ASPHALT DEPOSITS AND OIL CONDITIONS IN SOUTHWESTERN ARKANSAS.

By HUGH D. MISER and A. H. PURDUE.

INTRODUCTION.

Seven asphalt deposits, three of which are in Pike County and four in Sevier County, in southwestern Arkansas, were examined by the writers during the progress of the field work for the De Queen-Caddo Gap folio, which is now in preparation. These deposits are all found at or near the same horizon in the Trinity formation. Only one has so far been developed into a mine from which asphalt has been shipped in commercial quantity. This deposit, which has been described by Hayes,[1] is about 2½ miles south-southeast of Pike, in Pike County. Of the other six deposits only three have been prospected.

GEOGRAPHY AND GEOLOGY.

GENERAL RELATIONS.

The asphalt deposits in Pike County are near Pike, Delight, and Murfreesboro. Pike and Delight are on a branch of the St. Louis, Iron Mountain & Southern Railway, and Murfreesboro is on the Memphis, Dallas & Gulf Railroad. The deposits in Sevier County are between Dierks, the terminus of the De Queen & Eastern Railroad, and De Queen, on the Kansas City Southern Railway; most of them are near the village of Lebanon, which is 5 miles west by south from Dierks. (See Pl. XXXIII.)

The deposits have a general east-west alinement on the north border of the Gulf Coastal Plain, north of which is the Ouachita Mountain region.

OUACHITA MOUNTAIN REGION.

The Ouachita Mountain region is 50 to 60 miles wide and extends from Little Rock, Ark., to Atoka, Okla., a distance of 200 miles. It is composed of numerous east-west ridges, several intermontane basins, and a dissected piedmont plateau 15 miles wide which lies along its southern border in Arkansas and which thus adjoins the Gulf Coastal Plain.

[1] Hayes, C. W., Asphalt deposits of Pike County, Ark.: U. S. Geol. Survey Bull. 213, pp. 353-355, 1903.

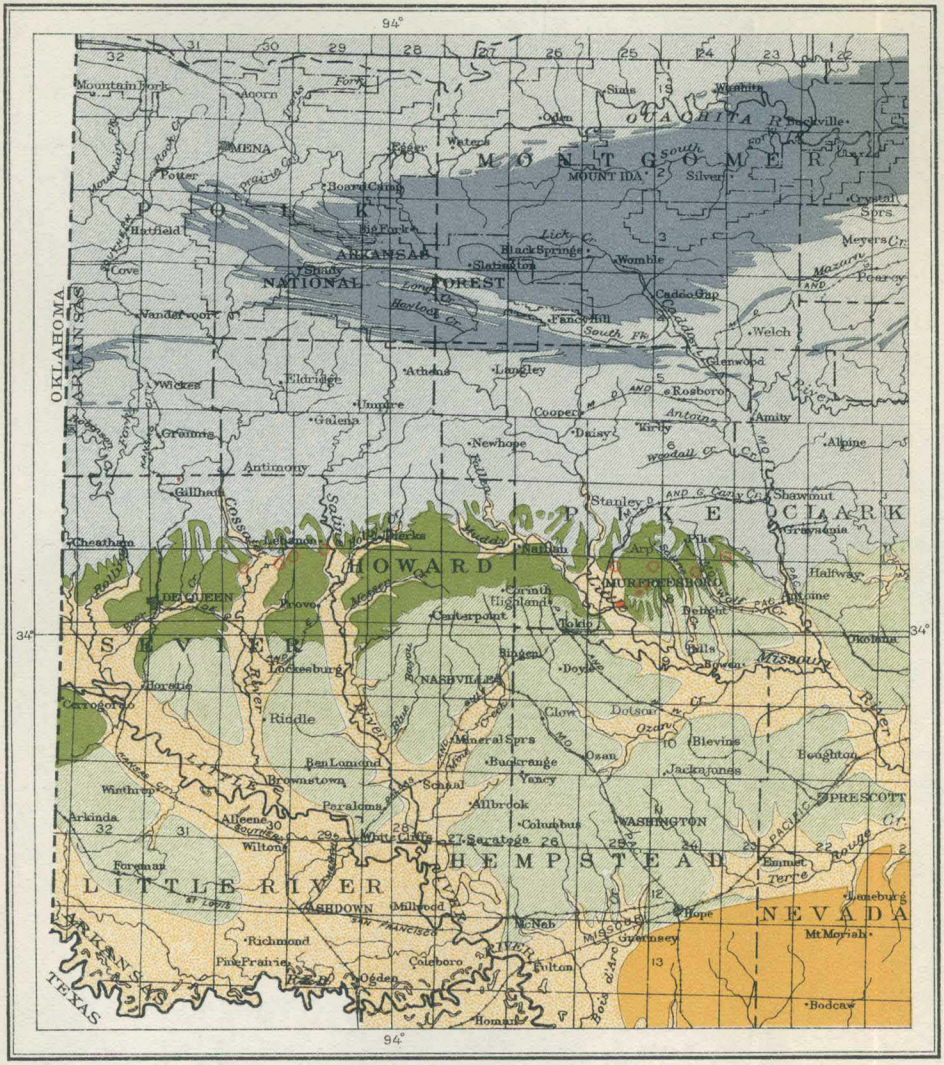
The exposed rocks range in age from Cambrian to Carboniferous and in west-central Arkansas present the following section:

Generalized section of Paleozoic rocks in the Ouachita Mountain region of west-central Arkansas.[1]

	Feet.
Carboniferous:	
Pennsylvanian:	
Atoka formation	6,000+
Mississippian:	
Jackfork sandstone	5,000–6,600
Stanley shale	6,000
Hot Springs sandstone	0–200
Unconformity.	
Devonian (upper part may possibly be Carboniferous):	
Arkansas novaculite	0–950
Unconformity (?).	
Silurian:	
Missouri Mountain slate	50–300
Unconformity (?).	
Blaylock sandstone	0–1,500
Unconformity (?).	
Ordovician:	
Polk Creek shale	0–200
Bigfork chert	700
Womble shale	250–1,000
Blakely sandstone	0–500
Unconformity (?).	
Mazarn shale	1,000
Ordovician (?).	
Crystal Mountain sandstone	850
Unconformity.	
Cambrian:	
Collier shale (observed thickness)	200

The accompanying map (Pl. XXXIII) shows two areas of excessive folding and uplift. One of these—the one extending eastward from the vicinity of Mena—is occupied by the west end of the Ouachita anticline, which is the prominent fold of the Ouachita region in Arkansas. The other area comprises the Cross Mountains, in the southwest corner of Polk County. It is occupied by the east end of the Choctaw anticline, which is the most prominent fold of the Ouachita region in Oklahoma. These large folds are composite and are thus essentially anticlinoria. Some of their major subdivisions can be followed for long distances, but the single folds are narrow, overlap one another lengthwise, and can be traced only a few miles along their axes. They all have the same general direction as that of the ridges and thus bear a close relation to the topography, for outcropping edges of the hard strata upturned on the folds have

[1] Several of the formation names used in this table have only recently been defined (Miser, H. D.), Manganese deposits of the Caddo Gap and De Queen quadrangles, Ark.: U. S. Geol. Survey Bull. 660, pp. 59–122, 1917).



LEGEND

- Quaternary (*flood-plain and terrace deposits only partly represented*)
- Tertiary (Eocene)
- Upper Cretaceous
- Lower Cretaceous
- Carboniferous
- Devonian, Silurian, Ordovician, and Cambrian
- Igneous rocks (peridotite) of Cretaceous age
- Asphalt deposits

Geology compiled from Arkansas Geological Survey Ann. Rept. for 1890, vol. 3, from manuscript maps for the De Queen-Caddo Gap folio, and from U. S. Geol. Survey Prof. Paper 46.

Base from U. S. G. S. map of Arkansas

A. HOEN & CO.

GEOLOGIC MAP OF PART OF SOUTHWESTERN ARKANSAS

Showing the location of the asphalt deposits on the north border of the Gulf Coastal Plain, to the north of which is the Ouachita Mountain region

Scale $\frac{1}{1,000,000}$

10 0 10 20 Miles

1918

formed the ridges, and the softer intervening beds underlie the valleys. Their general trend does not greatly depart from due west, but it is north of west in the Ouachita anticline, west in the Choctaw anticline, and south of west in the piedmont plateau. Many adjacent folds are of nearly the same height, and the same beds are repeated many times at the surface. The sides of most folds have been compressed until the rock beds are parallel, and in many places those on one side have been overturned. In some parts of the region shown on the map such overturning is from the north; in others it is from the south. The beds have high dips, usually more than 40°. As a rule the folds are smallest, most numerous, and most closely squeezed in the shales and thin-bedded sandstones and chert. Joints in several sets and slickensides are common in all the rocks but are most numerous in those just mentioned.

Faults are common, though less so than might be expected in strata that have been so closely compressed as these, owing to the great predominance of thin-bedded strata over massive rigid beds like the Crystal Mountain sandstone, Arkansas novaculite, and Jackfork sandstone, in consequence of which the beds bent under stress instead of breaking. The faults are thrust faults, and most of them were produced by the breaking and overthrusting of strata in closely compressed anticlines in which the overthrust movement came from both the south and the north. The direction of the faults, therefore, is in the main easterly, or parallel with the ridges, and the dip of the fault planes, which is everywhere high, is either to the south or to the north. The dislocations, even along a single fault, range from a few feet to a few thousand feet or more but can not be accurately determined. The length of the longest ones does not exceed 12 miles, and most of them are much shorter.

GULF COASTAL PLAIN.

The portion of the Gulf Coastal Plain lying in Pike, Howard, Sevier, and adjoining counties has a gently undulating surface consisting of shallow valleys, of wide alluvial tracts along the larger streams, and irregular hilly interstream areas usually 400 to 600 feet above sea level. In these counties it is underlain by sediments of Cretaceous, Tertiary, and Quaternary age. The terrace and alluvial deposits belong to the Quaternary system.

The Cretaceous rocks crop out over most of this part of Arkansas and present the section following.

Section of Cretaceous rocks in southwestern Arkansas.

[Largely after A. C. Veatch.[1]]

	Feet.
Upper Cretaceous:	
Arkadelphia clay	200–600
Nacatoch sand	60–185±
Marlbrook marl	50–750
Annona chalk	0–100+
Brownstown marl	150–650
Bingen formation	0–580
Unconformity.	
Lower Cretaceous:	
Washita group	250
Goodland limestone	15–25
Trinity formation	0–1,695+

The Trinity formation, which contains the asphalt deposits, is exposed in a belt a few miles wide extending from a point near Delight westward across Pike, Howard, and Sevier counties and thence into Oklahoma. It has a thickness of over 600 feet at a locality 2 miles north of Center Point, Howard County, and probably has a like thickness farther west in Arkansas, but it thins out near the east border of Pike County. It consists predominantly of clay but includes subordinate beds of sand, gravel, and limestone. The limestone occurs in two beds, the Dierks limestone lentil[2] and the De Queen limestone member,[2] both of which are exposed in narrow belts. The De Queen limestone, the higher of the two, is near the middle of the formation. It ranges in thickness from a feather edge to 72 feet, and its outcrop extends from Plaster Bluff, near Murfreesboro, westward through De Queen into Oklahoma. The Dierks limestone at some places is 50 feet above the base of the formation and at others is probably 200 feet above the base. Its thickness ranges from a feather edge to 40 feet. Its outcrop extends from a locality about 2 miles north of Delight westward to Cossatot River, where it thins out. The gravel also occurs in two beds that attain a thickness of 100 feet. The lower of the two gravels is at the base of the formation. It is called the Pike gravel member[3] and is exposed in an almost continuous though irregular belt from the west side of the State to the east end of the outcrop of the Trinity. The upper gravel, the Ultima Thule gravel lentil,[4] is above the Dierks limestone and is exposed in an irregular belt extending from Cossatot River westward into Oklahoma. These four lentils and members and the interbedded sands and clays of the Trinity and overlying formations have a slight southward dip. Although the Trinity

[1] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: U. S. Geol. Survey Prof. Paper 46, pp. 19–28, pl. 3, 1906.

[2] For definition see Miser, H. D., and Purdue, A. H., Gravel deposits of the Caddo Gap and De Queen quadrangles, Ark.: U. S. Geol. Survey Bull. 690, pp. 21–22, 1918 (Bull. 690–B).

[3] Idem, p. 20.

[4] Idem, p. 21.

occupies a nearly horizontal position it rests upon the truncated upturned edges of steeply dipping shales and sandstones of Carboniferous age, which, however, form a smooth floor that has only minor irregularities and undulations. A pronounced unconformity therefore occurs at the base of the Trinity. A notable though less striking unconformity exists at the top of the formation, as is shown by the eastward truncation of its beds and the resulting overlap of the Bingen formation, which is at the base of the Upper Cretaceous series.

The structure of the Trinity and succeeding formations is very simple. They now probably have the same attitude as when they were deposited, except that they have been slightly tilted toward the south, the oldest formations having been tilted the most. The strike of the Trinity formation and the lower part of the Bingen formation is east or nearly so, but that of the Brownstown marl, the Tokio sand member [1] of the Bingen, and other formations that are exposed east and south of this area is north of east. The dip of the base of the Cretaceous is about 100 feet to the mile from the north edge of the Gulf Coastal Plain south to Nashville, Ark., a distance of 15 miles. A well at Nashville reached the base of the Cretaceous at a depth of about 1,250 feet. The dip is more than 110 feet to the mile from the edge of the Coastal Plain south to Whitecliffs, Ark., a distance of 27.5 miles, as a well 2,635 feet deep at Whitecliffs did not reach the Paleozoic rocks. Similarly, the dip exceeds 88 feet to the mile from the edge of the Coastal Plain south to Hope, Ark., a distance of 34 miles, as the Hope City water well, 2,685 feet deep, did not pass entirely through the Cretaceous rocks. The dip is also more than 85 feet to the mile from the Cretaceous border south to Fulton, Ark., a distance of 40 miles, as a well 3,025 feet deep near Fulton failed to reach the base of the Cretaceous. The wells at Whitecliffs, Hope, and Fulton, however, probably reached the lower part of the Trinity and might have gone entirely through it at a depth of 200 or 300 feet more. On the north edge of the Gulf Coastal Plain in Sevier, Howard, and Pike counties the Paleozoic floor emerges from beneath the Cretaceous cover at an elevation of about 350 feet above sea level along the principal streams, and it gradually rises to the north, the highest remnants still capped by the Cretaceous attaining an elevation of 800 feet above sea level. The slope of the floor where the Cretaceous cover is thus partly removed ranges from about 60 to 100 feet to the mile, but the usual slope is about 80 feet to the mile.

The Cretaceous strata, as noted in the foregoing paragraphs, do not everywhere have a uniform dip to the south. Although they are thus slightly warped, none of the folds in Pike, Howard, and Sevier counties are known to be definite anticlines or synclines.

[1] Idem, p. 23.

The igneous rocks in this region consist of diamond-bearing peridotite which occurs in four areas near Murfreesboro. It was intruded during the period represented by the unconformity separating the Trinity and Bingen formations.

ASPHALT DEPOSITS.

GENERAL FEATURES.

The asphalt impregnates nearly horizontal beds of loose sand in the basal part of the Dierks limestone lentil or still lower in the Trinity formation. The deposits thus consist of asphaltic sand except at one place where the asphalt impregnates the Pike gravel member at the base of the formation. The layers containing the asphalt range from an inch to 12 feet in thickness.

LOCAL DETAILS.

PIKE, PIKE COUNTY.

A deposit of asphaltic sand occurs on the west side of the Pike-Delight wagon road, about 2½ miles south-southeast of Pike. It was worked from 1903 to 1906, inclusive, by the Arkansas Asphalt Co., and yielded 4,815 tons of asphaltic sand, valued at $22,368. A tram road about half a mile long conveyed the sand to the St. Louis, Iron Mountain & Southern Railway, whence it was shipped to Little Rock for use in paving streets. The old open cut out of which the sand was mined is 100 feet wide, 200 feet long, and 15 feet deep, and is in a depression which is drained eastward into Wolf Creek. The hills to the west and south show exposures of the Dierks limestone, but the beds in the cut consist chiefly of coarse sand, in some places rather calcareous, with beds of clay in the bottom of the cut. The sand is much cross-bedded and is incoherent except where charged with asphalt. The most productive part seems to have been at the north end, where some 4 feet of the base is asphaltic. The asphalt is not confined to any definite layer, the upper limit of it being very irregular. The only asphalt exposed in the south half of the cut in 1908 was 8 to 12 inches thick, but beneath it was clay with thin streaks of more or less asphaltic material.

Hayes,[1] who last visited the deposit in November, 1902, when the opening was new and not caved and not partly filled with water as at present, described the deposit as follows:

> The deposit is in the form of a sand stratum, which varies in thickness from 6 to 12 feet, more or less thoroughly saturated with asphaltum. The deposit was discovered by the escape of small quantities of asphaltum to the surface in a spring, and this led to prospecting for its source. A pit was dug about 12 feet in depth, passing through the bed, and the thick, viscous asphalt has slowly oozed out into this pit for the last 30 years.

[1] Hayes, C. W., Asphalt deposits of Pike County, Ark.: U. S. Geol. Survey Bull. 213, pp. 253–254, 1903.

The asphaltic rocks show considerable variation in character and in the amount of asphaltum which they contain. This variation is shown by the following analyses made for the Arkansas Asphalt Co. by G. W. Howard, of New York City:

Specimen No. 1, known at the pit as brown cap sand, contains 5.06 per cent of bitumen, or 1.73 per cent of petrolene and 3.33 per cent of asphaltene. It is essentially a sandstone, since it contains 92.40 per cent silica.

Specimen No. 2 is a black sand rock containing 16.53 per cent bitumen, of which 14.13 per cent is petrolene and 2.40 per cent asphaltene. The percentage of silica in this rock is 81.20.

Specimen No. 3, a grayish rock exhibiting banding, contains 6.68 per cent of bitumen, 69.15 per cent of silica, and 20.35 per cent of carbonate of lime.

Specimen No. 4 is a black, gummy rock carrying 8.86 per cent of bitumen, 79.50 per cent of silica, and 6.14 per cent of carbonate of lime. The bitumen determined as petrolene amounts to 6.61 per cent, and the asphaltene to 2.25 per cent.

Specimen No. 5, which is calcareous sandstone, contains 4.58 per cent bitumen, which equals 3.46 per cent petroleum and 1.12 per cent asphaltene. The carbonate of lime in this specimen amounts to 46 per cent, and the silica to 49.42 per cent. At the pit this rock is known as limestone.

No doubt specimens taken from these classes of rock would vary from place to place in the pit. The analyses, however, probably represent fairly the materials obtainable. * * *

By means of test borings the asphaltum bed has been proved to extend over a number of acres, under a cover sufficiently thin to permit profitable mining by stripping. * * *

The utilization of this deposit is a technical matter which can not be entered upon here. Its chief value will doubtless be as a paving material. As stated above, some portions of the bed form a natural paving mixture, which hardens on exposure to the sun, and, so far as could be judged, would be fully as durable as the ordinary artificial mixtures made from Trinidad asphalt. Other portions are too rich to be used in a natural state. Tests of these portions in the preparation of a paving mixture have been made by the St. Louis Testing & Sampling Works, with excellent results. * * *

No experiments have yet been made in refining the asphaltic sand for the preparation of pure asphaltum, and this may be found to be more profitable than shipping the crude product.

DELIGHT, PIKE COUNTY.

An asphalt deposit that was prospected in 1914 by the Grayson-McLeod Lumber Co. lies in the head of a hollow about 4 miles north-northwest of Delight, just east of the wagon road. A number of pits and cuts have been made, but at the time of visit (June 29, 1916), they had caved somewhat and were partly filled with water so that the asphalt bed could not be seen. Asphalt was found on the dumps of several openings for a distance of 175 feet down the hollow and was presumably thrown out of them. The other openings from which no asphalt was taken appear not to have extended deep enough to reach the asphaltic bed, which occupies a nearly horizontal position. About 10 feet of coarse quartz sand is exposed above the water in the openings. Above this there is 20 to 25 feet of loose gravel extending to the crest of the ridge. Several feet of the gravel may have slipped down the slope and thereby concealed beds of sand higher than the sand exposed in the openings. The gravel is the basal bed of the Bingen formation, whose higher beds are exposed

farther south near Delight but have here been removed through erosion. The sand belongs to the part of the Trinity formation that is above the Pike gravel member and below the Dierks limestone lentil. This limestone is exposed on Little Wolf Creek 2 miles farther south but is absent at the asphalt locality, as it is overlapped northward by the Bingen formation, at whose base there is, as previously stated, an unconformity.

The asphalt bed is said to range in thickness from 3 to 5 feet. Clay below the asphalt is said to contain seams of oil.

The asphalt on the dumps softens and flows in the sunshine, becomes plastic under the stroke of a hammer, is pliable in the hands, and adheres to the fingers. It contains quartz sand and a few nodules of iron pyrites. An analysis supplied by the Grayson-McLeod Lumber Co. shows the asphaltic sand to contain 17.21 per cent of asphaltum and 82.80 per cent of white sand. Only sample lots have been shipped.

MURFREESBORO, PIKE COUNTY.

A viscous asphalt impregnating a few inches or more of the Pike gravel member of the Trinity formation is exposed at the water's edge on the east side of Prairie Creek about 1 mile northeast of Murfreesboro. The thickness and extent of the deposit are not known.

Asphalt several feet thick is said to have been found in digging a well on the Irving farm, in sec. 1, T. 8 S., R. 25 W., 5 miles east of Murfreesboro. It affected the water to such an extent that the well has since been converted into a cistern.

LEBANON, SEVIER COUNTY.

Asphaltic sand is exposed by the wagon road on a low hill adjoining the Saline River bottom half a mile southeast of Lebanon. It occurs in lenticular layers the thickest of which is only a foot thick. It is much weathered in the exposures, being dark brown and falling to a powder when struck with a hammer, but it becomes viscous when heated with a match. The asphalt impregnates sand which is below the Dierks limestone exposed to the southwest south of Woolsey School and which, as shown in the following section at this locality, overlies the Pike gravel:

Partial section of Trinity formation half a mile southeast of Lebanon.

	Feet.
Yellow sand partly concealed by surficial gravel extends to the top of the hill. A 2 or 3 inch layer of asphaltic sand is 3 or 4 feet above the base of this bed of sand	12–25
Yellow sand, lenticular layers of which are impregnated with asphalt. The thickest layer is 12 inches thick	2–3
Gray and yellow sand, some of which is indurated	5
Gravel with pebbly sand in its upper part. The exposure extends down to the edge of the second bottom of Saline River (Pike gravel)	16

Asphaltic sand is exposed in a gully by the wagon road at the foot of a hill about 2½ miles west-southwest of Lebanon, apparently in the southeast corner of sec. 1, T. 8 S., R. 30 W. This sand is much weathered, being brown and friable, and is in two layers each 1 inch thick which are separated by a few inches of sand and are overlain and underlain by sand. The sand containing the asphalt appears to be between the Pike gravel and the Dierks limestone.

Sand impregnated with asphalt is exposed on the south side of the road half a mile east of Sardis School and 4 miles west-southwest of Lebanon. The asphalt here also is much weathered and is brown and friable. The following section was measured up the hill southwest of the deposit:

Section 4 miles west-southwest of Lebanon.

	Feet.
Terrace deposits: Gravels and cobbles occupying crest of hill. The thickness of the gravel bed is less than 35 feet, for the gravel has probably slipped down the slope, thus concealing beds of the Trinity formation	35
Trinity formation:	
Dierks limestone lentil:	
Red and yellow clay containing some pieces of limestone	12
Platy limestone containing fossil oyster shells	4–5
Gray compact sand	6
Sand impregnated with asphalt, a few inches.	
Gray compact sand	1½

Asphaltic sand is revealed in a shallow pit by a road leading up the hill just northwest of Moody Shoal Ford, on Cossatot River 6½ miles west-southwest of Lebanon. The following section was measured here:

Section west of Moody Shoal Ford, 6½ miles southwest of Lebanon.

	Feet.
Terrace deposits: Gravels and cobbles. The thickness is probably less than 55 feet, as some of the gravel and cobbles have doubtless slipped down the slope and thus conceal beds of the Trinity formation	55
Trinity formation:	
Dierks limestone lentil:	
Red clay	2
Limestone containing fossil oyster shells	1
Clay	5
Asphaltic sand. A limestone layer 1½ inches thick was found in the base	2½
Red clay	10

VALUE OF DEPOSITS.

The asphalt deposit near Pike is the only one from which asphalt has been shipped in commercial quantity. The asphaltic sand mined at that locality from 1903 to 1906 by the Arkansas Asphalt Co. is said to have amounted to 4,815 tons, valued at $22,368. It was used in Little Rock in paving West Markham Street from Main to Cross streets, a distance of 12 blocks, and in paving part of Center

Street.[1] A 2-inch surface of the asphalt was laid upon a 5-inch concrete base, which rested upon clay.[2] Owing to improper preparation of the asphalt the paving was not entirely satisfactory.

The asphalt deposit near Delight is thin, the reported thickness being 3 to 6 feet. If the deposit is later proved to maintain that thickness under a considerable area, it might be profitably worked, but the overburden is so thick, 30 to 35 feet or more, that underground mining would probably be necessary. The asphalt exposed at the other localities is not thick enough to be mined and probably is no thicker away from the outcrops.

ORIGIN OF THE ASPHALT AND POSSIBILITY OF OIL AND GAS.

The Trinity formation contains petroleum and asphalt at many places in northern Texas and southeastern Oklahoma. The asphalt in these two States and in Arkansas, as in other regions, is doubtless a residue of crude petroleum, whose lighter and more volatile parts have escaped by evaporation. The petroleum yielding the asphalt in Arkansas is believed by the writers to have been derived from the Carboniferous rocks underlying the Trinity formation, near the base of which the asphalt is found. In support of this belief is the fact that there are small amounts of asphalt in the sandstone of the Atoka formation, of Carboniferous age, which crops out in two narrow belts with a north of east trend in Pike County, a few miles north of Pike and Murfreesboro. Asphalt is also found in Carboniferous and older rocks near Mena, Ark., and in southeastern Oklahoma. The Carboniferous rocks pass beneath the Trinity formation, and the beds are tilted in such a manner that their edges project against the base of the Trinity. Any oil in the Carboniferous beds would, in the course of time, work its way upward into the Trinity. It could not go higher than the lower limestone of the Trinity, because of the impervious character of this limestone and the associated clays. As the Trinity has a gentle dip to the south, the oil would be conveyed up the dip to the surface. There is, however, no direct proof that some or all of the petroleum did not originate in the basal part of the Trinity formation, which contains some fossiliferous limestone.

On the assumption that the petroleum yielding the asphalt herein described originated either in the Trinity or in the underlying rocks, the petroleum has probably migrated northward. There is, however, a possibility that it came upward from the Paleozoic strata immediately subjacent to the areas containing the asphalt deposits. As explained on page 275, the Cretaceous rocks in southwestern Arkansas have a southward dip of about 100 feet to the mile, and although they have been slightly warped, no pronounced anticlines or syn-

[1] Letter dated Dec. 22, 1916, from John H. Page, Commissioner of Mines, Manufactures, and Agriculture, State of Arkansas.

[2] Letter dated Jan. 1, 1917, from W. R. Duley, ex-mayor of Little Rock.

clines occur in Pike, Howard, and Sevier counties. Thus, if petroleum occurs in the region south of the asphalt deposits, its accumulation into quantities of possible commercial importance would probably be controlled by terrace structure, lenticular character of sands, or irregularities in the Cretaceous floor. Harris [1] says: "Hopes may be entertained of finding oil and gas so entrapped [by change in character of sediments] in wells sunk in various places near the Eocene-Cretaceous contact from Arkadelphia [Ark.] to and beyond San Antonio."

The peridotite masses near Murfreesboro may have lifted the Trinity so as to produce structure favorable for the accumulation of oil about them, just as volcanic necks or plugs have done in Mexico and probably in Texas, but such phenomena have not been observed around the peridotite masses.

There is no possibility that either oil in commercial quantities or gas in large pools will be found in the Ouachita Mountain region of west-central Arkansas or in most of this region in Oklahoma. The Carboniferous and older rocks have been so highly tilted and so much fractured and metamorphosed that if oil or gas were ever present in them the gas and much of the oil would have made their escape to the surface and the remainder of the oil would have been distilled to asphalt.

DRILLING FOR OIL.

The presence of asphalt in Pike and Sevier counties has from time to time attracted the attention of those interested in oil development. Land in these and adjoining counties has been leased at different times, and a few wells have been sunk with the hope of finding oil. Thus far oil has not been found in commercial quantity.

WELL RECORDS.

Detailed information on the geology of this region and other parts of southern Arkansas, including well records, was published in 1906, in a report by Veatch,[2] but this report is out of print and may be consulted only in libraries. A great many wells, most of them for artesian water, have been drilled since then. The deepest wells in the area shown on the accompanying map (Pl. XXXIII) are at or near Prescott, Bodcaw, Hope, Fulton, Nashville, and Whitecliffs. For the information of persons who drill wells in this part of the State for oil or artesian water the records of these wells are here given. O. B. Hopkins, of the United States Geological Survey, has kindly furnished copies of the drillers' records of the wells at Prescott, Bodcaw, Fulton, and Whitecliffs. The interpretations of the geologic formations are supplied by the writers of this report.

[1] Harris, G. D., Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States: U. S. Geol. Survey Bull. 429, p. 27, 1910.

[2] Veatch, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: U. S. Geol. Survey Prof. Paper 46, 1906.

Record of well in the NW. ¼ SE. ¼ sec. 10, T. 11 S., R. 22 W., near Prescott, Ark.

Age and formation.		Driller's record.		
		Material.	Thickness.	Depth.
Quaternary.		Clay and gravel	Feet. 35	Feet. 35
Upper Cretaceous.	Arkadelphia clay.	Blue shale and gumbo	159	194
	Nacatoch sand.	Nacatoch water sand	176	370
	Marlbrook marl.	Blue shale and slate	57	427
	Annona chalk.	White chalk	43	470
	Brownstown marl.	Blue shale and slate	540	1,010
	Bingen formation.	Bingen water sand; flows	50	1,060
		Gumbo	40	1,100
		Sand and a little salt water	20	1,120
		Red rock or shale	160	1,280
		Sand and salt water with a show of oil	22	1,302
		Red rock or shale	213	1,515
		Sand	35	1,550
		Gravel	10	1,560
Lower Cretaceous.	Trinity formation.	Sand	50	1,610
		Red shale	140	1,750
		Sand	110	1,860
		Red shale	270	2,130
		Red sand	10	2,140
		Red shale with some sand and blue rock	189	2,329
		Red sand	18	2,347
		Red shale with some sand and blue rock	908	3,255

Record of well at Bodcaw, Ark.

Age and formation.		Driller's record.		
		Material.	Thickness.	Depth.
Eocene.	Wilcox formation.	Clay	Feet. 20	Feet. 20
		Water sand	2	22
		Black gumbo	78	100
	Midway formation.	White and brown gumbo	160	260
		Quick sand	8	268
Upper Cretaceous.	Arkadelphia clay.	White, blue, and black gumbo	597	865
	Nacatoch sand.	Nacatoch water sand	150	1,015
		Blue sand	28	1,043
	Marlbrook marl.	Red, white, and brown gumbo	327	1,370
	Annona chalk.	White chalk or shale	30	1,400
	Brownstown marl.	White and blue gumbo	470	1,870
		Soft blue gumbo	2	1,872
	Bingen formation.	Sand	15	1,887
		Red shale	30	1,917
		Bingen water sand; artesian water	43	1,960
		Shale, sand, and boulders	38	1,998
		Blue and red gumbo and sand	63	2,061
		Sand and shells	2	2,063
		Sand and shells; mixed blue and red shale	11	2,074
		White, brown, and red gumbo	50	2,124
		Dark-gray sand	6	2,130
		Salt-water sand	5	2,135
		Shale and sand	26	2,161
		Sand	21	2,182
		Sand and blue and red shale, mixed	36	2,218

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.

[Drilling begun August, 1914; well completed April 20, 1916. Elevation above sea level about 355 feet. Driller's record furnished by Charles M. Richards, superintendent of plant.]

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
				Material.	Thickness.	Depth.
Quaternary.		*Feet.*			*Feet.*	*Feet.*
				Soil	10	10
				Sand	2	12
Upper Cretaceous.	Arkadelphia clay.			Clay, yellow	23	35
				Clay, blue	17	52
				Shale, black	23	75
				Gumbo, blue	27	102
				Rock, hard, shell-like	1	103
				Shale, black	32	135
				Shale, gray	43	178
				Shale, black	52	230
				Rock, hard, shell-like	1	231
				Shale, gray	139	370
				Rock, hard	8	378
	Nacatoch sand.			Shale, sandy	14	392
				Rock, hard	36	428
				Rock, soft sand	25	453
				Rock, hard	4	457
				Rock, hard sand	8	465
				Rock, sand, soft, water-bearing.	85	550
	Nacatoch sand or Marlbrook marl.	565–570	Soft calcareous glauconitic fine-grained sandstone is represented by some small pieces. The glauconite is so abundant in these pieces that the sandstone has a dark-gray color. The bulk of the sample is glauconite which has become concentrated in the drilling operations; it is black with a greenish cast. Some fragile fossil remains show in the small pieces of sandstone.	Shale, blue	10	560
		570–575	Greenish-gray calcareous fine-grained earthy sand containing some glauconite.			
		575–580	Greenish-gray glauconitic calcareous fine-grained sand containing very small pieces of shells.			
		580–583	Greenish-gray glauconitic fine-grained calcareous sand, mixed with which are small pieces of shells.	Sand rock, black	40	600
		583–590	Greenish-gray glauconitic calcareous fine-grained sand.			
		590–600	Greenish-gray glauconitic calcareous earthy fine-grained sand.			
		600–620	Greenish-gray glauconitic calcareous earthy fine-grained sand.			
	Marlbrook marl.	620–650	No sample.	Shale, blue	50	650
		650–695	Gray calcareous sandy earth (marl).	Shale, sandy	50	700
	Annona chalk (?).	695–710	Gray soft, highly calcareous earth, which slacks readily in water.			
		710–728	Gray soft, highly calcareous earth, which slacks readily in water.	Rock, soft lime	25	725
		728–770	Gray soft, highly calcareous fossiliferous earth, which slacks readily in water. This is light gray and is much lighter in color than the two preceding samples.	Shale, brown	125	850

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.—Continued.

Age and formation.	Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
			Material.	Thickness.	Depth.
	Feet.			*Feet.*	*Feet.*
Upper Cretaceous. Brownstown marl.	770–805	Gray soft calcareous clay; two pieces of fibrous vein calcite or aragonite are in sample.			
	805–900	Gray soft calcareous clay like that just above.	Shale, slate	40	890
	900–925	Gray soft calcareous clay.			
	925–950	Gray soft calcareous clay.	Shale, blue	60	950
	950–980	Very light gray calcareous clay; chalky in appearance but highly plastic.	Gumbo, white	65	1,015
	980–1,015	Gray calcareous clay not so light as that just above. Two or three pieces of a shell and one specimen of a foraminifer were seen in sample.			
Bingen formation (?).	1,015–1,037	Bluish-gray fossiliferous calcareous clay. Some fine gray sand and much pyrite. About a dozen Foraminifera were found.	Shale, blue	10	1,025
	1,037–1,040	In sample is one piece of hard fossiliferous dark-gray limestone. Others are calcareous sandy earth and fragments of fossils. This is a very small sample.	Shale, black	15	1,040
	1,040–1,080	Gray, micaceous sandy calcareous earth. Some pieces of shells. Two pieces of hard dark-gray limestone like that in preceding sample. Several specimens of Foraminifera were found.	Rock, hard	2	1,042
			Shale, blue	18	1,060
	1,080–1,110	Dark-gray calcareous clay, fine quartz sand, and some glauconite. Two or three Foraminifera were seen.	Sand rock, soft	40	1,100
	1,110–1,128	Mixture of different kinds of material. One subangular pebble of novaculite 1¼ inches in diameter; most of larger pieces are micaceous dark-gray calcareous sandy clay; few of larger pieces are glauconitic calcareous sandstone; fine material is glauconite and sand. Minute fossils are present. Foraminifera found. One spine is probably that of a sea urchin.	Shale, blue	25	1,125
	1,128–1,140	Gray sandy micaceous fossiliferous calcareous clay.			
	1,140–1,190	Mixture. Comminuted shells, among which is a shark's tooth; glauconitic calcareous sand like first sample; dark-gray calcareous fossiliferous micaceous clay; and two small dark flint pebbles (3 millimeters in diameter); loose glauconite and sand grains. Sand grains are translucent, well-rounded to subangular, and 0.5 millimeter or less in diameter. Foraminifera are present.	Shale, sandy	25	1,200
	1,190–1,365	Dark-gray calcareous clay. One rather perfect pelecypod in sample.	Shale, blue	25	1,225
	1,365–1,383	Dark-gray, slightly calcareous clay, pieces of lignitiferous matter, and a very small amount of quartz sand.	Shale, blue	45	1,285
			Gumbo, red	15	1,300
			Shale, blue	60	1,360

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.—Continued.

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
				Material.	Thickness.	Depth.
		Feet.			*Feet.*	*Feet.*
Upper Cretaceous.	Bingen formation.	1,383–1,389	Gray quartz sand. The grains are angular and subangular. Average diameter is less than 0.25 millimeter. Considerable pyrite present. Some pyrite cements sand grains together. Lignitiferous matter present. Mixed with sand are some pieces of clay like that in bed above.	Gumbo	30	1,390
		1,389–1,400	Sample consists chiefly of dark-gray calcareous clay, some pieces of which are fossiliferous. Minor portion of sample is sand like that in preceding sample. A little lignitiferous matter present.			
		1,400–1,415	Sample contains some lignitiferous matter and a few pieces of clay like that above, but bulk is glauconitic, very fine grained quartz sand.	Sand rock, soft	57	1,447
		1,415–1,420	This sample is a complex mixture. Calcareous sandy clay and fine quartz sand in almost equal quantities, a few pieces of lignitiferous matter, a few pieces of glauconitic calcareous sand like first sample, and some pieces of shells. The minor constituents are probably foreign to the beds at this depth. Several Foraminifera were found.			
		1,420–1,430	Very fine gray quartz sand and a little glauconite. Sand grains subangular.			
		1,430–1,432	No sample.			
		1,432–1,480	Angular to subangular quartz sand, grains of which average less than 0.25 millimeter in diameter. A little pyrite and glauconite are present. Mr. Richards says this is water-bearing sand, yielding 400,000 gallons a day, and that before pumping water rose to within 32 feet of surface.	Shale, sandy Sand rock, soft	23 10	1,470 1,480
		1,480	White sand, washed more than the preceding sample.			
		1,481–1,487	Sample consists of four pieces of firm rock which is sandy, micaceous, glauconitic, calcareous, and laminated. One piece shows what appears to be a good fossil foraminifer or some other simple organism. Pyrite in small crystals shows in three pieces and on one of these pieces it is very abundant. This rock would probably be classed as an impure sandstone.	Sand rock, hard	20	1,500
		1,300–1,500	Pieces of carbonized wood which were picked out of the drillings through about 200 feet. While at Hope the senior author saw one piece of wood 3 or 4 inches long obtained at this horizon.			
		1,487–1,495	This sample consists chiefly of fine white quartz sand. A little glauconite, some pyrite, and a few feldspar grains are present. One piece of a shell is in sample. A large number of pieces of dark calcareous clay also occur.			

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.—Continued.

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
				Material.	Thickness.	Depth.
		Feet.			*Feet.*	*Feet.*
Upper Cretaceous.	Bingen formation.	1,495–1,501	A drab-colored micaceous sandy clay.			
		1,501–1,585	Mixture in about equal amounts of micaceous sandy greenish-gray earth and micaceous calcareous glauconitic sand containing some small kaolinized feldspars here and there. There are a few small crystals of pyrite.	Shale, blue Gumbo Shale, sandy	30 10 45	1,530 1,540 1,585
Lower Cretaceous.	Trinity formation.	1,585–1,595	Mixture of drab clay with a smaller amount of red clay. Still smaller amounts of pyrite, quartz sand and a few fragments of shells are present, but these are probably foreign.			
		1,595–1,610	Mixture of red clay, chiefly, with some sandy drab-colored clay and loose glauconitic quartz sand. All but the red clay are probably foreign.	Gumbo, red	20	1,605
		1,610–1,675	Main constituent is red clay; the minor constituents are drab-colored sandy clay, sand, pyrite, and lignitiferous matter. Three specimens of Foraminifera were found.	Rock, hard Gumbo Rock, soft	10 35 25	1,615 1,650 1,675
		1,675–1,700	Fine angular quartz sand makes up most of sample, though there is some red clay and some dark clay. Three specimens of Foraminifera found.	Rock, hard	25	1,700
		1,700–1,720	Drab-colored, slightly calcareous clay and some pieces of red clay.	Shale, blue	20	1,720
		1,720–1,735	This sample is so mixed that the character of the rock can not be determined. It consists of dark clay, calcareous gray sandstone containing abundant carbonized wood, red clay, pieces of limestone or shells, and much pyrite.	Rock, hard	30	1,750
		1,735–1,750	Sample consists mainly of brown fine quartz sand. Some pieces of sandstone having a calcareous cement are present. Some pyrite was seen. One foraminifer found.			
		1,750–1,758	Red and greenish clay, mainly red.	Gumbo	5	1,755
		1,758–1,780	Brown fine quartz sand with a little pyrite. Few pieces of red clay, and the other rocks are probably foreign. Some pieces of sandstone present.	Shale	25	1,780
		1,780–1,820	Gray fine angular quartz sand.			
		1,820–1,825	Pyrite abundant; one piece of woody matter partly replaced by pyrite; good many comminuted shells, much quartz sand, which makes up half of sample; and both red and dark clay.			
		1,825–1,835	Fine gray sand mixed with some calcite. This may be from a calcareous sandstone. There is one large piece of fossiliferous calcareous sandstone containing fine particles of disseminated pyrite. Some red and drab clay are present.	Rock, hard, white; salt water at 1,920–1,975 feet.	215	1,995
		1,835–1,852	Fine gray quartz sand and some calcite (probably calcareous sandstone). Very few pieces of dark clay present.			

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.—Continued.

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
				Material.	Thickness.	Depth.
		Feet.			*Feet.*	*Feet.*
Lower Cretaceous.	Trinity formation.	1,852–1,865	Pyritized wood; fragments of pelecypods, gastropods, Bryozoa, and Foraminifera; much pyrite; calcareous gray sandstone; much loose gray sand; pieces of gray fine-grained limestone. Rocks at this depth appear to include calcareous sandstone and limestone.			
		1,865–1,880	Fossiliferous light-gray limestone containing some pyrite.			
		1,880–1,900	Dark-drab calcareous clay and some pieces of gray limestone which have probably come from above.			
		1,900–1,910	Calcareous dark-drab clay; pyrite; gray limestone, dark-gray sandstone, red clay; one shark's tooth. Beds are probably calcareous drab clay and sandstone.			
		1,910–1,917	Gray limestone; much pyrite and much anhydrite.			
		1,917–1,995	Some gray clay, much gray calcareous sandstone, pieces of oyster shells, and much anhydrite.			
		1,995–2,025	Dark-gray calcareous clay and some pieces of shells.	Shale, blue	30	2,025
		2,025–2,190	Red clay; only a few pieces of gray clay are present.	Shale, red	165	2,190
		2,190–2,215	No sample.	Shale, gray	25	2,215
		2,215–2,230	One half of sample is gray clay; the rest is red clay.			
		2,232	Gray clay.			
		2,230–2,262	Sample consists mainly of red clay; the rest is gray clay.			
		2,262–2,280	Gray clay and a little buff clay.	Shale, conglomerate	85	2,300
		2,280–2,301	Fossiliferous gray clay and some pieces of red clay and shells.	Shale, red and very adhesive.	3	2,303
		2,301–2,340	Red clay and a few pieces of buff clay. While at Hope the senior author was shown a large piece of clay that was removed from the drill bit from a depth of 2,303 feet.			
		2,340–2,370	Gray clay and smaller amounts of green, buff, and red clay. These slake quickly in water.			
		2,350–2,402	Duplicate sample. Fossiliferous light-gray limestone and some pieces of calcareous yellow sandstone. A few pieces of red and gray clay are mixed in with rest of sample.	Shale, mixture	99	2,402
		2,370–2,402	Bluish-gray clay, some of which contains minute fossils and one piece contains what appears to be carbonized plant matter; some pieces of red and buff clay and some of the limestone like that in preceding sample. These clays slake in water.			
		2,402–2,407	Gray fossiliferous limestone and many pieces of shells. There are some pieces of hard clay and sandstone.	Rock, hard	5	2,407
		2,407–2,425	This sample consists chiefly of green and red clays that slake in water. Some pieces of shells and a few crystals of pyrite are present.	Rock, soft	18	2,425
		2,425–2,505	Light-green and brown clays that slake quickly in water. They were also found to be highly plastic.	Shale, brown	80	2,505
		2,505–2,525	Highly plastic brown clay.			

Record of well No. 4 of Hope Water & Light Plant, Hope, Ark.—Continued.

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser. No samples above 565 feet were preserved.)	Driller's record.		
				Material.	Thickness.	Depth.
Lower Cretaceous.	Trinity formation.	*Feet.*			*Feet.*	*Feet.*
		2,525–2,595	Highly plastic brown clay and some highly plastic light-green clay. A few pieces of shells and limestone are present.	Shale, brown.....	85	2,590
		2,595–2,610	Most of this sample is pieces of shells. These are embedded in a hard sandy argillaceous matrix, as indicated by cuttings.	Rock, limestone.....	20	2,610
		2,610–2,620	Sample consists chiefly of plastic red and green clays, though there are a few bits of shells.	Conglomerate.....	15	2,625
		2,620–2,625	Highly plastic red clay, some green clay, and a few pieces of limestone.	Shale, mixture gray and red.	60	2,685
		2,625–2,685	Most of sample is plastic red clay; some gray fine-grained sandstones, some buff sandy clay, and a few pieces of shells.	Mineral (salt water) in the last 16 or 18 feet.		

Record of Shults No. 1 well, drilled by Gulf Refining Co. 500 feet east and 300 feet south from northwest corner of sec. 33, T. 13 S., R. 26 W., near Fulton, Ark.

[Drillers, A. F. Tarver and H. C. Fouts. Drilling began Mar. 19, 1916; well completed June 9, 1916. Elevation, 256.7 feet above sea level. Driller's record furnished by Gulf Refining Co.]

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser.)	Driller's record.		
				Material.	Thickness.	Depth.
Quaternary.	Alluvium or terrace deposit.	*Feet.*			*Feet.*	*Feet.*
				Red sandy loam.....	59	59
Upper Cretaceous.	Arkadelphia clay.	300	Very dark clay.	Blue gumbo shale.....	194	253
				Hard broken rock and sand; artesian water.	72	325
				Blue gumbo shale.....	20	345
				Hard blue sandy gumbo..	44	389
				Hard blue sandy clay.....	40	429
				Hard sand rock.....	1	430
				Soft sand.....	10	440
				Sand rock.....	11	451
				Tough blue gumbo.....	59	510
	? Nacatoch sand. ?	648–692	Called "artesian-water sand rock." Two large pieces are sandy limestone and two smaller pieces are dark and buff clay, but most of sample is loose sand and small pieces of gray clay with the sand predominating.	Hard rock.....	2	512
				Hard sand.....	10	522
				Sandy gumbo.....	44	566
				Hard sand rock.....	2	568
				Sandy gumbo.....	44	612
				Hard sand rock.....	6	618
				Hard white gumbo.....	62	680
				Soft sand.....	15	695
	Marlbrook marl.	692–776	Tough dark clay.	Hard white gumbo.....	35	730
				White shale.....	50	780
				White soapstone.....	133	913
	Annona chalk.			Hard chalk rock.....	25	938
	? Brownstown marl. ?			Chalk-rock formation.....	374	1,312
				Blue shale.....	23	1,335

Record of Shults No. 1 well, drilled by Gulf Refining Co. 500 feet east and 300 feet south from northwest corner of sec. 33, T. 13 S., R. 26 W., near Fulton, Ark.—Continued.

Age and formation.		Depth at which sample was obtained.	Description of samples. (By H. D. Miser.)	Driller's record.		
				Material.	Thickness.	Depth.
		Feet.			*Feet.*	*Feet.*
Upper Cretaceous.	Bingen formation.			Hard sand rock	15	1,350
				Blue shale	18	1,368
				Hard sand rock	7	1,375
				Hard sand	15	1,390
				Hard blue shale	18	1,408
				Sand rock	8	1,416
				Blue shale	16	1,432
				Sandy gumbo	10	1,442
				Rock	5	1,447
				Blue gumbo	15	1,462
				Hard sand with streaks of pyrite, showing water.	38	1,500
				Tough blue gumbo	129	1,629
				Hard red shale	27	1,656
				Hard rock	2	1,658
				Red sand and shale	17	1,675
				Tough red gumbo	20	1,695
				Rock	1	1,696
				Tough red gumbo	44	1,740
				Brown sand rock; hard streaks.	175	1,915
—?	—?			Blue sticky shale	85	2,000
				Hard sand	23	2,023
				Tough brown gumbo	132	2,155
				Sand rock	13	2,168
				Brown gumbo	25	2,193
				Hard sand	20	2,213
				Brown gumbo	29	2,242
				Brown shale	14	2,256
				Hard rock	4	2,260
				Hard sand	10	2,270
				Hard rock	4	2,274
				Hard brown shale	17	2,291
				Tough gumbo	5	2,296
				Hard rock	4	2,300
		2,300–2,406	One piece is part of shell; two or three pieces of red clay; several pieces of bluish clay and several of a sandy compact greenish earth.	Hard sand	10	2,310
Lower Cretaceous.	Trinity formation.	2,300–2,371	Gray sand and a little red clay and gray clay.	Gumbo	12	2,322
				Rock	3	2,325
				Red gumbo and shale	5	2,330
				Gypsiferous rock	12	2,342
				Red gumbo	13	2,355
				Hard rock	11	2,366
				Gumbo and boulders	18	2,384
				Hard rock	8	2,392
		2,406–2,451	Laminated light greenish-gray clay containing a few red spots.	Hard shale and boulders	24	2,416
				Broken rock with gray gumbo.	26	2,442
		2,451–2,537	Sample consists of three pieces of hard calcareous pyritiferous sandstone and one piece of dark clay.	Hard slate and shells	147	2,589
		2,537–2,546	Gray plastic clay and some red clay.			
		2,546–2,549	Two pieces of gray hard compact fossiliferous limestone.			
		2,566–2,654	Gray sand and some gray and red clays.	Hard gray limestone	12	2,601
		2,654–2,745	Tough red clay.	Red shale with hard streaks of sand.	103	2,704
		2,745–2,748	Sample is a piece of a large shell.	Hard broken sand rock	76	2,780
		2,748–2,912	Tough red clay.	Tough red gumbo	10	2,790
				Hard rock	3	2,793
				Red gumbo	27	2,820
				Hard red shale	20	2,840
				Hard rough rock	6	2,846
				Hard blue sandy shale	20	2,866
				Tough blue gumbo	25	2,891
				Hard broken sand rock; salt water.	39	2,930
				Hard broken slate with streaks of sticky shale; artesian flow of salt water.	95	3,025

Record of well drilled at Nashville, Ark., by the Perpetual Oil & Gas Co.

[Furnished by F. G. Bozeman, secretary. Driller, Frank Harper. Elevation about 358 feet above sea level.]

Age and formation.		Driller's record.		
		Material.	Thickness.	Depth.
Quaternary.	Terrace deposit.		*Feet.*	*Feet.*
		Red surface sand	20	20
		Bluish sand and gravel	15	35
Upper Cretaceous.	Bingen formation.	Gray sand; water	5	40
		Blue muck	63	103
		Fine gray sand	3	106
		Conglomerate rock, grit, and sand	10	116
		Limestone rock, sand, and gravel	5	121
		Fine water sand	1½	122½
		Blue muck	20½	143
		Dark-blue coarse sand	2	145
		Blue muck	13	158
		Chocolate-colored muck and gravel	4	162
		Blue gumbo and blue sand alternating with rock	36	198
		Coarse sand rock and gravel	4	202
		Red muck and gravel	48	250
		Pink clay, gravel, and sand; trace of oil	10	260
		Red muck and gravel	40	300
		Coarse sand and gravel	20	320
		Fine pink sand; showing of oil	4	324
		Fine white water sand; strong stream of water	6	330
		Red muck mixed with gravel	70	400
		Grayish-brown muck, gravel, and sand	30	430
		Chocolate-colored muck and light-colored gravel	30	460
		Sand	1	461
		Sand; water	4	465
		Coarse sand	4	469
		Bluish muck, gravel, and sand	39	508
Lower Cretaceous.	Trinity formation.	Sand; good showing of oil	4	512
		Shale rock and sand	9	521
		Blue muck	30	551
		Disintegrated shells, mixed with gravel and soapstone (De Queen limestone member of Trinity formation)	47	598
		Dark-red clay mixed with sand and gravel	54	652
		Sand	2½	654½
		Gray muck; some fine sand	2½	657
		Assorted rock of various hardnesses	18	675
		Alternating rock, sand, and muck, light colored	123	798
		Black muck mixed with oil (third showing)	5	803
		Limestone, gravel, sand, etc	13	816
		Slate	37	853
		Limestone muck and sand	8	861
		Light-brown soapstone	51	912
		[No record was kept of rocks penetrated at this depth, but a sample of mixed cuttings examined by the senior author contains limestone, pyrite, and blue clay]	348	1,260
Carboniferous.		[Hard black shale, hard sandstone, and much pyrite in cuttings examined by senior author. These are apparently Carboniferous]	20	1,280

Record of well drilled by Gulf Refining Co., at Whitecliffs, Ark.

Age and formation.		Driller's record.		
		Material.	Thickness.	Depth.
Quaternary.		Brown loose gravel	*Feet.* 6	*Feet.* 6
Upper Cretaceous.	Annona chalk.	White soft chalk	15	21
	Brownstown marl.	Soft blue marl	230	251
		Blue slate	10	261
		Blue marl; showed shells	60	321
		Black hard shell sand	2	323
		Soft blue marl; top of water sand	29	352
		Blue hard sand	6	358
		Soft blue slate; showed shells	25	383
		White soft sand; pyrites of iron	20	403
		Blue soft slate	77	480
		White hard sand	40	520
		White hard lime; showed shells	6	526
	—?	Soft blue marl	134	660
	Bingen formation.	Sand and gravel, brown	30	690
		Light soft slate	2	692
		Soft red rock; pyrites of iron	12	704
		Blue soft sand and slate	28	732
		Soft red rock	37	769
		Blue soft marl	14	783
		Light hard sand; salt water	14	797
		White soft sand	20	817
		White hard sand	25	842
		White soft sand; sulphur water	48	890
		White soft slate	3	893
		Hard lime shell	3	896
		White soft sand; water clear	10	906
		White soft slate; showed pyrites of iron	6	912
		Black hard sand	15	927
		White soft sand; water	25	952
		Hard lime	5	957
		Soft red rock	10	967
		White soft slate	15	982
		Red rock	20	1,002
		Brown soft sand; more water	65	1,067
		Brown medium sand	20	1,087
		Light soft sand	3	1,090
		Soft red rock	28	1,118
		White soft sand	7	1,125
		Soft red rock	40	1,165
		White hard sand	2	1,167
		White soft sand; water	30	1,197
		Soft mixed slate	3	1,200
		Medium sand	40	1,240
		Soft red rock	20	1,260
	—?	White soft sand; more water	47	1,307
Lower Cretaceous.	Washita group.	Soft red rock	15	1,322
		Sand and red rock, mixed	17	1,339
		Yellow soft gumbo	7	1,346
		Soft red rock	73	1,419
		Hard blue marl	10	1,429
		Soft red rock; shows pyrites of iron	45	1,474
		Shells, sand, and red rock	30	1,504
		Soft blue marl	15	1,519
		Mixed very hard lime	6	1,525
		White soft sand; water	12	1,537
		White soft slate	3	1,540
		Mixed hard lime; pyrites of iron	6	1,546
	—?	White soft slate	10	1,556
	Goodland limestone.	White hard lime shell; showed shells	12	1,568
		Black soft slate	10	1,578
		Lime shells, all colors, pyrites of iron and shells	7	1,585
		White hard lime	25	1,610
		Soft blue slate	4	1,614
		White hard lime	55	1,669

Record of well drilled by Gulf Refining Co., at Whitecliffs, Ark.—Continued.

Age and formation.		Driller's record.		
		Material.	Thickness.	Depth.
			Feet.	*Feet.*
Lower Cretaceous.	Trinity formation.	Soft red rock	2	1,671
		Blue soft slate	24	1,695
		Soft red rock	10	1,705
		White soft slate; shows black stuff	5	1,710
		Dark hard sand	40	1,750
		Mixed hard sandy lime	10	1,760
		Soft red rock	36	1,796
		Blue tough gumbo	12	1,808
		Shells, all colors	26	1,834
		White hard sand	7	1,841
		Soft red rock	50	1,891
		Sand shell, hard	3	1,894
		Soft red rock	3	1,897
		Lime and sand, all colors	30	1,927
		Mixed hard lime	12	1,939
		Soft blue marl	22	1,961
		Blue and white soft marl; showed streaks of white lime	35	1,996
		Mixed hard lime	10	2,006
		Soft red rock	20	2,026
		Blue hard lime; showed pyrites of iron	3	2,029
		Soft blue marl	15	2,044
		Soft red rock	30	2,074
		Soft white slate	6	2,080
		Sand and lime, all colors	32	2,112
		Sand and slate medium; more fresh water	11	2,123
		White soft sand	32	2,155
		Soft red rock	5	2,160
		White soft sand; salty water	5	2,165
		Soft red rock	17	2,182
		Gray hard sand, mixed with lime	19	2,201
		White medium sand	15	2,216
		Soft red rock	2	2,218
		White medium sand, carrying water	75	2,293
		Mixed soft sand	110	2,403
		Soft red rock	3	2,406
		White soft sand	10	2,416
		Soft red rock	8	2,424
		Soft yellow rock	6	2,430
		Gravel, all colors	10	2,440
		Soft red rock	15	2,455
		Soft blue marl	25	2,480
		Soft yellow rock	6	2,486
		Soft blue marl	20	2,506
		White soft sand	10	2,516
		Soft blue marl	20	2,536
		Blue soft sand	5	2,541
		Soft blue marl	15	2,556
		Gray soft sand	5	2,561
		Soft blue marl	10	2,571
		Gray medium sand	10	2,581
		Soft blue marl	15	2,596
		Blue soft sand	10	2,606
		White soft sand	15	2,621
		Soft blue marl	15	2,626
		White soft sand	5	2,631
		Soft blue marl	4	2,635