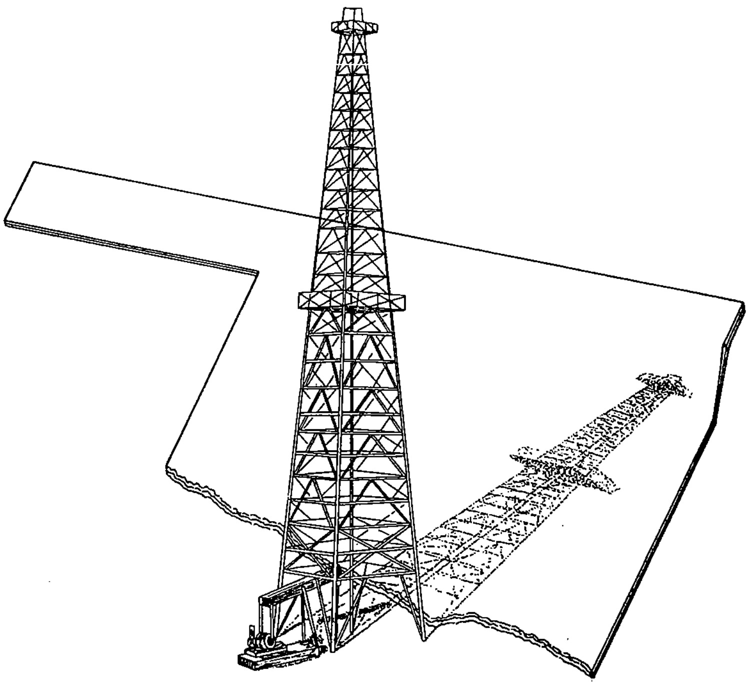
Oklahoma Geology Notes



OKLAHOMA GEOLOGICAL SURVEY
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OKLAHOMA MICROCRINOIDS

Microcrinoids are tiny crinoid calyces, many of them less than one millimeter high. Only one species had been made known from Oklahoma Mississippian rocks, an underscribed species of **Catillocrinus** noted by Laudon in the Pitkin limestone. Harrell L. Strimple of Bartlesville and John W. Koenig of Rolla, Missouri, have just described and illustrated 6 species from the St. Joe limestone near Tahlequah, and 5 species from the shale under the Welden limestone near Ada; one of the species occurring in both localities. Several forms are described from the Nunn member of the Lake Valley limestone, Otero County, New Mexico.

The Oklahoma species are:

Allagecrinus sculptus n. sp.: Nunn mem. of New Mexico, and St. Joe ls., N.E. Okla.

Kallimorphocrinus angulatus n. sp.: Nunn mem. of New Mexico, and St. Joe ls., N.E. Okla.

Kallimorphocrinus weldenensis n. sp.: "sub-Welden sh.," S. Okla.

Kallimorphocrinus tintinabulum n. sp.: "sub-Welden sh.", S. Okla.

Trophocrinus variabilis n. sp.: "sub-Welden sh.", S. Okla.

Trophocrinus biconis n. sp.: St. Joe ls., N.E. Okla.

Trophocrinus brevis n. sp.: St. Joe ls., N.E. Okla.

Lampadosocrinus minutus (Peck) n. gen., n. comb.: St. Joe ls., N.E. Okla.

Passalocrinus triangularis Peck: "pre-Welden sh.," S. Okla.; St. Joe ls., N.E. Okla., and Nunn mem., New Mexico.

The specimens are beautifully illustrated by camera lucida drawings. The paper is an excellent one.

Microcrinoidal taxonomy has been more than normally plagued by faulty word formation. Weller erected **Kallimorphocrinus** by transliterating the Greek kappa as k rather than as c. The present authors have given us **Lampadosocrinus** by using the entire Greek noun rather than the root. The correct form would have been Lampadocrinus.

This reviewer collected the sample from which the New Mexico forms were separated. The locality is a small area of bare weathered rock in a dry wash on the steeply dipping west slope of the Sacramento Mountains. The wash is low in the slope south of Marble Canyon very near the southwest corner of section 22, Township 16 S., Range 10 E., Otero County, New Mexico. The collection was made in 1946.

The article is "Mississippian microcrinoids from Oklahoma and New Mexico," Journal of Paleontology, vol. 30, no. 5, pp. 1225-1247, September 1956.

CCB

BROMINE IN BRINES OF THE RED FORK—EARLSBORO SANDS (PENNSYLVANIAN) IN THE SEMINOLE AREA OKLAHOMA

Neville M. Curtis, Jr.

Introduction

Since the end of World War II, sales of bromine and of bromine compounds have increased enormously in response to a greater market for gasoline using bromine antiknock compounds. Most automobiles are now powered by high-compression motors for which "ethyl" gasoline is recommended. Ethylene dibromide, the essential constituent of "ethyl" gasoline, is the principal form in which bromine compounds are sold. Total sales of ethylene dibromide, bromine, and other bromine compounds in 1955[1] were 216.7 million pounds valued at 39.8 million dollars, an increase since 1946 of more than 250 percent.

In the United States bromine is recovered from sea water, well brines, and lake brines, and in 1955 the operating companies were distributed as follows[1]:

> "The Ethyl-Dow Chemical Co. recovered bromine from sea water at Freeport, Texas, and Westvaco Chemical Division of Food Machinery and Chemical Corp. operated at a seawater plant in the San Francisco Bay area. The following firms recovered bromine from well brines in Michigan: The Dow Chemical Co., Midland and Ludington; Great Lakes Chemical Corp., Filer City; Michigan Chemical Corp., Eastlake and St. Louis; and Morton Salt Co., Manistee. The Westvaco Chemical Division at South Charleston, W. Va., also treated well brines. American Potash and Chemical Corp. recovered bromine from the brine of Searles Lake in California."

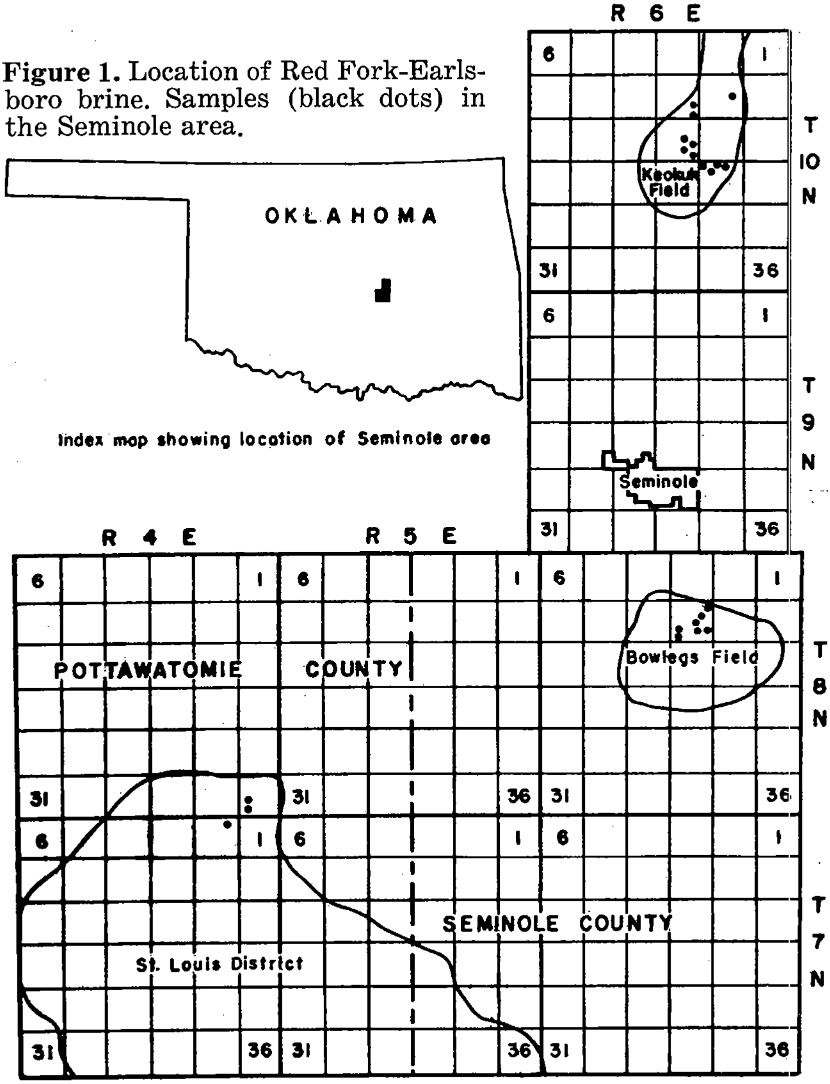
Present Investigation

A preliminary investigation of oil field brines from various formations in the Seminole area of east-central Oklahoma, conducted by the Oklahoma Geological Survey in 1953, revealed through chemical analyses that oil field brines from the Red Fork-Earlsboro sands have a relatively high content of bromine and might be a commercial source of that element. The Red Fork-Earlsboro sands are in the Des Moines series of Middle Pennsylvanian age and are well known oil-producing sands. In the area of present investigation they occur at an average depth of approximately 3,275 feet and have an average thickness of 62 feet. The brines in the sands are produced and wasted as a byproduct in the production of petroleum.

To test their possible economic value, brines from 21 Red Fork-Earlsboro wells were sampled in four producing oil districts of the Seminole area in Seminole and Pottawatomie Counties (Fig. 1 and Table I). Analyses of these brines show that bromine ranges from 540 to 1,020 ppm, an abnormally high concentration com-

[1] Stipp, H. E. and Marks, A. L., Bromine in 1955, U. S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys, Mineral Market Report MMS No. 2542 August 28, 1956.

Figure 1. Location of Red Fork-Earlsboro brine. Samples (black dots) in the Seminole area.



pared with normal oilfield brines, but probably not high enough for commercial bromine recovery. Brines from commercial bromine wells elsewhere generally contain at least 1,500 ppm.

Samples were collected in 1-gallon glass containers that first were washed clean with the sample water itself. These brine samples were taken either from the well "head" or from the separator that served wells producing only from the Red Fork-Earlsboro sands. Bromine was determined in the chemical laboratory of the Oklahoma Geological Survey by T. E. Hamm.

For assistance in collecting the samples and supplying other essential information, appreciation is gratefully extended to Fred-

Operator	Well	Field or District	Location	Depth in feet Red Fork-Earlsboro	(Br) ppm	Sample
Sinclair Oil Co.	W. Taylor #3	Bowlegs	SE NE NE Sec. 10-T.8N.-R.6E.	3207-3452	970	Well "head"
	R. Cumsey #4		NE SW NE Sec. 10-T.8N.-R.6E.	3002-3132	990	Well "head"
	R. Cumsey #5		SW SW NE Sec. 10-T.8N.-R.6E.	2970-3008	990	Well "head"
	M. Taylor #1		SW NW SE Sec. 10-T.8N.-R.6E.	2908-3030	980	Well "head"
	M. Taylor #2		SE NW SE Sec. 10-T.8N.-R.6E.	2955-3184	1,000	Well "head"
	J. N. Harber # 8		NE SW SW Sec. 10-T.8N.-R.6E.	3139-3302	540	Well "head"
	J. N. Harber #4		SE SW SW Sec. 10-T.8N.-R.6E.	2873-3054	990	Well "head"
Carter Oil Co.	M. Wilson #1	Keokuk	SE SE SE Sec. 10-T.10N.-R.6E.	3353-3387	650	Separator
	M. Wilson #2		SE NE SE Sec. 10-T.10N.-R.6E.	3348-3369	650	Separator
	R. Hully #1		E/2 NE SE Sec. 15-T.10N.-R.6E.	3367-3398	660	Separator
	R. Hully #2		E/2 SE SE Sec. 15-T.10N.-R.6E.	3394-3433	660	Separator
	R. Hully #3		NW NE SE Sec. 15-T.10N.-R.6E.	3363-3396	660	Separator
	R. Hully #4		NW SE SE Sec. 15-T.10N.-R.6E.	3408-3440	660	Separator
	J. Warrenburg #2		C E/2 NW SE Sec. 11-T.10N.-R.6E.	3366-3403	680	Well "head"
	F. Black #1		E/2 NW NW Sec. 23-T.10N.-R.6E.	3395-3422	740	Separator
	F. Black #3		NW NW NW Sec. 23-T.10N.-R.6E.	3405-3420	740	Separator
	McDonald #2		NW NE NW Sec. 23-T.10N.-R.6E.	3381-3401	670	Separator
	McDonald #3		NE NE NW Sec. 23-T.10N.-R.6E.	3370-3392	670	Separator
Shenandoah Drilling Corp.	Martin #1	St. Louis	SE NE SW Sec. 36-T. 8N.-R.4E.	3483-3512	710	Separator
	Martin #2		SW NE SW Sec. 36-T. 8N.-R.4E.	3512-3548	710	Separator
Sinclair Oil Co.	Lee Kelley #2-A		NW NW NE Sec. 2-T. 7N.-R.4E.	3466-3567	1,020	Well "head"

erick Smith and John Eibeck, Sinclair Oil Co.; Deane Gill and L. E. Chase, Ambassador Oil Corp.; L. N. Smith, General American Oil Co.; W. M. Decker, Cities Service Oil Co.; J. A. Kelly, J. B. Campbell, and Bill Van Meter, Carter Oil Co.; and Walter E. Bailey, Shenandoah Drilling Corp.

Red Fork-Earlsboro Brines

Brines from the Red Fork-Earlsboro sands are similar in most respects to brines from other sands of Pennsylvanian, Devonian, and Ordovician age in the Seminole area. Thirty analyses cited by Burwell[2] show that the total dissolved solids in most brines from the Pennsylvanian-Ordovician rocks in this area average about 160,000 ppm, ranging upward to 173,000 ppm and downward to about 135,000 ppm. The salts of all these brines consist essentially of sodium and calcium chlorides. Analyses of a typical Red Fork-Earlsboro brine from the Seminole area, in parts per million, is as follows:

Specific gravity: 1.115	Sodium (Na, K): 47,126
Total solids: 161,179	Bicarbonate (HCO_3): 104
Calcium (Ca): 11,520	Sulfate (SO_3): 10
Magnesium (Mg): 2,430	Chloride (Cl): 99,989

The critical point of distinction is that the Red Fork-Earlsboro brines have a higher bromine content than the other brines. The data in Table II show this comparison and demonstrate that Red Fork-Earlsboro brine has 2 to 3 times more bromine than Cromwell and Wilcox brines.

Table II. Bromine in Oilfield Brines in the Seminole Area

Pennsylvanian		Ordovician
Red Fork-Earlsboro sands	Cromwell sand	Wilcox sand
540-1,020 ppm	200-400 ppm	200-300 ppm

Referring to the analyses in Table I, it is apparent that bromine has unequal concentration within the Red Fork-Earlsboro sands, the concentration differing variously with geographic location, depth, and thickness of the producing sand. These relations are summarized in Figure 2.

The highest bromine content is in the Bowlegs field, where 7 analyses show an average of 923 ppm, whereas in the nearby Keokuk field the average of 11 samples is 680 ppm. Strangely, one of the samples in the Bowlegs field was the lowest of all analyzed. The highest concentration of all the analyzed samples is 1,020 ppm, found in the St. Louis district in the Sinclair Lee Kelley 2-A. This sample also is one of the deepest tested, yet two other brines from greater depth in the same district had only intermediate concentrations.

Because none of the brines tested is a commercial source of bromine, and also because there is neither a significant geographic trend nor any apparent relation of bromine concentration to depth

[2] Burwell, A. L., The possibility of magnesia from Oklahoma oil field brines, Oklahoma Geological Survey, Mineral Report No. 14, September, 1942.

or thickness of the Red Fork-Earlsboro brines, it is concluded that there is no basis for further bromine investigations in the Seminole area.

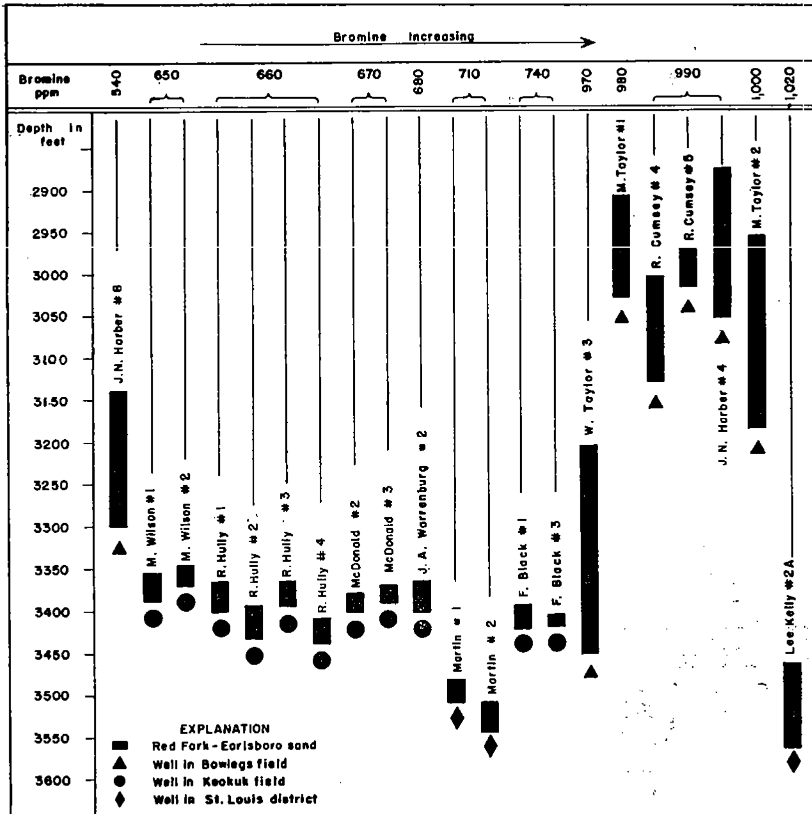


Figure 2. Relation of bromine in Red Fork-Earlsboro brine to depth and thickness of the sand.

First Paleotectonic Maps Released

The first unit of the paleotectonic map project has been issued by the U. S. Geological Survey as Miscellaneous Geologic Investigations, Map 1-175. The publication is a folio of 6 pages and 9 maps on a scale of 1-5,000,000 dealing with the Jurassic system. The maps show control points, paleogeology, lithofacies (4 maps), paleogeography, and environments. Oklahoma barely enters into the picture with its panhandle area and with a theoretical sea invasion in the extreme southeast corner. The folio is available for $5.00. It is more than worth the price.

New Quarries Supplying Northeast Turnpike Needs
Edward C. Stoever, Jr.

Quarries supplying crushed rock used in the construction of the Northeast Turnpike were located and examined on October 5th and 6th, 1956. There are, in all, eighteen quarries along the route of the turnpike, and seventeen of these are newly opened. The locations and a brief description of each, are given in the accompanying chart.

It is now possible to drive along the right-of-way for the entire length of the turnpike. All cutting and filling has been completed, and all bridges and road crossings are open, although work continues on overpasses and interchanges. Driving southwest from the northeast end of the eighty-eight mile long turnpike, one sees the road-bed in all stages of completion, with, in general, a higher degree of completion toward the southwestern end.

Going southwestward along the turnpike, rocks of successively younger age are encountered, and this is reflected in the crushed rock used for construction. Mine chat, and stream gravels consisting principally of rounded chert pebbles from the Boone formation are used between the northeast end of the turnpike and Miami. Between Miami and a point on the turnpike six and one-half miles northeast of the Claremore interchange there are three quarries in the Osagean Boone formation and eight quarries in Hindsville formation of Chester age. The remainder of the southern end of the turnpike is supplied by two quarries in the Fort Scott limestone and two quarries in the Oologah formation. Both of these formations are of Des Moines age.

Quarrying is usually done on a six or a twelve foot face, although these figures are sometimes exceeded. Deeper quarrying necessitates two or more benches. Overburden is usually less than six feet. An exception to this is a quarry near Tulsa which was operating before construction began on the turnpike. In this operation, five feet of soil and six feet of weathered limestone are stripped from above a 35 foot quarry face.

Quarried rock is crushed right at the quarry site, utilizing portable crushing equipment. A coarse material suitable for subbase is produced, and also a mixture of coarse and fine material for the aggregate layer. Oversize material, too large to fit into the crusher, is generally pushed to one side and abandoned.

These quarries afford excellent exposures of limestones not otherwise as well-exposed. They will be useful in evaluating the limestone resources of northeastern Oklahoma, and also in studying the stratigraphy of the area. Of particular interest will be the quarries in the Hindsville formation, as there has been some confusion regarding the use of this name. "Hindsville," as used here-in, follows the usage established by Huffman (1953) and Slocum (1955), and reflects the current opinion of the Oklahoma Geological Survey.

Quarries Supplying Crushed Rock For Northeast Turnpike

Location	Formation	Tonnage	Ht. of Face	O.B.	Remarks
Sec.19, T.29N., R.25E.	Stream gravel				
Sec. 5, T.28N., R.24E.	Stream gravel				
Sec.20, T.28N., R.24E.	Stream gravel		8		
SE¼, Sec. 5, T.27N., R.23E.	Hindsville Ls.	100,000T	12	0-5	No longer worked.
NW¼, Sec.31, T.27N., R.23E.	Hindsville Ls.	100,000T	12-14	5	No longer worked.
SW¼, Sec.24, T.26N., R.22E.	Hindsville Ls.	1000T/day	24	6	Boone chert forms quarry floor.
S½, Sec.12, T.25N., R.22E.	Boone chert (?)				Not visited.
NE¼, Sec. 4, T.25N., R.21E.	Hindsville Ls.	*130,000T	15	4	
NW¼, Sec.32, T.25N., R.21E.	Hindsville Ls.	* 38,000T	15-18	4	
NW¼, Sec. 8, T.24N., R.20E.	Keokuk		12½	2	Used for rip-rap only. No longer worked
NW¼, Sec.10, T.24N., R.20E.	Keokuk	70,000T	12	4-6	
SE¼, Sec.32, T.24N., R.20E.	Hindsville Ls.	29,000T	6-7	3-5	Some oil staining. No longer worked.
SE¼, Sec.24, T.23N., R.19E.	Hindsville Ls.	+100,000T	36	0-5	8½ feet heavily oil saturated limestone. No longer worked.
S½, Sec.30, T.23N., R.20E.	Hindsville Ls.	2500T/day	28	5	
W½, Sec.24, T.22N., R.15E.	Fort Scott Ls.	170,000T	22	1-5	No longer worked.
N½, Sec.33, T.21N., R.15E.	Fort Scott Ls.	50,000T	11½	5	Clay filled sink noted.
S½, Sec.16, T.20N., R.14E.	Oologah Ls.	5000T/day	35	11	In operation six years.
SE¼, Sec.16, T.20N., R.14E.	Oologah Ls.				Not visited.

*Estimated Final Total Production

Bibliography of Recent Published Material Pertaining to Geology along the Northeast Turnpike

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Reed, E. W., Schoff, S. L., and Branson, C. C., 1955. Ground-water resources of Ottawa County, Oklahoma. Oklahoma Geological Survey, Bulletin No. 72.

Slocum, R. C., 1955. Post-Boone outliers of northeastern Oklahoma. Oklahoma Geological Survey, Circular No. 35.

ADDITIONAL FOSSILS FROM THE HUNTON GROUP, OKLAHOMA

Thomas W. Amsden

In June 1956 the writer's catalog of Hunton fossils was published by the Oklahoma Geological Survey. Five additional names have subsequently been found and should be added to this list.

HARAGAN FORMATION

TRILOBITA

DICRANURUS HAMATUS (Hall) 1859. (Whittington 1956, pp. 518-519, pl. 60, figs. 9-11, 15). Whittington's illustrated specimens are from the Haragan formation, Arbuckle Mountain region, Oklahoma; repository, U. S. National Museum, and Museum of Comparative Zoology, Harvard University.

MIRASPIS sp. indet. (Whittington 1956, p. 515, pl. 60, figs. 1, 4). White Mound, sec. 20, T. 2 S., R. 3 E., Murray County, Okla.; U. S. National Museum.

LEONASPIS WILLIAMSI Whittington 1956 (pp. 509, 510, pl. 57, figs. 10-16; pl. 58, figs. 1-4, 6, 7). Arbuckle Mountain region, Oklahoma; holotype, White Mound, sec. 20, T. 2 S., R. 3 E., Murray County, Okla.; holotype, U. S. National Museum; figured specimens, Museum of Comparative Zoology, Harvard University.

HENRYHOUSE FORMATION

CEPHALOPODA

LEUROTROCHOCERAS STEVENSI Miller and Collinson 1952 (pp. 622-623, pl. 84, figs. 1, 2). Holotype, NE¼, SW¼, sec. 4, T. 2 N., R. 6 E., Pontotoc County, Oklahoma; State University of Iowa, 9813.

CHIMNEYHILL LIMESTONE?

CLIFTONIA (CLIFTONIA) BELLULA Ulrich and Cooper 1936 (p. 337, pl. 48, figs. 14-16, 19). The holotype came from a "Boulder in the Johns Valley shale, thought to have come from the Chimney Hill limestone, of Early Silurian (Medinan) age; Johns Valley, Oklahoma." U. S. National Museum, 91881.

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Amsden, T. W., 1956. Catalog of fossils from the Hunton group, Oklahoma: Okla. Geol. Survey, Circular 38, pp. 1-63.

Miller, A. K., and Collinson, C., 1952. A trochoceratoid nautiloid from the Henryhouse shale (Silurian) of Oklahoma: Jour. Paleontology, vol. 26, pp. 622-623, 1 pl.

Ulrich, E. O., and Cooper, G. A., 1936. New Silurian brachiopods of the family Triplesiidae: Jour. Paleontology, vol. 10, pp. 331-347, 3 pls., 1 text fig.

Whittington, H. B., 1956. Type and other species of Odontopleuridae (Trilobita): Jour. Paleontology, vol. 30, pp. 504-520, 4 pls., 4 text figs.

OIL SEEPAGES NEAR ADAIR, OKLAHOMA

Edward C. Stoever, Jr.

During the examination of new quarries supplying crushed rock to the Northeast Turnpike, an occurrence of petroleum-bearing limestone was noted in a large quarry three miles northeast of Adair, Oklahoma. This quarry presents an unusually good exposure of the Hindsville limestone of Chester age. The face of the quarry is probably in excess of 35 feet, although the quarry was partly flooded at the time of investigation, and only the upper 24.5 feet were exposed. The section exposed is:

Soil and weathered limestone overburden	0 to 5 feet
Light gray and greenish gray interbedded flaggy fine-grained silty limestone and calcareous siltstone, all exhibiting cross-bedding	4 feet
Dark gray, coarse-grained, massive crinoidal limestone, heavily saturated with petroleum; some stylolites present	8.5 feet
Light gray, fine-grained, massive, silty limestone	12 feet exposed

The quarry face of 35 feet probably represents the whole of the Hindsville limestone, as its maximum thickness in this area, as reported in recent Master of Science theses of the University of Oklahoma, is 36 feet. Unfortunately, no information could be obtained as to the nature of the quarry floor. The upper 4 feet of the face, however, is typical of the transition zone between the Hindsville limestone and the overlying Fayetteville shale.

The petroleum is confined to the 8.5 foot coarse, crinoidal limestone, and no trace of petroleum was noted in adjacent beds. The rock is quite heavily saturated, particularly in the upper 2 to 3 feet, and five well-developed seeps have formed on the quarry walls. A sample from within the upper 3 feet of the oil-saturated zone was found to contain 2.84% hydrocarbon by weight.

Oil seeps and shows are not uncommon in northeastern Oklahoma, but the occurrence of a reservoir rock of this thickness and permeability below the Fayetteville should be of interest.

BLAINE COUNTY ADDED TO GAS AREA

Louise Jordan

Blaine County, in the northwestern part of the state, becomes the sixty-eighth county to produce petroleum products with the discovery of gas in the Chesterian rocks of the Mississippian system. This rank wildcat and discovery well (John W. Coyle, Jr. and Perkins Brothers No. 1 Dougherty, SW¼ SW¼ SW¼ sec. 10, T. 19 N., R. 11 W.), thirteen miles south of the Ringwood field, flowed 3,735,000 cubic feet of gas per day from a depth of 7,415 to 7,570 feet. In December, 1955, Johnston was added to the list of producing counties with a flow of gas from a depth of 1,134 feet in the Wapanucka formation of Morrowan age. Probably Dewey, Woodward and Roger Mills Counties will be the next areas added to the list, leaving Adair, Cherokee, Choctaw, Delaware, Harmon, and Pushmataha as unproductive.

1956 Field Trip of SEPM

The Permian Basin Section of the Society of Economic Paleontologists and Mineralogists was held May 11 and 12 in Parker County, Texas. The guide book of 78 pages was prepared by several geologists. Dr. Leo Hendricks was the leader and his map of southwestern Parker County prepared for the Texas Bureau of Economic Geology is issued in preliminary form in the packet. Dr. O. D. Weaver wrote a general chapter on the Fort Worth Basin, Dr. B. J. Scull presented his sedimentary analysis of the Meek Bend sandstone, which shows that deposition was by long-shore currents. Fusulinids of the Hill Creek beds are described by W. E. King. R. J. Cordell used his method of comparing peak occurrences of ostracode species for stratigraphic purposes. An ostracode occurrence chart of the Desmoinesian of the Ardmore Basin is his Fig. 2. The generalized structural map (by Mark Clement and R. C. Weart) is on the top of the Ellenburger and on top of the Arbuckle in Love, Carter, Jefferson, Cotton and Tillman Counties, Oklahoma.

Copies of the symposium are obtainable for $5.00 each from E. A. Vogler, Treasurer, Shell Oil Co., Midland, Texas.

The Axioms of Uranium Mining ([14])

1. Over the long pull, the biggest profits lie in a well planned, long term exploration program.
2. Regardless of quantity or quality of experience elsewhere, the record shows that it takes about two years for engineers, prospectors and geologists to become effective in uranium exploration.
3. Make sure that you learn both state and federal mining laws, and equally important, find out what is the prevailing local custom regarding the mining laws.
4. Think of mining in terms of pounds of uranium rather than necessarily in tons of ore, but don't get the idea that this eliminates large enterprises.
5. There is generally more profit in mining than in milling.

6. If you seriously intend to explore and mine uranium, you can get a lot of helpful information and save yourself time and money by talking with on-the-spot AEC officials first.
7. If you are going into the uranium business by buying uranium stocks, be careful.

THE BERENDS FAUNA OF BEAVER COUNTY

A review by David B. Kitts

The Berends fauna consists of organisms preserved in Pleistocene deposits above the Pearlette volcanic ash 4.5 miles north and one mile west of Gate, Beaver County, Oklahoma. In the past, molluscs (Taylor, 1954), fish (Smith, 1954), mammals (Rinker and Hibbard, 1952; Taylor, 1954; and Smith, 1954) and a bird (Mengel, 1952) have been recorded from the locality. A paper by Starrett (Pleistocene mammals of the Berends fauna of Oklahoma, Jour. Paleontology, Vol. 30, 1956, pp. 1187-1192) deals with recent additions to the mammalian fauna including a prairie vole, a pocket gopher, a pocket mouse, a meadow vole, a new species of muskrat, the common shrew, the shorttail shrew, a coyote, two species of beaver, a new species of deer mouse, a horse, a rabbit, and an elephant. From nearby deposits of apparently equivalent age, an incisor of a very large rodent was found. It has been tentatively referred to the Sciuridae, or squirrel family. Starrett's conclusion that these mammals lived during a cool moist period is consistent with the conclusions of other workers based upon analyses of the other faunal elements and on the pollen found in the deposits.

INDEX

OKLAHOMA GEOLOGY NOTES, Volume 16, 1956

Prepared by

Neville M. Curtis, Jr.