OKLAHOMA GEOLOGY NOTES

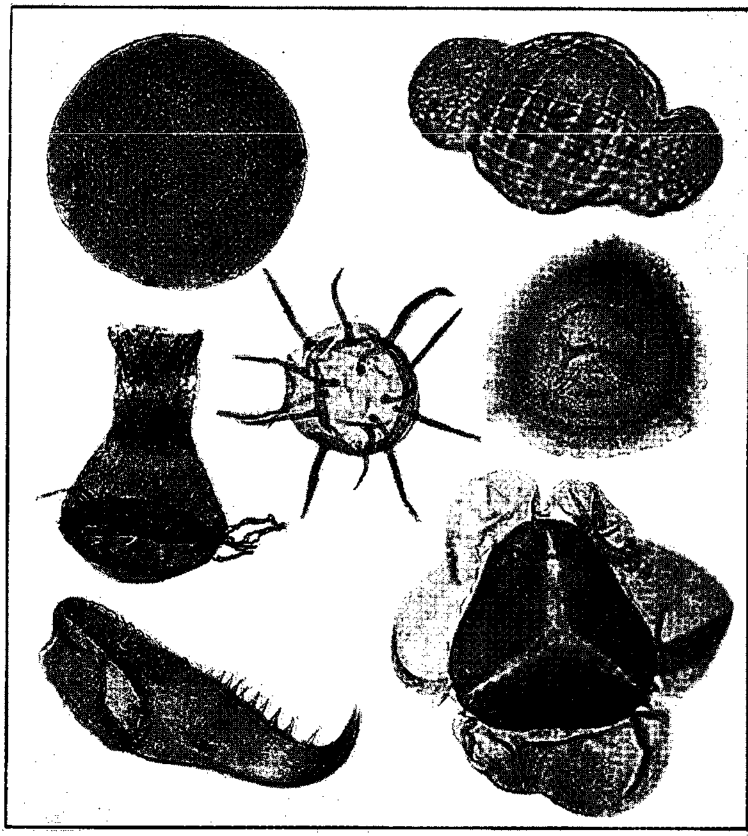

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PLATE I

A SOLITARY RUGOSE CORAL OF EXCEPTIONAL SIZE FROM THE MIDDLE PENNSYLVANIAN OF OKLAHOMA

PATRICK K. SUTHERLAND AND J. M. COCKE

INTRODUCTION--The authors are indebted to Harrell Strimple and Jack Hood for bringing to their attention the occurrence in the Oologah formation (upper Desmoinesian) of a solitary rugose coral of the caniniid type which reaches the unusual size of nine to ten inches in length and three inches in diameter. The brief description which follows is based on about 20 specimens including some collected by the authors but most were supplied by Strimple and Hood. The specimens were collected from poor exposures in a field approximately 0.2 miles west of an abandoned house located 0.2 miles north of the southeast corner of sec. 27, T. 21 N., R. 14 E., Rogers County, Oklahoma. The specimens now form part of the collection of the School of Geology, University of Oklahoma.

The Oologah formation in this area consists predominantly of limestone beds and thin shales and is about 40 feet thick (Oakes, 1952, p. 30). The exact stratigraphic position of the corals here described could not be readily determined because of the poorly exposed nature of the Oologah formation at the collection locality. In addition to the species described here, a number of other interesting rugose corals have been collected from the Oologah formation at several other localities. A description of the entire fauna is planned.

DIFFICULTIES OF CLASSIFICATION—Caniniid corals in many cases make up a major part of Pennsylvanian rugose coral faunas in North America. They are often classified as *Caninia torquia* (Owen). It seems certain that many different corals have been included in this broadly interpreted species to the point that the name has become synonymous in many faunal lists with Pennsylvanian corals of the caniniid type. A careful study of this group will be necessary before a meaningful classification can be attempted.

There is disagreement as to what generic name should be used for corals of the *C. torquia* type. Hill (1956, p. F292), in her important compilation of the rugose corals for the *Treatise on Invertebrate Paleontology*, included forms with a wide dissepimental zone in the genus *Caninia* even though the type species of this genus, *C. cornucopiae* Michelin, from the Lower Carboniferous of Belgium, has few dissepiments and is relatively small. Other recent authors (Moore and Jeffords, 1945, p. 145; Sutherland, 1958, p. 63) have included species with a wide, non-lonsdaleoid dissepimental zone in the genus *Pseudozaphrentoides*. This latter usage is followed in this paper. For a discussion of various genera related to *Caninia* see Sutherland (1958, p. 62). No attempt is made at this time to classify the form here figured as to species.

EXPLANATION OF PLATE I

Pseudozaphrentoides sp., x1. Side view of a large but incomplete specimen. Early conical stage missing and calyx broken. Complete specimen may have reached 10 inches in length. Note marked rejuvenescence. O. U. Cat. No. 3434.
(Photograph by N. M. Curtis)

PLATE II

Pseudozaphrentoides sp.

(plate I; plate II, figs. 1, 2)

General Description—All of the larger specimens available for study are incomplete. The largest single fragment is about 16 cm (about 6½ inches) in length (plate I) and the complete specimen probably had a total length of 23 to 26 cm (about 9 to 10 inches). All specimens are cylindrical in the adult stages but are markedly rejuvenescent (plate I). Most are slightly crushed and considerably weathered. Some show well-preserved patches of the epithecal surface, which has conspicuous growth lines and faint interseptal ridges. The greatest diameter observed is about 7.5 cm (3 inches) but in most specimens the maximum diameter is nearer 6.5 cm (about 2½ inches). The early curved, conical (trochoid or ceratoid) stage grows to a length of from about 4 to as much as 8 cm (1½ to 3 inches) before a specimen becomes straight and cylindrical. All specimens showing early growth stages exhibit a small irregular attachment area which ranges in maximum length from 1.0 to 2.0 cm (poorly shown in plate II, figs. 1, 2). It seems doubtful that a fully mature specimen could have been supported by such a small attachment surface. Most specimens show a sideward tilting of the calyx toward the concave side of the corallite. The adult corallite may have become unattached and may have settled to a horizontal position on the sea floor with a resulting tendency for the calyx to grow to one side during remaining stages of life.

The calyx is free in most specimens studied. It appears to be relatively shallow, its depth being probably less than the maximum diameter. The septa can be observed in the calyx in most specimens (plate II, fig. 2). Thin sections were also studied. In the adult, cylindrical stage, among the specimens studied, there are typically 38 major septa at a diameter of 5 to 7.5 cm but a very few specimens have 40 septa and one has 42. The major septa are typically about two-thirds the radius in length leaving an open tabular area in the axial region. The major septa are thin and sinuous in the dissepimentarium but become somewhat thickened and straight in the tabularium. Minor septa are short, incomplete and none extends across the dissepimental zone. The cardinal septum is shortened and lies in a narrow cardinal fossula which is inconspicuous in thin-section but shows clearly in a weathered calyx (plate II, fig. 2). The position of the cardinal fossula is unrelated to the plane of curvature and lies in a different position in relation to this plane in nearly all specimens. This irregularity does not appear to have been due to twisting of the specimen during growth. The dissepimentarium, one-fourth to one-third

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Explanation of Plate II

Figure 1. *Pseudozaphrentoides* sp., x1. Side view of a young specimen showing early conical stage and the beginning of the cylindrical stage. Most of epitheca missing. Note side view of calyx. Indistinct horizontal mark near apical end indicates small attachment surface. O. U. Cat. No. 3435.

Figure 2. View into calyx of specimen in figure 1, x1. Early conical portion slopes away from camera and thus appears shortened. Note that cardinal fossula (indicated by arrow) is not located in plane of curvature (horizontal in photo). Groove at apical end shows location of attachment area.

(Photographs by N. M. Curtis)

the radius in width, forms a distinct peripheral zone composed of five or six rows of steeply inclined dissepiments. They appear well rounded to globular in longitudinal section but in many specimens they have a herringbone appearance in transverse section. The tabulae are flat but turn downward sharply near their peripheral margins.

Early growth stages have not as yet been studied in detail. A polished surface of one specimen at a diameter of 3.0 cm (about 1¼ inches) shows 36 major septa with those of the cardinal quadrants greatly thickened in the tabularium. This is a distinctive feature which does not persist into the adult stage in most specimens. At this early stage the major septa are slightly more than two-thirds the radius in length. The peripheral zone of dissepiments is relatively narrow compared to later stages, being about one-sixth the radius in width and composed of three or four rows of dissepiments.

REMARKS—As far as is known to the authors the species here illustrated is the largest caniniid coral thus far described from the Pennsylvanian of North America. An undescribed species from the Middle Pennsylvanian of northern New Mexico, of which there are about 30 specimens in the collection of the senior author, has a maximum length of nearly ten inches but the diameter of few specimens exceeds two inches. The largest caniniid coral described by Moore and Jeffords (1945, p. 149) from the lower Pennsylvanian of Texas, *Pseudozaphrentoides spatiosus* n. sp., has a maximum length of five inches and a diameter of about one-and-a-half inches. The largest caniniid coral described from anywhere in North America appears to be *Pseudozaphrentoides burlingi* described by Sutherland (1958, p. 67) from the Middle Mississippian of northwest Canada. It reaches a maximum length in excess of one-and-a-half feet and a diameter of more than three inches.

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WOODWARD COUNTY'S GAS FIELDS

LOUISE JORDAN

Woodward County, where hydrocarbon production was first discovered in December of 1956, now has eight gas-condensate productive areas and one marginal oil well. The County in northwestern Oklahoma is southeast of Harper County and east of Ellis County where excellent reserves of gas have been found in the late nineteen fifties. Three new areas of gas production were found in 1959 (T. 21 N., R. 17 W. and T. 26 N., R. 19 W.) as shown on the oil and gas map, figure 1, and previously discovered areas were extended at Northwest Quinlan, Northeast Woodward and Woodward Fields. Production has been found in Missourian sandstones (Mussellem or Cottage Grove and Tonkawa) and Morrowan sandstones of Pennsylvanian age, and in limestones of Mississippian age.

The County's first "deep" test was commenced in 1929 shortly after the discovery of the Oklahoma City Field. The well, listed in the Corporation Commission files as the Billy Oil and Gas No. 1 Wyatt (SE¼ SE¼ section 9, T. 23 N., R. 20 W.), was plugged at 5,660 feet in February 1930. Seven strings of casing ranging in size from 20 inch to 5 3/16 inch were used to case off water during drilling. In June of 1930, Prairie Oil and Gas No. 1 Wilbur (NE¼ NE¼ NE¼ sec. 23, T. 23 N., R. 17 W.) was finally abandoned as a dry hole in Mississippian rocks at total depth of 7,345 feet. Drilling of this well was started in September 1928 and the report reads that "rotary tools were used from 0 to 4,290 feet and cable tools from 4,290 to 6,297 feet." Gas amounting to 200,000 cubic feet was reported from "sandy lime" at 5,992 to 6,016 feet.

Until 1959, only five tests, amounting to footage of 39,400 feet, were drilled in the County area of 1,232 square miles. At the end of 1959, a total of 67 tests had been made and of these 23, or 34 percent of the total, are productive of oil or gas. Nearly all tests have been drilled into the top of the Mississippian system and six have penetrated part of the Ordovician section (fig. 1). Table I gives the results of tests and footage drilled for the 30-year period, 1930-1959.

Permian rocks of Guadalupean age crop out in northwest-trending bands parallel to the Cimarron and North Canadian River valleys. In the northeast portion of the County, the following formations, which dip at low angles southwestward, are exposed (ascending order): Flowerpot shale, Blaine formation, Dog Creek shale, Marlow formation, Rush Springs sandstone and Cloud Chief formation. The valley of the North Canadian River with its Quaternary deposits separates the northeast area of Permian exposures from the southwest area where Rush Springs sandstone and Tertiary beds of clay, sand, and gravel are found. Clifton (1926, p. 21) reports limited exposures of Comanchean Cretaceous in the northwestern, eastern, and southern parts of the County. Arthur J. Myers of the School of Geology, University of Oklahoma, presently is mapping the County area which had been studied by reconnaissance methods for the Geologic Map of Oklahoma (1954).

Table I.—Gas-condensate wells, oil wells, dry holes and footage drilled in Woodward County, Okla., 1930-1959

Year	Gas-condensate	Oil	Dry	Total	Footage drilled
1930	0	0	2	2	13,085
1943	0	0	1	1	10,078
1948	0	0	1	1	6,978
1949	0	0	1	1	9,272
1950	0	0	2	2	15,512
1951	0	0	3	3	28,772
1953	0	0	4	4	36,455
1955	0	0	1	1	8,412
1956	1	0	2	3	31,839
1957	5	1	7	13	108,927*
1958	8	0	6	14	107,950*
1959	7	1	14	22	178,136*
	21	2	44	67	555,411

* *Oil and Gas Journal*, annual review issue.

The upper two-thirds of the Permian section consists of red beds, salt, gypsum, and anhydrite with a few beds of dolomite normally less than five feet thick. Salt strata occur in the shale below both the Blaine formation and the Cimarron anhydrite, and in the Wellington formation, which is predominantly anhydrite with interbeds of gray shale. The lower one-third of the section is essentially dolomite and limestone interbedded with gray shale. Where the Blaine formation is exposed in T. 27 N., R. 18 W., thickness of the Permian section is about 3,400 feet; and the top of the Pennsylvanian is penetrated at an average subsea depth of 1,800 feet. Southwestward in T. 20 N.,, R. 22 W. (southwest township of the County), the equivalent Permian section is about 4,400 feet thick and is overlain by approximately 600 feet of younger Permian; top of Pennsylvanian is at an average subsea depth of 2,800 feet.

The Pennsylvanian system is 2,400 feet thick in the northeast part of the County (T. 26 N., R. 18 W.) where the basal unit, Morrow, is absent (fig. 2); and more than 4,500 feet thick in T. 20 N., R. 20 W. where the Morrow ranges from 350 to 650 feet in thickness as shown on the map of Morrow thickness, figure 2, prepared by J. Durwood Pate, consulting geologist of Oklahoma City. A linear belt of marked thickening trends northward through the central part of the County. It overlies a similar belt of thinning in the underlying Chesterian series (Pate, 1959, p. 48); and represents the filling of a channel-like feature existing in Chesterian rocks during Morrowan deposition. The term Morrow formation is applied locally to that section of rocks consisting of shale underlain by sandstone which lies below the "Thirteen Finger lime" and above the Pennsylvanian-Mississippian unconformity. A structure map constructed at the top of the Morrow formation, figure 3, shows a general southward dip into the Anadarko basin.

Late Pennsylvanian sandstones, "Tonkawa" and "Mussellem" (Cottage Grove) are productive of gas or oil in three fields; gas has been found in Morrow sandstone in four fields. (The productive reservoirs of individual wells are shown by symbols on fig. 1). Shows of hydrocarbons have been reported from the Checkerboard limestone and from Desmoinesian and Atokan rocks.

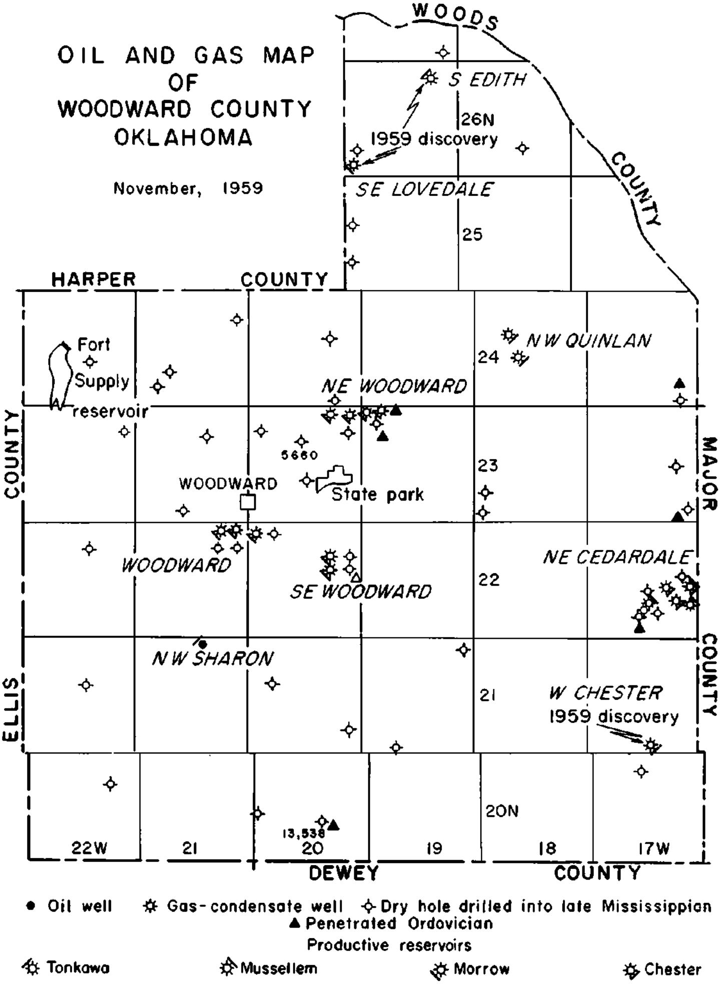

Fig. 1. Map showing oil and gas fields of Woodward County, productive wells, dry holes, tests penetrating Ordovician rocks, and name of productive pay in individual wells.

Limestones of Late Mississippian age normally immediately below the Pennsylvanian-Mississippian unconformity are gas-productive in three areas (fig. 1). Although shows of oil and gas have been noted in older rocks (Hunton, Viola, and Simpson) in some wells penetrating the Ordovician, no commercial production has been developed. Reported depths below derrick floor and thicknesses of units older than Pennsylvanian for the Sinclair No. 1 Morrow at the north and the Magnolia No. 1 Borden about 20 miles south are given in table II.

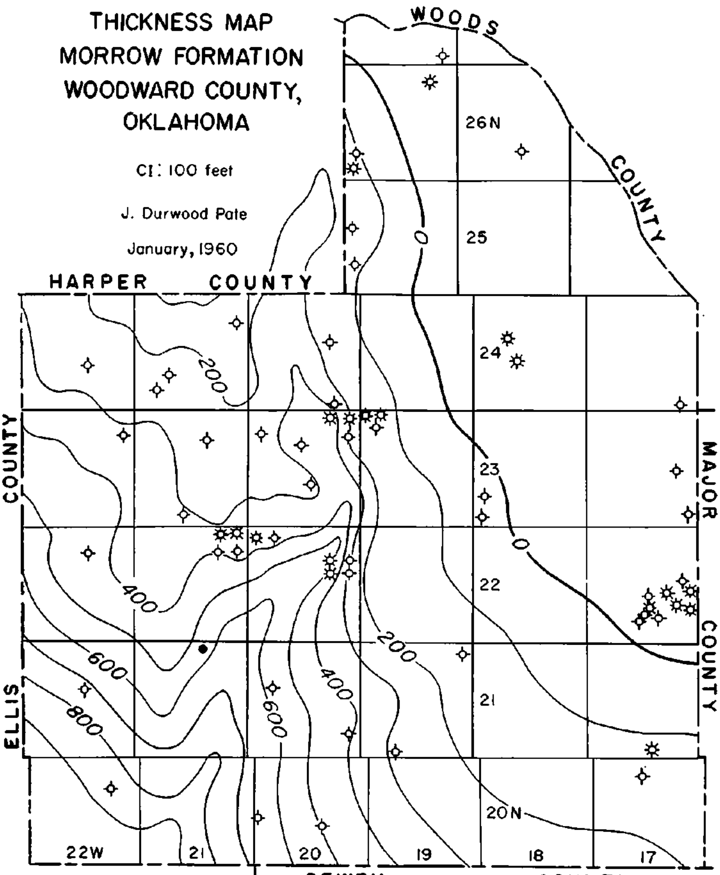

Fig. 2. Thickness map of Morrow formation showing a linear belt of marked thickening extending northward through the center of Woodward County.

The data concerning the discovery of each field and zone are listed below in order of completion date. All gas wells are shut in awaiting pipeline connections.

Woodward, Southeast: Union Oil of Calif. No. 1 McCormick, SE¼ SE¼ NW¼ sec. 14, T. 22 N., R. 20 W., elevation: 2,040. *Morrow* gas-condensate pay, 8,234; perforated 8,234-8,244; open flow 25,000.000 cubic feet, 62 bbls. condensate (60° gravity), daily. Total depth, 8,491; completed December 27, 1956.

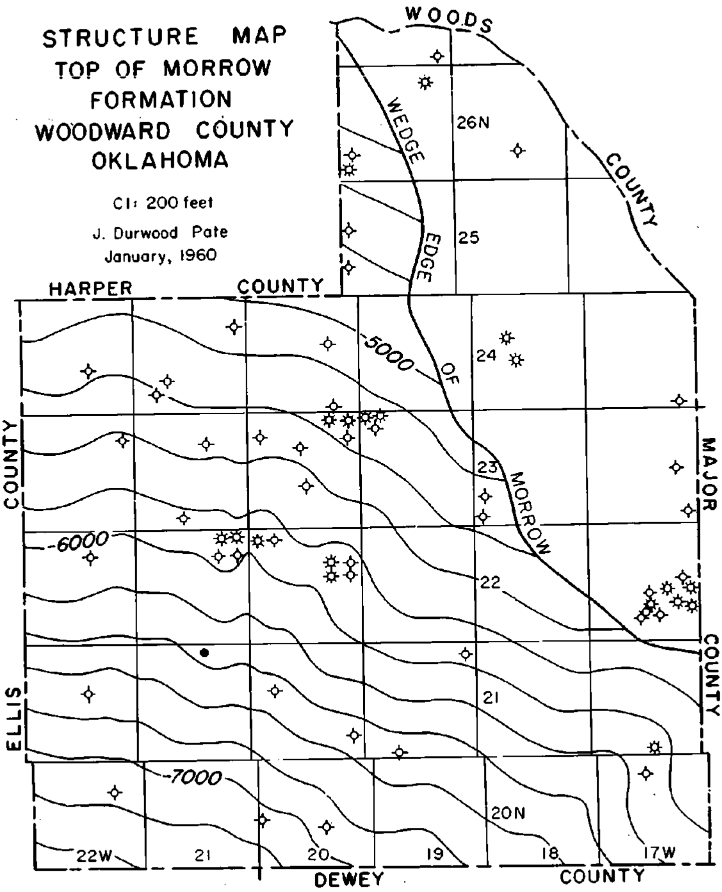

Fig. 3. Structure map contoured on the top of the Morrow formation.

Table II.—Depth and thickness in feet of pre-Pennsylvanian units	North	South
Unit	6-23N-19W Elev. 2020	22-20N-20W Elev. 2164
Mississippian	7,469 (1,822)	9,572 (2,482)
Woodford	9,291 (12)	12,054 (44)
Hunton	9,303 (221)	12,110 (278)
Sylvan	9,524 (36)	12,388 (56)
Viola	9,560 (142)	12,444 (376)
Simpson	9,702 (370)	12,820 (392)
Arbuckle	10,072	13,212
Total depth	10,327	13,528

Woodward: Champlin Oil & Refg. No. 1 McDonald, SE¼ NE¼ sec. 1, T. 22 N., R. 21 W., elevation: 2,042. *Morrow* gas-condensate pay, 8,191; perforated 8,256-61 and 8,277-89; open flow 9,100,000 cubic feet, 315 bbls. condensate (59° gravity), daily. Total depth, 8,383; completed April 17, 1957.

Cedardale, Northeast: Shell Oil No. 1 Garvie, NE¼ NE¼ sec. 26, T. 22 N., R. 17 W., elevation: 1,745. *Chester* gas-condensate pay, 7,236; perforated 7,236-58 and 7,294-7,314; open flow 5,400,000 cubic feet, 29 bbls. condensate (56.5° gravity), daily. Total depth, 7,450; completed July 24, 1957. New zone discovery: *Mussellem* gas pay, 6,310; perforated 6,310-6,362, open flow 6,500,000 cubic feet and 5.4 bbls. condensate (60° gravity) daily in Shell Oil No. 1-24 State of Oklahoma, SW¼ NE¼ sec. 24, T. 22 N., R. 17 W., elevation: 1,759. Dual completion with Chester gas pay for 14,600,000 cubic feet gas, 33 bbls. condensate per day, completed January 28, 1958.

Woodward, Northeast: Sinclair Oil & Gas No. 1 Gilbert, SE¼ NW¼ sec. 1, T. 23 N., R. 20 W., elevation: 2,043. *Morrow* gas pay, 7,381; perforated 7,523-38 and 7,567-71; open flow, 3,500,000 cubic feet daily. Total depth, 7,849; completed October 24, 1957.

Sharon, Northwest: Pan American Petrol. No. 1 Dean, SW¼ SE¼ sec. 3, T. 21 N., R. 21 W., elevation: 2,187. *Lower Tonkawa* oil pay, 6,592; perforated 6,629; pumping 22 bbls., 38° gravity in 24 hrs. Total depth, 9,257; completed December 31, 1957. Well reworked in 1958 resulting in slight improvement.

Quinlan, Northwest: Calvert Drlg. No. 1 Young, NE¼ NE¼ sec. 17, T. 24 N., R. 18 W., elevation: 1,867. *Chester* gas pay, 6,674; perforated 6,669-75, 6,684-6,707, and 6,729-6,737; flowed at rate of 9,000,000 cubic feet daily through 21/64-inch choke. Total depth, 6,950; completed March 1, 1958.

Lovedale, Southeast: Sinclair Oil & Gas No. 1 Dotter, SE¼ NW¼ sec. 31, T. 26 N., R. 19 W., elevation: 1,795. *Morrow* gas pay, 6,375; perforated 6,388-6,409, fractured, flowed at rate of 7,120,000 cubic feet daily through ¾-inch choke. Total depth, 6,660; completed March 10, 1959.

Chester, West: Ashland Oil and Refg. No. 1 Shoreline, NE¼ SW¼ sec. 34, T. 21 N., R. 17 W., elevation: 1,748. *Chester* gas pay, 7,946; perforated 7,952-60 and 7,966-80; flowed at daily rate 3,000,000 cubic feet through ¼-inch choke. Total depth, 8,150; completed October 23, 1959.

Edith, South: Pure Oil No. 1 Selman Morris Unit, SW¼ SW¼ SE¼ sec. 2, T. 26 N., R. 19 W., elevation: 1,715. *Tonkawa* gas pay, 5,016; perforated 5,016-20; open flow, 1,300,000 cubic feet gas daily. Total depth, 6,160; completed November 28, 1959.

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A NEW FOSSIL PLANT LOCALITY IN THE SYLAMORE MEMBER, CHATTANOOGA FORMATION, NORTHEASTERN CHEROKEE COUNTY, OKLAHOMA

George G. Huffman and John M. Starke, Jr.

The basal Sylamore sandstone member of the Mississippian Chattanooga formation, named from exposures in the vicinity of Sylamore Creek, Stone County, Arkansas, crops out in several localities in northeastern Oklahoma. Although it has a wide range in thickness and is erratic in distribution, it has been identified in exposures from near Marble City, in northern Sequoyah County, northward to the Spavinaw Creek area, in Delaware and Mayes Counties.

The Sylamore sandstone unconformably overlies the St. Clair, Frisco, and Sallisaw formations (Silurian-Devonian) near Marble City. It lies upon the Tyner-Fite-Fernvale sequence (Ordovician) near Tahlequah, and upon the Cotter and Burgen formations (Ordovician) along Spavinaw Creek, Spring Creek, and the upper part of the Illinois River valley in Oklahoma. It is succeeded conformably by the black shale member (Noel equivalent) of the Chattanooga formation. It is thought to be equivalent to the Misener sand of the Oklahoma subsurface and to the Hardin sandstone of Tennessee.

Lithologically the Sylamore is a white to yellow-brown phosphatic sandstone with a "salt and pepper" appearance on fresh surface. The basal portion consists of dark-gray to black shale and bluish-gray phosphatic slightly calcareous sandstone. The Sylamore sandstone weathers gray to yellow-brown and locally to red and becomes pitted in appearance. Many individual sand grains have well-developed crystal faces. The degree of cementation is not uniform; generally the sandstone is friable but locally it becomes well cemented, hard, and quartzitic. The thickness ranges from zero to 18 feet (T. 14 N., R. 24 E.).

Few fossils have been reported from the Sylamore. Small phosphatic brachiopods of the genus *Lingula*, rare fragments of "spirifers," and traces of fossil wood constitute the known fauna and flora.

A new fossil plant locality was found recently by Starke during mapping and investigations along the Illinois River in northeastern Cherokee County.

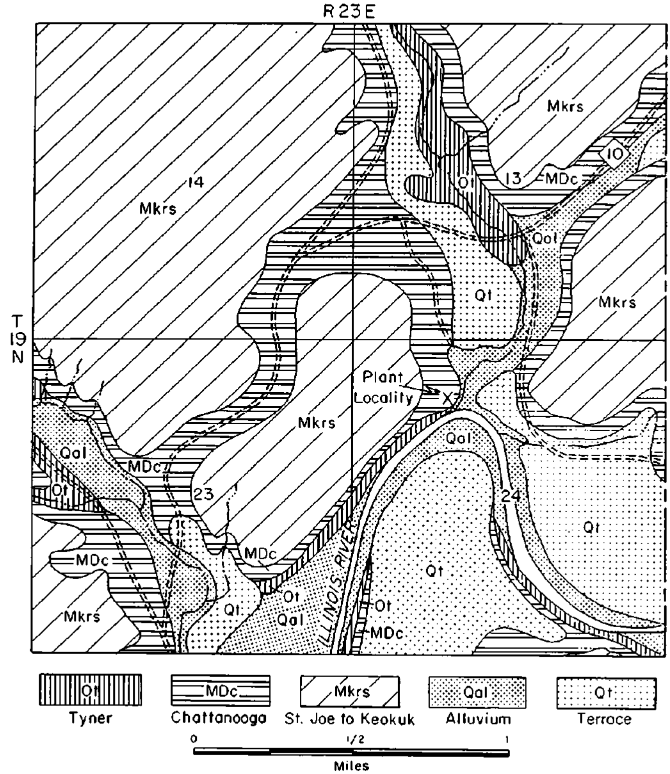

Figure 1. Geologic map of part of northeastern Cherokee County, Oklahoma, showing fossil plant locality.
(Modified from J. M. Starke, Jr., unpublished map)

The exposure is at river level in the SE¼ NW¼ sec. 24, T. 19 N., R. 23 E. (fig. 1). There the Sylamore includes approximately one foot of sandstone separated into three beds and nearly two inches of basal black shale. It overlies three feet of Tyner shale (exposed during low water) and is succeeded by a twenty-foot exposure of black Chattanooga shale which forms the west river bank.

The fossils (fig. 2) consist almost entirely of shallow molds of tree trunks in the upper surfaces of the sandstone layers. Some twenty or thirty specimens can be seen at this locality. Typical specimens range from one to six feet in length and have diameters of five to seven inches. Several of the larger specimens measure nearly ten inches in diameter. All of the specimens are characterized by transverse ridges which cut the molds into fairly uniformly spaced segments. Preservation is poor and only faint suggestions of vertical striations are present.

Floral affinities of these remains have not been definitely established and await further field and laboratory study. It has been suggested by L. R. Wilson (oral communication, December 1950) that these fossil trees belong to the genus *Cordaites* and that the jointed appearance is due to cracking of the logs during diagenesis. This theory tends to rule out the possibility that they are *Calamites*, a Paleozoic rush characterized by a uniform jointing of the stem and strong longitudinal ribbing.

Figure 2. Two views of fossil tree molds in the Sylamore sandstone, sec. 24, T. 19 N., R. 23 E., Cherokee County, Oklahoma.
(Photographs by J. M. Stark, Jr.)

GLASSY PEBBLES IN SOUTHWESTERN OKLAHOMA—OBSIDIAN vs. TEKTITE

WILLIAM E. HAM

In January 1960, Mr. Delbert Markwell of Oklahoma City gave to the writer a black glassy pebble (fig. 1) that he had found near Lugert, Kiowa County, in the Wichita Mountain region of southwestern Oklahoma. Mr. Markwell, a past president of the Oklahoma Mineral and Gem Society and an avid mineral collector, found the pebble while searching in gravel deposits for silicified wood, jasper, and other semiprecious stones. His primary interest was that the pebble might be a tektite, as a tektite had been mistakenly reported (Stair, 1956) from Delhi, Beckham County, Oklahoma, only about 30 airline miles northwest of Lugert.*

Figure 1. Shape and surface markings of the Markwell obsidian pebble from Lugert, Oklahoma, x2. The straight edge at the bottom is a surface cut with diamond saw for the slice illustrated in figure 3.
(Photograph by R. E. Denison)

Tektites are glassy rocks superficially like obsidian, but they are believed to originate as meteoritic fragments that were fused to glass during transit through the atmosphere. Known first from Australia, Indochina, the Philippine Islands, Bohemia-Moravia, and Africa, they were later found at several localities in Texas. Tektites from Texas are known as bediasites. They were described and compared with tektites from other parts of the world in a comprehensive paper by V. E. Barnes (1939).

The rarity of tektites in North America, and the possibility that additional discoveries will assist in cosmologic interpretations of the Earth, led to the investigations of the Markwell pebble that are reported here.

* A review of Stair's report appeared in *Oklahoma Geology Notes*, vol. 16 p. 102, 1956.

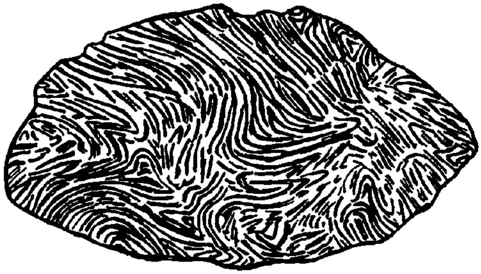

Figure 2. Flow structure in a tektite (bediasite) from Texas, x2. Sketched from a full-tone illustration (Barnes, 1939, Plate 26a).

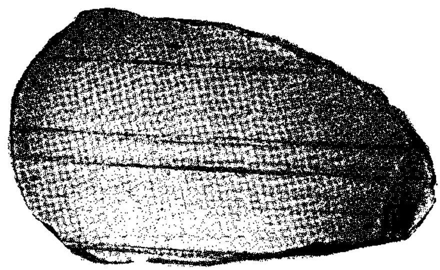

Figure 3. Flow bands in obsidian pebble from Lugert, x2. Section approximately 2 mm thick, photographed in transmitted light.
(Photograph by R. E. Denison)

The pebble was submitted to V. E. Barnes for an expert opinion. In a letter to the writer dated January 14, 1960, Dr. Barnes made the following statement:

"It is obsidian similar to that in the U. S. National Museum from near Delhi. Two or three years ago I visited the Delhi area and collected one specimen of obsidian from a high terrace near where the specimen was collected for the U. S. National Museum. After finding one piece of obsidian I asked to borrow the Museum's specimen and found it was also obsidian."

Thus the Delhi tektite is discredited, and with this new information it is clear that no tektite has as yet been described from Oklahoma.

The difference between the Markwell pebble and genuine tektites is discussed below, and specimens are illustrated in figures 2 and 3. The most easily observed difference, and certainly one of critical importance, is that tektites have contorted flow structure of the type that is likely to develop only in small masses which cool quickly because of their small size (fig 2). Flow layers in large masses of slowly cooled obsidian, however, generally are plane, gently curving, or gently undulating (Barnes, 1958, p. 271). The pebble from Lugert is composed of uniform dark-gray glass containing small crystallites and showing strongly developed planar flow bands (fig. 3). These flow structures terminate abruptly against the abraded edges of the pebble, showing that the entire specimen is a fragment of a larger mass, probably an obsidian flow, and that the pebble could not have originated as a glassy body of its present size and shape.

The ranges in specific gravity, index of refraction, and silica content of obsidian are quite similar to those of some tektites, with the result that these properties may not serve to distinguish unequivocally between them. In table I the Lugert pebble is compared with other obsidians and with some well-known tektites, and the conclusion is drawn that the pebble, although not unlike the moldavites, is much more closely related to obsidian.

TABLE I.—SELECTED PROPERTIES OF OBSIDIANS AND TEKTITES

	Index of Refraction (N_{na})	Specific Gravity	Percent SiO_2	Percent H_2O
Obsidians				
Obsidian pebble, Lugert, Okla.1/	1.487	2.343	74.41	0.80
Obsidian2/	1.485-1.491	2.34	73-78	0.1-0.9
*Tektites*3/				
Australites	1.509	2.424	69.80-79.51	
Bediasites	1.497	2.374	73.52-77.76	
Moldavites	1.488	2.336	77.75-82.68	

1/ Index of refraction (Nna) by sodium light in immersion oils by Ham; specific gravity on Berman microbalance by R. E. Denison; SiO_2 by HF method, and water loss at 110-1000°C., by J. S. Schleicher.

2/ Nineteen obsidians from United States and foreign occurrences (Ross and Smith, 1955).

3/ Average index of refraction and specific gravity of 9 australites from Australia, 79 bediasites from Texas, and 38 moldavites from Bohemia-Moravia (Barnes, 1939).

Through the careful work on natural glasses by Ross and Smith (1955), who studied 19 specimens of obsidian from the continental United States, Alaska, Iceland, Ascension Island, and New Zealand, it is known that obsidian normally has an index of refraction between 1.485 and 1.491, a water content between 0.1 and 0.9 percent, and SiO_2 content between 73 and 78 percent. Considering obsidian as a rock group, these are surprisingly low ranges in composition. Yet the Lugert pebble has an index of refraction of 1.487, a water loss of 0.80, and SiO_2 content of 74.41, and accordingly each property lies well within the stated ranges. There is no doubt that the pebble is a normal obsidian.

The Markwell obsidian from Lugert is a discoidal pebble which measured 1 x 1.7 x 1.7 inches and weighed approximately 65 grams before it was cut. It was found in a terrace-gravel deposit of probable Pleistocene age, which, like most terrace deposits of southwestern Oklahoma, is made up largely of quartzite, quartz-mica schist, chert, jasper, yellowish-brown opal, silicified wood of Cretaceous age, coarse-grained pegmatitic granite, and epidote-rich greenstone. None of these is common in the Precambrian rocks of the Wichita Mountains or in the Paleozoic rocks of southwestern Oklahoma and the Texas panhandle.

The streams of the region flow southeastward away from the continental divide in the Rocky Mountains; and from geological considerations it is known that all the streams of western and central Oklahoma have had substantially the same direction of flow since the beginning of Tertiary time, approximately 60 million years ago. The conclusion is therefore inescapable that the gravels were derived mainly from the crystalline and extrusive rocks of the Rocky Mountains in New Mexico and Colorado, and from the Cretaceous and younger rocks of the High Plains. Many of the southwestern Oklahoma pebbles may have been reworked from gravels originally deposited in the Pliocene Ogallala formation that covers much of the High Plains, and indeed it seems that the yellowish variety of common opal was certainly derived from the Ogallala (Swineford and Franks, 1959), but the fact remains that the ultimate source of most of the Oklahoma gravels was in northeastern New Mexico and southeastern Colorado.

Obsidian is so rare in these gravels that the writer, during many months of field work in this region, has not found a single specimen. The obsidian found by Markwell, however, was not carried to its present site by Kiowa or Comanche Indians, who formerly inhabited the region and had extensive camps along North Fork of Red River near Lugert. The obsidian specimen is characterized by well-rounded form and an exterior surface marked by numerous pits and by depressions that are outlined by conchoidal fractures (fig. 1). It is not fluted or scored like a meteorite. In shape and surface markings it has every aspect of a stream pebble, and the writer has no doubt that it was transported into Oklahoma by streams from obsidian-bearing volcanic rocks of the Rocky Mountains. Many of the obsidian specimens studied by Ross and Smith (1955) are from the Valles Mountains region of north-central New Mexico. It appears highly probable that flows of the same type in the nearby Sangre de Cristo Mountains have supplied the obsidian pebbles now found in southwestern Oklahoma.

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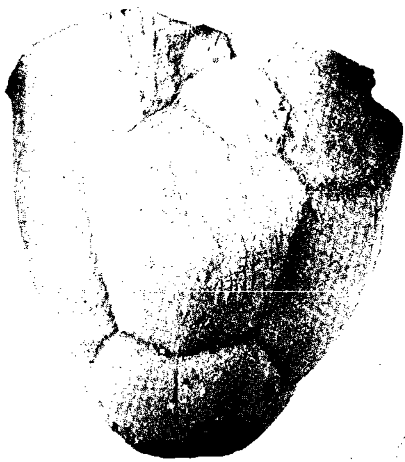

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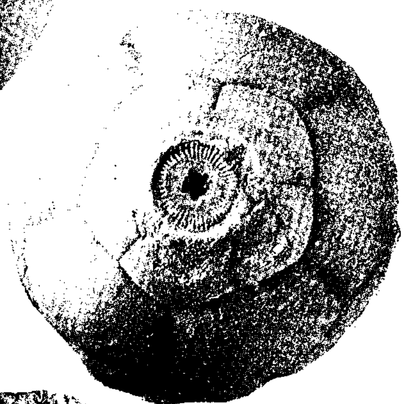

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AN OCCURRENCE OF ULOCRINUS BUTTSI MILLER AND GURLEY IN OKLAHOMA

William R. Cronoble

A dorsal cup of *Ulocrinus buttsi* Miller and Gurley, was recently discovered in the Hogshooter formation (Missourian) of Nowata County, Okahoma. Only one flattened specimen of this species has been previously reported from Oklahoma (Wright and Strimple, 1945). Strimple (1939) also reported *Ulocrinus convexus* Moore and Plummer as *Ethelocrinus* from Missourian strata near Bartlesville. Moore (1939) reported the occurrence in Texas of infrabasal circlets belonging to the genus *Ulocrinus*, but only *Ulocrines americanus* (Weller) was definitely identified. The nearest occurrence of *Ulocrinus buttsi* to Oklahoma is the specimen described by Miller and Gurley (1888, p. 331) as the holotype of the genotype in Missourian beds near Kansas City, Missouri.

The new specimen was discovered in SE¼ SW¼ sec. 18, T. 28 N., R. 15 E., approximately three miles southeast of Wann, Nowata County, Oklahoma. The Hogshooter formation at this locality is well exposed along the southern branch of California Creek. The dorsal cup was collected from a limestone unit nine feet above the base of the Winterset member of the Hogshooter formation (upper Skiatook). It was partially weathered from a dark yellowish-orange, limonite-stained, fossiliferous limestone which also contained numerous large and small crinoid columnals and several genera of brachiopods, including *Composita* sp. and "*Dictyoclostus*" sp.

The dorsal cup is extremely well preserved, and some of the more important measurements were made in accordance with Moore's suggestions (Moore, 1939, and Moore and Plummer, 1939):

Height of dorsal cup	34.3 mm
Maximum width of cup	34.8 mm
Ratio of height to width	0.98
Width of stem	7.0 mm
Width of infrabasal circlet	18.9 mm
Width of basal circlet	32.3 mm
Maximum length of infrabasal	11.0 mm
Maximum width of infrabasal	11.9 mm
Maximum length of basal	21.1 mm
Maximum width of basal	20.1 mm
Maximum length of radial	12.5 mm
Maximum width of radial	21.5 mm
Length of interinfrabasal suture	7.9 mm
Length of interbasal suture	13.2 mm

Explanation of Plate

(opposite page)

Ulocrinus buttsi Miller and Gurley (new specimen from Oklahoma)

Figure 1. Posterior view illustrating the position and shape of the anal plates, x2.
Figure 2. Anterior view, x2.
Figure 3. Dorsal view, x2.
(Photographs by Dwight E. Waddell)

Length of interradial suture	8.1 mm
Length of radianal (measured from the radial-basal suture to truncation by anal X plate)	10.4 mm
Width of radianal (measured perpendicular to the truncation by the posterior basal)	7.1 mm

The dorsal cup (figs. 1-3) has an elongate bowl like shape which is widest at the distal part of the radials. The convex base permits an entire infrabasal plate to be visible in a side view. The infrabasal circlet contains five well-defined, upward-flaring, pentagonal plates, inclined at approximately 40-45 degrees from the basal plane: the five interinfrabasal sutures are readily apparent. In the next higher circlet there are five upward-flaring basal plates which alternate with the infrabasals. Four of these plates are hexagonal; the fifth plate, the posterior basal, is octagonal because of encroachment by the radianal (fig. 1).

Two anal plates are present in the dorsal cup. The radianal is the larger of the two, and is hexagonal; it is truncated once by both the left posterior radial and the anal X plate, and twice by both the right posterior radial and the posterior basal. The anal X plate is crudely pentagonal; it is situated obliquely above and slightly to the left of the radianal. In the third and highest circlet, there are five radial plates alternating with the basals. Three of the radials are pentagonal; the right and left posterior radials are heptagonal because of truncations by the radianal and the anal X plate. The stem is round with a pentalobate lumen (fig. 3).

TABLE I.—COMPARISON OF TWO SPECIMENS OF *Ulocrinus buttsi* MILLER & GURLEY

Dimension	Specimen of *U. buttsi*	
	Holotype	New specimen
Width of stem (mm)	9.0	7.0
Width of infrabasal circlet (mm)	28.0	18.9
Width of cup (mm)	37.5	34.8
Width of stem / Width of infrabasal circlet	0.32	0.37
Width of infrabasal circlet / Width of cup	0.75	0.54

In table I a few dimensions of this new specimen are compared to those of the holotype as listed in Moore and Plummer (1939, p. 365). It can be seen that the infrabasal circlet has a steeper inclination from the basal plane in the Oklahoma specimen than in the holotype. There is also a difference in the radianals. The original description by Miller and Gurley mentions that the radianal of the holotype is irregularly quadrangular; in the Oklahoma specimen the radianal has six distinct sides. Even though these differences exist, they do not appear sufficiently divergent to require a subspecific name. This specimen is therefore assigned to *Ulocrinus buttsi* Miller and Gurley. It has been placed in the paleontological collection at the University of Oklahoma (catalog number 3433).

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COVER MICROFOSSILS

L. R. Wilson

Inquiries for more information about the microfossils illustrated on the 1960 cover of the Oklahoma Geology Notes have been received. The following brief comment about their nature, occurrence, use, preparation and study is in answer to those questions.

Unlike the large plant and animal fossils that have been used for many years in the study and exploration of Oklahoma's rocks, the illustrated microfossils have been known in the State slightly more than a decade. Since their discovery they have proved to be more abundant than other fossils and have proved to be equally useful to the geologist. They are the fossilized remains of plants and animals which lived on the land, or in the waters that covered Oklahoma in the ancient past. The plant fossils are in most cases carbonaceous, having been derived from cellulose, whereas the animal fossils are normally chitinaceous. Both types may be modified by the fossilizing process. Their sizes range from approximately two microns to one-tenth of a millimeter. Because of their small size they are preserved in many more sedimentary deposits than are the larger fossils and they have been found in rocks as old as the Late Precambrian and throughout the geological section.

The fossils illustrated on the cover of the Geology Notes are as follows: On the upper left is *Tasmanites*, a problematic microfossil, assigned by some to the algae. It is abundant in the Devonian rocks. On the upper right is a Permian pollen grain belonging to the Cymnospermae. On the left in the middle row is an Ordovician chitinozoan which belongs to a group of extinct animals, possibly to the Protozoa. The center fossil is an Ordovician *Hystrichosphaeridium*. The hystrichosphaerids are a heterogenous group of fossils probably representing the eggs or resting stages of either dinoflagellates, bryozoans, copepods, desmids, or some other groups that are now extinct. On the right in the center row is a plant spore of the genus *Cirratriradites*, a Late Paleozoic and Mesozoic microfossil related to the modern Selaginellaceae.

The fossil on the left in the bottom row is a scolecodont, or worm jaw of an Ordovician polychaete. On the right is a Pennsylvanian plant spore, *Alatisporites*, which at prasent is without any known close affinity.

Recovery of the microfossils from rock samples requires both physical and chemical treatment. Briefly the technique is as follows: Calcareous rocks are subjected to hydrochloric acid to remove the calcium carbonate, siliceous rocks are treated with hydrofluoric acid to remove the silica, and the carbonaceous rocks, such as coal, are macerated in a mixture of nitric acid and potassium chlorate, which is followed by a treatment with a base such as potassium hydroxide, ammonium hydroxide or potassium carbonate. The fossils weather these drastic treatments and remain as insoluble residues in the solutions. Often it is necessary to concentrate them by washing and decanting or by centrifuging them in heavy liquids like saturated solutions of zinc chloride or zinc bromide. The concentrated fossils are then mounted on microscope slides in glycerine jelly, Canada balsam, or Clearcol and when these preparations are hardened they are examined under the compound microscope. The first step in the microscopic study is to identify the microfossils and to determine their relative abundance. With this information it is in most cases possible to determine the geologic age of the rock and to state what the environment was at the time of deposition. It is also possible to correlate the rock in which they are found with others in the vicinity, or in some instances with deposits which may be thousands of miles distant. It is also possible to extend the knowledge of ancient land and water distribution, and to determine the climates of the past. This information is vital to the oil industry and to most other fields of geology.

Further information about the theory of microfossil investigation and the techniques used in the study can be secured from the literature listed in the references.

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Funkhouser, J. W., and Evitt, W. R., 1959, Preparation techniques for acid-insoluble microfossils: Micropaleontology, vol. 5, p. 369-375.

Wilson, L. R., 1946, The correlation of sedimentary rocks by fossil spores and pollen: Jour. Sedimentary Petrology, vol. 16, p. 110-120, 3 figs.

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Discoveries From Abandoned Holes!

Research Oil Reports, January 9, 1960, lists 23 abandoned oil tests which were reworked during 1959 with the result that 13 new fields were discovered, six field areas were extended, and new productive zones were found in four fields. Two of the abandoned holes were drilled in 1944, two in 1945, and the remainder in the period 1952-1959.

TWO TECHNIQUES FOR STAINING HYSTRICHOSPHAERIDS*

L. R. WILSON AND R. W. HEDLUND

Hystrichosphaerids, a group of problematic planktonic microfossils, abundant in many marine and brackish-water deposits ranging in age from Late Precambrian to the present, are difficult to stain for microscopic study. Hystrichosphaerids are normally recovered as insoluble residues from shales and cherts by the use of hydrofluoric acid. Small chips of these rocks are allowed to dissolve in the acid until completely reduced to their insoluble constituents. Water is then added and the residues are concentrated by centrifuging. Washing and centrifuging should be repeated several times. If the appendages which cover most species of hystrichosphaerids are obscured by undissolved mineral particles, these particles may be removed by treating the preparation in an ultrasonic generator for several minutes or by placing the solution in a deep flask and bubbling a strong jet of air through the liquid.

When the preparation is sufficiently clean, several cubic centimeters of the residue should be placed in a three-inch diameter watch glass and diluted with approximately five times as much water. The residue is allowed to settle for a minute and then the watch glass is gently rotated to cause the particles to concentrate in the center and to rise toward the surface. Most of the microfossils will be carried along in the rising sediment and may be removed to a second watch glass with a small-apertured pipette. This second concentration can be examined for microfossils under the low power of a compound microscope. For many samples it will be necessary to repeat the rotation technique several times until the fossils are free of associated silt particles. Ammonium hydroxide should be added to raise the pH of the solution to 8 and aqueous safranine stain is added until the solution is dark red. Pour the preparation into a test tube and suspend it in a beaker of boiling water for five or ten minutes. The hystrichosphaerids should acquire a stain within this period but a test slide can be made to determine if additional heating is necessary. When the desired stain is attained the preparation should be centrifuged and the residue repeatedly washed with distilled water and centrifuged until the liquid is clear. If the microfossils have been stained too darkly a few drops of sodium hypochlorite, "Clorox," may be added to bleach them. The microfossils can then be mounted in glycerine jelly, Clearcol, or other mountants.

Another staining method that has been found successful is as follows: Add malachite green powder to melted glycerin jelly until it is a medium-green color. Place a drop of melted glycerine jelly on a micro cover glass and add a small quantity of the hystrichosphaerid preparation. Stir gently with a warm needle. Spread the mixture uniformly over the cover glass and nearly to its edges. Then place the cover glass in an oven with the temperature maintained at 40°C and allow the glycerine jelly to completely dehydrate. The dehydration usually requires several days, during which time most of the

* Preliminary report of one study being conducted under National Science Foundation Grant No. G6589.

hystrichosphaerids will have absorbed the green stain and become darker than the glycerine jelly. When the glycerine jelly has been dehydrated the cover glass is placed preparation down on a drop of Canada balsam on a micro slide. The slide is returned to the oven until the Canada balsam has become hard enough to be a permanent mount. Hystrichosphaerids stained by the second method four years ago are still dark green and show no evidence of fading although several have been exposed to sunlight for extended periods.

ADDENDA TO PUBLISHED PAPERS ON OKLAHOMA GEOLOGY IN THE YEAR 1959

(Published in Oklahoma Geology Notes, vol. 20, no. 3, p. 55-73)

Compiled by NEVILLE M. CURTIS, JR.

Branson, C. C., 1959, Regional relationships of Ouachita Mississippian and Pennsylvanian rocks: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 118-121, 1 correlation chart. Discussion of the clastic, abnormally thick Mississippian and Morrowan section exposed in the Ouachita Mountain area.

Cline, L. M., and Shelburne, O. B., 1959, Late Mississippian-Early Pennsylvanian stratigraphy of the Ouachita Mountains, Oklahoma: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 175-208, 18 figs., 2 tables.

Decker, C. E., 1956, Correlation of Lower Paleozoic formations of the Arbuckle and Ouachita areas as indicated by graptolite zones: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 92-96, 1 table.

Elias, M. K., 1959, Some Mississippian conodonts from the Ouachita Mountains: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 141-165, 2 pls. Systematic description of conodonts from Kiamichi Mountains and Potato Hills.

Flawn, P. T., 1959, The Ouachita structural belt: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 20-29, 1 map. Discusses tectonics, foreland elements, development of geosyncline, age of deformation, and comparison with Appalachian system.

Goldstein, August, Jr., 1959, Petrography of Paleozoic sandstones from the Ouachita Mountains of Oklahoma and Arkansas: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 97-116, 1 fig., 3 pls.

Ham, W. E., 1959, Correlation of pre-Stanley strata in the Arbuckle-Ouachita Mountain Regions: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 71-86, 1 fig., 1 table. Correlation of pre-Stanley stratigraphic units (based on review of literature), geosynclinal aspects of Arbuckle and Ouachita regions, and depth to Precambrian in McCurtain County, Oklahoma.

Harlton, B. H., 1959, Age classification of the upper Pushmataha series in the Ouachita Mountains: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 130-139, 4 figs. Particularly concerned with the age assignment of the Johns Valley shale and discussion of various "bouldery" shales.

Hendricks, T. A., 1959, Structure of the frontal belt of the Ouachita Mountains: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 44-56, 2 figs. Discussion of faults.

Howell, J. V. and Lyons, P. L., 1959, Oil and gas possibilities of the Ouachita province: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 57-61, 2 tables. Location and stratigraphic level of asphalt deposits.

Laudon, R. B., 1959, Some age relationships of Chesterian and Morrowan rocks in eastern Oklahoma: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 122-129, 6 figs. McAlester basin is area of study. Three electric-log cross sections.

Miser, H. D., 1959, Structure and vein quartz of the Ouachita Mountains of Oklahoma and Arkansas: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 30-43, 3 figs.

Morrison, J. D., 1959, The Choctaw Nation: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. xvii-xxii. Geographic description of area in Oklahoma.

Pitt, W. D., 1959, Summary discussion of the geology of the core areas of the Ouachita Mountains, Arkansas and Oklahoma: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 87-91. Discussion of field evidence for believing that the core area of the Choctaw anticlinorium of southeastern Oklahoma is anticlinal in structure, rather than a fenster.

Scull, B. J., 1959, The age of mineralization in the Ouachita Mountains of Arkansas and Oklahoma: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 62-70, 1 map. Discusses diamonds, cinnabar, antimony, lead-zinc-copper, manganese, titanium and barite.

.................., Glover, G. D., and Planalp, Roger, 1959, The Atoka of the McAlester Basin-Arkansas Valley region: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 166-174, 2 figs. Brief discussion of environments of deposition and tectonic setting.

Tomlinson, C. W., 1959, Ouachita problems: Geology of the Ouachita Mountains, Symposium: Dallas and Ardmore Geol. Societies, p. 1-19, 4 figs. Discussion of the extent of low-angle thrust faulting and the source and mode of emplacement of the exotic boulders which occur in the Johns Valley shale. Related questions discussed.

Southern McCurtain County Bulletin Issued

Oklahoma Geological Survey Bulletin 86, Gology and ground-water resources of southern McCurtain County, Oklahoma, by Leon V. Davis, was issued on February 26, 1960. The bulletin contains 108 pages of text, illustrated by 19 figures and one plate (Geologic map of southern McCurtain County, Oklahoma, by Leon V. Davis and Charles J. Fair). The figures include four subsurface structure maps and six isopachous maps, each of a Cretaceous unit. The report is supplemented by two appendices describing 12 subsurface and 21 surface stratigraphic sections.

The bulletin is available at the Survey office. Price: $2.75 bound in blue cloth, $2.00 paper bound.

Introducing the Editor

On February 15, 1960, Alexander Nicholson became Geologist-Editor with the Survey. His arrival coincided with that of the galley proof for the Notes, vol. 20, no. 3, and he began his work on that proof. He is now editing the Notes, Bulletin 85, Bulletin 88, and Circular 54.

Alex. has had a varied career. He spent nearly five years in the U. S. Army during World War II. He graduated from Brooklyn College in geology and made Phi Beta Kappa.

After an interim he completed two years of graduate work at Harvard and a year-and-one-half at State University of Iowa.

He has worked for the Ground Water Branch of the U. S. Geological Survey in New Mexico and spent one summer in northern Manitoba doing reconnaissance mapping for the Geological Survey of Canada. For the past year he has been editing volumes one (Geology and Geophysics) and two (Drilling and Production) of the Proceedings of the Fifth World Petroleum Congress.

—C. C. B.