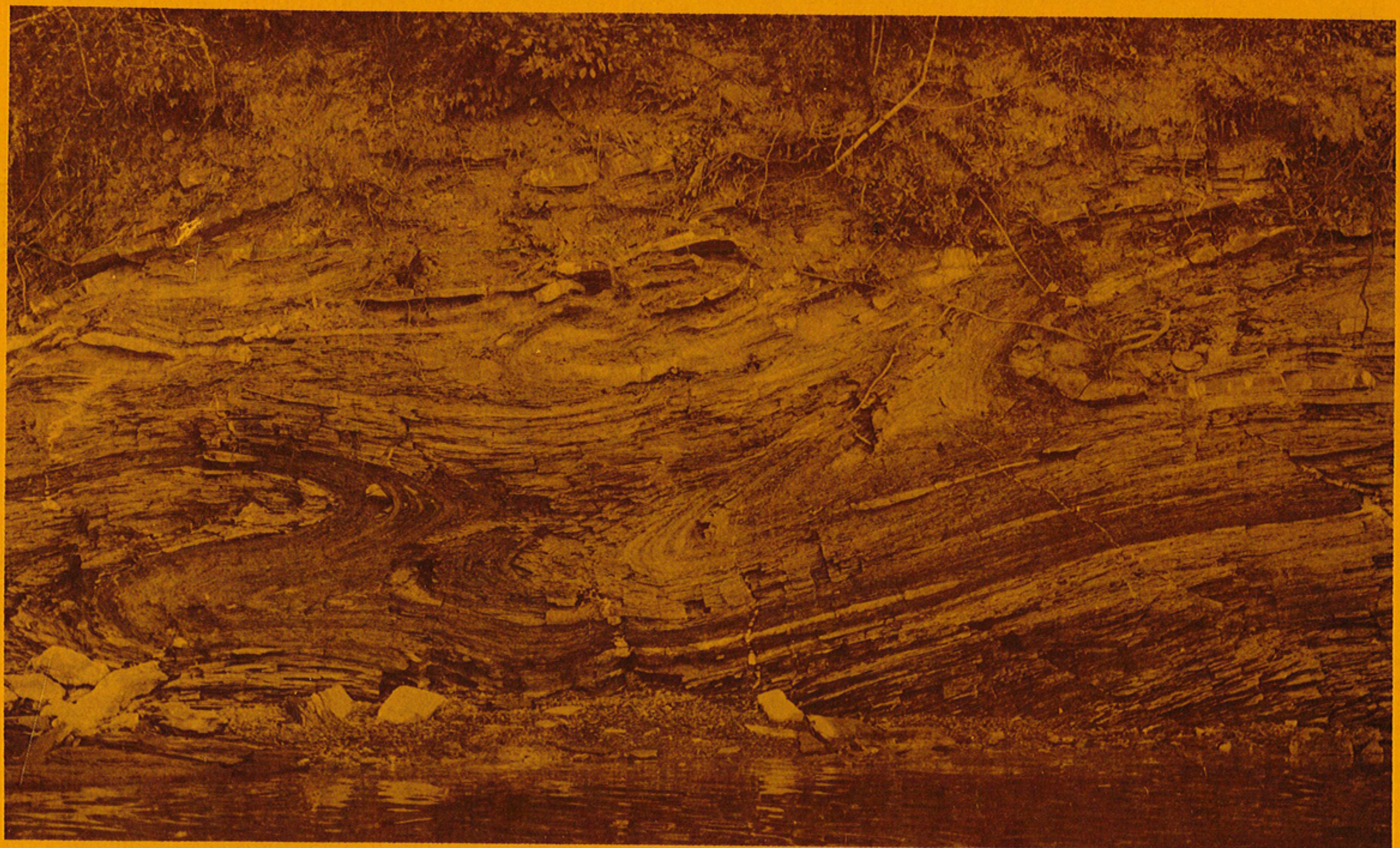
STATE OF ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION

Norman F. Williams, Director

A GUIDEBOOK TO THE SECOND GEOLOGICAL EXCURSION ON LAKE OUACHITA

by
Boyd R. Haley, Charles G. Stone, and John D. McFarland, III



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STATE OF ARKANSAS
Bill Clinton, Governor

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Arkansas Geological Commission
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PREFACE

This guidebook has been organized to present geologic knowledge about some of the very complex geology around Lake Ouachita. Lithologic, sedimentary, and structural features in all of the formations of the core area of the Ouachita Mountains will be examined. The various Stops, Photo Tours, Localities and other geological descriptions are presented in a continuous fashion as one proceeds along in a boat on the geofloat excursion.

The map presented in this guidebook was made by C. G. Stone and Boyd R. Haley as they were mapping the Ouachita Mountains for the new Geologic Map of Arkansas. G. W. Viele (University of Missouri) has augmented the map by providing fold data. Most of the photographs are by John D. McFarland, III.

H. D. Miser and A. H. Purdue and, to a lesser extent, L. S. Griswold, were giants in the early mapping of the Ouachita Mountains of Arkansas and established the basic lithologic and stratigraphic nomenclature. Although their original structural interpretations have been altered through the years, these modifications are not a reflection upon their abilities but represent: (1) a change in thinking from folding to both folding and faulting; (2) a better understanding of structural problems made possible by better base maps and aerial photographs; (3) more knowledgeable ways of measuring and interpreting very small structural features; and (4) to a significant degree the continued enthusiasm and persistence until his death, of Hugh D. Miser in attempting to unravel the complex Ouachita problems.

The stratigraphic nomenclature and age cited in this guidebook does not necessarily conform to that of the U. S. Geological Survey.

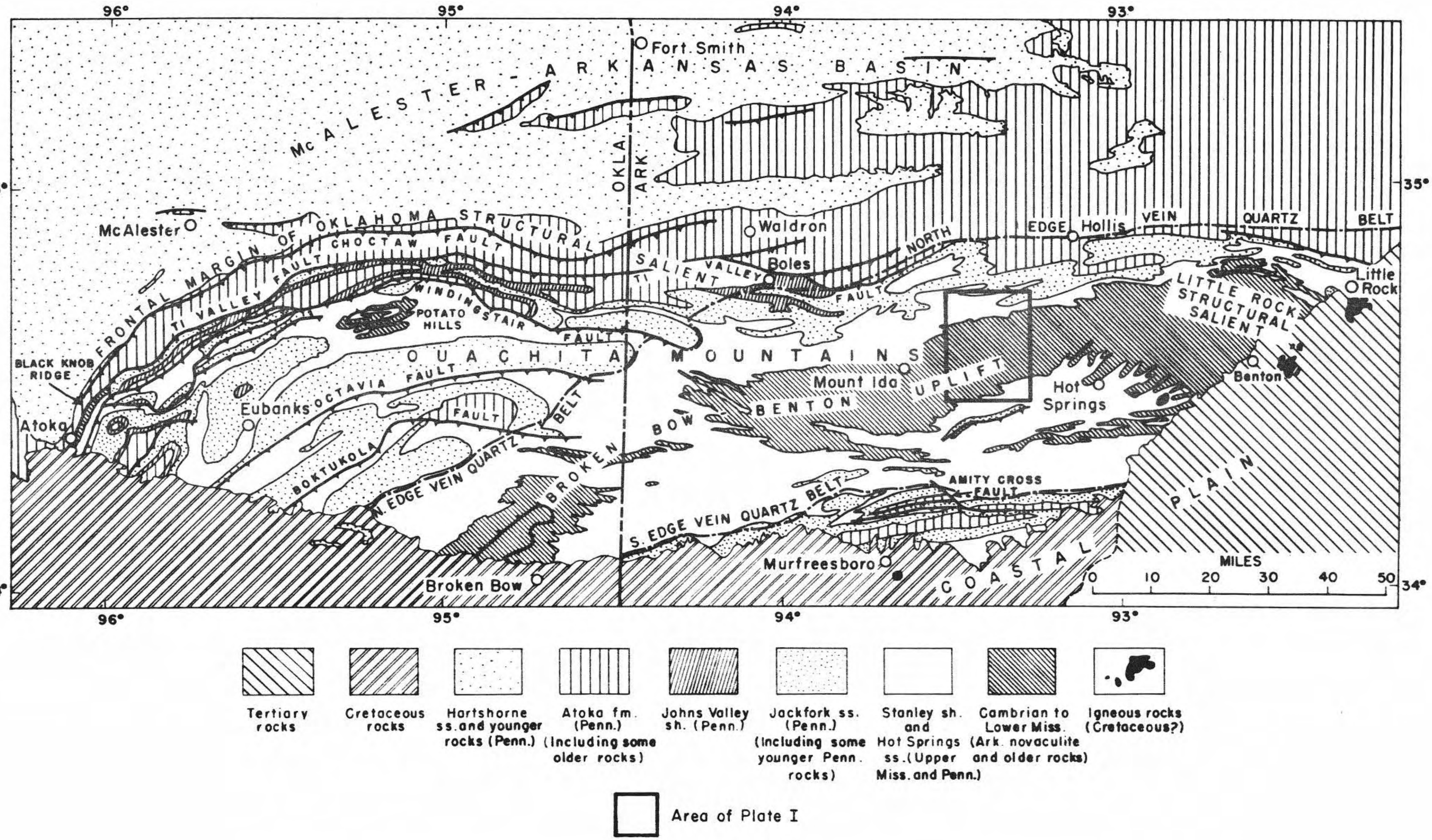

Figure 1. -- Generalized geologic map of Ouachita Mountains. (Modified from Miser, 1959, Fig. 3)

CORRELATION OF THE PALEOZOIC ROCKS IN THE OUACHITA MOUNTAIN, ARKANSAS VALLEY AND OZARK REGIONS, ARKANSAS

System	Series	AGE	OZARK – ARKANSAS VALLEY SECTION	MAP SYM.	OUACHITA MTN. SECTION	MAP SYM.
CARBONIFEROUS SYSTEM	PENNSYLVANIAN	DES MOINES	Boggy Fm.	IPby	Missing	
			Savanna Fm.	IPsv		
			Mc Alester Fm.	IPma		
			Hartshorne Sandstone	IPhs		
		ATOKA	Atoka Fm.	IPa	Atoka Fm.	IPa
		MORROW	Bloyd Shale: Kessler Ls. Mbr.	IPbh; IPbk	Johns Valley Shale	IPjv
			Bloyd Shale: Woolsey Mbr.	IPbh; IPbw		
			Bloyd Shale: Brentwood Ls. Mbr.	IPbh; IPbb		
			Hale Fm.: Prairie Grove Mbr.	IPbh; IPhp	Jackfork Fm.	IPj
			Hale Fm.: Cane Hill Mbr.	IPhc		
	MISSISSIPPIAN	UPPER	Pitkin Limestone	Mpfb; Mp	Stanley Shale: 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	
			Short Creek Oolite Mbr.	Mb	Hot Springs SS Mbr.	
		LOWER	Boone Fm.		Arkansas Novaculite: Upper Div.	MDa
			St. Joe Ls. Mbr.			
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	Sm Opc; Smb
			Lafferty Limestone	Slsb	Blaylock Sandstone	
			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		Basal Collier and 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

EXPOSED NEAR LAKE OUACHITA

Unit	Maximum Thickness (feet)
Pennsylvanian System	
Atokan Series	
Atoka Formation - shale, siltstone, and sandstone	27,500+
Morrowan Series	
Johns Valley Shale - shale, minor sandstone and limestone, and erratic boulders	1,500
Jackfork Sandstone - sandstone, siltstone, 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
Ordovician System	
Polk Creek Shale - shale	175
Bigfork Chert - chert, limestone, and shale	800
Womble Shale - shale with some limestone and sandstone	3,500
Blakely Sandstone - shale and sandstone	450
Mazarn Shale - shale with some sandstone, limestone, and siltstone	3,000
Crystal Mountain Sandstone - sandstone, siltstone, and shale	850
Collier Shale - shale and limestone	1,000

SECOND GEOLOGICAL FIELD TRIP EXCURSION ON LAKE OUACHITA

by

Boyd R. Haley[1], Charles G. Stone[2], and John D. McFarland, III[2]

Via Crystal Springs - Brady Mountain - Buckville - Avant - Iron Fork - Big Fir - and Mountain Harbor Landings

SUMMARY

Lake Ouachita is located in the core area of the Ouachita Mountains, with a very small portion of its northern part in the frontal belt. When the lake is periodically lowered a few feet, an almost continuous exposure of the rocks is present. Recumbent and overturned folds, high and low-angle thrust faults, two or possibly three generations of folding, erratic-bearing conglomeratic limestone and sandstone, and other geologic features are well displayed. A hypothesis can be formulated that complex nappe structures and associated windows and klippens are present in the core area of the Ouachita Mountains.

The stops and localities listed in this guidebook are arranged in numerical and alphabetical order as though the lake trip starts and terminates at the Joplin Recreation Area. On this trip we will start from and return to the Crystal Springs Landing.

BEGINNING OF TRIP

Proceed northward from Crystal Springs Landing on Lake Ouachita. Sandstone and shale of the Blakely Sandstone and banded shale and fine grained limestone of the Mazarn Shale are exposed along the west bank. The Crystal Mountain Sandstone is present at the surface in the large southward overturned anticline in the gap between Hickorynut and Bear Mountains, but is poorly exposed.

Continue northward to Point 7 (See page 7) and follow the trip as described in this guidebook.

STOP 3 - 1 MAZARN SHALE AND BLAKELY SANDSTONE

This is a complexly folded and faulted sequence of banded gray-black shale and silty, bluish-gray limestone of the Mazarn Shale and some interbedded gray shale and thin-bedded, fine to grained, quartzitic, sometimes calcareous sandstone of the Blakely Sandstone (Figure 3). The fold hinges or cylinders generally trend north-northeast. Milky quartz veins with some calcite are present in the more intensely deformed areas. The bottom marks present on some sandstone beds indicate that most of the section is overturned to the north. Along the northeastern margins of the Lake some of the thick sandstones in the Blakely contain erratics of granite, meta-arkose, sandstone , chert, and limestone, but erratics have not been noted in the Blakely in the vicinity of this

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Figure 3. -- **Stop 3-1.** Thin bedded sandstone and shale of the Blakely Sandstone overturned to the north. Bottom marks and trace fossils (burrows and trails) are present on some of the beds.

stop. It is suggested that most of the Blakely at this site represents thickening upward lobe sequences in a middle submarine-fan depositional environment and was transported by bottom and turbidity currents from sources to the north or northeast.

Proceed southwestward around the point.

Locality A. Quartz veins mark a large thrust fault separating Mazarn shale and siltstone on the north from Collier shale and limestone on the south.

Turn to the east along the shoreline.

Along the south bank are outcrops of fairly massive, often oolitic or pelletoidal, gray, conglomeratic, sandy limestone; thin bedded dense limestone; "talcose" shale; and black chert of the Collier Shale. Numerous milky quartz-calcite veins are present.

STOP 3 - 2. LIMESTONE IN THE COLLIER SHALE

Fairly massive, often oolitic, pelletoidal, conglomeratic, sandy, bluish-gray limestone of the Collier Shale is exposed at this stop. The clasts in the conglomerate are dominated by limestone but include chert, phyllite, feldspar and other lithologic types (Figure 4). Also there are layers of bluish-gray, fine-grained limestone, black chert and "talcose" shale. Milky quartz-calcite veinlets fill fractures in the rock. The folds are very tight (Figure 5) and some intervals have

Figure 4. — Stop 3 – 2. Clasts of limestone (some pelletoidal and/or oolitic), chert, and sandstone in conglomeratic limestone of the upper Collier Shale. This conglomerate likely represents a submarine landslide deposit from shelf facies to the north of the Ouachita trough. Quartz-calcite veinlets of hydrothermal origin fill the fractures.

Figure 5. — Stop 3 – 2. Very tight folds in thin units of shale and calcareous siltstone of the uppermost Collier Shale.

pervasive axial plane cleavage. It is our opinion that these conglomeratic limestones represent slumps and debris flows derived from shelf areas and submarine scarps along the north flank of the Ouachita trough. Conodonts have recently been studied from similar limestones in the region by John Repetski and Ray Ethington and indicate an early Ordovician age for the Collier Shale.

Proceed eastward on the trip.

At Point 14 is the contact between weathered, brownish-red, silty limestone and "talcose" shale of the Collier Shale (north) and the calcareous quartzitic sandstone and shale of the Crystal Mountain Sandstone (south).

PHOTO TOUR 3 - A. FOLDS IN CRYSTAL MOUNTAIN SANDSTONE

Exposed at this stop are large recumbent isoclinal folds with nearly flat-lying cleavage and minor associated faults in massive, medium-grained, calcareous, conglomeratic (shale, chert, and limestone clasts) sandstone; bluish-gray, flaggy, sandy or silty limestone; laminated siltstone; and shale of the Crystal Mountain Sandstone (Figures 6, 7, and 8). The sandstone is thought to be in thinning upward sequences that were deposited in the channels of a middle submarine-fan environment. The source of these sediments was probably from shelf deposits to the north or northeast. The sandstone dike which dissects the siltstone and shale was injected after the start of deformation and prior to solidification of the sediments (Figure 9). Small milky quartz-calcite veins fill fractures in the rock.

Proceed eastward on your journey from Point 11. In this area a large fault separates the Collier Shale on the south from the Womble Shale on the north.

Continue the trip eastward by Points 10 and 9. Womble Shale underlies the small islands in this area. The channel to the south leads to **Crystal Springs Landing.**

Continue the trip eastward by Points 7 and 6. Northward dipping cleavage is present in the highly folded Womble Shale in this area.

Sandstone, quartz, and novaculite cobbles and pebbles are in the Ouachita River terrace deposits overlying Womble Shale at Point 5. Proceed on your trip east-southeastward.

Locality B. Along the south bank is the contact between the siltstone and shale of the Womble and the thin sandstone and shale of the Blakely. The east-west ridge to the south is underlain by tightly folded, thin to massive, usually quartzitic, fine-to medium-grained sandstone and banded siltstone and shale of the Blakely. The prevailing dip of the strata is about 20^{o}-30^{o} to the north.

STOP 3 - 3. MAZARN SHALE

Exposures of calcareous, gray siltstone; laminated fine-grained siltstone; thin bedded, fine-grained, blue-gray, limestone; and banded shale in the upper part of the Mazarn Shale (Figure 10) may be examined at this stop. A study of the fold trends suggests a southward direction of folding and overturning of the rocks. Trace fossils (trails and burrows) are numerous in many of the rocks and accompanied with other data suggest a deep-water origin. Small sandstone dikes, recumbent isoclinal folds, and several low-angle faults are present. The vegetation types on the ridge show the change from cedars on the Mazarn to pines on the Blakely.

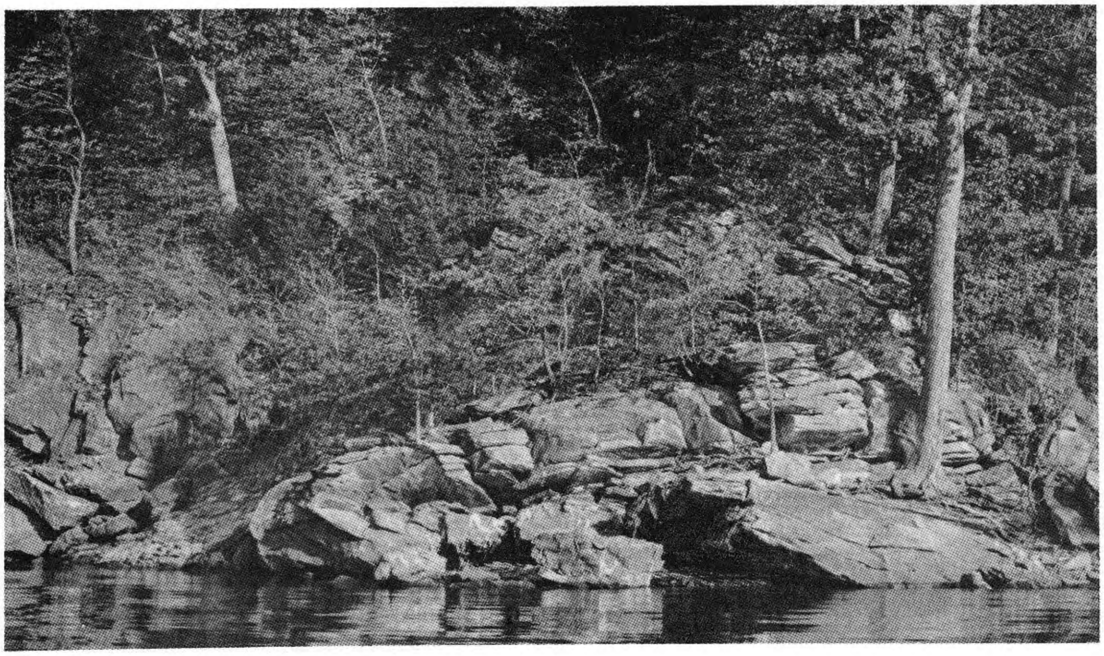

Figure 6. — Photo Tour 3 – A. Recumbent isoclinal folds in calcareous sandstone of the Crystal Mountain Sandstone.

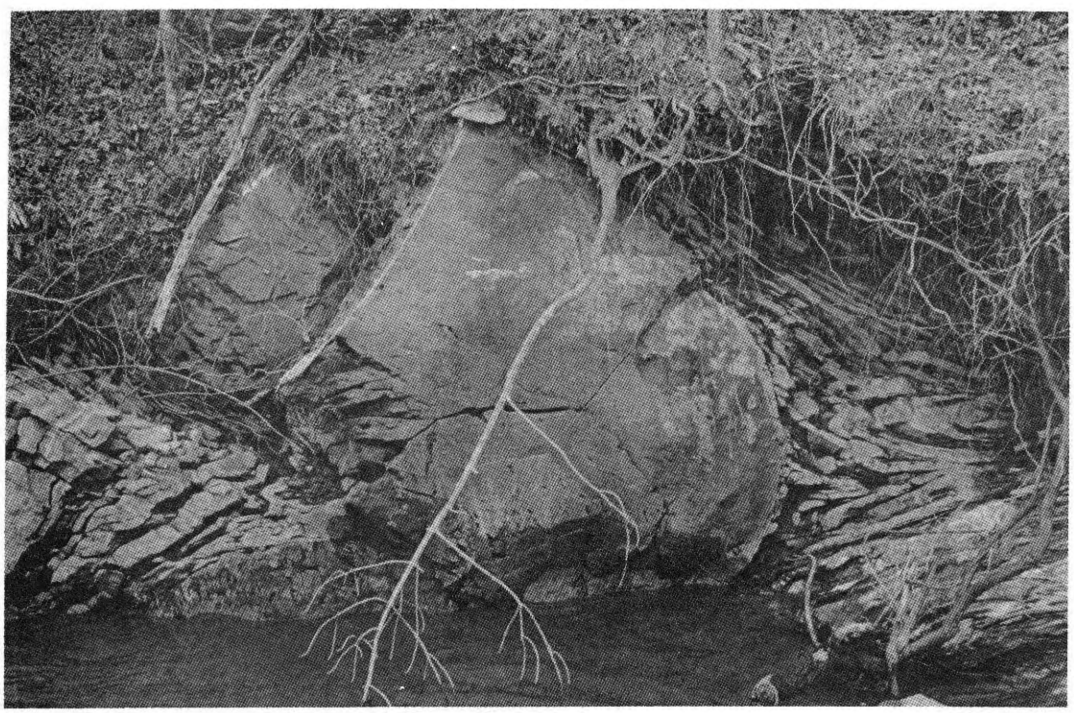

Figure 7. — Photo Tour 3 – A. Crystal Mountain Sandstone. Closeup of recumbent isoclinal fold in the sandstone, distortion of siltstone and shale in the fold hinge, and refraction of cleavage into the sandstone.

Figure 8. – Photo Tour 3 – A. Crystal Mountain Sandstone. Closeup (to the left of folded sandstone in Figure 7) of shale and siltstone with cross-cutting cleavage.

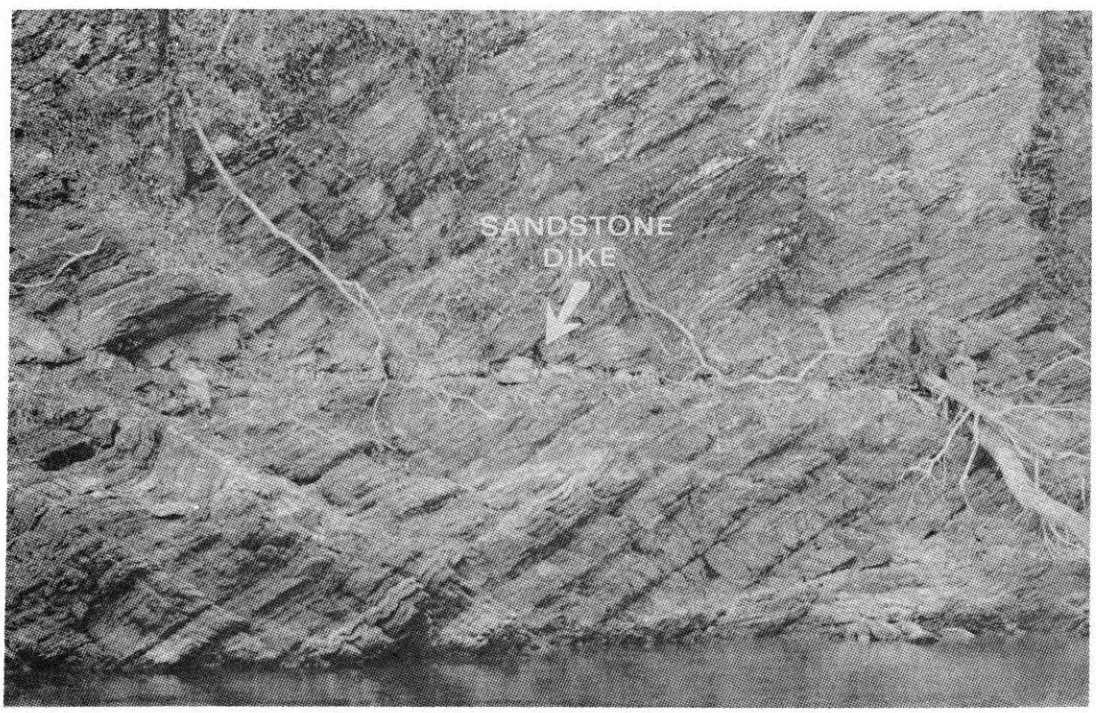

Figure 9. – Photo Tour 3 – A. A sandstone dike in siltstone and shale of the Crystal Mountain Sandstone. The dike was injected during deformation.

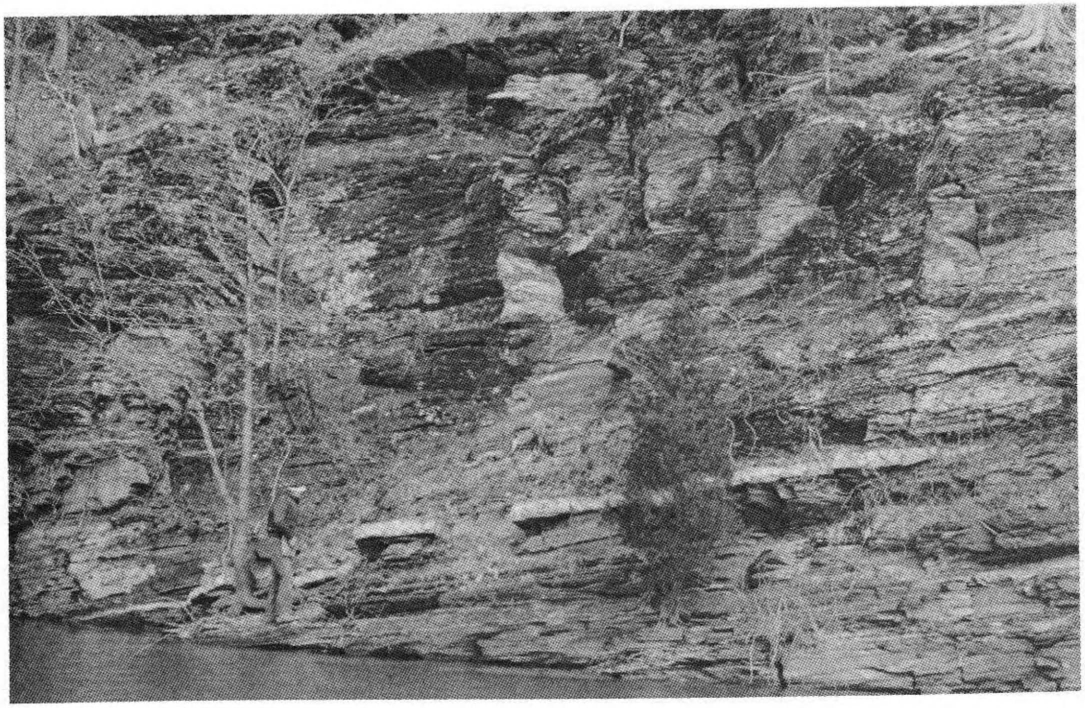

Figure 10. — Stop 3 — 3. Shale and thin-bedded sandstone of the upper Mazarn Shale. Trace fossils (trails and burrows) and other features indicative of deep-water deposition are present in the sequence.

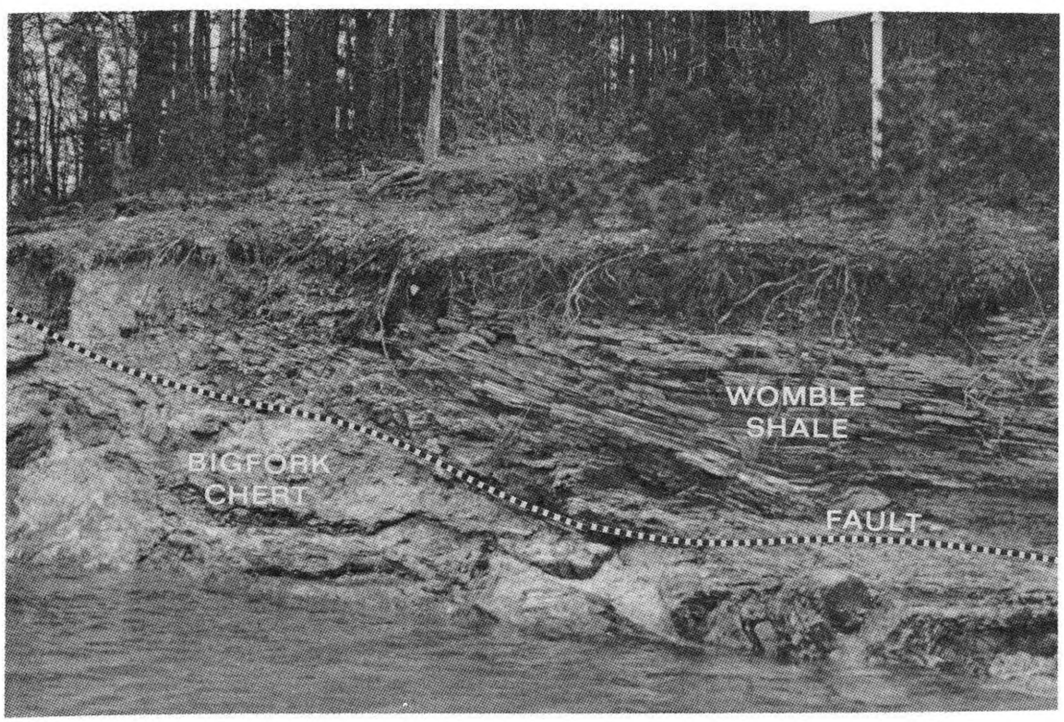

Figure 11. — Stop 3 — 4. Womble Shale thrusted over Bigfork Chert with milky quartz veins and gouge present along the fault contact.

Locality C. Blakely Sandstone on the ridge to east is in fault contact with the Womble Shale.

STOP 3 - 4. FAULT IN WOMBLE SHALE AND BIGFORK CHERT

A low angle fault has thrust calcareous siltstone and shale of the upper Womble over gray chert and tripolitic (decalcified) silty chert of the Bigfork Chert (Figure 11). Several episodes of deformation are present in the sequence. Milky quartz veins are present in the highly sheared intervals of the fault zone.

Continue north-northwest from Point 3.

Contact of Womble Shale and Bigfork Chert west of Point 41.

Continue northwest along west side of island.

PHOTO TOUR 3 - B. FOLDS IN BIGFORK CHERT

Intensely folded chert and decalcified silty chert of the Bigfork Chert are in fault contact with underlying Womble Shale (Figure 12). Small caves develop in the calcareous chert due to the pounding waves of the Lake. There are numerous overturned and recumbent chevron folds with east-west trending hinges or cylinders and pervasive flat-lying cleavage (Figures 13, 14, and 15). The Bigfork is thought to represent deep-water deposits of siliceous and limy ooze with minor amounts of silty clastics. The contact between the Bigfork and Womble is exposed near Point 40.

Proceed west past poorly exposed Womble Shale.

Point 36 is immediately to the north. Gravel of the Ouachita River terrace deposit caps weathered brown calcareous siltstone and gray shale of the Womble Shale.

Continue west beyond Points 34 and 33 (to the north) which are underlain by the Womble Shale.

Locality D. Brown, calcareous siltstones; flaggy, dense, gray limestones; and gray shales of the Womble are exposed to the north.

Point 28 is to the south. To the north are exposures of Womble shale, siltstone and limestone with milky quartz veins. Proceed north-northwest along east side of the Lake.

Locality E. Womble shales, siltstones and limestones with several fold systems and some milky quartz veins are exposed to the east (Point 27 is to the west).

Locality F. Large quantities of milky quartz rubble cover the Womble Shale in a large thrust fault zone to the east. Proceed north-northwest.

Point 25 to the east. There are numerous small exposures of Womble shale, calcareous siltstone, and dissecting milky quartz veins in this area.

Avant Landing to the east is in Womble Shale. In this area of the flooded North Fork

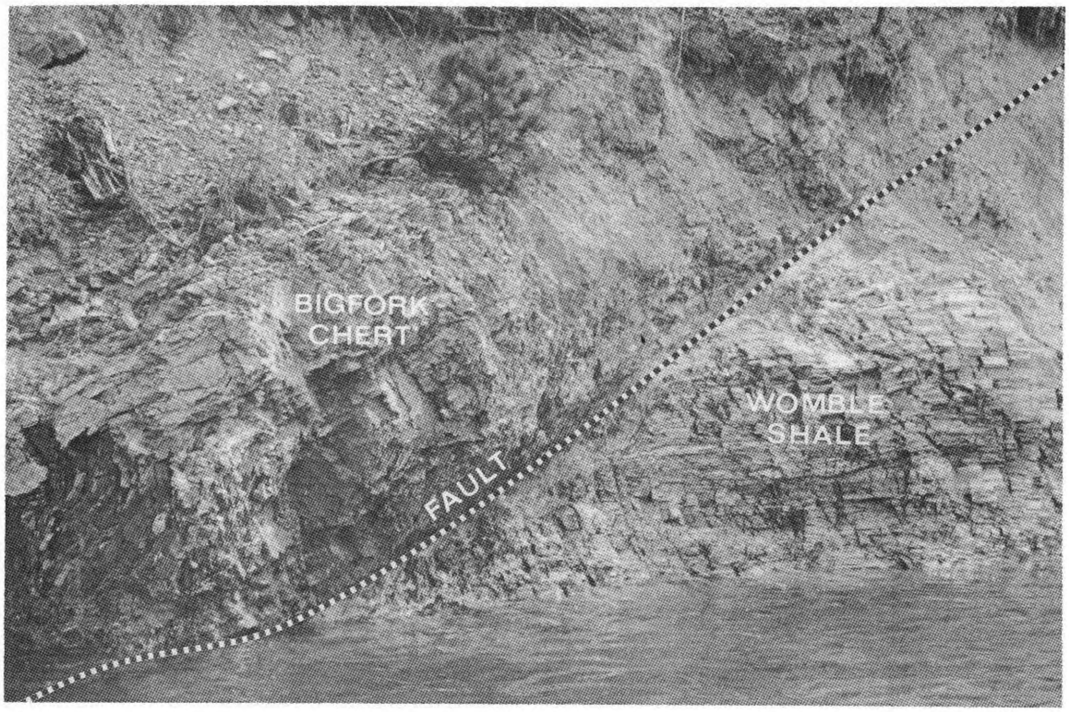

Figure 12. -- Photo Tour 3 – B. Bigfork Chert (left) in fault contact with Womble Shale (right). A thin gouge is present in the fault zone.

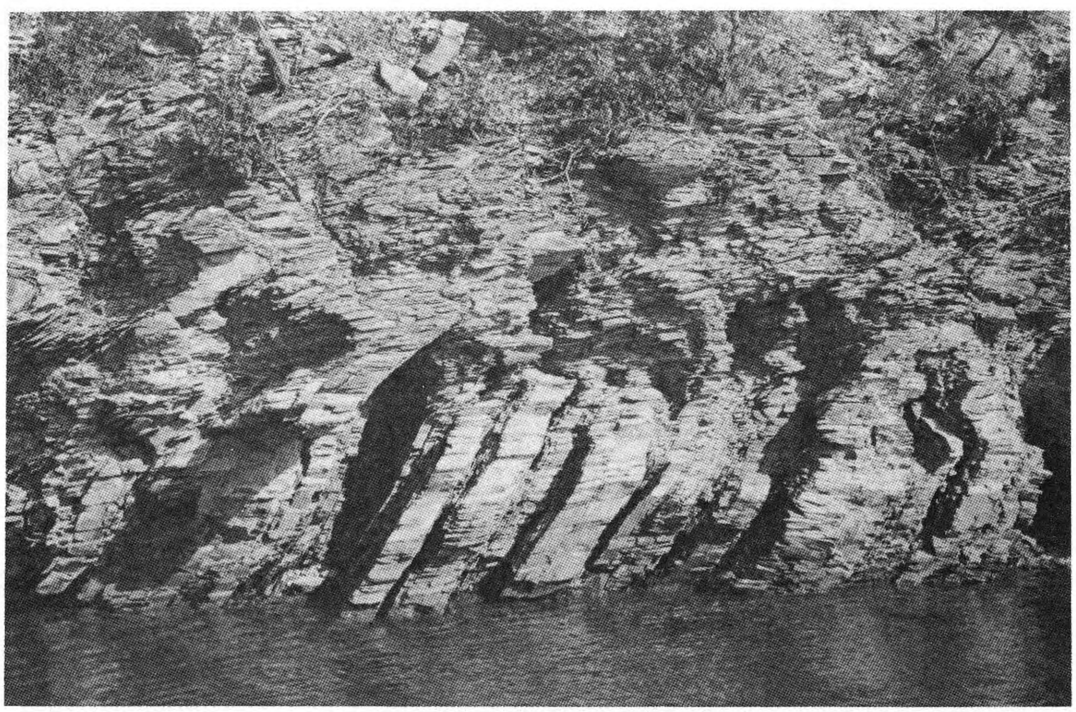

Figure 13. – Photo Tour 3 – B. Tight overturned and recumbent folds in chert, calcareous silty chert, and siliceous shale of the Bigfork Chert. Note the pervasive horizontal axial plane cleavage and the small crenulations that nearly obliterate the folds.

Figure 14. — Photo Tour 3 — B. Closeup of very tight folding in thin alternating chert (dark) and calcareous silty chert (light) of the Bigfork Chert.

Figure 15. — Photo Tour 3 — B. Closeup of complex folding and pervasive cleavage in calcareous silty chert of the Bigfork Chert.

of the Ouachita River, the folds are inclined; axial surfaces dip northward; and most hinge lines are nearly horizontal. The dominant direction of folding and overturning of the rocks is southward.

Proceed north-northwest across the Lake to exposures of calcareous siltstone, shale and milky quartz of the Womble Shale and turn northward along the shoreline.

STOP 3 - 5. WOMBLE SHALE – FAULT – MAZARN SHALE

This is an opportunity to examine the calcareous siltstones and shales of the Womble; quartz veins in the intensely fractured fault zone; and the banded shales, laminated siltstones, and thin bedded, fine-grained, bluish-gray limestones of the Mazarn. There are at least three fold systems present in these deformed rocks. Cleavage, flowage into the hinges of folds, boudinage, mullions, and other structural features are present. The cedar trees once again favor the Mazarn for their habitat.

Proceed north along the west shoreline.

Locality G. Additional exposures of Mazarn shale, siltstone and limestone.

Proceed to the east bank of the Lake towards point 24 which is underlain by Mazarn Shale. Cobbles are derived from a very high Ouachita River terrace deposit which caps the hill to the east.

Locality H. Continue northward along the east bank. Banded shale with abundant folds and with well-developed cleavage are present in the Mazarn Shale.

Locality I. A thrust fault marked by milky quartz veins and quartz rubble separates the Mazarn Shale to the south from Womble Shale to the north.

Proceed northwest across the Lake.

Locality J. Poorly exposed, tightly folded, tripolitic, calcareous chert and siliceous shale of the Bigfork Chert.

Continue northeast across inlet.

STOP 3 - 6. MISSOURI MOUNTAIN SHALE AND ARKANSAS NOVACULITE IN THE NORTHERN MOUNTAINS.

In the central and southern parts of the Ouachita Mountains, the Arkansas Novaculite can be divided into the Lower, Middle, and Upper Divisions. In many parts of the northern Ouachita Mountains the three Divisions cannot be firmly established.

The Missouri Mountain Shale at this stop consists of olive-brown shale with minor thin beds of sandstone and novaculite. The northern facies of the Arkansas Novaculite consists of olive-brown shale and thin beds of light colored novaculite (Figure 16) grading upward to dark colored thin bedded novaculite with some siliceous shale (Figure 17). This unit is overlain by siliceous shale and light colored thin bedded novaculite. Upright and southward overturned folds with east-west trending axes are present in the units throughout most of this syncline.

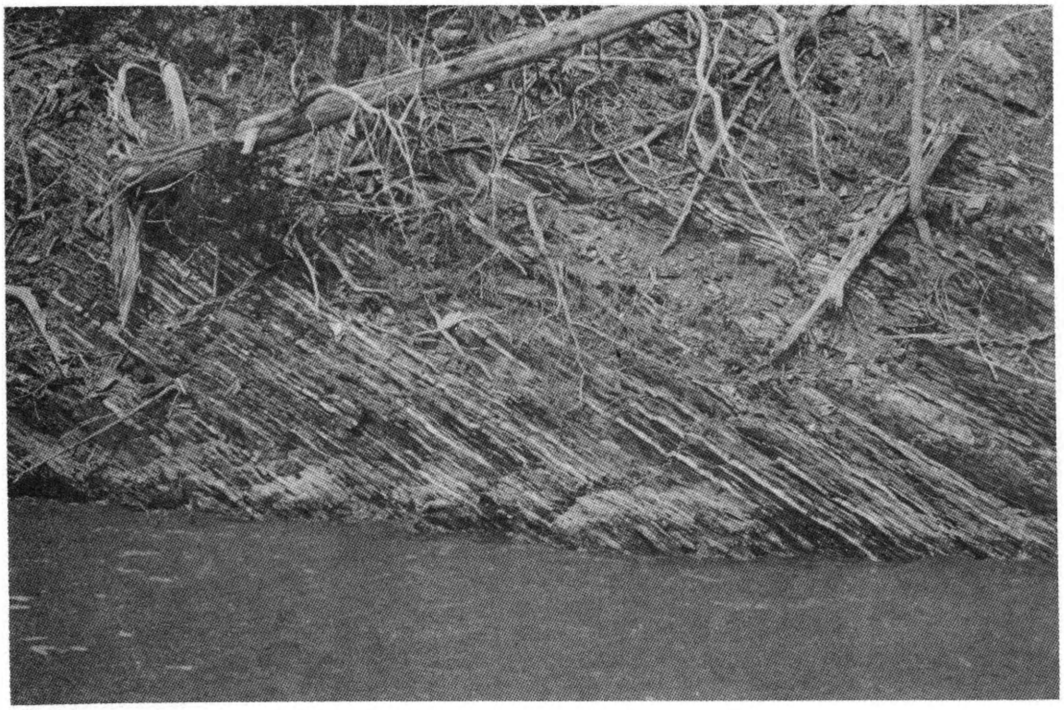

Figure 16. — Stop 3 -- 6. Thin beds of radiolarian-bearing novaculite (white), siliceous shale, and shale of the northern facies of the lower part of the Arkansas Novaculite.

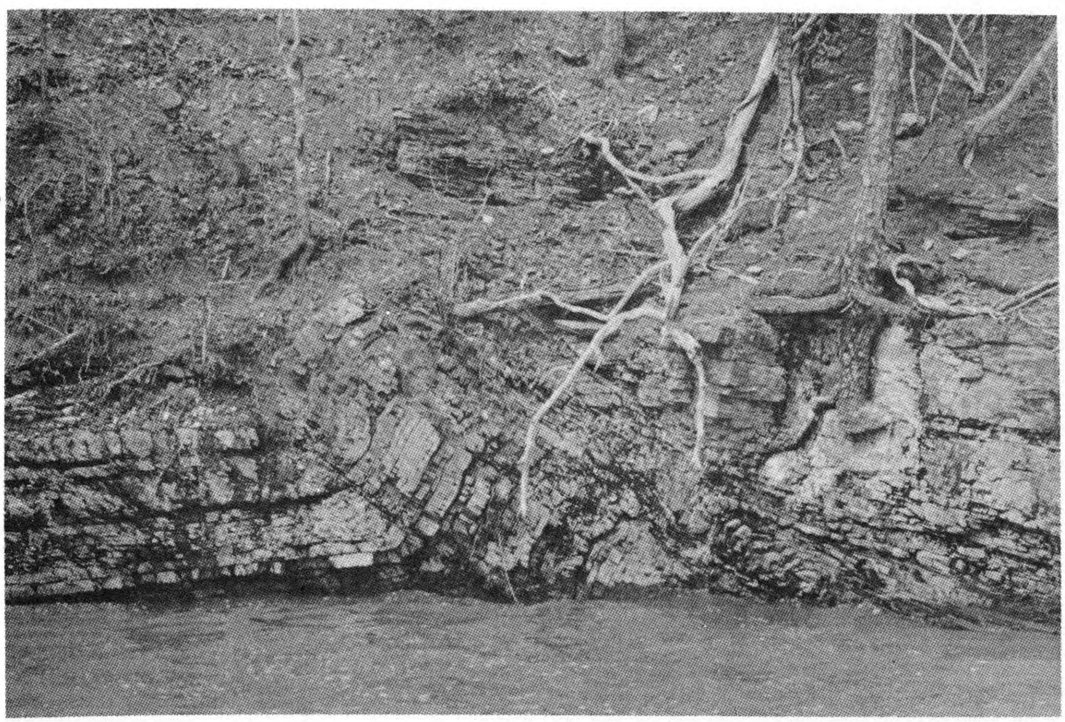

Figure 17. — Stop 3 – 6. Small overturned fold in thin beds of novaculite of the middle part of the Arkansas Novaculite. Some small milky quartz veins fill northward dipping (right) cleavage along the fold hinge.

Proceed east-southeast around bend of the Lake.

PHOTO TOUR 3 - C. ARKANSAS NOVACULITE AND FOLDS

This is the east side of the complex synclinal structure with additional exposures of thin novaculite and shale of the Arkansas Novaculite. The Missouri Mountain Shale is poorly exposed at the south end of Photo Tour 3 - C.

Locality K. A poorly exposed sequence of the Bigfork Chert is present to the east. The Bigfork Chert probably has fewer lithologic changes than other formations throughout the Ouachita Mountains.

A stream terrace containing cobbles covers the Womble Shale where it is in fault contact with the Mazarn Shale.

Continue around point and head northward along the west bank.

Banded shale and thin laminated siltstone of the Mazarn Shale. Small milky quartz veins commonly fill fractures in the shale and siltstone.

Locality L. A major thrust fault separates the dark banded shale of the Mazarn from the grayer shale of the Womble to the north at this locality. The contact of shale and calcareous siltstone of the Womble Shale and the chert and tripolitic chert of the Bigfork Chert is about 50 feet farther to the north. Small overturned folds are present.

Proceed northward to the olive-brown shale in the Missouri Mountain Shale.

Locality M. Thin interbedded shale, novaculite, and conglomerate of the Arkansas Novaculite. The Missouri Mountain Shale crops out a short distance to the north and contains many milky quartz veins.

Locality N. Northward dipping sheared novaculite and shale of the Arkansas Novaculite are exposed.

Continue northward.

Locality O. Exposures are formed by northward dipping, black, silty shale and lenticular beds of graywacke of the Stanley Shale. Bottom marks and load features are present on some beds, and cone-in-cone concretions are present in some intervals. Quartz float marks the trace of a northward dipping thrust fault. The northern variety of "spanish moss" is often found on bushes and trees growing on the Stanley Shale. Return southward along the east side of the Lake.

Turn east up North Fork.

PHOTO TOUR 3 - D. FOLDED ARKANSAS NOVACULITE AND LOWER STANLEY SHALE

Southward overturned chevron folds with northward dipping cleavage in siliceous shale and novaculite of the Arkansas Novaculite and shale and conglomeratic sandstone of the lower

Stanley Shale (Figures 18 and 19). Conglomerates or breccias composed of chert, novaculite, siliceous shale, sandstone and other clasts in a sandy or siliceous matrix occur in the Arkansas Novaculite and the lower Stanley Shale at several localities in the area. These conglomerates or breccias were derived from sources to the north along postulated submarine scarps and likely represent channel fills in an upper submarine-fan depositional environment where deep-water siliceous, often organic, ooze and mud were being deposited. The Dug Hill wavellite (hydrous aluminum phosphate) locality is about 1.5 miles to the east. Studies by Foster and Schaller (1966, Am. Mineralogy Bulletin) have determined that spherulites of wavellite may contain as much as 0.81 percent vanadium, and that the green, black, or yellow color is directly related to the differing valence of the vanadium. Larry Holt (MS thesis, Univ. of Arkansas, 1972) investigated many wavellite and variscite deposits in the Ouachita Mountains of Arkansas and ascribed a secondary supergene ground water origin. Studies still in progress by Charles Milton and Charles Stone indicate that many of the wavellite deposits are associated with Late Paleozoic quartz veins and are, in part, primary and of hydrothermal origin.

Return southwest on Lake Ouachita.

Point 24 is to the east.

Locality P. Reclined folds and shallow, northward dipping cleavage in calcareous siltstone and shale of the Womble Shale are exposed.

Locality Q. Turn to the southwest around peninsula with an exposure of intensely folded shale of the Womble. Point 26 is to the south.

Turn west to Point 19 (former channel of the Ouachita River) then proceed back to the east along the bluff from Point 19.

PHOTO TOUR 3 - E. MAZARN SHALE AND A LARGE LOW-ANGLE FAULT

Locality R. Banded shale with some laminated siltstone and thin bedded, fine-grained, bluish-gray limestone of the Mazarn Shale are exposed. There are several fold trends with well-developed cleavage. Several quartz-calcite veins fill fractures in the sequence.

Locality S. This is a large low-angle thrust fault separating the Womble Shale above from the Mazarn Shale below. Numerous milky quartz veins are present in the fault zone.

Housley Point Recreation Area with exposed Womble Shale.

Proceed south-southwest toward the former channel of the South Fork of the Ouachita River.

Locality T. Milky quartz veins fill fractures within a fault zone in the Womble Shale. Turn west (south of island and Point 18) and proceed through small channel in Womble Shale.

Big Fir Landing is to the north.

Continue west from Point 17.

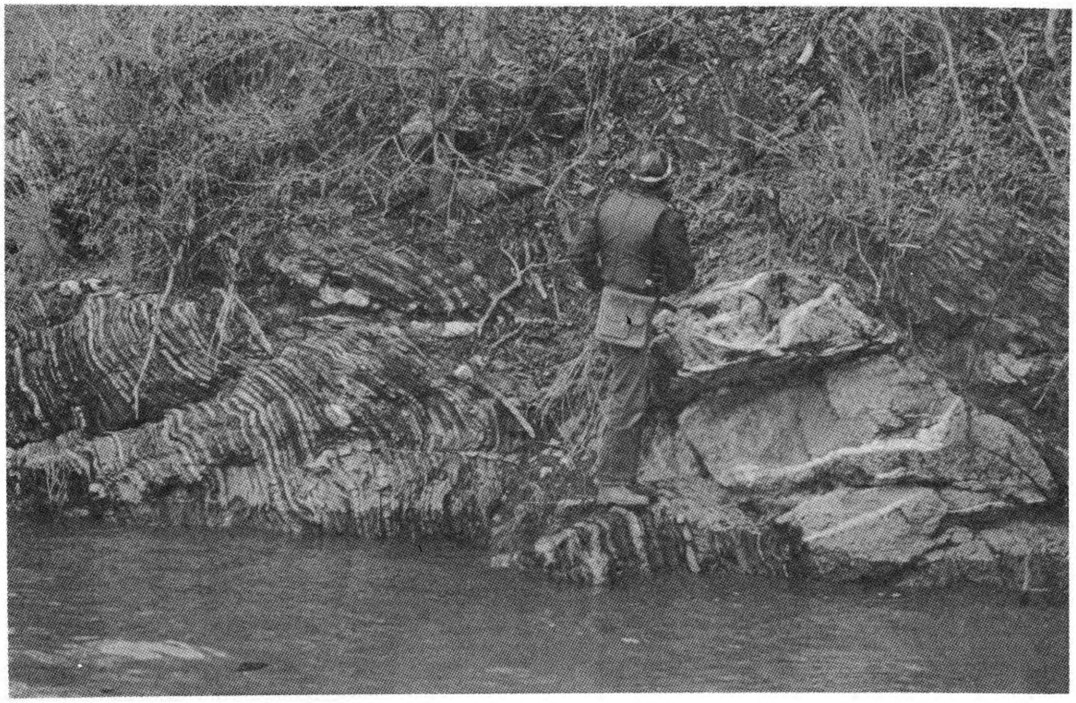

Figure 18. — Photo Tour 3 — D. Thin beds of white novaculite and dark shale in the upper part of the Arkansas Novaculite with an overlying sandstone conglomerate in the lower part of the Stanley Shale. Thick intervals of similar conglomerate occur throughout the northern core area of the Ouachita Mountains of Arkansas. They likely represent submarine-fan channel sequences derived from the continental slope flanking the north side of the Ouachita trough.

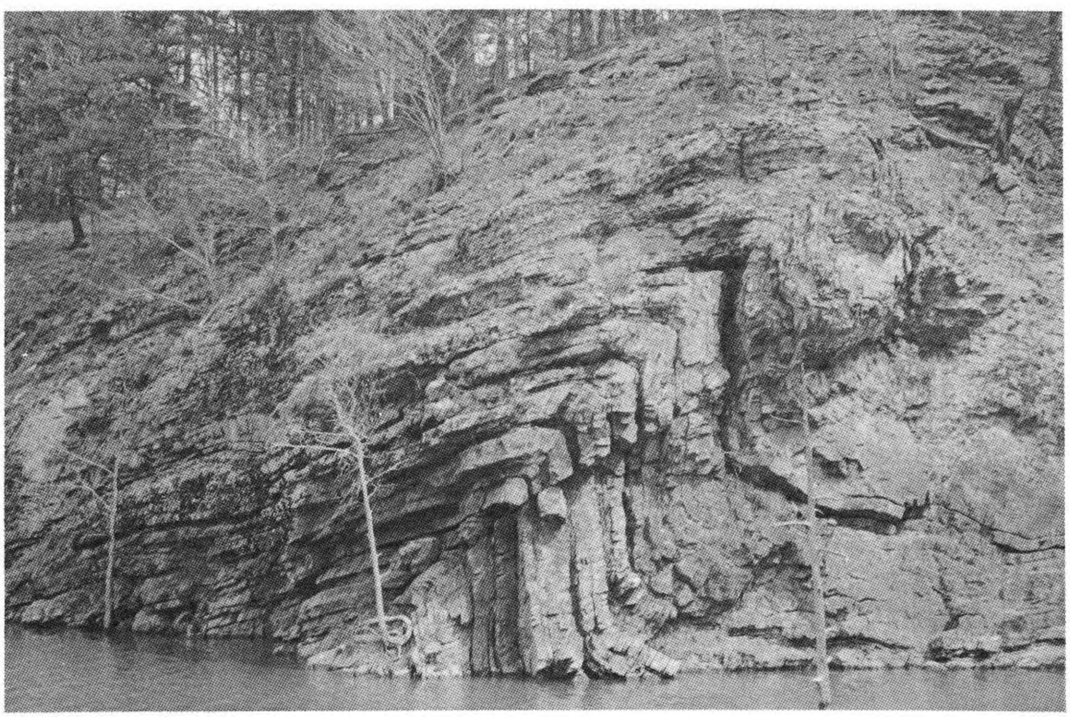

Figure 19. — Photo Tour 3 — D. Chevron folds overturned to the south in thin beds of novaculite of the middle Arkansas Novaculite. Note cleavage refracting around the fold hinges and thrust fault with small displacement.

STOP 3 - 7 AND PHOTO TOUR 3 - F. CONTORTED WOMBLE SHALE AND FAULTS

This large exposure contains intensely deformed gray silty limestone, gray calcareous siltstone, and black to gray shale of the Womble Shale. The three trends of folding suggest three separate periods of deformation with the initial period related to the slumping of the sediments while they were still soft. Also, a large northward dipping fault zone with abundant milky quartz and calcite veins and veinlets occurs in the exposure (Figures 20, 21, and 22). In this area George W. Viele found evidence for both northward and southward folding. Return eastward for further examination and picture taking to Point 17, then southward for more complexly deformed Womble exposures (Figure 23).

Proceed southwest.

Locality U. This bluff of intensely deformed gray, silty limestone and calcareous siltstone of the Womble contains solution pits (above) and light colored travertine or dripstone (below). Quartz veins containing lead-zinc-copper-silver-antimony mineralization were previously mined on a small scale at several locations immediately to the southwest of this locality, near the community of Silver, Arkansas.

Proceed eastward on Lake Ouachita to Point 26.

Locality V. Highly deformed conglomeratic limestone, thin bedded fine-grained limestone, and shale of the Womble Shale. Milky quartz-calcite veins commonly fill fractures in the rock. It is suggested that the shale and limestone are of deep-water origin and that their deposition was sporadically augmented by slumps and debris flows detached from the shelf areas to the north (Figures 24, 25, 26, and 27).

Continue southeast to the Crystal Mountain Boat Dock.

END OF GEOLOGICAL EXCURSION ON LAKE OUACHITA

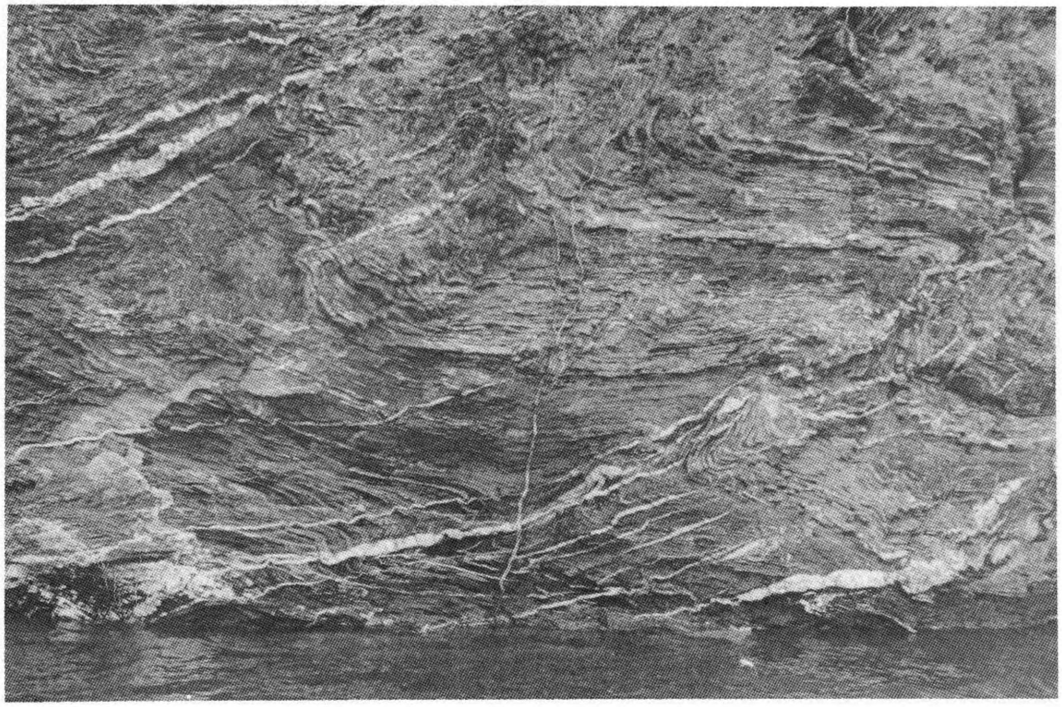

Figure 20. — Stop 3 — 7. Quartz-calcite veins along cleavage planes in the highly deformed calcareous siltstone and shale of the Womble Shale.

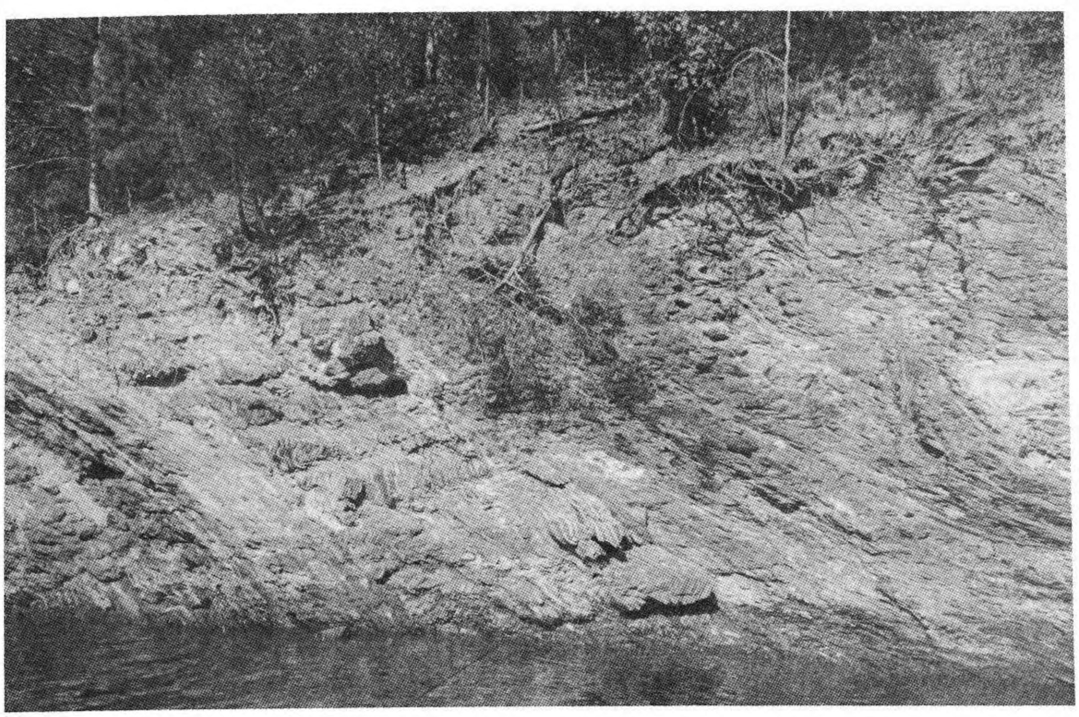

Figure 21. — Stop 3 — 7. A complexly folded unit of calcareous siltstone and shale between less deformed units in the Womble Shale. At least three periods of folding and deformation are exhibited by the strata at this locality.

Figure 22. — Stop 3 – 7. Closeup of the folded Womble calcareous siltstone and shale units shown in Figure 21. The rocks of this unit were probably folded (in part) as the semiconsolidated sediments slumped southward into the Ouachita trough.

Figure 23. — Photo Tour 3 – F. Recumbent isoclinal folds with nearly horizontal cleavage and small faults in calcareous siltstone and shale of the Womble Shale. Note how the shale has flowed from the flanks into the fold hinges.

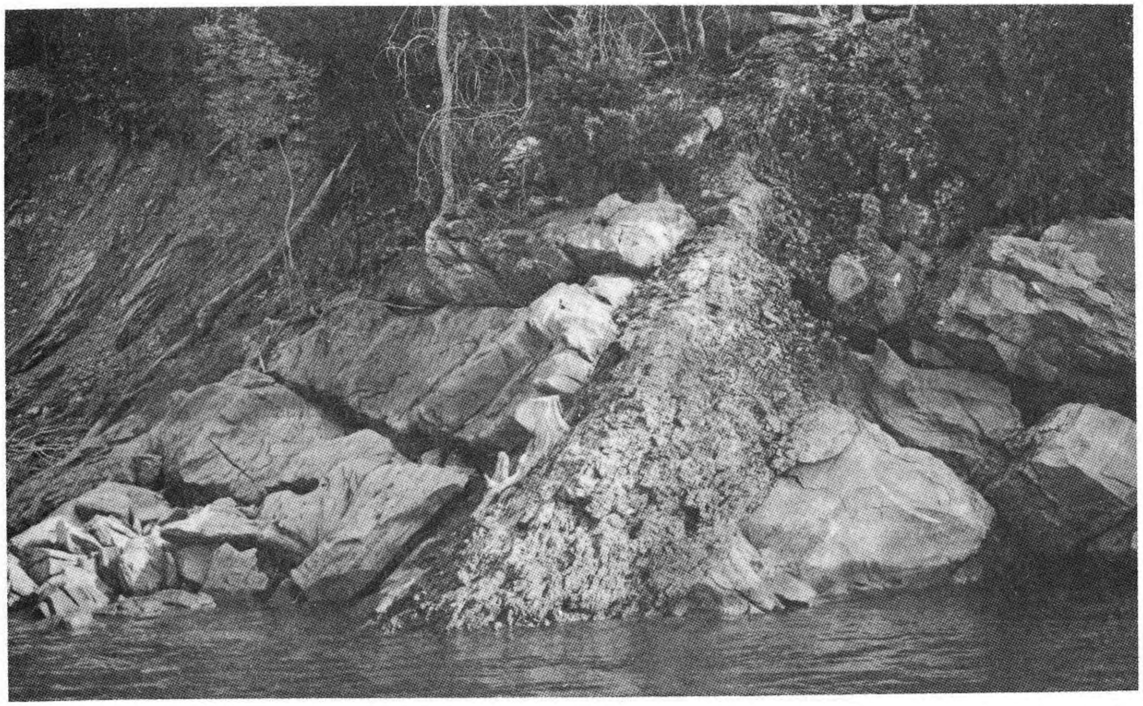

Figure 24. -- Locality V. Conglomeratic limestone of the Womble Shale containing clasts of limestone, chert, and sandstone.

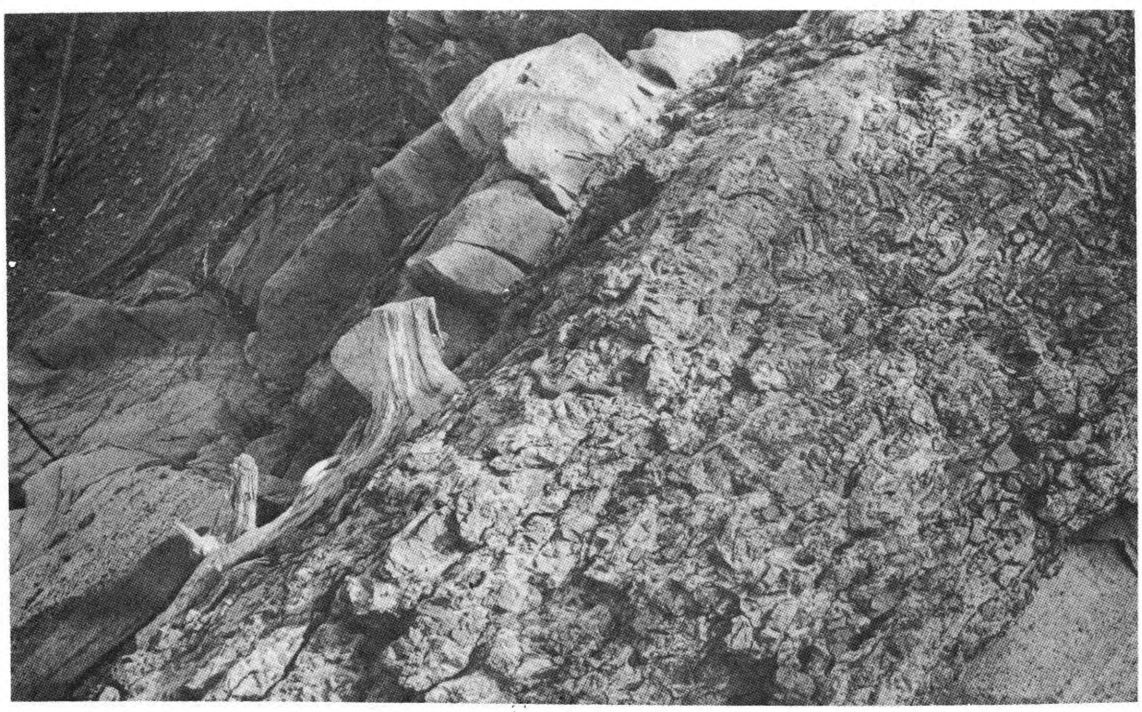

Figure 25. — Locality V. Closeup of Figure 24 with a typical Arkansas outcrop hazard to the right of the stump. This conglomerate zone likely represents a submarine landslide deposit from the shelf area to the north.

Figure 26. — Locality V. Conglomerate in Womble Shale. The clasts are mostly limestone (light) and chert (dark).

Figure 27. — Locality V. Very tight folds and small thrust faults in thin calcareous siltstone and shale of the Womble Shale.

EXPLANATION

CRETACEOUS	Ki	Igneous Dikes
PENNSYLVANIAN	Pj	Jackfork Sandstone
MISSISSIPPIAN	Ms	Stanley Shale
DEVONIAN / MISSISSIPPIAN	MDa	Arkansas Novaculite
SILURIAN / ORDOVICIAN	Sm-Opc	Missouri Mountain Shale and Polk Creek Shale
ORDOVICIAN	Obf	Bigfork Chert
	Ow	Womble Shale
	Oby	Blakely Sandstone
	Om	Mazarn Shale
	Ocm	Crystal Mountain Sandstone
	Oc	Collier Shale

	Thrust Faults
	Formation Contacts
. . . .	Route of Field Trip
x Stop 3-5	Stop Locations
x Photo 3-D	Photo Tour Locations
E	Outcrop Descriptions
●	Boat Landings
. 14	Point Location Markers
	the strike and dip of cleavage
	the strike and dip of an axial plane
	a lineation formed by intersecting cleavage and bedding planes
	a hinge of a fold
	the direction of rotation of a fold viewed down the plunge (clockwise and counter-clockwise)
56, 45	strike and dip of a cleavage plane and the rake of a lineation in the plane
13, 59	strike and dip of an axial plane and the rake of a fold hinge in the plane; clockwise rotation of the fold viewed down plunge; the tick on the rotation symbol gives the direction of facing

PLATE 1

PRELIMINARY GEOLOGIC MAP OF A PART OF THE FANNIE, AND Mc GRAW MOUNTAIN QUADRANGLES, ARKANSAS

Prepared for Lake Ouachita field trip

PLATE 1

PRELIMINARY GEOLOGIC MAP OF A PART OF THE AVANT, AND CRYSTAL SPRINGS QUADRANGLES, ARKANSAS

Geology by C.G. Stone and B.R. Haley, 1969-1971