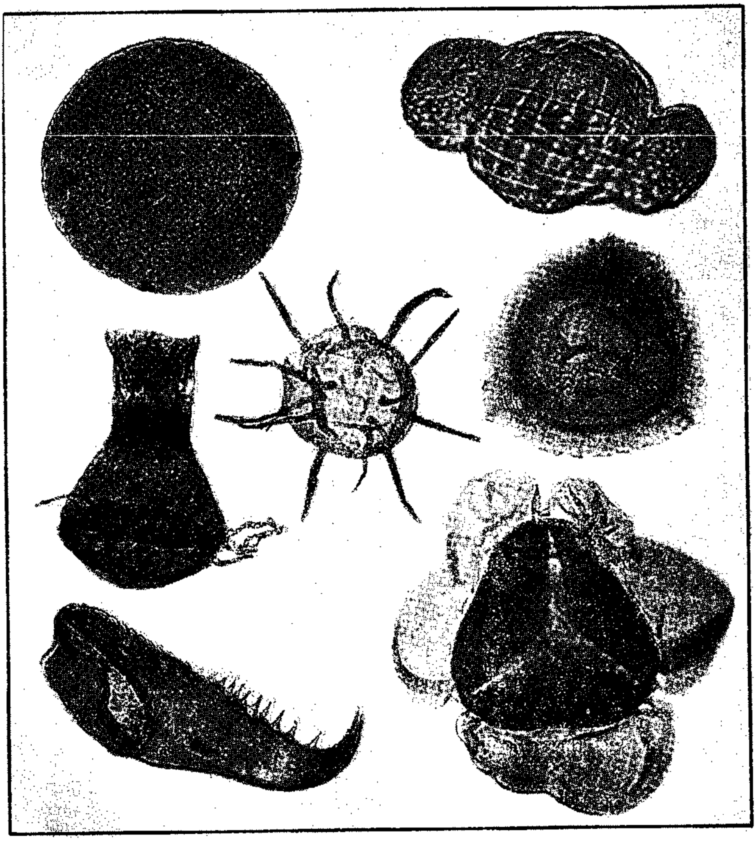
OKLAHOMA GEOLOGY NOTES



OKLAHOMA GEOLOGICAL SURVEY

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COVER FOSSILS

Assemblage of important plant and animal microfossils from the Paleozoic rocks of Oklahoma is illustrated on the 1960 cover of the Geology Notes. Most of the fossils are new to science and soon will be described in publications of the Oklahoma Geological Survey.
Top row (left to right):

Tasmanites sp. from the Woodford formation (Devonian) of the Arbuckle Mountains. Diameter: 116.2 microns. One of the species of *Tasmanites* being described in a Master's thesis by James B. Urban.

Gymnosperm pollen grain from the Flowerpot formation (Middle Permian) of Greer County. Dimensions: 23.7 x 68.2 microns. This fossil is the genotype of a new genus being described by L. R. Wilson.
Middle row (left to right):

Chitinozoan from the Sylvan shale (Ordovician) of the Arbuckle Mountains. Dimensions: 80.7 x 122 microns. One of the species described in the Master's thesis of Richard W. Hedlund.

Hystrichosphaeridium sp. from the Sylvan shale (Ordovician) of the Arbuckle Mountains. Overall diameter: 128 microns. A species being described by L. R. Wilson.

Cirratriradites maculatus Wilson and Coe, a spore from the "Porter" coal near Porter, Wagoner County. Dimensions: 88.4 x 90.3 microns. The age of this coal is the subject of Maurice J. Higgins' Master's thesis.
Bottom row (left to right):

One of many minute scolecondonts (worm jaws) occurring in the Sylvan shale (Ordovician) of the Arbuckle Mountains. 66.9 x 161.5 microns. This specimen and others are being described in the Master's thesis of Richard W. Hedlund.

Alatisporites sp. from the "Porter" coal near Porter, Wagoner County. Dimensions: 102 x 110 microns. This and other spores are being described in the Master's thesis of Maurice J. Higgins.

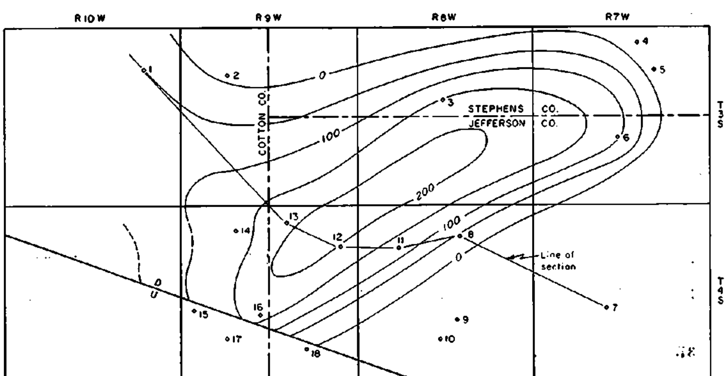
L. R. Wilson

A CANYON REEF IN SOUTHERN OKLAHOMA

Philip A. Chenoweth

Pennsylvanian limestone reefs are well known from surface exposures and in the subsurface of north and northwest Texas. Most of them occur in strata assigned to the Canyon (Missourian) series, although locally thick limestones are also present in the underlying Strawn (Desmoinesian) series. Older (Mississippian) and younger (Permian) reefs are also well known in the same general area. The Texas reefs of all ages occur in greatest numbers and in their thickest development on the major structural highs of western Texas: the Central Basin Platform, the Eastern Shelf, and the Matador arch. North and northeastward, towards the Red River, the reefs are less numerous, thinner, and of smaller areal extent. It is a common misconception that they are not present north of the Red River in Oklahoma.

At least two fairly large reefs are present, however, in southern Oklahoma; one trending north-south in Harmon and Jackson Counties in the southwest corner of Oklahoma, the other in northwestern Jefferson County. This paper describes the second of these, which owing to the density of drilling is somewhat better known. There is, furthermore, a distinct possibility that other similar reefs are present elsewhere in the southern part of the state. The Loco limestone, an oil-producing zone in the Loco oil pool of southern Stephens County, may well be reef-like in nature. Others may be present in Cotton County and Tillman County where many oil wells have encountered locally thick Canyon limestones.



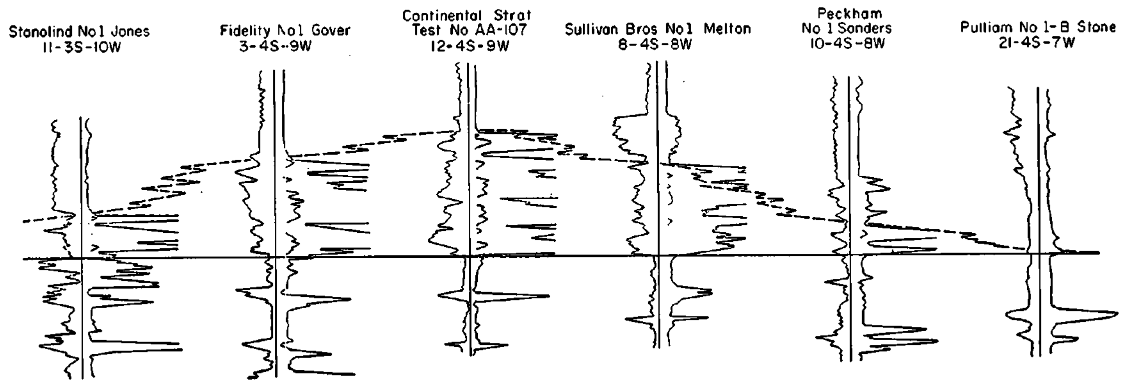
Isopach Map of Canyon Reef, Northwestern Jefferson Co., Oklahoma

The subject of this note is an elongate oval mass of dense to finely crystalline and slightly cherty fossiliferous limestone with thin interbedded shales and calcareous sandstones somewhat more than 200 feet thick near the center. The limestones give way rapidly to calcareous shales towards the north, east, and south. To the west a series of thin limestones and shales, aggregating about 75 feet in thickness, serves to connect the reef with a more or less continuous limestone unit in Cotton County. Close to the reef this may represent a type of back-reef facies, although lacking the typical lagoonal deposits. A log of a typical well in the central portion of the reef is tabulated below:

PARTIAL SAMPLE LOG OF THE FIDELITY No. 1 GOVER
Cen NW¼ SE¼ Sec. 3, T. 4 S., R. 9 W.,
Jefferson County, Oklahoma

(Elevation 1037 DF. Dry and abandoned)

Depth	Remarks
3500-3570	Shale, very finely micaceous, light gray, with thin beds of gray limestone and very fine-grained calcareous white sandstone.
3570	Top of reef limestone
3570-3590	Limestone, very finely crystalline to dense, creamy white to light gray, slightly cherty, slightly sandy at top. Fossil fragments common.
3590-3600	Sandstone, calcareous, white, fine-grained. Ostracod-bearing shale bed at top.
3600-3670	Limestone, dense to finely crystalline, white to light gray, fossiliferous. Contains some smoky white chert at 3620-3630, thin beds of fine-grained friable white calcareous sandstone at 3630-3640 and 3660-3670, and thin beds of argillaceous gray limestone at 3640-3650. Fusulinid fragments near middle.
3670-3690	Limestone, fine-crystalline, gray to creamy-buff, argillaceous.
3690-3710	Limestone, very finely crystalline, argillaceous, gray, with chalky-white interbeds and some thin crinoid-bearing shale laminae.
3710-3720	Limestone, dense to finely crystalline, white to light gray.
3720-3730	Limestone, finely crystalline to pellet-type, argillaceous, resinous. Fossiliferous.
3730	Base of reef limestone
3730-3780	Shale, finely micaceous, dark gray, splintery, with fossiliferous argillaceous limestone beds.
3780-3790	Sandstone, very fine-grained, white, calcareous
3790-3808	Limestone, dense to finely crystalline, white, fossiliferous.
3808-3860	Shale, finely micaceous, dark gray, splintery. Base of logged interval.



Electric Log Cross-section Canyon Reef, Northwestern Jefferson County, Oklahoma
Datum: Base of reef

The reef proper trends roughly northeast-southwest in the extreme northwest corner of Jefferson County and the southwest corner of Stephens County. It is approximately 16 miles long, thinning gradually toward the northeast and the southeast, but terminating abruptly at the southwest end. The southwest extremity of the reef abuts against a large pre-Pennsylvanian fault scarp suggesting that during the time of reef-building this escarpment formed a steep shoreline along the northeast margin of an island or peninsular land area. This point is further brought out by a northeastward thickening of the Missourian and Desmoinesian sediments beneath the reef.

Subsequent to the formation of the reef, and probably coincident with the late Pennsylvanian orogenic movements centered in the Arbuckle Mountains to the northeast, the sediments of this area were down-warped to form a large northwest-southeast syncline (Marietta-Sherman syncline). The reef crosses the trough of the syncline almost at right angles to it so that the thin ends are structurally higher than the central thickened portion. The base of the reef is at an elevation of approximately 3,600 feet below sea level at the lowest part, the northeast end is approximately 3,000 feet below sea level, and the southwest end, where it lies against the pre-Pennsylvanian fault, is about 2,200 feet below sea level. Doubtless the weight of the mass of limestone resting as it does on soft shale has caused considerable downwarping in the underlying sediments. Subsurface control in these beds is, however, inadequate to prove such a feature. It is likewise probable that later Missourian sediments draped over the crest of the reef, producing gentle anticlinal folds in the super-reef strata. This also cannot be clearly demonstrated.

The limestone which forms this reef, and probably similar ones to the west, is generally referred to as "Canyon lime" by oil geologists working in this part of the state. It is no doubt correlative with a portion of the true Canyon series of Texas but should more properly be placed in the Hoxbar group. Stratigraphically, it is located beneath the Daube limestone and above the equivalents of the Confederate limestone, perhaps roughly the equivalent of the Anadarche limestone of the Ardmore area. Owing probably to the cyclic nature of these units and to the rapid lateral changes, more exact correlations are extremely tenuous. No doubt a careful paleontologic study could increase the precision of correlation in this whole general area.

MASJID-I-SULAIMAN FIELD, IRAN

The first oil discovery in Iran, once called Maidan-i-Naftun (field of oil) and found May 26, 1908, lies in a desert area in the foothills of the Bakhtiari Mountains. Oil seeps had been known for centuries in the area. The field is on an elongate anticline, 17 miles long and 4 miles wide, which has 2,200 feet of closure above the water-oil contact. Production comes from permeable and fractured Asmari (Miocene) limestone, 900 feet thick with the upper 400 feet more porous. After 51 years, 23 wells are producing at a daily rate of 37,000 barrels, giving a total annual crude oil production of 13,505,000 barrels for 1958 (*World Oil*, vol. 149, no. 3, August 15, 1959). A total of 257 wells have been productive in the field. Production decreased 10.8 percent below the previous year, 1957.

L. J.

GENOTYPE OF SCHWAGERINA

a translation by M. K. Elias, 1958

1956. Rauser-Chernoussova, D. M.—On the impossibility to qualify *Borelis princeps* Ehrenberg, 1854, as a species typical of the genus *Schwagerina* Moeller, 1877: Akad. Nauk SSSR, Doklady, vol. 111, no. 6, p. 1161 (English titles), 1333-1335.

(p. 1333). The genus *Schwagerina* Moeller, 1877, one of the most widely distributed and stratigraphically important among the genera, has been understood in the course of 59 years, since 1936, in a quite stable and generally accepted sense, as shown by a fine illustration of a specimen of *Schwagerina princeps* Moeller, 1878 (not Ehrenberg), and his corresponding clear-cut diagnosis. However, in the diagnosis of the genus given in 1877 Moeller incautiously indicated *Borelis princeps* Ehrenberg, 1854, as its typical species.

Since 1854 no one has studied *Borelis princeps* Ehrenberg. The illustrations by Ehrenberg (Mikrogeologie, Leipzig, 1854) give no idea of the internal structure of the shell, basic in diagnoses of all fusulinids. When Moeller indicated *B. princeps* Ehrenberg as a typical species of the genus *Schwagerina* he had not undertaken to investigate Ehrenberg's originals by sectioning, which was his adopted method, as correctly pointed out by Dunbar and Skinner in 1936. All subsequent authors, beginning with Schwager, considered *Schwagerina princeps* Moeller 1878, not Ehrenberg, as actual typical species for the genus *Schwagerina*.

In 1936 Dunbar and Skinner prepared thin sections from Ehrenberg's originals, which are silicified. The preservation of the originals, as observable on their Plate 10, figs. 7 and 8, is such that one can only guess what the structure actually is: its initial volutions, according to the author's own statements, "are altered to clear quartz and do not show plainly" (their p. 86); as to the structure of the wall, which is one of the most important characters of a genus, there is not a trace preserved; and the only character established by them is the inflated shape of the conch and the intense fluting of septa. In view of this these authors were not able to establish even a lectotype of the species.

In spite of the fact that the specimens of *Borelis princeps* Ehrenberg do not provide an understanding of the species, and in spite of the absence of precise locality and age of the originals in Ehrenberg's article, the authors of the "revision" decided to resurrect this unrecognizable and unidentifiable species, and to recognize it as the genotype for the genus *Schwagerina*. In doing so these authors have had to discard another genus—*Pseudofusulina* Dunbar and Skinner, 1931, also widely distributed among the fusulinids. They have put this genus in the synonymy of the genus *Schwagerina* Moeller, 187? and they offered a new name, *Pseudoschwagerina* Dunbar and Skinner, 1936 for the previously established genus *Schwagerina*.

However, species of several fusulinid genera of different ages possess globular shape and intense fluting. Therefore,, as a result of the resurrection of *Borelis princeps* an obvious damage was inflicted to the stability and universality of the nomenclature and systematics of fusulinids, contrary to one of the basic principles of systematics advanced by the Copenhagen Congress of Zoologists in 1951.

(p. 1334). In 1936 D. M. Rauser-Chernoussova protested against Dunbar and Skinner's offer to rename the two most important genera of fusulinids in view of the following:

(1) Unsatisfactory state of preservation of the originals of *Borelis princeps* Ehrenberg and obscurity of its generic characters, and also absence of indication of topotypic area, which is likely to lead in the future to new renamings and a state of flux in the nomenclature;

(2) Stabilization and general recognition in the course of 59 years of the genus *Schwagerina* Moeller, 1877, as factually erected not on *Borelis princeps* Ehrenberg;

(3) The fact that Moeller and other authors accepted only *Schwagerina princeps* Moeller (not Ehrenberg) as factual typical species of the genus (in the first diagnosis of the genus given by Moeller in 1877 the characters of the internal structure are utilized, unknown in *Borelis princeps* Ehrenberg until 1936;

(4) The possibility of interpreting Moeller's reference to *B. princeps* Ehrenberg in the diagnosis of 1877 merely as a reference to a species characteristic for the genus, and not as genotype (see opinion 71 of the International Rules of Zoological Nomenclature; and

(5) The necessity to preserve *Schwagerina* as *nomen conservandum* in view of the great stratigraphic significance of this genus, deeply rooted in the geologic and paleontologic literature.

In 1940 Rauser-Chernoussova and C. F. Shcherbovich showed that the typical species of the genus *Pseudoschwagerina* Dunbar and Skinner 1936 (*P. uddeni* Beede and Kniker) are generically sharply different in many respects from *Schwagerina princeps* Moeller, 1878, and the latter should be segregated into a separate genus (loc. cit., p. 63-64). At present all paleontologists in the SSSR are following D. M. Rauser-Chernoussova, and distinguish three genera: *Pseudoschwagerina* Dunbar and Skinner, 1936; *Schwagerina* Moeller, 1877; and *Pseudofusulina* Dunbar and Skinner, 1931, accepting the latter two genera in their old meaning.

Beginning with 1954 M. L. Thompson recognized anew the genus *Pseudofusulina* Dunbar and Skinner, 1931, as he considers its typical species (*P. huecoensis* Dunbar and Skinner) quite unlike *Borelis princeps* Ehrenberg, 1884. This author placed in the genus *Schwagerina* only a part of the former pseudofusulines, but he failed to give a clear-cut outline of their characters, which undoubtedly will lead in the future to further changes in the scope of the genus *Schwagerina*, as understood by the American and a few other authors.

M. Elias (Jour. Paleontology, v. 24, no. 2, 1950) pointed out the noncorrespondence of some characters in *Borelis princeps* Ehrenberg and pseudofusulines, and greater similarity of the shell to schwagerines (in the old sense). He considered the proposed re-naming of schwagerines insufficiently substantiated, because it is based on an obviously non-typical species, and without taking into account of the full scope of the species and its phylogeny. In view of this M. Elias considers undesirable direct application of the International Rules of Zoological Nomenclature to the paleontological genera with an old and wide recognition, as it frequently leads to confusion in nomenclature and systematics instead of clarification and uniformity.

A number of authors (R. Ciry, Ann. Paleontologie, vol. 30, 1943; C. O. Dunbar and J. W. Skinner, Univ. Texas Bull. 3701, 1937; S. Hanzawa, Japanese Jour. Geology Geography, vol. 16, nos. 1-2, 1939; G. Kahler, Palaeontogr., vol. 87, Abt. A, 1937) expressed regret about the previous double re-naming of the fusulinid genera, which caused considerable difficulties in the systematics, and, principally, in practical stratigraphical use of fusulinids. The authors of the re-naming themselves had to admit (1937, p. 625-625) that it is possible that in truth *Schwagerina princeps* Moeller, 1878, and not *Borelis princeps* Ehrenberg, 1854 was considered the typical species of the genus *Schwagerina* by Moeller in 1877. The same authors emphasize the desirability of preserving the genus *Schwagerina* in the old sense as *nomen conservandum* (p. 625, note 1). Hanzawa (1939) doubts the possibility of stabilizing the genus *Schwagerina* in the new sense.

All this gives a good ground for recognition of *Borelis princeps* Ehrenberg, 1854 as *nomen dubium* in view of the obscurity of its generic and specific characters and the absence of indication of its *locus typicus*. This name brings confusion in the systematics of fusulinids and must be considered obsolete. *Schwagerina princeps* Moeller, 1878 (not Ehrenberg) is an undoubted type of the genus *Schwagerina*, because it is the first (p. 1335) most completely described, and well illustrated species of this genus, which was understood quite clearly, uniformly, and universally by all paleontologists in the course of 59 years. Besides, the genus *Schwagerina* Moeller, 1877, being widely and for a long time used in the geologic literature, and having very important stratigraphic significance, has excellent reason to be conserved, as per Opinion 107, International Rules of Zoological Nomenclature, and paragraphs 28 and 128 of the decisions of the Zoological Congress at Copenhagen in 1951.

PETROCHEMICAL PLANTS IN OKLAHOMA, 1959

DX Sunray Oil Co., Duncan, Okla.
Raw material: Natural gas and butadiene
Principal product: Acetal resin

Sinclair Petrochemicals, Inc., Sand Springs, Okla.
Raw material: Petroleum fractions.
Principal products: Demulsifying agents, corrosion inhibitors, acid-layer-type petroleum sulfonate (sodium salt), and oil-layer-type sulfonate (sodium salt).

Deere & Co., Grand River Chemical Division, Pryor, Okla.
Raw material: Natural gas.
Principal products: Ammonia (200 tons per day), urea (90,000 tons per year), and nitrogen solutions.

Callery Chemical Co., Muskogee, Okla.
Raw material: Natural gas and boric acid.
Product: High-energy fuel.
Status: This plant is essentially completed at a cost of $38,000,000. The Navy recently has cancelled its contract.

Source: *Oil and Gas Journal*, vol. 57, no. 37, September 7, 1959, p. 121-160.

AN AREA OF GYPSUM KARST TOPOGRAPHY IN OKLAHOMA

Arthur J. Myers

The word karst is a comprehensive term applied to areas that possess a topography peculiar to and dependent upon underground solution and the diversion of surface waters to underground routes. In the United States the significant karst areas are in central Florida, the Great Valley of Virginia and Tennessee, southern Indiana, west-central Kentucky, and north-central Tennessee.

Solution will occur wherever there are soluble rocks such as limestone, dolomite, rock salt, or gypsum. Four conditions are essential for maximum karst development: (1) a soluble rock must be present at or near the surface, (2) the rock should be dense, highly jointed, and preferably thin bedded, (3) there must be entrenched major valleys below uplands underlain by soluble well-jointed rocks, and (4) the area must receive at least a moderate amount of rainfall (Thornbury, 1954, p. 317-318). The features which are characteristic of karst regions are: terra rosa (a surface or near surface residue of a red, clayey soil), lapies (an etched, pitted, grooved, fluted, and otherwise rugged surface on the rock), sinkholes (depressions caused by the removal of soluble rocks), solution valleys (valleys formed in the soluble rocks and containing streams that drain into sinks), natural bridges (formed by the removal of soluble rock), and caves. Normally in any one area not all features will be present.

Northeastern Woodward County is an area which can be classified as having a karst topography in a belt approximately 6 to 8 miles wide parallel to the Cimarron River (Figure 1). The various karst features have formed in the essentially horizontal Blaine formation (El Reno group, Permian) which in Woodward County, consists of the following units (in ascending order): Medicine Lodge gypsum, 30 feet thick; unnamed shale, 13 feet thick; Nescatunga gypsum, 13 feet thick; unnamed shale, 7 feet thick; Shimer gypsum, 13 feet thick; unnamed shale, 4 feet thick; and Haskew gypsum, 4 feet thick. In some areas the Blaine gypsums form escarpments, and in others, a slope ranging in width from a few feet to a hundred feet. The shales are easily eroded and are visible as scarp slopes below the gypsum. The gypsum beds form a series of steps essentially parallel to the Cimarron River.

The Blaine formation is not ideally suited for karst development because of the interbedded shales; however the gypsum members are dense, jointed rocks, and the Cimarron River and its major tributaries have eroded their channels well below the lowermost gypsum bed. In Woodward County the more common karst features are sinkholes, solution valleys, caves, and natural bridges. All of these features can be observed in the general area of Alabaster Caverns State Park in secs. 28 and 33, T. 26 N., R. 18 W. Figure 2 is a geologic map of this area and shows the location of the karst features. Figure 3 is a stereo-pair of the same area.

Most of the sinkholes have their rims in the Shimer gypsum, but many are in the Nescatunga. At some places the rim is a scarp to the underlying shale and even to the underlying gypsum bed. These sinks range in diameter from 100 to 200 feet and have an average depth of 15 feet. Good examples of this type are in NE¼ SW¼ sec. 28, T. 26 N., R. 18 W. and SW¼ NW¼ sec. 22. T. 26 N., R. 19 W. Much more common are the sinks with irregular rims and moderately steep slopes into the depression. These occur normally in clusters. Individual sinks of this type may be only a few tens of feet in diameter and up to 10 feet deep, whereas the clusters will be a few hundred feet in diameter and as much as 20 feet deep. Examples of this type are in NW¼ sec. 15, T. 26 N., R. 19 W. and NW¼ NW¼ sec. 33, T. 26 N., R. 18 W. However, they can be seen almost anywhere in the area.

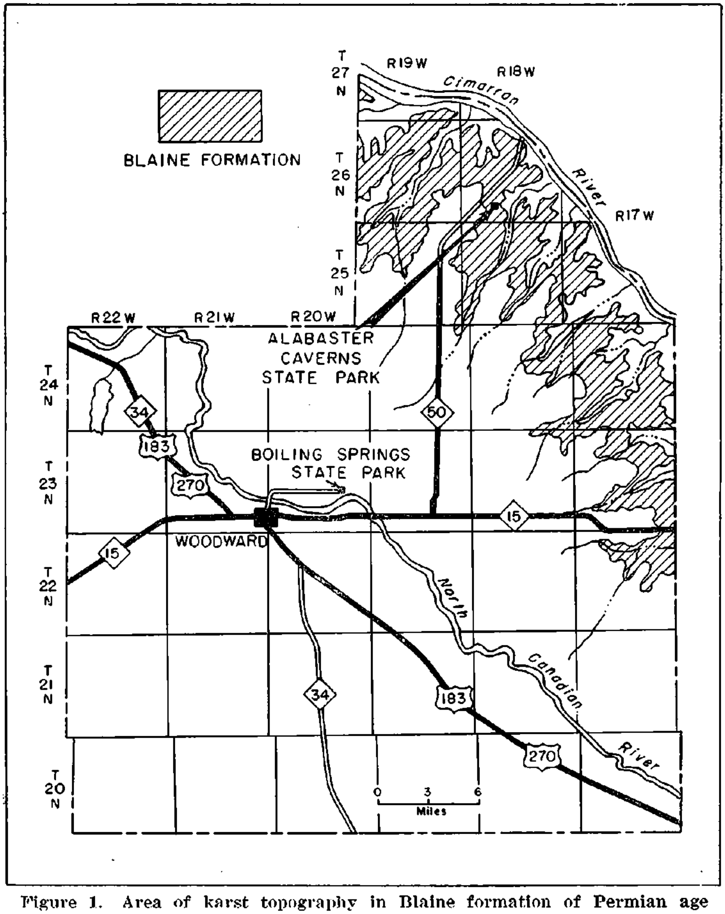


Figure 1. Area of karst topography in Blaine formation of Permian age in northeastern Woodward County, Oklahoma.

The Cimarron River and its major tributaries have eroded their channels into the Flowerpot shale, which underlies the Blaine; but most of the secondary tributaries flow on the shales of the Blaine formation. The majority of the secondary tributaries flow directly into tributaries, but others flow into sinkholes. The solution valleys containing streams which drain into sinks are normally less than a mile in length and are common throughout the area. Larger valleys, which are over a mile in length are in secs. 32 and 33, T. 26 N., R. 18 W. and in secs. 16 and 21, T. 26 N., R.19 W. Of special interest is an inlier of the Medicine Lodge in the northwestern part of sec. 33, T. 26 N., R. 18 W. The Medicine Lodge gypsum is not actually exposed in this U-shaped area of approximately a half square mile, but the

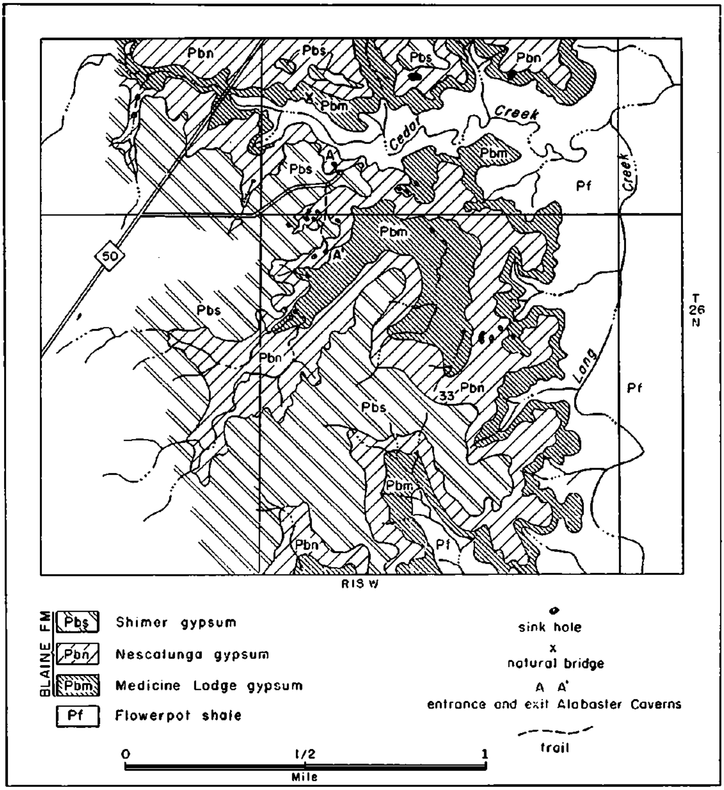


Figure 2. Geologic map of Alabaster Caverns area showing location of karst features.

Figure 3. Stereo pair of Alabaster Caverns area. North to the right: stream in stereo pair is Cedar Creek.

Nescatunga gypsum does rim the lowland. Four streams drain into sinks within this area.

Caves are present in most parts of the area and serve as subsurface drainage-ways for the solution valleys. Most caverns, normally within a single gypsum layer, are tube-like openings with diameters ranging from a few inches to a few feet and ranging in length from a few feet to several hundred feet. In some caves collapse of the roof to the next higher gypsum layer has resulted in cavern heights as great as 40 feet. The largest cave is Alabaster Caverns in secs. 28 and 33, T. 26 N., R. 18 W. It is approximately a half mile long with a maximum height of about 40 feet. Other caves are in NE¼ NW¼ sec. 15, T. 26 N., R. 19 W., and NW¼ NW¼ sec. 30, T. 25 N., R. 19 W.

Natural bridges have formed where erosion has cut under a gypsum bed leaving an arch of rock. The largest observed is in the NW¼ SW¼ sec. 28, T. 26 N., R. 18 W.

Reference cited

Thornbury, W. D., 1954, Principles of Geomorphology: New York, John Wiley & Sons, p. 317-318.

ONE HUNDRED YEARS OF THE PETROLEUM INDUSTRY

The history of the petroleum industry for 100 years is recorded in all kinds of books. In the *Petroleum Engineer* for October, 1959, Ernestine Adams presents a list of such books based on the preferences of oil company librarians. Although most agreed that no comprehensive history of the industry has yet been written, they each had a favorite book on the subject.

The centennial of the industry has brought forth several new books this year. Among these are *The Greatest Gamblers* by Ruth Shelton Knowles (McGraw-Hill, 1959), *The Great Oildorado* by Hildegard Dolson (Random House, 1959), *Covered Wagon Geologist* by Charles N. Gould (University of Oklahoma Press, 1959) and the first volume of the American Petroleum Institute sponsored history, *The Age of Illumination* by Harold F. Williamson and Arnold R. Daum (Northwestern University Press, 1959). This last book, which covers the years 1859-1899, should serve as a fine reference.

Of course, most of the recommended books are of an earlier age. Included among these are found biographies, Histories and novels such as: *Fever in the Earth* by William A. Owens (Putnam, 1958), *The Oil Business as I saw It* by W. J. Connelly (University of Oklahoma Press, 1954), *This Fascinating Oil Business* by Max Ball (Bobbs-Merrill, 1940), *Oil! Titan of the Southwest* by Carl Coke Rister (University of Oklahoma Press, 1949), *Early Days of Oil* by Paul H. Giddens (Princeton University Press, 1948), *Coal Oil and Coal* or *The Geology of the Earth* by Eli Bowen (T.P.B. Peterson and Brothers, 1865), *The Rise of American Oil* by Leonard M. Fanning (Harper, 1936), *Three Stars for the Colonel* by James A. Clark (Random House, 1954), *Black Bonanza* by Earl M. Welty and Frank J. Taylor (McGraw-Hill, 1958), *The Amazing Petroleum Industry* by Vladimir Anatole Kalichevsky (Reinhold, 1943), and *The Oil Century* by Joseph Stanley Clark (University of Oklahoma Press, 1958).

Miss Adams' quick survey leads her to the conclusion that "the collection of petroleum historical books is not very comprehensive".

Jack W. Dickey

HELIUM PLANT COMPLETED AT KEYES

Keyes Helium Plant, the fifth and largest helium-recovery plant owned by the Federal government, was formally dedicated on November 17, 1959. Attending the ceremony were Royce Hardy, Assistant Secretary of the Interior and many distinguished guests, including members of the Congress, representatives of Federal, State and local government, industrial and governmental users of helium, and members of firms interested in the national helium-conservation program.

The Keyes plant, constructed at a cost of $10 million, has a designed capacity of approximately 290 million cubic-feet of helium a year. At peak operation, it will be processing 50 million cubic-feet of natural gas daily to extract the helium, which averages 2 percent. The natural gas, piped to the Keyes plant from privately owned wells, is returned to commercial pipelines for marketing after the helium has been extracted. The current United States production rate of helium has been increased by 65 percent through the installation of this new extraction plant at Keyes, which is about 15 miles east of Boise City in Cimarron County, Oklahoma.

The plant, begun in November 1958,[1] was completed in August by the Fluor Corporation, Ltd. of Los Angeles, California. Constructed during an unusually severe Oklahoma Panhandle winter, the job required the services of 500 workers at peak periods. The plant is composed of low-temperature helium separation units, carbon dioxide removal and dehydration equipment and compressors.[2] Operated by the Bureau of Mines with Carl H. Schlegel as superintendent, the plant employs about 90 persons.

Use of the lightweight uninflammable gas, vital to defense and industrial needs, has increased fivefold in the past ten years. Secretary Seaton has forecast that even greater amounts will be required in the future. He has proposed a national helium-conservation program under which 12 additional plants would be built and operated, either by industry or government, to conserve, for future use, 32 billion cubic-feet of helium whch otherwise will be lost when natural gas containing it is burned as fuel.

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1 Ham, W. E., 1958, New helium plant in Oklahoma Panhandle: Okla Geology Notes, vol. 18, p. 181.

2 Kansas-Oklahoma Oil Reporter, 1959, Helium produced at Keyes plant: Kan.-Okla. Oil Reporter, vol. 2, no. 7 (October), p. 17.

L. J.

COAL

Laboratory investigations have found that coal itself can be used as an aggregate for flexible paving. One promising process indicates that as much as 1,000 tons of coal will be needed to make a mile of highway. This involves dissolving coal in low-temperature coal tar. A number of test roads have been put down for all-season testing in several parts of the country using several different processes and materials.

Quoted from Rock Products, October 1959, page 9.

A. L. B.

LOCAL FOSSIL ASSEMBLAGE IN THE SEMINOLE FORMATION

Carl C. Branson

A small collecting locality in the Seminole formation has yielded an amazingly large invertebrate fauna. The material was collected by Harrell L. Strimple for the Oklahoma Geological Survey. The locality is one-tenth mile south of the first section-line road south of Glenpool, on the east side of the road, NW¼ NW¼ NW¼ sec. 23, T. 17 N., R. 12 E., Tulsa County. The zone is, according to Oakes' map (1952) a short distance above the Dawson coal.

The fauna consists of:

	Number of specimens
Porifera (sponges)	7
Crinoidea	
calyces and crowns	22
columnals	55
plates	173
basal cups	6
Anthozoa (corals)	
Lophophyllidium sp.	13
Pleurodictyum eugeneae	7
Bryozoa	
ramose type	12
fenestellid type	1
encrusting type	8
Brachiopoda	
Chonetes geinitzianus	355
Composita subtilita	7
Crurithyris planoconvexa	6
"Dictyoclostus" sp.	3
Hustedia mormoni	3
"Marginifera" muricatina	108
Mesolobus mesolobus	36
Neospirifer dunbari	72
Rhynchopora sp.	2
Spirifer cameratus	9
Lamellibranchiata	
Allorisma sp.	1
Anthraconeilo taffiana	4
Astartella concentrica	64
Clavicosta sp.	1
Culunana bellistriata	2
Euchondria sp.	1
Myalina sp.	3
Nuculopsis girtyi	8
Palaeonucula (?) anodontoides	4
Schizodus sp.	6
new genus?	17

Gastropoda	
Amphiscapha catilloide	1
bellerophontids, unidentifiable	67
Bucanopsis tenuilineata	3
Euphemites carbonarius	24
Orestes nodosus	51
Patellostium montfortianum	1
Pharkidonotus percarinatus	73
Sphaerodoma primigenia	8
Trepospira depressa	38
Zygopleura sp.	6
Cephalopoda	
Mooreoceras sp.	1
Tainoceras sp.	4
Scaphopoda, unidentifiable	20
Total	1,305

Strimple reported (letter December 7, 1959) two cups and 20 plates of *Cibolocrinus*, eight cups of *Apographiocrinus*, eight cups of *Lecythiocrinus*, one cup of *Galateacrinus*, one cup of *Plaxocrinus*, one cup of *Delocrinus*.

The fauna is distinctly molluscan, brachiopod, and crinoidal. Of the specimens (all megafossils) 256 are crinoidal, 601 brachiopods, 111 clams, 269 snails. A conspicuous missing element is the fusulinids, and corals and bryozoans are few. No phosphatic brachiopod, and no conulariid was found. Dominant forms are bellerophontids (168), chonetids (391), "*Marginifera*" (108), and *Astartella* (64). The total species identified is 40. Known Seminole faunas of Oklahoma are few. Morgan (1924, p. 113) listed 19 species from six localities. Weaver (1954, p. 75) listed 39 species from Hughes County; Ries (1954, p. 51-52) 41 species from Okfuskee County; and Tanner (1956, p. 61-62) but 11 species from Seminole County. Miller and Owen (1937) had a fauna of one clam specimen and 10 species of cephalopods from the cap-rock of the Dawson coal at Collinsville.

References

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Ries, E. R., 1954, Geology and mineral resources of Okfuskee County, Oklahoma: Okla. Geol. Survey, Bull. 71.

Tanner, W. F., 1956, Geology of Seminole County, Oklahoma: Okla. Geol. Survey, Bull. 74.

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BIBLIOGRAPHIC CITATIONS

A person is apt to forget that a journal like these Notes receives wide circulation, and he may not remember that libraries use many cataloging systems. A recent letter from Professor Knut Faegri of the Botanical Museum, University of Bergen, Norway, points out his objections to the Oklahoma Geological Survey system of citing references. An international system is being sought, as his letter states, and inasmuch as he gives permission to print the letter, it is given in full here.

"I should like to take exception to the article, signed C. C. B., about the correct form of citation of literature references (Vol. 19 (4), p. 89-90). There is no single correct form. Any method which gives a maximum of information for a minimum of expense and with a minimum of possibilities for errors (printers' and others) is acceptable. Unfortunately, the system advocated by your correspondent does not satisfy these demands.

As the scientist is in most cases dependent upon a librarian to produce the book in question, references should be geared to existing bibliographical routines. There are many different systems in use in public libraries, but there are two main trends. Some quote the title of the periodical in full with no change of sequence of words, and alphabetize accordingly, omitting only articles if they happen to come first. In such a case your journal would be entered under *Oklahoma*, say between *Ohio* something or other and *Omaha* ditto. The second school uses a key word for arranging periodicals. In your case it would be *Notes*, and the journal would be put in with other *Notes* between, say, *Notarisia* and *Notulae entomologicae*.

It will be seen that in neither case does the issuing body enter in the title of the periodical. and it certainly has no place there. Your correspondent himself gives an excellent example of this in connection with the quotation of *Meddelelser om Gronland*, putting in all that unnecessary stuff and, incidentally, making hash of it.

The form of quotation advocated by C. C. B. is a good one for a list of learned societies etc. with incidental mentioning of the periodicals issued by them. It is too complicated for literature references.

Your correspondent may perhaps also on a second thought find out why his advice that non-English words should not be abbreviated is well suited to extract a little smile from readers in other countries.

I am writing this as convener of a committee, nominated by the International Union of Biological Sciences to study this and similar problems. We have reached the preliminary conclusion that the matter is beyond the scope of IUBS alone, and have asked that it be referred to the International Council of Scientific Unions in collaboration with the International Standards Organization. I hope this will be done presently. In the meantime I may draw your attention to ISO Recommendation R 4 on the abbreviation of titles of periodicals, and also to Draft recommendation ISO/TC 46 about bibliographical references.

It would indeed, be unfortunate if geologists adopted some quite different procedure from this one, which seems gradually to become prevalent elsewhere."

Faegri's points are well taken for an international standard for all sciences, but during the present lack of such standards the system outlined by me (Okla. Geol. Survey, Okla. Geology Notes, vol. 19, p. 89-90) will be used by the Survey. The correct name of the Danish publishing organization, using dipthongs for the diacritical marks, is:
Kommissionen for Videnskabelige Undersoegelser i Groenland, Meddelelser om Groenland.

Carl C. Branson

COST OF WELLS IN OKLAHOMA

The *Oil and Gas Journal* reports annually on costs of wells in certain active fields in the United States. The data, representative of average conditions, include the cost of a well drilled to a certain pay and depth, normal rig-time distribution, casing and mud programs, core data and average drilling depths to oil or gas pays. The report for 1959 (vol. 57, no. 42, October 12, p. 148-153) gives information for 13 field areas in Oklahoma. The approximate cost of a well to a given pay and depth in each of the areas is listed below:

1. Camrick, Beaver County. Pay: Purdy sand, 7,500 feet. Dry hole (pipe set): $97,000.
2. Cherokee trend, Alfalfa County. Pay: basal Pennsylvanian sandstone, 5,200 feet. Flowing well: $46,500; dry hole: $24,000.
3. Knox Bromide, Grady County. Pay: second and third Bromide sands, 15,500 feet. Flowing well: $850,000; dry hole: $750,000.
4. Laverne area, Harper County. Pays: Hoover, Tonkawa, Morrow, Chester, 7,300 to 7,600 feet. Flowing well: $95,000.
5. Southeast Marietta, Love County. Pay: basal Oil Creek sand, 14,200 feet. Flowing well: $504,000; dry hole: $400,000.
6. Maysville, Garvin County. Pay: upper Bromide, 6,600 feet. Flowing well: $70,000; well on pump: $80,000; dry hole: $50,000.
7. Mocane area, Beaver County. Pays: Tonkawa, Morrow, Mississippian, 7,500 feet. Flowing well: $125,000; dry hole: $85,000.
8. Moore district, Cleveland County. Pay: Hunton, 8,025 feet. Flowing well: $80,000; well on pump: $90,000; dry hole: $50,000.
9. North Buffalo, Harper County. Pays: Lansing, Kansas City, Oswego, Arbuckle, 7,750 feet. Flowing well: $185,000; well on pump: $200,000; dry hole: $85,000.
10. North Carter, Beckham County. Pay: Desmoinesian rocks, 9,000 feet. Flowing well: $150,000; dry hole: $83,000.
11. Panhandle Gas, Texas County. Pay: Krider, 2,550 feet. Flowing well: $6,257.
12. Payne, McClain County. Pays: Hart, Gibson, Hunton, 6,876 to 7,995. Flowing well: $60,000 to $105,000.
13. Sho-vel-tum, Stephens County, Pay: Oil Creek-McLish, 8,100 feet. Flowing well: $125,000; well on pump: $131,000; dry hole: $75.000.

L. J.

BIBLIOGRAPHY OF NORTH AMERICA GEOLOGY, 1956

The United States Geological Survey has just issued its Bulletin 1078, a bibliography of published geologic papers for the year 1956. The book contains 554 pages and sells for $1.75, cash in advance to Superintendent of Documents, Washington 25, D. C.

Oklahoma items listed total 112, including abstracts. Of these, 24 are in the AAPG volume, "Petroleum Geology of Southern Oklahoma", five in Geophysical Case Histories, and 15 in the AAPG Bulletin. Oklahoma Geological Survey published 21, Tulsa Geological Society Digest nine, Oklahoma City Geological Society Shale Shaker 10, and Ardmore Geological Society seven (exclusive of the Southern Oklahoma symposium). Single papers were published by Geological Survey of America, The Compass of Sigma Gamma Epsilon, Seismological Society of America, Journal of Geology, Rocks and Minerals, American Mineralogist, American Museum of Natural History, Panhandle GeoNews, International Geological Congress, Mines Magazine, and Astronomical Society of the Pacific. Oddly enough the Federal Survey published nothing on the State.

Oklahoma Geological Survey listed 156 Oklahoma articles in Oklahoma Geology Notes, vol. 17, no. 4, April 1957. Articles in trade journals were more extensively covered and several general articles with mention of Oklahoma were given.

CREEK COUNTY BULLETIN AVAILABLE

Oklahoma Geological Survey Bulletin 81, Geology of Creek County, Oklahoma, by Malcolm C. Oakes with a section on petroleum geology by Louise Jordan is now available at the Survey office. The bulletin contains 134 pages of text with 20 figures showing relations of both surface and subsurface formations. A separate map box made of stiff cardboard contains: Plate 1, geologic map of the County printed in four colors on a black base; Plate II compiled outcrop sections; and Panel I which consists of four plates: Plate A, map of oil and gas fields; Plate B, structure map contoured on base of Woodford shale; Plate C, east-west elctric log stratigraphic section of Fort Scott and younger formations; and Plate D, northwest-southeast stratigraphic section of Arbuckle and younger rocks. Price of the bulletin bound in blue cloth, $3.50, paper $3.00.