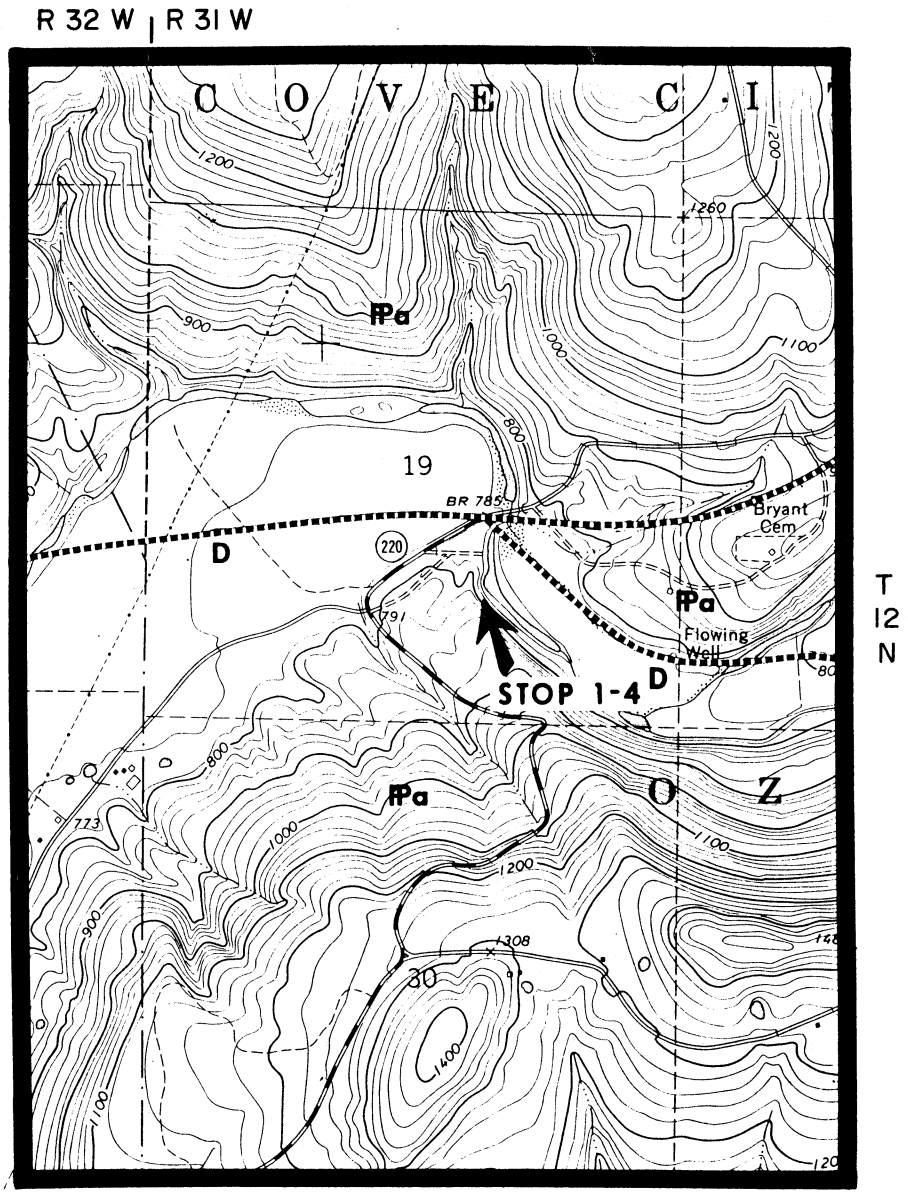

PLATE 4. LEE CREEK – STOP 1-4.

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Geology by Boyd R. Haley

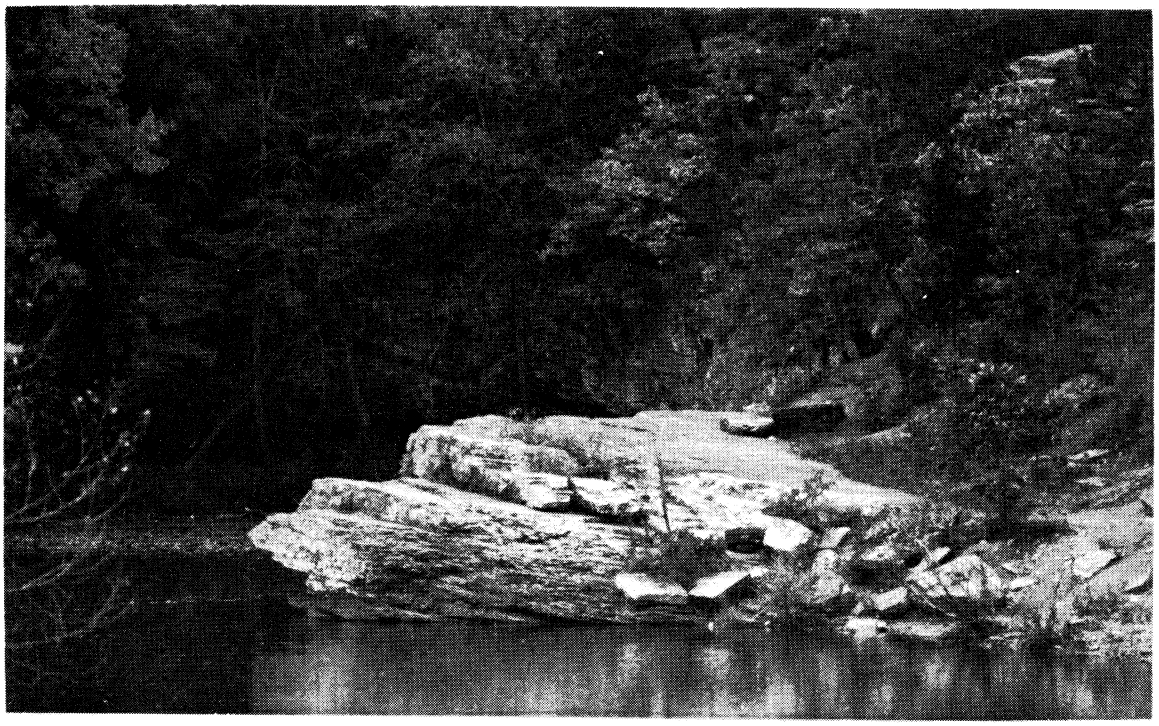

Figure 9. STOP 1-4. Lee Creek. Rocks can be classified as near shore fringe deposits of a prograding delta. Note the upward increase in sand grain size and abundance of fossils.

Figure 10. STOP 1-4. Lee Creek. The more shaly rocks are classified as fringe deposits but are farther from the front of the prograding delta than the overlying sandy zone.

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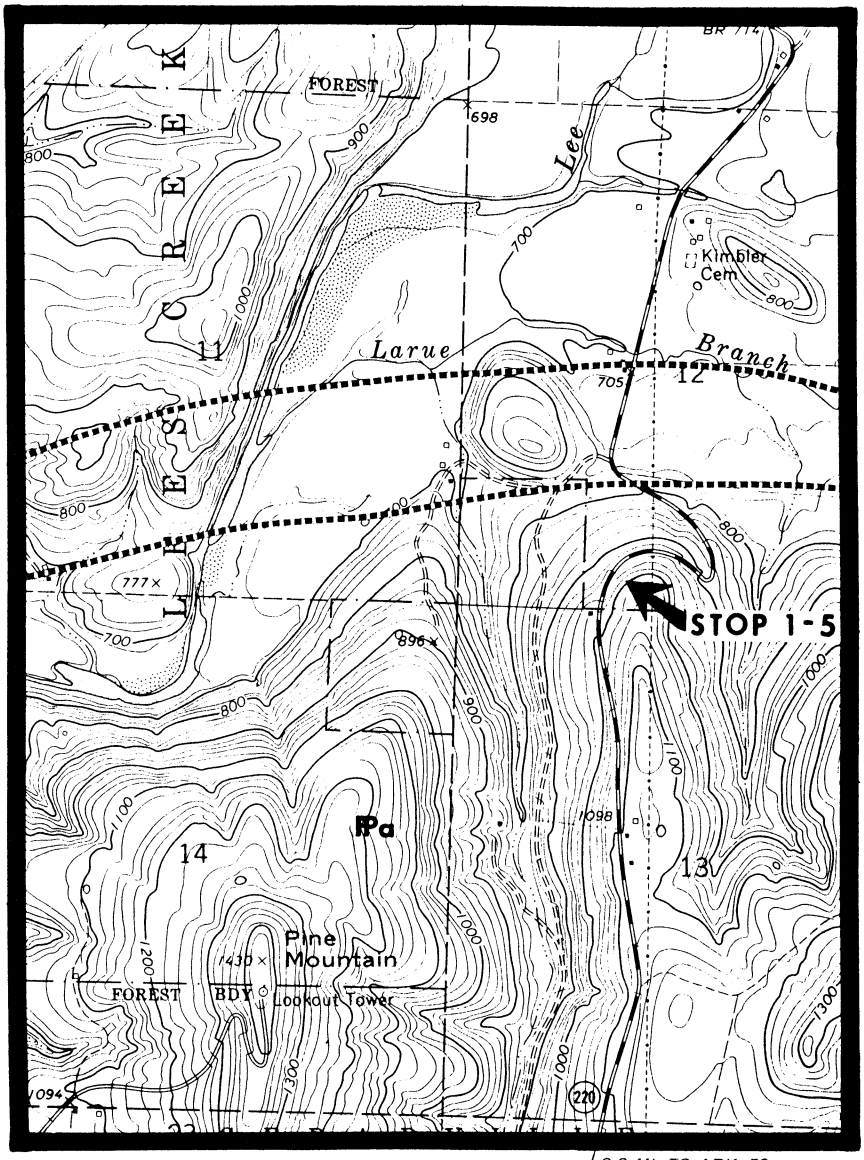

PLATE 5. PINE MOUNTAIN – STOP 1-5.

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Geology by Boyd R. Haley

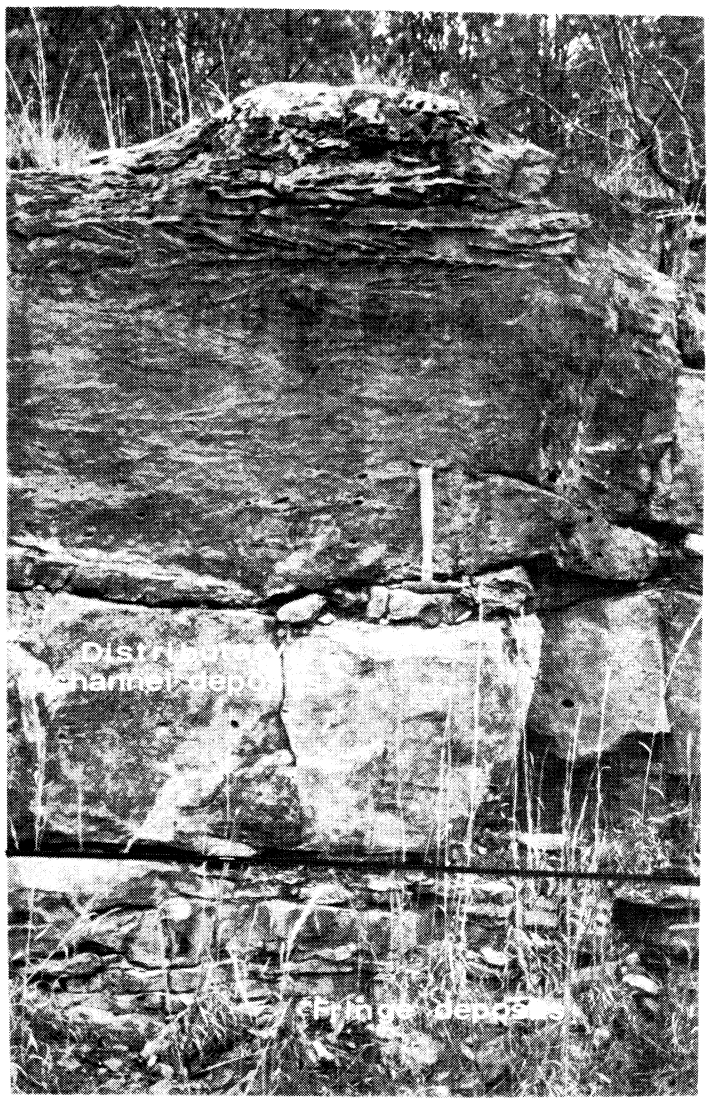
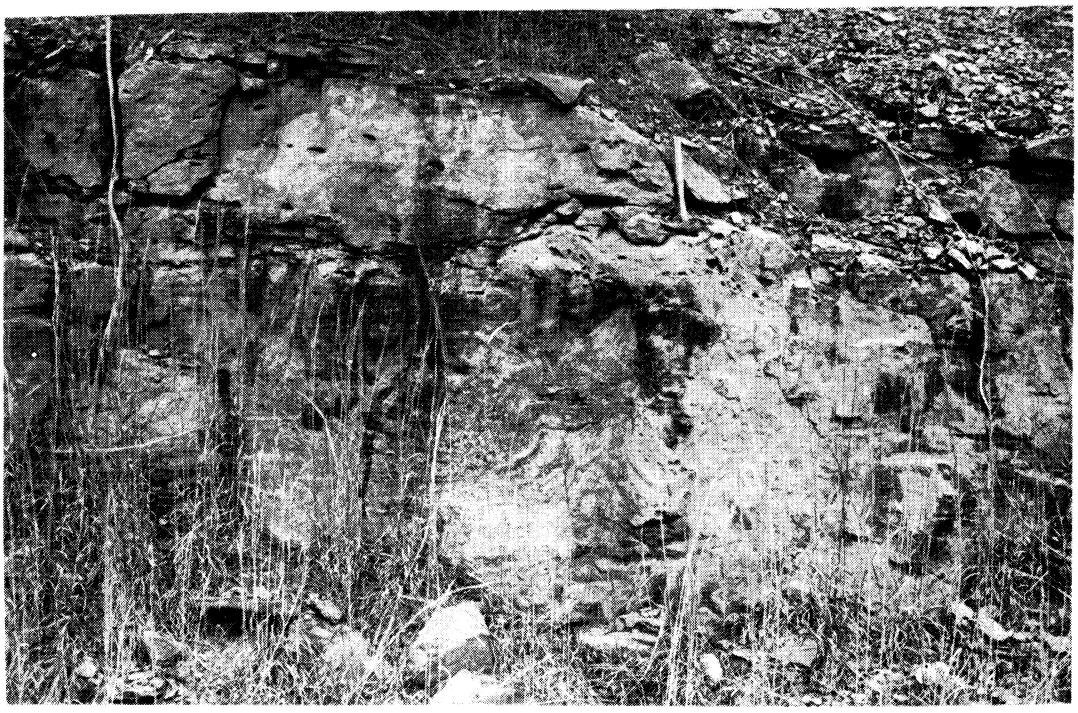


Figure 11. STOP 1-5. Atoka Formation.

Figure 12. STOP 1-5. Distributary channel deposits.



Mileage	Description
50.6	Outcrop of Atoka siltstone and sandstone to the west.
51.4	**STOP 1 - 6:** Siliceous shale of the Atoka. Plate 6, Figure 13. Outcrops on both sides of road. (Stop is in a dangerous curve). This zone of siliceous shale has been traced from the Oklahoma line eastward to north of Ozark, about 40 miles. It is about 1,200 feet above the base of the Atoka Formation. The more this rock is weathered the more siliceous or cherty it appears, which may be one reason it has never been noted in logging well samples.
51.5	Junction with Ark. Hwy. 59, *turn south (left),* onto Hwy. 59.
53.3	City limits of Cedarville, Arkansas.
53.6	Junction with Ark. Hwy. 162.
55.6	Junction with Ark. Hwy. 220.
55.8-56.1	Outcrop of Atoka sandstone, siltstone, and shale.
56.6-56.3	**STOP 1 - 7:** Prograding delta in Atoka shale, siltstone and sandstone. Plate 7, Figure 14. Parking problem, go past the stop to top of hill. As you walk southward, note the steady progression from outer fringe to inner fringe to distributary channel deposits.
57.7	Downtown Figure Five, Arkansas.
58.1	Outcrop of Atoka sandstone, siltstone, and shale, prograding delta.
59.0	Exposure of Atoka sandstone and siltstone.
59.8	Outcrop of Atoka sandstone to the east.
61.7	Junction with I-40, *turn left (east)* onto I-40, riding on Atoka.
63.7	Exit 7 to Van Buren and Fort Smith, 1-540 *turn south onto I-540.*
64.8	Outcrop of McAlester shale to the east. The McAlester Formation consists mainly of a dark gray shale, with lesser amounts of micaceous siltstone and sandstone. Lenticular coal beds can be found throughout the formation, but the thickest and most continuous is the Lower Hartshorne Coal at the base of the McAlester. The formation ranges in thickness from 500 to 1,000 feet. Even though it is continuous through west central Arkansas, outcrops are few.
65.4	Outcrop of McAlester shale to the east.
65.6	Riding on Arkansas River Alluvium.
66.0	Exit to Ark. Hwy. 59.
66.9	Center of Bridge over Arkansas River.
68.4	Exit to Kelly Highway.

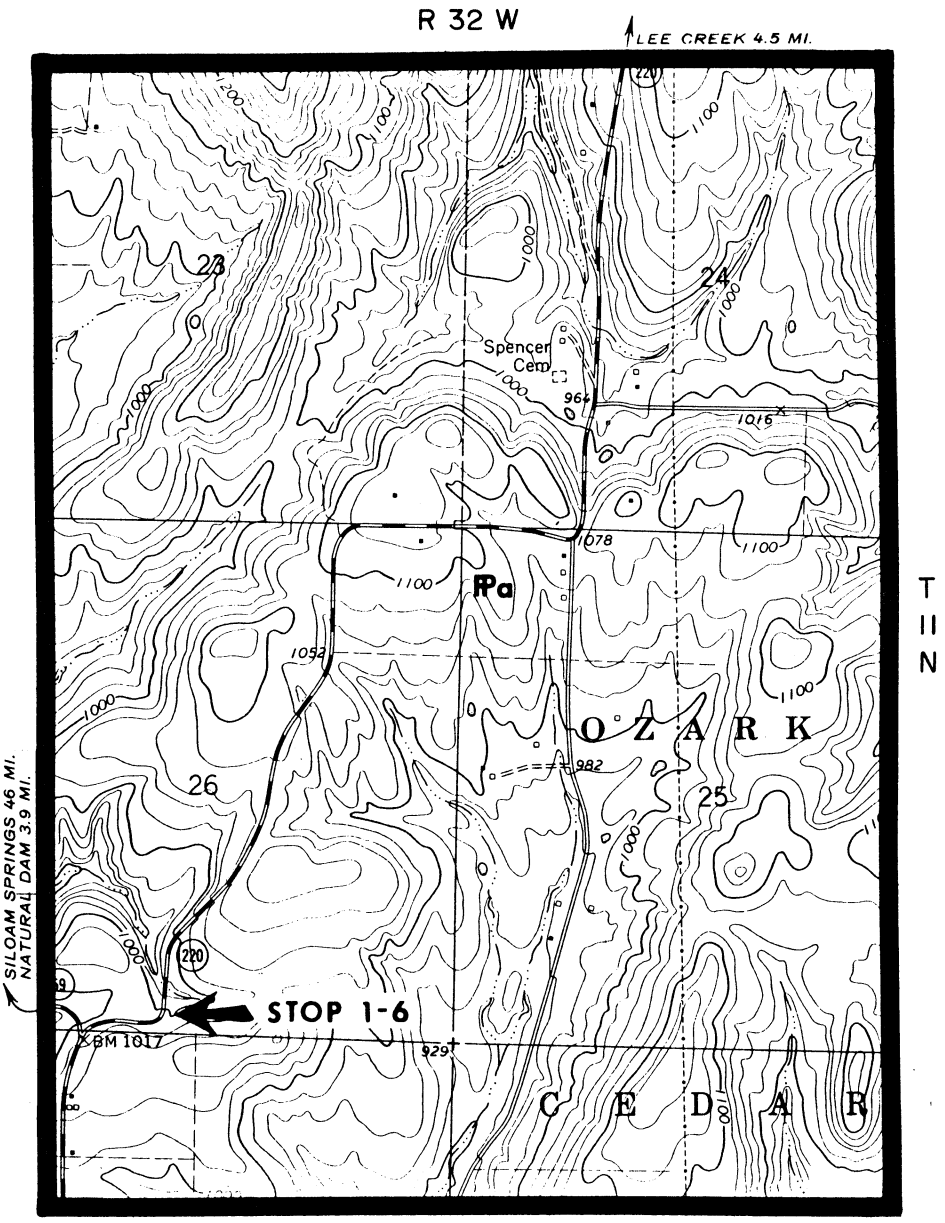


PLATE 6. HIGHWAY 220 SILICEOUS SHALE – STOP 1-6.

Geology by Boyd R. Haley

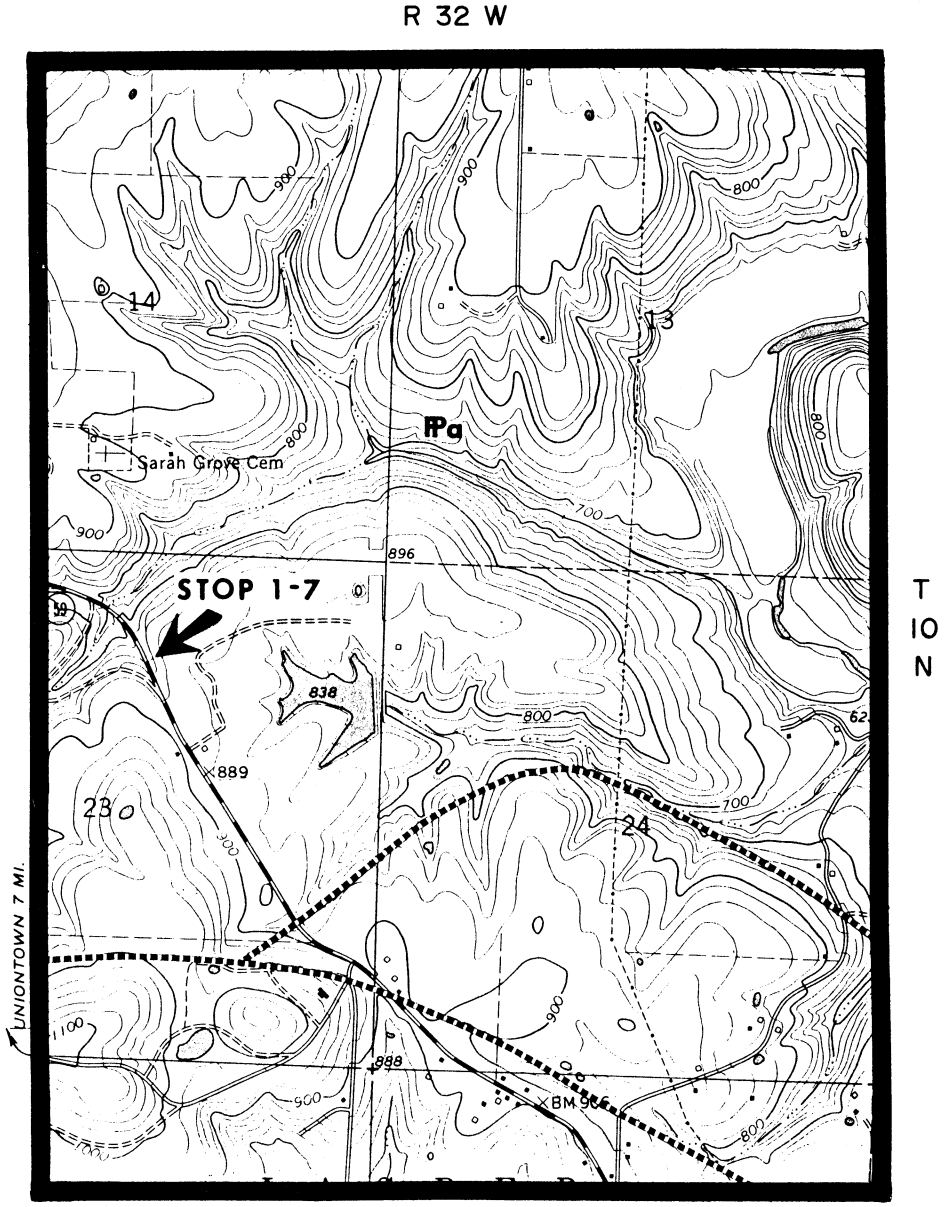


PLATE 7. NORTH OF FIGURE FIVE, ARKANSAS – STOP 1-7.

Geology by Boyd R. Haley

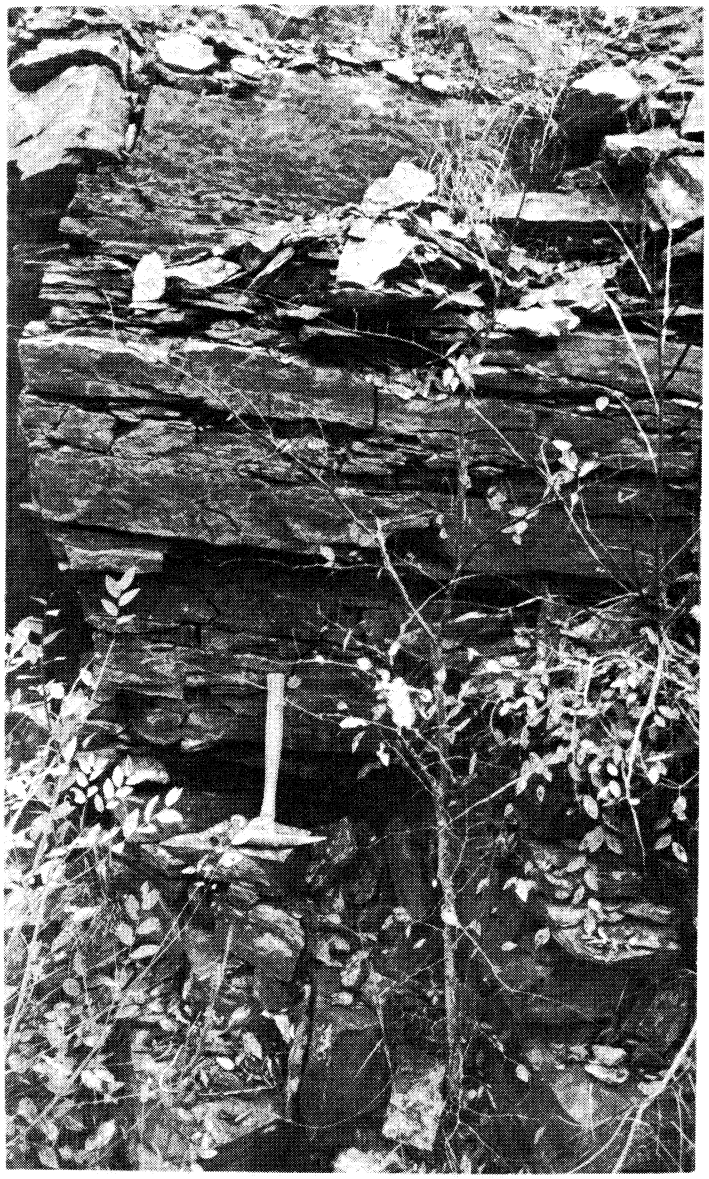


Figure 13. STOP 1-6. Siliceous shale in the Atoka Formation.

Figure 14. STOP 1-7. Outer fringe deposits.

Mileage	Description
69.2	Outcrop of McAlester shale overlain by gravels of Arkansas River Terrace deposits to the west.
69.5	Exposure of McAlester Shale to the west.
69.7	Exit to Grand Ave.
70.3	Outcrop of McAlester shale, siltstone, and sandstone to the east.
71.5	Exit to Ark. Hwy. 22.
73.0	McAlester shale crops out to the north.
73.4	Exit to Ark. Hwy. 45.
74.5	Exit to Ark. Hwy. 59.
75.5	Exit to Ark. Hwy. 71, *take exit.*
75.7	Junction with U. S. Hwy. 71, *turn south (left).*
78.5	Outcrop of McAlester shale, siltstone, and sandstone, prograding delta.
78.6	Junction with Ark. Hwy. 45, *turn left (west).* Riding on sandstone of the McAlester.
80.0	Hill to the south is capped by the basal sandstone of the Savanna Formation.
	The Savanna Formation lies conformably on the McAlester and consists chiefly of dark gray shale, and lesser amounts of gray, micaceous siltstone and fine grained gray sandstone. Several thin coal beds occur throughout the unit. Thickness of the unit reaches a maximum of 2,200 feet where the Boggy Formation is present.
81.0	Junction with paved road to the south.
82.0	Junction with Ark. Hwy. 253 and 45, *turn left (south).*
82.5	Hill to the west is capped by the basal sandstone of the Savanna Formation.
84.0	Downtown Bonanza, Arkansas. Site of the first commercial production of gas from Silurian age rocks. It was discovered by Shell Oil Corp. No. 1 Western Coal and Mining Company Well in Sec. 36, T. 7 N., R. 32 W. The structure of the rocks in the vicinity of the Bonanza Gas Field as depicted by Buchanan and Johnson (1968, Fig. 7) is shown as Figure 15 of this report. Using their structural interpretation, the gas now being produced from Silurian age rocks may be Pennsylvanian age gas that has migrated northward across the faults and through the Silurian age "pipeline" to its present location. Production is from the Siluro-Devonian Hunton Limestone, the Morrowan Hale Formation and the lower Atoka Formation at depths ranging from 3,922 to 8,110 feet. The field covers over 13,700 acres along an east-plunging anticline whose axis roughly follows the Backbone Thrust Fault. Cumulative gas production to 1977 was 78,663 MMCF.

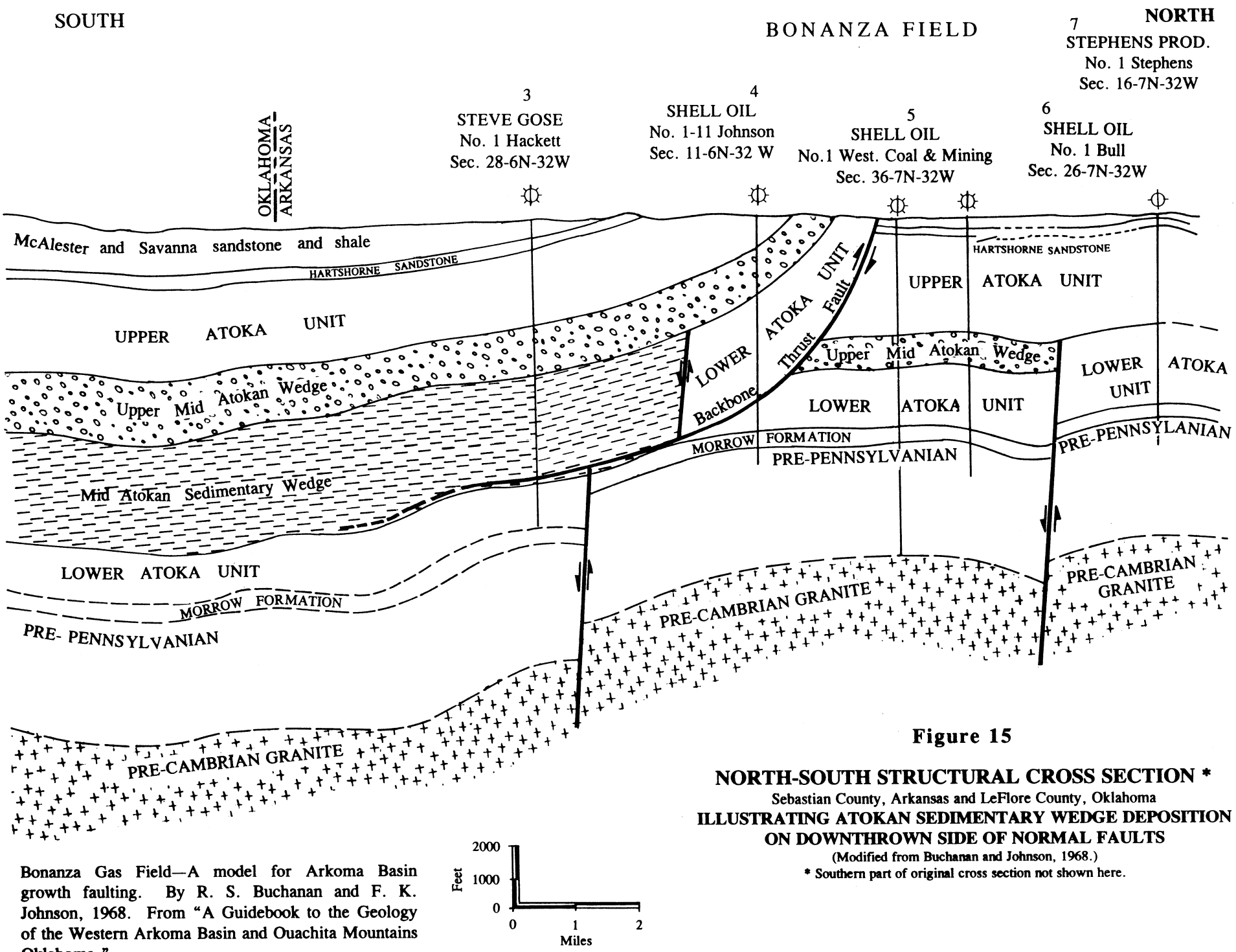


Figure 15

NORTH-SOUTH STRUCTURAL CROSS SECTION *

Sebastian County, Arkansas and LeFlore County, Oklahoma

ILLUSTRATING ATOKAN SEDIMENTARY WEDGE DEPOSITION ON DOWNTHROWN SIDE OF NORMAL FAULTS

(Modified from Buchanan and Johnson, 1968.)

* Southern part of original cross section not shown here.

Bonanza Gas Field—A model for Arkoma Basin growth faulting. By R. S. Buchanan and F. K. Johnson, 1968. From "A Guidebook to the Geology of the Western Arkoma Basin and Ouachita Mountains Oklahoma."

Mileage	Description
84.6	Coal Strip mine in the Lower Hartshorne to the east. Coal from the Great Western Mine (on mile to the west) was analyzed by the U.S. Bureau of Mines and that analyses is listed below.

Thickness (inches)	U.S. Bureau of Mines lab No.	Condition	Air-drying loss	Proximate analyses				Ultimate analyses					Btu/lb.	Fusibility of ash (°F.)			Remarks
				Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen		Initial defor-mation temp.	Softening temperature	Fluid temperature	
39	B-60289	1	1.6	2.0	18.1	70.4	9.5	1.4	4.1	79.4	1.5	4.1	13620	—	—	—	
		2	—	—	18.5	71.8	9.7	1.4	4.0	81.0	1.6	2.3	13890	—	—	—	
		3	—	—	20.4	79.6	—	1.6	4.4	89.7	1.7	2.6	15380	—	—	—	
36	B-60290	1	1.5	2.0	16.6	71.4	10.0	1.5	—	—	—	—	13540	—	2150	—	
		2	—	—	16.9	72.9	10.2	1.5	—	—	—	—	13810	—	—	—	
		3	—	—	18.8	81.2	—	1.7	—	—	—	—	15390	—	—	—	
42	B-60291	1	1.5	2.0	16.4	73.1	8.5	1.3	—	—	—	—	13830	—	2230	—	
		2	—	—	16.7	74.6	8.7	1.3	—	—	—	—	14100	—	—	—	
		3	—	—	18.3	81.7	—	1.5	—	—	—	—	15440	—	—	—	
—	B-60292	1	1.5	2.0	16.8	71.8	9.4	1.4	4.1	79.5	1.6	4.0	13630	—	—	—	Composite of samples B-60290 and B-60291.
		2	—	—	17.2	73.2	9.6	1.4	4.0	81.1	1.6	2.3	13910	—	—	—	
		3	—	—	19.0	81.0	—	1.6	4.4	89.7	1.8	2.5	15380	—	—	—	

Condition of sample: 1 - as received; 2 - moisture free; 3 - moisture and ash free.

84.8 Backbone Fault, thrust northward. The Backbone Fault extends eastward into Arkansas from Oklahoma to near Greenwood, Arkansas. The fault is a high-angle thrust fault with the south side moving to the north and has a maximum displacement of 5,000 feet in Arkansas. The lower part of the Atoka has been thrust over the Hartshorne along the route of this trip.

84.9 Outcrop of lower Atoka sandstone.

85.8-86.0 Outcrop of Atoka sandstone. Same sandstone as the producing sand at Mansfield, Ark.

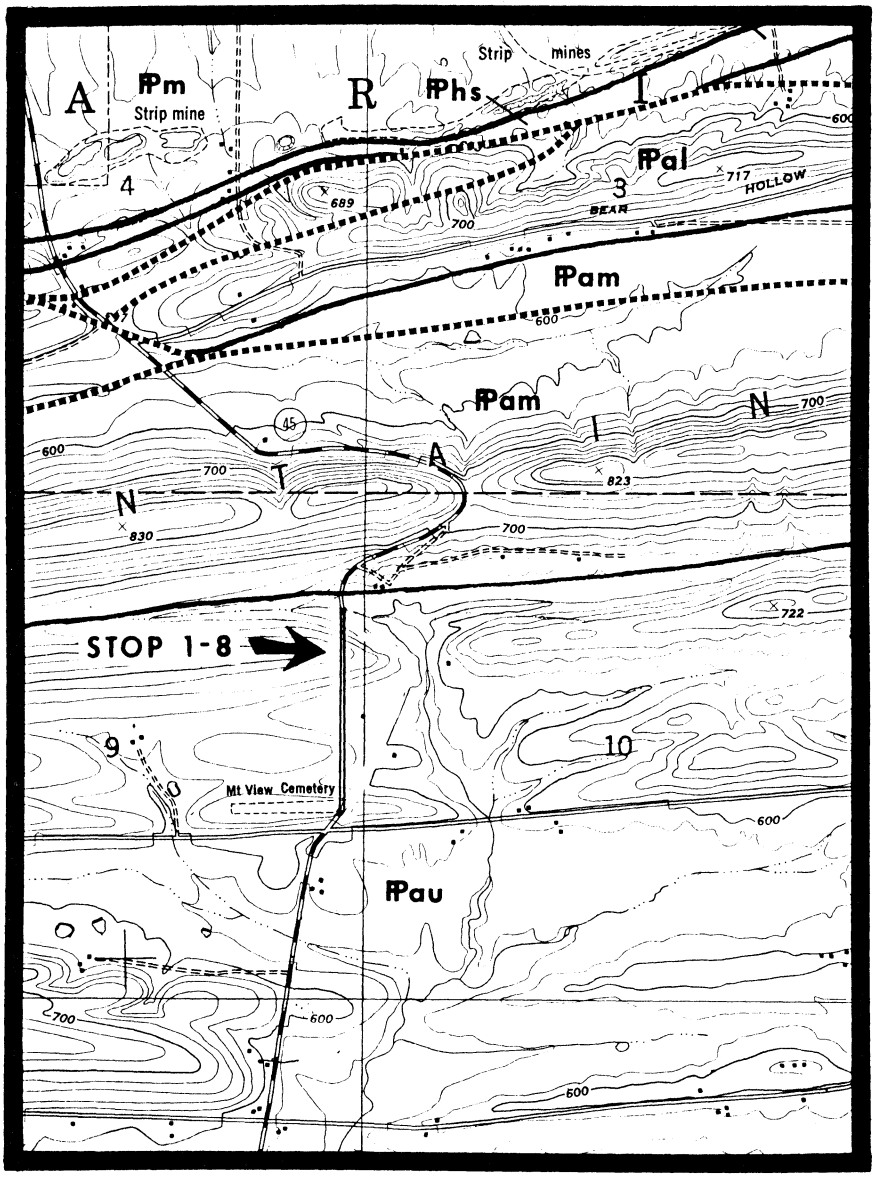
86.2 **STOP 1 - 8 : South of Bonanza.** Plate 8 , figures 16, 17. This is an excellent exposure of a complete prograding delta sequence in the upper part of the Atoka Formation. The rocks progressively change upward from pro-delta deposits on the north end of the exposure through outerfringe, innerfringe, distributory channel to stream channel deposits on the south end of the outcrop. A zone of plant fossils or a thin coal bed is present above this sequence in nearby outcrops.

86.9 Outcrop of Atoka shale, siltstone, and sandstone.

88.0 Excellent exposure of Hartshorne - Atoka contact. Junction with Ark. Hwy. 10, turn left (east), riding on Hartshorne, dip slope to the south. (North edge of Hackett, Ark.)

The Hartshorne Sandstone lies unconformably on the Atoka Formation. Thickness varies from 25 to 180 feet. The formation consists of a thin to massive-bedded, fine-grained, gray, micaceous sandstone and interlayers of dark gray micaceous shale. The Hartshorne is at the base of the Des Moines Series and extends from Faulkner County west into Oklahoma.

R 32 W



T 6 N

PLATE 8. SOUTH OF BONANZA – STOP 1-8.

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

Figure 16. STOP 1-8. Prodelta, outer fringe, and inter fringe deposits.

Figure 17. STOP 1-8. Bioturbated deposits of the inner fringe deposits.

Mileage	Description
93.5	Junction with Ark. Hwy. 253 to the south.
95.1	Junction with U. S. Hwy. 71, *turn right (south).*
95.2	Coal mine dump from Hartshorne Coal to the west.
95.8	Outcrop of McAlester shale to the east.
96.2	**STOP 1-9: Devils Backbone.** Plate 9, Figures 18–20. From north to south: McAlester shale with the Lower Hartshorne Coal consisting of two coal beds; Hartshorne Sandstone; and, Atoka Formation. The rocks in the Hartshorne Sandstone at this stop may be classified as a series of stream (fluvial) channel deposits. Note the claystone conglomerates, plant fragments, and stringers of coal near the base of many of the channels. Some, if not all, of the rock between the sandstone and the lower coal bed may be overbank deposits. The Hartshorne Sandstone unconformably overlies the Atoka Formation everywhere in Arkansas. At this stop it overlies outerfringe and prodelta deposits. *Turn around proceed north on U. S. Hwy. 71.*
97.3	Junction with Ark. Hwy. 10.
97.4	**STOP 1-10: Sand Ridge;** Plate 9, Figure 21. Excellent exposures of stream channel deposits in the Hartshorne Sandstone overlying prodelta deposits of the Atoka Formation. The sand in the Hartshorne as exposed on the east side of the highway may be classified as intermingled stream and fringe deposits.
97.9	Exposure of Atoka sandstone to the west.
98.0	Junction with Ark. Hwy. 105.
98.2	Atoka sandstone crops out to the east.
99.0	Junction with Ark. Hwy. 10 Spur.
100.2-100.4	Outcrop of Atoka sandstone and shale to the east.
100.9	**STOP 1-11: Jenny Lind,** Plate 10, Figure 22. The contact between the Hartshorne Sandstone and the Atoka Formation is exposed in the north end of the road cut. The faults in the Backbone Fault System just south of here are south-dipping and have northward moving thrust plates. The fault exposed in the middle of this road cut (Fig. 22) has a north-dipping fault plane, and a southward moving thrust plate. The movement along this fault represents adjustment of younger rocks to the acute folding along the north side of the Backbone Anticline.
103.3	Outcrop of McAlester shale, siltstone and sandstone represents another good example of a prograding delta sequence.
104.7	Outcrop of McAlester shale, siltstone and sandstone. Prograding delta sequence.

R 31 W

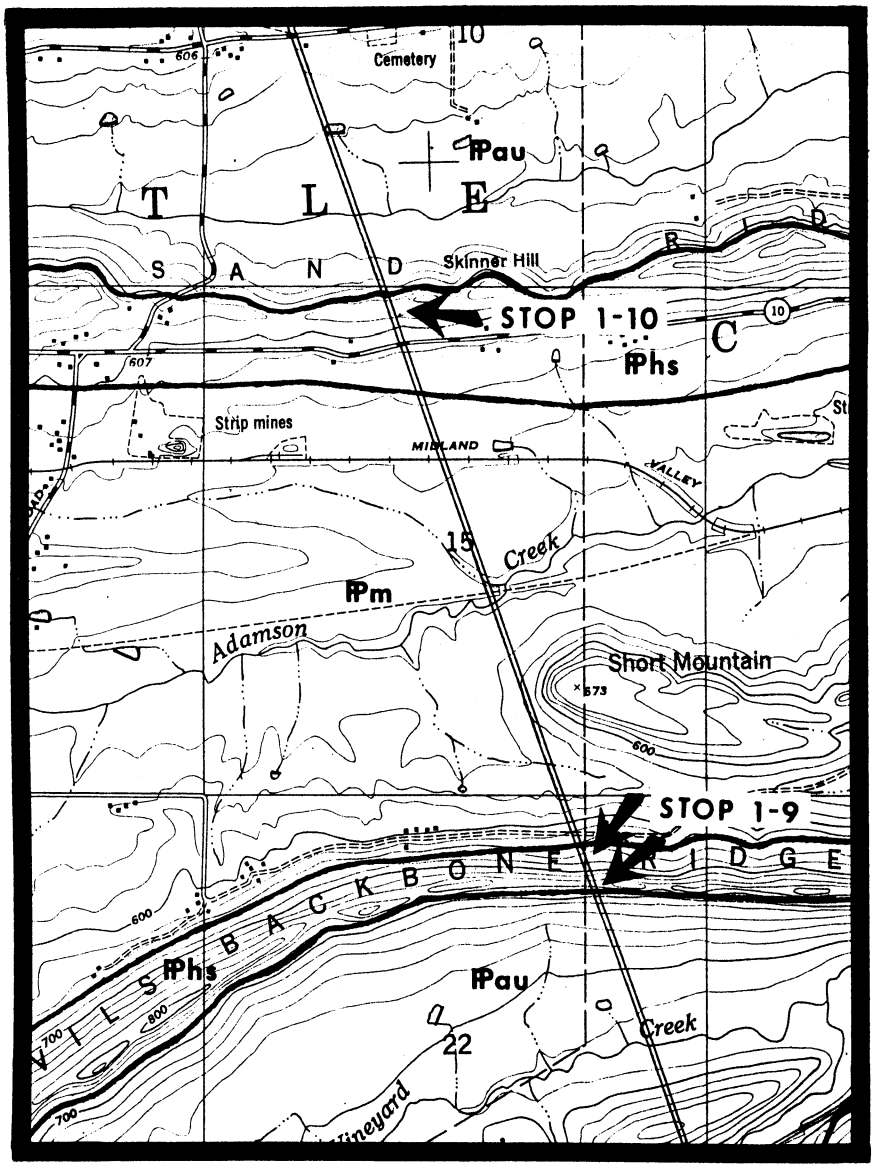


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PLATE 9. DEVILS BACKBONE, STOP 1-9 AND SAND RIDGE, STOP 1-10.

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

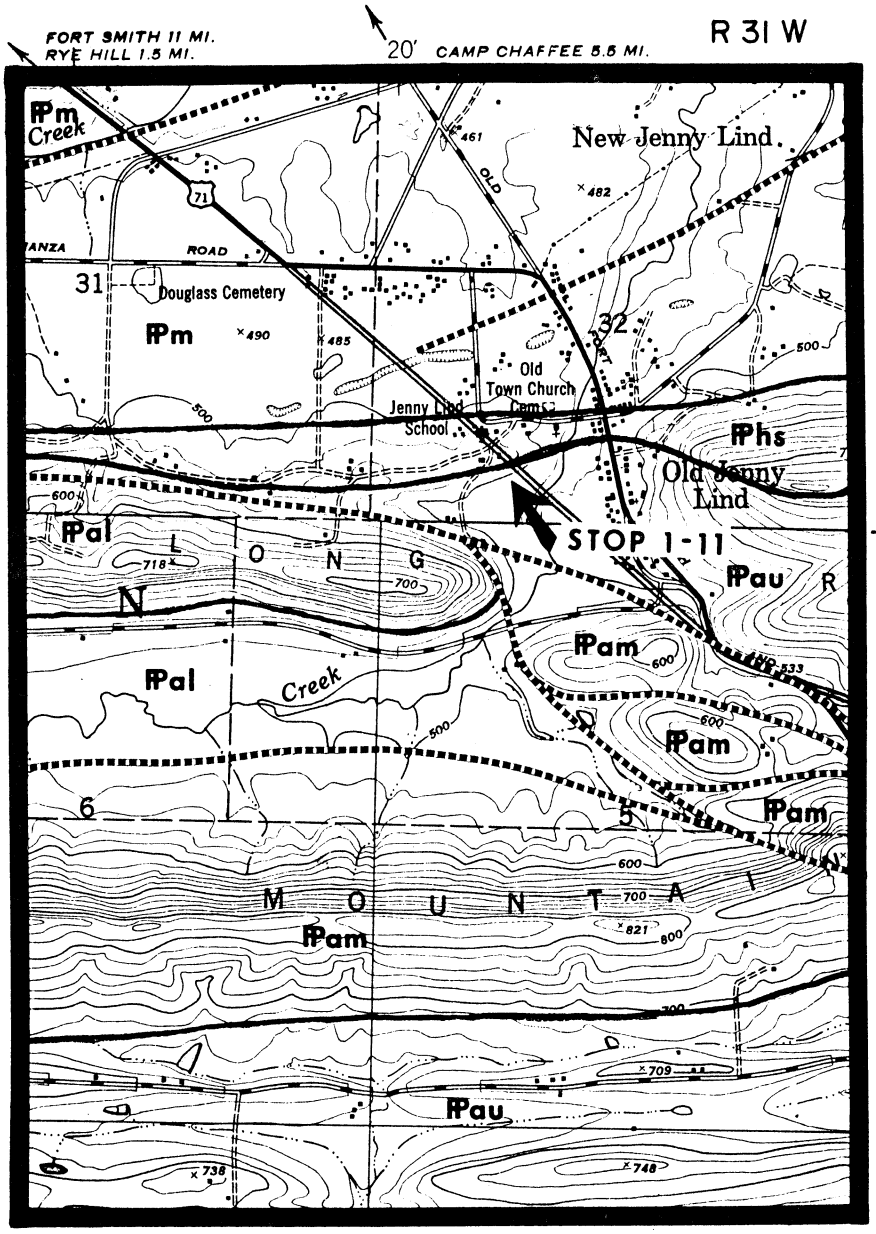

PLATE 10. JENNY LIND — STOP 1-11.

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

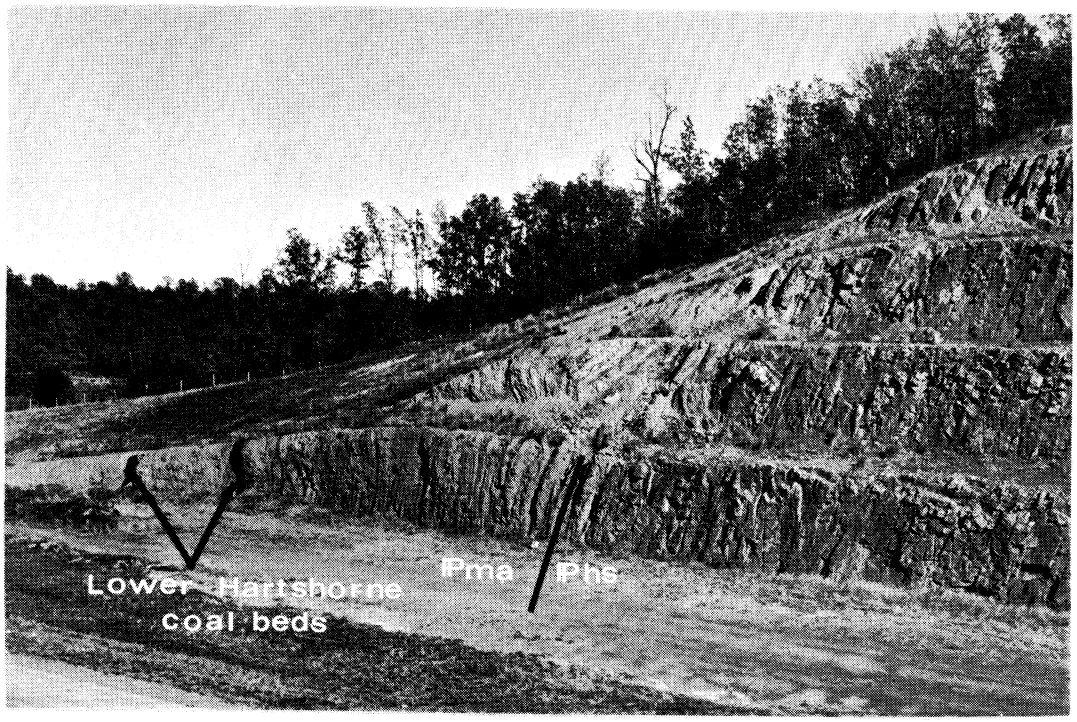

Figure 18. STOP 1-9. Devil's Backbone (north end of outcrop looking east).

Figure 19. STOP 1-9. Devil's Backbone (south end of outcrop looking east).

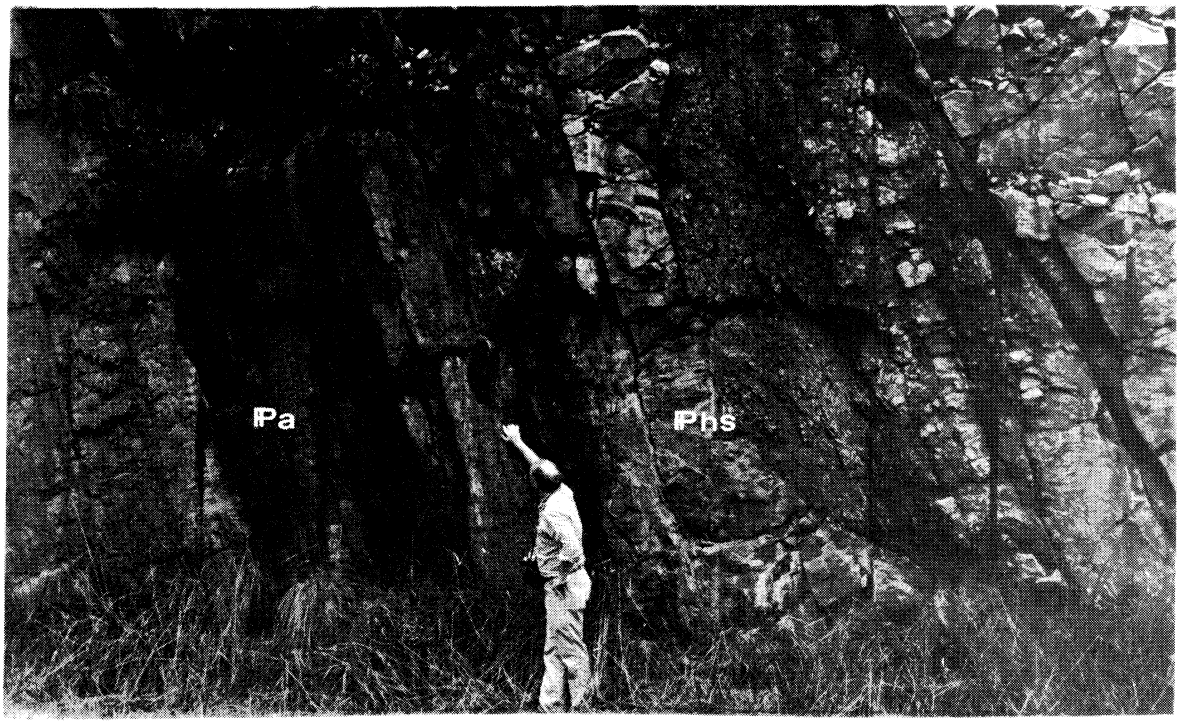

Figure 20. STOP 1-9. Devil's Backbone (looking west). Charles Stone is pointing to the contact between the Hartshorne Sandstone and the Atoka Formation. Note the shale pebble conglomerate in the lower part of the channel just left of Stone.

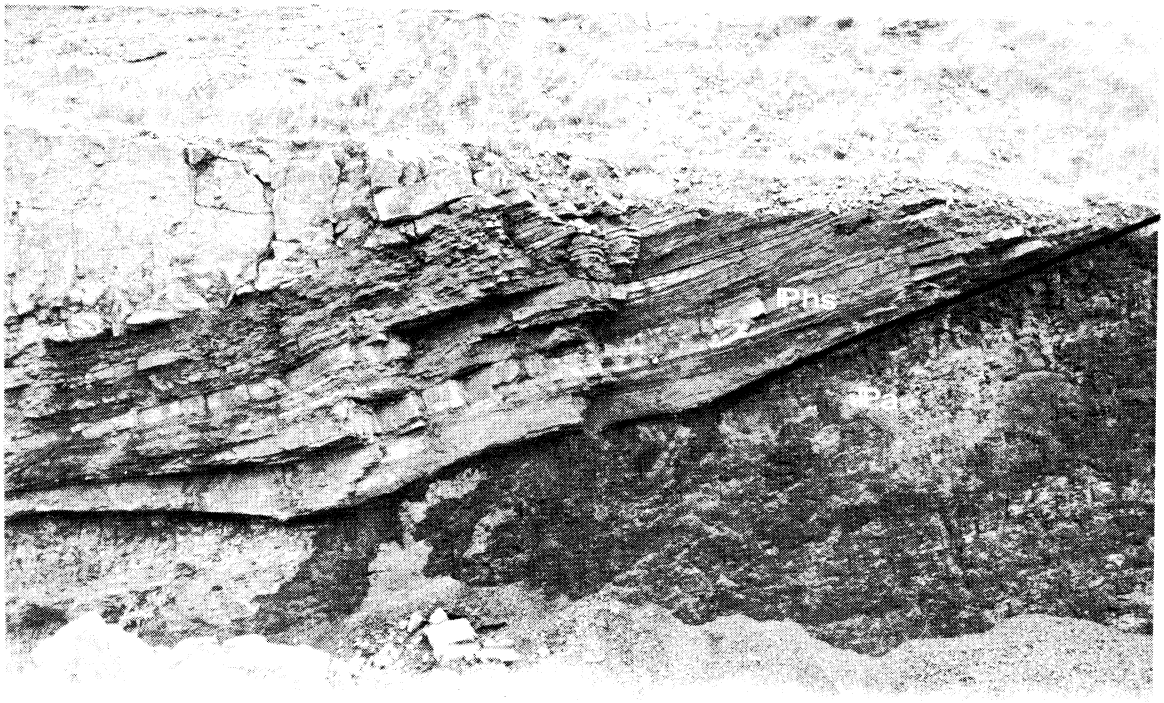

Figure 21. STOP 1-10. Excellent exposure of a Hartshorne Sandstone channel cutting into the Atoka Formation.

Figure 22. STOP 1-11. North dipping thrust fault cutting a channel sequence in the upper Atoka sandstone and shale.

Mileage	Description
105.8	Exposure of McAlester shale.
106.4	Pimple Mounds to the west.
107.2	Exit to I-540, *turn right (north)* onto I-540.
108.2	Exit to Ark. Hwy. 59.
108.9	Exit to Ark. Hwy. 45.
109.8	McAlester shale crops out to the left.
111.1	Exit to Ark. Hwy. 22 (Rogers Ave.), *take exit.*
111.4	Junction of Ark. Hwy. 22 (Rogers Ave.), *turn right (west)* onto Rogers Ave.

END OF 1st DAY ROAD LOG.

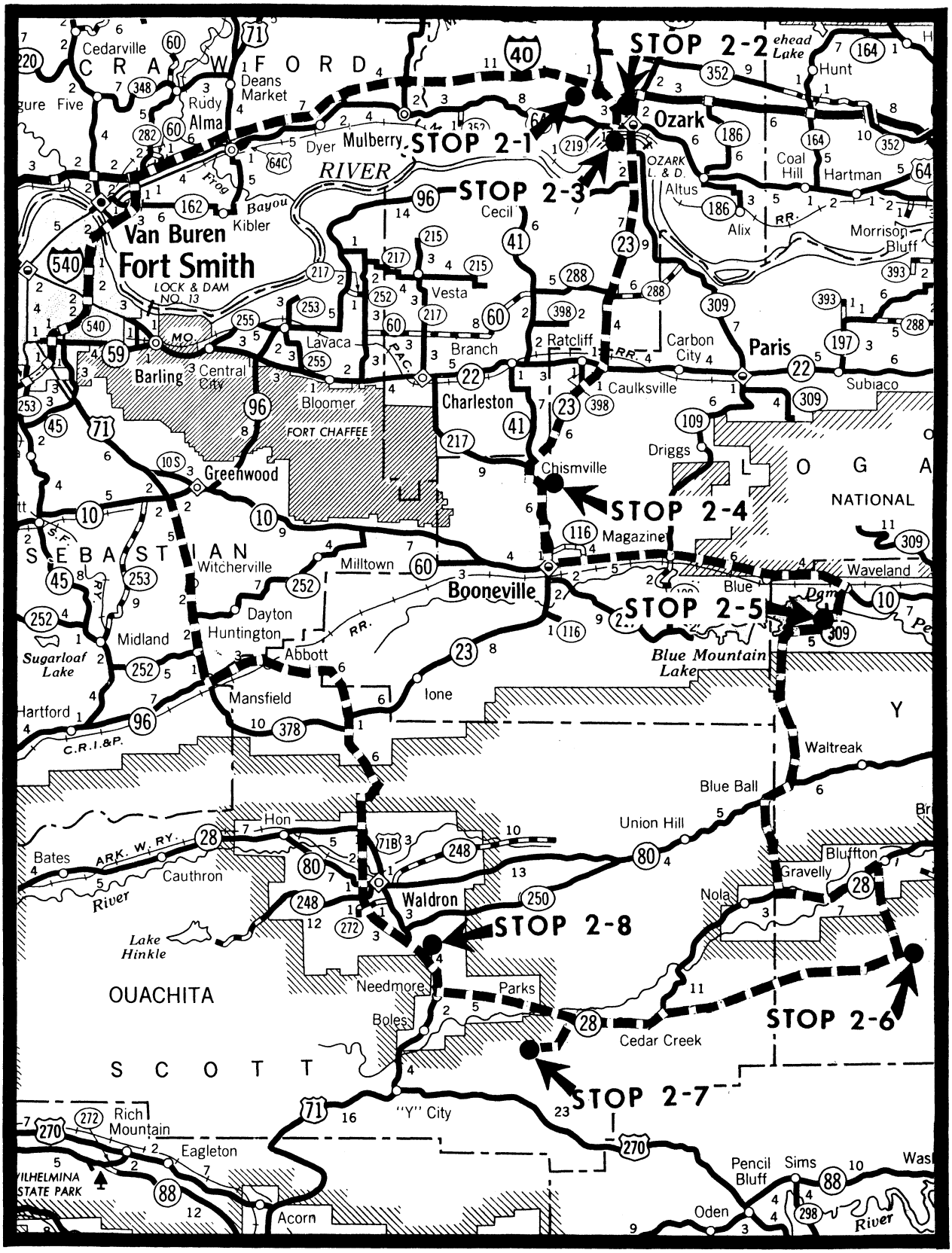

FIGURE 23 INDEX MAP OF SECOND DAY ROAD LOG

MILES 0 5 10 15 20 25

Route

STOP 2-1

CORRELATION OF CARBONIFEROUS ROCKS IN THE OZARK, ARKANSAS VALLEY, AND OUACHITA MOUNTAIN REGIONS, ARK.

AGE			OZARK - ARKANSAS VALLEY SECTION		MAP SYM.	OUACHITA MTN. SECTION		MAP SYM.
CARBONIFEROUS SYSTEM	PENNSYLVANIAN	DES MOINES	Boggy Fm.		$\mathbb{P}$by	Missing		
			Savanna Fm.		$\mathbb{P}$sv			
			Mc Alester Fm.		$\mathbb{P}$ma			
			Hartshorne Sandstone		$\mathbb{P}$hs			
		ATOKA	Atoka Fm.		$\mathbb{P}$a	Atoka Fm.		$\mathbb{P}$a
		MORROW		Kessler Ls. Mbr.	$\mathbb{P}$bk			
			Bloyd Shale	Woolsey Mbr.	$\mathbb{P}$bw	Johns Valley Shale		$\mathbb{P}$jv
				Brentwood Ls. Mbr.	$\mathbb{P}$bb			
			Hale Fm.	Prairie Grove Mbr.	$\mathbb{P}$hp	Jackfork Fm.		$\mathbb{P}$j
				Cane Hill Mbr.	$\mathbb{P}$hc			
	MISSISSIPPIAN	UPPER	Pitkin Limestone		Mp	Chickasaw Creek Mbr.		Ms
			Fayetteville Shale	Wedington SS Mbr.	Mf	Stanley Shale		
			Batesville Sandstone	Hindsville Ls. Mbr.	Mbh			
			Ruddell Shale		Mr	Hatton Tuff		
			Moorefield Fm.		Mm	Hot Springs SS Mbr.		
		LOWER	Boone Fm.	Short Creek Oolite Mbr.	Mb	Arkansas Novaculite	Upper Div.	MDa
				St. Joe Ls. Mbr.				

GENERAL LITHOLOGIC DESCRIPTION OF UNITS

OZARK MOUNTAINS ARKANSAS VALLEY	Max. Thickness	OUACHITA MOUNTAINS	Max. Thickness
Pennsylvanian System		Pennsylvanian System	
Des Moinesian Series		Des Moinesian Series	
Boggy Formation			
Savanna Sandstone—sandstone and shale	850		
McAlester Formation—shale, sandstone, and coal	1,000	"missing"	
Hartshorne Sandstone—massive sandstone	180		
Atokan Series		Atokan Series	
Atoka Formation—sandstone and shale	6,500	Atoka Formation—shale and sandstone	27,500±
Morrowan Series		Morrowan Series	
Bloyd Shale—shale, sandstone, limestone, and minor coal	350	Johns Valley Shale—shale, minor sandstone and limestone, and erratic boulders	1,500±
Hale Formation—shale, sandstone, and limy sandstone	250	Jackfork Sandstone—sandstone and shale	6,000
Mississippian System		Mississippian System	
Chesterian Series			
Pitkin Limestone—massive limestone and shale		Stanley Shale—shale, sandstone, and some chert	8,500
Fayetteville Shale—black shale with minor limestone and sandstone	200		
Batesville Sandstone—sandstone and limestone	350		
	75		
Kinderhookian—Osagean—Meramecian Series		Upper and upper portion of the Middle Divisions of	
Boone Formation—limestone and chert		the Arkansas Novaculite—novaculite and shale	130
	400		

Figure 24

ROAD LOG — SECOND DAY

ARKANSAS VALLEY — OUACHITA MOUNTAINS

by

William V. Bush, Boyd R. Haley, Charles G. Stone
and John D. McFarland, III

Mileage	Description
0.0	Start from Rogers Ave. (Ark. Hwy. 22), Fort Smith, Arkansas. *Turn right (south)* onto ramp for I-540 north.
1.2	Outcrop of McAlester shale, siltstone, and sandstone to the east.
1.7	Exit to Grand Ave.
2.1	Outcrop of McAlester shale to the west.
2.3	Outcrop of McAlester shale overlain by gravels of Arkansas River Terrace deposits to the west.
3.1	Exit to Kelly Highway.
5.0	Center of bridge over Arkansas River.
5.3	Exit to Ark. Hwy. 59.
5.9	Riding on Arkansas River Alluvium.
6.4	Outcrop of McAlester shale to the east.
6.9	McAlester shale crops out to the east.
7.4	Exit to Van Buren.
7.8	Exit 7 to Van Buren.
8.1	Exit to Little Rock, *take I-40* to the east.
12.7	Bridge over Bull Frog Bayou.
13.7	Exit 13 to Alma.
14.4	Outcrop of Atoka shale to the north. I-40 is on the surface trace of the Mulberry Fault. Displacement of this normal fault is approximately 2,500 feet with the downthrown side to the south. Ridge to the north is underlain by the middle part of the Atoka and the hill to the south is underlain by the Savanna Formation.
20.0	Outcrop of Atoka shale and sandstone to the north.
20.4	Exit 20 to Dyer and Mulberry.
23.5	Exposure of McAlester shale to the south.
24.4	Exit 24 to Mulberry.
25.2	Franklin County Line and Mulberry River.

Mileage	Description
29.6	Outcrop of Atoka shale, siltstone and sandstone representing a prograding delta sequence.
31.0-31.4	Outcrop of Atoka sandstone to the north represents a stream (fluvial) channel deposit.
32.2	Bridge over creek.
34.4	Outcrop of Atoka shale to the north.
34.8	**STOP 2-1: Upper Atoka shale, siltstone, sandstone and coal bed.** Plate 11, Figure 25. (Watch for traffic on I-40). A unique growth fault cuts this overbank and channel sequence of upper Atoka. The purpose of this stop is mostly to examine the fault shown in Figure 25. The fault has two rather unique features: (1) it has displacement indicative of a thrust fault; and (2) movement along the fault plane ceased during deposition of the overlying sandstone. Note the continuity and westward thickening of the upper beds of sandstone across the upper end of the fault. This growth thrust fault could have been caused by the following sequence of events: (1) the coal bed and the underlying sediments were deposited; (2) a channel was eroded in these deposits to the east or northeast of this stop; (3) the channel was filled and sand was deposited on the coal bed; and (4) during the deposition of the sand the weight of the sediments in the channel caused lateral movement in the surrounding deposits. This fault is an expression of that lateral movement.
35.0	Exit 35 to Ozark, Arkansas.
35.9-36.3	**STOP 2-2. Atoka shale and sandstone.** Plate 11, Figures 26-28. (Watch for traffic on I-40). Rest area and picnic area. Most of the rock at this stop can be classified as interfringe deposits. Sedimentary features such as a shale-filled channel and a sand plug(?) or diapir(?) will be examined and discussed.
37.5	Take exit 37 to Ozark, Arkansas.
38.0	Junction with Ark. Hwy. 219, *turn right (south)* onto Hwy. 219.
38.4	Outcrop of Atoka sandstone to the west.
38.6	Fault, downthrown side to the south.
38.7	Outcrop of Atoka sandstone and siltstone to the east.
39.9	Junction with U. S. Hwy. 64, *turn right (west)* onto Hwy. 64, downtown Ozark.
40.2	Junction with Ark. Hwy. 23.
40.5	*Turn left (south)* onto 12th Street, just east of the cemetery.
40.6	*Turn west on loop (jog in road to right)*
40.7	**STOP 2-3: Upper part of the Atoka Formation at Ozark, Arkansas.** Plate 12, Figures 29-32. In front of end house, walk south on the east side of the house along the gulley to the railroad tracks. Permission must be obtained before crossing private property. Depositional sequence of the rocks exposed in this outcrop can be explained as follows: clay and silt were deposited on the outer fringes of a delta; the delta advanced and a stream eroded a channel in the clay and silt; the channel was filled with sand; and, the weight of the sand caused the deformation of the underlying and adjacent clay and silt (Figures 30 and 31). Should the sediments in the channel be classified as a stream or as distributary deposits?
40.8	*Proceed around loop, turn north* onto 12th Street.

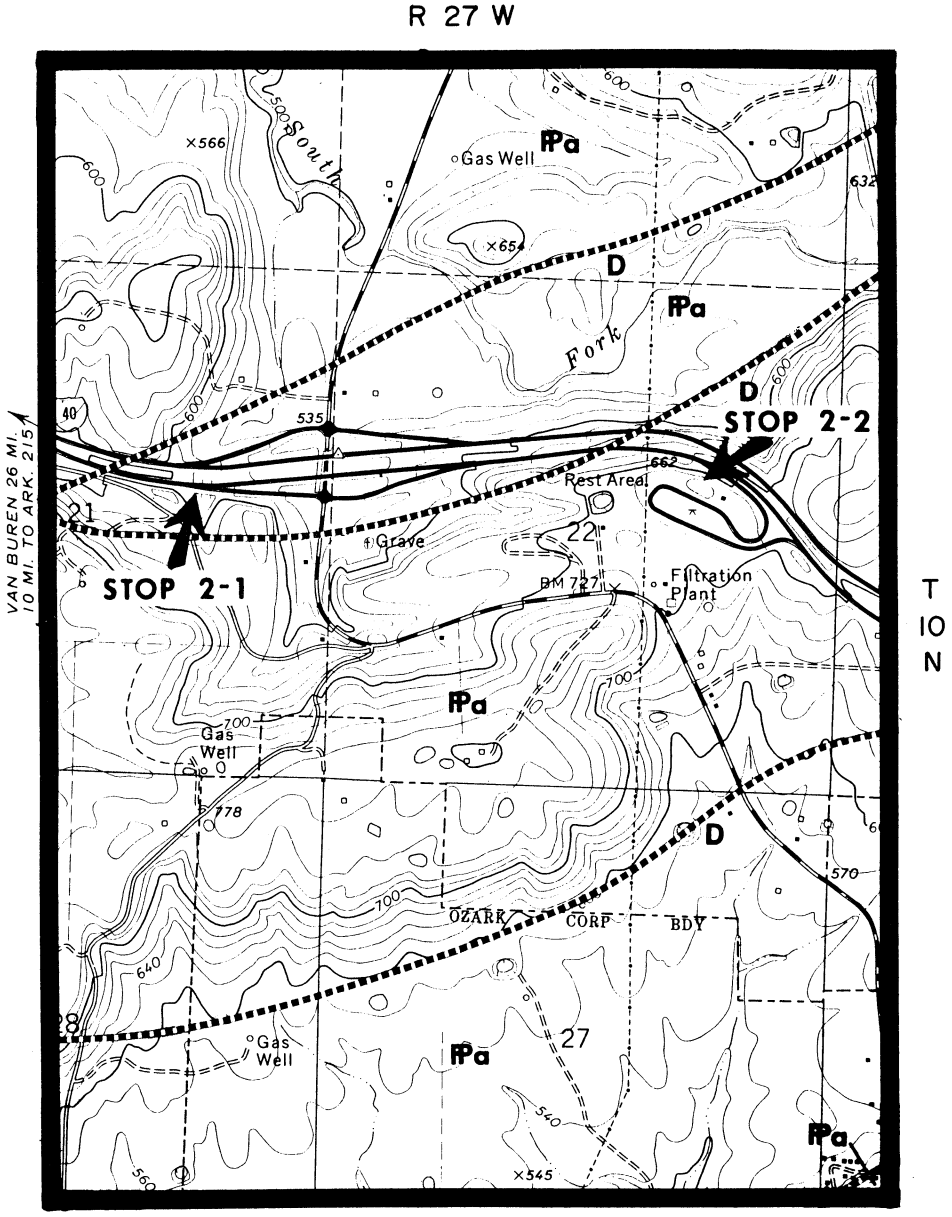

PLATE II. ATOKA FORMATION ALONG I-40 — STOPS 2-1

1000 0 1000 2000 3000 FEET

Geology by Boyd R. Haley

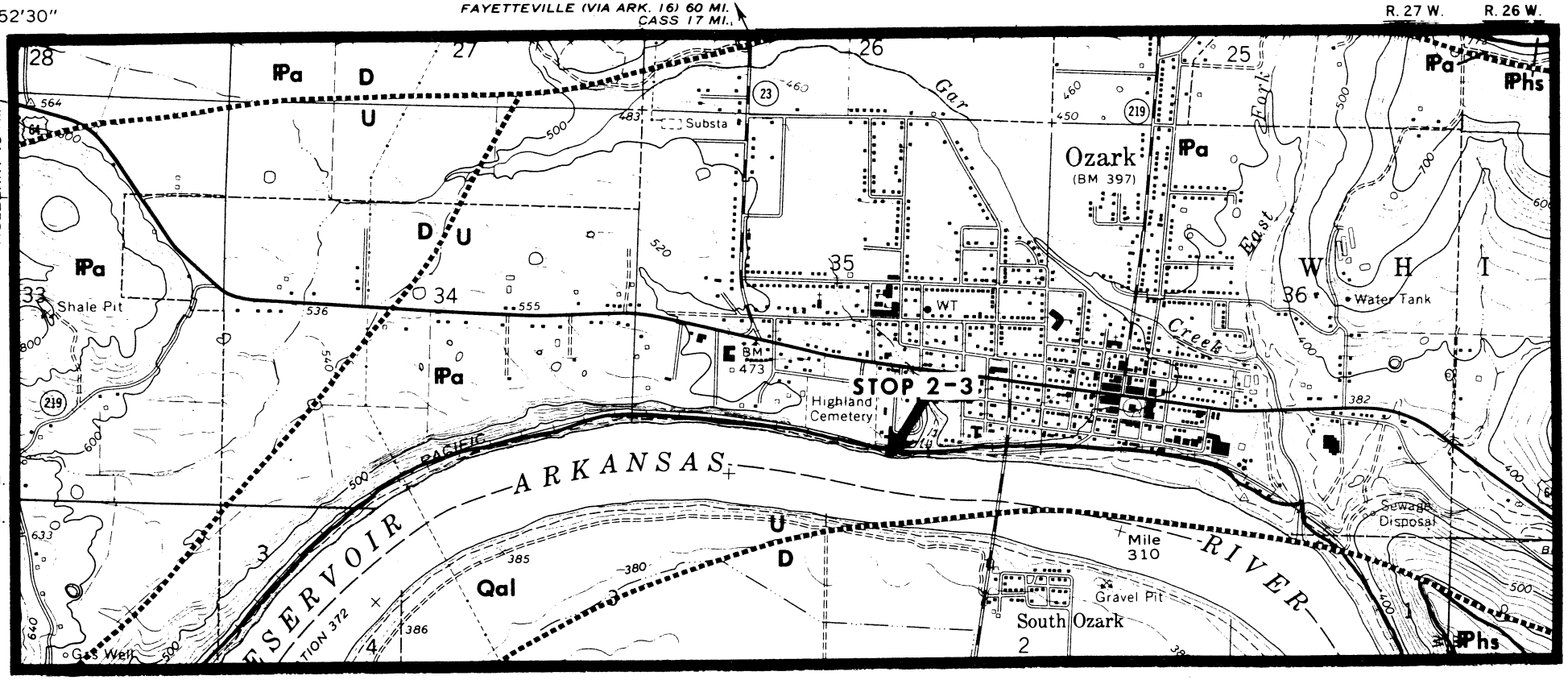

PLATE 12. OZARK, ARKANSAS — STOP 2-3.

1000 0 1000 2000 3000 FEET

Geology by H. A. Arndt

Figure 25. STOP 2-1. An apparent growth thrust fault in the rocks of the upper Atoka Formation.

Figure 26. STOP 2-2. Fringe deposits.

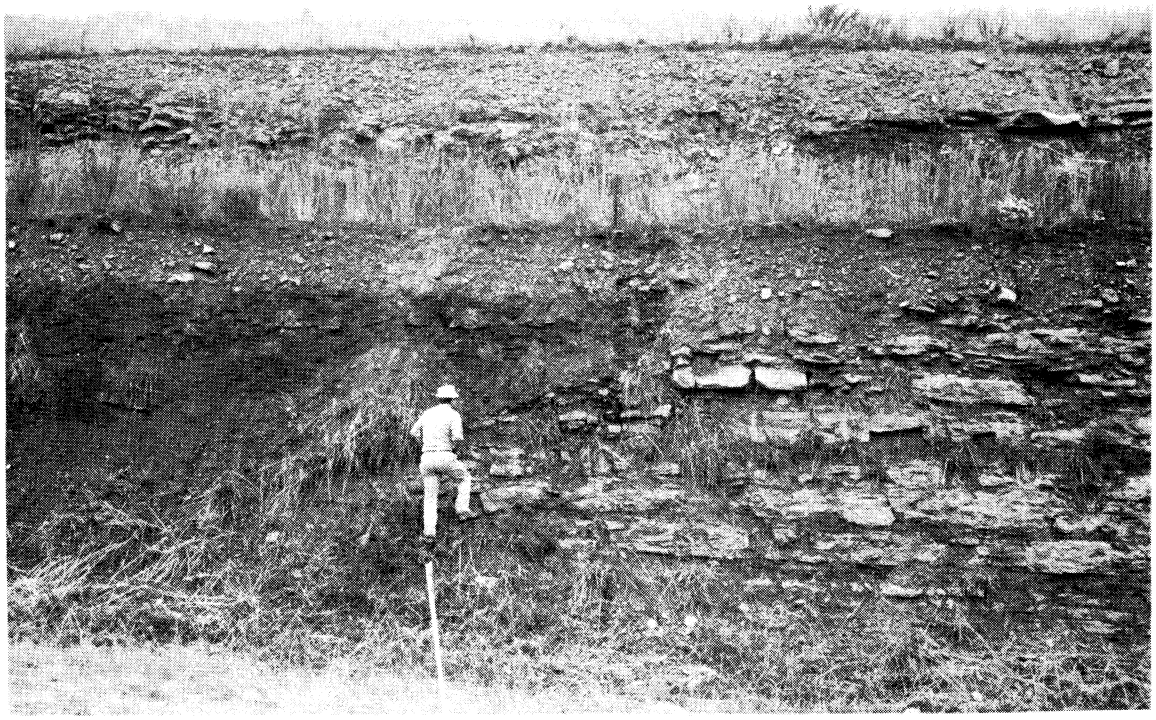

Figure 27. STOP 2-2. Fringe deposits with a shale filled channel.

Figure 28. STOP 2-2. Fringe deposits with a sand plug(?) diapir(?) or a sand filled channel.

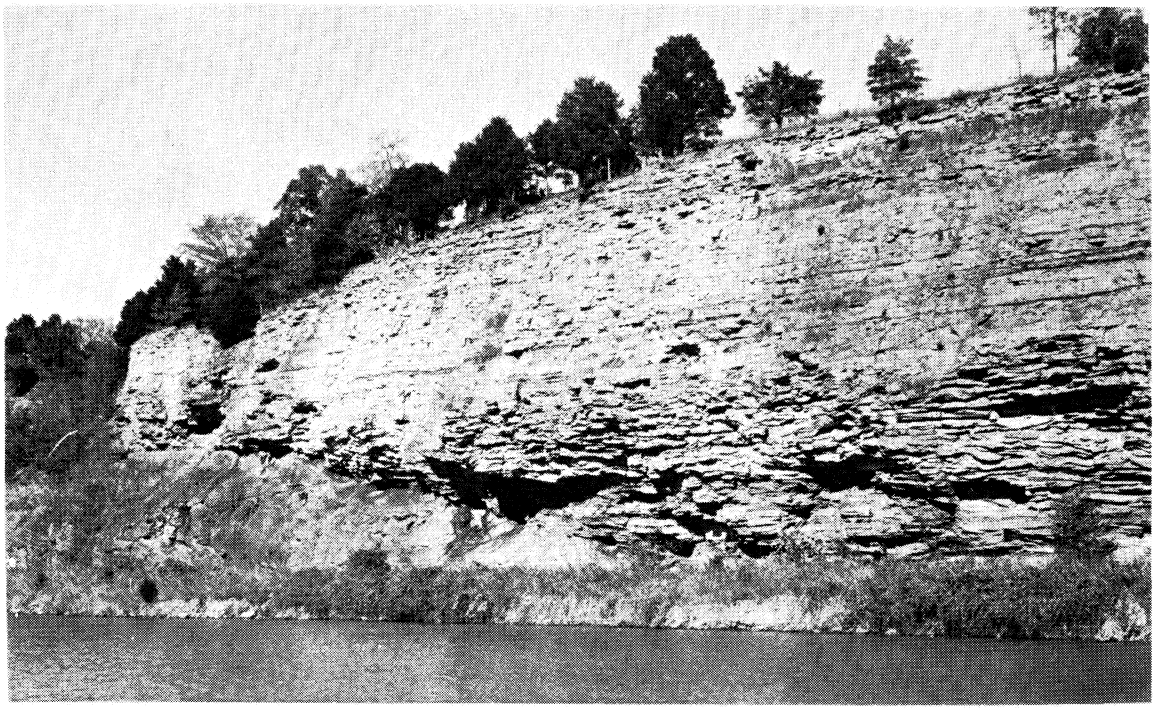

Figure 29. STOP 2-3. Sand filled channel in outer fringe deposits of the upper Atoka Formation along the north shore of the Arkansas River at Ozark, Arkansas.

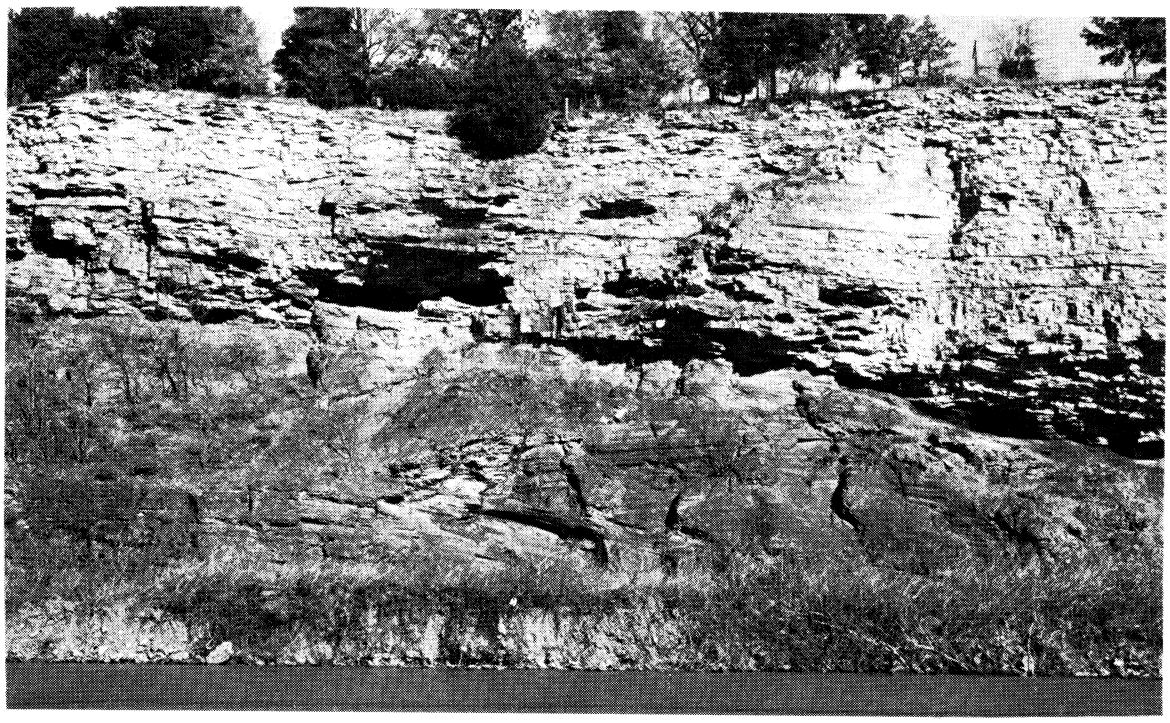

Figure 30. STOP 2-3. Closer view of the rocks shown on the left edge of Figure 29. Note the displaced blocks of outer fringe deposits.

Figure 31. STOP 2-3. Closeup of the deformed shale shown on the right edge of Figure 30.

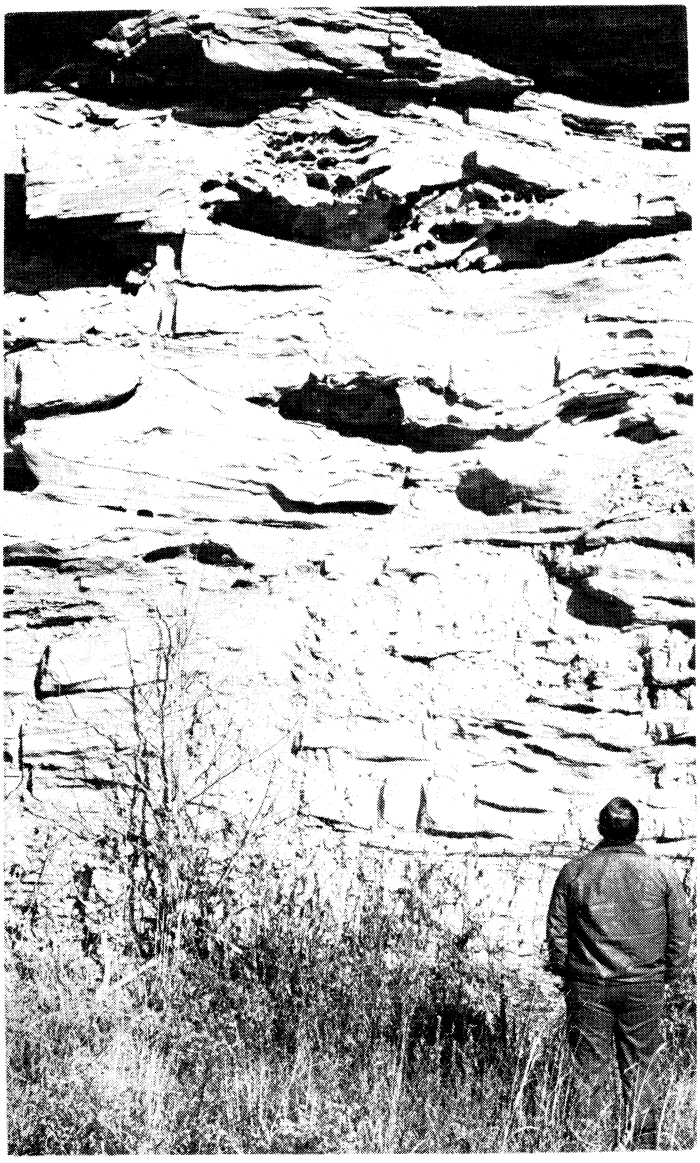

Figure 32. STOP 2-3. Cross-bedding and convolute bedding in the channel deposits.

Mileage	Description
40.9	Junction with U. S. Hwy. 64, *turn right (east)* onto Hwy. 64.
41.2	Junction with Ark. Hwy. 23, *turn right (south)* onto Hwy. 23.
41.4	Middle of the bridge over the Arkansas River. Look back to the northwest at bluff visited in STOP 2-3. Note the channel (see Figure 29).
42.2	Outcrop of Atoka sandstone to the east.
42.6	Junction with Ark. Hwy. 309. Downtown Webb City, Arkansas, riding on the Arkansas River Terrace deposits.
43.6	Hartshorne Sandstone on top of the ridge.
44.1	Junction with Ark. Hwy. 96. Gas well to the west was completed in the Prairie Grove Member of the Hale Formation through perforations at 5,078-86 feet with an initial production of 11, 600 MCFPD. A fault is near the intersection and the downthrown side is to the south. Most of the surface material is terrace deposits.
44.5	Outcrop of Hartshorne Sandstone to the west.
46.7	Smith Creek.
46.8	Exposure of Hartshorne Sandstone to the east.
48.7	Hartshorne Sandstone crops out to the west.
48.9	Fault with downthrown side to the south. Exposure of Hartshorne Sandstone to the north and McAlester shale to the south.
49.2	Contact of McAlester and Hartshorne Formations.
49.6	Aetna Gas Field to the west. The Aetna Anticline yielded the first commercial gas production in Franklin County, Arkansas. At the present time the Aetna Field covers over 34,000 acres in Franklin and Logan Counties and produces from several zones in the Atoka Formation and the subjacent Morrowan age rocks at depths ranging from 1,700 to 7,100 feet. Cumulative gas production to 1977 was 270,385 MMCF.
49.9	Outcrop of Hartshorne Sandstone.
50.0	Fault with downthrown side to the south. Exposures of Hartshorne Sandstone to the north, and McAlester Formation to the south. Junction with Ark. Hwy. 288 east.
50.4	Junction with Ark. Hwy. 288 west.
50.6	Pimple Mounds.
51.0	Crossing into the Savanna Formation from the McAlester.
51.2	Fault with downthrown side to the south in the Savanna Formation.
51.5	Hurricane Creek Bridge.
52.2	Garner Creek Bridge.

Mileage	Description
52.9	Pimple Mounds on the west side of the road. The Boggy Formation which caps Horseshoe Mountain to the east is the youngest Pennsylvanian Formation (Desmoinesian series) in the Arkansas Valley. Only the lower part of the Boggy remains and it is a light gray sandstone with thin beds of gray shale. The formation lies conformably on the Savannna.
53.7	Logan County Line.
53.9	Outcrop of the Savanna Formation.
54.2	Railroad track.
54.6	Caulksville, Arkansas, Junction with Ark. Hwy. 22.
55.0	Little Creek.
55.1	Fault with downthrown side to the north in the Savanna Formation and the McAlester Formation on the south side.
56.0	Junction with Ark. Hwy. 398 west.
57.3	Wilcox Cemetery.
57.7	Sixmile Creek.
58.1	Outcrop of Savanna Formation to the west and McAlester shale to the east. Road closely follows this contact for the next 1.2 miles.
59.3	Savanna Formation exposed on both sides of the road.
60.1	Franklin County Line.
61.3	Logan County Line.
61.6	Junction with Ark. Hwy. 41 west.
61.7	Outcrop of Savanna Formation to the west.
62.1	Junction with Ark. Hwy. 217 west.
62.3	Downtown Chismville, Arkansas. Note old log building.
62.4	As you start up hill, you are driving in upper Atoka.
62.5	**STOP 2-4: Chismville, Arkansas.** Plate 13. Sandstone in the upper Atoka on west side of road dipping to the north about 35^0.
63.4	Outcrop of middle Atoka. You are going across the thrust faulted crest of the large Washburn Anticline. Natural gas production is from several intervals in the Atoka on this structure.
63.6	Sixmile Creek.
64.7	Start up Booneville Mountain, outcrop of flaggy bedded upper Atoka.
65.2	Excellent outcrop of upper Atoka on the east.
65.3	You are starting down the south side of Booneville Mountain.
66.0	South dipping Atoka sandstone and shale to the west.

R 28 W

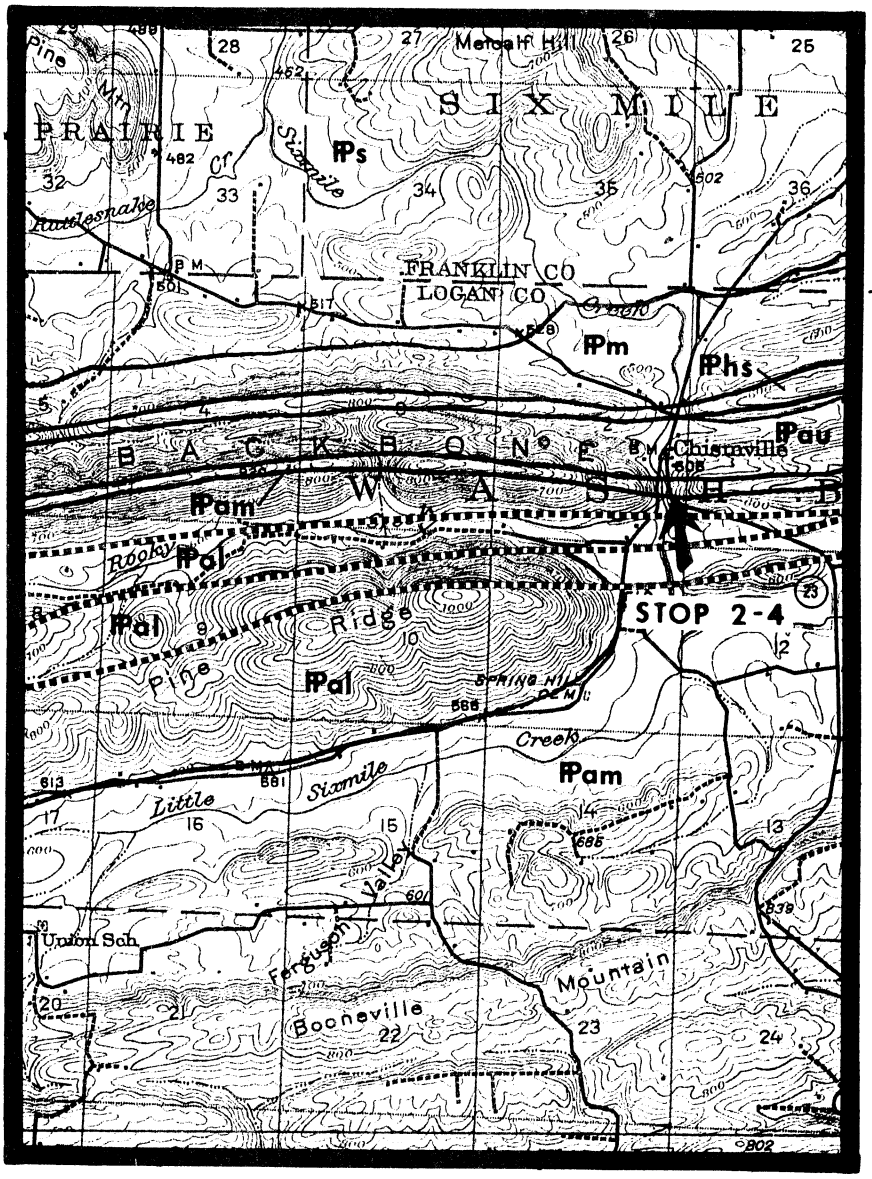

PLATE 13. CHISMVILLE, MIDDLE ATOKA — STOP 2-4.

1000 0 3000 6000 9000 FEET

Geology by B. R. Haley and C. G. Stone

Mileage	Description
66.4	Upper Atoka sandstone and shale crops out to the west.
67.0	Outcrop of upper Atoka flaggy sandstone and shale to the west.
67.2	Notice dipslope formed by sandstones in the upper Atoka to the south.
67.7	Junction with Ark. Hwy. 116 east.
67.9	City limits of Booneville, Arkansas.
68.3	Outcrop of upper Atoka shale.
68.9	Junction with Ark. Hwy. 10, *turn left (east)* onto Hwy. 10, downtown Booneville, Arkansas.
70.4	Pimple Mounds.
72.1	Booneville Airport.
74.2	Scotts Creek.
75.5	Downtown Magazine, Arkansas. Junction with Ark. Hwy. 109. Riding on sandstone in the upper Atoka. Hogbacks to the south are in the middle Atoka on the north side of the Ranger Anticline. The crest of the Ranger Anticline is about 3 miles south of here. The crest of the anticline is broken by high angle thrust faults and the hydrothermal clay mineral dickite is common on slickenside surfaces. The exposed rocks along much of the crest are in the upper portion of the lower Atoka. Eighteen wells have been drilled for gas on the Ranger Anticline; 8 did not have any reported shows of gas; 3 had reported shows of gas; and 6 were completed as producers with reported gas production ranging from 174 MCFPD to 5,560 MCFPD. The deepest well, Pacific Oil and Gas Company No. 1 Ples Garner (Sec. 29, T. 5 N., R. 26 W.), was drilled to a depth of 14,460 feet without any reported shows of gas. The well did not reach rocks of Mississippian age at total depth, thus in the vicinity of the well the Atoka and Morrowan age rocks have a combined thickness of at least 19,000 feet.
78.6	Magazine Mountain to the northeast is the highest point in Arkansas with an elevation of 2,753 feet above MSL. The mountain is capped by sandstone of the Savanna Formation.
81.2	Downtown Blue Mountain, Arkansas. The high hill to the south is underlain by the same middle Atoka sandstone as the producing sandstone in the Mansfield Gas Field (Sebastian County).
81.4	Yell County Line.
81.8	Outcrop of sandstone in the north-dipping middle Atoka.
85.1	Railroad overpass.
85.9	Waveland, Arkansas, Junction with Ark. Hwy. 309. *Turn right (south)* onto Hwy. 309.
86.7	Junction with road to Waveland Recreation Area, *turn right (west).*
87.4	*Turn left (south)* onto the bridge over the overflow.
87.7	*Turn left (east)* toward Blue Mountain Dam, proceed across dam.
88.3	**STOP 2-5. Blue Mountain Dam.** Plate 14, Figures 33-36. Continental slope, submarine channel and turbidite deposition with soft rock deformation near the top of the lower part of the Atoka Formation. The turbidic transition from shallow-water marine deposition to deep-water marine flysch is well shown within the Atoka Formation at several localities in northwestern Arkansas. For example, the middle part of the Atoka Formation, as exposed north of Clarksville along Arkansas

Mileage	Description
	Highway 21 in Secs. 21 and 22, T. 11 N., R. 23 W. consists of sandstone, siltstone, and shale deposited in a shallow-water marine environment. Most of the rocks in this area are thought to have been deposited by regressive seas or prograding deltas, although some have lithologic characteristics suggesting deposition by transgressive seas. Criteria indicative of sedimentary slump or flow are rare. The Clarksville area the middle part of the Atoka Formation was deposited on a very gentle slope where the gradient was not great enough to induce soft sediment deformation.
	The middle part of the Atoka Formation, as exposed in the overflow channel of Paris Lake Dam in Sec. 14, T. 7 N., R. 26 W., consists of sandstone, siltstone, and shale deposited in a shallow-water marine environment. At this locality soft sediment flow features are common and the most significant of these are termed "pull-aparts". "Pull-aparts" are thought to represent lenticular remnants of a moving sheet of sand that tended to stretch and thus pull itself apart. This stretching movement and resultant "pull-aparts" is in sharp contrast to the thickening movement and the resultant contorting of beds seen in subsequent stops during this field trip. At Paris Lake Dam the middle part of the Atoka was deposited on a slope whose gradient was great enough to permit soft-sediment flow.
	The top of the lower Atoka, as exposed at the south end of Blue Mountain Dam in Sec. 15, T. 5 N., R. 25 W., consists of sandstone, siltstone, and shale deposited in a marine environment. The depth of water is conjectural because most of the exposed rocks at the dam site and in the immediate vicinity contain few criteria that would indicate that they were deposited in shallow-water above wave base. At this locality the slope gradient was steep enough to permit soft sediment flow within a bed and also to permit large blocks of unconsolidated bedded sediments to slump or slide down hill. The slope gradient was also great enough to support turbidity currents, some of which eroded channels in the earlier sediments in which these or subsequent turbidity currents deposited sand.
	Return north across dam toward Waveland, Arkansas.
89.9	Junction with Ark. Hwy. 309, *turn right (south)* onto Hwy. 309.
90.7	Bridge over Petit Jean River.
91.4	*Turn right (west)* continue on Ark. Hwy.309.
92.0	Cedar Creek.
94.2	Junction with road to Lick Creek Recreation Park to west.
95.5	Crossroads, continue on Ark. Hwy. 309, Potato Hill Mountain capped by flat lying upper Atoka sandstone to the southeast (left).
96.0	Outcrop of upper Atoka in roadcut.
98.2	Junction with road to Petit Jean Mountain to the west. Top of the hill is capped with Hartshorne sandstone.
98.3-98.9	Shallow-water shale, siltstone and sandstone deposits in the upper Atoka to the west.
100.0	Junction with road from the left, continue to the right.

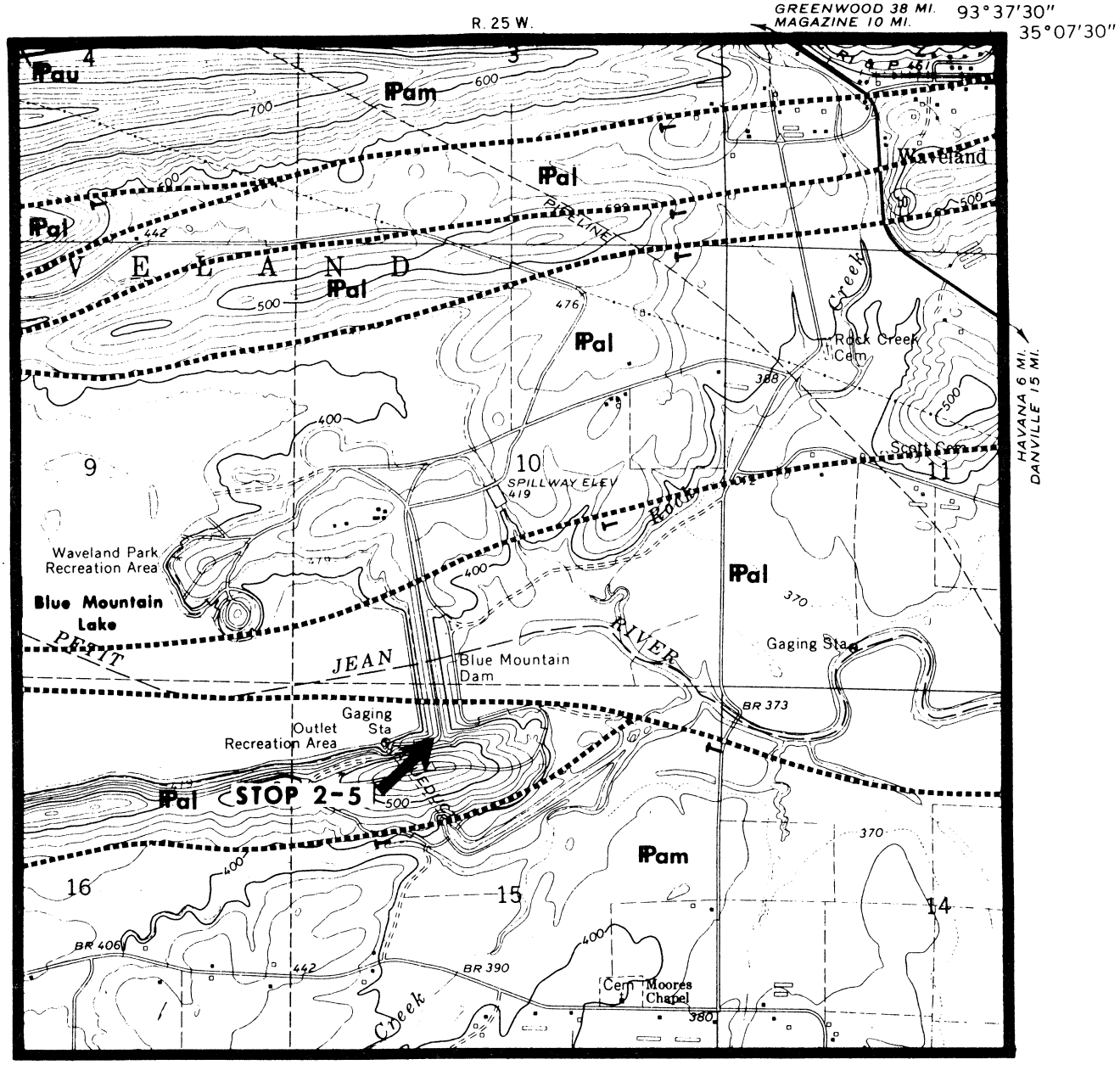

PLATE 14. BLUE MOUNTAIN DAM — STOP 2-5.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley

Figure 33. STOP 2-5. Blue Mountain Dam. The submarine channel sandstone resting on black shale and siltstone near the top of the lower Atoka Formation. Some of the contortions can be attributed to the weight of the sediments in the channel (see Figure 34).

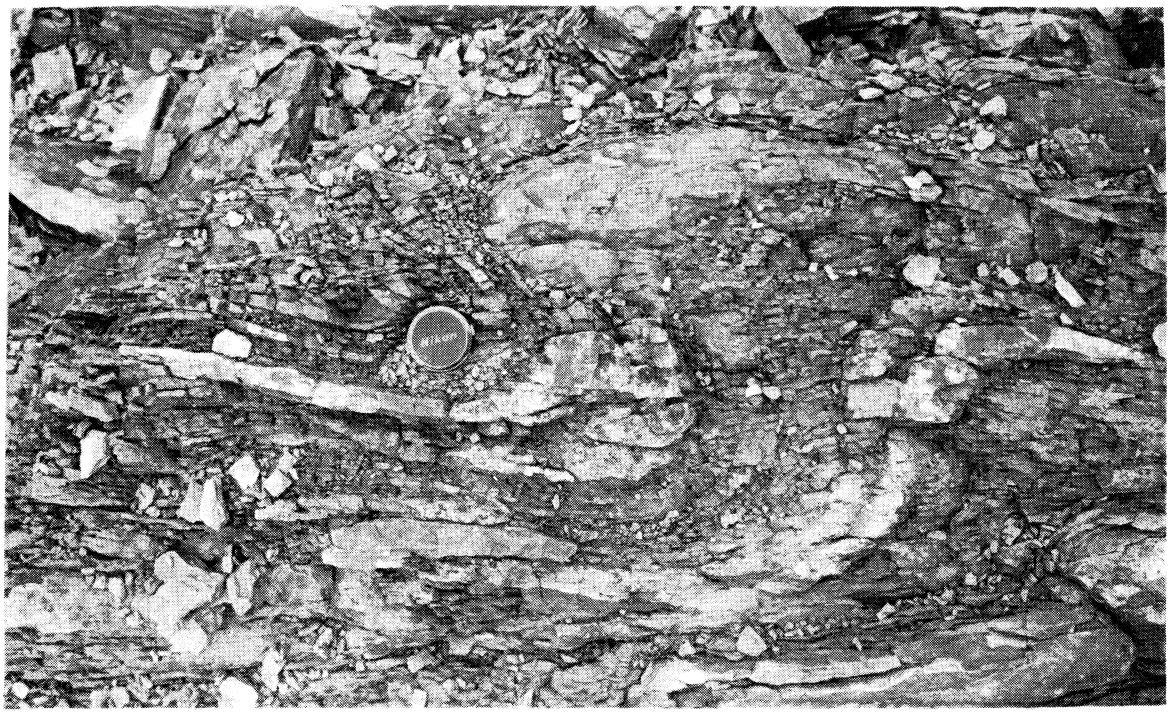

Figure 34. STOP 2-5. Blue Mountain Dam. Contorted shale and siltstone caused by sedimentary slumping.

Figure 35. STOP 2-5. Blue Mountain Dam. Displaced blocks of shale and siltstone. Probably represents soft sediments that slumped as blocks down the slope of the sea floor shortly after deposition.

Figure 36. STOP 2-5. Slump blocks overlain by turbidite deposits, note sandstone dikes.

Mileage	Description
100.5-100.7	Upper Atoka shale, siltstone, and sandstone crops out to the east and in the creek to the west.
102.1	One lane bridge! Outcrop of middle Atoka sandstone to the east.
103.4	Low water bridge over Dutch Creek.
103.7	Junction with Ark. Hwy. 80, *turn right (west).*
105.5	Scott County Line, Blue Ball, Arkansas. Several small peridotite dikes of probable Cretaceous age locally dissect the middle Atoka shales in this area.
106.5	Junction, *turn left (south)* toward Gravelly, Arkansas.
107.4	Portion of the Ross Creek high angle thrust fault which thrusts lower Atoka northward over middle Atoka.
107.8-107.9	Flysch sequence in steeply south dipping lower Atoka.
108.4	Another portion of the Ross Creek high angle thrust fault involving lower Atoka units. The lower part of the Atoka consists of more than 10,000 feet of alternating beds of sandstone, siltstone, and shale.
110.1	Proceed down hill, outcrops of lower Atoka.
110.2	Good exposure of lower Atoka.
112.1	Junction with road from the left, continue on the same road.
112.2	One lane bridge!
112.3-112.5	Massive sandstone in the upper part of the lower Atoka and then crossing into the middle Atoka. Section same as seen at Blue Mountain Dam.
113.3	Junction with road from the right, continue straight ahead.
114.4	Junction with Ark. Hwy. 28, *turn left (east)* onto Hwy. 28, Gravelly, Arkansas.
114.5	Continue right on Ark. Hwy. 28.
116.5	Bridge over Fourche LaFave Creek.
120.2	Bridge over Gaffords Creek.
120.6	Junction with paved road, *turn right (south)* onto paved road.

Mileage	Description
122.8	High angle thrust fault thrusting lower Atoka northward over lower Atoka. Note the vertically dipping rocks on the east side of the road. Same part of Atoka as seen at Blue Mountain Dam.
123.3	Junction with dirt road from left (National Forest Service Road No. 519) *turn left* onto dirt road.
124.3	Junction with road from the left, continue to the right.
125.3-125.6	Middle Atoka sandstone and shale dipping to the north 75° to vertical. Bottom to the south.
125.8	One lane bridge over Caney Creek.
126.3-126.6	**STOP 2-6. Chula stop in the lower Atoka.** Plate 15, Figures 37-40. This sequence of lower Atoka is about 18,000-20,000 feet below the Hartshorne Sandstone and about 5,000 feet or more above the Johns Valley Shale. The rocks consist of sandstone, siltstone, and shale, and are a classic example of flysch, in the sense that flysch is characterized by being rhythmic depositional units that gradually grade from sandstone to siltstone to shale, with a sharp contact at the base of the sandstone and each rhythmic unit being widespread laterally. Excellent examples of graded bedding, bottom marks and soft rock deformation are exposed at this stop. Flute marks, prod marks, and groove casts on the bottom of some of the sandstone beds indicates some of the westward flowing currents had slightly different azimuths (see Figure 38). The convolute bedding on some of the sandstone beds indicate a southward(?) slump after deposition of the sand. Evidently the sand was deposited on a slope by a current flowing along the slope. Both "thickening" and "thinning" upwards of sandstone sequences are present and probably indicate submarine middle fan and lobe deposition.
126.7	Road to the left, *turn around and proceed back on the same road.*
126.9-127.2	Continue northwest by STOP 2-6.
127.6	One lane bridge over Caney Creek.
127.9-128.2	Same exposures as mileage 125.3-125.6.
128.7	Junction with dirt road from the east (right), continue on road to left.
130.1	Junction with paved road from the left (National Forest Service Road No. 970) *turn left (west)* onto paved road (NFS Road No. 970).
130.2	Bridge.
130.7	Lower Atoka crops out to the right.
130.8	Junction with road from the left, bridge, continue on same road.
136.0	Shale in the upper part of the lower Atoka crops out in the roadcut to the south.
136.7	Outcrop of sandstone and shale in the upper part of the lower Atoka to the north.
138.5	Junction with dirt road from the left, continue on same road.
138.7-139.0	Note the ripple marks on the top of the sandstone bed in the lower Atoka.
139.3	Outcrop of ripple mark sandstone in the lower Atoka.
140.7	Junction with dirt road from the right, continue on same road.
141.7	Sandstone and shale in the lower Atoka to the right.

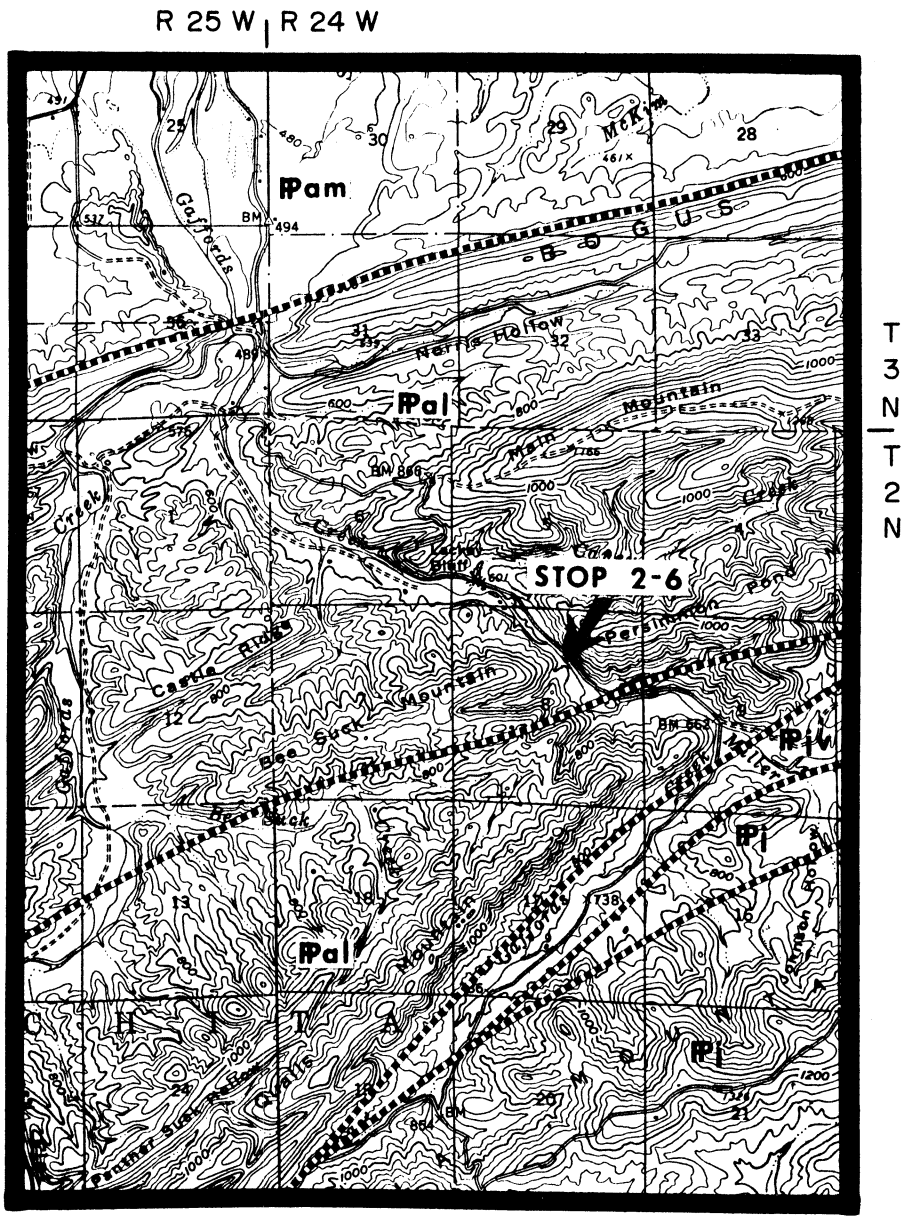

PLATE 15. CHULA STOP, LOWER ATOKA – STOP 2-6.

1000 0 3000 6000 9000 FEET

Geology by C. G. Stone and B. R. Haley

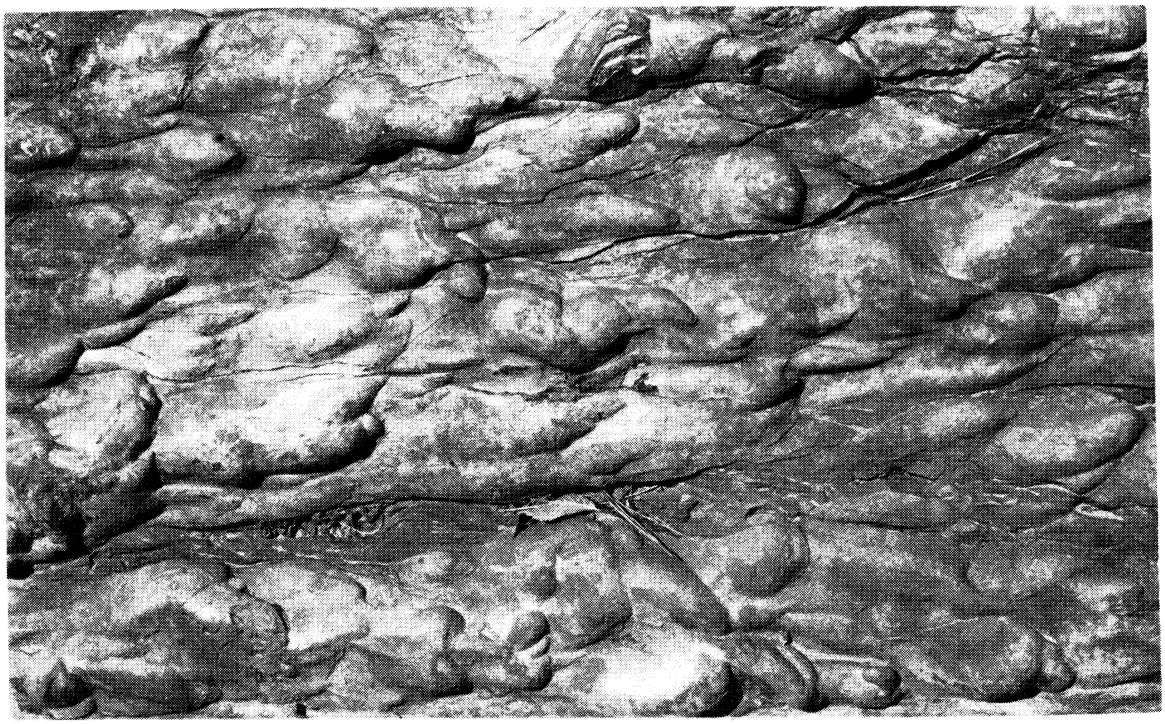

Figure 37. STOP 2-6. Chula. Flute marks indicative of westward flowing currents and deformed by loading pressures of subsequent deposits.

Figure 38. STOP 2-6. Chula. Flute casts, prog marks and groove casts indicative of slightly different azimuths of bottom currents.

Figure 39. STOP 2-6. Chula. Is this a soft-sediment or a tectonic fold?

Figure 40. STOP 2-6. Chula. Flute cast indicative of westward flowing current and convolute bedding indicative of a southward(?) slump after deposition.

Mileage	Description
143.1	Two massive beds of sandstone and shale in the lower Atoka.
143.3	Outcrop of lower Atoka.
143.4	Junction with Ark. Hwy. 28, *turn left (west)* onto Hwy. 28.
144.1	Exposure of sandstone and shale in the lower Atoka.
144.4	Bridge.
144.6	Junction with road from the left, continue on Ark. Hwy. 28. The old town of Forester to the left has been totally removed.
145.8	Outcrop of lower Atoka.
145.9	Cedar Creek Community.
147.9	Outcrop of middle Atoka shale.
148.0	Bridge over Little Cedar Creek.
149.3	Middle Atoka shale crops out in roadcut.
149.4	Junction with dirt road from the left, *turn left (south)* onto dirt road.
149.6	Junction, *stay to right and cross low water bridge.*
149.8	Outcrop of lower Atoka.
150.5	Junction with Robertson Creek Road from the left, continue on road to right.
151.0	Junction, *turn left.*
151.1	Exposure of shale and sandstone of the lower Atoka. C. Gomer Stone (noted Ouachita Mountain geologist) said: "It is folded and zapped!!!"
151.3	Exposure of shale in the lower Atoka and crossing into the Johns Valley Shale.
151.4	Junction with road from the left, continue straight ahead. Riding on the Johns Valley Shale.
151.7	Junction with road from the right, continue straight ahead.
152.3	Junction with road from the right, *turn right.* Gate across road may be locked. If locked, park here and walk.
152.4	Outcrop of Johns Valley Shale.
152.7	**STOP 2-7: Johns Valley Shale pit.** Plate 16, Figures 41-42. Walk about 100 yards up the creek (south) to shale pit. The Johns Valley Shale at this stop consists of claystone containing erratic blocks derived from Ozark-Arbuckle facies consisting of limestone, dolomite, chert and sandstone, beds of graded submarine debris flow (Fig. 42), and beds of graded sandstone. Compare the unweathered appearance of some erratics to the decalcified nature of others. This is one of the easternmost known occurrences of Johns Valley containing pre-Pennsylvanian erratics in the frontal Ouachita Mountains of Oklahoma and Arkansas. *Turn vehicle around and go back out the same way you came in.*
152.9	Junction, *turn left.*

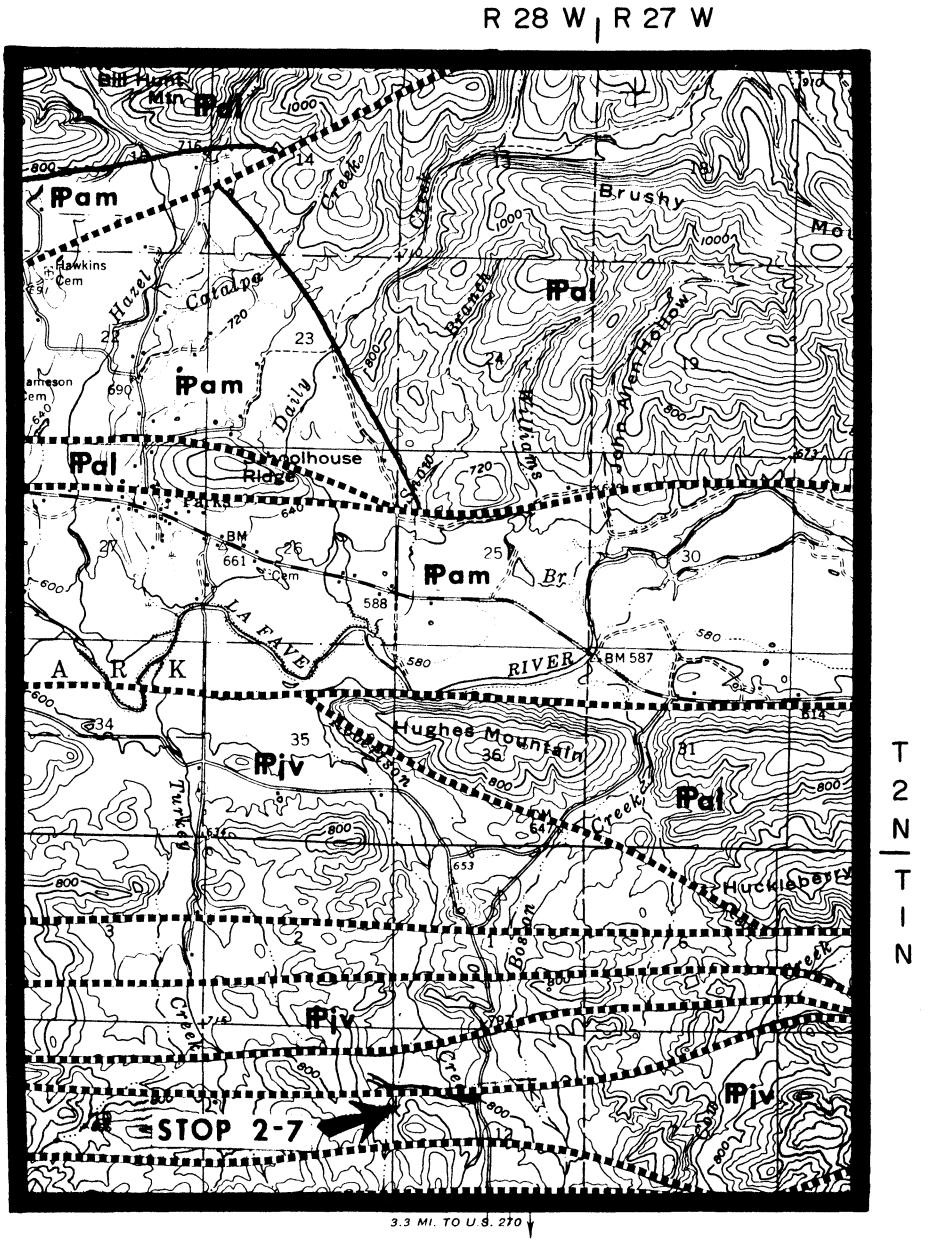

PLATE 16. JOHNS VALLEY SHALE PIT – STOP 2-7.

1000 0 3000 6000 9000 FEET

Geology by B. R. Haley and C. G. Stone

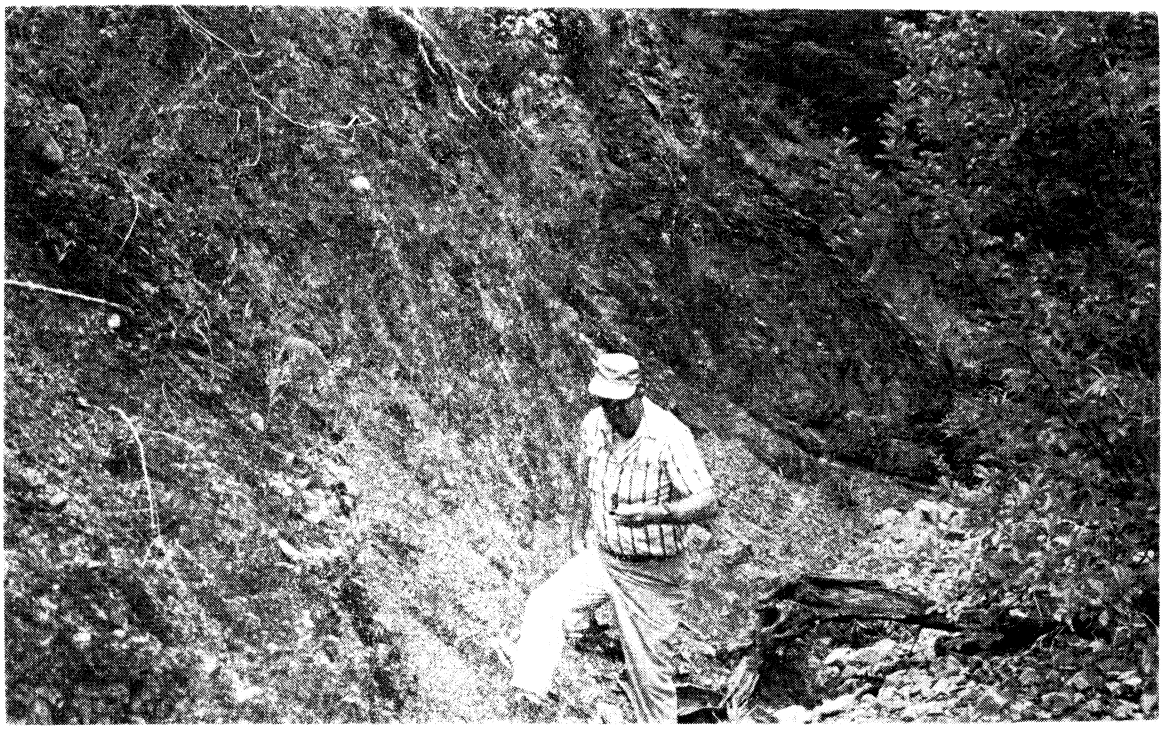

Figure 41. STOP 2-7. Exposure in the shale of the Johns Valley Shale, note the individual erratics.

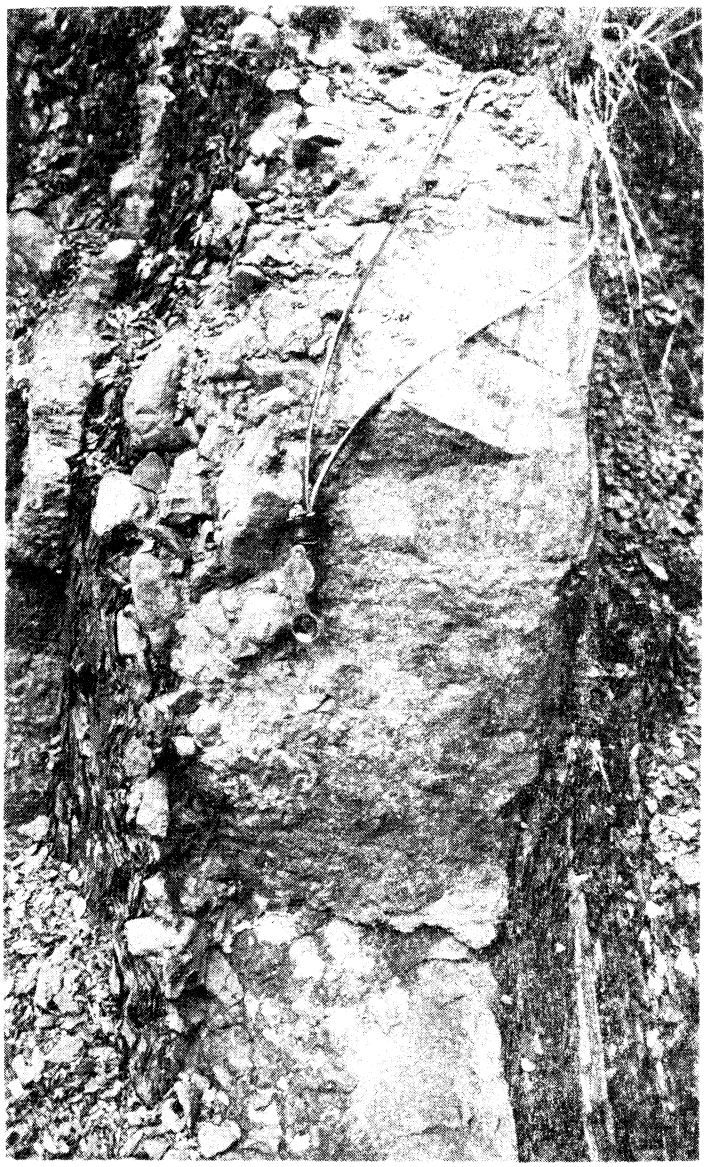

Figure 42. STOP 2-7. Excellent example of submarine debris flow, note the grading from erratics to sandstone, top is to the right.

Mileage	Description
153.4	Junction with the road from the left, continue straight ahead.
153.6	Junction, *turn right.*
154.1	Junction with road from the left, continue straight ahead.
155.2	Low water bridge and junction with road from the right, continue on road to the left.
155.4	Junction with Ark. Hwy. 28, *turn left (west)* onto Hwy. 28.
156.1	Bridge over Fourche LaFave River.
158.5	Parks, Arkansas, driving on middle Atoka.
160.4	Outcrop of shale of middle Atoka.
163.1	Junction with U. S. Hwy. 71 at Boles, Arkansas, *turn right (north) onto Hwy. 71.*
166.3	Bridge over Ross Creek and Ross Creek thrust fault. The lower Atoka is thrust northward over middle Atoka.
166.9	**STOP 2-8: Middle Atoka south of Waldron, Arkansas.** Plate 17, Figure 43. Junction of U. S. Hwy. 71 and 71-B, stay on Hwy. 71. This sequence of alternating sandstone, siltstone, and shale is at the base of the "traceable three" of the middle Atoka Formation. The "traceable three" sandstone intervals and the underlying shale interval are key markers in the thick Atoka sequence in the southern Arkansas Valley-frontal Ouachita Mountain area. At this stop the beds have bottom marks, graded bedding, cross laminations and other features indicative of turbidity current deposition. The preponderance of "thinning" and "fining" upwards of various sandstone sequences suggest that these beds were deposited as submarine upper fan channel deposits. To the north and east of this locality these beds have increasingly shallow-water sedimentary features.
167.6	Rest area to the west.
168.7	Contact between middle and lower Atoka.
169.6	Junction with Ark. Hwy. 272.
170.1	Junction with Ark. Hwy. 248.
170.8	Junction with Ark. Hwy. 80.
173.9	Junction with Ark. Hwy. 28 west.
175.5	Lower Hartshorne Coal bed and Hartshorne Sandstone crop out to the east.
176.4	Outcrop of the basal sandstone of the Savanna Formation.
176.6	Poteau Syncline.
176.8	Outcrop of the basal sandstone of the Savanna Formation.
179.7	Sandstone in the McAlester Formation occurs in roadcut.
180.6	Junction with Ark. Hwy. 378.
180.7-180.8	Hartshorne sandstone and coal beds to the west. (Sandstone at the road intersection to the west could be the upper Hartshorne Sandstone of Oklahoma.)

R 24 W

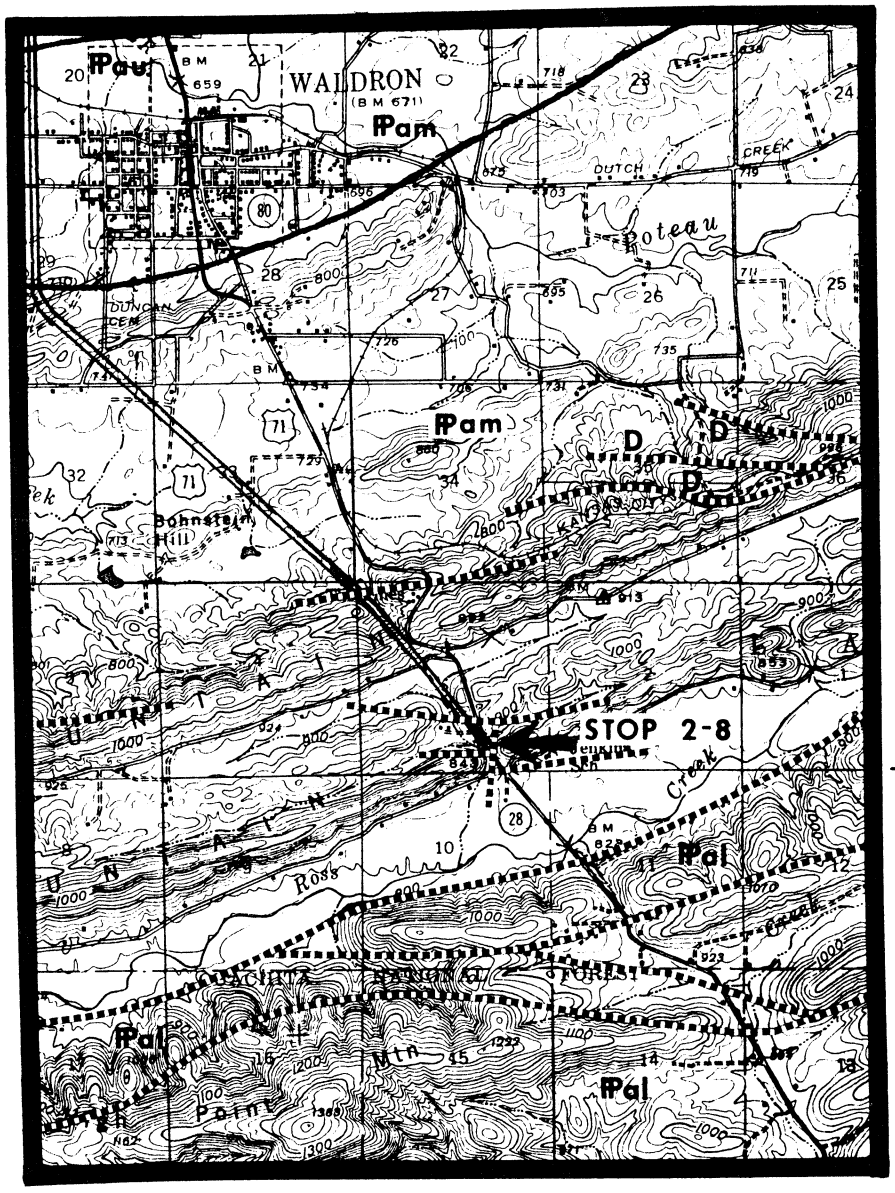

PLATE 17. MIDDLE ATOKA, HWY. — STOP 2-8.

1000 0 3000 6000 9000 FEET

Geology by B. R. Haley and C. G. Stone

Figure 43. STOP 2-8. Sandstone, siltstone, and shale in the middle part of the Atoka south of Waldron.

Mileage	Description
180.9-180.1	Outcrop of upper Atoka shale, siltstone, sandstone, and coal bed to the west.
181.4	Junction with Ark. Hwy. 23 to the east.
183.4	Logan County Line.
183.7-184.0	A prograding sequence of upper Atoka shale, siltstone, and sandstone to the west.
184.5	Scott County Line.
187.6	Downtown Abbott, Arkansas. Upper Atoka shale and siltstone at railroad underpass.
191.0	Road to downtown Mansfield, Arkansas. Junction with Ark. Hwy. 96.
191.6	Roadcut in upper Atoka sandstone.
192.3	Excellent exposure of Hartshorne-Atoka contact to the east.
192.6	Downtown Huntington, Arkansas. Junction with Ark. Hwy. 252.
193.2	Reclaimed and orphan spoils from strip mines in the lower Hartshorne coal bed to the west and east.
194.4	Junction with Ark. Hwy. 252 east.
194.8	Pimple Mounds to the west.
196.4	Downtown Witcherville, Arkansas.
197.5-197.7	Outcrop of upper Atoka shale, siltstone, and sandstone.
198.9	Crossing the western end of the Hartford Anticline. The first commercial production of gas in northern Arkansas was discovered by the Choctaw Oil and Gas Company Duncan No. 2 Well completed in 1902. The gas in the Mansfield Gas Field comes from 32 different intervals in the middle part of the Atoka. The Wilson Production Company completed the E. J. Harp No. 1 as a dry hole in 1972. The well reached a depth of 15,472 feet and stopped in the Cotter Dolomite of lower Ordovician age. The base of the Atoka in this well is at a depth of 12,545 feet, thus the Atoka is more than 15,000 feet thick in the vicinity of Mansfield. Cumulative gas production from the Mansfield Field to 1977 was 15,782 MMCF.
199.5-199.7	Outcrop of Atoka sandstone and shale.
200.2	Outcrop of Hartshorne Sandstone.
201.3	Junction with Ark. Hwy. 10.
	END OF SECOND DAY ROAD LOG AND FIELD TRIP.