JULY 1964

Volume 24, Number 7

$2.00 per year, $0.25 per copy

OKLAHOMA GEOLOGY NOTES

COAL MINING, ROGERS COUNTY

OKLAHOMA GEOLOGICAL SURVEY • THE UNIVERSITY OF OKLAHOMA • NORMAN, OKLAHOMA

Cover Picture

MINERAL INDUSTRIES OF OKLAHOMA

COAL

Pennsylvanian bituminous coal is widely distributed over an area of 20,000 square miles in eastern Oklahoma. This coal has been mined commercially for 93 years, during which time more than 180 million tons have been produced at a value of nearly $600 million. Production has ranged from an annual average of less than 60,000 tons in the initial years 1872-1880 to the record 4,849,000 tons in 1920. Production declined steadily from the 1920 high until the World War II period when defense needs created an increased demand for coal in the steel industry. After the war, the demand for Oklahoma coal resumed its decline, although at a rate retarded by the opening of new markets for coking coal in the new steel mills in the western states. Annual production is now about 1,000,000 tons.

During early development, almost all production was from underground mines. As late as 1913, more than 90 percent came from such operations. Principally as a result of the development of power equipment, strip mining became increasingly important so that by 1943 strip mines accounted for more than 50 percent of production; today, approximately 85 percent is produced by strip mining.

The cover photograph is an aerial view of the strip pits at Sequoyah, T. 23 N., R. 6 E., Rogers County, as they appeared in 1941. The seam worked here is the Croweburg coal in the Senora Formation (Desmoinesian).

—A. N.

Magnetic Field Study of Basement Relief and Susceptibility Variation in the Muskogee-Tahlequah Area, Oklahoma

J. A. E. Norden

INTRODUCTION

This magnetic investigation complements a long-range regional study of the basement in Oklahoma being conducted by Louise Jordan, geologist with the Oklahoma Geological Survey. Previous magnetic surveys established good control on the configuration of the basement surface in northeast Oklahoma (Norden and Langton, 1963a, 1963b), and these successes encouraged the extension of this survey into the Muskogee-Tahlequah area where depth data from several old wells were inconclusive owing to poor logs. Also, in some areas the depth to basement was unknown because the old wells penetrated only into Arbuckle rocks. A network pattern of 11 wells was selected by Jordan, who considered that a vertical-magnetic-intensity cross-tie among the wells would be advisable. In three of the wells (nos. 1, 5, 9, table I) the depth to basement was confirmed by reliable geologic evidence. These wells are scattered over Cherokee, Muskogee, and Wagoner Counties (fig. 1).

It was decided to run magnetic-profile lines across these wells with careful selection of the stations in order to have complete freedom from interference during recording. According to Barret (1931), a vertical magnetic variometer would not be affected by the casing at 250 feet from a well having a composite casing 4,609 feet long. In the present survey the nearest approach to an old well was 1,600 feet, a distance beyond the range of any casing effect. During this survey the author was ably assisted by G. L. Garner and J. M. Markas, students in the School of Geology of The University of Oklahoma.

VERTICAL-MAGNETIC-INTENSITY SURVEY

The field instrument used in the vertical-magnetic-intensity survey was a Ruska type V-3 vertical magnetometer (serial no. 5708). The instrument sensitivity was set to 10.07 gammas per scale division and the temperature correction factor was +0.1 gamma per 1°C. Observed field data, after correction for temperature, diurnal, and geomagnetic latitude and longitude variations, were reduced to a base station near Proctor, Adair County. This reduction permitted a tie comparison with the Adair County data and the possibility of comparing the depth data under tie control. The depth of the basement below the Proctor magnetic base station had been determined to be 1,270 feet; the station is slightly off the apex of the Proctor magnetic anomaly, the top of which has been computed to be at a depth of 1,200 feet (Norden and Langton, 1963b). Geological evidence for the depth to basement in this area, based upon known thicknesses of overlying strata, agrees with the geophysical data.

Ninety magnetic-observation stations were located along selected lines tying to the wells in Cherokee, Muskogee, and Wagoner Counties; the locations of the wells and magnetic stations are indicated in figure 1 and data for the wells are given in table I.

RESULTS OF THE VERTICAL-MAGNETIC-INTENSITY SURVEY

Previous investigations of magnetic-susceptibility variation between the Spavinaw Granite, considered as a representative member of the basement in Adair County, and the overlying Pennsylvanian-Ordovician sedimentary section revealed a strong susceptibility contrast between the basement and the sedimentary formations (Norden and Langton, 1963b). Owing to this strong magnetic-susceptibility contrast, the variation of the vertical magnetic intensity may be interpreted as the effect of a magnetic Precambrian basement.

Figure 2 shows the vertical-magnetic-intensity-anomaly plot of the magnetic basement effect south of Tahlequah, Cherokee County. This profile reveals the effect of faulting near well 8 (Walker, 1 Smith Heirs) and well 10 (Bracken Oil, 1 Davis). Based upon the magnetic profile, the estimated depth of basement at well 8 is about

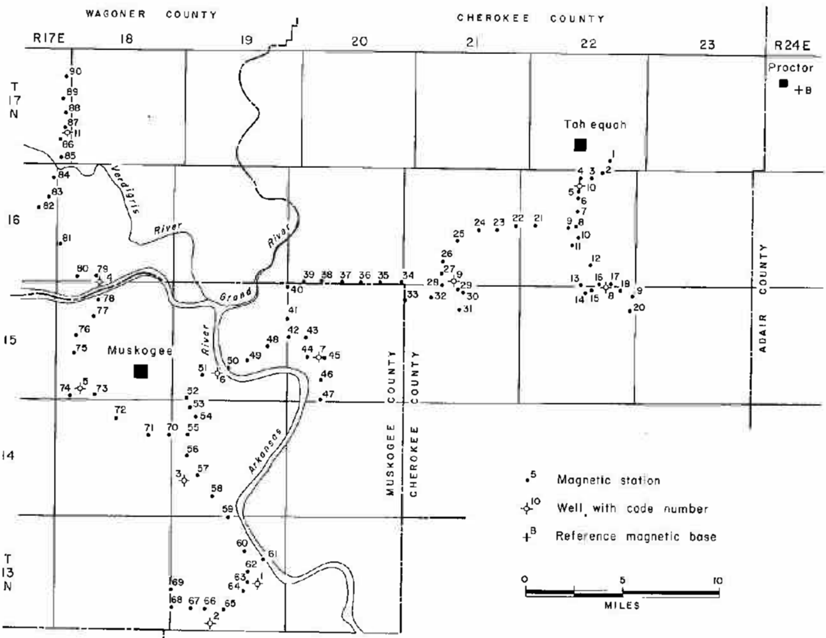


Figure 1. Locations of magnetic stations in Muskogee-Tahlequah area, Oklahoma.

Table I.—List of Wells Along Line of Magnetic Profile

Well Number	Well Name Location	Elevation Total Depth Year Drilled	Depth to Basement (Feet) Geological	Driller's Log	Geophysical
1	USSRAM Expl. Co. 1 Marshall 23-13N-19E NW-NW-SE	601′ 3,294′ 1958	3,274		3,274
2	Sheets Bros. 1 Chandler & Jackson 33-13N-19E SW-NW-SW	510±′ 2,300′ 1920's	In Arbuckle by correlation No samples	2,200	3,140
3	M. E. Johnson 2 Harris 30-14N-19E SE-NW-NE	575±′ 2,121′ 1927		2,024?	2,930
4	E. C. Lantz 1 Rulison 4-15N-18E NE-NW-NW	529′ 4,605′ 1923		2,970? 3,104?	4,600
5	W. H. Pine 1 Klein 32-15N-18E NE-NW-SW	635′ 3,496′ 1952	3,481		3,481
6	H. F. Campbell 1 Tilly 28-15N-19E SE-NE-SW	550±′ 3,690′ 1920		3,373	3,373
7	S. E. Cusack 1 Fee 20-15N-20E NE-SW-SE	620±′ 1,975′ 1920's?		1,920	1,920
8	Walker 1 Smith Heirs 2-15N-22E NE-NE-NW	960±′ 1,500′ 1955		In Arbuckle	2,800
9	W. H. Pine 1 Lemon 33-16N-21E C-SW-SE	690′ 2,093 1962	2,083		2,083
10	Bracken Oil 1 Davis 3-16N-22E SW-SW-SW	834′ 1,450′ 1957	In Arbuckle		2,500
11	J. H. Scriba 3 Cane 30-17N-18E NW-NW-SW	543′ 1,740′ 1920's		1,610	1,610

2,800 feet and that at well 10 is about 2,500 feet below the surface. Neither well was drilled to basement. Well 8 was drilled to a total depth of 1,500 feet after having penetrated 964 feet of the Arbuckle lime. Well 10 was drilled to a total depth of 1,450 feet and recorded 985 feet penetration in the Arbuckle lime.

Figure 3 is the plot of the vertical-magnetic-intensity variation between the Tahlequah area and the Arkansas River. A drop of more than 200 gammas in the vertical magnetic intensity may be observed at the Bayou Manard Creek section of the line. This may be interpreted as a drop in the basement relief with fault control at the sides of the depression.

A similar faulted depression can be recognized near Bayou Mungro Creek in the vicinity of well 7 (S. E. Cusack, 1 Fee). In well 7 the depth of the basement was found to be 1,920 feet below the surface. Identification of the basement was based upon the driller's log. Figure 3 shows that well 7 is in the high zone of the magnetic anomaly. Based upon the magnetic profile, the center of the fault immediately to the west of well 7 was estimated to be about 2,500 feet. The depth of the basement at well 9 (W. H. Pine, 1 Lemon) is 2,083 feet, determined upon the basis of rock cuttings.

Figure 4 shows the continuation of the magnetic profile across well 6 (H. F. Campbell, 1 Tilly), well 1 (USSRAM Exploration Co., 1 Marshall), and well 2 (Sheets Bros., 1 Chandler and Jackson) in the Muskogee area. This profile again crosses the Bayou Mungro Creek fault zone and traverses the broad depression along the Arkansas River. At the Coora Creek section the effect of faulting may be recognized. The profile shows that wells 1 and 2 were drilled on a relative basement high, controlled by faulting along the Arkansas River. Depth of the basement at well 1 is 3,274 feet, determined upon the basis of rock cuttings and electrical log, whereas the depth of the base-

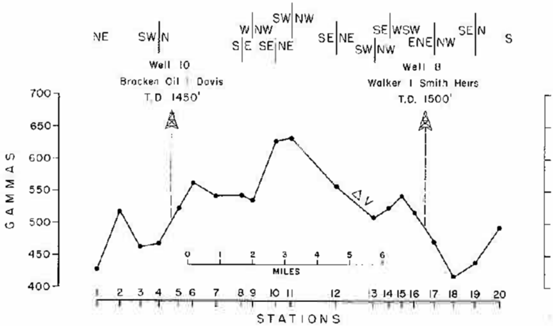


Figure 2. Vertical-magnetic-intensity profile across wells 10 and 8, Cherokee County.

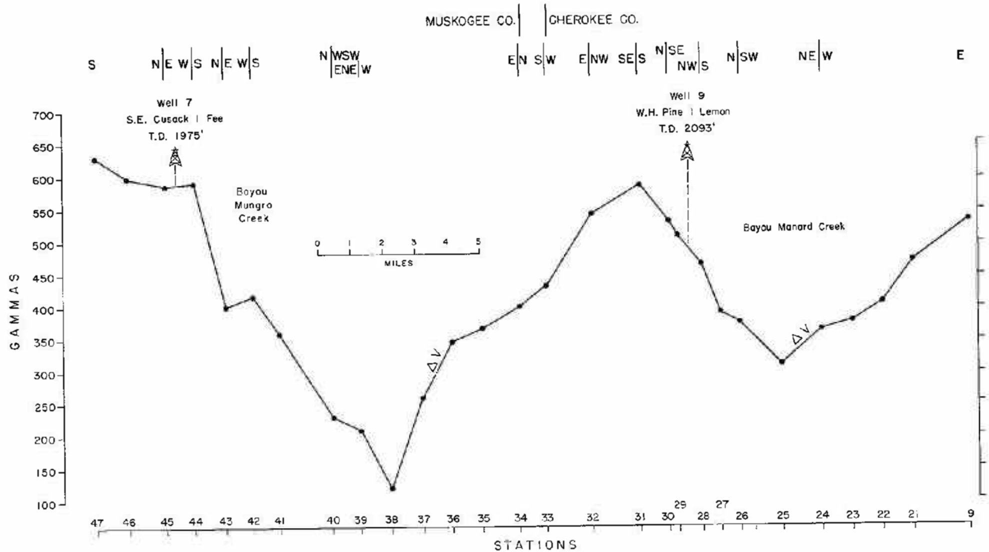


Figure 3. Vertical-magnetic-intensity profile across wells 7 and 9, Muskogee and Cherokee Counties.

ment at well 6 is 3,373 feet, determined upon the basis of the driller's log. Near well 2 the magnetic profile shows a slight increase in gamma values relative to the magnetic intensity at well 1. Based upon the magnetic profile, the estimated depth of the basement at well 2 is about 3,140 feet.

Figure 5 is the extension of the magnetic profile from well 1 to well 3 (M. E. Johnson, 2 W. B. Harris), well 5 (W. H. Pine, 1 Klein), well 4 (E. C. Lantz, 1 B. L. Rulison), and well 11 (J. H. Scriba, 3 Cane) from Muskogee County into Wagoner County. This profile again enters the depression at the Arkansas River and traverses the Muskogee area. The basement relief shows a local high below the Muskogee oil field followed by a fault-controlled basement rise near the Arkansas River between stations 75 and 79 in Muskogee County. From the Arkansas River depression to the north, two local basement highs can be recognized along the entrenchment of the Verdigris River in Wagoner County. Depth of the basement at wells 5 and 11 was determined upon the basis of rock cuttings and driller's log, respectively. At well 5 the basement was found to be at a depth of 3,481 feet and at well 11 at a depth of 1,610 feet. The magnetic profile gave a depth estimation at well 3 of about 2,930 feet and at well 4 of about 4,600 feet. The total depth reached in this well was 4,605 feet. Well 4 was drilled in 1923, and the driller's log indicated basement at 2,970 feet or possibly 3,104 feet. These figures are in strong contrast to the character of the magnetic anomaly at the Arkansas River. The rapid drop of more than 150 gammas magnetic intensity at the Arkansas River depression may be interpreted as a fault-controlled entrenchment of the basement relief near well 4. It is unlikely that basement rocks were penetrated in well 4 to a total thickness of 1,500 feet or more.

MAGNETIC-SUSCEPTIBILITY VARIATION OF THE BASEMENT ROCKS

The variation of vertical magnetic intensity between the Muskogee and Tahlequah areas, with the control of the depth to the basement at the wells reported, invoked a theoretical approach for investigation of the possible magnetic-susceptibility variations in the magnetic basement formation. This study was performed by a comparative calculation between the magnetic reference base near Proctor, Adair County, and the wells surveyed by the magnetic profiles. The magnetic reference base at Proctor is about 33 miles southeast of the Spavinaw Granite outcrop near Spavinaw, Mayes County. From an earlier magnetic study of this outcrop (Hawes, 1952), it is known that the remanent magnetization of the Spavinaw Granite, although apparently exceeding the induced magnetization by a factor of the order of 25, neutralizes itself at comparatively short distances from the source. The remanent magnetization at a height of 500 feet above the Spavinaw Granite is eliminated. According to Hawes, a rough calculation showed that, even if the structural relief over the granite in the Spavinaw area is taken as 200 feet instead of the 90 feet measured on the top of the Arbuckle, only a small fraction of the magnetic relief associated with the granite outcrops can reasonably be assigned to

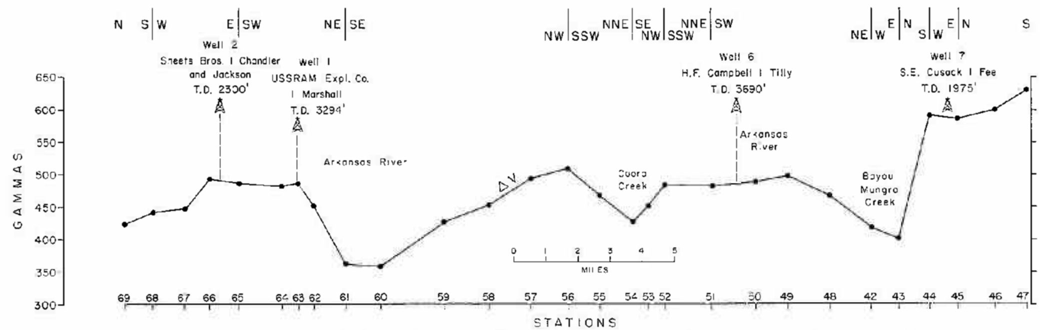


Figure 4. Vertical-magnetic-intensity profile across wells 2, 1, 6, and 7, Muskogee County.

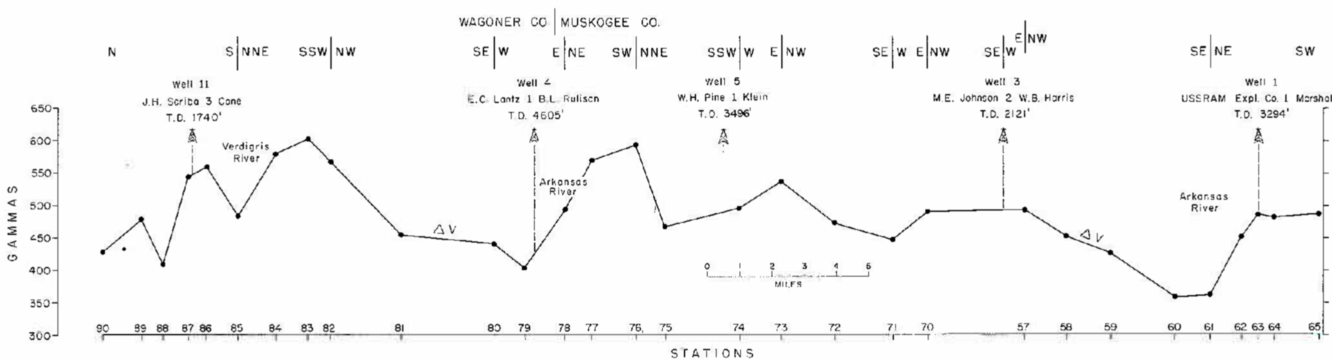


Figure 5. Vertical-magnetic-intensity profile across wells 11, 4, 5, 3, and 1, Wagoner and Muskogee Counties.

this cause. Consequently a large part of the anomaly present can be most reasonably explained as due to a polarization change in the basement. Such a change would normally accompany a petrologic change and may therefore be considered good evidence of a transition from one rock type to another. Hawes found that the magnetite content of nine samples of Spavinaw Granite in percent by volume ranged from 1.11 to 2.68, the average being 1.78. With the consideration that for prospecting calculations, magnetic susceptibilities determined according to the Slichter method (Slichter, 1929) yield safer values (Dobrin, 1960), the magnetite percent by volume found in the Spavinaw Granite was computed for susceptibility values by Slichter's equation:

$$k = k_m P = 300{,}000 \times 10^{-6} \cdot P$$

where P is the percentage by volume of disseminated magnetite and k_m is the susceptibility of magnetite in powdered, disseminated form for which Slichter's figure may be used; k is the rock susceptibility. Thus for the average magnetite content of the Spavinaw Granite the rock susceptibility is computed to be

$$k = 5{,}340 \times 10^{-6} \text{ cgs unit}$$

which, according to the tabulated values of magnetite content of granites (Stearn, 1929) and the calculation of the Slichter method (Slichter, 1929), places the Spavinaw in the higher range of susceptibility values for granites.

In order to perform a calculation for susceptibility variation of the basement rocks in the Muskogee-Tahlequah area, it was assumed that, at the magnetic reference base near Proctor, the average value of granite susceptibility was $k = 2{,}700 \times 10^{-6}$ cgs unit computed by the Slichter equation upon the basis of Stearn's data. The geological assumption that the basement magnetic effect in the Proctor area is caused by granite was based upon the drilling data reporting granite at 1,395 feet in the Adair Oil and Gas Co., Artie Brown 1 well (NE¼ SE¼ NW¼ sec. 32, T. 19 N., R. 25 E.) about 10 miles northeast of the magnetic reference base station near Proctor. For the theoretical computation of the effect for variable basement polarization, a vertical-line element was selected with the bottom of the cylinder at infinite depth. The radius of this cylinder was assumed to be 1 kilofoot (1,000 feet) and for the depth, z, to the top of this cylinder the depth of the basement was assumed as it was determined at the magnetic reference base station near Proctor as well as at the eleven different wells reported in this study.

The effect of a vertical-line element (Nettleton, 1942)

$$V = \pi \cdot R^2 \cdot z \cdot I/(x^2 + z^2)^{3/2}$$
$$= K \cdot f_1 \left(\frac{x}{z}\right)$$

where

$$f_1 \left(\frac{x}{z}\right) = (1 + x^2/z^2)^{-3/2}$$
$$K = 3.14 \times 10^5 \frac{R^2 \cdot I}{z^2}$$

I is the polarization contrast and x is the horizontal distance to the center of the cylinder.

In this study x was assumed to be zero, and the effect above the cylinder with the amplitude constant K was computed.

Based upon the assumption of a susceptibility contrast of 2,700 $\times 10^{-6}$ cgs unit for granite basement, the polarization contrast in a field of H = 0.56 oersted is 0.00151 cgs unit at the magnetic reference base near Proctor. When this polarization contrast for a vertical-line element buried with its top at 1.27 kilofoot depth and with a radius R = 1 kilofoot was applied, the vertical magnetic effect of this cylinder was shown to be K = 295 gammas.

Placement of this vertical-line element under similar polarization and dimension conditions at a depth of 3.274 kilofeet, which is the depth of the basement at well 1, shows that the vertical magnetic effect is K = 44 gammas. The vertical-magnetic-intensity drop between the magnetic reference base and well 1 in the field survey was found to be ΔV = 105 gammas. The difference between 295 and 44 gammas is 251 gammas, which exceeds by 146 gammas the value recorded in the field survey. The rock cuttings from the basement in well 1 were identified as rhyolite. The magnetic susceptibility of this rhyolite was tested by a magnetic-susceptibility bridge, model MS-3*. The measurement with this instrument is made in a field of the same order of magnitude as that of the Earth's field. The field used in the MS-3 is produced by alternating current, and the instrument neither measures nor is affected by remanent magnetization (Geophysical Specialties Co., 1962). The magnetic susceptibility of the rhyolite sample from well 1 was found to be

$$k = 117 \times 10^{-6} \text{ cgs unit}$$

In a field of H = 0.56 oersted with a susceptibility of this order, the polarization would be 0.0000655 cgs unit. Application of this polarization for a vertical-line element of the same dimension as computed above for a depth of 3.274 kilofeet shows that the vertical effect of this cylinder would be only about 2 gammas. It seems reasonable, therefore, to assume that there must be a rock of higher susceptibility below the rhyolite in order to have a combined effect of K = 190 gammas. The difference between K = 295 gammas and K = 190 gammas is 105 gammas, the difference actually recorded in the field survey between the Proctor magnetic reference base and well 1. The known depth of the basement at well 1 and K = 190 gammas show that the polarization contrast of a cylinder with radius R = 1 kilofoot would be 0.00658 cgs unit. The susceptibility contrast of this cylinder in a field of H = 0.56 oersted would be

$$\Delta k = 11{,}580 \times 10^{-6} \text{ cgs unit}$$

With this susceptibility contrast a vertical-line element at a depth of 3.3 kilofeet would produce an effect of K = 188 gammas compared with the K = 190 gammas required to explain the ΔV drop across the magnetic reference base at Proctor and well 1. It is reasonable to

*Geophysical Specialties Co., Hopkins, Minn.

assume that the low-susceptibility rock (rhyolite) above the higher susceptibility rock (basaltic rock) of $k = 11{,}580 \times 10^{-6}$ cgs unit, computed upon the basis of the theoretical assumption, may represent only a relatively thin cover on the basement surface at well 1.

Under the theoretical consideration presented above, the basement polarization was computed at each well given in this report. These computations were made relative to the Proctor magnetic reference base. Since the vertical-magnetic-intensity change relative to the magnetic reference base was known at the wells and the depth of the basement was determined at these locations, the polarization contrast was determined for a cylinder buried at the given depth and having a radius $R = 1$ kilofoot. For the susceptibility calculations, a field of $H = 0.56$ oersted was applied. With the polarization contrasts thus computed, the variation of the vertical magnetic intensity surveyed between the magnetic reference base at Proctor and the wells reported in this study may well be coordinated.

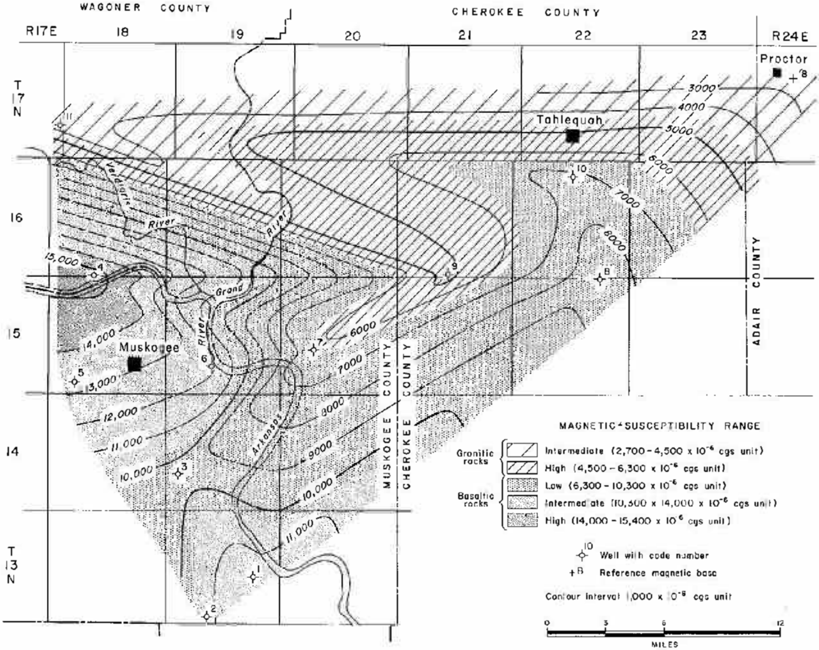


Figure 6. Variation of magnetic susceptibility of basement rocks, Muskogee-Tahlequah area, Oklahoma.

VARIATION OF MAGNETIC SUSCEPTIBILITY OF BASEMENT IN MUSKOGEE-TAHLEQUAH AREA

The results of the susceptibility-variation calculations are plotted in figure 6. In order to establish an approximate boundary between the granitic-type rock and the basaltic-type rock susceptibilities, $6{,}300 \times 10^{-6}$ cgs unit value was arbitrarily chosen. Susceptibilities for igneous rocks calculated upon the basis of Stearn's data (Stearn, 1929) with the Slichter equation give a broad range for these rocks (Dobrin, 1960). The granites are listed with the maximum value at $5{,}700 \times 10^{-6}$ cgs unit, and the basalts from a minimum value of $6{,}900 \times 10^{-6}$ cgs unit to a maximum value of $26{,}000 \times 10^{-6}$ cgs unit.

The $1{,}200 \times 10^{-6}$-cgs-unit gap between the maximum value of granites and the minimum value of basalts is a transition range, the median value of which was arbitrarily selected as the approximate separation value between the acidic and basic rocks. The other boundaries shown on the map approximate the ranges given by Dobrin (1960).

The pattern of susceptibility variation in the Muskogee-Tahlequah area discloses a definite trend for basic rocks in the basement along the Arkansas River fault zone north of Muskogee. Another zone of basic rocks seems to appear in the area of wells 1 and 2, along the Arkansas River southeast of Muskogee. It seems reasonable to assume that these basic rocks, considered to be basalts, were injected into the upper zone of the basement along deep-going fault systems, which later may have affected the hydrodynamic course of the Arkansas River by rejuvenated movements in sediments above the fault systems. The tonguing pattern of susceptibility variation in the basement may reflect the character of a complex magnetic field, modified by polarization variation and depth displacement of various types in the basement.

CONCLUSION

Vertical-magnetic-intensity surveys in the Muskogee-Tahlequah area confirmed the practical use of the magnetometer in the delineation of the basement-surface configuration because of the strong susceptibility contrast between the weakly magnetic sediments and the magnetic basement complex.

Magnetic surveying in the Muskogee-Tahlequah area rendered control on the depth of the magnetic basement, where, due to poor logs, earlier well reports had placed the basement at geologically questionable depth. Due to the depth control in the magnetic survey, together with known depth of the basement at wells tied to the magnetic profiles, there appeared a possibility, upon the basis of the vertical-magnetic-intensity variations, of computing the susceptibilty change in the basement rocks. Polarization effect computed with these susceptibility variations may be coordinated with the actual magnetic-anomaly variations surveyed in the field. The susceptibility-variation map of the basement reveals the possibility of a basic rock (basalt) injection into the upper basement zone along deep-going fault systems.

The low-susceptibility thin rhyolite cover on the basement surface locally contributes only a very small effect and alone cannot account for the complex magnetic anomaly.

References Cited

Barret, W. M., 1931, Magnetic disturbance caused by buried casing: Amer. Assoc. Petroleum Geologists, Bull., vol. 15, p. 1371-1389.

Dobrin, M. B., 1960, Introduction to geophysical prospecting: New York, McGraw-Hill Book Co., Inc., 270 p.

Geophysical Specialties Co., 1962, Instruction manual, magnetic susceptibility bridge, model MS-3: Hopkins, Minn.

Hawes, Julian, 1952, A magnetic study of the Spavinaw Granite area, Oklahoma: Geophysics, vol. 17, p. 27-55.

Nettleton, L. L., 1942, Gravity and magnetic calculations: Geophysics, vol. 7, p. 293-310.

Norden, J. A. E., and **Langton, J. M.,** 1963a, Magnetic delineation of the basement surface, Christie-Westville area, Adair County, Oklahoma: Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 241-248.

———— 1963b, Magnetic profile control of basement configuration, northern Cherokee County, Oklahoma: Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 261-266.

Slichter, L. B., 1929, Certain aspects of magnetic surveying, **in** Geophysical prospecting: New York, Amer. Inst. Mining Metall. Engineers, Trans., vol. 81, p. 238-260.

Stearn, N. H., 1929, A background for the application of geomagnetics to exploration, **in** Geophysical prospecting: New York, Amer. Inst. Mining Metall. Engineers, Trans., vol. 81, p. 315-344.

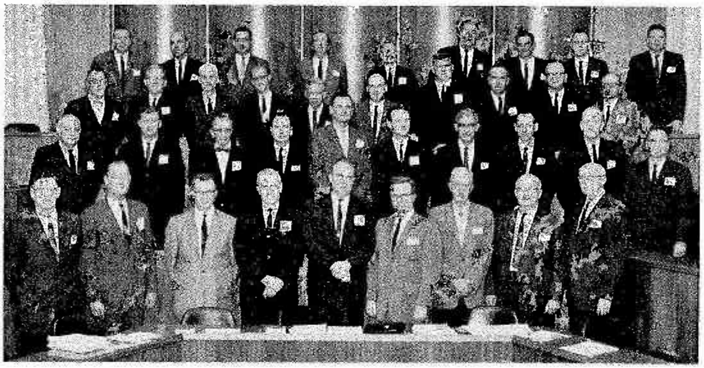
State Geologists Meet at Norman

The fifty-sixth annual meeting of the Association of American State Geologists (AASG) was held at the Oklahoma Center for Continuing Education on the campus of The University of Oklahoma, Norman, April 20-21, 1964. The host for the meeting was the Oklahoma Geological Survey. The Association membership comprises the chief geologists of 47 states and Puerto Rico. At the April meeting, 29 states were represented by 39 geologists. Also participating in the meeting were 16 persons representing the U. S. Geological Survey, U. S. Bureau of Mines, U. S. Bureau of Reclamation, and Earth Science Curriculum Project.

The Association and the Oklahoma Geological Survey are the same age, the Association being a mere 74 days older. Appropriately, the speaker at the annual banquet was Robert H. Dott, who has been closely associated with both. He held office in the Association from 1943 to 1946 (as president in 1945-1946), and he was Director of the Survey from 1935 to 1952.

The Association first met on May 12, 1908, in Washington, D. C., nineteen state geologists attending. They met at the invitation of Director George Otis Smith, and the U. S. Geological Survey paid their railroad fare! In December 1909, the Association met with the Geological Society of America at Cambridge, Massachusetts.

In 1906 seven state geologists formed the Association of State Geologists of the Mississippi Valley. This group met occasionally until 1913.



State geologists and associates at fifty-sixth annual meeting of the Association of American State Geologists.

Front row: **G. F. Hanson, C. C. Branson,** R. H. Dott, **F. C. Foley, E. F. Cook, J. B. Patton, I. Campbell,** R. C. Moore, **W. W. Hagan.**
Second row: **J. D. Forrester,** W. E. Ham, **E. C. Reed, D. J. McGregor, J. L. Calver, P. K. Sims, H. G. Hershey,** W. C. Hayes, **G. E. Eddy, L. W. Hough.**
Third row: **G. W. Stewart, J. W. Peoples, C. G. Doll,** A. S. Furcron, V. E. Barnes, **T. R. Beveridge,** S. R. Windham, **K. N. Weaver, N. F. Williams, P. T. Flawn.**
Rear row: **R. E. Cohenour,** M. Hansen, **A. Socolow, P. H. Price,** C. W. Hendry, Jr., **R. O. Vernon, J. C. Frye,** W. W. Hambleton, M. E. Biggs.

(Boldface indicates state geologist)

AASG made provision for field meetings as well as annual meetings. The first such meeting was at Houghton in 1914. The only previous visits to Oklahoma were the field meeting at Ardmore in 1929 (October 5-6) and an extra meeting in Tulsa at the AAPG meeting on December 29, 1931.

Recent annual meetings of AASG have been in Kentucky (1956), Michigan (1957), Texas (1958), Kansas (1959), Pennsylvania (1960), Idaho (1961), New York (1962), West Virginia (1963). The next meeting (57th) is scheduled for California in 1965.

During the past year Joseph Singewald of Maryland passed away, Bill Daoust of Michigan retired, Allen Agnew of South Dakota resigned, and Ralph Meyers of New Hampshire retired.

The following officers were elected for the period 1964-1965:

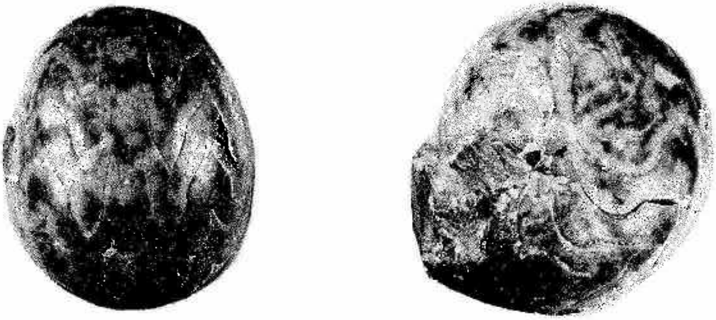
President	Frank C. Foley (Kansas)
President-Elect	Ian Campbell (California)
Vice President	Thomas R. Beveridge (Missouri)
Secretary-Treasurer	John B. Patton (Indiana)
Historian	George F. Hanson (Wisconsin)
Editor	Robert O. Vernon (Florida)
Statistician	Wallace W. Hagan (Kentucky)

FALSE COLOR PATTERN ON AN OKLAHOMA GONIATITE

CARL C. BRANSON

A specimen of the cephalopod *Goniatites choctawensis* was recently added to our collection. Most of the surface of the internal mold is light brown, and a pattern of dark-brown bands occurs on most of the specimen. These bands at places follow sutures of alternate camerae and thus appear similar to color patterns such as those known on some orthocones and ammonites. The dark bands are believed to be the result of recrystallization, in which light-brown fine-crystalline calcite was replaced by clear calcite crystals which appear dark brown in the matrix.

The specimen was collected from the Delaware Creek Member of the Caney Shale on Tell Creek near Clarita, in Coal County, Oklahoma (S¼ cor. sec. 22, T. 1 S., R. 8 E.).



1 *2*

Specimen of Goniatites choctawensis **with false color pattern, x2. OU 5240.**
Figure 1. Dorsal view.
Figure 2. Lateral view.
(Photographs by Jan Cannon)

On the small areas of preserved shell are fine revolving lirae upon which are minute nodes lined up in transverse bands.

A similar occurrence was reported by Oppenheim (1918, p. 382) and noted by Foerste (1930, p. 143). Specimens of *Goniatites striolatus* Phillips from the Lower Carboniferous of Derbyshire have brown patterns along the sutures. They can be seen through the shell and are considered to be internal mineral color and not color patterns.

References Cited

Foerste, A. F., 1930, The color patterns of fossil cephalopods and brachiopods, with notes on gasteropods and pelecypods: Mich., Univ., Museum Paleontology, Contr., vol. 3, p. 109-150.

Oppenheim, Paul, 1918, Über die Erhaltung der Färbung bei fossilen Molluskenschalen: Centralblatt Mineralogie Geologie Paläontologie, Jahrgang 1918, p. 368-392.

Calpichitina scabiosa, A New Chitinozoan from the Sylvan Shale (Ordovician) of Oklahoma*

L. R. Wilson and R. W. Hedlund†

A rich assemblage of chitinozoans, hystrichosphaerids, and scolecodonts occurs in the Sylvan Shale outcrop, on U. S. Highway 77, 4.5 miles south of Davis, Murray County, Oklahoma, in NE¼ NW¼ sec. 30, T. 2 S., R. 2 E. Most of the Chitinozoa specimens illustrated in this paper are from approximately 50 feet above the top of the underlying Viola Limestone. A preliminary report on the chitinozoan assemblage was published in 1958 by Wilson, and it included an illustration of the new genus and species here described. In 1960, Hedlund completed a Master of Science thesis in which the microfossil fauna was described in greater detail.

The Sylvan Shale is recognized as an Upper Ordovician (Richmond) formation by the presence of its graptolite fauna (Decker, 1935). In Oklahoma it is a greenish-gray calcareous shale which crops out mainly in the eastern part of the State, but also occurs westward in the subsurface. The Sylvan Shale ranges from approximately 60 to 353 feet in thickness and averages about 150 feet. The described megafauna consists of nine species of graptolites, three species of inarticulate brachiopods, one species of scyphozoan, and two genera of conodonts (Amsden, 1957). The Sylvan Shale is considered to be correlative with the Polk Creek Shale of eastern Oklahoma and Arkansas (Decker, 1935).

FOSSIL DESCRIPTION

Phylum PROTOZOA Goldfuss, 1818
Class RHIZOPODA Dujardin, 1841
Order CHITINOZOA Eisenack, 1931

Calpichitina gen. nov.

Type species.—*Calpichitina scabiosa* gen. et sp. nov.

Tests single, subspherical, urn-shaped, slightly broader than high; oral opening operculate, approximately one-half diameter of test, with flaring membranous collar which arises from a thickened annulus at neck; operculum circular, bordered by a narrow membranous flange; aboral end rounded, cupola none; unbleached specimens black, bleached specimens brown to yellow; wall approximately two microns thick, outer part opaque, appears to be composed of a vermiculate network, inner part translucent, smooth, appears structureless.

The prefix of the generic name is from the Greek word *kalpion,* given in reference to the fossil's urn-like shape and its diminutive size.

*One project supported by National Science Foundation Grant G6589.
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Explanation of Plate I

Calpichitina scabiosa gen. et sp. nov. from the Sylvan Shale (Ordovician) of Oklahoma. All photomicrographs taken with a Zeiss Photomicroscope using Neofluar 40/0.75 objective, 12.5 oculars, optivar 2, and a medium-green filter. The photographic film used was Adox KB14.

Figure 1. Holotype, OPC 235-113-1, showing operculum slightly detached from oral opening, collar flange slightly reduced by preservation or preparation, annulus distinct, test chamber slightly compressed, showing compression folds; specimen slightly bleached to show nature of the ornamentation which is granular on the aboral surface and vermiculate toward the oral end, operculum granular to vermiculate; greatest diameter 79 microns, length 60 microns, oral opening 41 microns, operculum 41 microns, annulus 9 microns in side dimension.

Figure 2. OPC 235 I-1-3. Side view showing profile of neck and flange-like collar with operculum in place; ornamentation reduced to fine granulation on aboral end and coarser over the remainder of the test. Diameter 61 microns, length 50 microns.

Figure 3. OPC 235-55-2. Side view showing characteristic compression folds and variation in ornamentation; operculum in place. Diameter 78 microns, length 53 microns.

Figure 4. OPC 235-49-1. Side view of well-bleached specimen, showing operculum in place, and variation in ornamentation from vermiculate on the sides to almost none on the aboral end. Diameter 75 microns, length 60 microns, oral opening 47 microns.

Figure 5. OPC 235-H-10-1. Side view with operculum slightly raised. Diameter 61 microns, length 52 microns.

Figure 6. OPC 235-110-3. Side view showing operculum in place and ornamentation grading from granulate to vermiculate. Diameter 72 microns, length 73 microns.

Figure 7. OPC 235-44-2. Slightly oblique view of test showing well-preserved collar-like flange, annulus at the neck, and vermiculate ornamentation. Diameter 79 microns, length approximately 50 microns, collar height 10 microns.

Figure 8. OPC 235-44-4. Slightly oblique view of test showing operculum separated from oral opening and membranous flange attached to rim of the operculum. Diameter 69 microns, length 53 microns, collar height 9 microns, operculum flange width 4 microns.

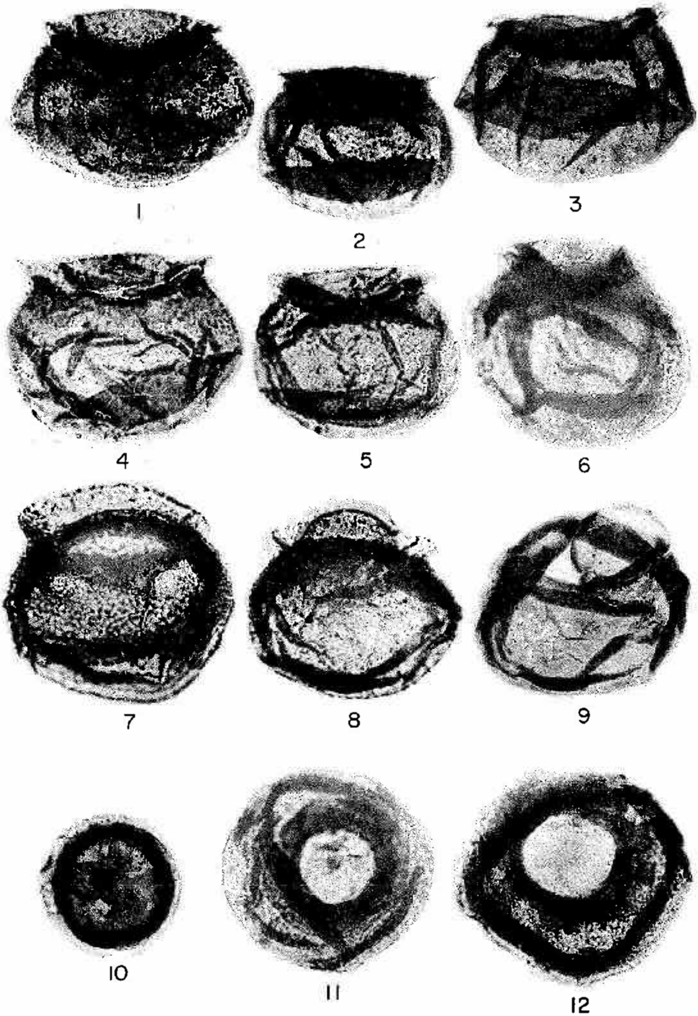
Figure 9. OPC 235-52-1. Test and operculum bleached and ornamentation completely removed. The collar-like flange about the oral opening and the membranous flange of the operculum removed by processing technique. Diameter of test 69 microns, diameter of operculum 30 microns.

Figure 10. OPC 235-45-1. Operculum removed from test showing vermiculate to smooth nature of the outer surface, and translucent membranous flange attached to the rim. Diameter of operculum body 40 microns, width of flange 2 to 8 microns.

Figure 11. OPC 235-108-3. Oral view of a test without operculum. Annulus and collar present at oral opening. Diameter 69 microns, oral opening 28 microns, annulus width approximately 5 microns.

Figure 12. OPC 235-109-1. Oral view of test without operculum. Diameter 75 microns, diameter of oral opening 28 microns, annulus width 6 microns.

Plate I



Calpichitina scabiosa sp. nov.
Plate I, figures 1-12

Holotype.—OPC 235-113-1. Plate I, figure 1

Diameter 60 to 80 microns; length 50 to 73 microns; oral opening diameter 28 to 47 microns; operculum diameter 28 to 41 microns, flange width 4 to 8 microns; annulus of neck 5 to 10 microns wide, 5 to 10 microns high; neck collar 9 to 14 microns high. Ornamentation in unbleached specimens a dense network of vermiculate ridges and short, irregular spinose thickenings; in partially bleached specimens the network of vermiculae which covers the entire fossil becomes distinct, but with additional treatment the vermiculae are destroyed and pass through a granular stage to a laevigate stage. The ornamentation on the aboral surface is generally finer than elsewhere on the test. Because no other chitinozoan presently is known that is morphologically like the described species, the ornamentation observed here may later prove to be a specific rather than a generic character.

The specific name is from the Latin word *scabiosus* (rough) in reference to the nature of the outer wall of unbleached specimens.

Discussion.—*Calpichitina scabiosa* is a common chitinozoan in the Sylvan Shale, and the description is based upon several hundred bleached and unbleached specimens. Bleaching has been accomplished by the use of Schulze's solution and a 5 percent potassium hydroxide solution, or by the use of a weak solution of sodium hypochlorite. The occurrence of an operculum, the lack of a cupola, and the subspherical test with a flaring, membranous collar are morphological characters that warrant the assignment of the specimens to a new genus. Although these fossils have been observed in groups, each specimen appeared to be the remains of a solitary animal rather than part of a colonial aggregate or chain.

References Cited

Amsden, T. W., 1957, Catalog of fossils from the Middle and Upper Ordovician of Oklahoma: Okla. Geol. Survey, Circ. 43, 43 p.

Decker, C. E., 1935, Graptolites of the Sylvan Shale of Oklahoma and Polk Creek Shale of Arkansas: Jour. Paleontology, vol. 9, p. 697-708.

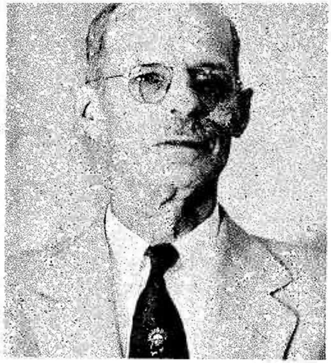
Hedlund, R. W., 1960, Microfossils of the Sylvan Shale (Ordovician) of Oklahoma: Okla., Univ., unpublished Master of Science thesis.

Wilson, L. R., 1958, A chitinozoan faunule from the Sylvan Shale of Oklahoma: Okla. Geol. Survey, Okla. Geology Notes, vol. 18, p. 67-71, 1 pl., 1 fig.

New Theses Added to O. U. Geology Library

The following Master of Science thesis was added to The University of Oklahoma Geology Library in May 1964.

Clay mineralogy of Lower Paleozoic rocks in Beavers Bend State Park, Ouachita Mountains, Oklahoma, by Wong Her Yue.



J. O. Beach (1895-1964)

John Osa Beach, known to all of us as J. O., died on Monday, May 25, 1964, in the Veterans Hospital at Muskogee after a long illness. He was with the Oklahoma Geological Survey from 1927 to 1954, inactive from 1931 to 1936 when the Survey was without funds.

J. O. was born in Wanette, Oklahoma Territory, on November 9, 1895, the son of J. H. and Rose Beach. His high-school training was at A. and M. High School, Stillwater, and Conners State School of Agriculture, Warner, where he was graduated in 1920. From January 1918 to June 1919 he was a sergeant in the medical service of the U. S. Army, stationed at Fort Riley, Fort Des Moines, and General Hospital No. 26, St. Louis. He was second lieutenant in the active reserve from 1926 to 1931 and in the inactive reserve from 1931 to 1936.

J. O. received his B.A. degree from The University of Oklahoma in 1923 and his M.A. degree in 1932, both degrees in government. From 1923 to 1924 he was a reporter for the *Ponca City News* and from 1924 to 1927 was news editor for the *Alva Daily Review-Courier.* He joined the Survey as secretary in 1927, was inactive during the years 1931 to 1936, became active again in 1937, and was made administrative assistant in 1947, a post he held until he resigned for reasons of health in 1954.

J. O. published reports on volcanic ash and tripoli, on glass sands, on limestone and dolomite, and on mineral production. He originated, edited, and wrote for *The Hopper,* a mimeographed periodical of Oklahoma mineral-resources information.

In 1924 J. O. and Jessie Lavina Bullard of Norman were married. Their children are Lillie Rose (Mrs. A. T. Corbin), Jessie Jo (Mrs. Arnold Curtis), and Norma Jean (Mrs. Kenneth Love). Mrs. Beach died in December 1933, and in 1936 J. O. and May McComb of Norman were married. They had a son, John Ezra, and the widow and son survive.

J. O. and May opened a bait-and-tackle shop on Lake Tenkiller in 1955 and continued to operate it until his health failed. J. O. had many talents, as a journalist, an editor, an accountant, and a mineral economist. His first love after his family was fishing.

—C. C. B.

Traces of a Shell-boring Organism

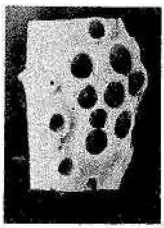
Carl C. Branson

Pits on the columns and plates of Pennsylvanian crinoids have been recorded by few authors, although such pits are apparently common. Girty (1915, p. 18-19, pl. 1, figs. 9-10a) described and figured pits on a calyx plate and on a segment of a column, these from a shale in the middle of the Wewoka Formation in the bluffs on the north side of the Canadian River in the northern part of sec. 5, T. 6 N., R. 9 E., and the southern part of sec. 32, T. 7 N., R. 9 E., Hughes County, Oklahoma. Girty considered that the pits were probably made by a sponge species. They occur only on crinoids.

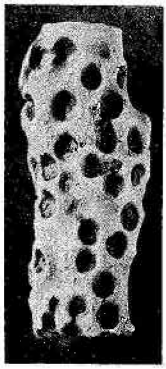
In our collection are two specimens (OU 66) collected by O. D. Weaver 0.4 mile east of the southwest corner of sec. 34, T. 6 N., R. 8 E., Hughes County. Girty's locality is mapped by Weaver (1955, pl. I) as shale below Wewoka 3b sandstone and his own locality as shale below Wewoka 3 sandstone.

Girty's specimens show a pattern of pits in which most of the smaller pits are at the edge of the affected area. Our specimens have few small pits and do not display this feature. The pits are circular in outline and have rounded bottoms like bowls. At most places the shell is thickened by secretion of calcium carbonate by the crinoid around the pits. In a few cases (fig. 1b) adjacent pits intersect.

Records of penetrant organisms on crinoid columns and arms are fairly numerous, and the agent is presumed to be a worm (*Myzostomites*). The crinoid forms cysts, or galls, around the hole made by



a



b

Figure 1. Pits of shell-boring organisms on crinoid columnals (OU 66).
(Photographs by Jan Cannon)

the penetrating organism. Such galls are known in Upper Ordovician to Permian specimens, and in Recent crinoids.

Pits of the type illustrated here are known from few localities. Strimple (1961, p. 15) mentioned occurrences in crinoids of Missourian age. Clarke figured a specimen like ours (1921, fig. 46) but noted only that it was from the Carboniferous. Moore and Plummer (1940, p. 290-291, pl. 18, figs. 3a-3b) described and figured pits on the calyx plates of a specimen of *Delocrinus abruptus* from the Florena Shale of Cowley County, Kansas. Clarke considered it possible that the pits were made by *Myzostomites*. Moore and Plummer speculated upon the possibility that gastropods were responsible. Girty (1915) and Strimple (1961) thought the pits to have been made by sponges, and it is here agreed that that agent is the more probable one. Our present record is from specimens in the Marmaton, the Missouri, and the Gearyan. Surely specimens must occur more widely stratigraphically and geographically.

References Cited

Clarke, J. M., 1921, Organic dependence and disease: their origin and significance: N. Y. State Museum, Bull. 221 and 222, 113 p.

Girty, G. H., 1915, Fauna of the Wewoka formation of Oklahoma: U. S. Geol. Survey, Bull. 544, 271 p., 35 pls.

Moore, R. C., and **Plummer, F. B.**, 1940, Crinoids from the Upper Carboniferous and Permian strata in Texas: Texas, Univ, Pub. 3945, 468 p., 21 pls.

Strimple, H. L., 1961, Late Desmoinesian crinoid faunule from Oklahoma: Okla. Geol. Survey, Bull. 93, 189 p., 19 pls.

Weaver, O. D., 1954 [1955], Geology and mineral resources of Hughes County, Oklahoma: Okla. Geol. Survey, Bull. 70, 150 p.

Kansas Geological Society Field Trip in Oklahoma Ozarks

The Kansas Geological Society will sponsor a field trip on October 1 and 2, 1964. It will be the Twenty-eighth Annual Field Conference of the Society. The area covered will be the Ozark region of northeastern Oklahoma, with emphasis on the Ordovician and Mississippian rocks, and in particular the Mississippian reefs.

Headquarters will be Western Hills Lodge in Sequoyah State Park in Cherokee County east of Wagoner, Oklahoma, south of State Highway 51. The trip will be led by George G. Huffman, Professor of Geology, The University of Oklahoma. A guide book is being prepared by Dr. Huffman. The trip will be by bus and the registration fee will be approximately $20. John E. Brewer, field-trip chairman, can be reached at 508 East Murdock Street, Wichita, Kansas, for further details.

Replacement Name for *Pakistania* Stehli

The generic name *Pakistania* was given by Eames to a gastropod in 1952. Stehli erected the new genus *Pakistania* in 1961 (p. 462) for brachiopods of the type of *Dielasma biplex* Waagen, 1882. Stehli now replaces the junior homonym with the new name *Whitspakia* (1964, p. 610). The species from the Doe Creek Lentil of the Marlow Formation of Oklahoma (Branson, 1961) now becomes *Whitspakia schucherti* (Beede), 1902, and the neotype of the species is that figured by Beede (1907) as plate 5, figure 1b-d.

References Cited

Beede, J. W., 1902, Invertebrate paleontology of the red beds: Okla. Terr. Geol. Nat. History Survey, 1st Bienn. Rept., Advance Bull., 11 p., 1 pl.

__________ 1907, Invertebrate paleontology of the Upper Permian red beds of Oklahoma and the Panhandle of Texas: Kans., Univ., Science Bull., vol. 4, p. 113-171, 4 pls.

Branson, C. C., 1961, Two new brachiopod genera from Oklahoma: Okla. Geol. Survey, Okla. Geology Notes, vol. 21, p. 232.

Stehli, F. G., 1961, New genera of Upper Paleozoic terebratuloids: Jour. Paleontology, vol. 35, p. 457-466, pl. 62.

__________ 1964, New names for two homonyms: Jour. Paleontology, vol. 38, p. 610.

—C. C. B.

OKLAHOMA GEOLOGY NOTES

Volume 24 July 1964 Number 7

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