STATE OF ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION

Norman F. Williams, State Geologist

A GUIDEBOOK
TO THE
GEOLOGY OF THE ARKANSAS PALEOZOIC AREA
(Ozark Mountains, Arkansas Valley, and Ouachita Mountains)

by

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

Little Rock, Arkansas
1977
Revised 1980

GUIDEBOOK 77–1

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A special debt of gratitude is expressed to Mrs. Loretta S. Chase, Donna Rinke, and L. P. Kelone for their unstinting technical assistance during the preparation of this Guidebook.

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PREFACE

This guidebook has been prepared to provide geologic information on the Ozark Mountains, Arkansas Valley, and the Ouachita Mountains. The route for the field trip was designed to cover most of the geologic units in the Paleozoic Rocks of Arkansas, and has been divided into two days. The first day is centered in the Ozarks and part of the Arkansas Valley, and the second day extends from the Arkansas Valley at Russellville, Arkansas through the Ouachita Mountains to the Diamond Mines at Murfreesboro, Arkansas.

The maps presented in this guidebook were compiled during the mapping program for the new State Geologic Map of Arkansas during the years 1968 to 1974. Stops were selected to show the best exposures of the units traversed and to display structural and depositional features.

In the back of this guidebook are two cross sections that follow the field trip route. The first day cross section extends from Beaver Dam in the Ozark Mountains southward to Ludwig in the Arkansas Valley. The second day cross section extends from Russellville in the central Arkansas Valley southward through the Ouachita Mountains to Murfreesboro in the area of Cretaceous overlap and igneous intrusions.

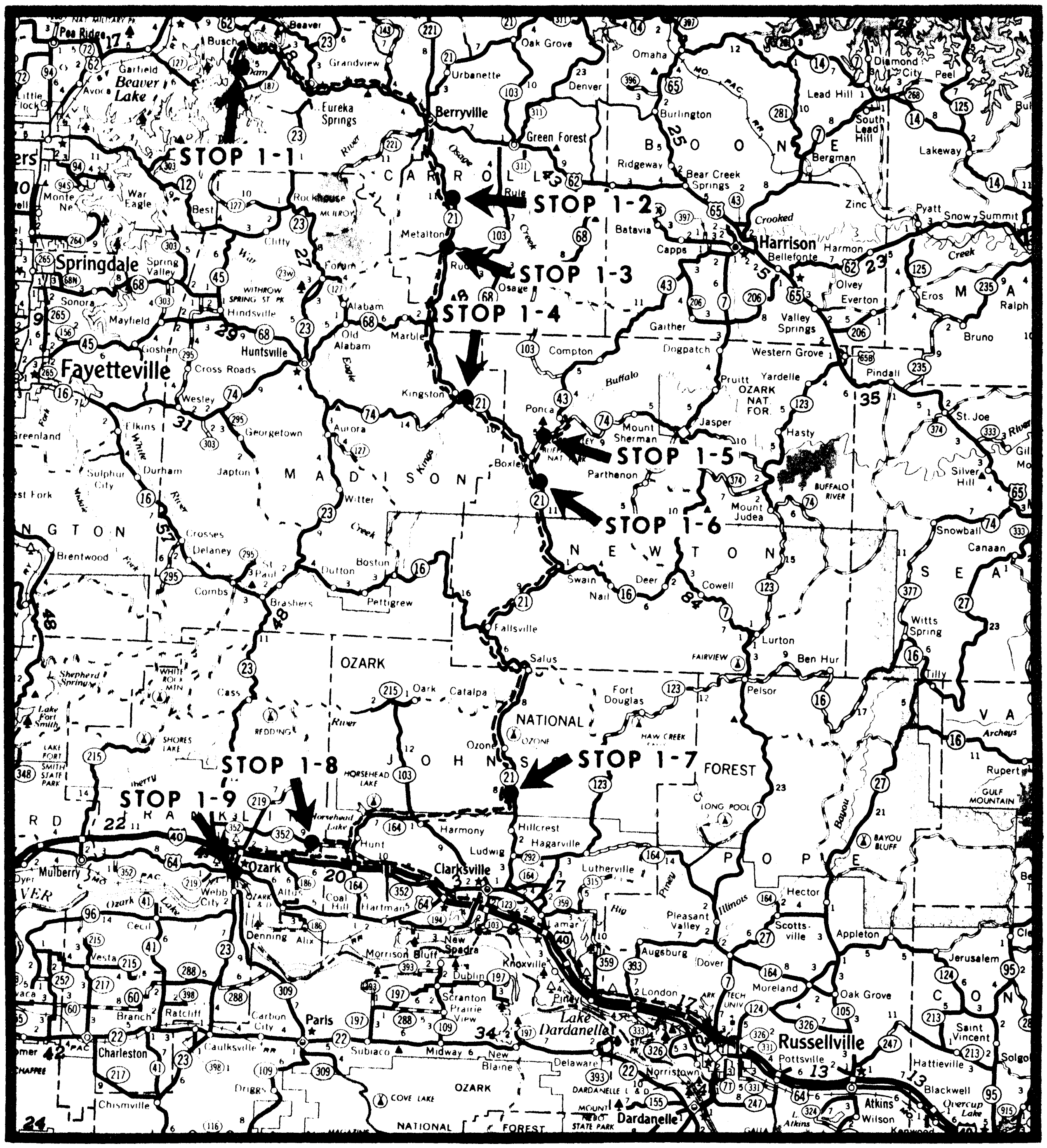

FIGURE 1.--INDEX MAP OF FIRST DAY ROAD LOG

- - -~- - Route

●⟵ STOP 1-1

Scale 1" = 13 miles

CORRELATION OF PALEOZOIC 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.		IPby	Missing		
			Savanna Fm.		IPsv			
			McAlester Fm.		IPma			
			Hartshorne Sandstone		IPhs			
		ATOKA	Atoka Fm.		IPa	Atoka Fm.		IPa
		MORROW	Bloyd Shale	Kessler Ls Mbr.	IPbh: IPbk	Johns Valley Shale		IPjv
				Woolsey Mbr.	IPbw			
				Brentwood Ls Mbr.	IPbb			
			Hale Fm.	Prairie Grove Mbr.	IPhp	Jackfork Fm.		IPj
				Cane Hill Mbr.	IPhc			
	MISSISSIPPIAN	UPPER	Pitkin Limestone		Mpfb: Mp	Stanley Shale	Chickasaw Creek Mbr.	Ms
			Fayetteville Shale	Wedington SS Mbr.	Mf			
			Batesville Sandstone	Hindsville Ls. Mbr.	Mbh			
			Ruddell Shale		Mr			
			Moorefield Fm.		Mm		Hatton Tuff	
			Boone Fm.	Short Creek Oolite Mbr.	Mb		Hot Springs SS Mbr.	
		LOWER		St. Joe Ls. Mbr.		Arkansas Novaculite	Upper Div.	MDa
DEVONIAN		UPPER	Chattanooga Shale	Sylamore SS	MDcp		Middle Div.	
		MIDDLE	Clifty Limestone				Lower Div.	
		LOWER	Penters Chert					
SILURIAN		UPPER	Missing			Missouri Mountain Shale		SmOpc: Smb
			Lafferty Limestone		Slsb	Blaylock Sandstone		
			St. Clair Limestone					
		LOWER	Brassfield Limestone					
ORDOVICIAN		UPPER	Cason Shale		Ocj	Polk Creek Shale		Opc
			Fernvale Limestone		Of	Bigfork Chert		Obf
		MIDDLE	Kimmswick Limestone		Ocj			
			Plattin Limestone			Womble Shale		Ow
			Joachim Dolomite					
			St. Peter Sandstone		Ose			
			Everton Fm.	Jasper Ls. Mbr.				
				Newton SS Mbr.				
				King River SS Mbr.				
		LOWER	Powell Dolomite		Op			
			Cotter Dolomite		Ocjc	Blakely Sandstone		Ob
			Jefferson City Dolomite			Mazarn Shale		Om
			Roubidoux Fm.		Not exposed	Crystal Mountain Sandstone		Ocm
			Gasconade-VanBuren Fm.	Gunter Mbr.		Collier Shale		Oc
CAMBRIAN		UPPER	Eminence Dolomite			Older rocks not exposed		
			Potosi Dolomite					
			Derby-Doerun-Davis Fm.					
			Bonneterre Dolomite					
			Lamotte Sandstone					
PRE-C			Igneous Rocks					

Figure 2

GENERAL LITHOLOGIC DESCRIPTION OF UNITS TRAVERSED FIRST DAY

	Maximum Thickness (feet)
Pennsylvanian System	
Des Moinesian Series	
Savanna Sandstone - sandstone and shale	850
McAlester Formation - shale, sandstone, and coal	1,000
Hartshorne Sandstone - massive sandstone	180
Atokan Series	
Atoka Formation - sandstone and shale	6,500
Morrowan Series	
Bloyd Shale - shale, sandstone, limestone, and minor coal	350
Hale Formation - shale, sandstone, and limy sandstone	250
Mississippian System	
Chesterian Series	
Pitkin Limestone - massive limestone and shale	200
Fayetteville Shale - black shale with minor limestone and sandstone	350
Batesville Sandstone - sandstone and limestone	75
Kinderhookian - Osagean - Mermecian Series	
Boone Formation - limestone and chert	400
Bachelor Formation - thin shale	----
Devonian System	
Chattanooga Shale - black shale and white sandstone	70
Clifty Limestone - limestone	2.5
Penters Chert - chert and dolomitic limestone	260
Ordovician System	
Cason Shale - shale	21
Fernvale Limestone - limestone	7
Plattin Limestone - limestone and dolomite	33
Joachim Dolomite - dolomite and dolomitic sandstone	15
St. Peter Sandstone - white friable sandstone with minor dolomite and shale	75
Everton Formation - limestone, dolomite, and sandstone	235
Powell Dolomite - dolomite with minor sandstone and shale	215
Cotter Dolomite - dolomite with some chert	450

ROAD LOG - FIRST DAY

OZARK MOUNTAINS - ARKANSAS VALLEY, ARKANSAS

William V. Bush[1], Boyd R. Haley[2], Charles G. Stone[1], Drew F. Holbrook[1], and John D. McFarland, III[1]

Beaver Dam - Eureka Springs - Berryville - Kingston - Boxley - Harmony - Peabody Coal Mine - Coal Hill - Ozark - Clarksville - Russellville (Figure 1)

MILEAGE	DESCRIPTION
0.0	**STOP 1 - 1**: Assemble at the south end of Beaver Dam (Plate 1). The Cotter Dolomite is exposed from river level to 20 feet above road level at the dam. Above the Cotter in the roadcut (in ascending order) is 6 to 12 ft. of the Powell Dolomite, 2.5 ft. of the Clifty Sandstone, 0.5 ft. of the Sylamore Sandstone Member of the Chattanooga Shale, 20 ft. of Chattanooga Shale, 2.2 ft. of olive green shale which is equivalent to the Bachelor Formation in Missouri, 47 ft. of the St. Joe Member of the Boone Formation, and the Boone Formation to the top of the quarry south of the dam (Figure 3). Flattened chert nodules are found 13.5 ft. above the base of the St. Joe here. The Kinderhookian Osagean series boundary as determined from conodonts is about 21 feet above the base of the St. Joe Member at this location. Proceed north across the dam on Ark. Hwy. 87. Figure 4 shows diagrammatically the relationship of formations of the Paleozoic rocks in northwestern Arkansas.
1.0	Cotter Dolomite is exposed in roadcuts for the next 3.7 miles to mileage 4.7.
1.7	Entrance to Dinosaur Park
3.0	Junction of Ark. Hwy 87 and U. S. Hwy 62, turn east (right) onto U. S. Hwy 62.
3.7	Bridge over White River below Beaver Lake.
4.7	Outcrop south of the road has 2 ft. of the Sylamore Sandstone Member, 2 ft. of Everton Formation, and 20 ft. of Cotter Dolomite.
4.8	Road to the west; Chattanooga Shale outcrops to the northwest.
5.0	St. Joe Limestone Member is exposed on the north side of the road.
5.2	For the next 2.1 miles to mileage 7.3 the route traverses the Boone Formation.

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[1]Geologist, Arkansas Geological Commission, Little Rock, Ark.
[2]Geologist, U. S. Geological Survey, Little Rock, Ark.

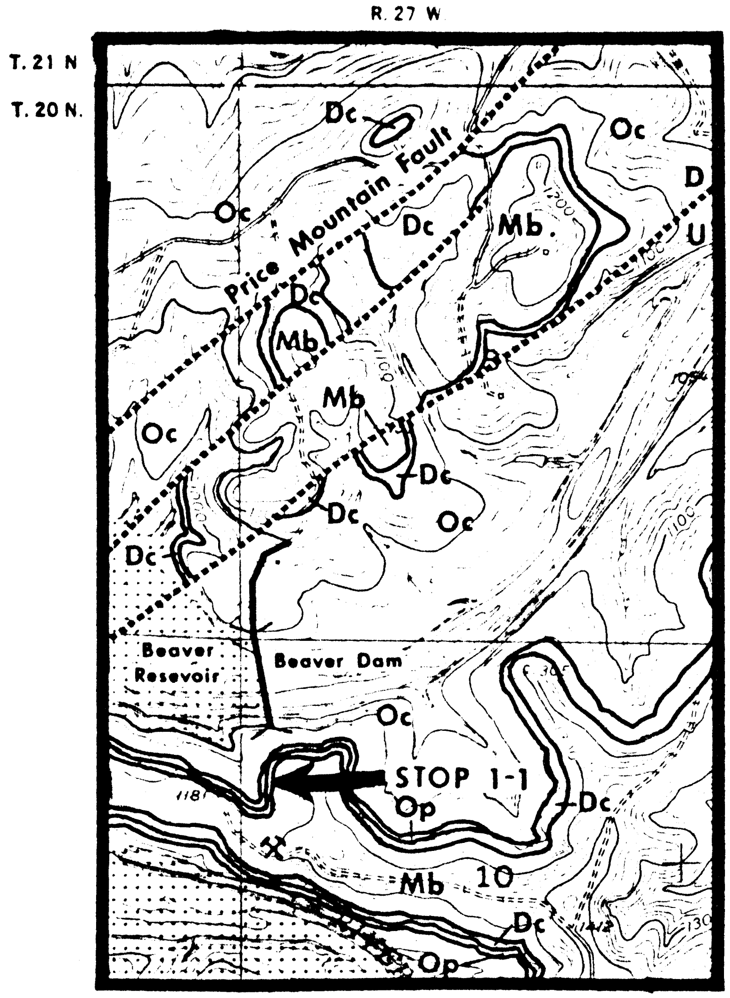


PLATE I. BEAVER DAM – STOP I–I.

1000 0 1000 2000 3000 FEET

Geology by E. E. Glick

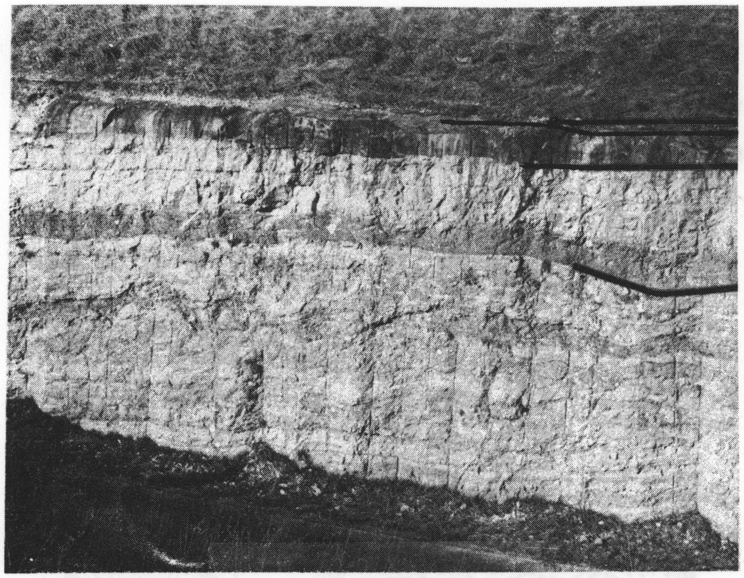


Figure 3. -- Stop 1 - 1. Chattanooga Shale (grass covered), Sylamore Sandstone Member of the Chattanooga Shale, Clifty Sandstone, Powell Dolomite, and Cotter Dolomite.

MILEAGE	DESCRIPTION
6.3	Inspiration Point, scenic view to the north looking over the Salem Plateau.
7.3	Junction of Ark. Hwy 187 to Beaver Dam, continue on U. S. Hwy 62.
7.8	Outcrop contains 54 ft. of the St. Joe Member, 10 ft. of Chattanooga Shale, 1 foot of the Sylamore Sandstone Member resting on the Cotter Dolomite.
7.9	Cotter Dolomite exposed for the next 1.1 miles to mileage 9.0.
8.4	Road to the north, entrance to Camp Leatherwood.
9.0	Outcrop of Cotter Dolomite, with 2 ft. of the Sylamore Sandstone Member above, then 7 ft. of Chattanooga Shale, and the St. Joe Limestone Member for the next 0.4 mile to mileage 9.4.
9.4	Boone Formation for the 7.0 miles to mileage 16.4.
9.7	City limits of Eureka Springs "Little Switzerland," Arkansas.
10.4	Road to the north, entrance to Pivot Rock.

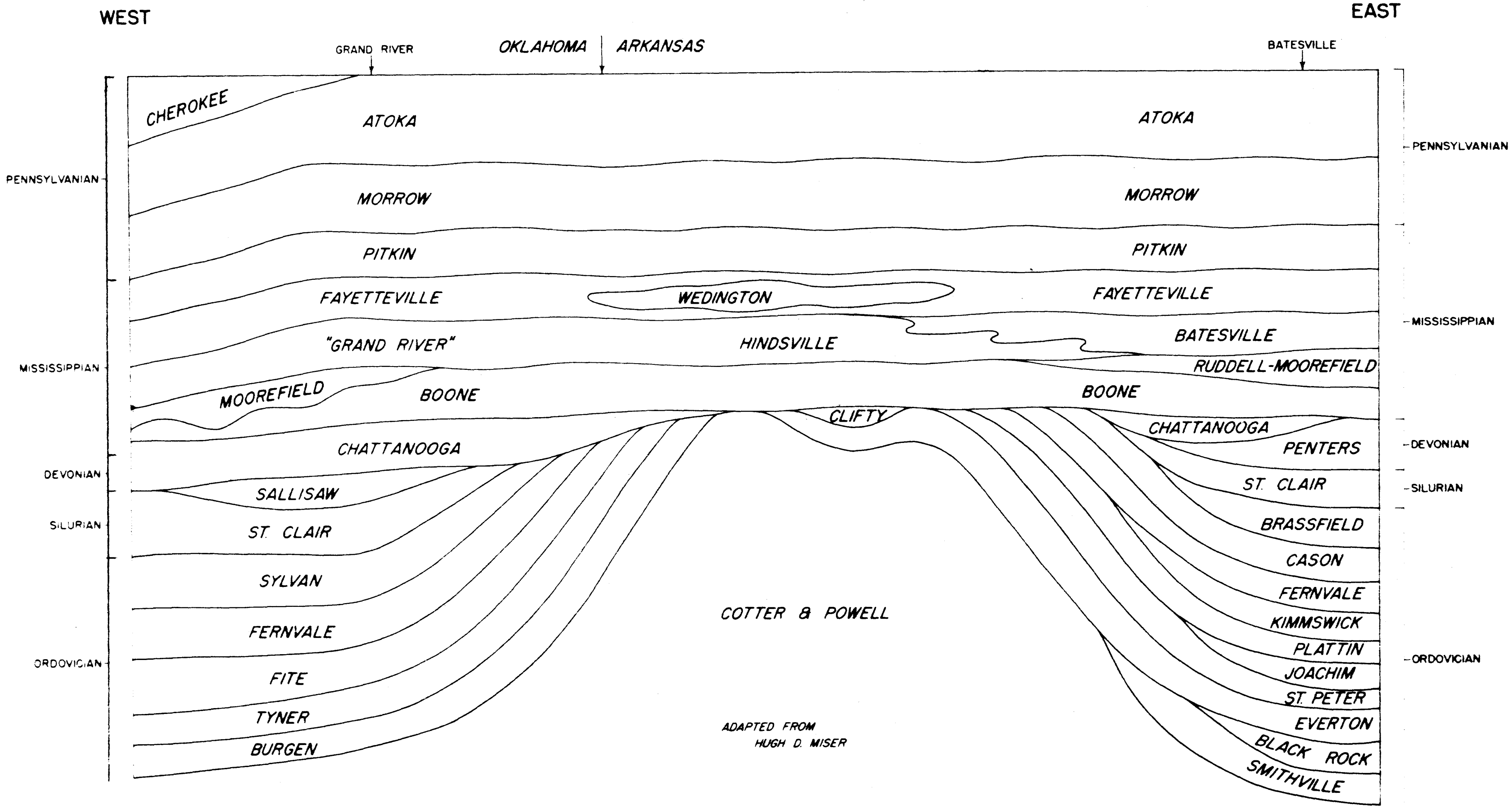


Figure 4 This sketch shows diagrammatically the relationship which exists between adjacent formations as a result of the unconformities in the Paleozoic rocks of northwestern Arkansas.

MILEAGE	DESCRIPTION
11.0	Mount Air Motel.
11.6	Junction with Ark. Hwy 23 to downtown Eureka Springs, continue east on U. S. Hwy 62.
14.1	Road to the north, entrance to Christ of the Ozarks and Passion Play.
15.8	Scenic view to the south looking over the Springfield Plateau.
16.4	Outcrop of the St. Joe Member with 5 ft. of Chattanooga Shale below, then 4 inches of the Sylamore Sandstone Member and the Cotter Dolomite for the next 15.4 miles to mileage 31.8.
19.0	Bridge over Kings River.
19.9	Junction with Ark. Hwy 143 to the north, continue on U. S. Hwy 62.
23.6	Downtown Berryville, Arkansas.
24.1	Junction with Ark. Hwy 21. Turn south (right) onto Hwy 21.
25.6	Bridge over Osage Creek.
30.1	On the edge of the bluff to the west, two Hoodoo rocks are sticking up above the trees. Hoodoo rocks are erosional remnants of irregular shaped masses of sandstone. This is the sand that was deposited in sinkholes, caves, or fractures in dolomite of the Powell or Cotter.
31.6	Sandstone on the right side of the road is a Hoodoo rock in the Cotter.
31.8	<u>STOP 1 - 2</u>: Excellent section, starting at the bottom of the hill in the Cotter Dolomite, and next the Powell Dolomite, then the Everton Formation and at mileage 31.95 is a fault with Everton against the Boone Formation. Downthrown side is to the south. The Boone is exposed for the next 2.6 miles to mileage 34.7 (Plate 2).
34.5	St. Joe Limestone Member exposed on the west side of the road.
34.7	Base of the St. Joe Limestone Member resting on the Everton.
35.0	Good exposure of Everton sandstone in the creek. Above the Everton is the St. Joe Limestone Member.
35.2	Bridge over Piney Creek, excellent exposure of Everton sandstone. Metalton, Arkansas.
35.4	<u>STOP 1 - 3</u>: Dirt road to the east (Plate 3). About 0.1 mile east in the east bank of the creek is a fault with the downthrown side to the south.

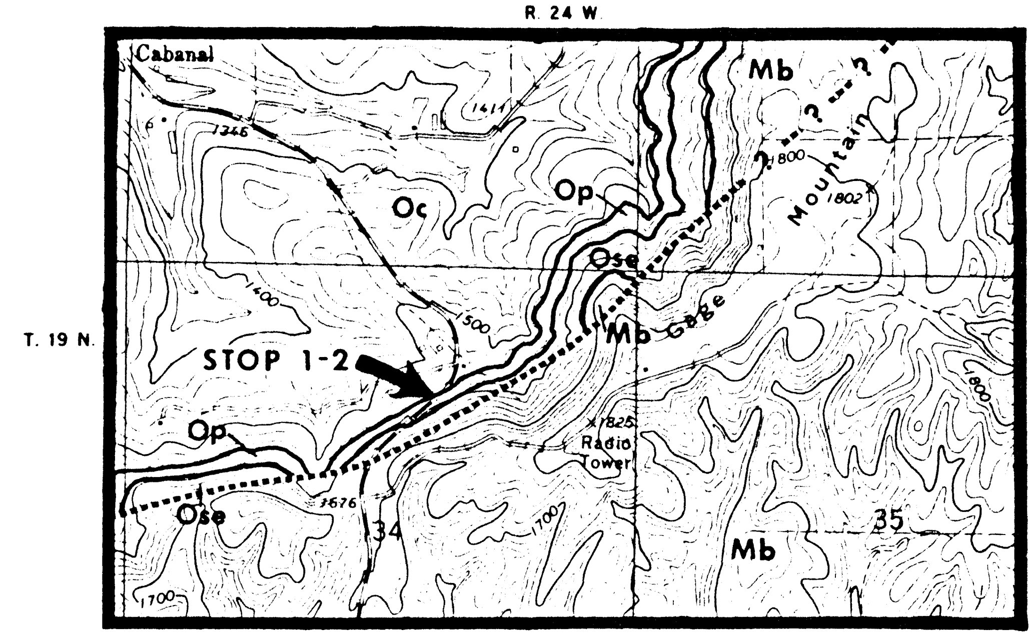


PLATE 2. BERRYVILLE SOUTH — STOP 1-2.

1000 0 1000 2000 3000 FEET

Geology by W. V. Bush and B. R. Haley

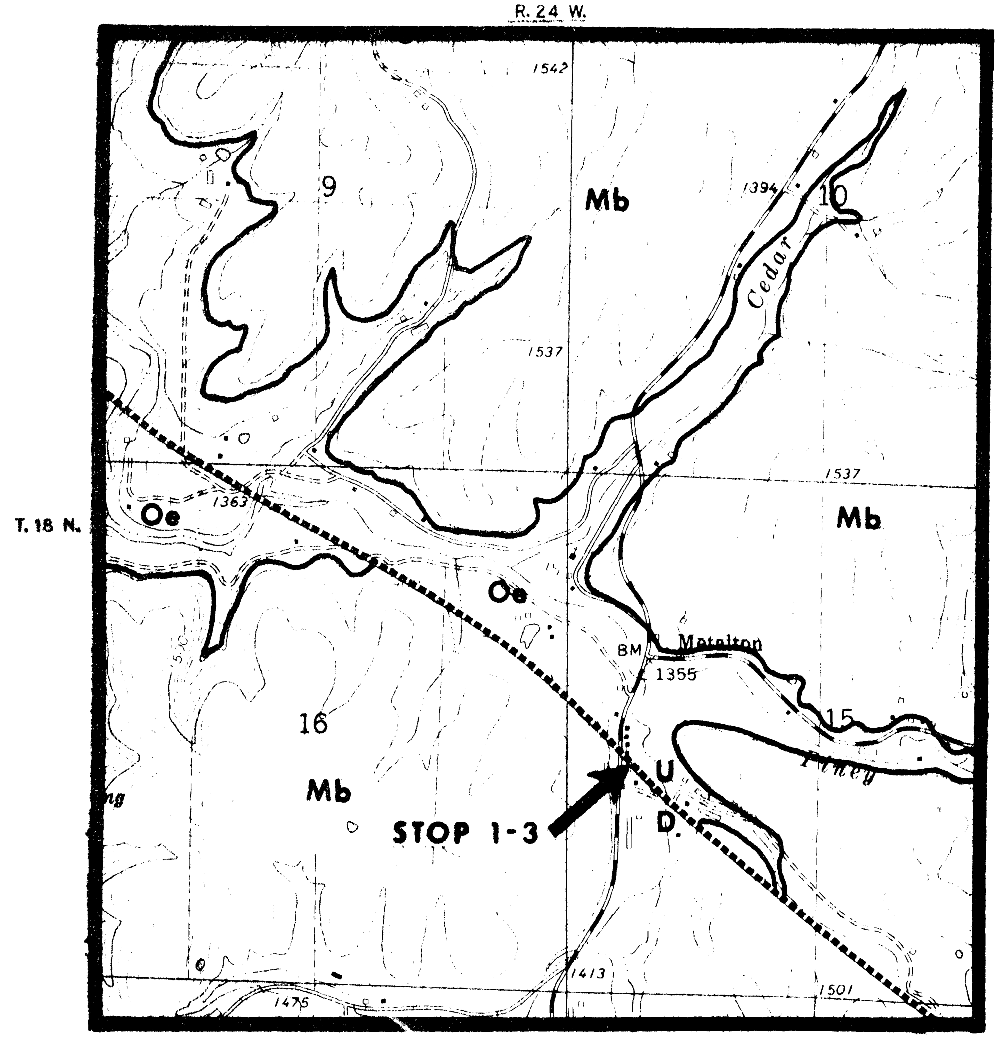


PLATE 3. METALTON, ARKANSAS — STOP I-3.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley and W. V. Bush

MILEAGE	DESCRIPTION
35.4 (cont.)	The St. Joe Limestone Member and Everton sandstone are faulted against the middle part of the Boone Formation. Displacement of the fault is approximately 100 feet. For the next 5.1 miles to mileage 40.5 the route traverses the Boone.
39.0	Bridge over Dry Fork Creek.
39.8	Excellent exposure of the Boone in the roadcut to the east.
40.6	Batesville Sandstone and Hindsville Limestone Member of the Batesville Sandstone caps the hill to the west.
41.0	Hindsville Limestone Member and Batesville Sandstone exposed in the ditch to the east. Below is the Boone which is exposed for the next 8.8 miles to mileage 49.8.
41.6	Junction of Ark. Hwy 68. Turn west (right).
41.9	Junction of Ark. Hwys 68 and 21, turn south (left) onto Ark. Hwy 21.
44.7	Bridge over Kings River.
45.5	Bridge over Kings River.
46.8	Collapse structure in the Boone Formation to the east.
47.7	Picnic area to the east.
49.0	Downtown Kingston, Arkansas, note the old bank on the north side of the square. Old antique safe in the lobby is worth a stop if time allows. Cafe next to the bank also serves good home cooked meals.
49.4	Batesville Sandstone is exposed in the roadcut to the south.
49.5	Fayetteville Shale is exposed south of the road.
50.2	STOP 1 - 4: Walk downhill. Fayetteville Shale (note septarian concretions), Batesville Sandstone, Hindsville Limestone Member of the Batesville Sandstone (Figure 5), and Boone Formation with Short Creek Oolite Member at the top (Plate 4).
50.9	Bridge over Dry Creek, Fayetteville Shale, Batesville Sandstone, Hindsville Limestone Member, and the lower part of the Boone Formation are exposed to the south. A down-to-the-south fault is under the road. Displacement of the fault is approximately 150 feet.
51.4	Fayetteville Shale is exposed in the roadcut to the south. The Boone is exposed in the ditch to the north. They are separated by the same fault as at mileage 50.9.

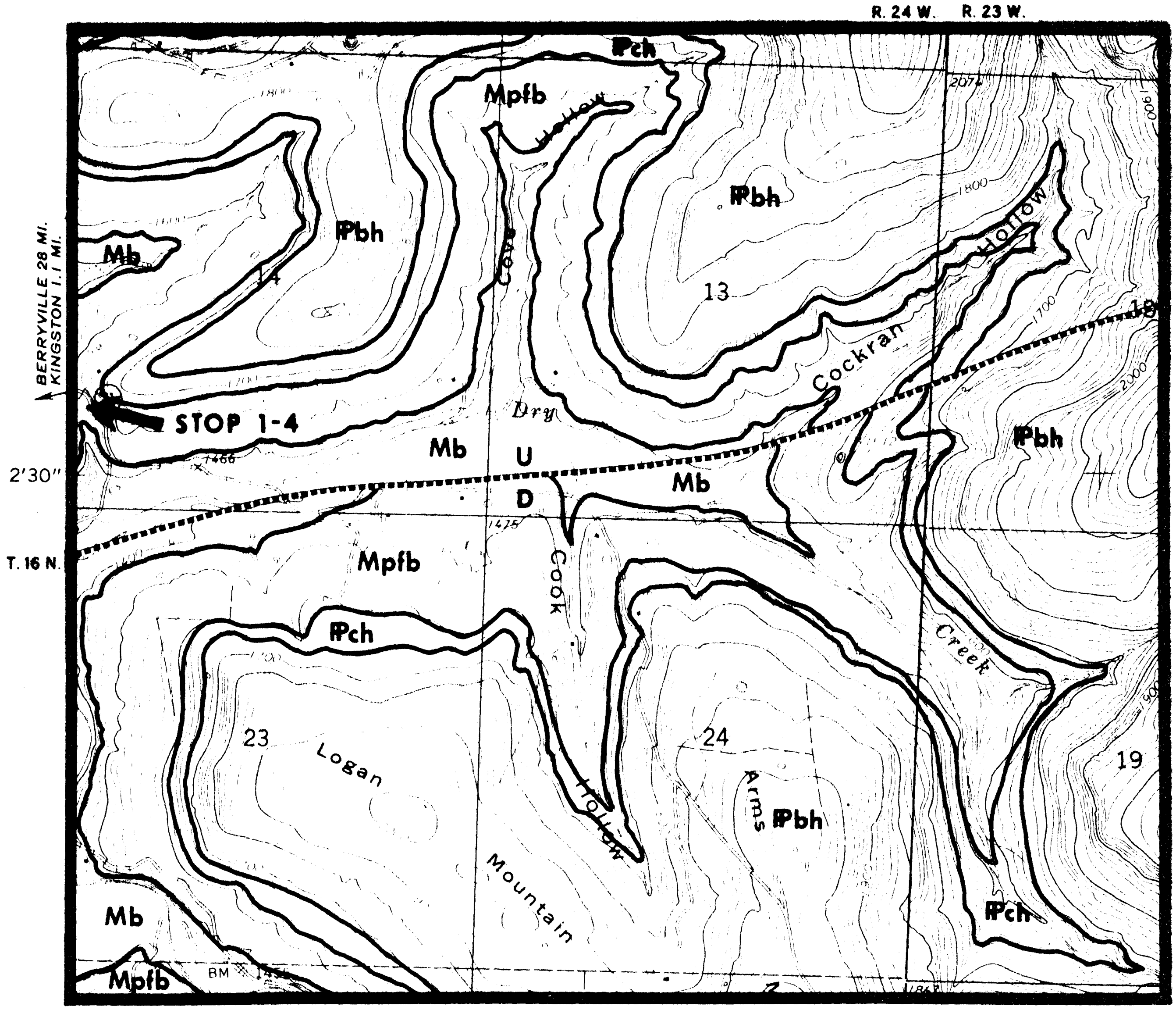


PLATE 4. DRY CREEK — STOP 1-4.

1000 0 1000 2000 3000 FEET

Geology by W. V. Bush and B. R. Haley

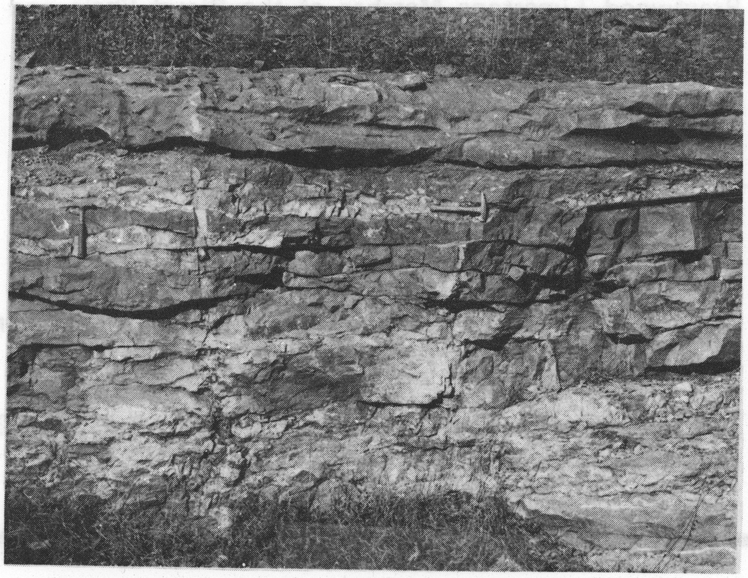


Figure 5. -- Stop 1 - 4. Hindsville Limestone Member of the Batesville Sandstone and the underlying Boone Formation. Note the rounded fragments of Boone in the lowermost part of the Hindsville.

MILEAGE	DESCRIPTION
51.6	Contact between the Cane Hill Member and the Prairie Grove Member of the Hale Formation.
51.8	Exposure of the Brentwood Limestone Member of the Bloyd Shale.
52.1	Base of the Caprock of the Baldwin Coal (Bloyd Shale). Excellent exposure of massive bedded and cross bedded sandstone. Bloyd Shale undifferentiated is traversed for the next 2.8 miles or mileage 54.9.
54.0	Newton County Line.
54.6	Fossiliferous sandstone in the Bloyd in the cut to the south.
54.9	Basal sandstone of the Atoka Formation.
55.5	Basal sandstone of the Atoka, then back into the Bloyd Shale for the next 0.9 mile to mileage 56.4.
56.0	Top of the Caprock of the Baldwin Coal (Bloyd Shale).
56.2	Base of the Caprock of the Baldwin Coal.

MILEAGE	DESCRIPTION
56.4	Brentwood Limestone Member of the Bloyd Shale and the Prairie Grove Member to the north.
56.7	Cane Hill Member exposed in the roadcut to the north.
57.1	Pitkin Limestone is exposed in the roadcut to the north.
57.3	Fayetteville Shale is exposed in the roadcut to the north.
57.5	Outcrop of Batesville Sandstone (8 ft.), 6 inches of Hindsville Limestone Member, and the Boone Formation to the base of the hill.
58.4	Junction of Ark. Hwy 43, continue south on Ark. Hwy 21 (unless side trip to Ponca is made).

SIDE TRIP TO PONCA, ARKANSAS

0.0	Junction of Ark. Hwys 43 and 21. Proceed north on Ark. Hwy 43.
0.4	Fernvale Limestone exposed on the west side of the road.
0.5	Outcrop to the west of the road is Everton sandstone overlain by Fernvale Limestone and the St. Joe Limestone Member of the Boone Formation.
0.9	Low water bridge.
1.7	St. Joe Limestone Member exposed behind trailer house to the west.
1.8	Fernvale Limestone on the west side of the road for the next 0.8 mile to mileage 2.6.
2.6	St. Joe Limestone Member exposed in the bluff to the west.
2.7	STOP 1 - 5: Small quarry on the west side of the road (Plate 5). Section in the quarry has about 15 feet of the St. Joe Limestone at the top, about 2 feet of the basal Mississippian conglomerate, thin lenses of the Cason Shale, and 25 feet of the Fernvale Limestone (Figure 6). Private property, permission from owner should be obtained.
3.1	Entrance to Lost Valley State Park to the west. This scenic park is noted for its geologic features (caves, cliffs, etc.) and for its archeological significance.
3.6	Everton Formation is exposed on the west side of the road and continues on for the next 0.8 mile to mileage 4.4.

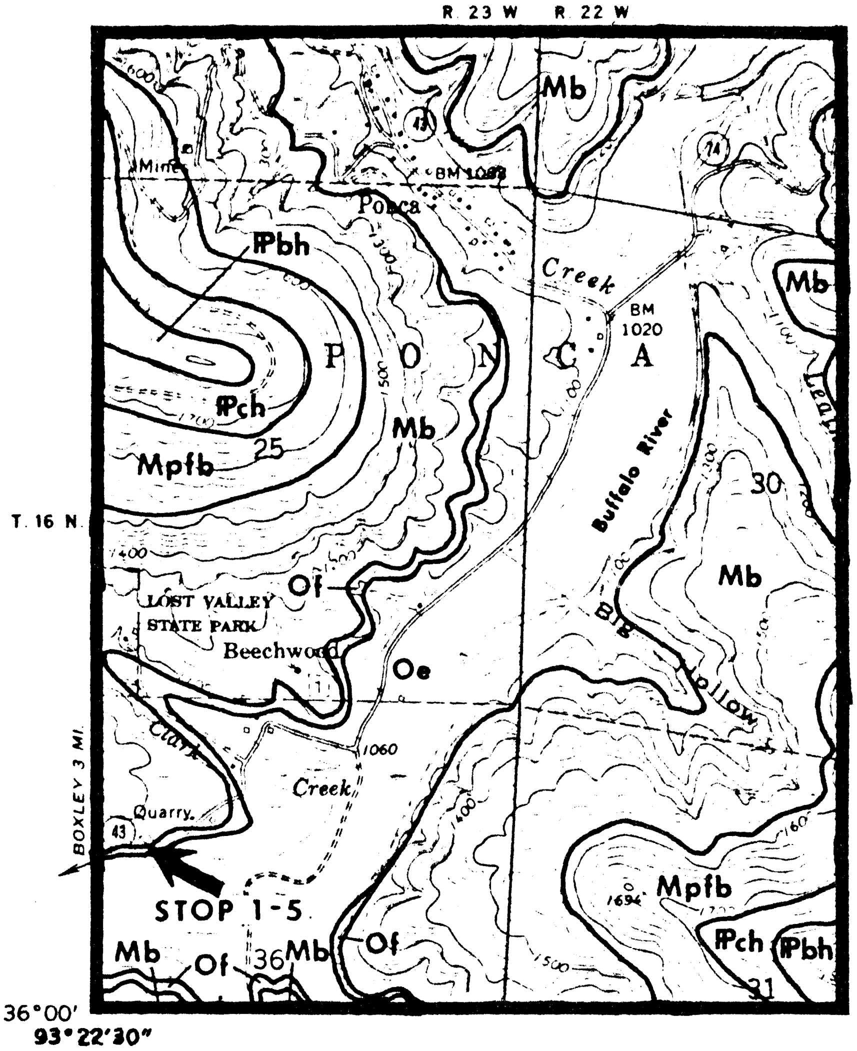


PLATE 5. PONCA, ARKANSAS — STOP 1-5.

1000 0 1000 2000 3000 FEET

Geology by W. V. Bush

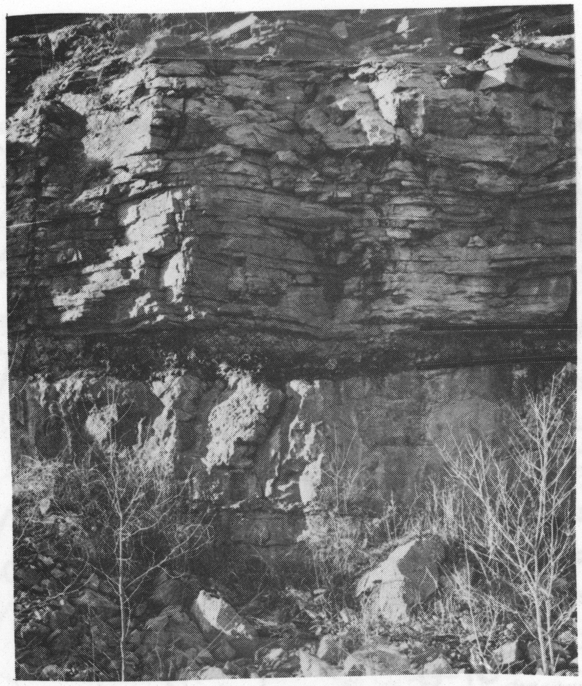


Figure 6. -- Stop 1 - 5. St. Joe Limestone Member of Boone Formation, basal conglomerate of Mississippian age, and underlying Fernvale Limestone of Late Ordovician age. The conglomerate at the base of the Boone Formation is always present in the areas where Chattanooga Shale is not present.

MILEAGE	DESCRIPTION
4.4	Junction of Ark. Hwys 74 and 43, continue on Ark. Hwy 43. Green shale in the Everton to the south. Buffalo National River to the east on Ark. Hwy 74 is famous for its scenic bluffs, small mouth bass fishing, and float trips.
4.5	Dolomite and sandstone in the Everton Formation to the south.
4.6	Old Mill from the mining days around Ponca.
4.7	Downtown Ponca, Arkansas. This community is in an old mining town. Deposits of lead and zinc are found in the form of zinc carbonate, zinc sulfate, and galena in the Boone Formation. Other sources of lead come from galena in the lower Batesville Sandstone. Activity dates back to Civil War days with maximum mining from 1914-1918. U. S. Bureau of Mines report 2500 tons of zinc concentrates and 1500 tons of lead concentrates have been produced from this area.
	This is the end of the Ponca side trip, return to Junction of Ark. Hwys 43 and 21.

MILEAGE	DESCRIPTION
58.4	Junction of Ark. Hwys 43 and 21, proceed south on Ark. Hwy 21.
58.8	Boxley, Arkansas.
59.2	Bridge over Moore Creek.
59.3	The Boone Formation forms the bluff to the east.
60.6	Bridge over Buffalo National River.
60.9	Outcrop of the Boone Formation to the east.
61.3	Outcrop of Hindsville Limestone Member, Batesville Sandstone, and Fayetteville Shale to the south.
61.6	STOP 1 - 6: The walk uphill traverses a section from the Pitkin Limestone to the Caprock of the Baldwin Coal (Plate 6). This section includes in ascending order the Pitkin Limestone (Figure 7), Cane Hill Member of the Hale Formation, the Prairie Grove Member of the Hale Formation and Brentwood Member of the Bloyd Shale undifferentiated (Figure 8), the Woolsey Member of the Bloyd Shale, and the massive sandstone Caprock of the Baldwin Coal of the Bloyd Shale (Figure 9). The end of this section is at mileage 62.6.
63.1	Basal sandstone of the Atoka Formation. Atoka is exposed for the next 39.6 miles to mileage 102.7.
63.2	Gravel Road to the west.
69.5	Junction of Ark. Hwys 21 and 16, turn west (right), continue on Ark. Hwy 21.
69.7	Scenic view to the south into Big Piney Valley, one of the deepest valleys (1300 ft.), in the Boston Mountains.
78.0	Fallsville, Arkansas, junction of Ark. Hwys 21 and 16, continue south on Ark. Hwy 21.
79.2	Fault in the Atoka Formation, this normal fault is downthrown to the south.
80.5	Atoka sandstone on the west side of road. This unit is one of several sandstones in the "Cecil Series", a productive gas zone, in the Arkansas Valley.
82.8	Normal fault in the Atoka with the downthrown side to the south.
84.0	Salus, Arkansas.
86.0	Road to Oark, Arkansas to the west.
87.3	Fault in the Atoka, with downthrown side to the south.

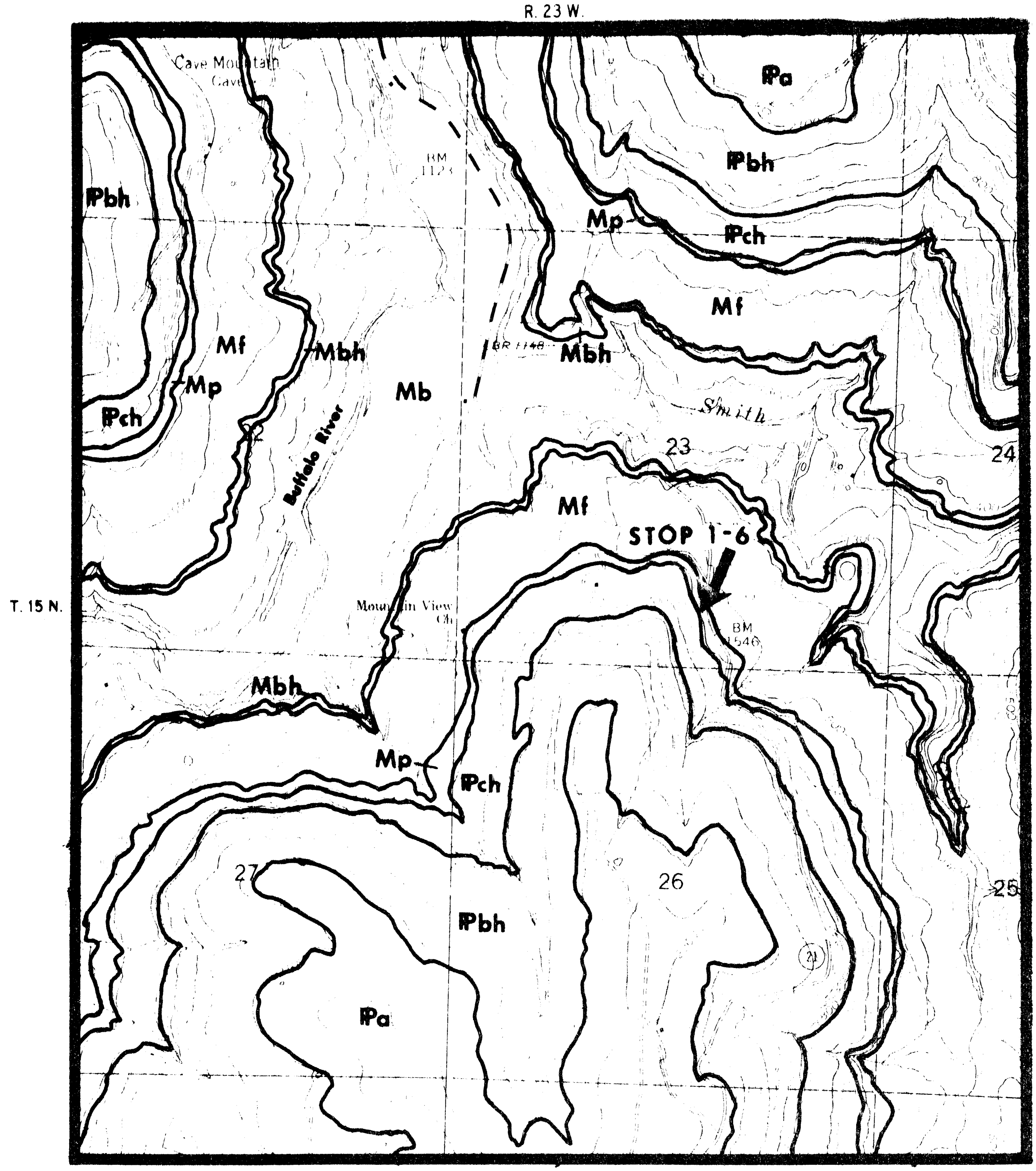


PLATE 6. BUFFALO RIVER — STOP 1-6.

1000 0 1000 2000 3000 FEET

Geology by E. E. Glick

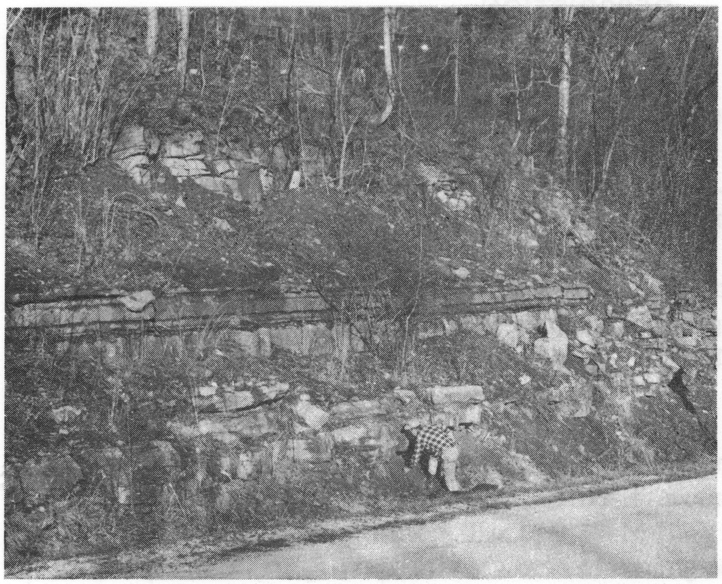
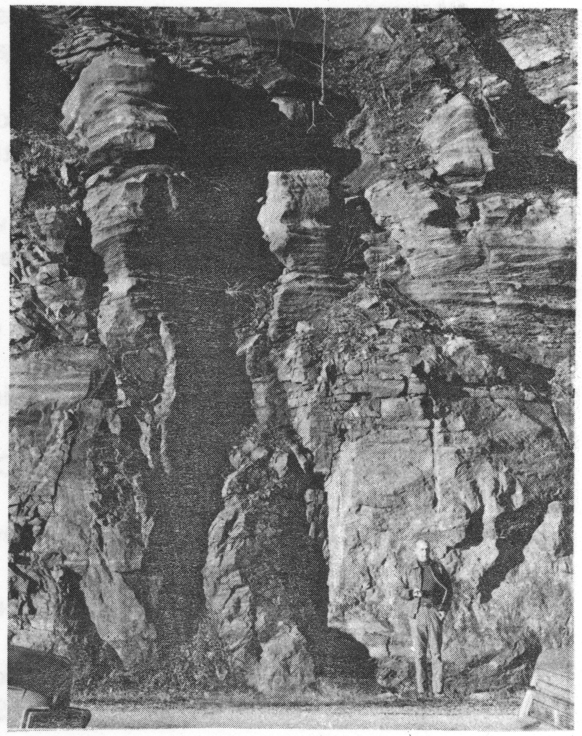


Figure 7 -- Stop 1 - 6. Pitkin Limestone and Fayetteville Shale. Contact is at the base of the limestone bed that is level with the man's head.

Figure 8 -- Brentwood Limestone Member of the Bloyd Shale and the Prairie Grove Member of the underlying Hale Formation.



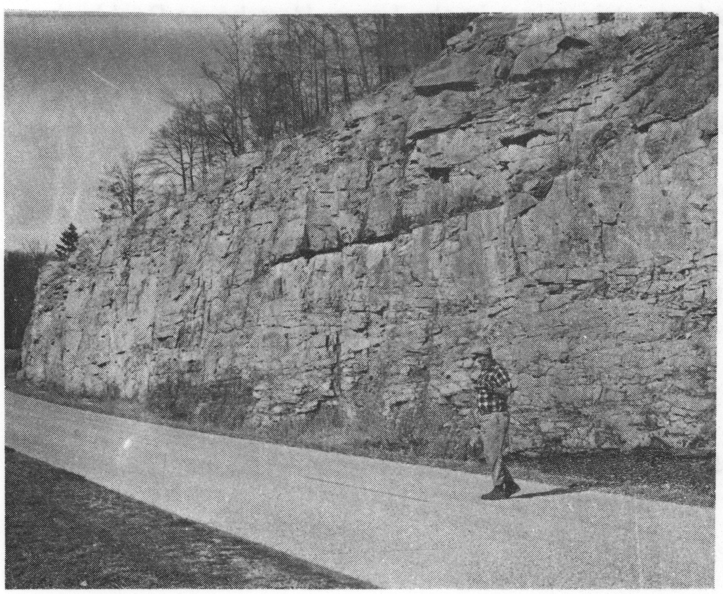


Figure 9 -- Stop 1 - 6. Caprock of the Baldwin Coal bed formerly mapped as basal sandstone member of the Atoka Formation.

MILEAGE	DESCRIPTION
92.0	Downtown Ozone, Arkansas.
93.1	Sharp turn in the Hwy. Quarry in Atoka sandstone to the north. The base of this sandstone is approximately 1500 feet above the base of the Atoka.
96.1	Start down a long grade, this is the south side of the Boston Mountains. The sandstone at the top of the grade is the sandstone (Atoka) at the quarry described at mileage 93.1.
97.8	**STOP 1 - 7**: Sharp turn to the south! Walk downhill. The top of this Atoka sandstone is 1100 ft. above the base of the formation (Plate 7). As you walk down the section (downhill) you will note a gradual decrease in the bedding thickness, in the grain size of the clastic quartz, and in the percentage of clastic quartz. In the old days, geologists would have interpreted a regressive marine depositional environment for this sequence of rocks. Nowdays some geologists would interpret a prograding deltaic depositional environment for this sequence of rocks.
98.9	Mulberry Fault, with the downthrown side to the south has a displacement of about 2500 feet.
99.8	Turn west (right) onto paved road.
100.6	Cross roads, continue west.
101.7	Road to Nubian Creek Goat Farm to north, continue west.
102.7	Base of the Hartshorne Sandstone.
103.0	Junction, turn north (right) onto dirt road.
103.1	Partially reclaimed spoils from strip mines in the Lower Hartshorne Coal bed of the McAlester Shale to the west.
103.9	Bridge over Spadra Creek.
104.7	Outcrop of McAlester Shale to the south.
105.9	Road to the south, continue west. Reclaimed spoil bank in the strip mine about ¼ mile to the south, mined and reclaimed by Garland Coal Company. Shale in the McAlester is exposed in the ditch to the north.
107.2	Junction with Ark. Hwy 103, turn north right onto Ark. Hwy 103.
107.4	Downtown Harmony, Arkansas, riding on the Hartshorne Sandstone.
107.7	Bridge.

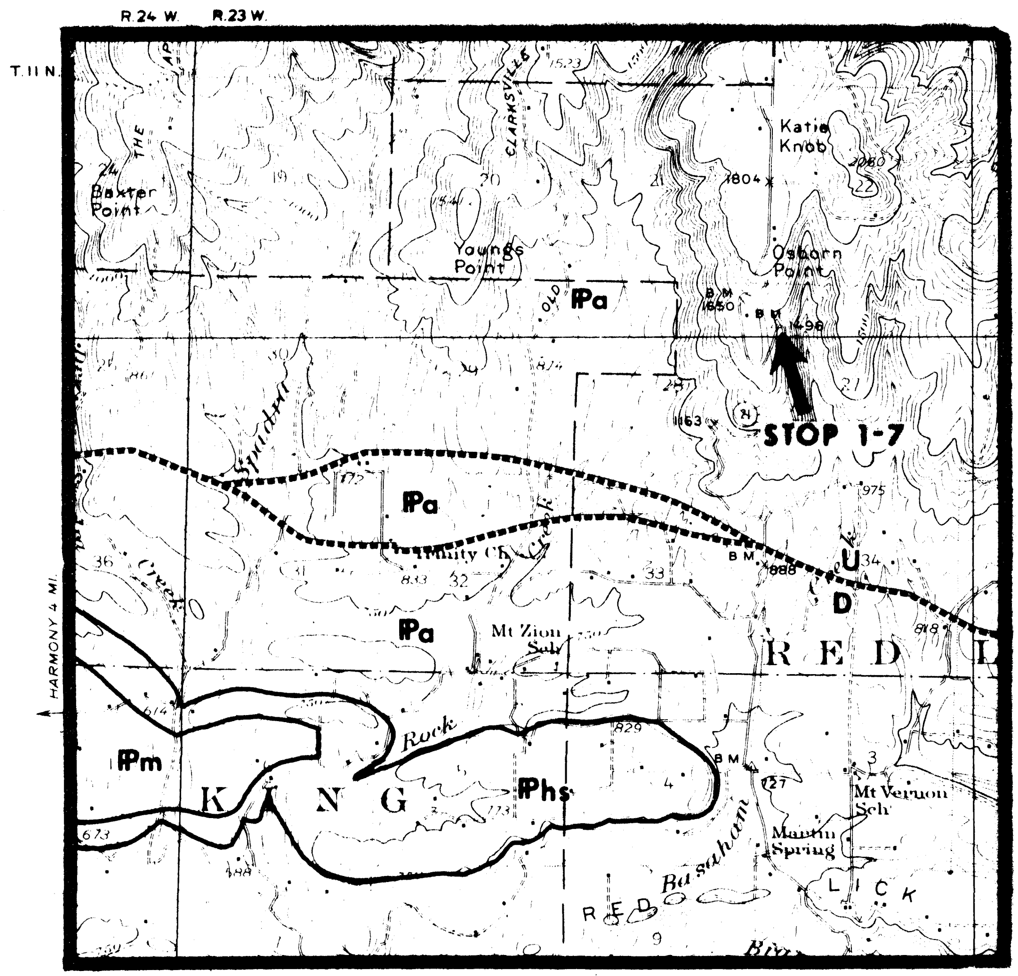


PLATE 7. ATOKA FORMATION — STOP 1-7.

1000 0 3000 6000 9000 FEET

Geology by B. R. Haley and E. E. Glick

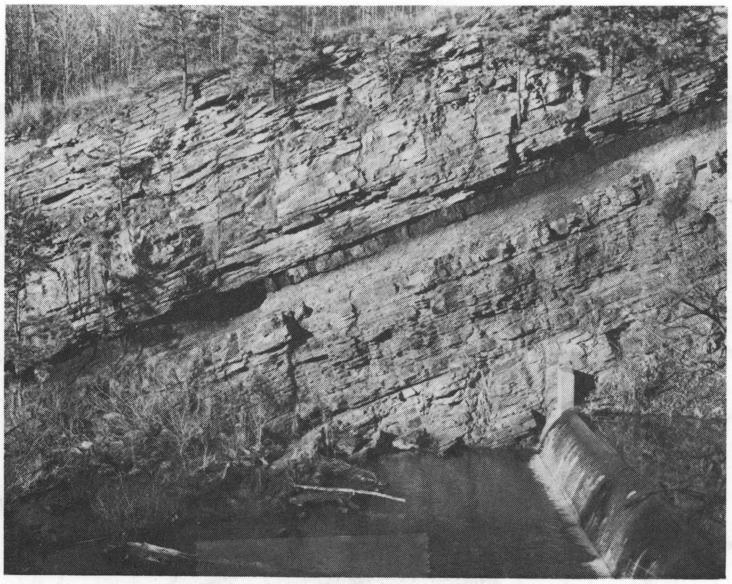


Figure 10. -- Spillway at Horsehead Lake (Mile 112). Sandstone in lower part of McAlester Formation, Lower Hartshorne Coal bed with mine opening, and sandstone of upper part of Hartshorne Sandstone. (See coal analyses, Table 1).

MILEAGE	DESCRIPTION
108.0	Bridge.
108.4	Junction of Ark. Hwys 103 and 164, turn west, left onto Ark. Hwy 164.
108.6	Reclaimed spoil from a strip mine in the Lower Hartshorne Coal bed of the McAlester Shale.
108.9	Hartshorne Sandstone for the next 1.3 miles to mileage 110.2.
110.3	Strip mine in the Lower Hartshorne Coal bed.
110.6	The Boston Mountains to the north are the south edge of the Ozark Mountains. The Mulberry Fault lies along the south edge of the range with the downthrown side to the south. Displacement is about 2500 feet.
110.9	Outcrop of McAlester Shale to the north.
112.0	Road to the north is the entrance to Horsehead Lake. Excellent exposure 0.3 mile north of the junction. Outcrop consists of Hartshorne Sandstone, Lower Hartshorne Coal bed of the McAlester Shale, thin sandstone, a higher thin coal bed, and the black shale of the McAlester. The upper coal bed extends throughout the Philpot syncline (Figure 10). See Table 1 for analysis of this coal. Coal was mined by Jack Lee, owner of the small store at mileage 112.4. Mulberry Fault runs near the north shore of the lake.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

COAL-ANALYSIS REPORT

Test No. Ark LH#2 Lab. No. K-54016

Sample of Coal Can No.

Operator Mine Jack Lee

State Arkansas County Johnson Bed Lower Hartshorne

~~Town~~ Cen. SE NE Sec. 3, T. 10 N., R. 25 W.

~~Location in mine~~ 22" of coal - collected from Jack Lee Mine and about 6" from the old face of the coal. Mine is about 30 years old.

Method of sampling Gross weight, lbs. Net weight, grams 3814.

Date of sampling Date of Lab. sampling 6/18/75 Date of analysis

B.ofM. or U.S.G.S. section U. S. G. S. Submitted by: ~~Collector~~ Boyd R. Haley

	AIR-DRY LOSS	COAL (Air dried)	COAL (As received)	COAL (Moisture free)	COAL (Moisture and ash free)
Proximate Analysis	Moisture		3.4		
	Volatile matter		17.7	18.3	18.9
	Fixed carbon		75.7	78.4	81.1
	Ash		3.2	3.3	
			100.0	100.0	100.0
Ultimate Analysis	Hydrogen		4.5	4.3	4.4
	Carbon		84.0	87.0	90.0
	Nitrogen		1.8	1.9	1.9
	Oxygen		5.9	2.9	3.1
	Sulphur		0.6	0.6	0.6
	Ash		3.2	3.3	
			100.0	100.0	100.0
	British thermal units		14480	14990	15500

Fusibility of Ash, °F.	
Initial deformation temperature	2090
Softening temperature	2140
Fluid temperature	2190

Free-swelling index no. 5

SULFUR FORMS:	Sulfate	Pyritic	Organic
As-received	0.01	0.01	0.01
Moisture-free	0.14	0.14	0.5
M. and ash-free	0.43	0.45	0.46

Date July 7, 1975

Forrest E. Walker
Chemist-in-Charge, Coal Analysis

Table 1

MILEAGE	DESCRIPTION
112.3	Bridge over Horsehead Creek.
112.4	Jack Lee's Store.
112.5	Dirt road to the north, continue west on Ark. Hwy 164.
112.7	Outcrop of McAlester Shale to the south.
114.0	The Mulberry Fault is along the base of the mountain to the north. The top bluff in the mountain is 1500 feet above the base of the Atoka Formation. The road is on the McAlester Shale which is about 4800 feet above the base of the Atoka and is on the downthrown side of the fault.
114.8	Downtown Hunt, Arkansas.
115.1	Mining Office of Peabody Coal Company.
115.4	Strip mine in the Lower Hartshorne Coal bed.
115.8	Outcrop of Hartshorne Sandstone.
115.9	Junction with road to the northwest, make a hard right turn to the northwest.
116.3	Outcrop of Hartshorne Sandstone.
116.6	Note the reclaimed land to the north. Orphan spoils to the east and west, the coal was mined by the Utah Construction Company in 1953. Note the size of the sycamore trees on the banks of the orphan spoils to the west.
116.7	Beginning of side trip through a Coal Mining area and a stop (**STOP 1 - 8**) at an active strip mine of Peabody Coal Company (Figure 11). Refer to Plate 8 for map of the area. The following is a brief summary of coal mining in Arkansas.

Coal was produced in Arkansas as far back as 1840 but significant activity didn't begin until 1870 and has continued to present. Production reached 2 million tons annually in 1903. By 1967 annual production had dropped to less than 189,000 tons. In 1972 a need for more energy increased activity in Arkansas coal and production was up to over 400,000 tons annually.

The 1976 coal production was 505,737 tons. From 1840-1975 total production of coal in Arkansas has been 103,190,026 short tons of which 12,626,602 have been mined from the surface and 90,565,424 were mined underground. Until 1958 underground mining produced annually more coal than did surface mining. In 1974 and 1975 no underground mines were in operation and one was in operation in 1976. The Arkansas coal fields cover a 1980 square mile area in the Arkansas Valley. The coal found in Arkansas is a bituminous or semianthracite coal. The Hartshorne Sandstone, McAlester Shale, and the Savanna Sandstone are the coal-bearing rocks in the Arkansas

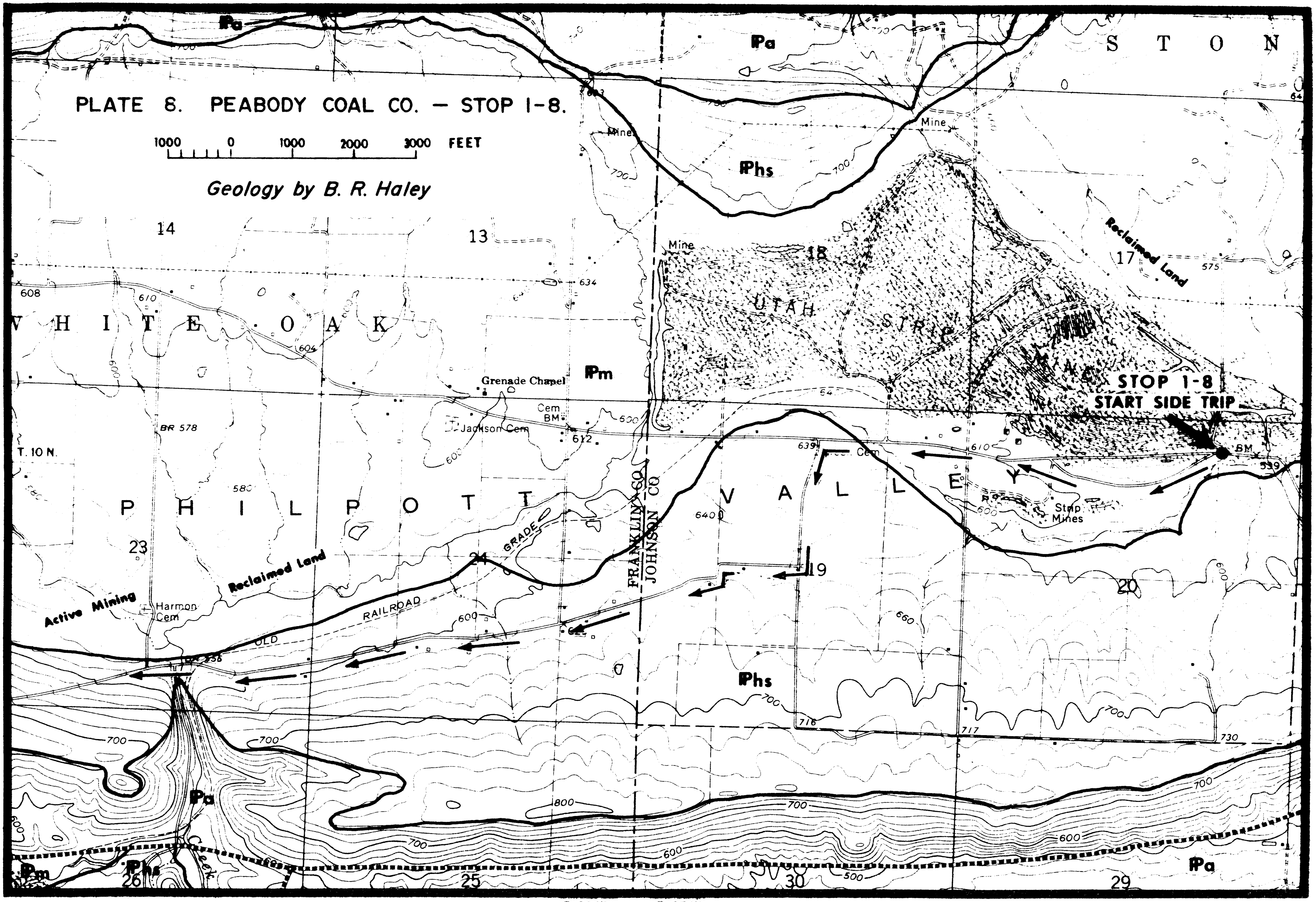


PLATE 8. PEABODY COAL CO. — STOP I-8.
1000 0 1000 2000 3000 FEET
Geology by B. R. Haley
STOP I-8
START SIDE TRIP
Reclaimed Land
Active Mining
UTAH STRIP MAC
WHITE OAK
PHILPOTT
VALLEY
STON
FRANKLIN CO
JOHNSON CO
Grenade Chapel
Jackson Cem
Harmon Cem
Strip Mines
Mine
OLD RAILROAD GRADE
Creek
T. 10 N.
R. 26 W.
R. 25 W.
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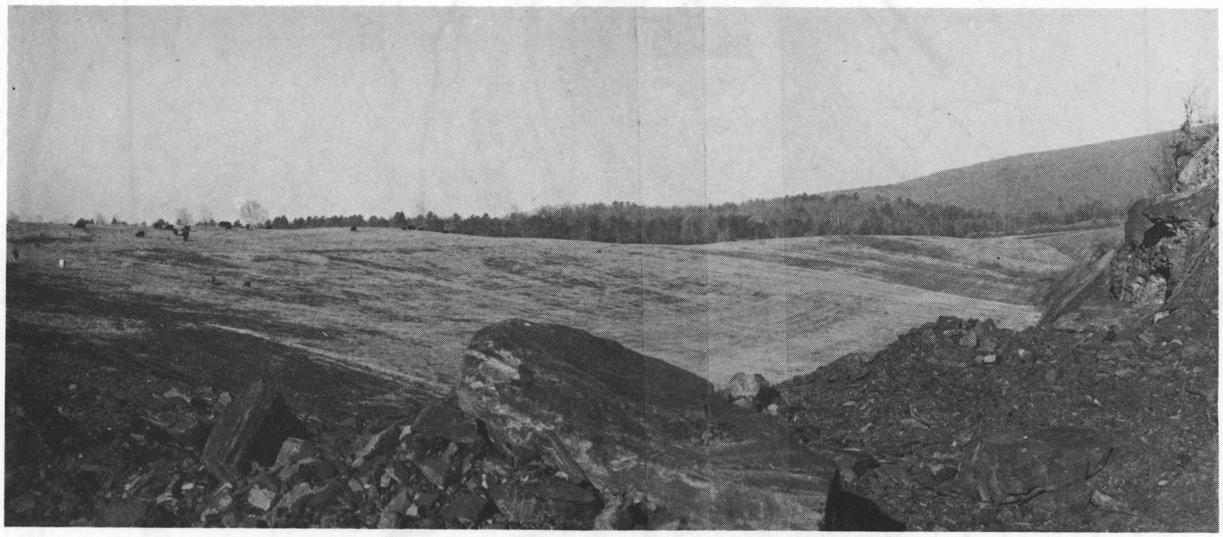

Figure 11 -- Stop 1 - 8. Strip mine of Lower Hartshorne Coal bed. The grass on the reclaimed land is less than one year old (see coal analyses, Table 2).

MILEAGE	DESCRIPTION
	Valley. The Bloyd Shale contains a coal bed in north Arkansas, (Baldwin coal) which has experienced some mining in the past. Lignite occurs in Tertiary units in south and east Arkansas and is presently under investigation for mining.
	Total coal reserves in Arkansas are approximately 2 billion tons. Lignite resources in south Arkansas have been estimated at 12 billion tons.
	From mileage 116.7 continue on dirt road, following the arrows on Plate 8, to the active mining operation of Peabody Coal Company. Enroute you will pass orphan spoils of the Utah Construction Company and reclaimed strip mines of Peabody Coal Company. Arkansas enacted a land reclamation law in 1971 which requires open cut mining operators to restore the land.
	Continue on dirt road for 3.5 miles to the active mining operation in section 23. The coal bed being mined is the Lower Hartshorne Coal bed of the McAlester Shale. Table 2 is a coal analysis for the same coal bed 3 miles to the east.
	To continue trip return to mileage 116.7 and proceed back to the east. Please note that permission must be obtained from Peabody Coal Company before entering the mine. Hardhats are required.
117.6	Junction of Ark. Hwy 352, continue to southeast (right) on Ark. Hwy 352. Outcrop of sandstone and shale in the Atoka.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

COAL-ANALYSIS REPORT

Test No. ARK LH-12 Lab. No. K-63741

Sample of Coal From Arkansas Geological Survey Can No.

Operator Peabody Coal Co. Mine Peabody Strip Bed Lower Hartshorne

State Arkansas County Johnson Town Hunt

Date of sampling 1/5/76 Date of Lab. sampling 5/11/76 Collector Boyd R. Haley

	Air-dry Loss	Coal (Air dried)	Coal (As received)	Coal (Moisture free)	Coal (Moisture and ash free)
Proximate Analysis	Moisture		1.6		
	Volatile matter		16.0	16.3	17.0
	Fixed carbon		78.1	79.3	83.0
	Ash		4.3	4.4	
			100.0	100.0	100.0
Ultimate Analysis	Hydrogen		4.3	4.2	4.4
	Carbon		85.4	86.8	90.8
	Nitrogen		1.7	1.7	1.8
	Oxygen		3.7	2.3	2.4
	Sulfur		0.6	0.6	0.6
	Ash		4.3	4.4	
			100.0	100.0	100.0
	British thermal units		14700	14930	15620

Fusibility of Ash, temp. °F.: Initial Deform. 2070 Softening 2120 Fluid 2220

SULFUR FORMS:	Sulfate	Pyritic	Organic
As-received	0.01	0.07	0.52
Moisture-free	0.01	0.07	0.52
M. and ash-free	0.01	0.07	0.55

Free swelling index no. 7

Date June 24, 1976

Forrest E. Walker
Chemist-in-Charge, Coal Analysis

Table 2

MILEAGE	DESCRIPTION
118.0	Turn south (right) onto dirt road (Ark. Hwy 164) and proceed to Interstate -40.
118.9	Junction of I-40 and Ark. Hwy 164, turn west (right) onto I-40.
120.2	Excellent exposure of Atoka shale on the north side of the road.
121.4	Franklin County Line.
122.0	Spill reclamation on the south side of the highway. In the Fall of 1976 a chemical leakage into the stream from a transport truck caused dangerous pollution. The stream has been completely drained, covered, and a new channel cut. Odor from the chemical still lingers in the spring of 1977.
124.1	Exit 41 to Altus, Arkansas, continue on I-40.
124.5	Strip Mine in the Lower Hartshorne Coal bed to the south. North of the highway about 200 feet is a fault with about 400 feet displacement. Down-thrown side to the south.
127.6	Exit 37 to Ozark, Arkansas, continue on I-40.
128.6	Exit for Rest Stop, continue on I-40.
129.6	Excellent exposure of sandstone in the Atoka Formation. Distributary channel sandstone at the base with fringe deposits at the top.
129.9	Flood control dam to the northeast.
130.4	Exit 35 to Ozark, take exit into Ozark.
130.6	Turn south (left) onto Ark. Hwy 23.
130.8	Barrow pit to the east is in the Atoka Formation.
133.8	Junction of Ark. Hwy 23 and U. S. Hwy 64, turn east (left) onto U. S. Hwy 64.
134.2	Turn south (right) on 12th Street just east of the cemetery.
134.4	Turn east (left) at edge of bluff.
134.4	<u>STOP 1 - 9</u>: Stop in front of house owned by F. D. R. Park. Permission from Mr. Park should be obtained before crossing his property, then proceed south around east side of house down to the railroad tracks and west along the tracks to west end of the deep cut (Plate 9). The depositional sequence of the rocks exposed in this outcrop can be explained as follows; clay and silt was deposited on the outer fringes of a delta; the delta advanced and a stream

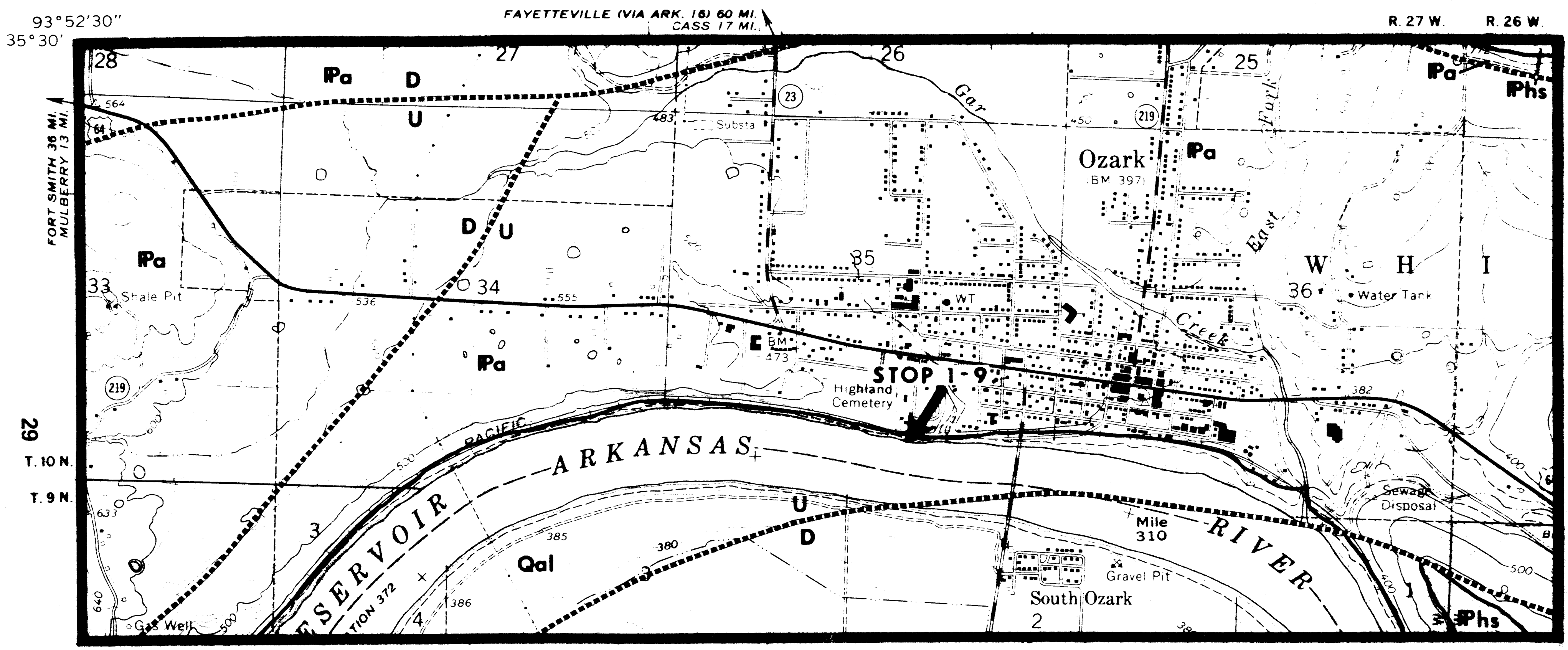

PLATE 9. OZARK, ARKANSAS — STOP 1-9.

1000 0 1000 2000 3000 FEET

Geology by H. A. Arndt

MILEAGE	DESCRIPTION
	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 12 and 13). The rocks are in the Atoka Formation.
134.6	Continue around circle and turn north (right) onto 12th Street.
134.7	Turn west (left) onto U. S. Hwy 64.
134.9	Junction Ark. Hwy 23 and U. S. Hwy 64. Turn north (right) onto Ark. Hwy 23.
138.0	Junction Ark. Hwy 23 and I-40, turn east (right) onto I-40.
138.7	Excellent exposure of the Atoka Formation to the south.
138.8	Atoka outcrop to the north.
140.2	Exit 37 to Ozark, Arkansas, continue on I-40.
142.5	Outcrop of Hartshorne Sandstone.
143.9	Strip mine in the Lower Hartshorne Coal bed to the south.
144.1	Exit 41 to Altus, continue on I-40.
145.3	Channel sand in the Atoka Formation to the north.
145.9	Bridge over Drywood Creek.
146.5	Spill reclamation (see explanation at mileage 122.0).
148.5	Atoka shale exposure to the north.
149.6	Exit to Coal Hill, Arkansas, continue on I-40.
150.9	Outcrop of sandstone and shale of the Atoka.
151.3	Bridge over Horsehead Creek.
151.9	Strip mine in Lower Hartshorne Coal bed to the south. Fault is located to the north of the highway, with the downthrown side to the south.
152.3	Quarry in Hartshorne Sandstone to the south.
153.8	Hartshorne Sandstone for the next 3.3 miles to mileage 157.1.
157.2	Strip mine in the Lower Hartshorne Coal bed.
158.2	Exit 55 to Clarksville, Arkansas, continue on I-40.

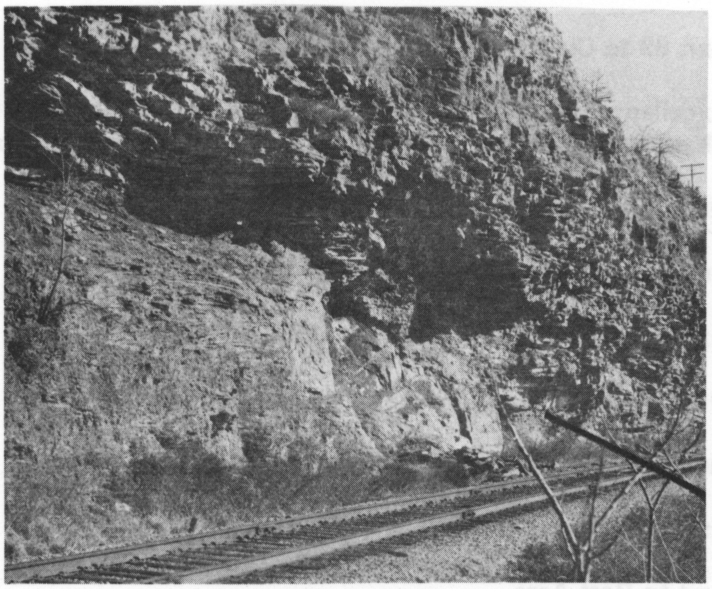

Figure 12 -- Stop 1 - 9a. Sandstone of the Atoka Formation deposited in a channel incised in shale of the Atoka Formation.

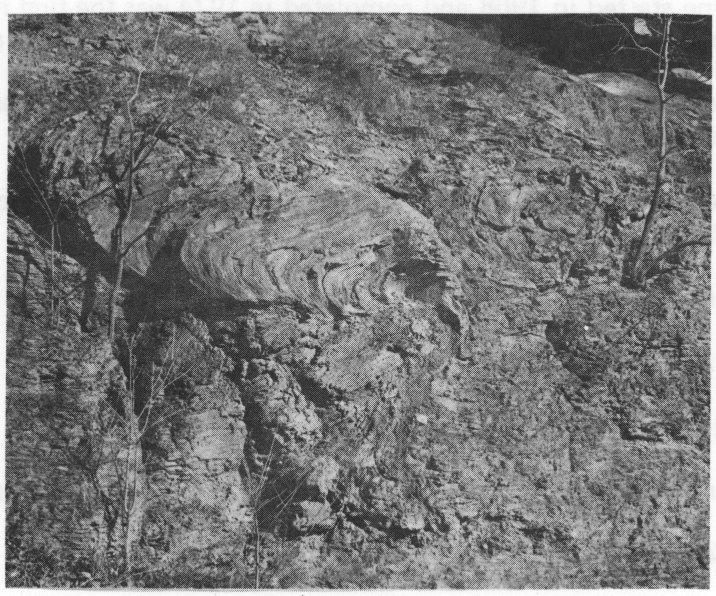

Figure 13 -- Stop 1 - 9 b. Closeup of soft sediment deformation of the shale underneath the channel sandstone. Sapling at upper right is on left side of photograph 9a.

MILEAGE	DESCRIPTION
161.5	Exit 59 to Clarksville, Arkansas, continue on I-40.
162.8	Excellent exposure to the south, with Savanna Shale underlain by the Charleston Coal bed. Note the soil profile underneath the coal bed.
166.0	Quarry in the Savanna to the south.
166.4	Bridge over railroad. Quarry in Savanna to the north.
166.8	Exit 64 to Lamar, Arkansas, continue on I-40.
168.2	Outcrop of McAlester Shale to the north.
168.9	Quarry in the Savanna to the south.
169.6	Exit 67 to Knoxville, Arkansas, continue on I-40.
170.8	Exit to Rest Area.
172.2	Hartshorne Sandstone exposure to the north, and for the next 10 miles to mileage 182.2.
172.8	Bridge over Big Piney Creek.
174.7	Power lines crossing highway from Arkansas Nuclear One Generator Plant.
176.9	Exit 74 to London, Arkansas, continue on I-40.
	Nuclear Power Plant No. 1 (complete) and No. 2 (under construction) to the southeast are owned by the Arkansas Power and Light Company. Nuclear One started in 1968 and completed in 1974 was the first nuclear power plant in the south. Maximum net output of Nuclear One is 832 megawatts. Nuclear Two was started in 1971 and is expected to be on the line in 1978. Maximum net output will be 912 megawatts. Nuclear One has produced energy equivalent to approximately 15 million barrells of oil.
178.6	Power line crossing road from Nuclear Power Plant. Excellent exposure of Hartshorne Sandstone.
180.0	Bridge over Mill Creek.
180.7	Exit 78 to Russellville, Arkansas, continue on I-40.
181.9	Quarry in Hartshorne Sandstone to the north.
183.4	Bridge over Illinois Bayou, an arm of Lake Dardanelle on the Arkansas River.
183.9	Take Exit 81 to Russellville, Arkansas.
184.2	Junction with Ark. Hwy 7, turn south (right), Holiday Inn on the corner. End of the First Day Road Log and will be the start of the Second Day Road Log.

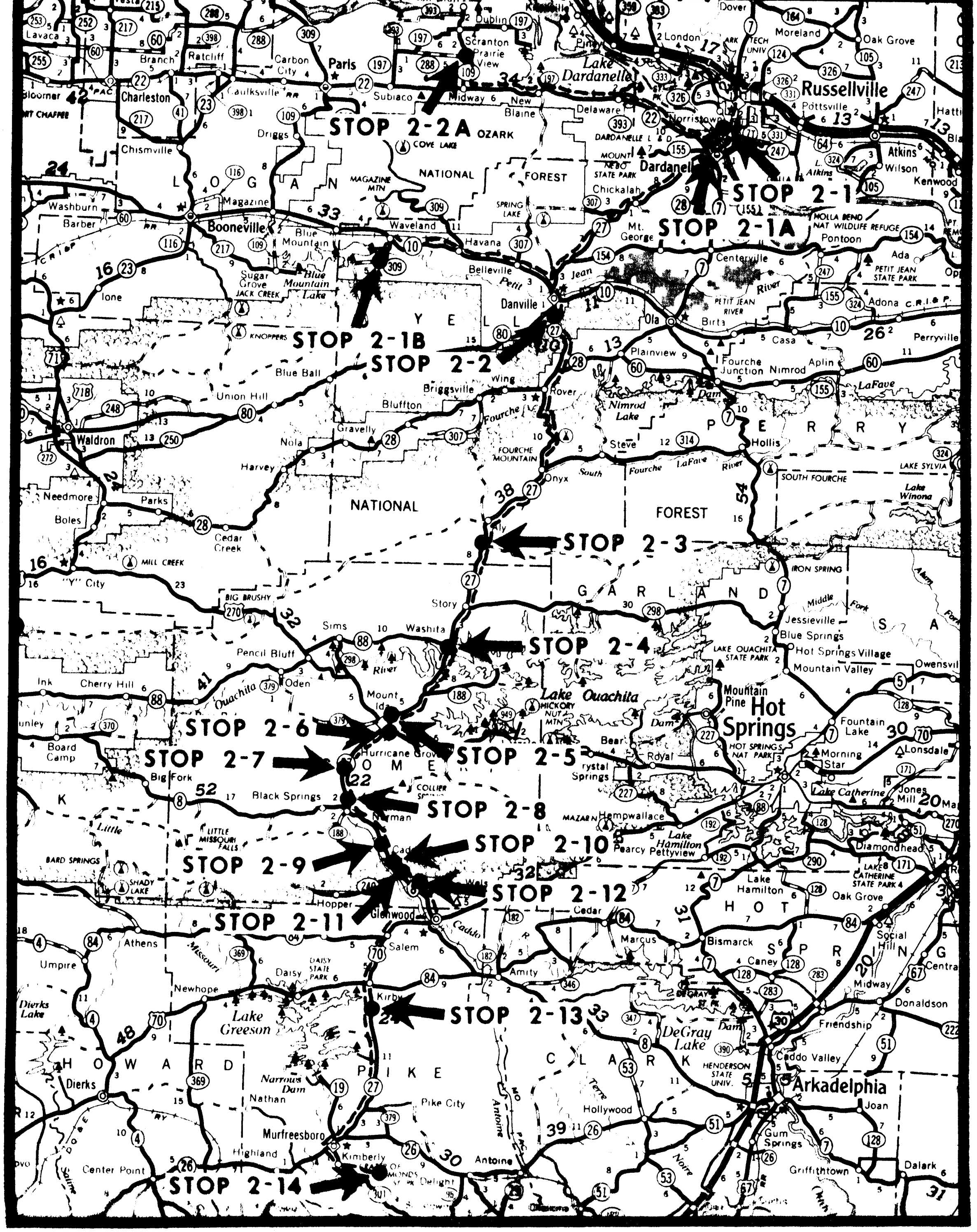

FIGURE 14.--INDEX MAP OF SECOND DAY ROAD LOG

----- Route

STOP 2-1

Scale 1" = 13 miles

CORRELATION OF PALEOZOIC 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.	ℙby	Missing	
			Savanna Fm.	ℙsv		
			Mc Alester Fm.	ℙma		
			Hartshorne Sandstone	ℙhs		
		ATOKA	Atoka Fm.	ℙa	Atoka Fm.	ℙa
		MORROW	Bloyd Shale: Kessler Ls Mbr.	ℙbh: ℙbk	Johns Valley Shale	ℙjv
			Bloyd Shale: Woolsey Mbr.	ℙbh: ℙbw		
			Bloyd Shale: Brentwood Ls. Mbr.	ℙbh: ℙbb		
			Hale Fm.: Prairie Grove Mbr.	ℙbh: ℙhp	Jackfork Fm.	ℙj
			Hale Fm.: Cane Hill Mbr.	ℙhc		
	MISSISSIPPIAN	UPPER	Pitkin Limestone	Mpfb: Mp	Chickasaw Creek Mbr.	Ms
			Fayetteville Shale; Wedington SS Mbr.	Mpfb: Mf	Stanley Shale	
			Batesville Sandstone; Hindsville Ls. Mbr.	Mpfb: Mbh		
			Ruddell Shale	Mr		
			Moorefield Fm.	Mm	Hatton Tuff	
			Boone Fm.: Short Creek Oolite Mbr.	Mb	Hot Springs SS Mbr.	
		LOWER	Boone Fm.: St. Joe Ls. Mbr.		Arkansas Novaculite: Upper Div.	MDa
DEVONIAN		UPPER	Chattanooga Shale; Sylamore SS	MDcp	Arkansas Novaculite: Middle Div.	
		MIDDLE	Clifty Limestone		Arkansas Novaculite: Lower Div.	
		LOWER	Penters Chert			
SILURIAN		UPPER	Missing		Missouri Mountain Shale	SmOpc
			Lafferty Limestone	Slsb	Blaylock Sandstone	Smb
			St. Clair Limestone			
		LOWER	Brassfield Limestone			
ORDOVICIAN		UPPER	Cason Shale		Polk Creek Shale	Opc
			Fernvale Limestone	Of	Bigfork Chert	Obf
		MIDDLE	Kimmswick Limestone	Ocj		
			Plattin Limestone		Womble Shale	Ow
			Joachim Dolomite			
			St. Peter Sandstone	Ose		
			Everton Fm.: Jasper Ls. Mbr.			
			Everton Fm.: Newton SS Mbr.			
			Everton Fm.: King River SS Mbr.			
		LOWER	Powell Dolomite	Op		
			Cotter Dolomite	Ocjc	Blakely Sandstone	Ob
			Jefferson City Dolomite		Mazarn Shale	Om
			Roubidoux Fm.	Not exposed	Crystal Mountain Sandstone	Ocm
			Gasconade-Van Buren Fm; Gunter Mbr.		Collier Shale	Oc
CAMBRIAN		UPPER	Eminence Dolomite		Older rocks not exposed	
			Potosi Dolomite			
			Derby-Doerun-Davis Fm.			
			Bonneterre Dolomite			
			Lamotte Sandstone			
PRE-C			Igneous Rocks			

Figure 15

GENERAL LITHOLOGIC DESCRIPTION OF UNITS TRAVERSED SECOND DAY

	Maximum Thickness (feet)
Cretaceous System	
Igneous Rocks - peridotite, kimberlite, and tuff	—
Trinity Group - gravel, sand, clay, gypsum, and minor limestone	150-1,000
Pennsylvanian System	
Des Moinesian Series	
Savanna Formation - sandstone and sandy shale	850
McAlester Formation - shale, sandstone, and coal	1,000
Hartshorne Sandstone - massive sandstone	325
Atokan Series	
Atoka Formation - shale and sandstone	27,500+
Morrowan Series	
Johns Valley Shale - shale, minor sandstone and limestone, and erratic boulders	1,500+
Jackfork Sandstone - sandstone and shale	6,000
Mississippian System	
Stanley Shale - shale, sandstone, and some chert	8,500
Devonian and Mississippian Systems	
Arkansas Novaculite - novaculite, shale, and conglomerate	950
Silurian System	
Missouri Mountain Shale - shale with minor sandstone	250
Blaylock Sandstone - sandstone, siltstone, and shale	1,500
Ordovician System	
Polk Creek Shale - shale	175
Bigfork Chert - chert, limestone, and shale	800
Womble Shale - shale with some thin limestone and sandstone	3,500
Blakely Sandstone - shale and sandstone	450
Mazarn Shale - shale with some sandstone and limestone	3,000
Crystal Mountain Sandstone - sandstone	850
Collier Shale - shale and limestone	1,000

ROAD LOG ---- SECOND DAY

ARKANSAS VALLEY ---- OUACHITA MOUNTAINS, ARKANSAS

Russellville, Dardanelle, Chickalah, Danville, Onyx, Aly, Mt. Ida, Norman, Caddo Gap, Glenwood, Kirby, Murfreesboro-Crater of Diamonds (Figure 14)

MILEAGE	DESCRIPTION
0.0	Holiday Inn - Junction, Ark. Hwy 7 and I-40. Proceed south on Hwy 7.
0.4	Hill to the north is formed by the Hartshorne Sandstone. The road to the right leads to Arkasnas Tech University.
2.0	Railroad crossing.
2.1	Downtown Russellville, Arkansas. Junction with U. S. Hwy 64, continue south on Ark. Hwy 7.
3.8	Exposure of upper Atoka shale and siltstone in the pit to the east (left).
4.2	Junction of Ark. Hwy 7 and Spur Hwy 7. Turn west (right) onto Spur Hwy 7 towards Dardanelle Lock and Dam.
5.5	Turn north (right) onto paved road.
5.8	Turn west (left) onto dirt road just prior to reaching the rock crusher.
6.1	STOP 2 - 1: Hartshorne Sandstone at Robinson Quarry (Plate 10). Walk straight ahead (north) to the quarry (Figures 16 and 17). Excellent exposure of the Hartshorne Sandstone, the unconformable contact between the Hartshorne and the underlying Atoka Formation, and the upper part of the Atoka Formation. A large channel has been cut into the shale, coal, and sandstone of the Atoka and filled with a cross-bedded sandstone that is likely indicative of alluvial (fluvial) stream channel deposits (personal communication, Rufus LeBlanc, Shell Oil Company). Return to Ark. Hwy 7.
6.6	Turn east (left) onto Spur Hwy 7.
7.9	Turn south (right) onto Ark. Hwy 7.
8.2	Railroad crossing. Coal has been mined underground from the Lower Hartshorne Coal bed in this general area, and is presently being surface mined on the east end of the syncline by Farrell-Cooper Mining Company.
8.8	Vertically dipping deltaic sequences (personal communication, Rufus LeBlanc, Shell Oil Company), lower McAlester Formation, Hartshorne Sandstone and upper Atoka sandstone and shale on south flank of the Shinn Syncline.

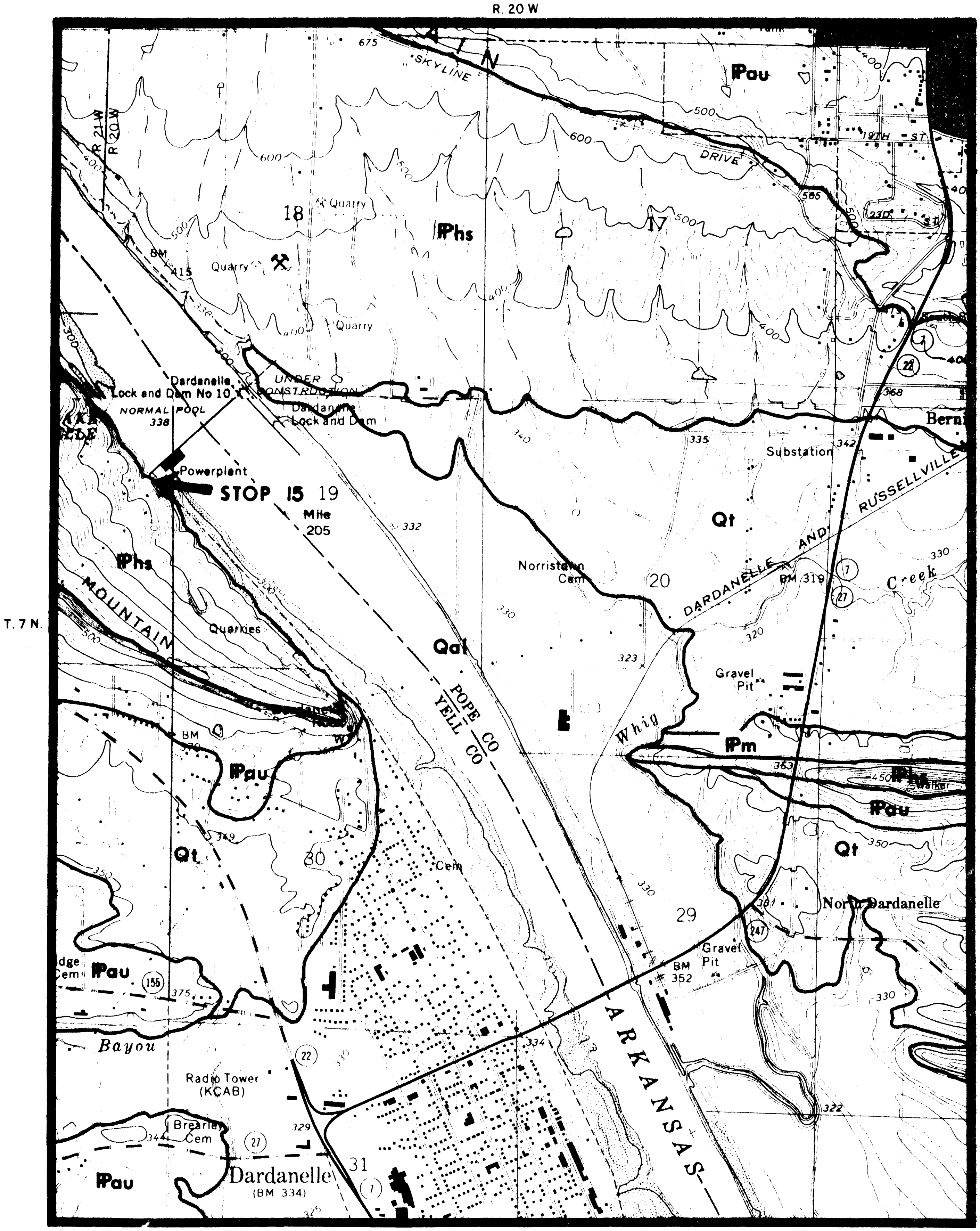

PLATE 10. ROBINSON QUARRY — STOP 2-1. and DARDANELLE DAM — STOP 2-1A.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley

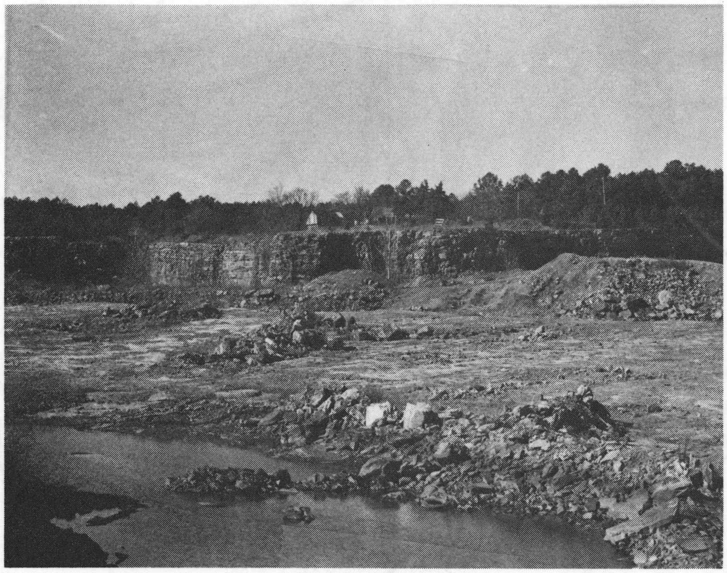

Figure 16 -- Stop 2 - 1. Robinson Quarry. The massive Hartshorne and upper Atoka sandstones were used by the U. S. Corps of Engineers in the construction of the Dardanelle Lock and Dam.

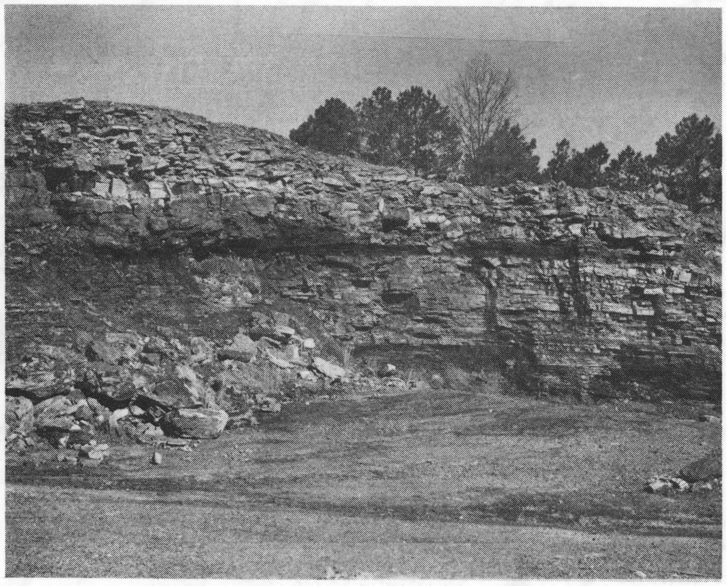

Figure 17. -- Stop 2 - 1. View in Robinson Quarry of massive alluvial sandstones of the Hartshorne resting uncomformably on a thin coal bed and probable inner deltaic fringe sandstones and shales of the upper Atoka (personal communication, Rufus LeBlanc, Shell Oil Company).

MILEAGE	DESCRIPTION
9.3	Red silty clay of lower Arkansas River terrace (approximately 40,000 years old) to the east (left).
9.6	Crossing the Arkansas River. Dardanelle Dam and Dardanelle Rock (Hartshorne Sandstone) to the west (right).
10.1	For side trip to Dardanelle Dam and Midway, Arkansas building stone quarries - turn west (right) onto Second Street at the Yell County courthouse.

SIDE TRIP TO DARDANELLE DAM AND MIDWAY, ARKANSAS BUILDING STONE QUARRIES

0.0	Dardanelle, Arkansas. Turn right (northwest) onto Second Street. Turn right (north) off Second Street at sign onto road to Dardanelle Dam. Dardanelle Rock on left. This famous landmark is formed by the northward dipping Hartshorne Sandstone. Note the contact with the underlying Atoka shale. Sandstone and siltstone in the Atoka equivalent to these in beds exposed at mileage 8.8 of second day road log may have been deposited here, removed by erosion, and the interval subsequently filled with this massively-bedded sandstone of the Hartshorne.
1.8	<u>STOP 2 - 1A:</u> Hartshorne Sandstone and Dardanelle Dam (Plate 10). Observation tower overlooking the Arkansas River and Dardanelle Dam. All of the rocks exposed at this Stop are in the Hartshorne Sandstone. Excellent examples of foreset beds, laminar beds, and convolute beds are exposed in the road cut and in the quarry at mileage 2.3. Note the steepness of the foreset beds, plant fossils on the surface of some of the foreset beds, and intersecting foreset beds in the central part of the south wall of the quarry and in the blocks of sandstone on the floor of the quarry. It is suggested that this sequence represents alluvial (fluvial) stream channel deposits (personal communication, Rufus LeBlanc, Shell Oil Company).
2.3	Quarry is Hartshorne Sandstone on right (west). Continue southeast back to Second Street.
3.2	Turn right (west) onto Second Street.
4.0	Junction of Second Street and Ark. Hwy 22. Continue straight (west) on Ark. Hwy 22. Ridge to the right (north) is underlain by Hartshorne Sandstone dipping 25° N. Highest mesa to the left (south) is Mt. Nebo and is underlain by nearly flat-lying Hartshorne Sandstone.

MILEAGE	DESCRIPTION
5.9	Road cut in sandstone, siltstone, and shale of the upper Atoka Formation. Ripple marks are common and indicate a current direction from north to N. 20° E. Worm borings are common. You are riding along the north flank of the Pine Ridge anticline.
7.5	Little Hayes Creek.
8.5	Dardanelle Reservoir and South Branch of Jones Creek.
8.8	Sandstone, siltstone, and shale of the upper Atoka Formation.
9.6	Road cut exposing the upper part of the Atoka Formation and most of the Hartshorne Sandstone. Hartshorne Sandstone consists of even-bedded sandstone in the lower part, dark gray shale in the middle part and massively bedded sandstone in the upper part. The even-bedded member is quarried for building stone west of here.
11.6	Stinette Creek.
11.8	County Line between Yell and Logan Counties.
12.5	Top of Hartshorne Sandstone. For the next 7.3 miles to mileage 19.8 (New Blaine, Arkansas) the road will be on or near this stratigraphic horizon along the Paris syncline.
13.1	Post Office in Delaware, Arkansas.
19.8	Post Office in New Blaine, Arkansas.
21.7	Sandstone and siltstone of the McAlester Formation.
24.5	Contact between McAlester Formation and overlying Savanna Formation on the right (north).
25.5	Road to Sorghum Hollow to the left (south). The upper part of the Atoka Formation and most of the Hartshorne Sandstone are well exposed about 1.5 miles south on the east side of Cane Creek. Excellent examples of cross-bedding, convolute bedding, lenticular bedding, irregular bedding, regular bedding, channel cut and fill, and ripple marks are exposed in the Hartshorne Sandstone. A most stimulating study can be made at the base of the bluff to determine the ecologic habitat of bream, goggle-eye, bass and catfish.
25.9	Contact between Savanna Formation and McAlester Formation.
26.0	Town of Midway, Arkansas. Turn right (north) onto Ark. Hwy 109. Road cuts from here to Stop 2-2A expose sandstone, siltstone, and shale of the McAlester Formation.

MILEAGE	DESCRIPTION
26.9	Contact between McAlester Formation and Hartshorne Sandstone.
27.0	Headquarters of Herman Swartz Building Stone Company.
27.2	STOP 2 - 2A: Swartz Building Stone Quarry in Hartshorne Sandstone (Plate 11).
	The evenly bedded sandstone being quarried for building stone is rather rare in the Hartshorne. In nearby quarries, where exposures are more complete, this evenly bedded sandstone is in the form of long and low angle foreset beds. Note the two different current directions indicated by the foreset beds in the sandstone above the stone being quarried. The quarry is located on the south flank of the thrust faulted Prairie View anticline. Return (south) to Ark. Hwy 22.
	Return from side trip to Junction of Ark. Hwys 7 and 22 at Dardanelle, Arkansas, at mileage 10.6.

10.6	Junction of Ark. Hwys 7 and 22, continue straight (southeast) on Ark. Hwy 7.
10.7	Junction of Ark. Hwys 7 and 27, turn southwest (right) onto Hwy 27. You are traveling on the upper part of the Atoka Formation for the next 12.4 miles to mileage 23.1.
11.3	Mt. Nebo State Park ahead is capped by the Hartshorne Sandstone. The slightly lower mountain to the south is capped by a massive upper Atoka channel sandstone.
17.9	Outcrop of shale in the upper part of the Atoka Formation. Thin coal beds which occur at several intervals in the upper Atoka in this area and near Centerville (about 10 miles to the southeast) have been mined for domestic purposes.
18.2	Chickalah, Arkansas. Note small exposures of upper Atoka siltstone and shale. Dizzy and Paul Dean, former big league baseball players, formerly lived in the Chickalah area. This locality is near the axis of the Magazine Mountain syncline.
19.2	Power line.
19.6	Outcrop of upper Atoka shale with a small channel sandstone to the west (right).
19.8	Junction of Ark. Hwy 307, continue on Ark. Hwy 27.

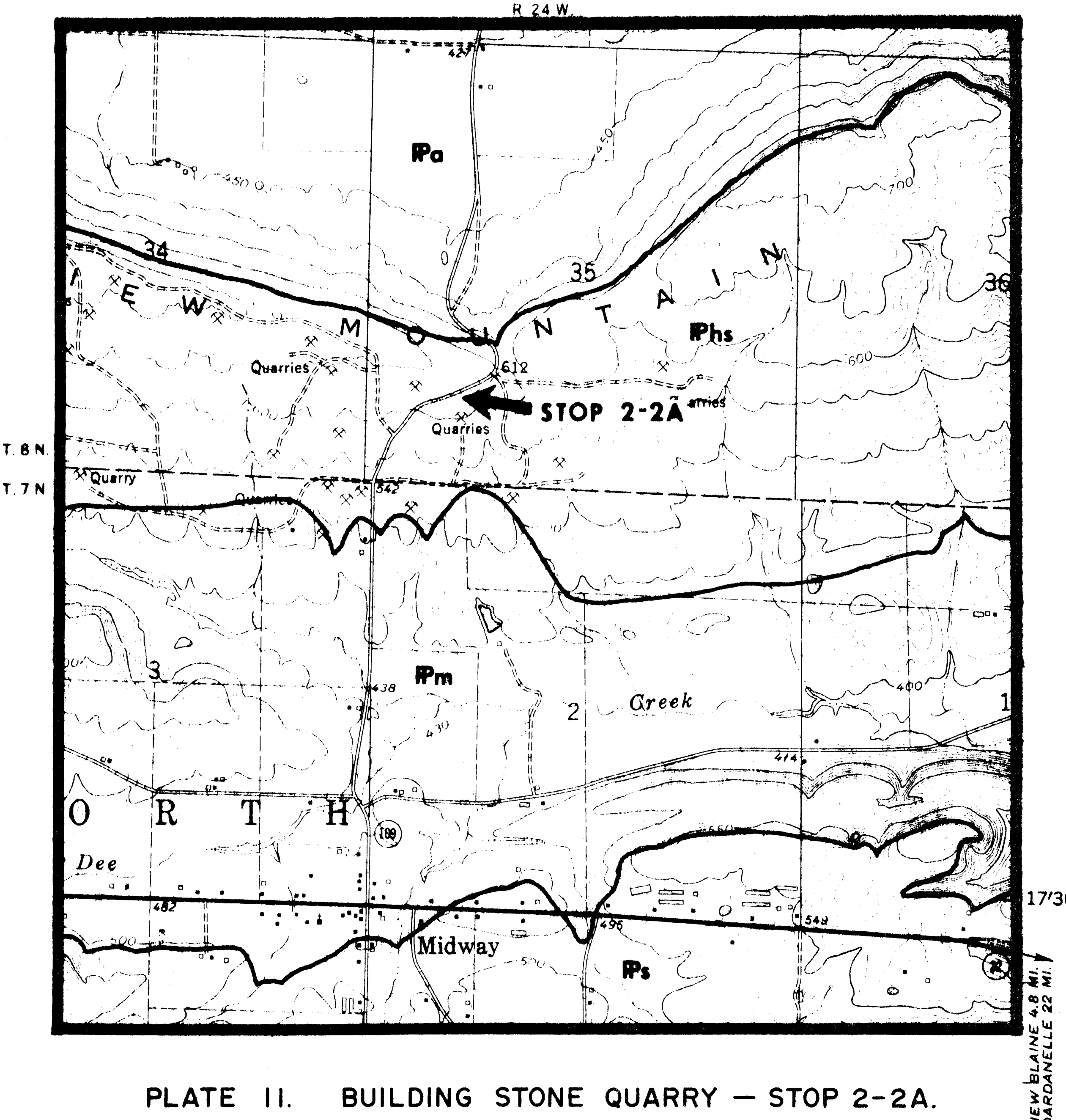

PLATE II. BUILDING STONE QUARRY — STOP 2-2A.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley

MILEAGE	DESCRIPTION
20.9	Hill to the west (right) is capped by the Hartshorne Sandstone. Large plant fossils were obtained from a massive upper Atoka sandstone in a quarry on the lower edge.
23.1	Northward dipping sandstone at the top of the middle Atoka Formation.
24.8	Approximate crest of the Ranger anticline. Both the north side and crest of the anticline are thrust faulted and the hydrothermal clay mineral dickite is common on slickenside surfaces. Exposed sandstone is in the upper portion of the lower Atoka. Eighteen wells have been drilled for gas on the Ranger anticline; eight did not have any reported shows of gas; three had reported shows of gas; and six 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 Morrow age rocks have a combined thickness of at least 19,000 feet.
25.7	Junction of Ark. Hwy 154 to the east, continue south on Hwy 27.
26.9	Top of the lower Atoka Formation.
27.3	Shell Oil Company No. 1-14 Bettis (Sec. 14, T. 5 N., R. 23 W.) was drilled to a depth of 12,392 feet about a mile to the west without any reported shows of gas. The well did not penetrate rocks of Mississippian age and may not have penetrated rocks of Morrowan age. The well was drilled through the thrust faults along the Ranger anticline and it is not known how much of the Atoka Formation is duplicated.
27.7	Small quarry in shale and siltstone in the middle Atoka Formation near the axis of the Poteau syncline on the right.
28.9	Junction of Ark. Hwy 10. For side trip to Blue Mountain Dam turn west (right) onto Hwy 10.

SIDE TRIP TO BLUE MOUNTAIN DAM

0.0	Junction of Ark. Hwy 10. Outcrop of sandstone represents the top of the middle Atoka Formation.
3.4	Downtown Belleville, Arkansas.
8.3	Downtown Havana, Arkansas, junction with Ark. Hwy 309 to the north. Continue west on Hwy 10. Mountain to the north (right) is Mt. Magazine, highest point in Arkansas, elevation 2753 feet. Bluff near the top is a sandstone in the Savanna Formation.

MILEAGE	DESCRIPTION
12.4	The hill to the north is underlain by sandstone in the upper part of the lower Atoka Formation.
13.8	Bridge. Sandstone and shale near the top of the lower Atoka Formation.
14.4	Outcrop of shale in lower Atoka Formation.
14.6	Junction with Ark. Hwy 309, turn west (left) onto Ark. Hwy 309 to Blue Mountain Dam.
15.4	Turn west (right).
16.0	Turn south (left).
16.4	Turn south and take road over dam.
17.0	STOP 2 - 1B: Lower Atoka Submarine inner Fan, Slope, and/or possibly Canyon Channel Deposition at Blue Mountain Dam (Plate 12).

Submarine channel, soft rock deformation and turbidite deposition near the top of the lower Atoka Formation (Figures 18, 19, and 20).

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 (Figure 21). For example, the middle part of the Atoka Formation as exposed north of Clarksville along Arkansas Hwy 21 in secs. 21 and 22, T. 11 N., R. 23 W. (Locality A, Figure 21) 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, although some have lithologic characteristics suggesting deposition by advancing seas. Criteria indicative of sedimentary slump or flow are rare. In 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 flow.

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. (Locality B, Figure 21), 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.

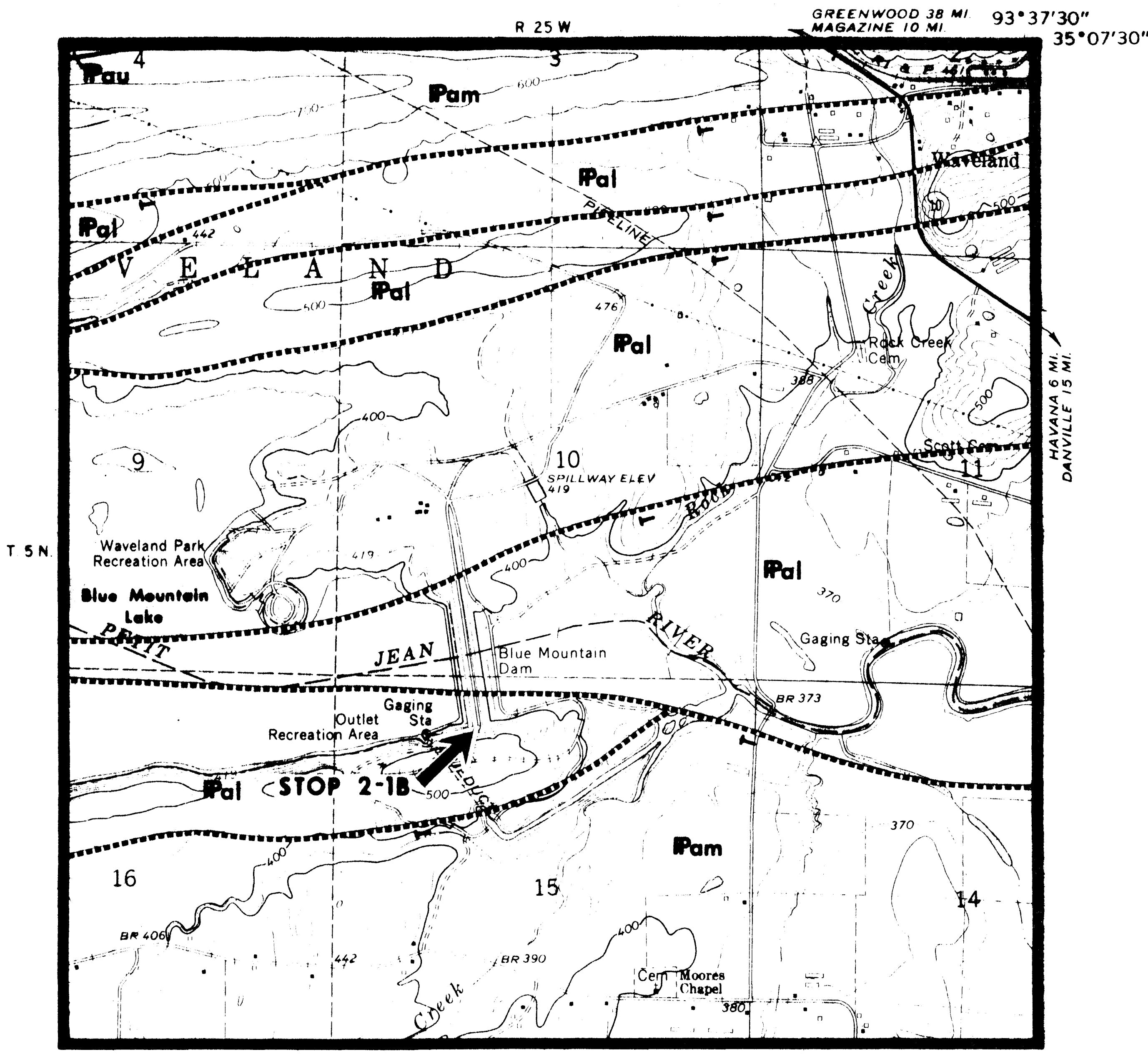

PLATE 12. BLUE MOUNTAIN DAM — STOP 2-1B.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley

Figure 18. -- Stop 2 - 1B. Interbedded sequence of bottom marked sandstone and black shale representing turbidite deposition in the submarine upper fan or possibly slope or canyon environment near the top of the lower Atoka Formation at Blue Mountain Dam.

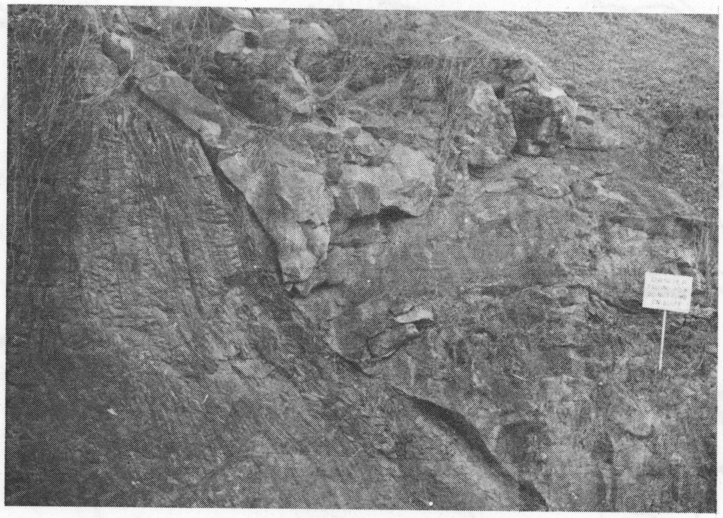

Figure 19. -- Stop 2 - 1B. Submarine upper fan or possibly slope or canyon channel sandstone cut into deformed (soft-sediment) black shale and siltstone near the top of the lower Atoka Formation at Blue Mountain Dam.

Figure 20. -- Stop 2 - 1B. Portions of submarine upper fan or possibly slope or canyon channel sandstone and shale sequence. Note the lenticular sandstone mass representing, in part, soft-sediment sliding near the top of the lower Atoka Formation at Blue Mountain Dam.

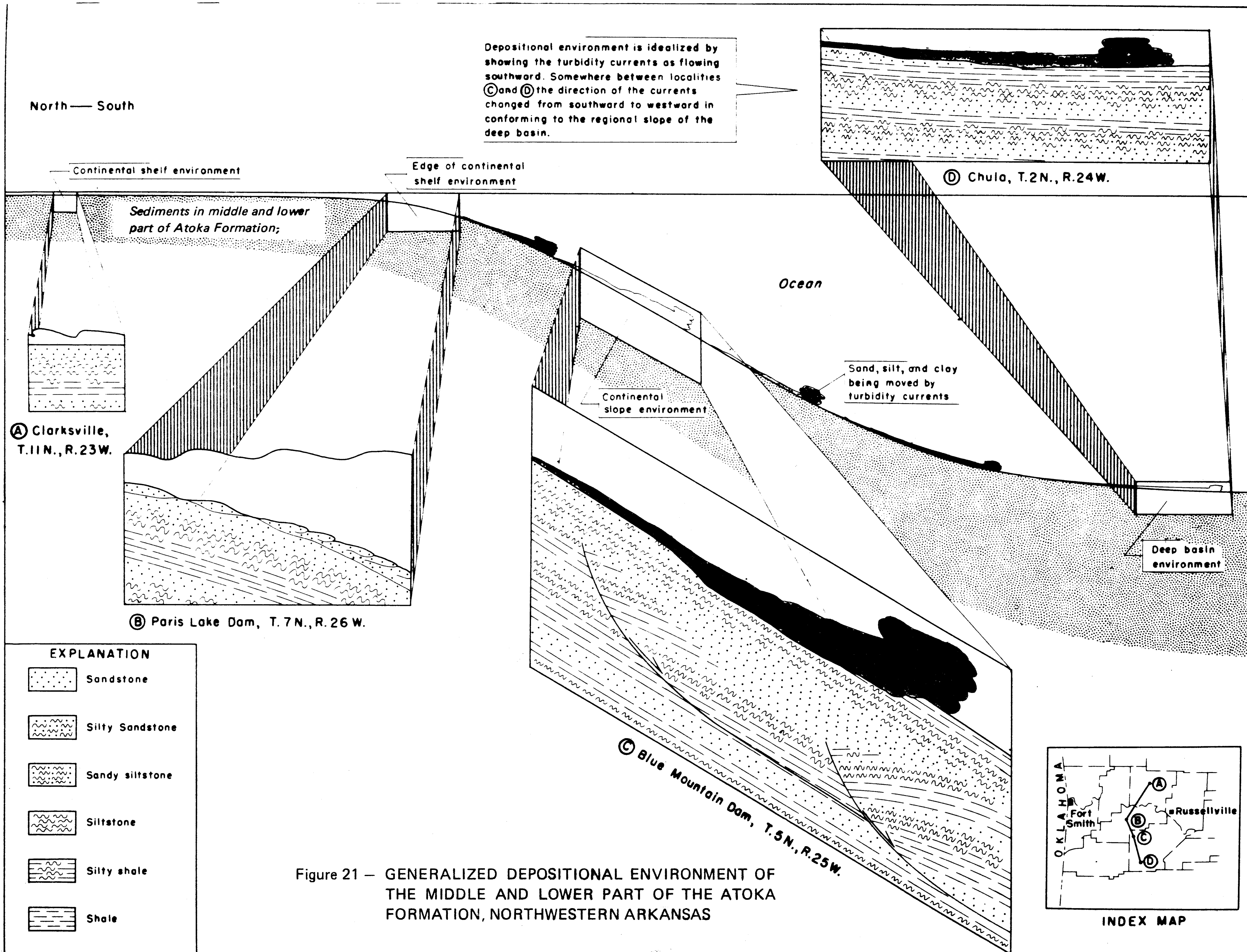

Figure 21 — GENERALIZED DEPOSITIONAL ENVIRONMENT OF THE MIDDLE AND LOWER PART OF THE ATOKA FORMATION, NORTHWESTERN ARKANSAS

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. (Locality C, Figure 21), 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. Abundant features in this area indicate soft-sediment slump and flow, as well as erosion and deposition caused by turbidity currents. At this locality the slope gradient was steep enough to permit soft-sediment flow within a bed and also to permit blocks as large as 10 feet square of bedded sediments to slump or slide downhill. 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.

The lower Atoka Formation, as exposed north of Chula along the Forest Service road in sec. 8, T. 2 N., R. 24 W. (Locality D, Figure 21), consists of sandstone, siltstone, and shale, and is a classic example of flysch, in the sense that flysch is characterized by being gradational rhythmic depositional cycles of sandstone, to siltstone, to shale, with a sharp contact at the base of the sandstone and each rhythmic unit being widespread laterally. Here the middle part of the Atoka Formation was deposited on a slope with a gradient that may have been great enough to sustain the turbidity currents, or the slope gradient may have been comparatively flat and the turbidity currents, through their momentum, were extended this far into the depositional basin.

Return to Danville, Arkansas, same as mileage 28.9, and resume road log for second day.

28.9 Junction of Ark. Hwys 10 and 27. Continue south on Ark. Hwys 27 and 10.

29.4 Bridge over Petit Jean River.

29.6 Downtown Danville, Arkansas.

29.7 Junction of Ark. Hwy 10 to the east (left), continue south on Ark. Hwy 27.

30.7 Junction with Ark. Hwy 8, continue south on Hwy 27.

31.2 <u>STOP 2 - 2:</u> Lower Atoka Flysch (Plate 13).

Exposures of alternating sandstone, siltstone, and shale in the lower part of the Atoka Formation. Some submarine fan channel sequences occur in the section with "thinning" of beds upwards, and "fining" of the grain size upwards. This interval likely fits into the middle submarine fan facies of Mutti - Ricci Lucchi.

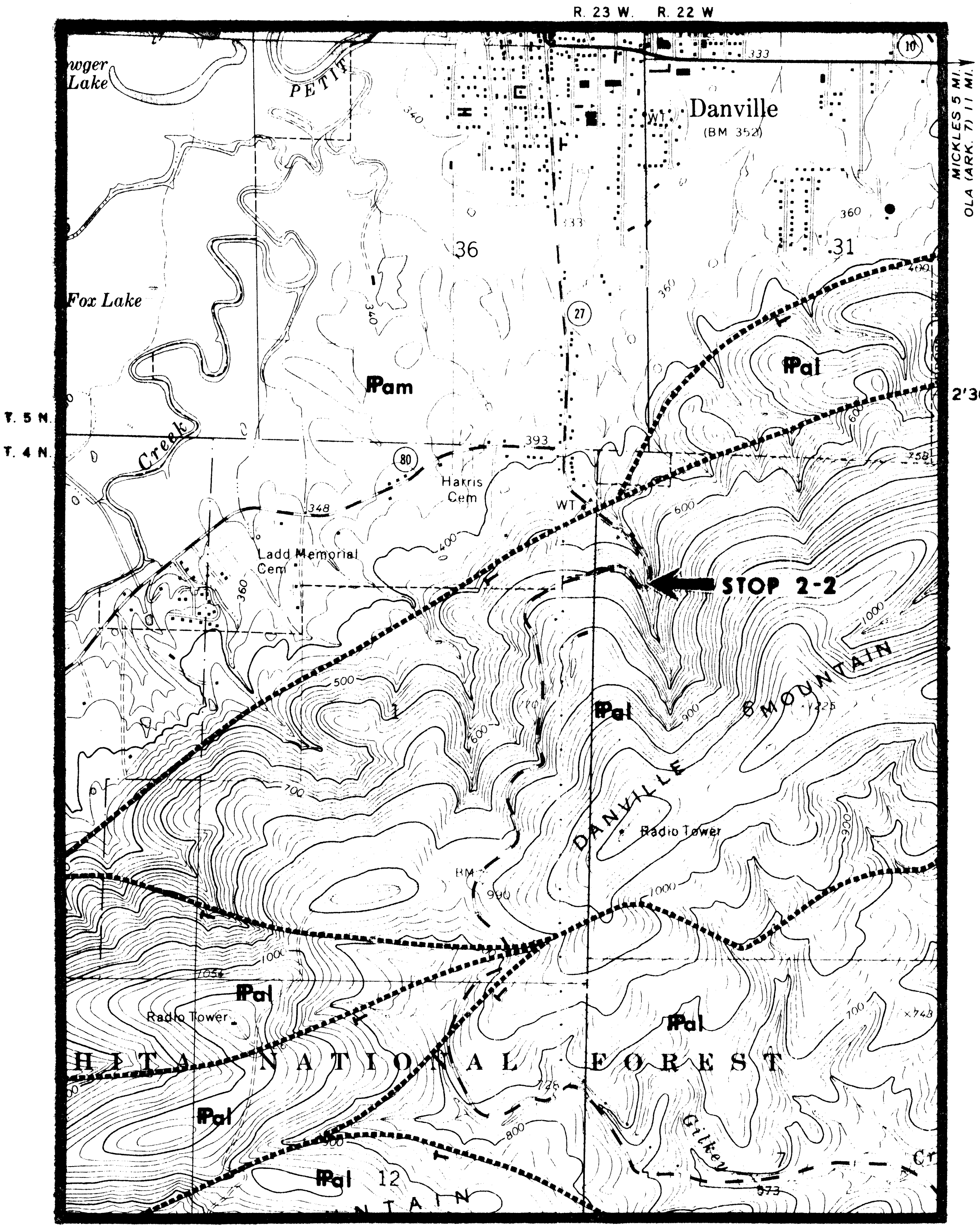

PLATE 13. LOWER ATOKA — STOP 2-2.

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

MILEAGE	DESCRIPTION
31.2 (cont.)	This is typical sandy flysch sequence. A fault with about 15,000 feet of displacement thrusts lower Atoka onto middle Atoka immediately north of this locality.
31.8	Alternating sandstones, siltstones, and shales in the lower Atoka, with good bottom marks and other flysch features (Figure 22).
32.4	About 2 miles to the west the Phillips Petroleum Company No. 1 Government well (Sec. 14, T. 4 N., R. 23 W.) was drilled to a depth of 10,018 feet without a show of gas. The well did not penetrate through this faulted anticlinal block of lower Atoka.
34.2	Contact between the lower and middle units of the Atoka Formation.
37.6	Junction of Ark. Hwys 27 and 28, continue west (right) on Hwy 27.
39.5	Downtown Rover, Arkansas, continue south (left) on Hwy 27. Note the thin terrace gravel deposits.
40.9	Bridge over Fourche La Fave River and approximate axis of the Fourche La Fave syncline.
41.6	Thrust faulted contact between middle and lower Atoka Formation. You are traveling across over 15,000 feet of generally steep northward dipping sandy flysch facies of the lower Atoka Formation for the next 5.6 miles to mileage 47.2.
42.4	Enter Ouachita National Forest.
46.9	Alternating sandstone and shale flysch sequence in the lower part of the Atoka Formation. Note the steep northward dip.
47.8	Highly faulted clayey shale and some thin sandstone and concretions in the Johns Valley Shale. Slickensides with the clay mineral dickite are common in most of the Johns Valley exposures in the area. About 8.4 miles to the east on the north side of Ark. Hwy 314 in the SE¼ NE¼ sec. 31, T. 3 N., R. 21 W., about three miles east of Steve, Arkansas, the Johns Valley Shale contains a discontinuous mass of silty limestone with Morrowan fossils (Mackenzie Gordon, Jr., written communication). Limestones and other platform lithologies, often in the form of erratic masses, commonly form wildflysch deposits farther to the west in the frontal Ouachita Mountains, but are exceedingly rare in this area.
48.1	Downtown Onyx, Arkansas, junction with Ark. Hwy 314 to the west. Continue south on Hwy 27.
48.3	South Fork of the Fourche La Fave River.

MILEAGE	DESCRIPTION
49.3	Intensely faulted Johns Valley Shale. This exposure shows both thin beds and lenticular glumpy masses of sandstone in the shaly sequence.
49.6	Faulted Jackfork sandstone and shale.
50.4	Interbedded Johns Valley shale and sandstone adjacent to local Weyerhaeuser headquarters. Note the numerous bottom marks on the thin, graded, cross-laminated sandstones.
50.9	Exposure of Johns Valley Shale, with slickensides, dickite, lenticular sandstone masses and some dark gray chert.
53.1	Johns Valley Shale, note abundant ripple marks on the top of the sandstone. The Johns Valley Shale has an estimated total thickness of 1500 feet or more in the area.
54.3	Bridge over Robertson Creek.
54.6	Downtown Aly, Arkansas.
55.3	Faulted Jackfork Sandstone with some small quartz veins and crystals. You are probably in middle Jackfork for the next 1.1 miles to mileage 57.0. Note abundant partially round (glumps) to round (gloops) of sandstone which are generally indicators of the middle unit of the Jackfork Sandstone in the frontal Ouachita Mountains. The Jackfork has an estimated total thickness of about 6000 feet in the area.
56.6	Irons Fork Creek Bridge.
56.7	**STOP 2 - 3:** Middle Jackfork at Irons Fork Creek (Plate 14).
	Typical development of round, lenticular sandstone masses (gloops) in the middle part of the Jackfork Sandstone (Figure 23). These sandstone masses are completely surrounded by shale and may have bottom marks on all "sides". This is a fine example of soft-sediment deformation, mostly of intrabasinal origin but in places includes some platform derived materials. The youngest fossils found in these "erratic" masses near Little Rock are Lower Pennsylvanian (lower Morrowan) in age (Mackenzie Gordon, Jr., written communication).
57.4	Faulted sandstones and shales of the lower Jackfork Sandstone.
57.7	Exposure of upper (probable Moyers Member) Stanley Shale to the east. You are in Stanley Shale to mileage 64.8.
58.4	Montgomery County Line. Good exposure of middle Stanley Shale with some cone-in-cone concretions and locally some thin siliceous shale beds. Note the northern variety of Spanish moss that grows on the trees.

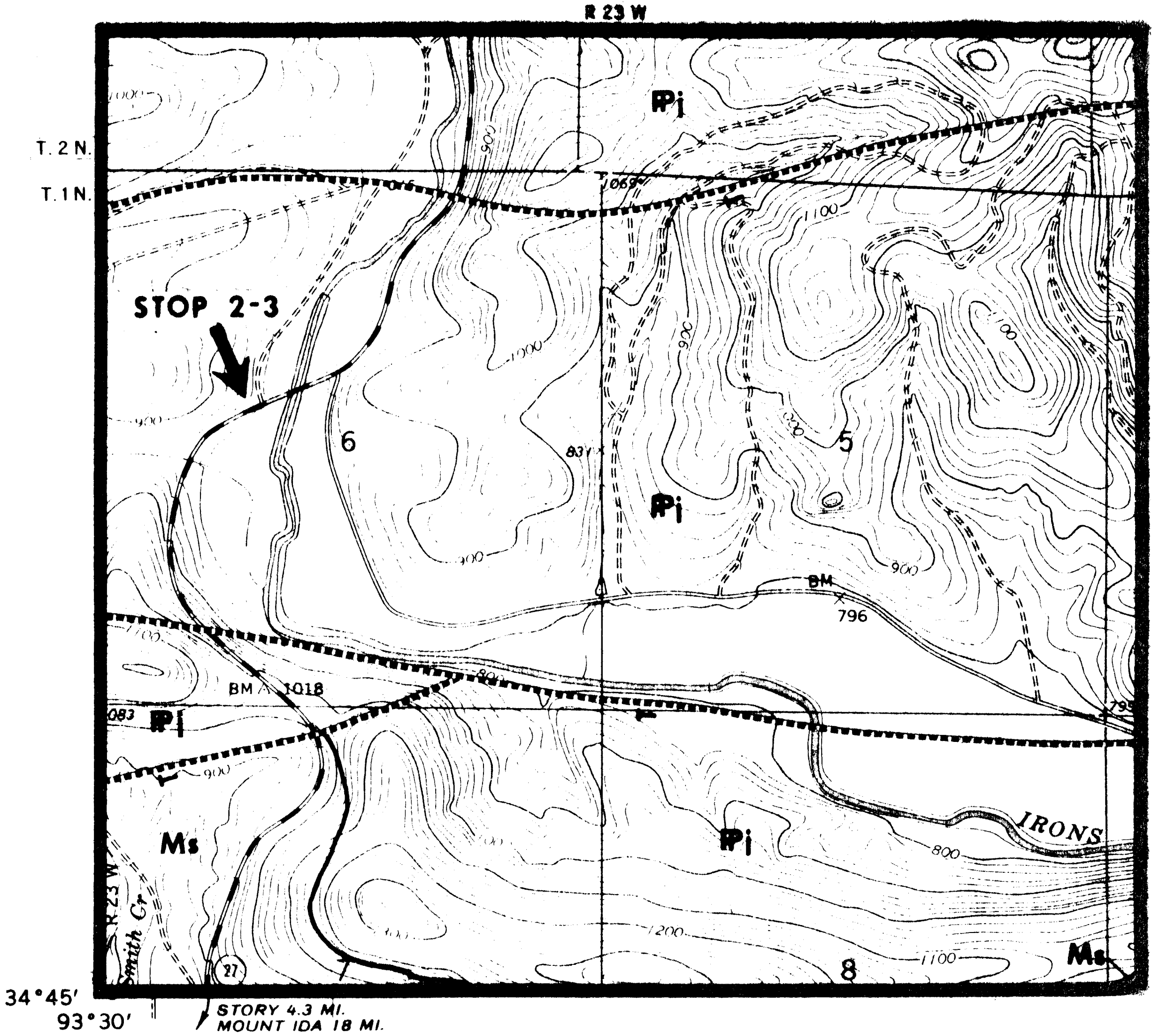


PLATE 14. IRONS FORK CREEK — STOP 2-3.

1000 0 1000 2000 3000 FEET

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

Figure 22. -- Stop 2 - 2. Bottom marks in lower Atoka Formation at Danville, Arkansas, are caused by turbidity flow. The scour marks indicate the azimuth of flow; the prod marks indicate the direction of flow—the knife blade indicates this direction.

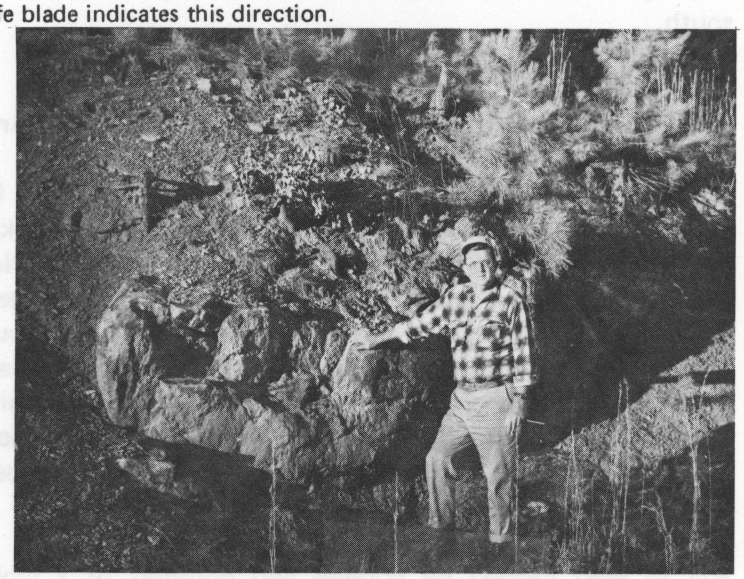


Figure 23. -- Stop 2 - 3. B. R. Haley standing with a round sandstone mass (gloop) in the middle Jackfork shale at Irons Fork River.

Figure 24. -- Stop 2 - 4. Conglomeratic lens with siliceous shale and shale in basal Stanley Shale at Washita, Arkansas.

MILEAGE	DESCRIPTION
58.9	Typical graywacke sandstone and sheared shales of the Stanley Shale.
59.0	Bridge over Muddy Creek.
62.2	Story, Arkansas, junction with Ark. Hwy 293 to the east (left), continue south on Hwy 27.
63.4	Bridge over Mill Iron Creek.
63.7	Note milky quartz veins in the lower Stanley Shale to the west (right). Veins of this type commonly occur near the many thrust faults that are present in the region. The Stanley Shale has an estimated total thickness of about 7500 feet in the area.
64.8	Stanley Shale--Arkansas Novaculite contact, rocks are overturned to the south.
65.2	<u>STOP 2 - 4:</u> Northern "Core" Area Facies, Washita, Arkansas (Plate 15).
	(Junction of Ark. Hwy 88 to the west (right) at mileage 65.3). Progressive exposures southward are: lower Stanley Shale; Arkansas Novaculite; Missouri Mountain Shale; Polk Creek Shale (beneath bridge over an upper prong of Lake Ouachita); Bigfork Chert (south of bridge at mileage 65.4). Note the many complex folds overturned towards the south in the Bigfork. Graptolites have been collected from the Polk Creek Shale at this locality. Massive novaculite is rarely present in the northern Ouachita Mountains. The Arkansas Novaculite interval usually contains shale, siliceous shale, chert, and thin novaculite with locally thick (15 feet or more) beds of channel-like sedimentary breccia and conglomerate (Figure 24).
65.5	Hill to west capped by cobbles and boulders of a high terrace deposit.
67.3	Bridge over Ouachita River and Lake Ouachita.
67.4	Contact of lower Stanley Shale and Arkansas Novaculite at south end of bridge.
67.5	Dirt road to west leads to a quarry in the Bigfork Chert (distance of about 2 miles).
68.1	Bigfork Chert crops out to west. Note thin interbedded intervals of chert and calcareous chert.
68.6	Womble Shale exposed to west. Note complex isoclinally recumbent folds in the limy siltstone intervals.
69.0	Womble Shale crops out to west (right).

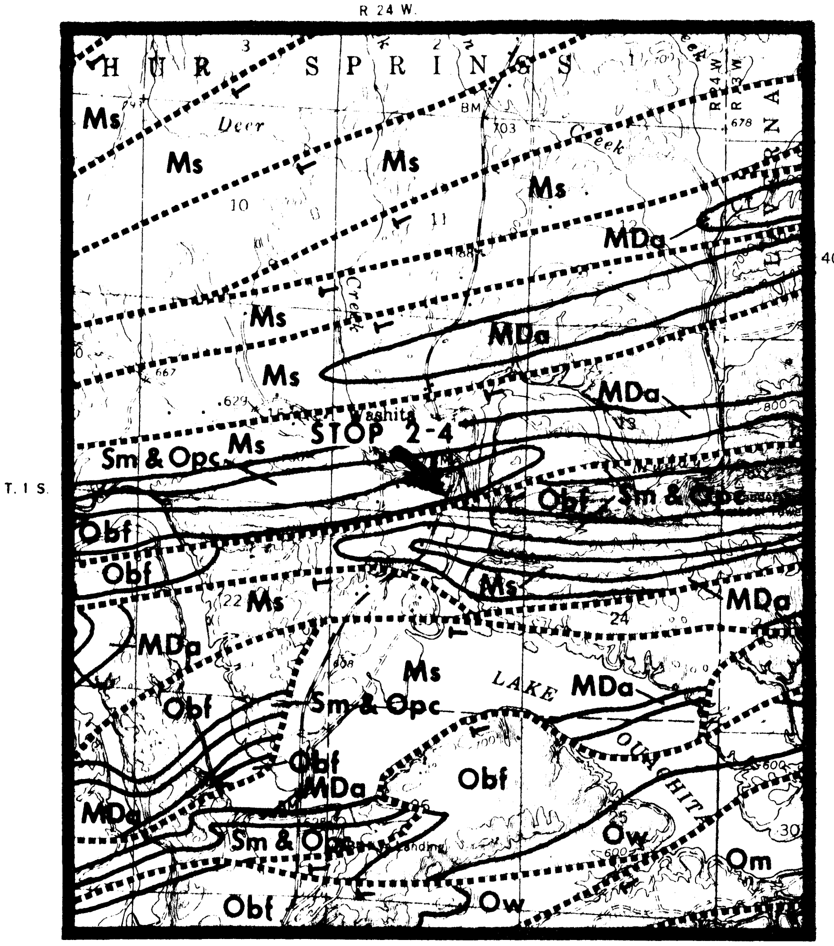


PLATE 15. WASHITA — STOP 2-4.

1000 0 3000 6000 9000 FEET

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

MILEAGE	DESCRIPTION
69.3	A rather shaly facies of the Blakely Sandstone to the east (left).
69.6	Shaly facies of the Blakely Sandstone to the east and west.
69.8	Mazarn Shale crops out to the east (left).
70.0	Crossing fault zone with Womble Shale overriding Mazarn Shale.
70.5	Junction of Ark. Hwy 188 to the east (left), continue on Hwy 27. Good exposure of the Womble Shale with numerous quartz veins to the northwest (right).
71.9	Bridge over Howell Creek.
74.8	STOP 2 - 5: Complexly Folded Womble Shale, Mt. Ida, Arkansas (Plate 16).
	Exposure of isoclinally recumbent folds in Middle and Lower Ordovician Womble shales and calcareous siltstones. Note development of cleavage, quartz veins containing calcite, and intensive weathering at the top of exposure.
75.3	Junction with U. S. Hwy 270, turn southeast (left) onto Hwy 270.
75.8	Downtown Mt. Ida, Arkansas to right (south).
76.2	Junction of Ark. Hwy 27, continue southeast on Hwy 270.
76.5	Turn south (right) on gravel road to Ocus Stanley Mineral Shop.
76.9	STOP 2 - 6: Ocus Stanley Mineral Shop, Mt. Ida, Arkansas (Plate 16).
	Mr. Stanley is one of the better known dealers in clear quartz crystals and other minerals common to the region. Quartz crystals have been mined in the Ouachita Mountains of Arkansas for many decades, first by the Indians who shaped them into arrowheads. More recently quartz has been used for making optical equipment and jewelry. Stones that are cut from quartz crystals are sold in Hot Springs, Arkansas, under the trade name of "Hot Springs Diamonds". These should not be confused with genuine diamonds from the diamonds mines at Murfreesboro, Pike County, Arkansas, nor with "rock crystal" (glass). Most of the quartz crystals from Arkansas find their way into mineral collections of institutions and individuals, and a relatively large volume is used in construction of water fountains and religious and memorial shrines. The value of the natural crystals sold each year has ranged from a few hundred to many thousands of dollars.
	During World War II, there was a great demand for oscillator quartz. At that time quartz crystal mining was greatly accelerated by individuals, the Diamond Drill Carbon Company, and the U. S. Government. Clear crystals

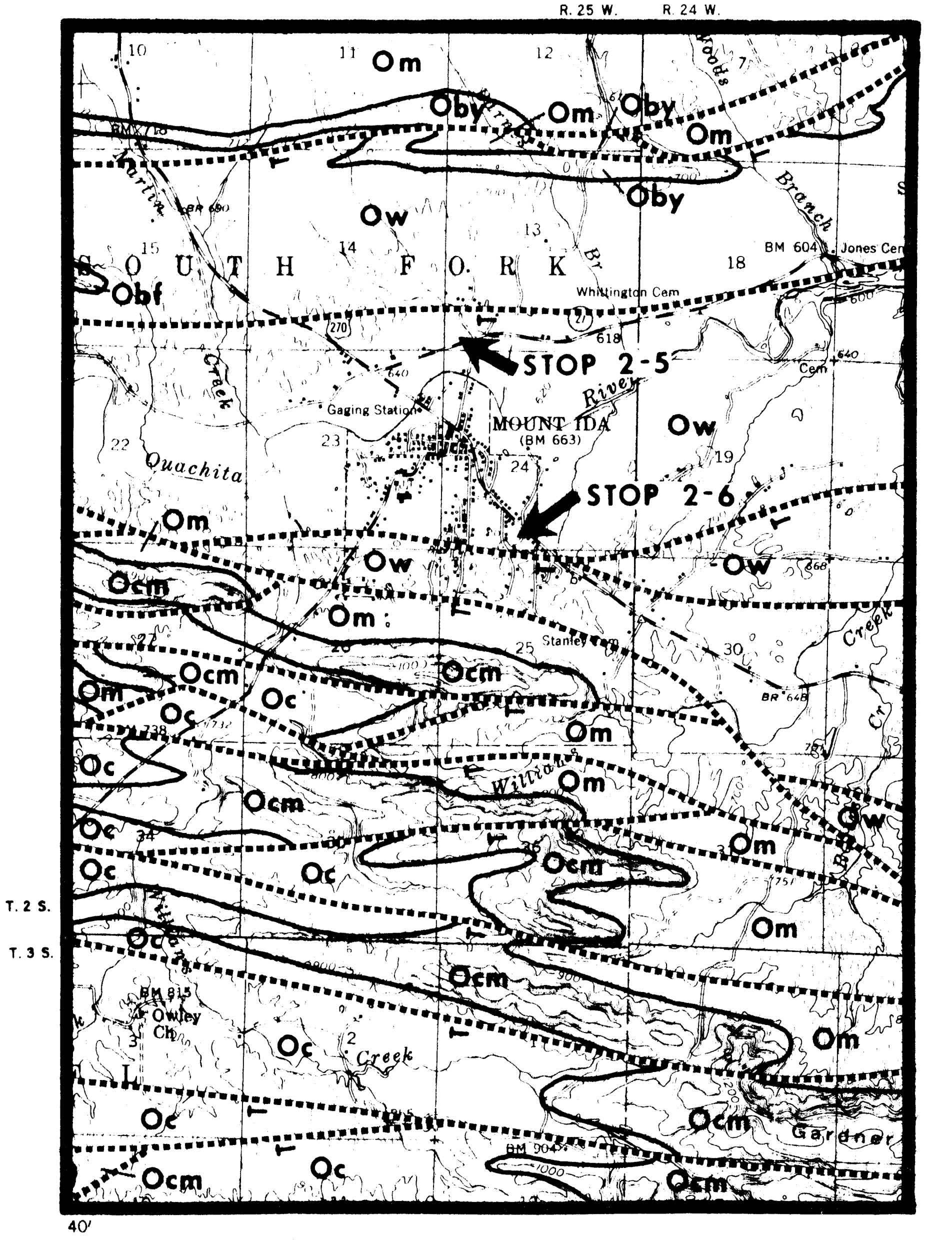
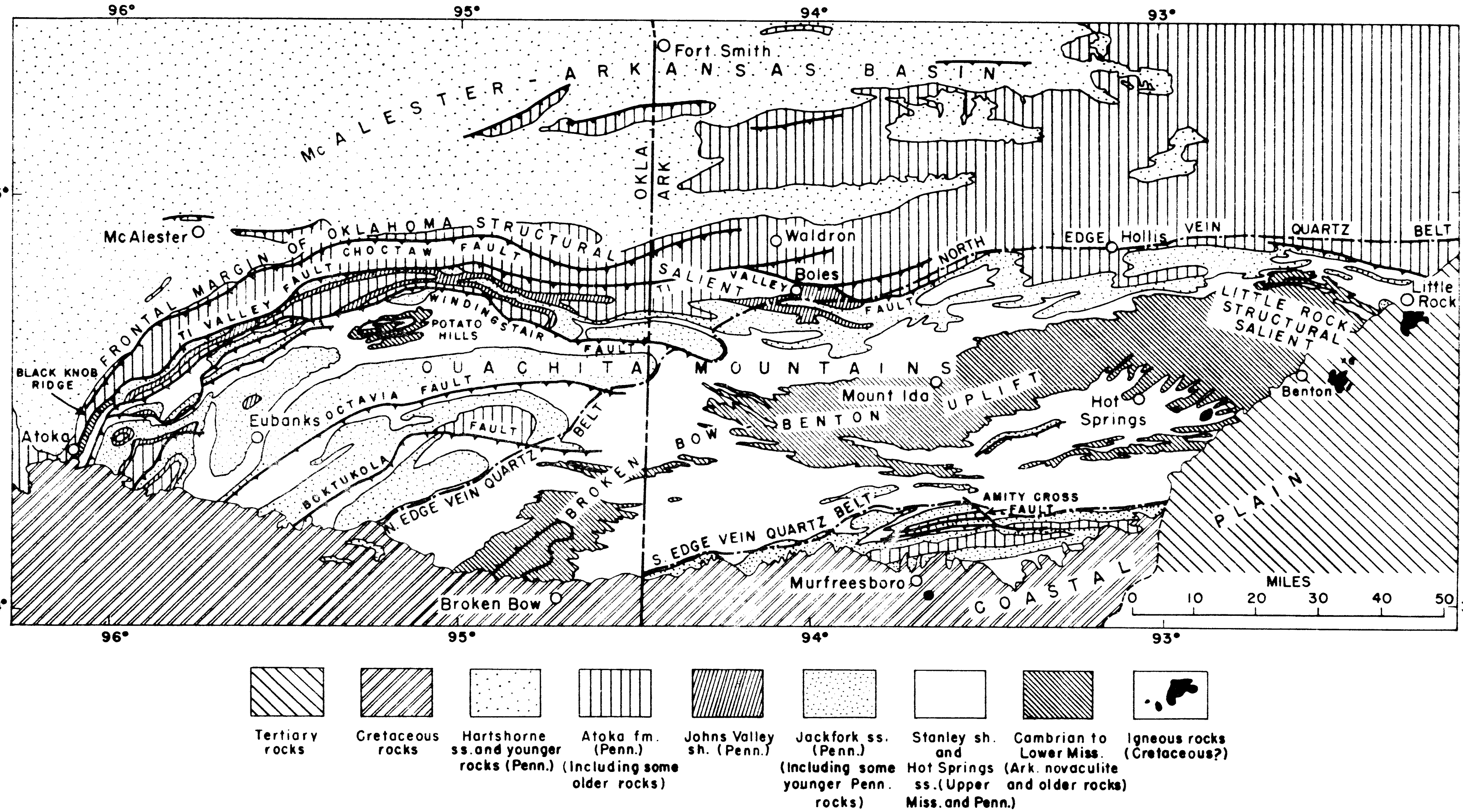


PLATE 16. FOLDED WOMBLE SHALE — STOP 2-5.
OCUS STANLEY MINERAL SHOP MT. IDA — STOP 2-6.

1000 0 3000 6000 9000 FEET

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

MILEAGE	DESCRIPTION
76.9 (cont.)	of oscillator grade are, however, so scarce that only about 5 tons of this quality were produced during the war years. This quantity was very small in comparison with the war-time requirements of 2000 tons nearly all of which was imported from Brazil. At the present time quartz crystals are also marketed for transparent fused quartz which has many chemical, thermal, and electrical applications not met by glass. Some production of crushed milky quartz for precast concrete products has also been recorded. The quartz crystal deposits are numerous and are found at many localities in a wide belt extending from Little Rock, Arkansas, westward to near Broken Bow, Oklahoma (Figure 25). They and their few associated minerals are hydrothermal deposits of probable tectonic origin, formed during the closing stages of the Late Pennsylvanian-Early Permian orogeny in the Ouachita Mountains.
77.3	Return to U. S. Hwy 270, turn northwest (left).
77.7	Junction of U. S. Hwy 270 and Ark. Hwy 27, turn west (left) onto Hwy 27.
78.1	Highly cleaved and folded, black shale and calcareous siltstone of the Womble Shale in small creek to west.
79.1	Sequence of: sheared black shale of the Womble Shale; a large decollement; massive, calcareous, broken sandstone of the Crystal Mountain Sandstone; and, poorly exposed shale and thin, dense limestone of the Collier Shale.
79.4	Exposure of intensely folded, gray, flaggy to thin-bedded, dense limestone intervals and shale of the Collier in bank to west. Notice abundant milky quartz-calcite veinlets. Conodonts have recently been obtained by John Repetski and Ray Ethington, University of Missouri, from the Collier limestones and they indicate an Early Ordovician age for the oldest Formation exposed in the Ouachita Mountains.
79.8	Intensely folded Collier limestone, "talcose" shale and flint stringers, with small quartz-calcite veinlets in small gully to west.
80.9	Weathered shale and punky decalcified siltstone with dissecting small quartz veins of the Collier Shale to east. To the west of this area in a roadcut in the NW¼ SE¼ sec. 35, T. 2 S., R. 26 W., Orville Wise of the Arkansas Geological Commission and others have found some small, algal(?) structures in thin, flaggy, Collier limestone. A flint-pebble conglomeratic limestone with some small plagioclase(?) fragments also occurs in a small stream just north of the locality.
81.4	View of the Crystal Mountains to the south formed by the Lower Ordovician Crystal Mountain Sandstone.
81.8	Bridge. A good exposure of intricately folded Collier shale and limestone occurs a few hundred feet upstream (southwest).



H. D. Miser

Geologic map of Ouachita Mountains showing area of occurence of vein quartz

Figure 25

MILEAGE DESCRIPTION

82.3 Some fairly massive beds of conglomeratic, pelletoidal, oolitic Collier limestone occurs in ditch to east (left). It is our opinion that these pelletoidal limestones represent soft sediment slurries from the cratonic shelf into the early Ouachita leptogeosyncline.

82.8 STOP 2 - 7: Crystal Mountain Sandstone (Plate 17).

When this road was resurfaced a few years ago, isoclinally recumbent folds, cleavage, and sedimentary features were well-exhibited by the alternating massive to thin, sometimes calcareous, often quartzitic sandstone and clayey to carbonaceous shale of the Crystal Mountain Sandstone. A large fold could be easily seen along the northern extremities of this exposure (west side of the road) and excellent top and bottom criteria indicated the northward shallow-dipping sandstone beds were upside-down and confirmed that older rocks of the Collier Shale were to the north. Note thin fracture-filling quartz veins and small crystals.

The following comments are from George Viele (Ouachita Mountain Guidebook, 1973, Ark. Geol. Comm.).

Between Mount Ida and Norman, Arkansas, fold attitudes are fairly constant. Axial surfaces are moderately inclined or recumbent, and they exhibit gentle warping. The fold hinges consistently plunge toward the west or southwest parallel to the trends and plunges shown by the map pattern. Rotation directions are consistently toward the south. The only problems occur in places such as at mileage 83.9 where if our top and bottom calls are correct, the rotation directions suggest an overturned, northward-moving limb. This is not completely anomalous, for we suggest initial movement toward the north, and at later stops we shall see definite proof for it. Tentatively the name Crystal Mountain trend is applied to these folds. The bearings of fold hinges in the Crystal Mountains are the same but the axial surfaces appear to be much steeper. Only more work will reveal whether this represents the effect of thick sandstones in the stratigraphic section or if the steep axial surfaces are related to a later phase of folding.

83.2 Exposure of banded shale and thin siltstone of Mazarn Shale to east at electrical power relay station.

83.7 Spring fed ponds to the west.

83.9 This is an exposure of banded slate and dense, often silty, gray limestone of the severely folded Mazarn Shale. Notice flowage of shaly units, minor faults, quartz veins with calcite, and the locally high degree of weathering. The complexity in this exposure is attributed to both structural deformation and soft sediment slide accumulations.

85.4 Junction of dirt road to east (left).

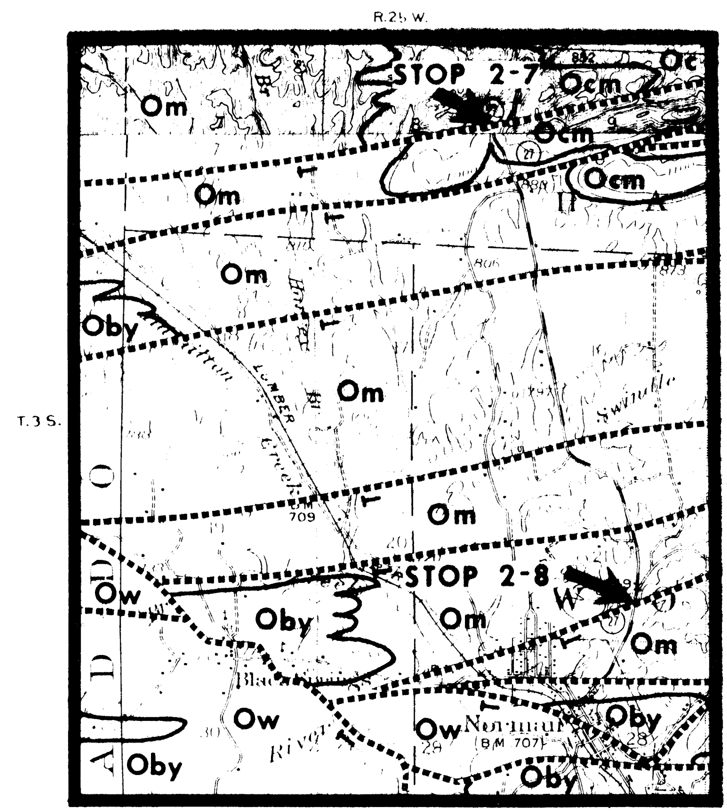


PLATE 17. GEOLOGIC MAP OF NORMAN, ARKANSAS AND VICINITY — STOPS 2-7 and 8.

1000 0 3000 6000 9000 FEET

Geology by A. H. Purdue and H. D. Miser, modified by C. G. Stone and B. R. Haley

MILEAGE	DESCRIPTION
85.5	STOP 2 - 8: Folded Upper Mazarn Shale (Plate 17).
	This is a highly folded and cleaved sequence of alternating banded shale or slate, thin siltstone and quartzitic, lenticular, sandstone of the upper Mazarn Shale. Excellent top and bottom criteria indicate direction of overturning is to south (Figures 26 and 27). Likely the banding in the shale or slate is due to turbidity grading of minute silt and clay fractions. Note small fracture-filling quartz veins.
85.9	City limits of Norman, Arkansas. Formerly known as Womble, but when Mr. Womble fell into disfavor, the name was changed.
86.0	Banded shale and discontinuous sandstone of the Blakely Sandstone. Faults are exposed south of here in an exposure near the school building.
86.3	LUNCH STOP: Hattie's Cafe to east serves the best in "home-cooked" food. Old courthouse to west (right).
	The following comments are extracted from George Viele (Ouachita Mountain Guidebook, 1973, Ark. Geol. Comm.).
	Fold patterns start to change south of Norman, Arkansas. Most axial surfaces are moderately inclined and dip southeastward, though about a third of those measured in the area between Norman and Caddo Gap dip gently to the northwest. They appear to be gently warped about a northeast-southwest axis. Fold hinges consistently plunge eastward toward the Mazarn synclinorium though reclined hinges plunging south-southeast become more numerous toward the south. Indeed, the outcrops of novaculite at Caddo Gap provide the best examples of superposed folding in the western Ouachita Mountains. On the geological map a downdip view of the Arkansas Novaculite-Stanley contact shows S rotations, but at Stop 2 - 11 a Z rotation has been superposed on the earlier folds. Axial surfaces of the S folds have been folded back towards the south. A reclined system has been noted in several localities almost as far west as the Oklahoma State Line (Figures 30 and 31).
87.0	Northward dipping sandstone and banded shale of the Blakely Sandstone to south (right).
88.5	Banded shale and very thin, often graded, sandstone of the Blakely Sandstone.
89.4	Northward dipping, upright, bottom marked and graded flaggy sandstone and shale of the Blakely Sandstone. How can this geology be so straightforward?
89.7	Good exposure of Blakely shale and sandstone with two generations of folds and cleavage. Fold axes or cylinders on one fold system are nearly vertical. Notice lenticular sandstone mass at north end of roadcut.
90.5	Caddo Gap School on left situated on terrace deposits.

Figure 26. -- Stop 2 - 8. Small southward overturned fold in banded shale or slate and siltstone of the upper Mazarn.

Figure 27. -- Stop 2 - 8. George Viele standing by a tightly folded, lenticular sandstone mass in the Mazarn Shale. Plastic flowage is present in the shale or slate and has, in part, created some if the discontinuity in the bedding.

MILEAGE	DESCRIPTION
91.0	STOP 2 - 9: Blakely Sandstone and Womble Shale at Collier Creek (Plate 18).
	Beneath bridge is a good exposure of thin-bedded, often graded, and bottom-marked sandstone and shale of the upper Blakely Sandstone.
	Notice the many sedimentary features and only minor folds and cleavage. Graptolites occur in some of the black shale of the lower Womble just south of the bridge. An intraformational breccia with limestone and silt-stone clasts occurs in Womble on east (left) side of road near parking area.
91.8	Post mill to west (right).
91.9	Contact between dense limestone and siliceous shale of Womble Shale and the overlying calcareous chert of the Bigfork Chert to east (right).
92.0	City limits of Caddo Gap, Arkansas.
92.4	STOP 2 - 10: Complex Folds in Bigfork Chert at Caddo Gap (Plate 18).
	At least two directions of folding are developed in this rucked sequence composed of thin chert, siliceous shale and decalcified silty chert of the Bigfork Chert. Note steep plunge on some of the folds and refraction of cleavage across various resistant layers. Good view of Caddo Mountains to south (Figures 28 and 29).
93.0	Bridge over creek.
93.3	STOP 2 - 11: Classic Exposures of Arkansas Novaculite at Caddo Gap (Plate 18).
	The sequence beginning at north end of roadcut is upper Missouri Mountain Shale with a thin chert-sandstone conglomerate bed; massive, dense, white to light gray, highly jointed, sometimes manganiferous, sometimes sandy in basal portions, Lower Division; black shale, and thin chert of the Middle Division; thin bedded to massive, cream to white, and, in part, tripolitic Upper Division of the Arkansas Novaculite; and shale, graywacke and thin chert-sandstone conglomerate of the lower Stanley Shale (Figures 30, 31, and 32).
	Many good exposures of these units occur along the highway, railroad, and Caddo River both to north and south of stop area. Hass-AAPG (1951) placed the Mississippian-Devonian boundary on conodonts some 27 feet below the top of Middle Divison. Especially note steep plunge of fold axes (cylinders) on one fold system. Another period of folding is much flatter in attitude. A thrust fault is present along southern margins of the Stop. Small hot springs issue from exposures of massive novaculite in the river and along the west bank to the north.

Figure 28. -- Stop 2 - 10. A rather intricate system of overturned folds in the thin-bedded chert and decalcified, cherty siltstones in the Bigfork Chert at Caddo Gap.

Figure 29. -- Stop 2 - 10. Close-up of small fold in the Bigfork Chert.

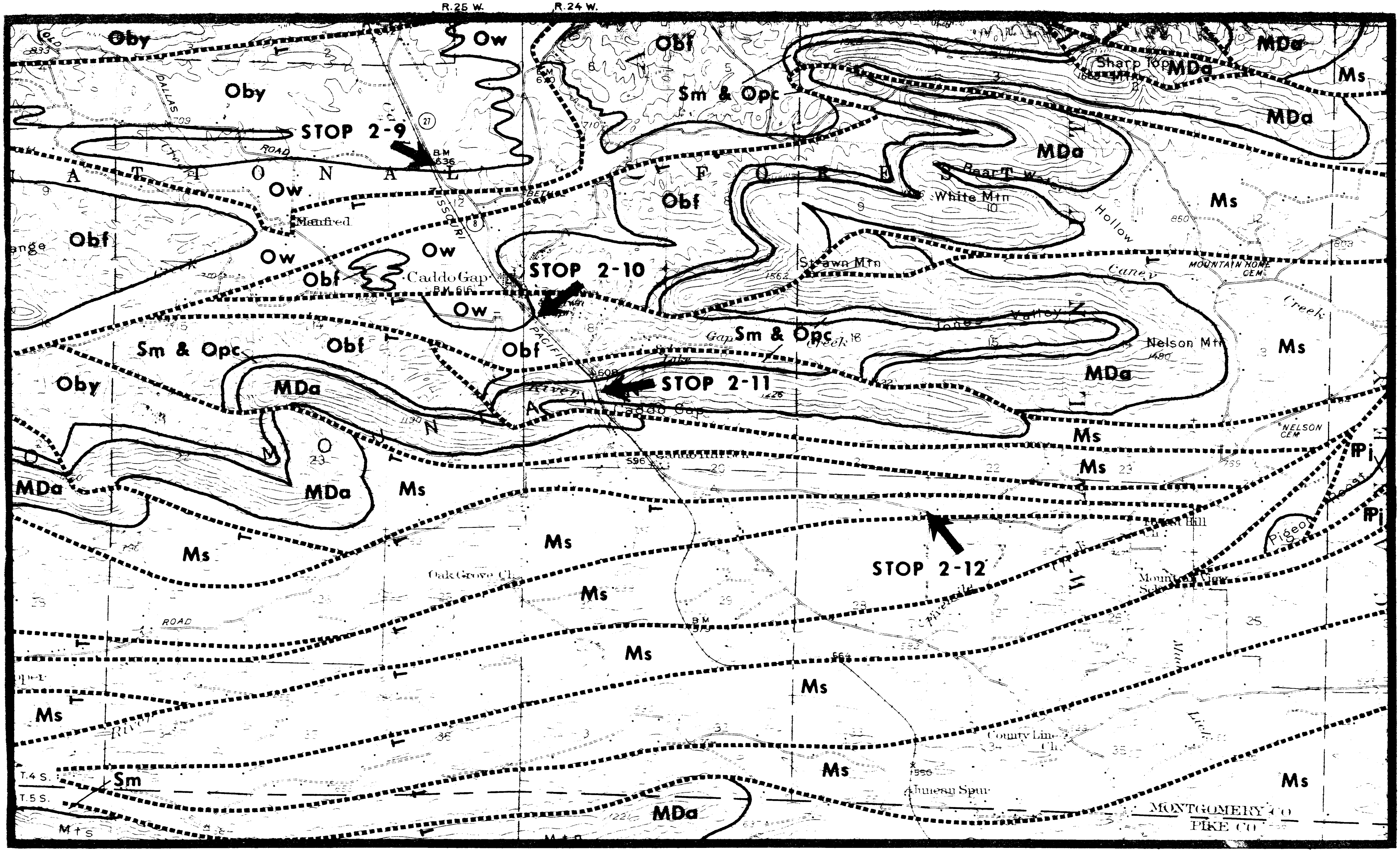


PLATE 18. GEOLOGIC MAP OF CADDO GAP, ARKANSAS AND VICINITY — STOPS 2-9, 10, 11, and 12.

1000 0 3000 6000 9000 FEET

Geology by A. H. Purdue and H. D. Miser, modified by C. G. Stone and B. R. Haley

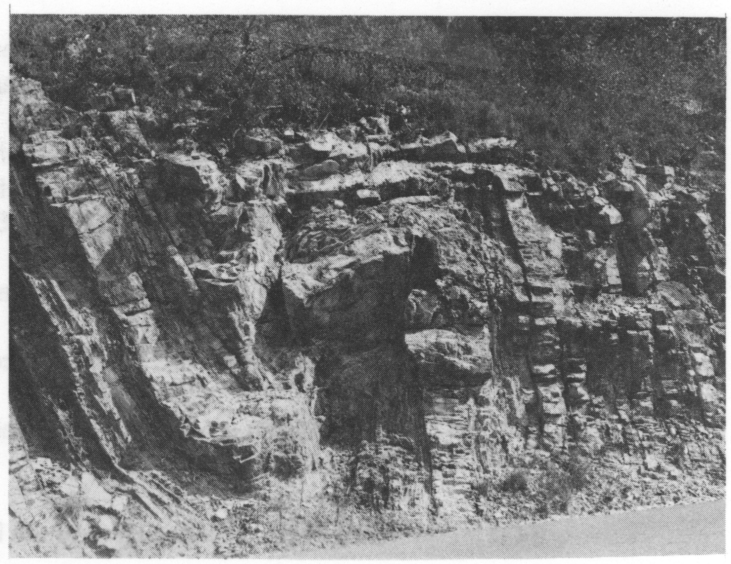


Figure 30. -- Stop 2 - 11. A reclined fold (standing nearly on end) within the massive Lower Division of the Arkansas Novaculite at Caddo Gap. Note the small fault breaching the sequence.

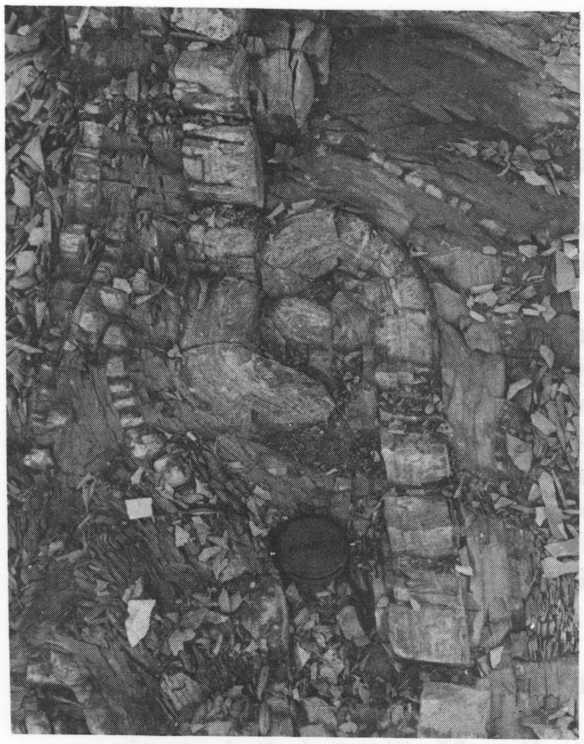


Figure 31. - Stop 2 11. Close-up view of small reclined fold in the Lower Division of the Arkansas Novaculite. Are some folds of this nature created by soft sediment deformation and rotated and deformed further by the tectonic episodes?

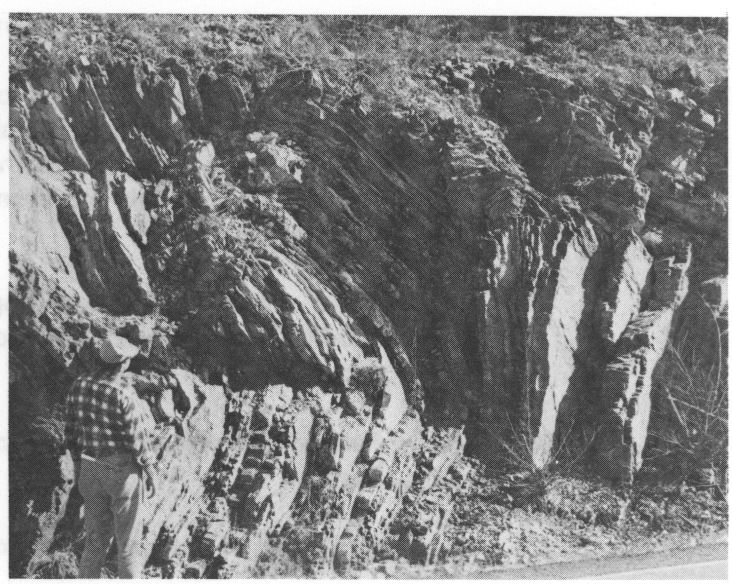


Figure 32. -- Stop 2 - 11. Comples folding and minor faults in the cherts and siliceous shales of the Middle Division of the Arkansas Novaculite at Caddo Gap.

MILEAGE	DESCRIPTION
93.3 (cont.)	Legend has it that in 1541 Hernando DeSoto's party was attacked here by the Tula Indians who rolled boulders down the steep slopes. Recent investigations by Albert Kidwell has disclosed a suite of rare iron phosphate minerals in some abandoned manganese mines and elsewhere in the Arkasas Novaculite 10 to 35 miles west of here.
93.5	Contact of Arkansas Novaculite and Stanley Shale.
93.6	Junction with Ark. Hwy 240, continue on Hwys 27 and 8.
93.9	Alternating graywacke and shale in highly folded and faulted lower Stanley Shale.
94.0	Bird and Son Roofing Granule Plant to west (right).
94.1	Junction with gravel road, turn east (left onto gravel road).
96.0	<u>STOP 2 - 12:</u> Bird and Son Slate Granule Pit in Stanley Shale (Plate 18). Slate in the lower Stanley is being mined and processed for roofing granules. This exposure of steeply southward-dipping, black shale and thin graywacke is cut by several thrust faults, with excellent broad polished slickenside (dickite, etc.) surfaces. Faulting has repeatedly shoved one sequence northward over another. The northward moving thrusts are slightly backfolded toward the south. Small quartz veins, with pyrite and calcite, fill fractures in the broken sandstone layers. Notice cleavage dipping both to the south and also some steeply to the north. Deposits of "bedded" barite occur locally in the Fancy Hill (west) and Pigeon Roost (east) Districts in the lower Stanley Shale. Scull (1958) considers the barite a hydrothermal deposit and relates it to Mesozoic intrusives; whereas Brobst and Ward (1965) and others ascribe a primary sedimentary origin. Return to junction of Ark. Hwy 27 and gravel road.
97.8	Junction, turn south (left) onto Ark. Hwy 27. Thrust faulted, steeply-dipping Stanley Shale is exposed for the next several miles in the western Mazarn Basin. Tall hills to the west are anticlinal mountains of Arkansas Novaculite, Blaylock Sandstone and older rocks of the Cossatot Mountain subprovince.
100.4	Good exposure of steeply-dipping, alternating graywacke and shale of the middle Stanley Shale. Numerous small negative or "water" quartz crystals occur in veins in the area.
101.3	Faulted, steeply northward-dipping, graywacke and shale of middle Stanley Shale.
101.4	City limits of Glenwood, Arkansas.

MILEAGE	DESCRIPTION
102.7	Downtown Glenwood, Arkansas. Junction of Ark. Hwy 27 and U. S. Hwy 70B, turn west (right) onto U. S. Hwy 70B.
103.1	Junction U. S. Hwys 70 and 70B, turn west (right) onto U. S. Hwy 70.
103.2	Bridge over Caddo River.
103.3	Junction with Ark. Hwy 8, continue west on U. S. Hwy 70.
104.4	Turn south (left) onto dirt road.
104.8	Contact between the Upper Division of the Arkansas Novaculite and the Stanley Shale. Note the thin conglomerates in the lower Stanley, and the locally tripolitic novaculite.
105.3	Return to U. S. Hwy 70 and turn west (left).
106.5	Ridge of Arkansas Novaculite to the north is at the eastern end of the Cossatot Mountains.
108.6	Overturned Stanley Shale and Arkansas Novaculite with the Stanley thrust over the top of the Middle Division of the Arkansas Novaculite. In the Cossatot Mountain subprovince to the west the underlying Blaylock Sandstone of Silurian age is over 800 feet thick and consists of interbedded thin sandstone, siltstone, and shale with many flysch-like characteristics including abundant probable deep-water trace fossils. The Blaylock is not present as a mappable unit in the central and northern Ouachita Mountains.
	Stanley shale and sandstone are present for the next 6.5 miles to mileage 115.1.
109.2	Downtown Salem, Arkansas. Junction with Ark. Hwy 84, continue on U. S. Hwy 70.
110.3	Exposures of the lower Jackfork Sandstone. Where the Stanley-Jackfork contact is unfaulted to the east some siliceous shales and cherts represent the Chickasaw Creek Member of the upper Stanley Shale.
111.1	Fault zone, with Stanley Shale thrust over the Jackfork. The hydrothermal mineral dickite is present along many of the slickensided intervals.
113.7	Downtown Kirby, Arkansas, Junction of U. S. Hwy 70 and Ark. Hwy 27. Continue southward on Ark. Hwy 27.
115.1	<u>STOP 2 - 13:</u> Lower Jackfork Sandstone (Plate 19).
	Walk up hill. At this locality, the lower Jackfork is thrust over the Stanley Shale and the rather typical siliceous shales of the Chickasaw Creek Shale

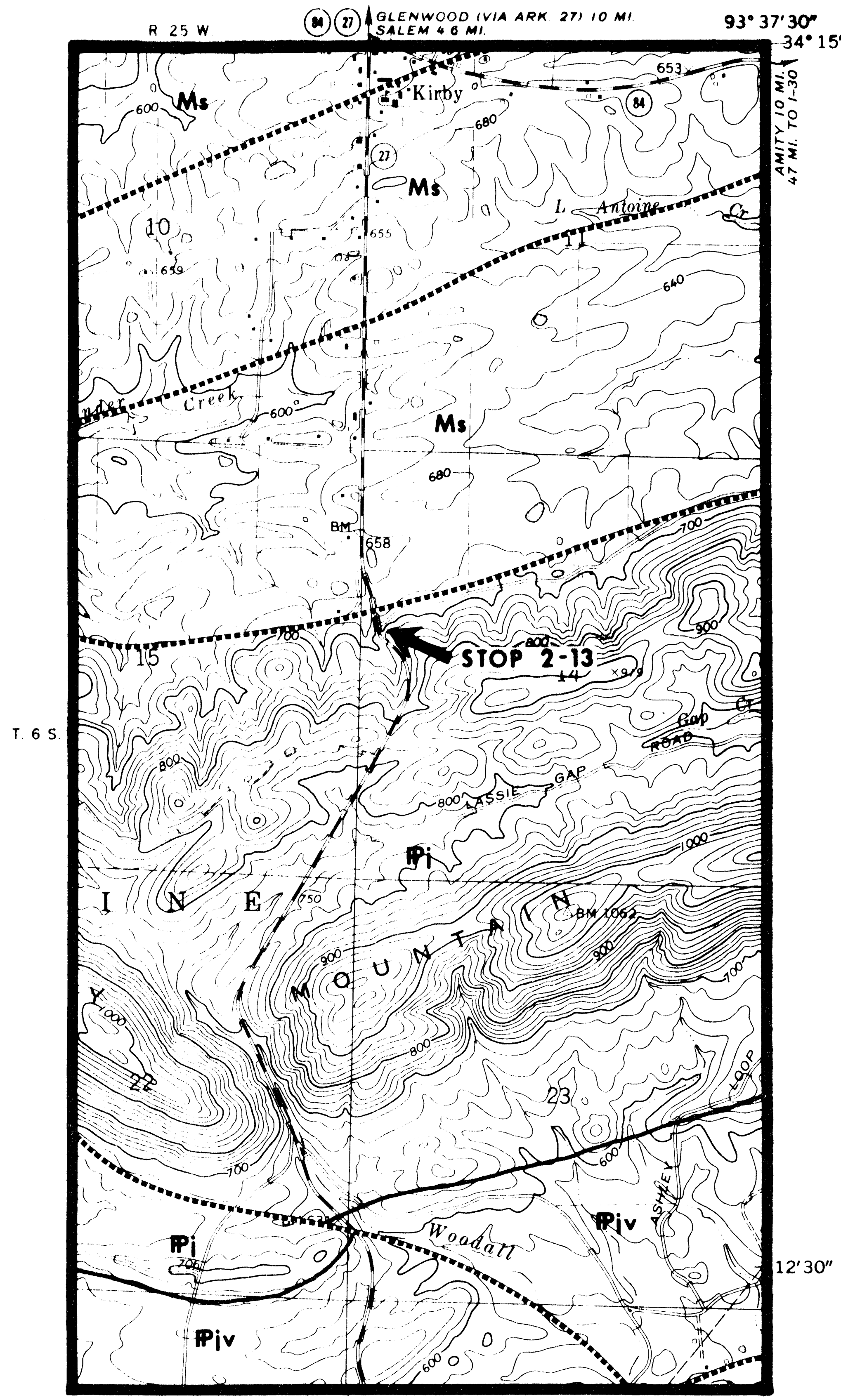


PLATE 19. LOWER JACKFORK SANDSTONE — STOP 2-13.

1000 0 1000 2000 3000 FEET

Geology by B. R. Haley, C. G. Stone, W. V. Bush and B. F. Clardy

MILEAGE	DESCRIPTION
115.1 (cont.)	Member of the upper Stanley are missing. The Jackfork has alternating fairly massive sandstone and shale sequences that likely fit into the submarine middle fan model of turbidite deposition (Figures 33 and 34).
115.9	Old mercury retort to right (west), which processed ores mined in the area. The mercury district occurs in a belt 6 miles wide and 30 miles long extending from eastern Howard County through Pike County and into western Clark County. Cinnabar was first discovered in southwestern Arkansas in 1930. Mining began in 1931 and mercury was produced each year through 1944. Production through this period was approximately 1500, 76-pound flasks. Mining has been negligible since 1944. The ore deposits occur in both the Stanley Shale of Mississippian Age and the Jackfork Sandstone of Pennsylvanian Age. Cinnabar and other primary minerals were deposited from aqueous solutions rising through the fractured Paleozoic rocks. The majority of ore deposits are associated with the larger faults in the area and generally occur in the overthrusted fault blocks within a mile of the fault traces. There are several opinions on the age of the cinnabar mineralization in Arkansas, these include: (1) during early Late Cretaceous time in connection with vein quartz deposition and the major period of igneous activity in Arkansas; and, (2) Late Paleozoic time in relation to thrust faulting and major vein quartz deposition.
116.4	A sequence of upper Jackfork Sandstone.
117.1	Contact of the Jackfork Sandstone with the Johns Valley Shale.
117.8	Atoka Formation thrusted over Johns Valley Shale.
118.6	Road to west leads to Laurel Creek Recreation Area.
118.9	Stanley Shale thrusted (Cowhide fault) over the Atoka Formation. Much of the cinnabar (mercury) mining ventures have been along the overthrusted block of this major fault.
119.1	Stanley Shale exposure.
119.3	Jackfork Sandstone thrusted over the Stanley Shale.
119.6	Road to right (west) leads to Greeson Fish Nursery Pond.
120.1	Jackfork Sandstone faulted over Stanley Shale.
120.7	Valley formed in Johns Valley Shale.
121.1	Exposure of Johns Valley shale and thin sandstone on right (west).
121.3	Bridge.

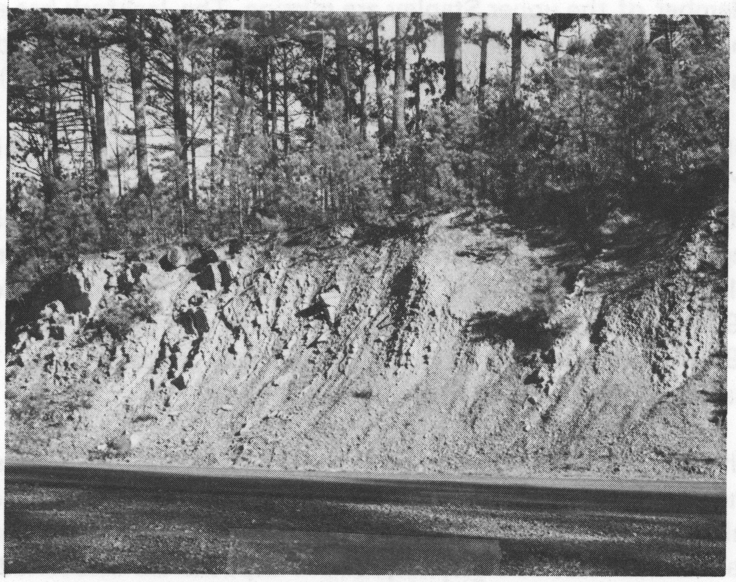


Figure 33. -- Stop 2 - 13. Steeply southward (right) dipping sandstone-shale turbidite sequence in lower Jackfork Sandstone south of Kirby.

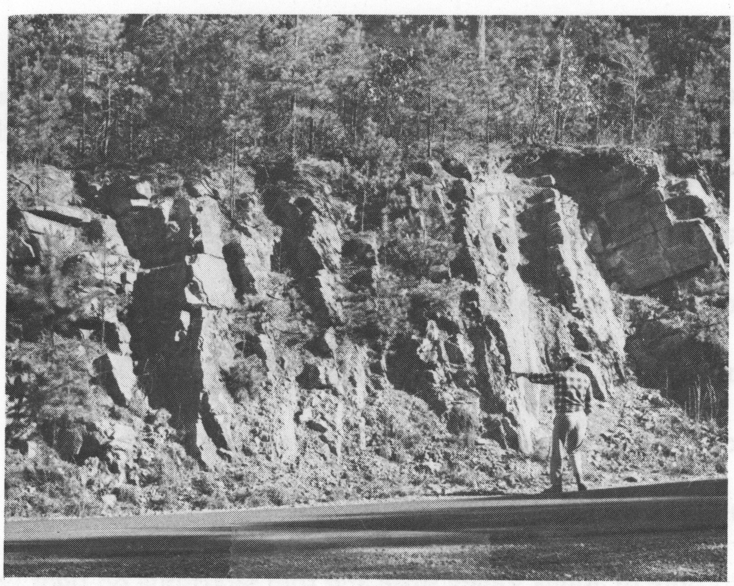


Figure 34. -- Stop 2 - 13. Massive lower Jackfork Sandstones with typical "thinning" of beds upwards (right) suggesting submarine middle fan channel deposition.

MILEAGE	DESCRIPTION
121.5	Sandstones and shales of the lower Atoka Formation. A transported mold fauna containing pieces of crinoids, brachiopods, and other fossils occur in steeply dipping, about 6 feet thick, brownish decalcified sandstone.
122.4	Pike Gravel Member of the Lower Cretaceous Trinity Group.
124.2	Gravel pit in Pike Gravel on the right. Note regional dipslope to the south of approximately 1°.
125.4	Top of the Pike Gravel Member.
127.5	Junction with Ark. Hwy 26, continue west (right) on Ark. Hwy 27.
128.0	Junction with Ark. Hwy 19, continue south (left) on Ark. Hwy 27.
128.5	Downtown Murfreesboro, Arkansas, continue around the courthouse, and turn south (right) onto Ark. Hwy 301.
129.5	Kimberley, Arkansas. Guess where it got its name?
130.0	Bridge over Prairie Creek.
131.0	Turn south (right) to Crater of Diamonds State Park.
131.4	STOP 2 - 14: Crater of Diamonds State Park (Plate 20). A small fee is charged for entrance.

The following summary on the kimberlite pipe is by Jerry Wilcox, geologist employed by the Arkansas Department of Parks and Tourism. Figures 35, 36, and 37 are pictures of the Diamond Mine.

THE HUMAN HISTORY

The geologic formation was studied as early as 1889 by John C. Branner and R. N. Brackett. They realized that the formation was similar to diamond-bearing pipes found in Africa, but they failed to find any diamonds. It wasn't until 1906 that John W. Huddleston, a local farmer-woodsman-treasure hunter, found the first diamond.

Once the diamonds proved genuine, a Little Rock jeweler, a banker, and others bought the Huddleston property and organized the Arkansas Diamond Mining Company. But the Huddleston property covered only half of the kimberlite. The other half was purchased by Austin Miller, a competent geologist who spent years running tests to determine whether diamond mining would be profitable. The tests proved positive and in 1919, Miller constructed a full-scale diamond mining operation; but Miller's hopes were consumed by the fires of greed. Arsonists burned down his entire operation. And this was only the beginning!

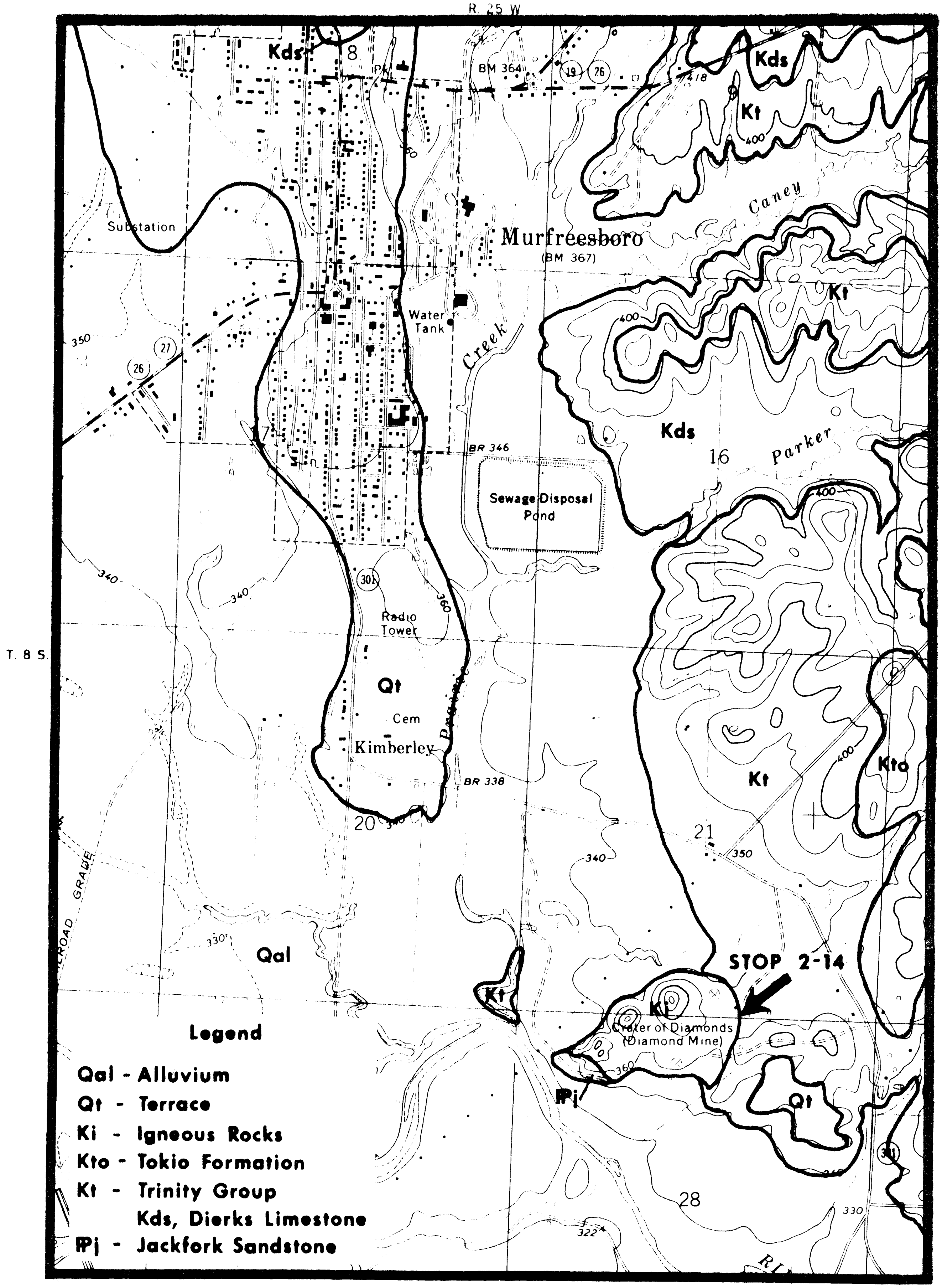


PLATE 20. CRATER OF DIAMONDS STATE PARK — STOP 2-14.

1000 0 1000 2000 3000 FEET

Geology by W. V. Bush and B. F. Clardy

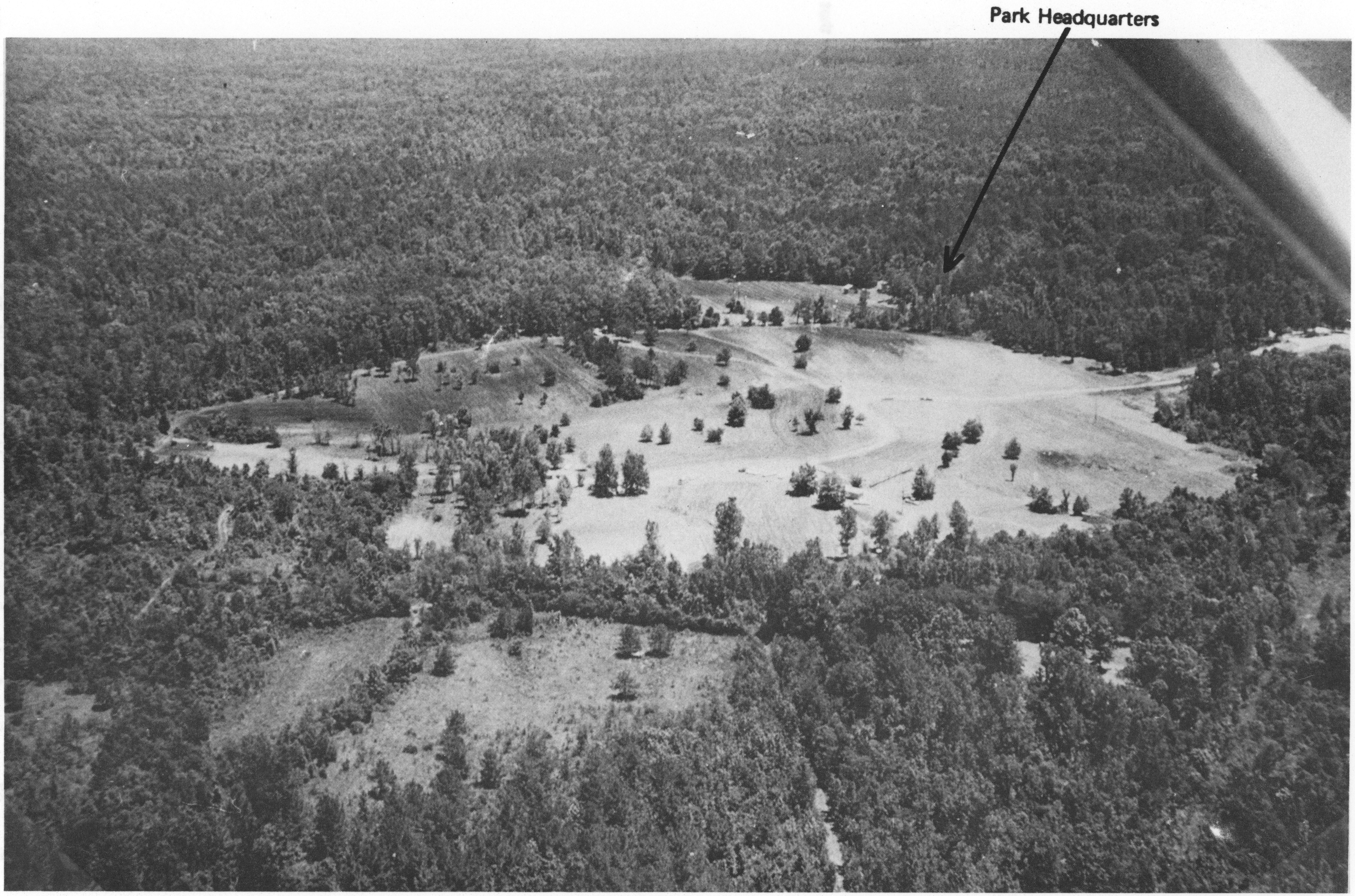


Figure 35. -- Stop 2 - 14. Aerial view (looking north) of the Crater of Diamonds in 1969. Picture taken by George Peter Gregory.

Figure 36. -- Stop 2 - 14. Searching for Diamonds. The park personnel periodically plough the fields so that "new ground" is continually being brought to the surface.

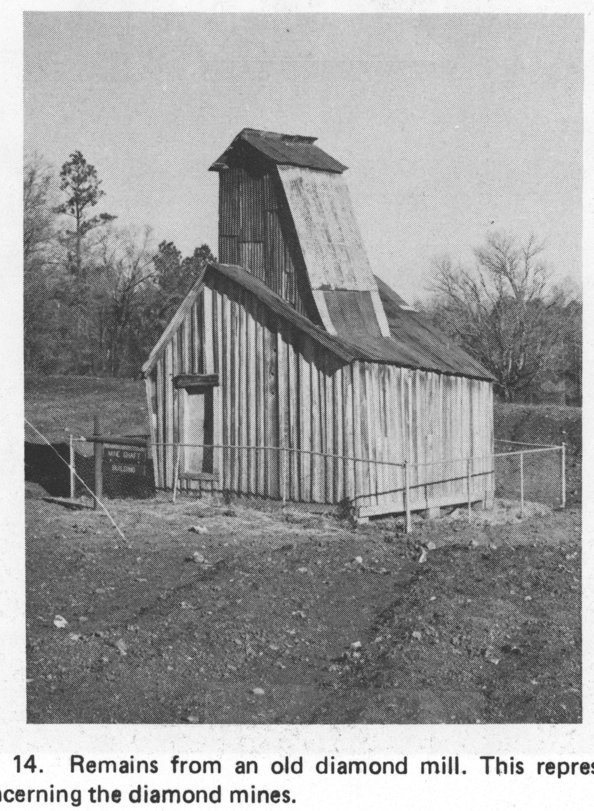


Figure 37. -- Stop 2 - 14. Remains from an old diamond mill. This represents but one of the many intriguing ventures concerning the diamond mines.

131.4 (cont.) As Austin Miller's son Howard A. Miller relates, "I became involved in a diamond drama that would bring on international intrigue, the deliberate destruction by fire of mine buildings and equipment, numerous lawsuits, and no telling how much undercover wheeling and dealing. . ." Commercial mining attempts were probably destroyed by greed rather than lack of diamonds.

GEOLOGY

The geology of the Crater is described in the excellent report U. S. Geological Bulletin 808, 1929, by Hugh D. Miser and A. H. Purdue. The following information is taken from that report:

The Prairie Creek peridotite area is roughly triangular in shape and comprises about 73 acres. It is adjoined on the east by clay and sand of the Trinity Formation and on the north and west and much of the south by alluvium. Outcrops of what is probably Carboniferous sandstone occur on the south, southwest, and east side of the mine. It is massive, very hard, and gray to greenish gray to brown.

Almost all of the peridotite exposed at the surface is weathered to soft earth or at least very soft rock and shows many shades of green, blue, and yellow. The surface soil is a gumbo tinted black by organic matter.

The rocks at the Crater may be divided into three catagories:

1. **Hardebank**: This is a hard, dense intrusive peridotite. It is greenish to brownish black. A good exposure may be seen on top of the small hump in the "search"area immediately to the northwest of the old mine shaft building. Only a few small diamonds have come from it.

The intrusive peridotite is composed mainly of phlogopite mica, olivine, serpentine resulting from weathering of the olivine, and small amounts of augite, perovskite, and magnetite. Except for texture, the next rock type described, breccia, is similar to the hardebank. This indicates that the intrusive peridotite is the hypabyssal equivalent of the breccia.

2. **Peridotite Breccia (Kimberlite)**. Most of the mine presently cleared is pyroclastic breccia; in particular, the east-central part of the south half of the "search" area. Most of the diamonds come from this area. It contains fragments of shale and sandstone that have been carried upward hundreds or even thousands of feet from their source. The breccia ranges from fairly hard rock to material that has completely disintegrated into clay and ranges from yellow to gray and green and blue in color.

3. **Tuff** and **Fine-Grained Breccias**: Canary Hill is in the southwest corner of the grayish-blue rock. It is composed mainly of secondary chlorite. A few diamonds have been found in it.

131.4 (cont.) **THE DIAMONDS**

The diamonds found here are, of coarse, pure crystalline carbon. They are distinguished by their hardness, high specific gravity, but most especially by their adamantine-greasy-metallic luster. A very peculiar character of the diamonds is their well rounded, highly polished surface. They look as though they have been polished in a rock tumbler.

Surprisingly, Crater diamonds are 20% harder than African diamonds and this, combined with their irregular crystal shape, makes them quite difficult to cut.

99% of the diamonds found at the Crater are various shades of brown, yellow, and white. A very few black, green, and even pink stones have been found. The average stone found is about one-half carat but gem quality diamonds of up to 40 carats have been found.

GEMS OTHER THAN DIAMONDS

Abundate agate, jasper, and amethyst and a few garnets and peridots are also found at the mine.

The following discussion on the origin of the diamond pipes and diamonds is by Mike Howard of the Arkansas Geological Commission.

ORIGIN OF DIAMOND PIPES AND DIAMONDS

Ever since the first diamonds were discovered and the art of cutting the stones began, men of science have attempted to explain their occurrence and origin. Early theories have fallen into disfavor in recent years as a result of information developed in the manufacture of synthetic diamonds and studies of natural stones.

Laboratory studies in growing diamonds indicate that they form only at temperatures above 1850°C and pressures above 66 kilobars. In order to shed further light on their origins, mineralogists recently began studying mineral grains contained in naturally occurring diamonds. These inclusions indicate the pressure, temperature, and chemical conditions at the time of the diamond formation. From a study of the inclusions diamonds appear to crystallize from molten rock chemically like that of peridotite or eclogite at upper mantle depths in the region of 93 to 125 miles (150 to 200 kilometers) and not in the kimberlite in which they are found.

The study of the rock type, kimberlite, that contains the stones gives the geologist a look deep into the earth that perhaps no other rock type allows. Kimberlite itself is a composite rock made of many finely ground angular fragments of highly altered magnesium-rich rock. The rock was apparently explosively intruded from some 93 to 125 miles (150 to 200 kilometers) depth by a carbon dioxide gas drive mechanism. Some geologists even

MILEAGE	DESCRIPTION
131.4 (cont.)	think this happened at supersonic speeds in a matter of a few seconds. This accounts for the fantastic assortment of xenoliths (carried along fragments) of numerous other rock types from the upper mantle and lower crust. Furthermore, diamonds are metastable crystals at surface pressures and temperatures and eventually revert to a less dense form of carbon, i. e. graphite. If the stones were transported slowly to the surface, this transformation would already have taken place.
	Interestingly enough, in reviewing many diamond pipes throughout the world, J. B. Dawson (1960) discovered that perhaps 90 percent of these pipes, including the Crater of Diamonds, were emplaced in Late Cretaceous time (about 90-100 million years ago). Geologists have yet to understand the conditions causing the sudden mobility of the upper mantle at this particular time in geologic history.

END OF SECOND DAY ROAD LOG

EXPLANATION

Symbol	Rock Units
IPa	Atoka Formation
IPbh	Bloyd Formation and Prairie Grove Member of Hale Formation
IPhc	Cane Hill Member of Hale Formation
Mpfb	Pitkin Limestone, Fayetteville Shale, and Batesville Sandstone with Hindsville Limestone Member
Mb	Boone Formation with Short Creek Oolite Member and St. Joe Limestone Member
MDcp	Chattanooga Shale with Sylamore Sandstone Member, Clifty Limestone, and Penters Chert
Slsb	Lafferty, St. Clair, and Brassfield Limestones
Ocj	Cason Shale, Fernvale Limestone, Kimmswick and Plattin Limestones, Joachim Dolomite
Ose	St. Peter Sandstone and Everton Formation
Op	Powell Dolomite
Ocjc	Cotter and Jefferson City Dolomites
Org	Roubidoux Formation and Gasconade Formation with Gunter Member
€el	Eminence and Potosi Dolomites, Derby-Doerun-Davis Formations, Bonneterre Dolomite, and Lamotte Sandstone
P-€	Pre-Cambrian

CROSS SECTION ALONG ROUTE OF FIRST DAY ROAD LOG

prepared for

TULSA GEOLOGICAL SOCIETY FIELD TRIP

by

Boyd R. Haley* and William V. Bush

Arkansas Geological Commission

1977

Scale

1 inch = approximately 4 miles

Vertical exaggeration 10:1

*U.S. Geological Survey

EXPLANATION

Symbol	Rock Units
Ki	Igneous
Kt	Trinity Group
IPau	Upper part of Atoka Formation
IPam	Middle part of Atoka Formation
IPal	Lower part of Atoka Formation
IPjv	Johns Valley Shale
IPj	Jackfork Sandstone
Ms	Stanley Shale
MDa	Arkansas Novaculite
Smb	Missouri Mountain Shale and Blaylock Sandstone
Opb	Polk Creek Shale and Bigfork Chert
Ow	Womble Shale
Ob	Blakely Sandstone
Om	Mazarn Shale
Ocm	Crystal Mountain Sandstone
Oc	Collier Shale

CROSS SECTION ALONG ROUTE OF SECOND DAY ROAD LOG

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by

Boyd R. Haley*, Charles G. Stone, and William V. Bush

Arkansas Geological Commission

1977

Scale

1 inch = approximately 4 miles

No vertical exaggeration

*U.S. Geological Survey