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OKLAHOMA GEOLOGY NOTES

Volume 31 August 1971 Number 4

Cover Picture

First Oklahoma Coal Shipped on New Waterway

This coal barge, shown loading at Carl Albert Port, 3 miles west of Keota, Haskell County, on the Robert S. Kerr Reservoir, was the first coal mined in Oklahoma to be shipped on the new Arkansas River Navigation System. The shipment, consisting of 2 barge loads totaling 2,600 tons, was bound for St. Louis for delivery to Great Lakes Carbon Company.

The coal cargo went out ahead of the planned first official shipment of manufactured products from Oklahoma, truck trailers, whose barge was damaged en route for the pickup and consequently delayed.

The coal was mined by Kerr-McGee Corporation from its underground Choctaw mine near Stigler, Haskell County, one of the deepest shaft mines in North America, operating at a depth of 1,400 feet in the Hartshorne coal.

Statistics of Oklahoma's Petroleum Industry, 1970

John F. Roberts[1]

Total drilling of wells related to the oil and gas industry decreased in all categories in 1970 (table 1, fig. 1). The decrease was due to diversion of funds to other areas involving large investments. Sixty-four counties were explored for new reservoirs, and 40 had successful completions (fig. 2), making a statewide success ratio for exploratory wells of 22 percent. Caddo County had the most exploratory tests (23), of which 5 were discoveries, followed closely by Woodward, Garvin, Jefferson, and Kingfisher Counties. Discoveries were in sandstone reservoirs of Pennsylvanian, Mississippian, and Ordovician ages and in carbonates of Mississippian and Silurian-Devonian units. Significant was the discovery of sizable reserves in Garvin County in the basal Oil Creek sand (Ordovician) at relatively shallow depths (5,900-6,000 feet). This is in an area surrounded by earlier unsuccessful exploratory attempts, except in younger units.

The 22 giant oil fields of Oklahoma are listed in table 2. (A giant field is one that has an estimated ultimate recovery of more than 100 million barrels of oil.) These giants produced approximately 45 percent of the yearly total of oil and accounted for about the same percent

[1]Geologist, Oklahoma Geological Survey

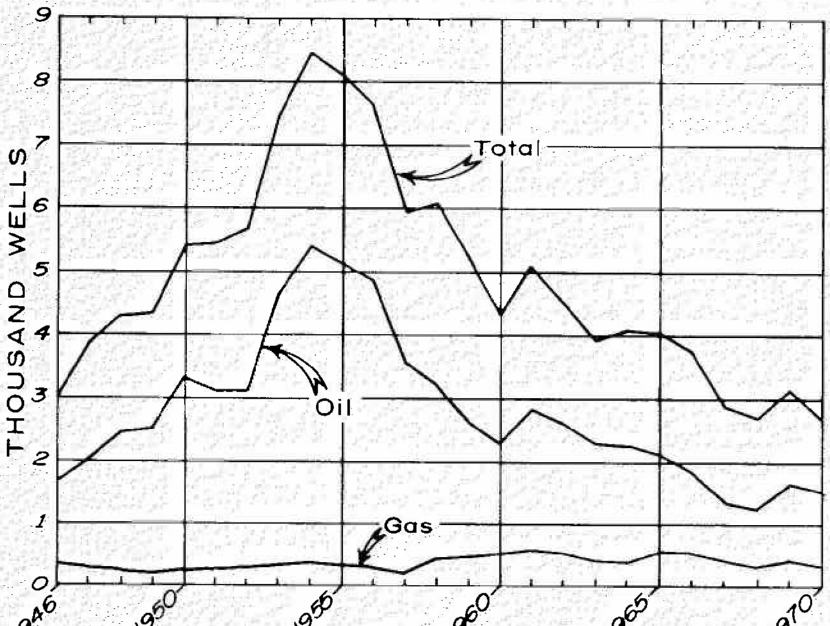

Figure 1. Graph showing total wells drilled, oil wells completed, and gas wells completed in Oklahoma, 1946-1970. Source: Oil and Gas Journal.

TABLE 1.—DRILLING ACTIVITY IN OKLAHOMA, 1970

	1970					1969
	CRUDE	GAS	DRY	SERVICE	TOTAL	TOTAL
All wells						
Number of completions	1,343	321	1,021	216	2,901	3,395
Footage					14,001,997[1]	16,696,892
Average footage					5,214	4,918
Exploration wells						
Number of completions	59	43	356		458	546
Percentage of completions	12.9	9.4	77.7		100	
Footage					2,776,607	3,243,121
Average footage					6,062	5,940
Development wells						
Number of completions	1,284	278	665	216	2,443	2,849
Percentage of completions[1]	57.7	12.4	29.9		100	
Footage					14,001,997[1]	12,904,613
Average footage					5,214	4,529

Source: **Oil and Gas Journal,** v. 69, no. 14, April 5, 1971.

[1]Excludes service wells and stratigraphic tests.

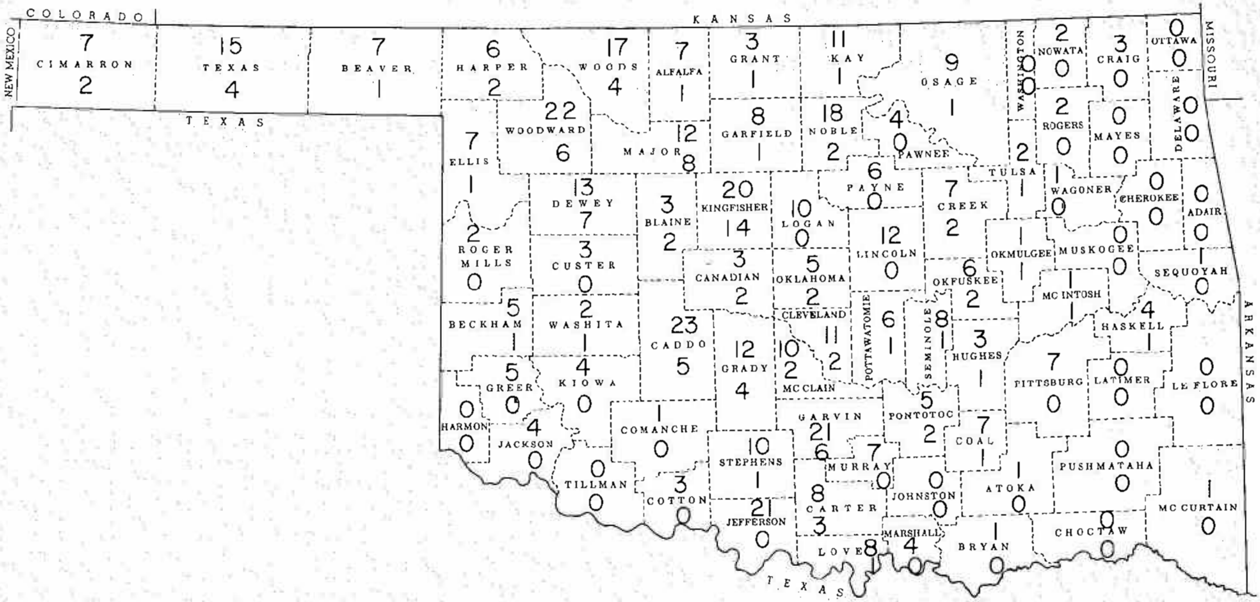

Figure 2. Exploratory drilling, by counties, during 1970. Upper figures give the number of exploratory wells drilled; lower figures give the number of successful completions. Source: American Association of Petroleum Geologists in cooperation with the U.S. Bureau of Mines.

of the estimated ultimate yield and remaining reserves. This production came from 40 percent of the total number of producing wells in the State.

Table 1 summarizes drilling activity during 1970. The average drilling depth of exploratory wells increased to 6,062 feet from 5,940 feet in 1969. Average depth of all wells drilled in the State increased to 5,214 feet from 4,529 feet in 1969. These increases in depths were due to continued exploration for and development of deeper reservoirs in the Anadarko basin of northwest Oklahoma.

Table 3 lists cumulative and yearly production and the value of all petroleum products to January 1, 1971.

Table 4 compares petroleum production of the past 2 years. Crude-oil production was slightly lower despite an increase of the proration factor to 150 percent during the year. This rate of production failed to meet market demands. Natural gas and natural-gas liquids had increases in production.

Figure 3 shows a decrease in natural-gas reserves from 17,593 trillion cubic feet in 1969 to 16,954 trillion cubic feet in 1970, owing to increased production in spite of slight increases in discoveries, extensions, and revisions.

Figure 4 displays a decrease in total liquid-hydrocarbon reserves from 1,856 billion barrels in 1969 to 1,710 billion barrels in 1970. Crude oil and natural-gas liquids shared in the decline.

TABLE 2.—GIANT OIL FIELDS OF OKLAHOMA, 1970

FIELD	1970 PRODUCTION (1000 BBLS)	CUMULATIVE PRODUCTION (1000 BBLS)	ESTIMATED RESERVES (1000 BBLS)	NUMBER OF WELLS
Allen	3,013	115,878	18,827	1,500
Avant	367	106,115	878	779
Bowlegs	1,976	151,614	8,615	180
Burbank	6,067	486,765	13,170	1,284
Cement	2,500	131,518	4,192	1,511
Cushing	4,757	449,619	17,650	1,830
Earlsboro	833	208,395	3,515	1,933
Edmond West	812	152,365	8,240	2,209
Elk City	111	59,321	40,800	253
Eola-Robberson	4,881	90,475	34,623	489
Fitts	1,240	142,987	6,066	663
Glenn Pool	2,714	300,934	19,437	1,093
Golden Trend	12,770	359,955	135,356	1,573
Healdton	4,070	269,301	11,314	2,092
Hewitt	4,256	195,698	11,747	1,441
Little River	477	158,646	1,985	172
Oklahoma City	1,799	726,409	32,603	351
Seminole Greater	1,391	194,339	12,442	175
Sho-Vel-Tum	23,425	864,586	36,537	7,990
Sooner Trend	17,624	135,539	112,376	2,740
St. Louis	1,567	211,234	3,974	613
Tonkawa	347	134,127	2,511	186
Total Oklahoma	96,997	5,645,820	536,858	31,057

Source: **Oil and Gas Journal,** v. 69, no. 4, January 25, 1971.

TABLE 3.—CUMULATIVE (THROUGH 1955) AND YEARLY (1956-1970) MARKETED PRODUCTION AND VALUE OF PETROLEUM, NATURAL GAS, NATURAL GASOLINE, AND LIQUEFIED PETROLEUM GAS IN OKLAHOMA[1]

YEAR	CRUDE PETROLEUM		NATURAL GAS		NATURAL GASOLINE AND CYCLE PRODUCTS		LIQUEFIED PETROLEUM GAS	
	VOLUME (1,000 BBLS)	VALUE ($1,000)	VOLUME (MMCF)	VALUE ($1,000)	VOLUME (1,000 GALS)	VALUE ($1,000)	VOLUME (1,000 GALS)	VALUE ($1,000)
Through 1955	7,230,010	11,443,269	12,977,332	1,378,370	14,420,482	890,729	3,673,364	120,097
1956	215,862	600,096	678,603	54,288	489,963	26,543	579,101	23,427
1957	214,661	650,423	719,794	59,743	460,644	25,329	587,140	21,824
1958	200,699	594,069	696,504	70,347	440,798	26,029	657,114	25,822
1959	198,090	578,423	811,508	81,151	448,353	29,443	675,869	27,070
1960	192,913	563,306	824,266	98,088	531,995	33,074	762,258	32,409
1961	193,081	561,866	892,697	108,016	521,237	33,358	817,082	30,141
1962	202,732	591,977	1,060,717	135,772	552,795	35,764	838,903	25,223
1963	201,962	587,709	1,233,883	160,405	555,467	35,131	810,894	28,981
1964	202,524	587,320	1,323,390	166,747	554,053	34,011	880,804	28,055
1965	203,441	587,944	1,320,995	182,297	570,129	34,561	894,665	32,208
1966	224,839	654,281	1,351,225	189,172	576,124	35,715	968,254	44,381
1967	230,749	676,095	1,412,952	202,052	568,905	35,846	1,005,633	49,276
1968	223,623	668,202	1,390,884	197,506	584,010	38,829	1,070,874	39,520
1969	224,729	701,155	1,523,715	223,128	614,082	38,931	1,146,768	34,403
1970[2]	224,500	711,665	1,597,061	252,650	629,580	40,773	1,186,080	45,466
Total	10,384,415	20,757,800	29,815,526	3,559,732	22,518,617	1,394,066	16,554,803	608,303

Figures from: **Minerals Yearbook** of the U.S. Bureau of Mines. Totals for crude petroleum differ from those compiled by the U.S. Bureau of Mines and the American Petroleum Institute principally because of the exclusion from USBM and API compilations of an estimated production of 26,355,000 barrels for the years 1905-1906.
Preliminary figures for 1970.

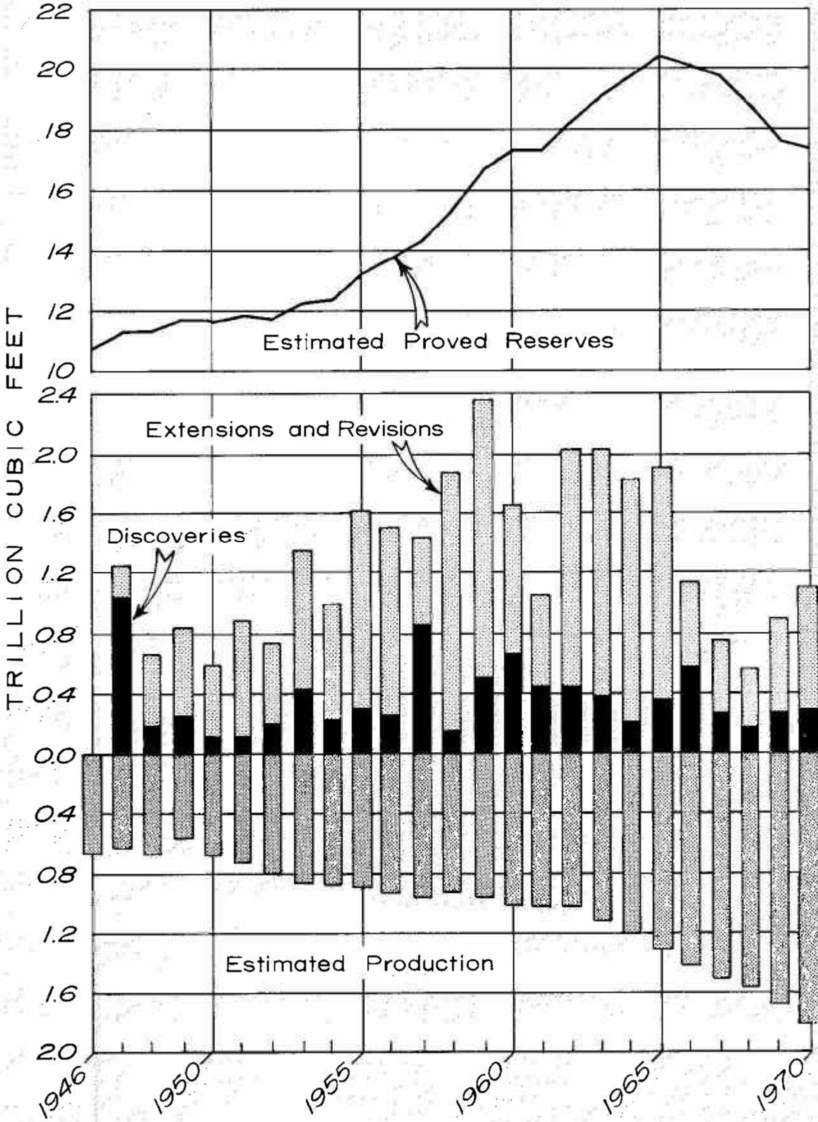

Figure 3. Graph showing statistics on estimated proved reserves of natural gas in Oklahoma, 1946-1970. Source: American Gas Association, annual reports.

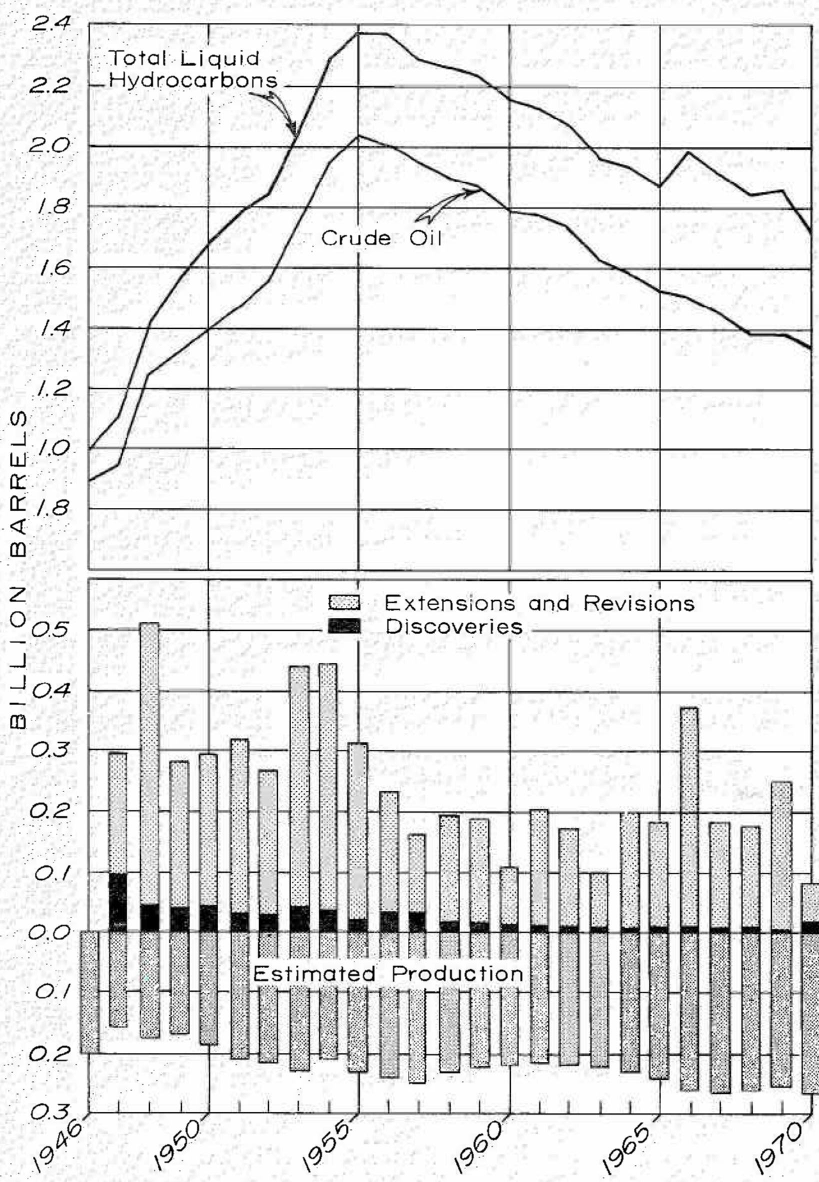

Figure 4. Graph showing statistics on estimated proved reserves of total liquid hydrocarbons in Oklahoma, 1946-1970. Source: American Petroleum Institute, annual reports.

TABLE 4.—HYDROCARBON PRODUCTION IN OKLAHOMA

	1969	1970
Crude oil and lease condensate		
Total annual production (1,000 bbls)[1]	224,729	224,500
Value ($1,000)[1]	701,155	711,665
Cumulative production 1891-year (1,000 bbls)	10,159,915	10,384,415
Daily production (bbls)	615,690	615,060
Total number of producing wells[2]	80,947	78,212
Daily average per well (bbls)	7.6	8.3
Oil wells on artificial lift (estimated)[2]	76,947	74,212
Natural gas		
Total annual marketed production (MMCF)[1]	1,523,715	1,579,061
Value ($1,000)[1]	233,128	252,650
Total number of gas and gas-condensate wells[2]	8,429	8,557
Natural-gas liquids		
Total annual marketed production (1,000 bbls)[1]	41,925	43,230
Value ($1,000)[1]	73,334	86,239

[1]Item for 1969 is U.S. Bureau of Mines final figure. Item for 1970 is U.S. Bureau of Mines preliminary figure.
[2]**World Oil,** annual forecast and review issue, v. 172, no. 3, February 15, 1971.

Stripper wells (those producing less than 10 barrels of oil per day) total 57,429, which constitute 74 percent of the State's total crude-oil producers. They account for approximately 39 percent of the total crude-oil production and are estimated to produce 51 percent of the remaining reserves. Daily average production from these wells was 4.15 barrels of oil.

Geologically interesting was the Viersen and Cochran 25-1 Wayerhaeuser in sec. 25, T. 5 S., R. 23 E., McCurtain County, 8 miles northwest of Broken Bow. The well was spudded in what is thought to be one of the oldest sedimentary units in the State, the Lukfata Sandstone. Projected depth was 4,000 feet, with basement rocks anticipated. At the actual total depth of 10,019 feet the well had penetrated only metasediments consisting mostly of slightly metamorphosed graywacke. Fresh water was encountered at about 1,200 feet, unusually deep for the area. At about 7,100 feet methane gas was found in an amount too small to measure. The well is capped awaiting further evaluation of the information obtained in the process of drilling.

Oklahoma continues to rank third in the nation in production and estimated reserves of natural gas and fourth in reserves and production of crude oil.

Lewis Manning Cline
1909-1971

Lewis Manning Cline died March 10, 1971, at age 61. To most Oklahoma geologists, especially to the staff of the Oklahoma Geological Survey, Lewis' sudden death was doubly shocking, coming as it did less than a year after the equally untimely passing of Bill Ham. The similarity of these two dedicated men is worthy of note. Both were excellent field geologists; they shared interest in stratigraphy and sedimentology; they contributed much to the knowledge of Oklahoma geology; and the principal theaters of their work complemented each other—Cline in the Ozarks and Ouachitas, Ham in the Arbuckles and Wichitas.

Lewis Cline had deep roots in Oklahoma. He was born in Duncan, September 25, 1909, the son of Edgar and Leila (Sims) Cline. He attended The University of Tulsa, receiving the B.S. degree in geology in 1931, and continued as a graduate assistant during the 1931-1932 term. He married a Tulsa girl, Grace Ellen Shaw.

Transferring to The University of Iowa, he received the M.S. degree in 1934 and the Ph.D. degree the following year. At Iowa he was a graduate assistant and instructor for the summer field course and was employed by the Iowa Geological Survey, 1935-1941, doing surface mapping and stratigraphic work.

With his brand-new Ph.D. in hand, Lewis went to Texas A&M College as an instructor in the fall of 1935, but the next year he returned to Iowa as an instructor at Iowa State College, where he stayed until 1942.

Temporarily abandoning the academic field, he worked for Standard Oil Company of Texas from June 1942 until September 1945, when he joined the faculty of The University of Wisconsin and, except for a year's leave (1952-1953) as distinguished professor at Texas Technological College, remained there until his death.

During his quarter of a century at Wisconsin, Lewis was active in university affairs and was a stalwart of the geology faculty; he served as departmental chairman, 1960-1965. Many generations of students profited from his broad knowledge, deep insight, keen mind, and inspiring leadership. Theses and dissertations suggested and supervised by him have contributed substantially to geological knowledge, especially to that of Oklahoma.

As stated, Cline received his advanced training at The University of Iowa. The state of Iowa, according to a statement made many years ago by A. C. Trowbridge, former state geologist and chairman of the Geology Department at the university, ranks low in mineral production, but very high in the production of eminent geologists. To a considerable degree, he added, this has been to the benefit of other states. Lewis Cline was one of these, and though Iowa was not completely neglected (as attested by six articles published during 1939-1949), Oklahoma —his native state—has been an important beneficiary.

In reviewing Lewis' scientific life, inevitably one returns, as he did, to Oklahoma. His Master's thesis, "Osage Formations of the Southern Ozarks (Northeastern Oklahoma)," and his doctoral dissertation, "Osage Blastoids, Part I, the Genera *Schizoblastus* and *Cryptoblastus*," indicate his early interest in Oklahoma and in stratigraphy and paleontology. His later work reflects a shift to sedimentology and paleoecology. But above all, his abiding love as a geologist, even in his last years, was field work—a new mountain to climb, a new valley to cross. And the Ouachita Mountains of Oklahoma, with their difficult terrain and equally difficult geology, offered an irresistible challenge to body and mind.

Oklahoma Geology Notes is an appropriate place to acknowledge the debt owed to Lewis Cline for his contributions, direct and indirect, to our knowledge of the stratigraphy of the late Paleozoic rocks of the Ouachita Mountains.

The Ouachita Mountains, containing the most rugged terrain in Oklahoma, enter the State from Arkansas and extend 100 miles westward to the town of Atoka. They were once described by the late John Fitts as "Arkansas Lapland"—that part of Arkansas that laps over into Oklahoma. The geology offers many complexities of stratigraphy and structure.

Joseph A. Taff had covered the Oklahoma area in reconnaissance around the turn of the century. Border areas, where the older formations crop out, had been mapped in considerable detail (Taff, 1899, 1901, 1902; Wallis, 1915; Honess, 1923, 1924; Hendricks and others, 1947), but the geology of the interior belt was still imperfectly understood. In this belt are exposed more than 20,000 feet of rocks of Mississippian and Early Pennsylvanian age, which Taff divided into only two formations—Stanley Shale and Jackfork Sandstone, in upward succession.

Obviously, this central belt needed attention. Harlton (1938) studied the western third of this interior belt and was able to subdivide the Stanley and Jackfork and also to split off several younger units from the Jackfork.

In 1953, the late C. W. Tomlinson, active supporter of research in the Ouachita Mountains and alumnus of The University of Wisconsin, offered a challenge to Lewis Cline, with the ultimate result that Cline and his students detailed much of the remaining two-thirds of the central belt; and the study of the Ouachita Mountains, though not complete, is well advanced.

Fruits of this ambitious program had already appeared in more than a dozen publications at the time of Cline's death, and no doubt there are more to come. Not only have we been given the basic facts of mapping and stratigraphic details, but also the interpretations of sedimentation, paleoecology, provenance of sediments, direction of paleocurrents, and similar information that permit a reconstruction of the heretofore mysterious history of the Ouachita Mountains and their rocks.

To Lewis Cline, because of his own work and the guidance, encouragement, and inspiration that he gave to others, belongs much of the credit.

Impressive as they are, Lewis Cline's contributions to geology were not limited to field work and teaching. Several organizations felt the impact of his enthusiasm for their causes.

He served the Society of Economic Paleontologists and Mineralogists as president, 1965-1966, as editor of the *Journal of Sedimentary Petrology*, 1961-1965, and on several important committees.

He was a member of the council of The Geological Society of America, was its representative on the American Stratigraphic Commission, served on the Publications Committee, and was program chairman for the annual meeting in Milwaukee in November 1970.

For The American Association of Petroleum Geologists, he served on the Research Committee, the Matson Award Committee, was district representative, and was chairman, 1967-1969, of the Academic Advisory Committee.

The American Geological Institute profited from his service on the Geostudy Curriculum Survey, Professional Development Panel, and Publications Committee.

Other scientific-organization memberships included The Paleontological Society, Sigma Xi (president of the Wisconsin Chapter, 1965-1966), Gamma Alpha, and the 1968 International Geological Congress in Prague, Czechoslovakia. He is listed in *Who's Who in America* and *American Men of Science*.

He was visiting scientist for the American Geological Institute, 1960-1961, and distinguished lecturer for The American Association of Petroleum Geologists in 1965.

During his student days in Tulsa, Lewis met Grace Shaw of Tulsa, and they were married in San Antonio, Texas, in 1935. Three children—Ellen, Catherine, and Charles—were born of the union. He is survived by the widow, his three children, three grandchildren, and a sister.

Interested as he was in geology, Lewis Cline was not a one-sided person, for he was devoted to his family and was a friend and counselor to his students and colleagues. He was a member of the Monona Methodist Church and a past vice-president of the Madison Rotary Club. He was interested in political affairs, and the collapse that led to his death occurred while he was giving a speech before the Dane County Republican Party's Resolution Committee.

The fatal collapse had been preceded by several heart attacks during recent years, because of which his family and friends urged him to slow down. But his driving spirit dictated otherwise. It may well be said that he "died in the harness," and he no doubt preferred it that way.

—*Robert H. Dott*

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by Lewis M. Cline and Students

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Ethelocrinids from the Vicinity of Bartlesville, Oklahoma

Harrell L. Strimple[1]

The following species had been previously ascribed to the genus *Ethelocrinus* Kirk from the Wann Formation, Ochelata Group, Missourian Stage, exposed in the hill called the Mound on Mound Road on the west edge of Bartlesville, Oklahoma (SE¼ sec. 3, T. 26 N., R. 12 E., Osage County): *E. plattsburgensis* Strimple, 1938, *E. expansus* Strimple, 1938, and *E. convexus* Strimple, 1939.

E. plattsburgensis has been referred to *Parethelocrinus* by Strimple (1961, p. 82). A young topotype crown (SUI 34605) of the species is figured herein (fig. 1, *D, E*) to illustrate for the first time the 16 biserial arms branching on primibrach *1* in all rays and secundibrach *1* in some rays and having almost flattened exteriors. A mature, undistorted cup (SUI 34604) is illustrated (fig. 1, *A-C*) to demonstrate the weakly planoconcave nature of the base and the broad subhorizontal infrabasal disc. The base of the holotype was slightly disturbed, and the nature of the infrabasal circlet somewhat conjectural. A fine granulation marks the surface of the topotypes.

E. expansus has been referred to *Aglaocrinus* by Strimple (1961, p. 86); however, a topotype (SUI 34603) shows more affinity with *Ethelocrinus* than with *Aglaocrinus*. As shown by figure 1 (*F, G*), the surface of the specimen has a pronounced granular surface as well as large pustules. The dorsal cup is lower, the lateral sides more curved, and the basal concavity smaller and more pronounced than in *Parethelocrinus plattsburgensis*.

Ethelocrinus convexus has been transferred to *Ulocrinus* by Wright and Strimple (1945, p. 222) and was discussed in detail by Strimple and Watkins (1969, p. 166).

The large topotype of *Parethelocrinus plattsburgensis* (fig. 1, *A-C*) has a maximum cup width of 29.6 mm and a height of 12.2 mm. The ratio of infrabasal-circlet width to cup width is 0.28. A comparable ratio for the holotype of *P. ellipticus* Strimple, 1961, type of the genus, is 0.25. The impressed sutures of *P. plattsburgensis* indicate possible relationship with *Aglaocrinus*, and the proportionately wide infrabasals support the possibility. *A. magnus* (Strimple, 1949), from the Holdenville Formation (Desmoinesian), has a ratio of infrabasals to maximum cup width of 0.32.

Evolution among these forms is thought to have been from wide infrabasal circlets to narrow circlets. The crown of the small topotype of *P. plattsburgensis* has an overall length of 31.0 mm. Rays bearing four arms are *C, D,* and *A* rays.

References Cited

Strimple, H. L., 1938, A group of crinoids from the Pennsylvanian of northeastern Oklahoma: Bartlesville, Oklahoma, Private pub., 13 p., 2 pls.

[1]Research associate and curator, Department of Geology, The University of Iowa, Iowa City.

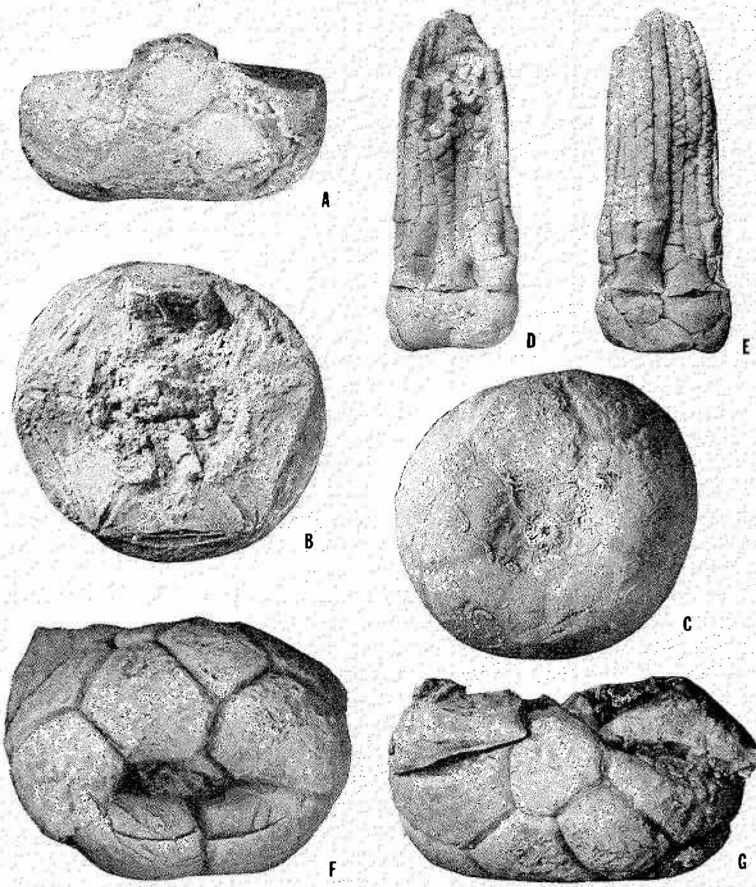

Figure 1. Ethelocrinids from the Wann Formation, Ochelata Group, Missourian. **A-C, Parethelocrinus plattsburgensis** (Strimple); mature topotype, dorsal cup (SUI 34604) viewed from **C-D** interray, summit, and base. **D, E, P. plattsburgensis;** young topotype, crown (SUI 34605) viewed from **E** ray and **B-C** interray. **F, G, Aglaocrinus expansus** (Strimple); mature topotype, dorsal cup (SUI 34603) viewed obliquely from below and from **C-D** interray. ×1.5.

——— 1961, Late Desmoinesian crinoid faunule from Oklahoma: Oklahoma Geol. Survey Bull. 93, 189 p., 19 pls.

Strimple, H. L., and **Watkins, W. T.,** 1969, Carboniferous crinoids of Texas with stratigraphic implications: Palaeontographica Americana, v. 6, 275 p., 56 pls.

Wright, James, and **Strimple, H. L.,** 1945, **Mooreocrinus** and **Ureocrinus** gen. nov., with notes on the family Cromyocrinidae: Geol. Mag., v. 82, p. 221-229, pl. 9.

Coal Geology, Chemistry, Library Science Specialties of Three New Staff Members

Two new professional positions, those of coal geologist and analytical chemist, have been created in the Oklahoma Geological Survey to fill growing research and industrial demands in the State. In addition to these new staff members, the Geology and Geophysics Library will have a new librarian in August, replacing Lucy Finnerty, who is retiring.

The new coal geologist is Samuel A. Friedman, a graduate of Brooklyn College of the City University of New York and The Ohio State University in Columbus. He comes to us from the U.S. Bureau of Mines Mineral Resources office in Knoxville, Tennessee, where he handled coal-reserve estimates and evaluation. Prior to his work with the Bureau, he was a geologist in the coal section of the Indiana Geological Survey. There he did field mapping of coal outcrops and subsurface coal reserves, compiled thickness and distribution data, and did liaison work with coal companies in the state. He has edited as well as published many technical reports and maps on coal resources in Indiana and the Appalachian region. Initially, his duties as coal geologist are concerned with formulating and directing a comprehensive coal-reserve study of Oklahoma, including supervision of a field staff and drilling programs.

David A. Foster is the new analytical chemist, and his efforts will provide a long-needed service to the professional staff of the Survey. Born in Joplin, Missouri, he received his B.S. in chemistry from The University of Oklahoma. His experience has included work as a chemist with the Brevard County Health Department in Rockledge, Florida, and as an associate scientist with Marathon Oil Company in Littleton, Colorado. As an analytical chemist with the Survey, he will conduct analyses of silicates and other minerals and rocks. His work will also provide necessary support to the new coal program.

Katherine Keener, the new librarian, is originally from Oklahoma, and she received both her B.A. in geology and her M.L.S. from The University of Oklahoma. She has been a librarian at the NASA-MSC Lunar Receiving Laboratory and the Lunar Science Institute, both in Houston, Texas. From June 1966 to June 1967 she was a library assistant at the OU Geology and Geophysics Library, during which time she also worked on her library science degree. She will supervise the library staff and programs while maintaining the degree of excellence for which the library is known.

Name for New Reservoir Adopted

The U.S. Board of Geographic Names has adopted the name Newt Graham Lake for a new reservoir formed by damming the Verdigris River 6.7 miles south-southwest of Inola. The reservoir was named by Congressional action under Public Law 91-585 on December 24, 1970, for Newt Graham (1883-1957), long known as the "lone voice" advocating the Arkansas River projects. Newt Graham Lake is in Wagoner County, 36°03'25" N., 95°32'10" W.

Rising Need for Environmental Studies Seen

With the growing interest in environmental studies has come the increased need for specialized evaluation of the effects and implications of alteration of our natural environment by man-made projects. Thus Oklahoma Geological Survey personnel are being asked more and more by various agencies for recommendations on the environmental impact of proposed local or regional development. Such environmental-impact studies have expanded the work load as well as the capabilities of the Survey staff. A list set up by the U.S. Geological Survey in its environmental-impact evaluation guide showing existing conditions that may be affected by development is being used in these studies.

Cooperative programs have developed from some requests and include such studies as investigation of ground-water supplies in the Arbuckle Limestone near Lawton (with the U.S. Geological Survey) and salt-water pollution in Oklahoma and adjacent states (with the U.S. Army Corps of Engineers). Environmental-impact studies have been requested by the Oklahoma State Highway Department Planning Division on proposed new and relocated roads, and land-use studies have been requested by the Oklahoma City Planning Department and the Association of Central Oklahoma Governments. Hydrologic reports have been sought on water and sewage systems in the State by the recently established Division of Community Affairs and on the suitability of selected dam-construction sites by the U.S. Bureau of Reclamation.

Two members of the Survey are presently handling most of the environmental-geology requests—Robert O. Fay and Kenneth S. Johnson. In order to have access to background material for use in their investigations, Dr. Fay has been compiling an environmental-geology library of pamphlets, books, and newspaper and magazine articles. This material includes information on such things as water resources and pollution, conservation, remote sensing, engineering, planning, and mining and materials. Not only does this library provide needed source information for Survey geologists, it is also helpful to students of Dr. John Wickham's new environmental-geology course for The University of Oklahoma School of Geology and Geophysics.

As the scope of Survey activities becomes widened by increased demands for research in environmental geology, new study proposals and programs are being developed. Many established projects, such as the 2-year coal-geology study begun in July and the proposed joint remote-sensing investigation with NASA using space-acquired imagery in the region encompassing the Arkansas River Navigation System, are expected to supplement research into environmental problems in Oklahoma.

Tulsa Quadrangle Hydrologic Atlas Available

Urbanization, economic growth, and improved standards of living in rural areas of Oklahoma require ever-increasing amounts of water, and basic information on the availability and usability of water is needed in many parts of the State by planners and individual water users for development of this vital resource. As temperatures soar in the State, the realization that water is one of our most priceless commodities becomes more apparent to every Oklahoman.

To help meet the demand for increased information on water resources available in the State, the Oklahoma Geological Survey in cooperation with the U.S. Geological Survey is working on a series of nine hydrologic atlases covering all of Oklahoma except the Panhandle. *Reconnaissance of the Water Resources of the Tulsa Quadrangle, Northeastern Oklahoma,* by Melvin V. Marcher and Roy H. Bingham, has just been released as Hydrologic Atlas 2. The 1:250,000-scale atlas contains four sheets showing a geologic map of the area, a water-availability map, a water-quality map, and precipitation and surface-water maps. HA-2 is available from the Oklahoma Geological Survey for $3.00.

The Tulsa quadrangle includes about 5,600 square miles in northeastern Oklahoma and contains one of the major urbanized areas in the State. Surface water is the major source of water used in the area, and the total amount used in 1968 is estimated at 25.4 billion gallons. Approximately 86 percent of this amount was taken from the lakes and rivers, and the remaining 14 percent was provided by ground-water development. Municipal and industrial use accounted for about 24 billion gallons; rural domestic use accounted for the remaining 1.4 billion gallons.

The Tulsa quadrangle was selected for appraisal because of the need for information on distribution, hydrologic characteristics, surface-water resources, and chemical quality of both ground and surface waters. This is the second quadrangle in the State to receive such appraisal, the first being the Fort Smith quadrangle, published as HA-1. The next hydrologic atlas to be published is the Ardmore-Sherman quadrangles.

Trilobites in Murray County, Oklahoma Subject of New Bulletin

Trilobites in the western Arbuckle Mountains, Murray County, Oklahoma, are the subject of a publication just released by the Oklahoma Geological Survey. In *Late Cambrian and Earliest Ordovician Trilobites, Timbered Hills and Lower Arbuckle Groups, Western Arbuckle Mountains, Murray County, Oklahoma,* James H. Stitt has listed 99 species and 67 genera, including 2 new genera and new species of *Bynumina, Missisquoia, Morosa, Plethometopus, Plethopeltis,* and

Sulcocephalus. The trilobites studied are similar to those of equivalent zones in central Texas.

Issued as Oklahoma Geological Survey Bulletin 110, this 82-page report contains 12 plates, including 4 charts listing stratigraphic occurrences and ranges of identified trilobites, and sells for $4.50 softbound and $5.50 hardbound.

The purpose of this study was "to collect and describe the Late Cambrian and earliest Ordovician trilobites in the western Arbuckle Mountains, Murray County, Oklahoma, to chart the stratigraphic distribution of identified species, and to attempt to erect a biostratigraphic zonation." Formations from which samples were taken included the Fort Sill Limestone, Royer Dolomite, Signal Mountain Limestone, Butterly Dolomite, and basal McKenzie Hill Limestone (in ascending order). The collected specimens constitute the faunas of the *Elvinia, Taenicephalus, Saratogia, Saukia, Missisquoia,* and *Symphysurina* Zones.

The *Elvinia-Missisquoia* assemblage defines the Ptychaspid Biomere, which has also been recognized in central Texas, and has been discussed in Susan A. Longacre's *Trilobites of the Upper Cambrian Ptychaspid Biomere, Wilberns Formation, Central Texas,* Paleontological Society Memoir 4 (Jour. Paleontology, v. 44, no. 1, supp., 1970).

James H. Stitt received his Ph.D. degree from The University of Texas at Austin and is now assistant professor in the Department of Geology, University of Missouri at Columbia.

AAPG Mid-Continent Section to Meet in Oklahoma City

The Mid-Continent Section of The American Association of Petroleum Geologists will hold its next biennial meeting in Oklahoma City September 29-October 1, 1971. The meeting will focus on "Natural Gas—Target for the 70's." The Oklahoma City Geological Society will act as host, and headquarters will be the Skirvin Hotel.

The first day's activities include a golf tournament and a field trip along I-35 through the Arbuckle Mountains, with special emphasis on the Hunton sequence.

Technical sessions on September 30 and October 1 will emphasize the importance of natural gas, including helium, as an exploration objective in the Midcontinent region, and the meeting will conclude with a trip to the Lone Star Producing Co. No. 1 Baden well near Elk City in Beckham County. This Anadarko basin test is being drilled to the Hunton, which is expected to be reached at 28,000 feet, for a new world depth record.

Detailed information on the meeting may be obtained by writing:

Franklin C. Jones
General Chairman
202 Oil & Gas Building
Oklahoma City, Oklahoma 73102

New Officers Announced by Oklahoma's Geological Societies

New officers and executive boards for the 1971-72 year have been announced by the following geological societies in Oklahoma:

Ardmore Geological Society	
President	Virgil H. Roan
Vice-President	Harris S. Smith
Secretary-Treasurer	C. W. Dobbins
Past-President	C. S. Verhoeven
Geophysical Society of Oklahoma City	
President	D. G. Westover
First Vice-President	Max Cieminski
Second Vice-President	Bill Dulaney
Secretary	Harold Harper
Treasurer	C. Wayne Carrier
Past-President	W. R. Wolfe
Oklahoma City Geological Society	
President	John W. Erickson
First Vice-President	Gary A. McDaniel
Second Vice-President	Tom G. Robinson
Secretary	Louis M. Ford
Treasurer	Sherrill D. Howery
Editor	Thomas E. Cochrane
Library Director	Charles E. Branham
Past-President	Herbert G. Davis
Public Relations Chairman	George T. Schmitt
Social Chairman	Bruce J. Mobley
Tulsa Geological Society	
President	Thomas H. Green
First Vice-President	Philip A. Chenoweth
Second Vice-President	Joseph F. Mueller
Secretary	R. J. Logsdon
Treasurer	R. W. Tillman
Editor	Thomas L. Thompson
Past-President	David R. Matuszak
Councilors-at-Large	Lewis F. Jenkinson
	Jack H. Lewis
	Glenn E. McKinley

New Dissertation Added to OU Geology Library

The following doctoral dissertation was recently added to The University of Oklahoma Geology and Geophysics Library:

Palynology of the Sand Branch Member of the Caney Shale Formation (Mississippian) of southern Oklahoma, by Reginald W. Harris, Jr.

USGS Water Resources Division Names New District Chief for Oklahoma

James H. Irwin has been appointed chief of the Oklahoma District, Water Resources Division, U.S. Geological Survey, succeeding John W. Odell, who recently retired.

A native of Oklahoma City and a veteran of World War II, Mr. Irwin studied zoology and geology at Oklahoma City University, The University of Oklahoma, and the University of New Mexico. He began work for the USGS in 1951 and has had a wide variety of assignments in New Mexico, Arizona, Colorado, Utah, Washington, D.C., and Oklahoma.

The staff of the Oklahoma Geological Survey is well acquainted with Mr. Irwin and his office through the joint OGS-USGS water-resources program in Oklahoma. Geologists from both agencies are working cooperatively on the Hydrologic Atlas series (*see* p. 84) and other projects throughout the State to develop reliable sources of surface- and ground-water information for continually expanding demand.

Environmental-Impact Evaluation Guide Issued

An environmental-impact evaluation guide based on the information "matrix" concept has been issued by the U.S. Geological Survey to aid agency planning for local or regional development. The guide is being used by the Oklahoma Geological Survey to evaluate man-made projects in the State.

The core of the guide is a desk-size, foldout checkerboard sheet of crossing horizontal and vertical columns. Factors that characterize existing conditions of the environment, such as kinds of plant, animal, and earth features, are listed vertically on the left side of the sheet. Across the top of the sheet is listed a variety of actions likely to be undertaken by man. The matrix lists a total of 88 conditions and 100 actions. With this matrix, the user can identify all actions that are part of the proposed project and then identify those parts of the environment likely to be affected by these actions. He then selects a number from 1 to 10 (10 = greatest impact; 1 = least impact) that indicates the magnitude of the possible impact of the action on the existing natural condition and puts it in the related square. Thus the user can evaluate which actions are most likely to affect the environment and what parts of the environment are most sensitive to a proposed action.

The environmental matrix was developed by Luna B. Leopold, Frank E. Clarke, Bruce B. Hanshaw, and James R. Balsley of the U.S. Geological Survey. The matrix and sample statement concerning impact of a proposed mineral development make up a report, *A Procedure for Evaluating Environmental Impact*. The report, USGS Circular 645, may be obtained free upon request from the Director, U.S. Geological Survey, Washington, D.C. 20242.

New Chief Geologist for U.S. Geological Survey

Dr. Vincent E. McKelvey has been appointed chief geologist to head the geologic division of the U.S. Geological Survey. He succeeds Dr. Harold L. James, who occupied the post since 1965.

A graduate of Syracuse University and The University of Wisconsin, Dr. McKelvey joined the Geological Survey in 1941. His special assignments have included consultant to chief of engineers, Manila; minerals specialist, Jordan; U.S. representative and advisor to energy committee of the Organization for Economic Cooperation and Development; U.S. representative to government advisory committees on energy and minerals; United Nations Resource and Transport Division; and advisor on phosphate exploration, Saudi Arabia.

Dr. McKelvey took over as chief geologist after serving as a senior research geologist. He is internationally known for his studies of phosphate deposits, for his investigations into problems related to long-range energy and mineral-resource needs, and, in recent years, for his analyses and assessments of seabed resources of the world.

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