THE DALLAS GEOLOGICAL SOCIETY

THE ARDMORE GEOLOGICAL SOCIETY

PRESENT THE

OUACHITA
FIELD TRIP
GUIDEBOOK

PREPARED FOR

THE ANNUAL CONVENTION

American Association of Petroleum Geologists

Society of Economic Paleontologists and Mineralogists

MARCH 1959

SYSTEM	SERIES	GROUP OR FORMATION	
Pennsylvanian	Desmoinesian	Boggy	
		Savanna	
		McAlester	
		Hartshorne	
	Atokan	Atoka	
	Morrowan	Wapanucka - Chickachoc	
		Springer	Johns Valley
Mississippian	Chesterian	Caney / Jackfork	Game Refuge
			Wesley
			Markham Mill
			Prairie Mountain
			Wildhorse Mountain
	Meramecian	Caney / Stanley	Chickasaw Creek
			Moyers
			Ten Mile Creek
Devonian	Upper and Middle?	Arkansas novaculite (Woodford)	Upper division
			Middle division
			Lower division -- Pinetop Chert
Silurian		Missouri Mountain	
		Blaylock	
Ordovician	Upper	Polk Creek	
		Bigfork	
	Middle	Womble	
	Lower	Blakely	
		Mazarn	
		Crystal Mountain	
		Collier	
		Lukfata	
Cambrian	Not exposed		
Precambrian	Not exposed		

Fig. 1. -- Composite correlation chart (after Cline and Ham--this symposium)

GEOLOGY OF THE OUACHITA MOUNTAINS
FIELD TRIP

FIRST DAY, MARCH 20, 1959

SUMMARY

The first day of the field trip is concerned primarily with the stratigraphy and structural geology of the Frontal Ouachitas as may be observed in the Atoka, Stringtown, and Hartshorne areas. The Index Map, Photo Map, and Hendricks' Fig. 3 (Oil and Gas Investigations, Preliminary Map 66, sheets 1 and 2) will be very helpful for both geographic and geologic reference.

Leaving McAlester, the trip will proceed to Stop 1 southeast of Atoka, after which the route will be retraced in part to Stops 2 and 3. The route then turns east to Stops 4 and 5, the latter being just south of Hartshorne. At the conclusion of Stop 5, the caravan will return to McAlester for dinner, discussions, and lodging.

ROAD LOG

Mileage	Discussion
0.0	Enter buses on west side of Aldridge Hotel. Caravan proceeds southward, down Second Street, McAlester.
1.1	Turn right as street dead ends.
1.15	Turn left onto United States Highway 69 business route. Hills to the right are capped with Blue Jacket sandstone, the most widespread sandstone in the Boggy formation.
2.0	Road curves to the right.
3.2	Merge with United States Highway 69.
3.8	Divided highway ends. Two way traffic ahead.
5.3	Gerty sandstone on right. This Pleistocene formation is widespread in east-central Oklahoma. See T. A. Hendricks, Geol. Soc. Am. Bull., vol. 48, no. 3, March 1937, pp. 365-372.
6.3	Peaceable Creek.
6.7	Road curves left.
6.9	Road cut in upper part of Savanna formation; the road is approximately parallel to the strike of the beds.

8.15 Road from United States Naval Ammunition Depot enters from right.

8.3 Entering town of Savanna.

8.85 Road curves to the left.

9.1 Note the steeply dipping beds near base of Savanna formation on the northwest flank of the Savanna anticline.

9.7 This is a McAlester shale valley higher structurally on the Savanna anticline.

11.4 Steeply dipping sandstone beds on left hand side of road. Wooded ridge to the left marks approximate position of the Hartshorne sandstone near the crest of the Savanna anticline.

12.1 Road curves left.

12.3 Northwestward dipping beds in the Hartshorne formation.

12.5 We are now in the structural top of the Savanna anticline with Atoka beds lying to the right and left on either side of the road.

13.35 Southeastward dipping sandstone beds of the Hartshorne formation marking the southeast side of the Savanna anticline. Some displacement of the sandstones by faulting may be observed on the left.

13.6 To the southeast the high ridges of the western Ouachitas, are the Atoka formation. To the southwest are sandstone hills in the Boggy formation.

15.4 Road curves left.

16.0 Road curves right, through the town of Kiowa, Oklahoma, near axis of Kiowa syncline, a structurally low area southeast of and parallel to the Savanna anticline.

17.1 Near base of Boggy formation, sandstone ridges ahead in the Savanna formation.

18.6 Savanna formation.

18.7 Road curves to the right and is approximately parallel to strike of the beds.

19.2 Note alternating maroon and light-colored shale beds in Savanna formation, dips in this locality approximately 90°--(See USGS Bull. 874-A-Plate 2). The trace of the Choctaw Fault lies about 1/4 mile to the southeast.

19.6 Refer here to Hendricks' Fig. 3 which is reproduced for the detailed geology of the area lying to the left of the road.

20.1 Overpass over Missouri Kansas and Texas railroad tracks.

20.25 Note ripple-marked surfaces on beds in left side of road.

20.45 Road curves left. McAlester shale valley to left ahead, the lower ridge being Wapanucka limestone and spiculite, the higher ridge on the sky-line being capped with massive Atoka beds. The significance of these ridges will be brought out in the discussion of the structural geology at Stops 1, 2, and 3, when we retrace our route on this highway.

22.5 Road curves to right.

24.0 Hartshorne sandstone exposed in road cut.

24.5 Cross Buck Creek.

25.45 Road curves left. Railroad cuts through the Wapanucka beds to the left ahead.

26.0 Road curves to right. We will go up this hill where steeply dipping Wapanucka limestone, spiculite and dark shales are exposed. This out-crop will be studied in detail at Stop 3. A generalized measured section of this outcrop is shown in Fig. 15 of this guidebook.

28.0 Road turns left.

28.35 Road curves right. In this area the uppermost ridge of the Wapanucka on the right exhibits many sigmoidal folds, some of which are shown with low angle aerial obliques; Figs. 2, 3, 4 in the guidebook.

31.5 Road curves left.

32.6 Road curves right.

32.8 Entrance to Oklahoma State Honor Farm.

33.0 Oklahoma State Highway 43 goes to the right. We continue southward on United States Highway 69.

34.1 Wapanucka limestone and spiculite in road cut on right.

34.25 Note the curving sandstone beds in the Atoka formation in the hill to the right front.

34.7 Wapanucka limestone and spiculite repeated.

34.8 To the left front lie the Ordovician rocks of the Black Knob ridge and farther ahead may be seen the working of the Southwest Stone Company where the Bigfork and Womble beds are quarried and crushed. For an excellent view of these workings and structural relations, refer to Fig. 5.

Fig. 2.--Sigmoidal folds in the Wapanucka limestone. Aerial view looking northeast. Katy Club fault between Wapanucka ridge on the left and U. S. Highway 69 on the right. (Photo courtesy Magnolia Petroleum Company)

Fig. 3.--Close up aerial view of sigmoidal folds of Fig. 2. (Photo courtesy Magnolia Petroleum Company)

Fig. 4.--Aerial view of sigmoidal folds in Wapanucka limestone. Same as Figs. 2 and 3, except southwest. (Photo courtesy Magnolia Petroleum Company)

Fig 5.-- Quarry of Southwest Stone Company, Stringtown, Oklahoma. Aerial view northeast. (Photo courtesy Magnolia Petroleum Company)

Fig. 6.-- Sigmoidal folds in Black Knob Ridge, north-northeast of Atoka, Oklahoma. Aerial view southwest. (Photo courtesy Magnolia Petroleum Company)

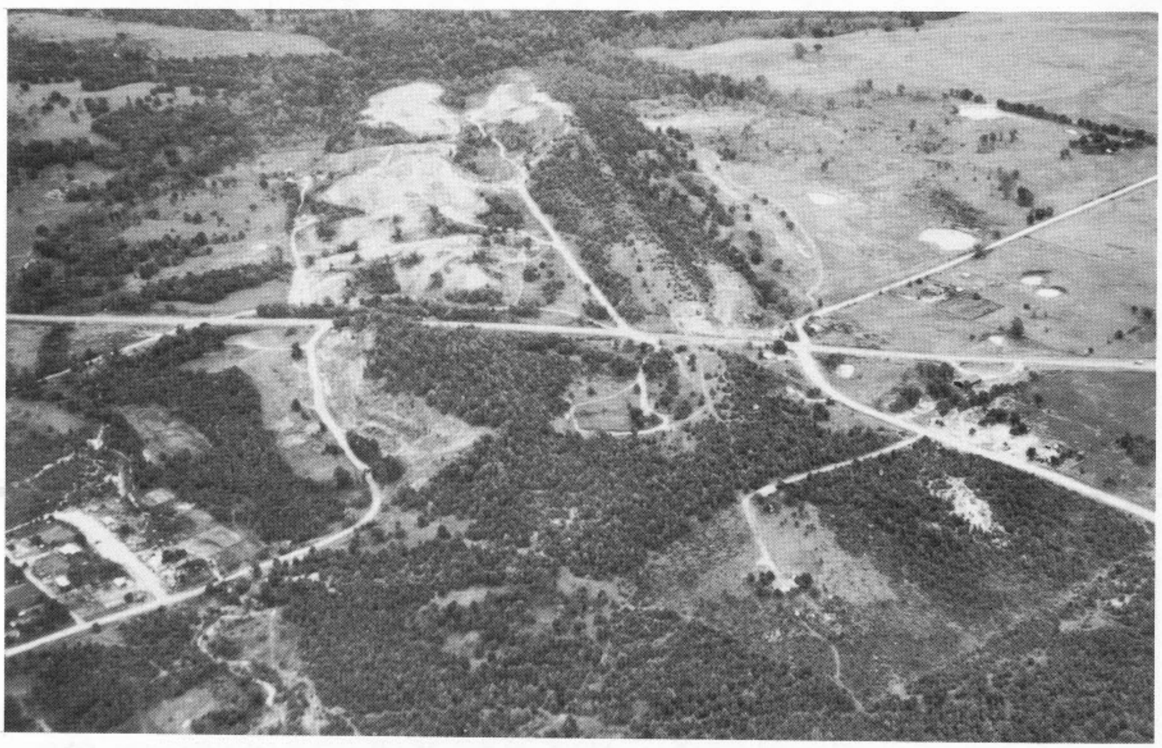

Fig. 7.-- Stop 1. Aerial view northeast along Black Knob Ridge which trends across center of picture. Stop 1 is where Oklahoma State Highway 3 crosses the ridge. (Photo courtesy Magnolia Petroleum Company)

36.4 Road curves right. Atoka sandstone in the hills to the right.

36.9 State Highway 43 goes to the left, we continue straight ahead through the town of Stringtown, Oklahoma.

38.1 Road curves left.

38.4 Steeply dipping sandstone beds in Atoka formation in cut on right. Road curves left.

39.1 Road curves right.

39.3 Cross North Boggy River.

39.45 Road curves right. The trace of the Ti Valley fault lies between this point and the Black Knob ridge to the left, and we recommend you follow Hendricks Fig. 3 closely.

40.7 Note steeply dipping beds in the railroad cut.

41.4 The road curves left. The sigmoidal folds in the Black Knob ridge to the left are pictured in Fig. 6.

42.8 Road curves left.

42.95 Road curves right.

43.5 Bridge--curve left.

43.8 Muddy Boggy River Bridge.

43.9 United States Highway 75 enters from right as we enter the town of Atoka.

44.4 Intersection. Turn left on State Highway 3 at intersection of Highway 69 and Highway 3 and proceed eastward through the center of Atoka.

44.7 Missouri Kansas and Texas railroad underpass. The Pine Mountain Fault trace is mapped in this approximate position.

45.0 Bridge. Road turns right. In the valley ahead is approximate position of the Ti Valley fault.

45.6 Fault contact of the Womble and the Bigfork. This outcrop will be studied in detail as we work westward from Stop 1.

45.8 Right turn on to gravel road. We will leave the buses at this point and cross to the north side of the road for the beginning of the discussion of the geology at this stop.

<u>STOP 1.</u> Arkansas novaculite exposed in road cuts along Oklahoma State Highway 3, Sec. 14, T. 2 S., R. 11 E., Atoka County, Okla-

Fig. 8. -- Stop 1. Tightly folded Arkansas novaculite exposed in road-cut of Oklahoma State Highway 3. (Photograph by Dan E. Feray)

Fig. 9. -- Stop 1. Bigfork chert thrust westward over Womble shale in Black Knob Ridge. (Photograph by Dan E. Feray)

homa. Section described by T. A. Hendricks, M. M. Knechtel, and Josiah Bridge. Reproduced from p. 14 of the Tulsa Geological Society Guidebook, 1947. Zones renumbered to correspond to stratigraphic position.

Measured Section

Top	Thickness in feet
Arkansas novaculite:	
5. Novaculite; light brown to gray, in beds as thick as 10 inches with some interbedded buff shale; radiolaria present.	30
4. Red and green siliceous and flaky shale containing some thin beds of novaculite; conodonts very abundant in some zones; radiolaria present.	45
3. Red and green flaky siliceous shale containing beds of novaculite as thick as nine inches; shale contains some conodonts; radiolaria present.	54
2. Novaculite; black to gray, in thin beds as thick as five inches, some green shale and numerous partings of black paper shale, some fine conglomeratic lenses present locally in basal part, some pyrite, spores, conodonts, radiolaria, and linguloid brachiopods.	100
1. Massive and thin-bedded gray novaculite with thicker beds in upper part, some thin green shale and one zone of black siliceous shale in middle part.	130

Note. - Unit 1 equivalent to Pinetop chert and upper Hunton group. Units 2-5 equivalent to Woodford chert.

The contact of the Stanley and Arkansas novaculite at this locality is marked by brownish-red and green shale and some thin-bedded siliceous beds. This variegated shale has been observed at several other localities in the Ouachitas. According to Hendricks, conodonts occur in some of the thin shale beds near the base of the Stanley at this locality. There is some difference of opinion as to whether the Stanley-Arkansas novaculite contact is conformable in the western Ouachitas. Hendricks is of the opinion that the Stanley is conformable on the novaculite in this belt. Cline is of the opinion that the two formations are conformable in the central and southern Ouachitas. Richard Laudon has observed a gradation from typical novaculite lithology upward into typical Stanley lithology on Dry Creek on the southwest side of the Potato Hills with repeated intertonguing of the two lithologies in an interval that is 100 feet thick. Cline has observed a similar gradation in Beaver Bend State Park on the northeast side of the Choctaw anticlinorium in the southern Ouachitas. Certainly the Stanley shale is much thinner in the frontal Ouachitas than in the central Ouachitas. The thinning toward the frontal Ouachitas may be depositional, with convergence at all stratigraphic levels, or it may be the result of an unconformity at the base of the Stanley accompanied by overlap to the west and north. The wooded valley immediately northwest of the novaculite ridge at Stop 1 is underlain by the relatively non-resistant Polk Creek and Missouri Mountain shales.

From this observation point the party will proceed on foot northwestward along the highway to the next ridge to the west. This is the second part of STOP 1. In the cut on the southwest side of the road the Bigfork chert may be seen resting on the Womble shale along a small thrust fault. Thomas Hendricks will explain the mechanics of faulting at this point.

46.1 Enter buses for resumption of caravan. We will retrace our route to United States Highways 69-75.

47.25 Intersection United States Highways 75-69; turn right (north).

47.65 Junction with United States Highway 75 on left. We continue northward on United States Highway 69.

47.8 Muddy Boggy River.

48.45 Road curves left. Black Knob Ridge lies to the front and right. You are referred to low-angle oblique photographs in the guidebook to show the intricate nature of this folding. The sigmoidal curves shown in the photographs suggest some strike-slip along the plane of the Ti Valley fault.

49.65 The large rounded wooded hill to the front and left is capped with Atoka sandstone in front of Black Knob ridge.

50.85 Note steeply dipping beds in railroad cut on right hand side in Springer formation. This is mapped as the Pine Mountain fault.

50.95 Road curves left.

52.35 Bridge over North Boggy River. Stop 2 is one-quarter mile to the east at the foot of the rounded knoll where the Bigfork and Womble beds are exposed. The traces of the Pine Mountain and Ti Valley faults lie between the highway and that knoll. There are steeply dipping-near vertical Atoka sandstones and shales in cuts on both sides of road as we leave the bridge.

53.15 Steeply dipping Atoka sandstones and red shales. Some of the beds are conglomeratic. The sandstones contain Leda and other pelecypods and the shales contain Lingula.

54.50 Turn right off United States Highway 69; cross Missouri Kansas and Texas railroad tracks. Note two tracks at this point, turn sharply to the right after crossing the second track. We will follow this gravel road to Stop Two, which was pointed out as we crossed North Boggy River.

55.55 Road forks. We continue on the right hand road and keep to right at all intersections to Stop 2. Watch for narrow bridges.

56.65 Steeply dipping Womble siliceous shale beds visible on the left ahead. Buses will unload at this intersection and we will proceed--approximately two tenths of a mile to discuss the geology of Stop Two. The buses will turn around, back into place and pick us up as soon as this geological discussion is over. They will then retrace the route to the Missouri Kansas and Texas railroad tracks.

Fig. 10. -- Stop 2. Aerial view northeast from Highway 69. North Boggy River in center. Stop 2 is on right where curving gravel road crosses river. (Photography courtesy Magnolia Petroleum Company)

STOP 2. Good exposure of Womble shale in roadcuts northeast of North Boggy River. The beds are vertical to slightly overturned. This is one of the localities where graptolites are abundant in this formation. The base of the section is at the northeast end of the cut; the Bigfork chert underlies the crest of the hill to the south. The Bigfork is also exposed at water level downstream from the bridge. Persons wishing to examine the Bigfork at this fresh outcrop will find it accessible through an open meadow on the south side of the North Boggy flood plain. Excellent graptolite collecting is available at this locality; you are referred to Decker's discussion of the Womble graptolites. The valley to the northwest is developed in the Springer and Caney formations. A few hundred yards west, toward the highway, the Caney shale contains a large limestone concretion typical of this formation which will be pointed out. The ridge immediately west of the Springer-Caney valley is developed in basal Atoka. Refer to Hendricks' Fig. 3 and 4 for interpretation of the faulting between the Womble on the east and the Atoka on the west. Hendricks believes that in this belt the Atoka rests unconformably on Springer beds with beds equivalent to the Wapanucka limestone being absent.

58.75 Retrace route to Stringtown. Turn sharply to the left. Cross railroad tracks.

58.85 Turn right on United States Highway 69. You are referred to your guidebook Fig. 5 for an aerial view of the workings of the quarry visible across the railroad tracks to the right, in the north part of Stringtown. This is the quarry of the Southwest Stone Company and has been in operation for many years. A large quantity of Womble shale, Bigfork chert and Arkansas novaculite has been removed and used for railroad ballast. The red and green rock is part of the Womble formation and is the partial equivalent of rocks exposed at Stop 2. It is equivalent to some portion of the Simpson group of the Arbuckle facies to the west.

59.1 State Highway 43 goes right.

59.55 Road curves left. The Black Knob Ridge is turning in a northeast arc away from the highway. Please refer to Hendricks' Fig. 3 for detailed geology of the area along which we are now traveling..

60.85 Sandstones in the Atoka formation in the ridge to the left.

61.25 Wapanucka limestone exposed in the road to the right and in the railroad cut.

61.55 Road curves right.

61.85 Good exposure of Wapanucka spiculite on road to the left.

62.95 State Highway 43 goes to the left. We continue straight ahead.

63.1 Oklahoma State Honor Farm.

63.35 Road curves left.

64.25 Road curves right. Refer to Figs. 2, 3 and 4 in the guidebook for low angle aerial oblique photographs of the sharply folded Wapanucka limestone ridge on the left on which the sigmoidal folds are well developed. The same type of folding was visible in the Black Knob Ridge north of Atoka and south of Stop 2.

67.45 Road curves left. Southeast dips in the Wapanucka limestone may be seen straight ahead. At the top of this ridge we will stop and study the full Wapanucka section as exposed in these old workings.

67.85 Chickachoc chert of Taff.

68.4 At this point we will leave the buses, discuss the geology and work at collections in this locality. This is STOP 3.

STOP 3. - Wapanucka limestone - Lunch will be served during this stop.

Fig. 11. -- Aerial view northeast along Limestone Ridge at Stop 3 where United States Highway 69 cuts through the ridge between Chockie and Limestone Gap. The Wapanucka formation in Limestone Ridge dips 42 degrees to the southeast and is overlain by the shales of the Atoka which are in fault contact with Springer shales along the Katy Club fault northwest of the railroad right-of-way. The Choctaw fault is to the northwest (left) of Limestone Ridge and just off the photograph. (Photograph courtesy Magnolia Petroleum Company)

Fig. 12.--Spiculitic limestone and shale of upper Wapanucka formation at Stop 3. These beds were referred to the Barnett Hill formation by Harlton in 1938. (Photograph by L. M. Cline.)

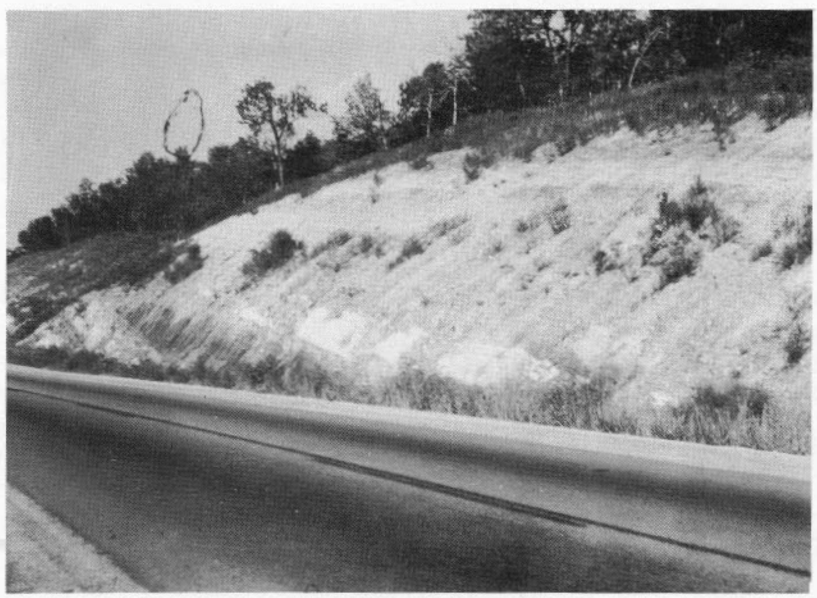

Fig. 13.-- Limestones and shales in lower Wapanucka formation at Stop 3. Some of the limestone beds are lenticular and contain much fossil debris. (Photograph by L. M. Cline.)

This fresh roadcut through Limestone Ridge exposes the upper part of the Wapanucka formation, the portion that Harlton (1938) proposed to call the Barnett Hill. There are continuous exposures of the Wapanucka in cutbanks on the east side of the road with the base of the formation being exposed approximately one mile north along the highway. Although these cutbanks offer unusually fine exposures of the Wapanucka we have not described the formation in detail because Harlton (1938, pp. 904, 905) has published a description of the formation where it is exposed in cuts along the Missouri Kansas and Texas right-of-way immediately to the east. The base of his published section begins near the watergap (Limestone Gap) and railroad trestle (see Stop 3, Fig. 15). It should be pointed out that Harlton referred to the upper 247 feet of the Wapanucka at this locality to the Barnett Hill formation. This is the massive limestone which holds up Limestone Ridge for many miles. The type locality of the Barnett Hill is at Clarita a few miles west of Limestone Gap. The type locality of the Wapanucka lies to the southwest of us, being 18 miles due west of Atoka.

Most geologists have continued to use the term Wapanucka as it was originally defined and have not recognized the need for a Barnett Hill formation. Cline is of the opinion that the fusulinids that have been described from Barnett Hill (geographic name) one-half mile north of Clarita are from the lower Atoka, rather than being from the equivalent of upper Wapanucka. This is an important point to stratigraphers.

The Wapanucka of the type locality contains considerable oolitic limestone and in general the formation contains more carbonate than you will observe here in Limestone Ridge. Harlton has pointed out that the Wapanucka of the frontal Ouachitas contains abundant sponge spicules, and additional studies by Richard Fetzner (Master's thesis, University of Wisconsin, 1956) reveal that the limestones of the frontal belt are very impure. Some beds that one would call limestone in a field description contain as much as 65% of insoluble residue. Cline is of the opinion that these impure spiculitic limestones represent a facies characteristic of the outer edge of a shelf and marginal to a geosyncline. He has observed the same type of rock in beds of Morrowan age in outcrops around the Llano uplift in central Texas. The facies probably is not confined to rocks of Morrow age because the siliceous shales of the Stanley-Jackfork succession in the Ouachita geosyncline contain abundant sponge spicules. The latter siliceous shales are believed to be of deep water origin, hence it seems likely that the tiny sponge spicules which have a large surface area in proportion to their mass, were transported from the edge of the shelf where the sponges lived and deposited in the geosyncline.

Be that as it may, the outcrops of the Wapanucka in Limestone Ridge and in the other fault slices of the frontal Ouachitas hold more than ordinary interest. In the next fault slice to the east, toward the geosyncline, the Wapanucka becomes very silty and has so many sponge spicules that Tom Hendricks has used the term spiculite to refer to this facies. It is so different from the Wapanucka that J. A. Taff in early work in the area failed to recognize its correlation with the Wapanucka and gave it the name "Chickachoc chert". East and south of the Pine Mountain fault the Wapanucka disappears, except for one outcrop in secs. 1 and 2, T. 2 N., R. 14 E., where it is believed to have been dragged upward on a fault slice, and it is not recognizable as such in the Ouachita geosyncline. This may have resulted from westward thrusting of the Ouachita facies over the Arbuckle facies or it may result principally from a rapid facies change. Cline is of the opinion that the two factors combined to produce the observed result. A microscopic examination of the Wapanucka at this locality (Stop 3), reveals that it is a mass of shell debris, composed of bryozoan stems, crinoid columnals, and brachiopod fragments. Most of the fragments show evidence of abrasion and transportation. The lenticular nature of some of the limestone beds is further evidence of rough water, and the rapidity with which some of them pinch out suggests that the Wapanucka, as such, may never have extended very far into the Ouachita geosyncline. In the central Ouachita, sandstones immediately overlying the Johns Valley shale have Atoka lithology and have been mapped as Atoka. Near the base of the "Atoka" of the Ouachitas, lenses of fossiliferous sandstone contain fossil fragments that Elias (personal communication) says are Morrowan in age. Cline believes that these Morrow fossils were debouched from a shelf environment, perhaps being carried from the shelf area to the west and northwest by turbidity currents into the Ouachita facies to the east and southeast.

Now to return to the exposures before us. Perhaps an eighth of a mile north of where we are standing limestones may be seen coming into the section. They are in the upper part of Harlton's restricted Wapanucka formation or the lower Wapanucka of some other geologists. Farther north, in Limestone Gap proper, a fine silty sandstone is exposed in railroad cuts north of the trestle. This sandstone was correlated by Harlton with the Primrose of the Ardmore basin. It is the Cromwell sandstone of the subsurface and the Union Valley sandstone of the outcrop east of Ada. At Union Valley school, seven miles east of Ada, the sandstone becomes calcareous upward and grades into a limestone. The sandy limestone contains a cephalopod fauna that was collected by R. V. Hollingsworth and L. M. Cline and described by A. K. Miller. According to Miller, the fauna is the same as that in the Hale sandstone in the lower part of the Morrow of northeastern Oklahoma and northwestern Arkansas.

By referring to Hendricks' Fig. 3, it will be observed that Hendricks has mapped the Choctaw fault approximately at the base of this Wapanucka escarpment. The valley immediately west is underlain by the Springer and Atoka formations, and the first ridge is developed in the Hartshorne sandstone of Desmoinesian age. We will cross the Hartshorne sandstone ridge on to younger Pennsylvanian rocks as we continue northward along our route.

69.65 Cross Limestone Creek.

Fig. 14.--Aerial view southwest along Limestone Ridge with Limestone Gap in the foreground. Stop 3 is in cutbanks along United States Highway 69. The trace of the Katy Club fault is between the ridge and the railroad. The Choctaw fault is to the right of the ridge. Both strike southwest and dip southeast, probably sharing the dip of the Wapanucka limestone in the ridge which is 42 degrees to the left. (Photograph courtesy Magnolia Petroleum Company)

69.75 Gravel road enters from the right.

71.65 Buck Creek.

71.85 Hartshorne sandstone in the road cut.
If you are following Hendricks' Fig. 3, please note that the trace of Highway 69 has been relocated from the position shown on that map of 1947 vintage. You can orient yourself with the position of the Missouri Kansas and Texas railroad tracks.

72.85 The sandstone ridges to the left are upper McAlester formation and lower Savanna formation.

73.65 At this point we diverge from the old highway 69 as shown on Hendricks' Fig. 3.

75.5 Road curves right, to the left are massive ridges of sandstone in the Savanna formation.

75.95 Cross Missouri Kansas and Texas tracks. Lower beds of Savanna formation on the right.

76.55 Note red shales in the Savanna formation.

77.05 Road curves left.

79.05 Approaching the town of Kiowa.

79.4 Turn right off Highway 69, toward town of Pittsburg.

80.5 Savanna sandstone exposed on either side of the road. McAlester Shale Valley ahead.

82.1 End of black top road.

82.6 Turn right, south through the ghost town of Pittsburg, Oklahoma, once a bustling mining center. The ridge ahead is of Wapanucka spiculite.

83.1 A sharp turn to the left (east). Approximate position of Choctaw Fault.

83.2 To the left there are remnants of a spiculite facies of the Wapanucka, evidently brought up in a fault slice. Note that this lies north of the main limestone ridge.

83.55 Bridge, take right hand fork after crossing.

83.95 Road turns left (east). Wapanucka ridge on the left.

84.2 Road junction. Continue straight east. Atoka valley to the right (south).

84.7 Road junction. Road intersection from the right. Continue east.

85.15 Turn right (south). Road continues south across Atoka formation.

85.6 Approximate position of Springer-Atoka contact.

85.8 Road turns left (east).

86.5 Contact of Springer and Wapanucka.

86.7 Wapanucka limestones, spiculite.

87.4 Rock bridge; we will be in Atoka beds shortly after crossing this bridge.

88.2 Road enters from left. Sandstone in the Atoka formation. Katy Club fault trace between this spot and shale exposures ahead.

88.45 Cuts on left side of road mapped as Caney.

88.85 Descending steep hill--good Caney exposures.

89.3 Bridge. This is a tributary to Brushy Creek. Below the bridge and to the right in the cutbank on the east side of the creek there are some tightly folded sandstones in the Atoka formation. (A photograph by Hendricks was reproduced as Fig. 5, p. 23, Tulsa Geological Soc. Guidebook, 1947.)

90.3 Atoka formation on right. These beds dip very steeply to the south; well developed bottom markings occur in some of the thin sandstones on the under sides of the beds.

90.35 Bridge over Brushy Creek. It is joined here by Elm Creek on the left hand side of road.

90.65 Small exposure in road cut mapped as Woodford chert. Approximate position of the Pine Mountain fault, which was last observed in the valley north of Stringtown, some 22 miles southwest.

91.15 Turn left sharply and cross cattleguard.

91.85 Road curves to left and descends steeply. Caney shale exposed. Stop 4 ahead.

91.95 STOP 4. North-trending ravine, NW 1/4 NE 1/4 sec. 4, T. 2 N., R. 15 E., Pittsburg County, Oklahoma.

The stratigraphic section exposed ranges from the Pinetop chert upward into the lower Springer. The Pinetop is exposed north of the road; the lower Springer is exposed south of the road near the east-west fence line.

The portion of the section that we will examine lies south of the road in cutbanks along the north-flowing stream. The contact of the Woodford chert (upper Arkansas novaculite) and overlying Caney shale (Mississippian) is exposed in cutbanks on the west side of the creek. Just above the Woodford will be observed about nine feet of green-gray shale which, according to Hendricks, has a glauconite and phosphatic basal zone. This may represent the initial deposit above an unconformity. Cline points out that this is typical Stanley lithology. This is an interesting and important point because just above the green shale typical dark gray to black, laminated Mississippian Caney lithology begins and continues upward through the section for 524 feet. At various stratigraphic levels there are dark gray to black limestone septaria which contain abundant and well preserved Mississippian Caney fossils. Near the fence line may be observed an intertonguing of Caney lithology with the lighter gray silty shales of the Springer. As Cline has noted (1956), the lower part of the Johns Valley shale of the central Ouachita Mountains contains black fossiliferous Mississippian shale which is in place. Below the Johns Valley shale and above the Arkansas novaculite there is approximately 16,000 feet of Stanley shale and Jackfork sandstone. Whether or not there is an unconformity at the base of the Caney here at Stop 4, we are faced with the problem of the loss of 16,000 feet of strata in coming from the central Ouachitas into this locality in the frontal Ouachitas. It may be that the entire section thins by convergence, in which case the lower part of the Caney at this locality represents the Stanley and the upper portion represents the Jackfork. The Jackfork is known to converge rapidly in this direction, so it is entirely possible that the Stanley thins in the same manner.

The top of the Springer can not be seen at this stop but Hendricks says the thickness of definite Springer in this fault block is 100 to 500 feet and that it is overlain by about 5,000 feet of beds that he believes to be of possible Atoka age. However, these beds may be of Springer age and they may have changed so greatly in character as to be unrecognizable. Spiculitic or similar beds are conspicuously absent in this fault block, but progressing northwestward into the other fault blocks, the Chickachoc chert (Wapanucka spiculite) first intervenes between the Springer and Atoka, and eventually the typical Wapanucka limestone facies takes its place between the Springer and Atoka. As a reminder, Cline interprets the southeastward disappearance of the Wapanucka as a rapid change in facies so that it is not necessary to appeal to great horizontal displacement to account for this relationship.

Description of stratigraphic section exposed in small stream, NW 1/4 NE 1/4 sec. 3, T. 2 N., R. 15 E., Pittsburg County, Oklahoma. After T. A. Hendricks and L. S. Gardner, Tulsa Geological Society Guidebook, 1947, pp. 23, 24.

Measured Section

Top	Thickness in feet
Springer formation	
17. Shale poorly exposed, pale gray, clayey, contains limonitic concretions.	20
Caney shale	
16. Shale, black, soft	85
15. Shale, black, cherty, blocky but weathers to plates . . .	2
14. Shale, black, fairly soft with a few one-inch bands of hard shale. Weathers into small flakes and finally to red and gray mottled clay. Contains some phosphatic nodules	184

13.	Shale and siltstone, black, hard, in layers 1/16 to one inch thick. Much harder than beds above and below and forms small ridge.	8
12.	Shale, black, hard, platy in layers 1/16 to 1/8 inch thick, weathers into plates and small flakes. Some layers are harder and stand as small ridges	100
11.	Shale, black, hard, platy, weathers to small flakes, contains septarian concretions.	50
10.	Shale, greenish gray, hard, breaks into small angular fragments	6
9.	Shale, similar to that above but contains large septarian concretions	10
8.	Shale, black, hard, gritty, platy to fissile, contains some layers of calcareous siltstone one to two feet thick, weathers gray	70
7.	Shale, greenish gray, breaks into small angular fragments, contains conodonts, and has abundant phosphate nodules and glauconite in a six-inch zone at the base	9
Woodford chert		
6.	Shale, black, hard, flaky, weathers gray, contains abundant phosphate nodules and conodonts	2 1/2
5.	Chert, black, in beds one to four inches thick, gritty. Contains partings of black paper shale, abundant round phosphatic nodules and flattened discoidal phosphatic nodules.	32
4.	Shale, hard, black, platy, cherty, in layers 1/16 to 1/4 inch thick, which contains some beds of blocky black chert about four inches thick. Weathers gray to white	25
3.	Chert breccia or conglomerate, white with some lenses of very fine-grained crystalline limestone . . .	7
Pinetop chert		
2.	Chert, mostly white, or light gray with some lenses of very fine-grained gray limestone, and thin beds of blue-gray earthy limestone. Some of the chert weathers brown and porous. Sparingly fossiliferous (Middle Devonian)	40

1. Limestone, blue-gray, very fine-grained, irregularly bedded, and slightly cherty, weathers buff with dendritic markings, sparingly fossiliferous (Middle Devonian) 20

92.05 Road curves right. Woodford formation on right.

92.15 Iron bridge. Sharp curve to right.

92.45 Curve left around farm house. For the next 6 1/2 miles the route will traverse Atoka beds forming the northeast-trending valley, lying between the Pine Mountain fault on the north and the Ti Valley fault on the south.

92.85 Road winds for the next five miles. Caution for sharp curves and narrow bridges.

94.6 Ranch house. Good view of Pine Mountain on left.

96.3 Cross bridge and turn left.

96.75 Turn Right.

96.95 Turn left into village of Ti.

97.1 Turn right. Go ahead slowly. There is a winding road with two narrow bridges on curves ahead.

98.55 Turn left. Good view of Pine Mountain ahead, with a meadow in foreground.

99.1 Road winds left, then right.

99.3 Dangerous bridge. A fault crosses the road at this locality. The fault is parallel to and possibly a part of the Pine Mountain fault. Covered Springer and Caney formations ahead.

99.55 Turn right. Another fault is mapped here parallel to the one we just crossed.

100.5 Atoka formation.

100.6 Slow. Winding road over low water crossing.

101.05 High timbered ridge to the front and right marks approximate position of Ti Valley fault.

101.95 Turn left (north). Road winds up the hill on Atoka formation.

102.45 Road curves left ahead and at the point of the curve on the hill ahead we cross a projected fault, which terminates against the main Pine Mountain fault about three-quarters of a mile to the northeast.

103.05 Cross another fault trace parallel to the last one. This one also terminates about a half mile to the northeast against the Pine Mountain fault. Springer and Caney formations mapped in valley ahead.

103.75 Atoka formation. We have crossed the Pine Mountain fault.

104.25 Road curves left around ridges of Atoka sandstone. Start ascending Pine Mountain.

104.4 Low water concrete slab crossing. Note the ripple and rill marks on dipping sandstone on right of road.

105.1 Hendricks mapped the Katy Club fault crossing the road at this approximate position. About two and a half miles southeast it terminates against the Pine Mountain fault.

106.25 High ridge ahead is Atoka formation. Curve left.

106.65 Steeply dipping Atoka beds.

106.8 Road curves right. Steep descent to left curve.

107.15 Curve left around ranch house.

107.35 Concrete bridge.

107.6 Wapanucka formation.

107.75 Anticlinal valley in Springer formation.

108.45 Atoka formation.

109.05 Blue Valley Ranch

109.7 Concrete bridge. Atoka formation on left.

109.85 Wapanucka limestone crosses road. Springer Valley ahead.

110.45 A fault trace crosses the road bringing Atoka formation on the north in contact with Springer formation on the south.

110.55 Black top road curves right. To the right in the top of the ridge may be seen the south dipping Wapanucka limestone in the abandoned workings of the Hartshorne quarry which will be our next stop. Contact of Wapanucka and Atoka formations is near the left hand side of road.

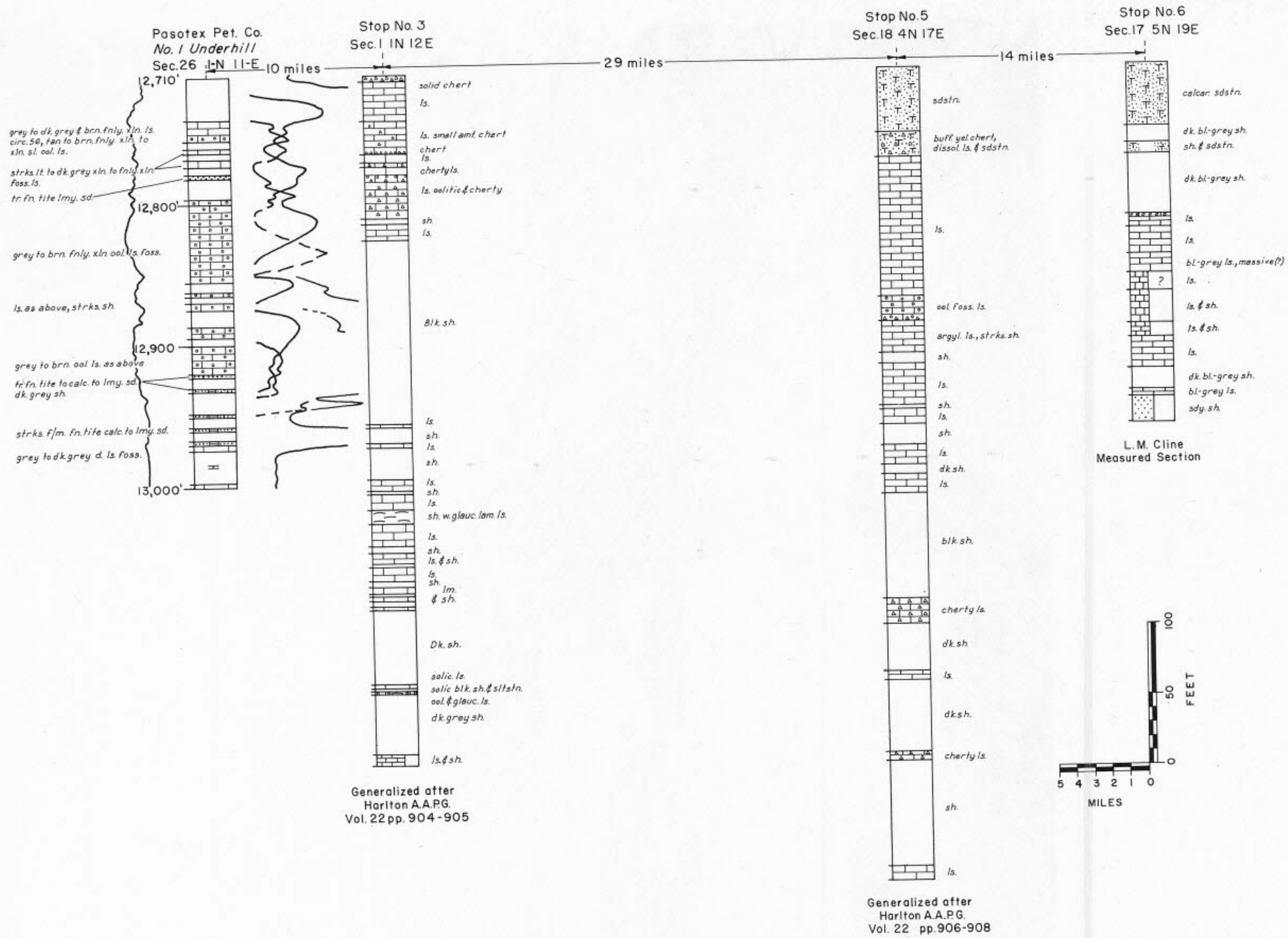

Fig. 15. -- Uncorrelated measured sections of Wapanucka formation from Lehigh Syncline (subsurface) into area of field trip.

110.75 Curve right. Wapanucka ridge parallel to road on left.

112.8 Left curve. Hartshorne Lake on the right. Wapanucka formation on the left.

112.9 Cross bridge and turn sharply to the right.

113.1 Stop on graveled parking space on the edge of the lake. Leave busses and walk into quarry.

STOP 5.

Fig. 16.--Aerial view northeast toward Limestone Ridge near the city water reservoir south of Hartshorne, Oklahoma. The Choctaw fault lies in the valley between the two ridges and strikes parallel to them. Stop 5 is in the Wapanucka limestone in the quarry beyond the lake. (Photography courtesy Magnolia Petroleum Company)

Abandoned quarry in Wapanucka limestone, approximately two miles south of Hartshorne. Upper part of Wapanucka limestone. Harlton (1938, pp. 906-908), who has given a detailed description of the Wapanucka in this quarry, referred all of the beds in the east wall of the quarry to the Barnett Hill formation. The dark gray to black shale exposed at the north end of the quarry face lies near the base of his Barnett Hill formation. The strata at the top of the south face of the quarry lie near the top of the Wapanucka; the contact with the overlying Atoka is well exposed in west side cutbanks along the black top road south of the bridge and near the outlet of the lake. The red sandstones at the top of the south face of the quarry are believed by Cline to represent the insoluble sand residue of the upper Wapanucka resulting from recent weathering; traces of the bedding planes may be seen grading laterally into fresh limestone. Maxim Elias has expressed the view (oral communication, August 1957) that they belong in the lower Atoka and that they rest unconformably on the Wapanucka. What is your opinion?

The Wapanucka is exceedingly fossiliferous throughout the quarry; numerous brachiopod fragments and dissociated crinoid remains are present; Tom Hendricks reports that he has found trilobites near the north end of the quarry. The two dark limestone beds midway in the east wall of the quarry are glauconitic. Hilseweck has called attention to residual oil along bedding planes and fracture surfaces in the south face of the quarry. In the south face of the quarry a dark shale can be seen wedging out to the east; this rapid variation in lithology is typical of the Wapanucka in the frontal Ouachitas.

Approximately three-fourths of a mile east there is another quarry that also exposes the upper Wapanucka.

113.25 Black top road. Travelling on Springer formation below Wapanucka limestone.

113.65 Trace of Choctaw fault crossing road. Now in Atoka formation.

114.1 Hartshorne sandstone dipping north away from the Choctaw fault. The last dip we saw at the quarry was south. After passing second Hartshorne sandstone exposure, we will be traveling on McAlester formation.

114.95 Intersection United States Highway 270 in Hartshorne. Turn left. Proceed to McAlester.

130.25 Aldridge Hotel in McAlester. Headquarters for the night.

GEOLOGY OF OUACHITA MOUNTAINS
FIELD TRIP

SECOND DAY, MARCH 21, 1959

SUMMARY

The buses will leave the hotel at 7:30 A. M. Today's trip will proceed from McAlester to Wilburton, Oklahoma turning south on Oklahoma State Highway 2. Stops 6, 7, 8, and 9 will be visited on Highway 2. Lunch will be served at roadside park at Talihina Junction. The trip will then proceed into the Potato Hills for Stop 10. From the Potato Hills the trip will continue through Talihina on to the Indian Road where Stops 11, 12, 13, and 14 will be visited between Talihina and Honobia. At the conclusion of Stop 14, the field trip will be over and the buses will proceed to their destination for the night.

ROAD LOG

Mileage	
.0	Board buses on west side of Aldridge Hotel; buses are headed north. Cross Grand Ave., proceed one block up the hill to Washington Avenue which is United States Highway 270, then turn right.
1.0	Cemetery on left.
1.25	Road turns sharply to right. Four lane highway ahead, United States Highway 270; stay in left lane.
1.9	Heavy sandstones in Savanna formation exposed in road cut. Four lane highway ends.
2.2	Savanna sandstone.
2.3	Road turns to the right
2.5	Basal sandstone of Savanna formation. Valley ahead developed in shale of McAlester formation which in this area is approximately 2,250 feet thick.
3.5	Road curves to right.
4.1	Road turns to left. Shale dumps from former mining operations. This

is the approximate position of the axis of the Savanna anticline which we crossed yesterday about 14 miles to the southwest.

4.6 Shale piles from old strip pit coal operations. The hills on the right are underlain by Savanna sandstone.

5.3 Village of Alderson.

5.65 Road curves slightly. Note other strip pit shale piles on left of road. Chicago, Rock Island and Pacific Railroad right-of-way on right.

5.8 Road curves to the left.

7.6 Road curves to the right.

7.9 Village of Bache. For the next 2 1/2 miles the highway follows the Gerty sand.

8.3 Road curves to right.

9.6 Excellent exposures of the Gerty sands.

9.8 Gerty outcrop to the left.

11.0 Dow Public Schools. This is the approximate axis of the Kiowa syncline which we crossed yesterday about 19 miles to the southwest.

11.25 Sharp curve to left.

11.9 Road curves sharply to the right and crosses Brushy Creek. Dow Lake to the left just beyond the bridge.

12.1 Sharp curve to right. Sandstone in the McAlester formation on both sides of road at curve.

12.9 Sharp curve to right. Hill is capped by sandstone member of the McAlester formation. Winding road ahead.

13.2 To the right and ahead the towns of Hartshorne and Haileyville are built on a Hartshorne sandstone ridge.

13.4 Sharp curve to the right under the Chicago Rock Island and Pacific Railroad. Sharp left turn coming out of the underpass. CAUTION. Follow United States Highway 270 through Haileyville and Hartshorne.

13.85 Sharp right turn in Haileyville.

14.1 Sharp turn to the left.

14.7 Road curves to the right. Hartshorne city limits.

14.9 Road curves to left.

15.3 Road intersection on the right is where we entered United States Highway 270 yesterday after examining the Wapanucka formation in the Hartshorne quarry at Stop 5. Continue through Hartshorne.

16.3 Junction United States Highway 270 and Oklahoma State Highway 63. Turn left on Highway 270. The mountains to the north and east are underlain by McAlester sandstones. The timbered ridge to the right is Hartshorne sandstone. The road for the next five miles follows close to the center of the Hartshorne syncline. We will be on McAlester shale most of the time, and the Hartshorne sandstone ridge can be seen circling the syncline.

16.8 Road winds left and goes through Rock Island Railroad underpass. Turn sharply to right immediately beyond underpass.

18.0 Turn left.

18.8 Shale dump on right marks abandoned coal mine that once produced from the Lower Hartshorne coal. McAlester sandstone in Belle Starr Mountain.

19.4 Highway curves right. Ahead is Jones Academy, established in 1891 by the Choctaw Nation for the education of Choctaw youth. It was a tribal school paid for and operated by tribal funds before the Federal Government took over the education program of the Five Civilized Tribes.

20.2 County line, Latimer and Pittsburg counties. We are now near the axis of the Hartshorne syncline. The low lying ridge in front and to the left is the Hartshorne sandstone. This outcrop has swung around the south and east side of the Hartshorne syncline and is now visible on the north side.

21.5 Strip pit workings on left. These abandoned strips worked the upper Hartshorne coal.

22.9 Curve left.

23.2 Hartshorne sandstone in road cut dipping south into syncline.

23.4 Lower Hartshorne sandstone on right. As road winds downhill note gradational contact with underlying Atoka formation. The wide valley on the left is underlain by Atoka formation with ridges in the distance formed by massive sandstone in the Savanna formation.

23.8 Atoka formation.

24.2 Curving bridge. This violates a principle of engineering.

26.0 Cross Gaines Creek. Road parallels axis of Hartshorne syncline.

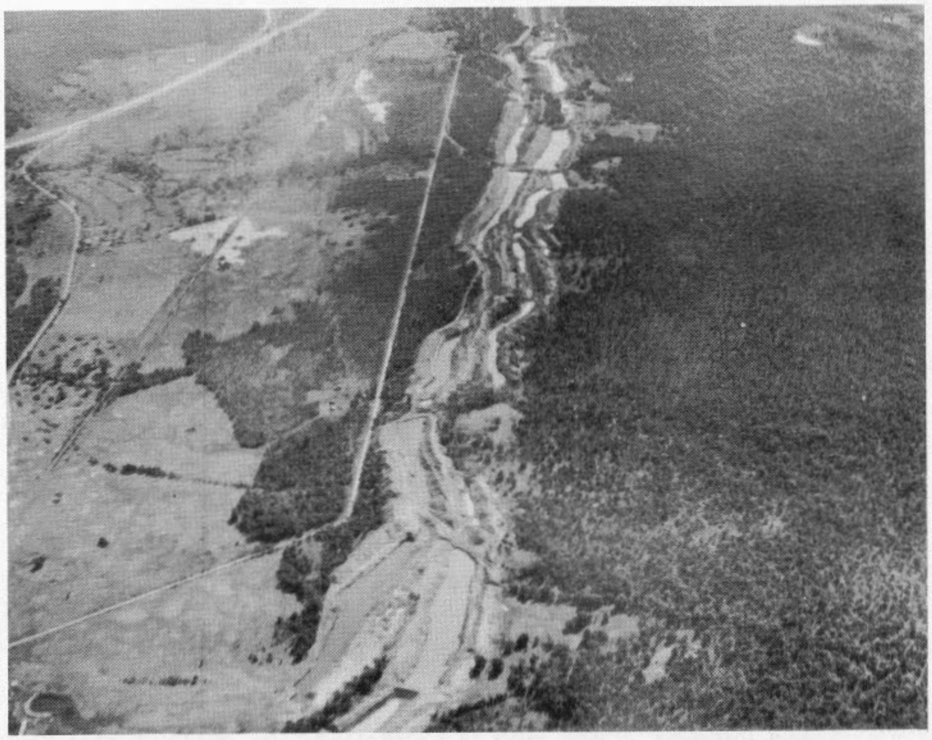

Fig. 17. -- Aerial view of strip-pit coal mines in upper Hartshorne seam near Hartshorne, Oklahoma. (Photograph courtesy Magnolia Petroleum Company)

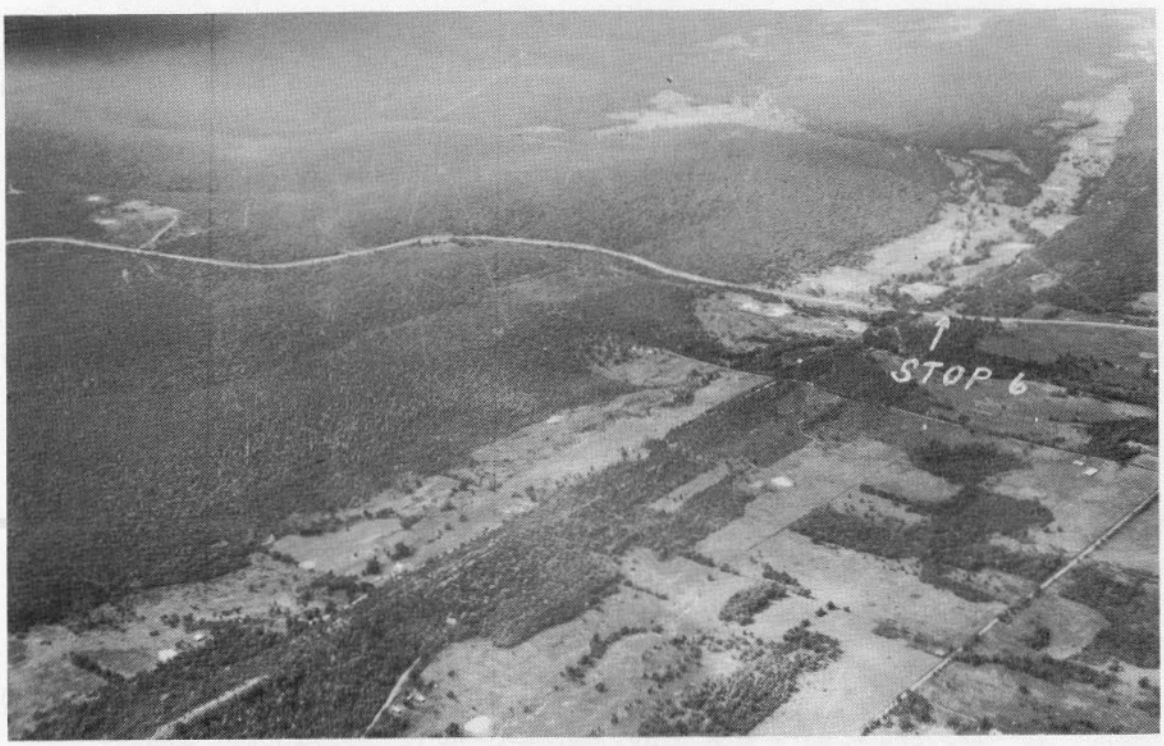

Fig. 18. -- Aerial view looking southwest at ridge underlain by Wapanucka formation, southwest of Wilburton, Oklahoma. Stop 6 is on Oklahoma State Highway 2. (Photograph courtesy Magnolia Petroleum Company)

27.4 Curve right. The Atoka formation underlies this valley for the remainder of the distance to Wilburton.

32.7 Entrance Eastern Oklahoma Agricultural and Mechanical College, Wilburton, Oklahoma.

33.1 Junction Oklahoma State Highway 2. Turn right.

33.25 Cross Chicago Rock Island Pacific Railroad tracks. The projected trace of the Choctaw fault crosses the road between this point and Stop 6 which lies just beyond the curve ahead.

34.3 Curve left and begin to slow down for Stop 6.

34.6 STOP 6. Cutbanks on west side of Oklahoma State Highway 2 just south of Bandy Creek at a location 1.45 miles south of the junction with United States Highway 271 at the southwest edge of Wilburton, Latimer County, Oklahoma.

The purpose of the stop is to examine the easternmost mapped outcrops of the Wapanucka formation. L. M. Cline and Richard Laudon have described a section the base of which begins at the north end of the road cut; the top is exposed at creek level.

Measured Section

Top	Thickness in feet
Pennsylvanian system	
Morrowan series	
Wapanucka formation	
14. Sandstone; calcareous, gray when fresh, weathers reddish-brown, cross bedded, with casts and molds of crinoid stems and other fossils. Top of section exposed near creek level where it is gray and calcareous. Remainder of zone probably was just as gray and calcareous prior to weathering.	44
13. Shale; dark blue-gray, thinly bedded, weathers platy, contains some thin zones of clay ironstone.	12
12. Shale and sandstone; the interbedded fine-grained sandstone preserves ropy fucoidal markings.	8
11. Shale; dark blue-gray, well bedded, weathers platy, containing many beds of clay ironstone averaging about one inch in thickness and spaced at intervals of one to two feet.	43

10.	Limestone; massive, medium gray, sublithographic, tops of beds are pseudo-conglomeratic or brecciated. . .	9 1/2
9.	Covered; some poorly exposed limestone.	19
8.	Limestone; poorly exposed; blue-gray, dense, sub-lithographic, pseudo-conglomeratic (algal?), seems to be massive.	13
7.	Covered; some limestone.	13
6.	Limestone and shale; poorly exposed; limestone varies from sublithographic at base to very crinoidal at top. . .	23
5.	Covered; probably shale and nodular limestone.	10
4.	Limestone; poorly exposed; blue-gray, very fossiliferous with the lower 3 feet being a coquina of crinoid stems and other fossil fragments.	22
3.	Shale; thin-bedded, dark blue-gray, weathers light gray.	15
2.	Limestone; blue-gray, composed largely of fossil fragments, some floating grains of quartz sand.	5
1.	Sandy shale; poorly exposed; shale and thin beds of fine-grained, poorly sorted sandstone with a three foot interval near the middle composed largely of sandstone; molds and casts of _Leda_, _Deltopecten_ and other molluscs; weathers to a deep reddish-brown.	19

Discussion. - It is noteworthy that the upper part of the Wapanucka includes considerable sandstone in these outcrops. The upper 44 feet of cross bedded sandstone carries a pelecypod and gastropod fauna. This member weathers brownish-red, a characteristic reminiscent of the uppermost weathered portion of the Wapanucka observed in the quarry south of Hartshorne at Stop 5 yesterday afternoon. The less weathered portions show considerable carbonate, and near creek level, at the very top of the section, the fresh rock is seen to be an arenaceous limestone. This emphasizes that the fresh rock might be called limestone and that the weathered rock might be called sandstone by the same geologist. Cline believes that the Wapanucka becomes increasingly arenaceous southward into the central Ouachitas and that it may be represented by fossiliferous sandstone lenses in the upper Johns Valley and lower Atoka formations as they have been mapped in that area.

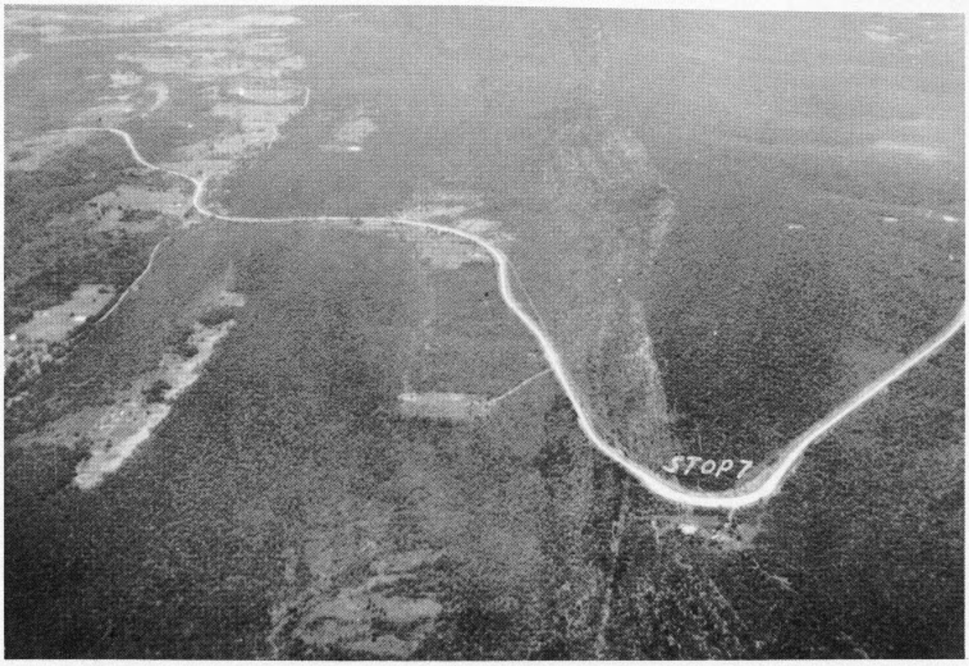

Fig. 19.--Aerial view looking west over Blue Mountain at Stop 7. Atoka sandstone and shale exposed in cuts along Oklahoma State Highway 2. (Photograph courtesy Magnolia Petroleum Company)

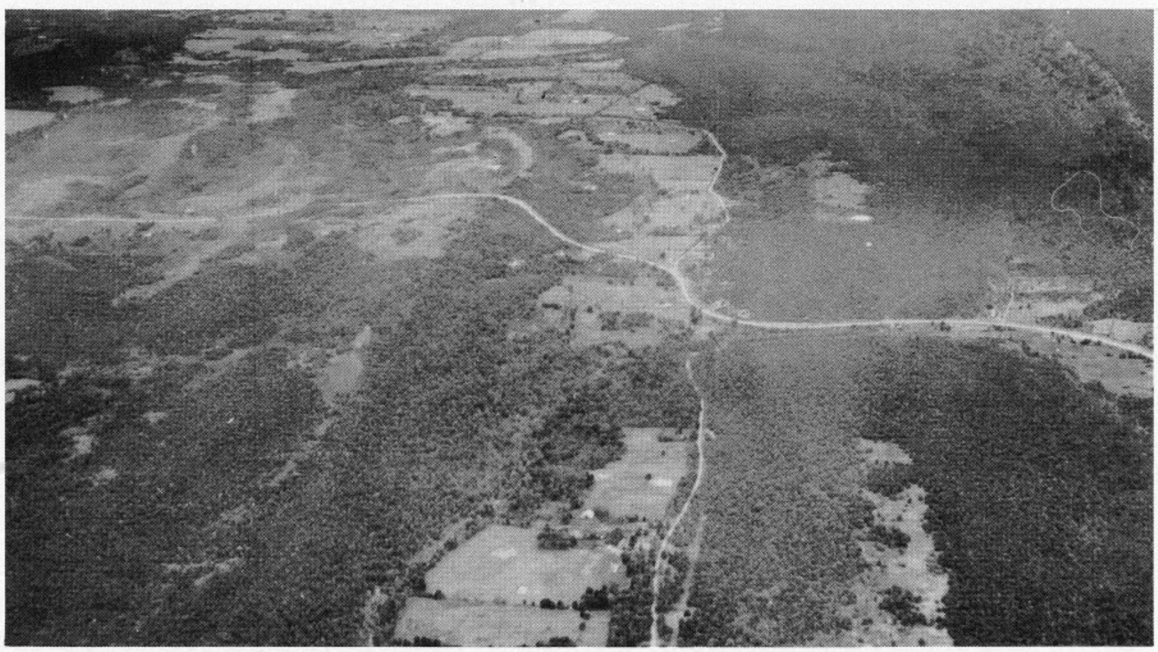

Fig. 20.-- Aerial view looking west from a point south of Blue Mountain. Stop 8, a possible klippe, is to the left of the center of the picture and along Oklahoma State Highway 2. (Photography courtesy Magnolia Petroleum Company)

Return to busses.

34.65 Bandy Creek bridge.

35.05 Curve right. South dipping sandstones in Atoka formation show well developed flute casts.

35.55 Curve left.

36.25 Curve left and begin ascent to crest of Blue Mountain. Shale, sandy shales, and sandstones of Atoka formation in road cut on right side of road.

37.35 STOP 7. Summit of Blue Mountain. This is a brief stop for the purpose of viewing Windingstair Mountain to the south.

Return to busses. We will be traveling on the Atoka formation for the next 2 1/2 miles to the next stop. A geologist seeing this area for the first time might have difficulty in distinguishing between the Jackfork and Atoka formations. In general, the Atoka formation in this part of the Ouachitas has considerably less sandstone than the Jackfork, the sandstone-shale ratio would probably be about 2:3 whereas in the Jackfork the ratio would be more on the order of 3:2 or perhaps even 2:1.

39.90 STOP 8. A brief stop to observe a possible klippe. The flat-lying sandstone on the left (east) side of road rests in fault contact with contorted shales below. J. V. Howell considers this a good example of flat thrusting that has produced crumpling of underlying shales. He believes that this is a remnant of a thrust sheet whose trace is farther south. On the west side of the road the sandstones in the thrust plate occupy a lower topographic position.

40.55 Tight isoclinal folds in Atoka formation in road cuts.

40.95 Gaines Creek bridge.

42.45 Entrance to United States War Veterans Colony on left.

42.65 Road curves right. Atoka sandstone; the flute casts would indicate that the beds are overturned.

43.55 Curve left. Note tight isoclinal folds on left.

44.65 Curve right. Atoka beds dipping north.

45.25 Curve left. Approximate position of the Ti Valley fault. Intersection of State Highway 63 ahead.

45.35 Johns Valley shale to right and left of road. Limestone pebbles, cobbles, boulders of Arbuckle facies are numerous. According to Bennison, Woodford type erratics are predominant.

46.15 Sharp curve to right. Atoka beds dipping south.

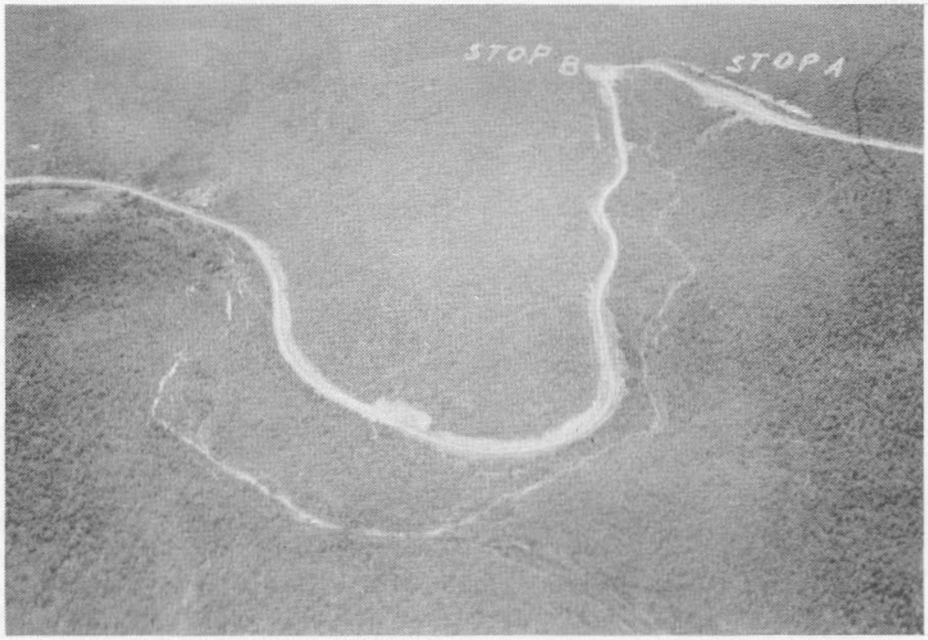

Fig. 21. -- Aerial view looking west toward Hairpin Curve (upper right) and Stop 9, about halfway between Wilburton and Clayton. The beds at Stop B are overturned to the north; the beds at Stop A dip north and are right side up. (Photograph courtesy Magnolia Petroleum Company)

47.55 STOP 9. Party will disembark and walk downhill studying the exposures and will board busses later at the hairpin curve. It is hoped that 1 1/2 hours can be allocated to this stop.

Description Of Strata Exposed Along Oklahoma State Highway 2, About Midway Between Wilburton and Clayton, In The South Part Of Sec. 3, T. 3 N., R. 19 E., Latimer County, Oklahoma. Described By L. M. Cline and Richard Laudon, August, 1958.

Stop A. Exposures in west side cutbanks of road beginning near concrete culvert and continuing downward to covered interval.

Measured Section

Top | Thickness in feet

Atoka formation

23. Shale and sandstone; dark blue-gray laminated shale comprising 60 to 65 percent of the interval; interbedded sand-

	stone in beds as thick as 6 feet. Flute casts abundant on lower surfaces of sandstones. Shale units as thick as 20 feet. Exposed below culvert.	335
	About the same thickness of Atoka is exposed above culvert.	
22.	Sandstone; hard, convolute bedding near top; casts of reed-like plants on base of bed, one being nearly 5 feet long, of uniform thickness, and with longitudinal ribs. . .	3 1/2
21.	Shale; medium gray, laminated, silty.	8 1/2
20.	Shale; gray, lower 2 feet dark gray to black, may be siliceous.	3 1/2
19.	Shale; medium gray, laminated silty.	3
18.	Sandstone; hard, laminated but weathers massive.	0.8
17.	Shale with thin beds of sandstone; dark gray, almost black, upper 2 feet siliceous; 4 sandstone beds in interval, each averaging only 3 inches but with prominent load and flute casts on under surfaces; beds slightly overturned.	7
16.	Shale; dark gray to black, thinly bedded, some clay-ironstone concretions.	10
15.	Sandstone; beds as thick as 3 feet; cut by small fault on north; convolute bedding and bottom markings abundant.	47
Johns Valley formation		
14.	Shale; dark gray, fissile	6
13.	Shale; poorly bedded, includes rolled sandstone masses; poorly exposed	12
12.	Sandstone; includes beds as thick as 3 feet; some shale . .	10 1/2
11.	Shale; gray	2 1/2
10.	Sandstone; massive contains a sandstone mold and cast fauna of marine invertebrates; stained brown	2
9.	Sandstone; in beds 4 to 5 feet thick	19
8.	Shale; gray, thinly bedded, weathers buff	5
7.	Sandstone and shale; sandstone predominating, weathers light gray, in massive beds the thickest of which is about	

2 feet; shale dark blue-gray, finely laminated. Some sandstone beds have flute casts and intricate convolute bedding. 38

6. Clay shale; with pebbles and cobbles of limestone erratics and masses of rolled sandstone; may be a repetition of upper part of zone 4. 16

5. Infolded sandstone and shale in small drag fold; in fault contact with underlying shale; probably belongs higher stratigraphically 32

4. Clay shale with included limestone boulders; the lower 11 1/2 feet occupies a channel cut into the underlying zone 3; limestone erratics are so thick that it resembles a coarse conglomerate; some of the boulders have diameters up to 2 feet. The upper half of the zone is a drab-weathering claystone which includes large masses of rolled sandstone of depositional origin; it also contains smaller limestone erratics 45

3. Sandstone and sandy shale; sandstone predominating, in beds as thick as 3 feet but averaging only 4 inches in upper portion; interbedded and laminated shale contains occasional limestone erratics. Abundant animal trails on upper surfaces of sandstones; a thin conglomerate 6 feet below the top. 23

2. Shale; dark blue-gray, laminated, weathers into small plates and chips; beginning 17 feet above the base numerous limestone erratics averaging 3 to 4 inches in diameter (but up to 1 foot) occur; they appear to have undergone some weathering prior to deposition in the shale. Some thin beds of fine-grained sandstone show numerous animal trails on upper surfaces and irregular load casts on under surfaces. One massive sandstone bed 4 feet below top. Some clay-ironstone concretions in shales. Upper 4 feet of shale contains abundant erratics and is well bedded 31

1. Gray silty shale; weathers drab; about 35 percent of interval composed of thin-bedded siltstone with sandstone beds up to 2 feet thick. Sandstone beds show convolute bedding and flute casts 36

Discussion. This most publicized of all Johns Valley localities has been visited by many geologists including those in attendance during the 1947 Tulsa Geological Society Field Conference in the Ouachitas. Hendricks and Averitt published a description and included two photographs of the Johns Valley at this locality in the guidebook (pp. 32-34). The

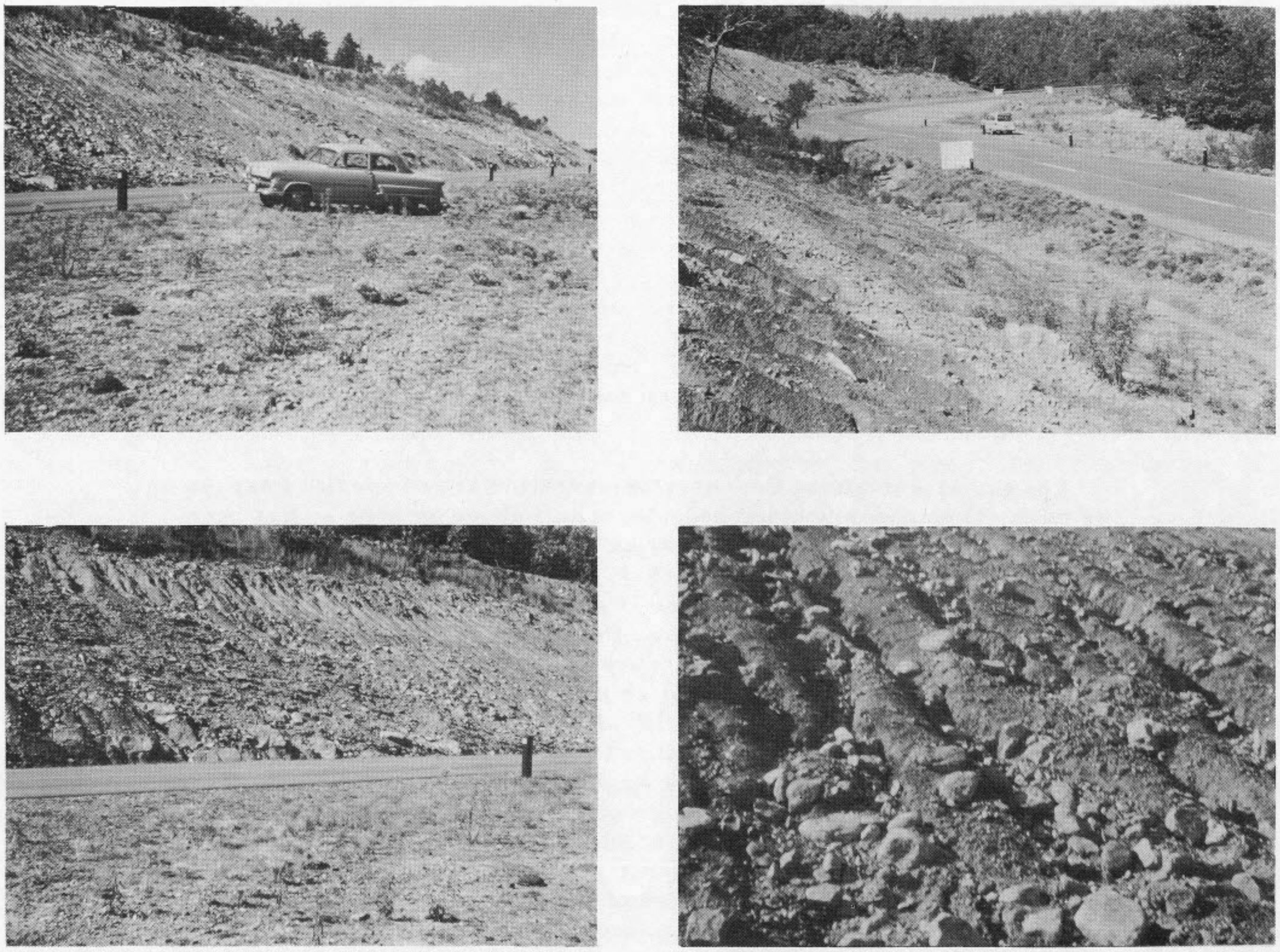

Fig. 22. -- Johns Valley shale in cutbanks along Oklahoma Highway 2, south part Sec. 3 T. 3 N., R. 19 E., about midway between Clayton and Wilburton. Upper left: boulder beds in upper part of Johns Valley; Atoka sandstones dipping right (north) on right side of photograph. Upper right: typical black, concretionary Caney shale lithology in lower part of Johns Valley; south of curve; beds are overturned and dip 35 degrees to left (south). Lower left: boulder-bearing shale resting in channel cut through shales and sandstones in upper Johns Valley; possibly cut by turbidity current which deposited the boulder beds. Lower right: boulder-bearing channel fill. Photographs by L. M. Cline.

strata are now much better exposed than when these men studied them because of recent widening of the road.

The lower portion of the Johns Valley is exposed at Stop B south of the hairpin curve. The upper Johns Valley, described above as Stop A, occurs in its normal stratigraphic position beneath the Atoka formation. We believe this contact is gradational and arbitrarily place it between zones 14 and 15. Some geologists may prefer to include the sandstone of zone 9 in the Atoka; this is a matter of opinion. The sandstone mold fauna of zone 10 has been examined by Dr. M. K. Elias who thinks it is Morrowan. The siliceous shale of zone 17 is placed in the lower Atoka by Hendricks who says it is widespread in the Ouachitas. Cline believes that this spiculitic zone correlates with some part of the upper Wapanucka of the frontal Ouachitas. If this correlation is correct, the lowermost part of the Atoka formation in the central Ouachitas includes some Morrow equivalents. One might expect lithology to transgress time lines as the Atoka is traced from the northeast Oklahoma platform into the Ouachita geosyncline.

The shales containing the limestone erratics are of special interest. The most conspicuous boulder bed, described above as zone 4, has been interpreted by some as a friction carpet at the base of an advancing thrust sheet. This boulder-bearing clay-shale rests in a channel which cuts out at least 11 1/2 feet of zone 3. There is a noticeable decrease in the size of the erratics upward in this deposit, the overall effect being not unlike that of graded bedding, but it is of course on a somewhat larger scale than the usual examples. The erratics in the lower part of the channel fill include well rounded boulders with diameters in excess of a foot, slightly rounded blocks of similar dimensions, the whole being embedded in a clay-shale matrix. Upward the boulders give way to cobbles and they in turn give way to pebbles which are widely separated in the shale and give a plum pudding effect. Throughout this deposit there are rounded masses of a hard, brown, quartzitic sandstone. We interpret this particular boulder bed as the product of a single turbidity flow or submarine slide. The flow initially attained a high velocity during which phase it was able to transport boulders and scour previously deposited muds and sands. As the peak of the flow was reached and the velocity trailed off, pebbles began to drop out and were deposited with the muds of the flow and the muds obtained from the reworked bottom. The rolled sandstone masses represent lenses of sand torn from the bottom and rolled along the flow. The convolute bedding and the flute casts on the undersurfaces of some of the sandstones support the general view that turbidity currents were operative during this time.

The small size erratics in zone 2 may have been dropped into accumulating muds by melting ice floes but again the included sandstone beds show the structural characteristics now thought of as being associated with turbidity flows. Maybe turbidity flows are being overworked!

<u>Stop B</u>. The lower Johns Valley is exposed south and southeast of the

hairpin curve. Between Stops A and B there is a covered interval of unknown thickness. The problem is complicated because the lower Johns Valley south of the curve is overturned; and because there probably is a strike fault between Stops A and B.

Description Of Lower Johns Valley Exposed South and Southeast Of The Hairpin Curve. Note That Strata Are Overturned and That Zone One Is At The Top Of The Cutbank. Described By L. M. Cline and Richard Laudon.

Measured Section

Stratigraphic Top	Thickness in feet
Johns Valley shale	
5. Shale; typical Mississippian Caney shale; black, laminated, includes several zones of siltstone that weather light gray; many rounded phosphatic concretions the size and shape of marbles, some contain goniatites including *Lyrogoniatites*. Exposed to road level	27
4. Shale; dark blue-gray, platy, with some zones of lighter colored clay shale; includes some lenticular beds of clay-ironstone and rolled masses of hard, fine-grained sandstone which shows convolute bedding. Limestone erratics are embedded in some of the gray clay-shale. Some small drag folds	59
3. Shale and siltstone; interlaminated dark gray shale and brown-weathering siltstone with shale predominating; contains some clay-ironstone concretions	15
2. Shale; jumbled appearance; alternating gray shale and brown silty shale including some beds of hard fine-grained sandstone as thick as 6 inches. Upper surfaces of sandstones have meandering animal trails, the lower surfaces have prominent load casts. Lenses of conglomeratic sandstone. Rolled sandstone masses prominent. Many features of turbidity flow deposition. Beds dip 34 degrees southeastward into the hill; note that dips become successively lower higher in the cut; actually, the lowest dips have the greatest structural disturbance because the entire section is overturned	16
Game Refuge sandstone	
1. Sandstone; only the top 5 feet described. In beds from 2 inches to 3 feet thick; medium-grained to fine-grained, weathers light gray with iron-stained surfaces; contains	

Lithologically and petrographically the Game Refuge is not significantly different from other sandstones in the Jackfork but its sedimentary structures are quite distinct. It is commonly ripple-marked in contrast to the underlying sandstones, it has cross bedding, it contains molds of a marine invertebrate fauna, and it has abundant fragmentary plant remains including an occasionally well preserved Calamites. Bottom markings are rarely found on the sandstone beds and convolute bedding is rare. This formation persists over a large area as a fairly pure sandstone and all-in-all gives evidence of having been deposited under moderately stable platform conditions in contrast to the turbidity flow characteristic of the older Jackfork sandstone.

49.35 Road curves right. Wesley siliceous shale member of Jackfork formation exposed on right hand side of road. An interesting type of sedimentary breccia, in which chert is conspicuous, is present in some of the beds near the south end of the cut, near the base of the Wesley. Hendricks has collected Goniatites from clay-ironstone concretions of the Wesley at this locality.

49.95 Curve left.

50.75 The east-west trending Potato Hills are seen directly ahead. They are underlain by the pre-Stanley cherts of the Ouachita facies and the outcropping beds range from the upper Arkansas novaculite downward to the Womble shale.

51.35 Johns Valley shale in cutbank on both sides of road. Boulder bearing shales crop out in creek, about 100 yards east of the highway.

51.45 Approximate location of Windingstair fault. Questionable boulders of Jackfork sandstone in fault gouge.

51.65 Intersection of State Highway 63. This locality is known as Talihina Junction. Buses will turn left into roadside park where lunch will be served.

Re-enter buses and continue on State Highway 63.

51.75 East end of "Y", State Highway 63. For the next six and one-half miles the road will be on Stanley shales. To the left front is Buffalo Mountain, a Jackfork sandstone synclinal mountain. The Windingstair fault lies just north of Buffalo Mountain, the north side of the low-lying Potato Hills are to the right. The Stanley shale is the most important valley-former in the Ouachitas, inasmuch as it is comprised of about 10,500 feet of soft greenish-gray shale with occasional sandstone members.

53.55 Buffalo Valley School on left.

54.55 Bridge over Buffalo Creek. On the right the northernmost ridge of the

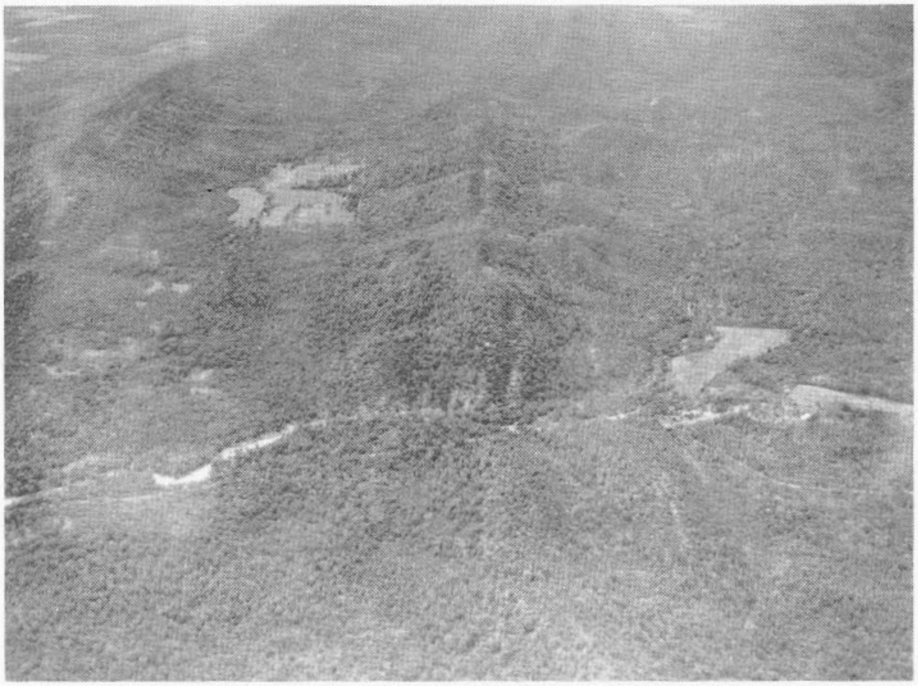

Fig. 23.--Aerial view looking east from a point over the west end of the Potato Hills. Stop 10 B is where the creek cut through ridge in center foreground. Stop 10A is farther along creek to left and just out of view. (Photograph courtesy Magnolia Petroleum Company)

Discussion of Stop 10 A (Stop 4 on Bennison and Johnson map). The "fenster" fault which is thought by some workers to surround the Potato Hills has been mapped through this area. Upstream to the east is an overturned and faulted syncline of Stanley shale and sandstone. On ridge about 600 feet east of ford are similar en-echelon synclines involving the Arkansas novaculite. It has been suggested by some that these synclinal features may be inverted anticlines on the diving tip of a nappe but superposition criteria indicate them to be in normal repose.

If the stream is at a low level we will walk upstream to Stop B at the chert ridge to the south. The limited exposures indicate an intervening syncline consisting of Stanley shales and sandstones. The Stanley is overturned in the vicinity of the chert ridge.

Discussion of Stop 10 B (Stop 3 on Bennison and Johnson map). A faulted anticline which involves the entire sequence from upper Womble Ordovician to lower Stanley Mississippian is exposed in the cliff sections along the stream. Upstream and southward you may note in sequence the following components of this anticline:

1. An almost vertical fault zone separating the Stanley and Womble formations. Horse and boudinage blocks of intervening formations are incorporated in the fault zone. Also note that the lower tip of the ridge forming Bigfork chert has been truncated by an almost horizontal offshoot of the main fault which has dragged Womble shale to the south.

2. Contorted Womble shale in anticline. Note that the south border of Womble shale is highly slickensided by probable bedding plane slippage between Womble shale and Bigfork chert.

3. Bigfork chert slightly overturned toward the south. Near the top of this formation a coarse boulder bed or intraformational conglomerate is exposed in the stream bed just above the ford.

4. Thin Polk Creek shale (Upper Ordovician) section with thin dolomite streaks. Similarity to Sylvan shale is striking.

5. Thin Missouri Mountain slate (Silurian). Platy siliceous shale with limonitic vugs is characteristic of this formation. Note highly oxidized zone at top of formation and silty layers at base.

6. Tripartite Arkansas novaculite formation (Devonian and Lower Mississippian?). The lower novaculite member contains curious stromatolite-like algal bodies that are low conical in shape and are pointed upward in reference to original bedding plane. This provides an important superposition criterion. The middle member contains much sporangeous black shale with fossil wood. The upper member is predominantly chert.

7. The lower Stanley formation (Lower Mississippian). A thin one inch gritty sand supposedly separates the Arkansas novaculite from the interbedded chert. Red shale with pencil cleaveage and conodont bearing siliceous shales may also be noted.

This anticline in our opinion is simply an isoclinal fold that has ruptured along part of its north flank through overstretching. The aforementioned fault appears to fade out in a short distance on both the east and west plunge of the anticline. Yet the fault zone exposed at this stop is more prominent than some of the few known outcrops of the so called "fenster fault", which supposedly involved many miles of displacement.

Stop 10 on this trip will be the same as Stops 3 and 4 on the map of this area of the Potato Hills (in pocket) prepared by Allan M. Bennison and Norman L. Johnson. Dr. Bennison will lead the discussion at this locality. Return to the buses.

Retrace route to State Highway 63.

70.6 Crossroads. Very narrow turn. Turn left.

71.1 Intersection State Highway 63. Turn right.

73.2 To the front and right is an inlier of Arkansas novaculite which is caused by a faulted anticline.

73.9 Road cuts in Stanley formation.

75.1 Dark green Stanley shale in cuts ahead.

75.8 Stanley.

76.6 Entrance to Eastern Oklahoma State Tuberculosis Sanitorium.

77.6 Bridge.

77.8 Enter Le Flore County, leave Latimer County. To the south is a very nice view of the east face of the Kiamichi range. This scarp is held up by resistant Jackfork sandstones which dip steeply southward into the Lynn Mountain syncline. Directly ahead to the east is the Windingstair range.

78.0 Hill of greenish gray Stanley shale on the right. Bridge.

78.35 City limits of Talihina.

78.4 Cross S. L. and S. F. railroad tracks.

78.5 Junction of United States Highway 271 and State Highway 63. Continue straight ahead. Highway 271 to the left crosses the Windingstair range between Talihina and Wister. A recent road building program has produced some beautiful exposures of the Jackfork, the boulder bearing Johns Valley and the Atoka formation. Unfortunately, the Oklahoma Highway Commission is making an effort to grow grass on these fine cuts, and the shales will soon be largely obscured.

79.0 Curve to the right.

79.2 State Highway 63 turns left and continues to the east. We keep to the right and follow United States Highway 271.

80.1 Bridge. We are now going south over a wide valley underlain by Stanley shale.

80.9 Concrete slab bridge. Curve to the left.

81.6 Concrete slab bridge. Good view of the Kiamichi Mountain in the distance.

81.9 Curve to the left.

82.1 Stanley shale and sandstones dipping south. Potato Hills lie directly west.

Fig. 24.-- Looking southeast from Kiamichi Post Office toward north escarpment of Kiamichi Range. (Photograph by L. M. Cline)

82.8 Prairie Creek

83.2 Stanley shale and sandstones dipping south in the cut and on the left in the meadow.

83.5 Intersection of United States Highway 271 and Indian Service road. We take the left hand road at this intersection.

84.35 Road cuts in alternating sandstones and shales in the Stanley, dipping about 45 degrees to the south. There are a number of sandstone members in the Stanley that seem to be moderately persistent although individual beds are discontinuous.

85.0 Crossroads; sharp right turn to west.

85.5 T-intersection; turn south (left).

86.1 Bridge over Kiamichi River.

86.55 T-intersection; turn east (left).

87.05 Crossroads; turn south (right).

87.75 South-dipping Stanley sandstones. This road extending southward from Albion through the Kiamichi country to Broken Bow is known to residents of this area as the Indian Service Road. As the road winds up the north face of the Kiamichi Range the cuts expose an almost continuous stratigraphic section from the Chickasaw Creek siliceous shale of the Stanley throughout the Jackfork and well up into the Atoka. This was the first complete and unfaulted section of the Jackfork to be described in detail (Cline and Moretti, 1956), thanks to a recent road building program.

89.35 A shale pit on the east (left) side of the road exposes some interesting structural features on the bottom surface of a sandstone in the Stanley. Some circular depressions attaining diameters of two to three feet show some concentric step faults which Cline has referred to as percussion structures (Cline, 1956, Ardmore Geological Society Guidebook, Fig. 5, p. 56). A picture of one of them is referred to below. This picture is reproduced as Fig. 25 of this guidebook.

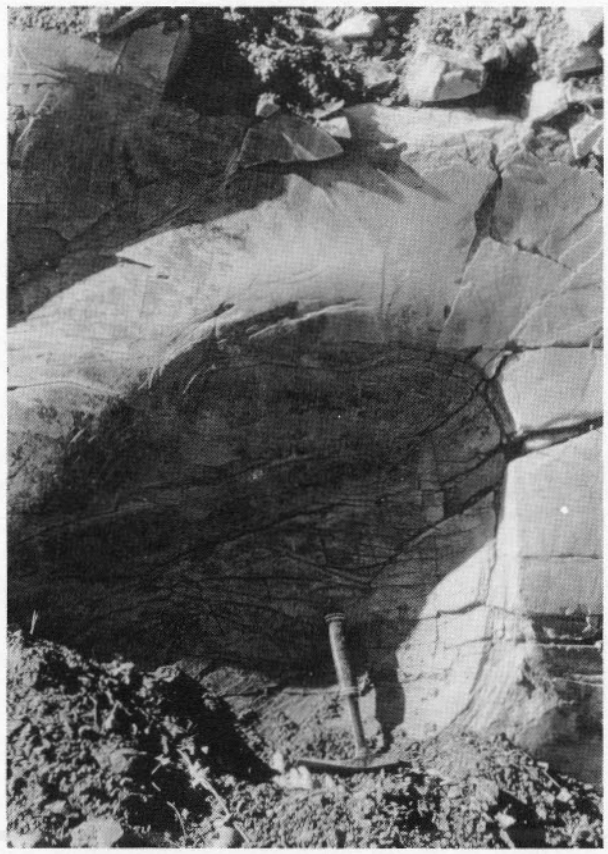

Fig. 25.-- Circular "percussion" fracture pattern in lower surface of vertical bed of Stanley sandstone. This is one of several such depressions affecting the under side of this bed. The sandstone is interbedded with thicker shales and during folding the upper surfaces developed small low domes which projected upward into the overlying shale. (Photograph by L. M. Cline)

Immediately south of the pit a thin, hard, black siliceous shale is exposed on both sides of the road. Max Elias has made a collection of conodonts from this locality. In the 1956 Ardmore Geological Society guidebook Cline referred this siliceous shale to the Moyers formation but Richard Laudon, who is currently making a stratigraphic study of the Stanley group, classes this as the basal bed of the Chickasaw Creek siliceous shale and Cline agrees with his correlation.

89.6 STOP 11. Dark siliceous shale in the lower Chickasaw Creek formation. The shale includes some thin beds of black chert which contain numerous small white areas of silica, some of which have radiolaria as nuclei. This speckled chert is so characteristic that where pieces of float are abundant one can be reasonably sure that the Chickasaw Creek formation is nearby.

89.75 More speckled chert. This marks the top of the Chickasaw Creek formation.

90.6 STOP 12. Lower contact of the Prairie Hollow shale. This variegated shale and sandstone is a member of the Wildhorse Mountain formation and lies well below the top of the lower third of the Jackfork group. It has been a pleasant surprise to find that this red clastic member is an excellent stratigraphic datum throughout the Ouachita Mountains. Its position can readily be determined on aerial photographs by the characteristic grid pattern of the steep short gullies that come in at right angles to the prominent strike valley. The top of the member is exposed at mileage 90.7 where on the right (west) side of the road it may be seen to be overlain by some dark shale with thin, hard, quartzitic beds of fine sandstone. These sandstones weather brown but fresh surfaces are very white.

90.9 The lowest outcrops of some very massive sandstones in the middle of the Jackfork group. These sandstones of the upper Wildhorse Mountain formation, together with some equally massive beds in the lower part of the overlying Prairie Mountain formation, form the crest of the Kiamichi Range. They are very resistant and form ridge crests throughout the Ouachitas.

91.15 Hairpin curve; sharp turn to right (west). These massive sandstones lie near the boundary of the Wildhorse Mountain and Prairie Mountain formations. The lower surfaces of some of the beds near the turn have a fine development of flute casts and flow casts (see Fig. 26). Cline is now engaged in a study of the directional properties of the Jackfork and Atoka sandstones. Most of the readings thus far obtained on the Jackfork sandstones indicate currents flowing west 12 degrees south, down the axis of the Ouachita geosyncline as though the trough were filled from the east. A smaller number of readings on the overlying Atoka sandstones would seem to indicate northwest-flowing currents for the Lynn Mountain area in Atoka time. As yet sampling is inadequate and any conclusions on source areas would be premature.

91.45 At approximately this position there is a coarse sandstone with abundant

Fig. 26.--Flute casts, flow casts, groove casts, and load casts characteristic of under surfaces of sandstones of Wildhorse Mountain formation. Widely used as a building stone in the Ouachitas. The Mike Emery dwelling, Kosoma, Oklahoma. (Photograph by L. M. Cline)

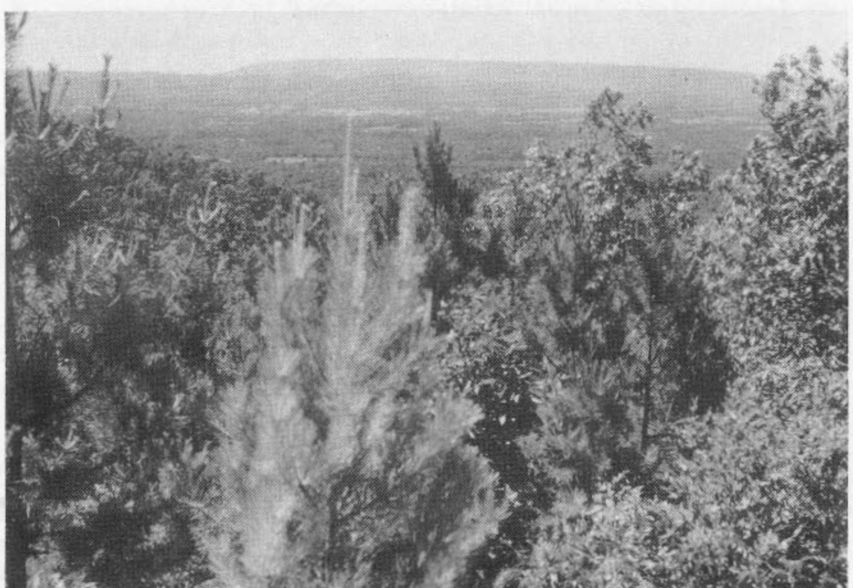

Fig. 27.-- Looking northwest toward the Potato Hills from Kiamichi Mountain southeast of Albion, Buffalo Mountain on the skyline to the center and right, is a syncline in which the Jackfork is preserved. (Photograph by L. M. Cline)

white quartz fragments of granule size. Cline has observed quartz granule conglomerate at approximately this same stratigraphic position at several places in the central Ouachitas.

91.6 At this point the Potato Hills may be seen rising out of the Stanley Valley to the northwest (see Fig. 27). The town of Albion is in line with the east end of the hills.

92.6 STOP 13. Wesley shale exposed in cuts and gullies on east (left) side of road just south of curve. The Wesley has proved to be one of the most persistent stratigraphic units in the Jackfork. In this locality may be seen some rhomboidal blocks of chert that are derived from a six or eight inch bed near the top of the formation. The chert is almost black when fresh but it weathers to a characteristic green-gray color. Some of the pieces have gray to white silica in the form of laminae or as spherical to almond-shaped areas. Some weathered pieces have a speckled appearance not unlike the Chickasaw Creek cherts and when abundant chert float is found care must be taken to distinguish between the two. With reference as to how this correlation has been made, the Wesley produces a strike valley that is easily followed on aerial photographs from near Antlers at the southwest end of the Lynn Mountain syncline, northeast and then east almost to the Arkansas line.

After having examined the Wesley, walk southward down the hill. The first important sandstone on the east (left) is the Game Refuge sandstone, the topmost sandstone in the Jackfork group. Observe the well defined bedding planes, the ripple marks, and worm trails that characterize this sandstone. The shale and sandstone interval that lies above the Game Refuge sandstone may be the Johns Valley shale. On the basis of stratigraphic position it should be Johns Valley and this correlation is borne out by tracing of a strike valley eastward from Clayton where it definitely is known to be Johns Valley. Just southwest of Clayton the Johns Valley has its typical development with tongues of the black laminated Mississippian Caney shale in the lower portion and with abundant boulders and blocks of limestone erratics from the Arbuckle facies. The prominent strike valley which develops in the Johns Valley can be traced from Clayton eastward to this locality but careful search has thus far failed to reveal limestone erratics in the outcrop belt east of Oklahoma State Highway 2.

At mileage 93.0 we will observe some blocks of a fossiliferous sandstone. The sandstone has much material of granule size and could perhaps be described as a conglomerate. It contains numerous molds and some casts of bryozoans, brachiopods, and crinoid columnals, all in a fragmental condition. Weathering has largely removed the carbonate skeletal material at this and most other localities where it has been observed, but at the locality in the Boktukola syncline where Honess first found the fossils some shell material yet remains. The zone seems to be rather widespread, being found at numerous localities. Whether the various occurrences are to be referred to precisely the same stratigraphic position is not known. Honess (1924) referred the fossiliferous sandstone of the north side of the Boktukola syncline to the Morrow on the strength of fossil identifications made by Schuchert and Girty. Max Elias has studied collections from Honess' locality and several other localities discovered by Cline and all of his determinations suggest a correlation with Honess' Glover Creek locality. Honess mapped this zone for several miles east and west of the discovery locality on the north side of the Boktukola syncline but Shelburne has not been able to trace the same bed around the east end of this syncline. Cline would like to suggest the possibility that the fossils were debouched from a platform or shelf environment into the geosyncline, possibly by turbidity flows. If this is the correct explanation of how these shallow water organisms came to rest in what otherwise seems to be a deep water environment, one would not expect individual fossiliferous sandstone beds to be continuous over large areas. Further, one might expect this type of rock at more than one stratigraphic level. At any rate, Morrow fossils occur in Johns Valley and Atoka lithologies in the central Ouachitas.

From this point south and southeast to the community of Honobia the road traverses Atoka shales and sandstones preserved in the Lynn Mountain syncline. The first valley south of the fossiliferous sandstone locality is underlain by a thick gray shale in which some thin siliceous (and at times cherty) shales occur. Fresh road cuts reveal a high proportion of shale in the Atoka. At Honobia the south limb of the Lynn Mountain syncline has been cut off by the Octavia fault, thus bringing Stanley shale in contact with the Atoka sandstone. As we approach the fault zone you will note numerous reversals in dip, and, in the crushed zone near the fault, steep dips and some overturning in the Atoka.

99.5 Road curves left (southeast) and begins descent of long grade into the valley of Little River. The valley is anticlinal, is developed in the Stanley shale and the north (nearest) limb is faulted. The timbered ridge to the south is the north rim of the Boktukola syncline, the rocks dipping south away from the observer.

99.75 Note steep dips in Atoka. This is in the Octavia fault zone, the main fault being just south of us. Several reversals of dip will be observed in the descent to Honobia at the foot of the mountains.

101.4 STOP 14. Disturbed beds in the Octavia fault zone. The dark blue-black siliceous shale is in the Stanley group. Back upslope the exposed sandstones are in the Atoka formation. The Octavia fault lies somewhere between.

101.9 Honobia Post Office and Store.

The Field Trip terminates at Honobia Post Office and Store. An alternate continuation of the road log route is offered for persons interested in continuing to Broken Bow, along which route the Choctaw anticlinorium is traversed.

The buses will return to Dallas, Texas via the Honobia-Nashoba-Antlers route.

102.4 Bridge over Little River.

102.8 Cross roads. Turn right.

107.3 "Little River Hotel" entrance on right.

108.3 Fork in road. Bear right. Road curves right and descends hill.

109.7 Little River. SLOW. Low water crossing.

111.6 "Bower Trail Road" enters from right. Continue straight ahead (west) through town of Fewell.

111.85 Concrete slab. Low water crossing.

112.05 Road enters from left. Continue straight ahead.

115.8 Concrete bridge.

116.25 Road enters from left. Continue straight ahead.

117.7 Wooden bridge.

119.6 "Dump Ground Road" on left.

121.05 "Trails End Road" on left.

121.7 School on left.

122.1 Nashoba Post Office on left. Continue west on winding road.

123.75 Concrete bridge.

124.9 Concrete slab low water crossing.

126.15 Road forks. Bear left.

126.3 Junction with Oklahoma State Highway 2 and United States Highway 271, turn left (southwest) towards Antlers.

A right turn will lead to Clayton and Wilburton and a junction with United States Highway 270.

END OF LOG

ALTERNATE ROAD LOG

HONOBIA POST OFFICE TO BROKEN BOW OKLAHOMA

(Modified from Ardmore Geological Society Ouachita Mountain Field Conference, 1956, pp. 48-51.)

Preliminary statement. From Honobia, in Le Flore County, southward to Broken Bow in McCurtain County, this route traverses the Boktukola syncline, the Boktukola fault, the Cross Mountains anticlinorium, the Linson Creek synclinorium and the Choctaw anticlinorium, in that order. Because the original objective of the Ardmore Society's trip (on which information this supplementary log is based) was a study of the Mississippian and Pennsylvanian strata, a detailed log of the pre-Stanley section is not given. One interested in studying the older Paleozoics is referred to a road log prepared by William D. Pitt of the University of Oklahoma, pp. 43-45 Ardmore Geological Society 1956 Guidebook and to Honess' original map in Oklahoma Geological Survey Bulletin 32, plate I.

Stops 15 and 16 are arranged for views of the northern limb and the axis of the Boktukola syncline, respectively.

The Boktukola fault crosses the traverse between Stop 16 and Bethel. At Bethel, the projected axis of the Cross Mountains anticlinorium is crossed. Between Bethel and Stop 17 we will cross the westward extension of the Linson Creek synclinorium.

At Stop 17 a volcanic tuff in the lower Stanley may be examined. This tuff is the only persistent map unit that has been recognized in the lower Stanley in this part of McCurtain County.

101.9	Honobia Post Office and Store.
102.4	Bridge over Little River.
102.7	Cross roads. Continue straight ahead.
103.5	Cross creek. The water gap just traversed was through a hogback formed by sandstone in the lower Wildhorse Mountain formation. A short distance north of the ridge is the Stanley-Jackfork contact. It is not known to be a fault contact.
105.7	Flashman Tower road on right.
106.35	Intersection with Boktukola Trail on left.

106.6 Road cut in sandstone in upper Prairie Mountain formation. Laminated shales interbedded with thin, evenly bedded, hard, quartzitic sandstones and siltstones which weather light gray is a characteristic association.

107.4 STOP 15. Location in the SW 1/4 SW 1/4 sec. 2, T. 1 S., R. 23 E. Siliceous shales in top of Jackfork (in the present restricted sense; this would be in the upper part of Honess' Lower Jackfork), exposed in cutbank on west side of road. Note south dip on north limb of Boktukola syncline. The dark siliceous shales contain one or more thin beds of dark chert and are correlated by Cline with a similar characteristic shale and chert at the top of the Jackfork in the Kiamichi Range. They are tentatively correlated with the Wesley of the Tuskahoma syncline. One can observe that by projecting the south dip these beds should lie a few hundred feet below the fossiliferous Morrow sandstone; the interval is estimated to be from 300 to 400 feet. The sandstone immediately above the shales in the road cut contains a few crinoid columnals and some fucoids.

107.9 Intersection with old logging trail on right (west). Beginning about one-half mile west and continuing downstream for quite some distance, are blocks of fossiliferous sandstone which contain a sandstone cast fauna. The blocks come from the faunal zone the trace of which Honess (1924) shows on his "Geologic and structure map" of southern LeFlore and northwestern McCurtain counties. The fauna that he (pp. 14-16) lists was collected from the southern part of sec. 6, T. 1 S., R. 23 E., from 3 1/2 to 4 1/2 miles from your present location. The fossils occur as molds and casts in a relatively coarse-grained, ferruginous sandstone, which becomes somewhat friable upon being weathered. Honess (p. 14) states that the zone lies about 6,000 feet above the base of the Jackfork sandstone. His estimate coincides nicely with the thickness of this same interval as determined by L. M. Cline and Frank Moretti in outcrops along the Indian Road in the Kiamichi Range at a locality almost exactly 12 airline miles from your present location.

From collecting localities west of us, Honess collected 4 species of corals, 2 identifiable species of bryozoa and many undetermined forms, 26 species of brachiopods, 23 species of pelecypods, 1 scaphopod, 16 species of gastropods, 1 conularid, 4 species of cephalopods, 1 trilobite, 2 species of crinoids and fragments of unidentified species, some wood fragments, and a shark spine. Hustedia brentwoodensis, H. miseri, and Euphemus (Euphemites carbonarius) were said to be abundant and to indicate a lower Pennsylvanian age. Spirifer rockymontanus, Phanerotrema grayvillensis, Euomphalus (Schozostoma) catilloides, Metacoceras cornutum, and Gastrioceras excelsum were said by Honess (p. 16) to also indicate a Pennsylvanian age. Honess (p. 18) regarded the fauna as "definitely Morrow and equivalent to the "Wapanucka".

Maxim K. Elias made a collection from the same faunal zone of a locality in the south-central part of Sec. 3, T. 1 S., R. 23 E., approximately one-half mile west of the Indian Service road, and in letters to C. W. Tomlinson dated March 19 and March 31, 1954, he stated that he considers the fauna to be middle Morrow, somewhat older than Wapanucka. C. W. Tomlinson also called attention to the presence of a similar fossiliferous sandstone in the Kiamichi Range at a locality which we will see at Stop 12 and he surmised that it is the same as Honess' faunal zone. Faunal studies by Elias support Tomlinson's preliminary correlation and recognition by Cline of a similar stratigraphic sequence below the fossiliferous sandstone at both localities further strengthens the correlation.

Although Honess' (1924, p. 18) recognized the Morrow age of the fossiliferous sandstone, he preferred to retain the name Upper Jackfork for the more than 6,000 feet of sandstones that lie above the fossil zone, his preference being based on the lithologic similarity of the sandstones both above and below the zone. However, he recognized that his Upper Jackfork is a sandy, shoreward phase of the typical Atoka that occurs farther north and northwest. O. B. Shelburne, who has recently mapped the geology of the Boktukola syncline, believes that Honess' "Morrow" fauna lies within the Johns Valley formation.

108.4 Road curves up hill on shales in lower part of Atoka formation.

109.4 Intersection with Wildhorse Trail on right (southwest).

110.6 Intersection with Burlew Trail on right (southwest).

112.35 STOP 16. We have been following the crest of a hogback carved from sandstone in the Atoka. Turn left off main road onto roadside park.

This brief stop is chiefly for the sceinic view. The park overlooks a tributary to the East Fork of Glover Creek, the valley gradually curving southward reflecting a change in strike as the axis of the Boktukola syncline is crossed. The syncline strikes east-west and pitches to the west. The rocks on which you stand are mapped as Atoka. The horizon of Honess' "Morrow" fauna, if present here, lies in the valley. The ridge beyond is Jackfork (restricted).

114.5 Stream crossing. We have just crossed the Boktukola fault.

Inasmuch as Stanley sandstone and shale are exposed below the bridge and a short distance upstream (west-north-west) massive sandstones referred to the Atoka crop out. These massive sandstones were mapped as Jackfork by Honess in 1923, as Upper Jackfork (above his "Morrow" fauna) in 1924, and as Atoka by Miser on the recent edition of the Oklahoma geologic map. The Boktukola fault appears to be of major importance and is shown on the state geological map as extending from near the Arkansas line westward and then southwestward to disappear beneath the Cretaceous overlap at a place about 4 miles west of Rattan. Both Honess and Miser have assumed south dip for the fault plane of the Boktukola fault. Miser (1929, p. 22, and sec. A on Pl. 3) pictures this fault as the outcropping portion of a low angle northward overthrust with the plane dipping southward under the Linson Creek synclinorium to rise and crop out as Honess' Glover fault on the north side of the Choctaw anticlinorium, passing over the anticlinorium and then dipping southward again. He estimated the horizontal displacement of the Boktukola fault where it cuts the Boktukola syncline to be at least five, and perhaps as much as eight, miles.

116.9 Road intersection.

117.9 Intersection with Battiest-Pickens road on right (west). Continue south.

119.2 Bethel, Oklahoma. Intersect State Highway 21 and continue towards Broken Bow.

This settlement lies a short distance north of the projected axis of the Cross Mountains anticlinorium. The fold area can be traced westward to within about three miles of Bethel where an anticline exposing the Arkansas novaculite is terminated by a fault striking slightly south of east. The Cross Mountains anticlinorium extends eastward for 30 miles, well into Arkansas, as a relatively narrow (four miles wide) fold belt. Honess describes the structure as a recumbent anticline with south dip, but a study of his structural cross sections G-G, H-H, I-I, J-J, and L-L, and a study of his mapped outcrop patterns, shows that the direction and amount of dip varies from one section to another and with individual folds on the anticlinorium. Some folds are overturned to the north, some are overturned to the south.

120.4 Turkey Creek trail on left.

121.85 Intersection with Phone Line Trail on left.

123.3 Road intersection on left. Mount Herman ahead.

126.0 STOP 17. Tuff lentil in lower Stanley shale. Exposed in road ditches and in large blocks just west of the road is a persistent volcanic tuff that has a stratigraphic position somewhat less than 300 feet above the base of the Stanley. Honess states that this is the only recognizable bed in the lower 3,000 feet of the Stanley in this area and his map shows it to crop out in narrow bands over a large area in McCurtain County. There is a good possibility that this bed is correlative with the Hatton tuff of Polk County, Arkansas, just to the east. Miser and Purdue (1929, p. 63) state that the Hatton is the thickest, most persistent, and stratigraphically the lowest, of three or four tuff beds in the lower Stanley of Arkansas and Oklahoma. Honess (1923, p. 150) states that he has seen no place in Oklahoma where he could be sure of two or more tuffs in the Stanley and is inclined to doubt that there is more than one bed.

Lithologically the tuff here simulates a coarse graywacke or arkose to the naked eye but a hand lens examination reveals fragments of fresh feldspar and other bits of volcanic fragmental ejecta embedded in a finer gray matrix which shows some chloritic mottling. Megascopic fragments include plagioclase, quartz, angular pieces of sandstone, limestone, slate, and occasional bits of basalt, now somewhat altered, and commingled with the original glassy, now devitrified, bits of ash which show vesicular and flow structures in thin-sections (Honess, 1923, pp. 179-180). A few crinoid columnals have been observed, testifying to the clastic nature of the tuff.

Our route from Bethel has crossed the western extension of the Linson Creek synclinorium. The synclinorium is typically developed a few miles to the east where it is defined on the north by the Cross Mountains anticlinorium and on the south by the Choctaw anticlinorium. Honess' structural cross section G-G (Honess, 1923, pl. 1) is a north-south section passing through a point 2 1/2 miles east of here and it shows north dip almost all of the way across the synclinorium but on the south limb he shows some southward overturning. It seems likely that anticlinal axes of minor folds also occur in the Stanley on the north limb but have gone undetected because of the lack of good key beds, such as the tuff lentil, so necessary for structural control. Folding and faulting are difficult to discern in much of the Stanley because of a lack of key beds and because much of the structural adjustment was along bedding planes, i.e., bedding plane faults which in many cases defy recognition.

127.0 Intersection with Baldwin Trail on right (west).

128.4 Intersection with road to Carter Mountain Lookout Tower on left (east).

129.5 Carter Mountain Trail on left.

132.15 Hairpin curve. We have traversed some sharply folded strata involving at least 4 anticlines which are overturned to the south and which pitch to the west, producing an intricate zig-zag pattern along the contact of the Arkansas novaculite and the Stanley shale.

132.5 Intersection with Cedar Creek Trail on right (west).

134.95 At approximately this position Honess (1923) mapped a fault contact between his Collier and Womble formations. He mapped it as a normal fault but Miser (1929) interpreted it as a northward-dipping thrust which he theorized connnected with the Boktukola fault farther north where that fault is supposed to emerge as a south-dipping fault plane. The argument that the core of the Ouachitas has been thrust many miles north and west of the trough in which the sediments accumulated is based, to quite an extent, on the interpretation that the core of the Choctaw anticlinorium is a fenster fault. Pitt is of the opinion that the Glover fault does not exist and that the core of the Ouachitas is not an eroded thrust plate.

Editor's Note: A review of all the pertinent evidence for and against the existence of the Glover fault is a sizeable task. However, a geologist should attempt to arrive at his own interpretation of the evidence. It would be well to study Pitt's map (Oklahoma Geological Survey, circular 34, pl. I) in connection with Honess' map (Oklahoma Geological Survey Bulletin 32, pl. I) in order to review the evidence for the diverse interpretations of the age determinations of many mapped rock units.

135.45 Intersection with Opah Trail on right (west).

137.5 Intersection with Hochatown road on left (northeast).

139.0 Intersection with State Highway 21A on left which leads eastward to Beavers Bend State Park on Mountain Fork River.

143.3 At this approximate position we leave the Ouachita fold belt, passing from the Blaylock sandstone of Silurian age to the Trinity sandstone of Comanchean age. The folds at this geological boundary are striking west-northwest, the rocks are dipping northward and are overturned southward along the south side of the anticlinorium.

Between this point and the hairpin curve we have crossed the main axis of the Choctaw anticlinorium, the main axis of which trends northeast.

145.7 Junction of United States Highway 70 and Oklahoma State Highway 3 west of Broken Bow.

END OF LOG

NOTES

AUXILIARY ROAD LOG

BIG CEDAR-OCTAVIA ROAD, EASTERN PART OF KIAMICHI RANGE

by

L. M. Cline

Introductory statement. The purpose of this trip is to afford an opportunity to study an unbroken stratigraphic sequence embracing the upper Stanley shale and the complete thickness of the Jackfork sandstone in relatively fresh road cuts. The dark gray shales and lighter gray sandstones are in marked contrast to the yellowish shales and buff sandstones of the same stratigraphic sequence where they are exposed in the much older road cuts of the Indian Service Road between Albion and Honobia, about 20 miles farther west in the Kiamichi Range. The Indian Road section was studied at three stops on the second day of the field trip.

Assembly point. Head cars south at junction of Oklahoma highways 63 and 103. The location is about 7.2 miles east of Muse, Oklahoma.

0.7 Cross bridge over Kiamichi River.

1.1 Stanley shale dipping south.

1.9 Moyers formation of upper Stanley age exposed for 0.3 mile.

2.25 Base of Chickasaw Creek siliceous shale. The top is exposed near the post on right side of road.

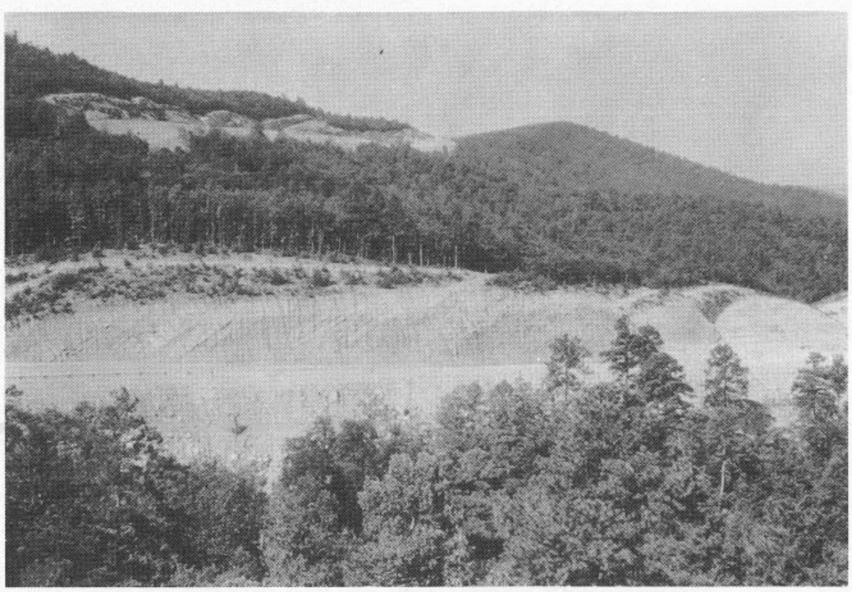

Fig. 28.-- Alternating sandstones and shales in lower Wildhorse Mountain formation in lower slope of Kiamichi Range, Big Cedar-Octavia road. Corresponds to mileages 2.25 to 2.7 in guidebook (auxiliary road log). (Photograph by L. M. Cline)

Fig. 29.-- Thinly bedded sandstones just below Prairie Hollow member of Wildhorse Mountain formation. North face of Kiamichi Range on Big Cedar-Octavia road. Corresponds to mileage 3.5 of guidebook (auxiliary road log). (Photograph by L. M. Cline)

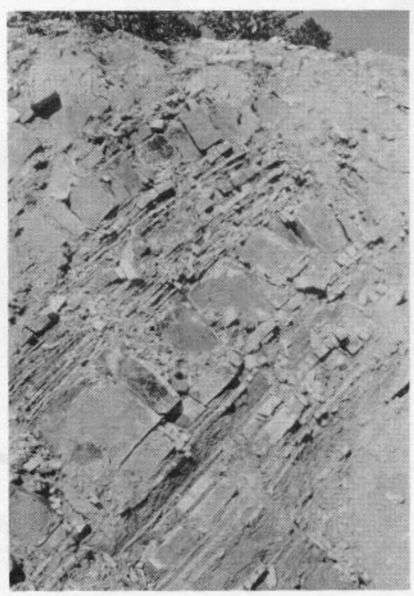

Fig. 30.-- Detail of sandstones shown in Fig. 29. (Photograph by L. M. Cline)

Fig. 31. -- Resistant sandstones in upper Wildhorse Mountain formation. (Photograph by L. M. Cline)

Fig. 32. -- Sandstones and shales in lower Prairie Mountain formation. (Photograph by L. M. Cline)

2.4 Beginning of good exposures of sandstone and shale in the lower Wildhorse Mountain formation. Observe that the sandstones are not nearly so yellow or buff as in weathered outcrops.

3.5 Sharp curve to right. On the outside (east) of the curve a dark blue-gray to black shale is badly crumpled and some containing sandstone lenses have been rolled into rounded masses. Are these "tectonic boulders" or were they rolled during deposition? A drag fold in the cutbank on the west side of road may influence your decision.

3.7 Base of Prairie Hollow maroon shale. Do you think the brownish-red color is primary?

4.0 Massive sandstones in upper part of Wildhorse Mountain formation. Individual beds probably are not persistent but the zone of heavy sandstones is widespread in the Kiamichi Range.

4.95 Cross-road. Summit Trail.

6.1 Strata in lower Prairie Mountain formation. Note ripple marked surface of one of the beds.

6.3 Junction of old road down mountain to Big Cedar (on west).

Note. Beginning at this point the highway has been rerouted since the original log was compiled. The old road down the mountain to Octavia traversed the upper Prairie Mountain formation to mileage 8.4 where it crossed the Wesley shale formation with its characteristic green-gray weathering speckled chert. The Wesley is well exposed on the new road but we do not have the correct mileage. According to O. B. Shelburne the Johns Valley shale is now exposed 0.5 south of the Wesley on the new road.

SUPPLEMENTARY LOG TRAVERSE THROUGH POTATO HILLS

Allan P. Bennison and Norman L. Johnson

Editor's Note. This excellent log through the Potato Hills is included for reference of those who at some future date, might be interested in further studies in the area.

The geological discussions contained in the supplementary log aid materially in understanding the geology of the Potato Hills. The numbered stops on the Bennison and Johnson map (in pocket) correspond to this log. However, the localities of Stop 4 and Stop 3 on it will be studied as Stop 10 on our field trip, and Mr. Bennison will lead in this discussion.

00.0 Turn north from U. S. Highway 271 at Sinclair station on black top road leading to Choctaw Council House. Good view of Potato Hills toward northeast and Kiamichi Mountains toward south.

00.2 Terrace gravels of chert boulders. Stanley shales and thin sandstones on lower slopes. End of pavement.

00.5 Stanley formation outcropping as interbedded dark greenish gray clay shale and argillaceous sandstone dipping south.

00.6 STOP # 1. South dipping tuffaceous mudstones and dark gray, indurated, carbonaceous shale of the Stanley formation. The correlation of this tuff bed with other tuff horizons in the Stanley is uncertain at the present. This particular bed is in the lower part of the Stanley and may be correlative with the Hatton. Petrographic analysis of this rock shows it to be a poorly sorted, argillaceous, tuffaceous sandstone with fine glass shards and coarse, angular feldspars in a matrix of clay and fine quartz grains. (Possibly Ten Mile Creek siliceous shale.)

00.7 Cross axis of west plunging anticline in which Arkansas novaculite, Missouri Mountain and Polk Creek beds are exposed to the east.

00.8 Dark gray indurated (silicified?) carbonaceous shale dipping north.

01.0 Junction of gravel road to west. Continue north. Vertical soft sandstones of the Stanley formation in low road cut.

01.3 Choctaw Council House to the left of road fork. Continue on gravel road to the right.

01.6 Cemetery east of road.

01.95 Farm road to right. Continue north.

02.1 Entering wooded area. West plunging anticline of uppermost member novaculite exposed immediately south of sharp bend to the right. Missouri Mountain, Polk Creek and Bigfork are exposed in the crest of this structure.

02.2 Gravel road to left. Continue northeast. Arkansas novaculite ridge parallels road a short distance to southeast.

02.9 Synclinal valley in weathered Stanley shale. High ridges to north composed of Bigfork chert.

03.35 Ford small stream, cutting through ridge of south dipping Arkansas novaculite. Missouri Mountain and Polk Creek shales form low valley north of ridge.

03.5 Light to dark gray cherts of Bigfork dip 50 degrees to the south. Note typical knee flexures in outcrops.

03.65 Approximate anticlinal axis. Contorted bedding.

03.7 Ford small stream. Steep north dip in Bigfork chert.

03.8 Road here parallels small cross fault offsetting so-called "south fenster" thrust fault. In outcrops both east and west of road almost vertical beds of Arkansas novaculite and Bigfork chert are in fault contact. Fault plane is almost vertical and following it east vertical beds of Womble shale may be seen faulted against Stanley. Along much of its outcrop this fault appears to be the result of an overstretched fold which has ruptured along its north limb.

03.9 STOP # 2. At road fork. Excellent exposure of Arkansas novaculite and basal quartzitic sandstone over greenish slaty shales of Missouri Mountain formation in small stream just east of road fork. Note giant spores in the Missouri Mountain shale. Along overgrown gravel road approximately 3/4 miles west of this point an exposure of coarse crystalline limestone several feet thick may be seen in the upper part of the Bigfork chert. After examination of contact return to cars and take right fork.

04.2 Weathered Polk Creek shale.

04.5 Fresh dark gray Polk Creek shale. Steep south dip.

04.65 Dark gray graptolitic cherty shale bed in Polk Creek shale. Hill immediately south capped by Missouri Mountain slate and Arkansas novaculite.

04.8 Same cherty shale bed.

04.85 Top of Bigfork chert at sharp bend of road to north. Dip 45° south. Note tendency for Bigfork chert to weather into white blocky fragments.

04.9 Approximate anticlinal axis in Bigfork chert.

05.0 Weathered Polk Creek shale flakes in soil of low road cut.

05.05 Basal green vitreous chert of Arkansas novaculite dipping south. Float of white quartzitic sandstone present along small drain east of road.

05.2 Top of Arkansas novaculite. Vertical to slightly overturned cherts outcrop on low hill just east of road.

05.35 Low hill just east of road composed of Stanley shale and thin sandstone capped by chert gravels. Approximately on axis of syncline.

05.4 Road passes over rocky knob of Stanley green siliceous shale and white quartzitic sandstone. Note steep dip into syncline.

05.5 Crossing small drain and approximate contact between lower green chert members and middle black carbonaceous shale and chert member. Continuing north for the next 800 feet we cross two anticlinal flexures entirely within the Arkansas novaculite.

05.7 Flat synclinal valley underlain by Stanley shale.

05.8 Stream crossing.

06.2 STOP # 3. Top of Arkansas novaculite below thin basal Stanley sandstone. From this point north for approximately 1500 feet the entire section from lower Stanley to upper Womble may be seen in an almost continuous exposure. Conodonts may be found in the Stanley shale and radiolaria and large chunks of wood may be observed in the Arkansas novaculite. Also, a number of interesting sedimentary features may be seen in the novaculite and near the top of the Bigfork chert. At the base of the section the Womble shale may be seen in nearly vertical fault contact with Stanley beds. Horse blocks of Big Fork and novaculite can be observed in the fault zone. This fault, (although within the area previously mapped as a fenster), has as much displacement as the "fenster" faults, but is merely the result of the overstretching and rupturing along the north limb of an anticline which plunges out toward the east and west.

06.25 Ford stream over the middle, black, carbonaceous shale member of the Arkansas novaculite.

06.35 Ford stream over Bigfork chert outcrops.

06.8 Travelling over flat valley. Scattered outcrops of Stanley shale and sandstone and bordering faults suggest structural graben.

07.1 STOP # 4. At stream. Ford. The "fenster" fault which is thought by some workers to surround the Potato Hills has been mapped through this area. Upstream to the east are overturned folds of Stanley shale and sandstone. It has been suggested by some that these synclinal features in the Stanley may be inverted anticlines on the diving tip of a nappe, but bedding markings indicate them to be in normal repose. On ridge about 600 feet east of ford are en-echelon folds of Arkansas novaculite and Missouri Mountain shale in horst, sliver blocks.

07.15 Dark gray blocky shale of Stanley formation dipping north. Immediately south are disturbed shales and sandstones probably in fault zone.

07.35 Stanley green gray shales and sandstones dipping north.

07.55 Turn right (east) at T-intersection.

07.7 Note resistant thin Stanley sandstones south and north of road.

08.0 Turn left (north) at T-intersection.

08.25 Travelling north over rolling Stanley shale terrain ribbed by intermittent, steep, north dipping sandstones.

08.4 Road passes over ridge of Stanley gray siliceous shale dipping north.

08.5 Turn right (east). Note medium gray papery fissile Stanley shale in ditch.

08.6 Turn left (north) at T-intersection.

08.9 Turn left (west). About 50 feet west are almost vertical, light green gray, papery thin, Stanley shales. Strike is north 70 degrees east.

09.0 Turn right (north).

09.1 Cross bridge over Buffalo Creek.

09.45 Road intersection to east. Continue north.

09.5 Cross low bridge over creek.

09.7 Slight jog to left (west) to join state highway 63 opposite Buffalo Creek Nazarene church, about 2.5 miles east of state highway 2.

A. P. Bennison[1]
N. L. Johnson[1]

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NOTES

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