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OKLAHOMA GEOLOGY NOTES

OKLAHOMA GEOLOGICAL SURVEY / THE UNIVERSITY OF OKLAHOMA / NORMAN, OKLAHOMA 73069

Cover Picture

Deep-Marine Ouachita Sediments

Turbidity-current sandstones of the Atoka Formation were examined in the Ouachita Mountains during a recent field trip sponsored by the Oklahoma City Geological Society (see p. 111 of this issue). In the exposure pictured deep-marine beds of dark-gray shale are interbedded with thinner sandstone units that possess some of the characteristics of turbidites: sharp base (top of beds is to the right), upward fining of sands, and sole marks (visible on the base of sandstone near Herb Davis' right hand).

The photograph was taken along Oklahoma Highway 1, in E½ sec. 24, T. 3 N., R. 25 E., at the site described as "Supplementary Locality 8" in the guidebook prepared in conjunction with this field trip.

—*Kenneth S. Johnson*

Statistics of Oklahoma's Petroleum Industry, 1971

John F. Roberts[1]

Total drilling of wells in search of oil and (or) gas decreased in all categories in 1971 (table 1, fig. 1). Sixty-one counties were explored for new reservoirs, and 32 had successful completions (fig. 2), making a statewide success ratio for exploratory wells of 20 percent. Garvin County had the most exploratory tests (30), of which only 3 were discoveries. Caddo, Grady, Kay, Stephens, and McClain Counties also had numerous exploratory tests but in addition had better success ratios.

The most concentrated drilling activity in Oklahoma during 1971 was along the Marchand sandstone trend in west-central Grady County and northeastern Caddo County. Although the discovery well was completed in 1967, development was slow until additional discoveries were made in 1969, 1970, and early 1971 in the 20-mile-long north-northwesterly trend. Fields in the trend include Northeast Verden (into which Dutton and Dutton Townsite fields have been combined), Northwest Chickasha, Northwest Norge, and Southwest Norge.

The name "Marchand" had been applied earlier to a productive sandstone of Middle Pennsylvanian (Missourian) age in the Cement field to the southwest in Caddo County, in a similar stratigraphic position. However, no one sand is a continuous reservoir in the area, deposition having occurred in what has been interpreted as a deltaic complex.

Depth to the Marchand reservoir is 10,000 to 11,000 feet. Well spacing has been established as 160-acre units. Initial-flow potentials range up to 1,675 barrels of oil per day.

The following is a comparison of production statistics as of December 31, 1970, with those as of December 31, 1971, given in barrels of oil (1 barrel = 42 U.S. gallons).

Number of wells		Daily average production		Cumulative production	
1970	1971	1970	1971	1970	1971
36	126	3,372	32,315	1,811,168	8,450,532

These figures show increases during 1971 of 90 producing wells, daily average production of 28,943 barrels, and cumulative production of 6,639,364 barrels. The daily average production per well for December 1971 was 256 barrels. Production has been high because of the combination of high discovery allowables and 150- and 200-percent allowable factors.

At year's end 17 wells were in various stages of completion, 7 rigs were drilling, and 5 locations had been announced.

The 21 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.) The Elk City field fell from this category in 1971 because of less oil production; possibly it should have remained

[1]Geologist, Oklahoma Geological Survey.

in the giant class because of other products recovered. These giants produced 49 percent of the year's total oil and accounted for 43 percent of the estimated ultimate yield and remaining reserves in the State. This production came from 35 percent of the total number of producing wells in the State.

Table 1 summarizes drilling activity during 1971. The average drilling depth of exploratory wells decreased to 5,880 feet from 6,062 feet in 1970. Average depth of all wells drilled in the State decreased

TABLE 1.—DRILLING ACTIVITY IN OKLAHOMA, 1971

	1971				1970
	CRUDE	GAS	DRY	TOTAL	TOTAL
All wells					
Number of completions	1,174	238	843	2,255	2,901
Footage				11,247,143	14,473,532
Average footage				4,987	4,989
Exploration wells					
Number of completions	42	27	346	415	458
Percentage of completions	10.1	6.5	83.4	100	
Footage				2,440,577	2,776,607
Average footage				5,880	6,062
Development wells					
Number of completions	1,132	211	497	1,840	2,443
Percentage of completions	61.5	11.5	27.0	100	
Footage					12,696,925
Average footage				4,786	5,197

Source: **Oil and Gas Journal,** v. 70, no. 11, March 13, 1972, p. 95.

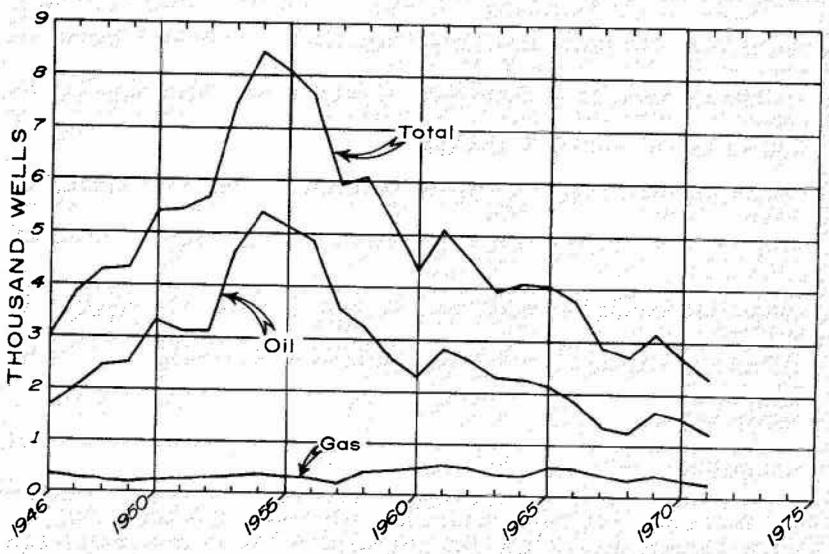

Figure 1. Graph showing total wells drilled, oil wells completed, and gas wells completed in Oklahoma, 1946-1971. Source: Oil and Gas Journal.

to 4,786 feet from the previous year's average of 5,214 feet. These figures do not entirely reflect the overall drilling picture during 1971, because at the end of the year numerous wells were drilling at depths below 18,000 feet in the Anadarko basin; as these wells were not completed by December 31, they are not included in these statistics.

Table 3 lists cumulative and yearly production and the value of all petroleum products to January 1, 1972.

Table 4 compares petroleum production of the past 2 years. Crude-oil production was slightly lower despite an increase of the proration factor to 200 percent during the year. This rate of production still failed to meet market demands.

Figure 3 shows a decrease in natural-gas reserves from 16,954 trillion cubic feet in 1970 to 15,713 trillion cubic feet in 1971, owing to decreased production, decreased discoveries, and revisions of previous estimates.

Figure 4 displays an increase in total liquid-hydrocarbon reserves from 1,710 billion barrels in 1970 to 1,743 billion barrels in 1971, owing to slight gains in both revisions and discoveries.

The decreases in most categories of the petroleum industry are due to many reasons. The price of crude oil is up slightly but not enough to offset increased operating expenses and taxes, and areas such as the continental shelves and foreign basins are more economi-

TABLE 2.—GIANT OIL FIELDS OF OKLAHOMA, 1971

FIELD	1971 PRODUCTION (1000 BBLS)	CUMULATIVE PRODUCTION (1000 BBLS)	ESTIMATED RESERVES (1000 BBLS)	NUMBER OF WELLS
Allen	2,920	118,875	15,907	1,520
Avant	365	105,467	1,435	608
Bowlegs	2,260	153,956	6,355	183
Burbank	5,240	491,902	43,760	1,172
Cement	2,370	133,884	17,630	1,485
Cushing	4,300	453,808	20,700	1,739
Earlsboro	765	209,078	2,750	186
Edmond West	730	153,076	7,510	477
Eola-Robberson	4,850	95,395	29,773	490
Fitts	1,420	144,474	10,646	611
Glenn Pool	2,480	303,342	16,957	1,036
Golden Trend	12,330	372,124	123,026	1,402
Healdton	4,600	273,892	40,400	1,934
Hewitt	5,660	199,783	29,340	1,284
Little River	440	158,771	1,545	164
Oklahoma City	1,750	728,158	16,853	315
Seminole, Greater	1,640	195,975	10,802	264
Sho-Vel-Tum	36,500	901,086	243,500	7,952
Sooner Trend	15,240	150,464	97,136	2,789
St. Louis	1,350	212,528	10,650	614
Tonkawa	290	134,403	2,221	185
Total Oklahoma	107,500	5,690,441	748,896	26,410

Source: **Oil and Gas Journal**, v. 70, no. 4, January 31, 1972.

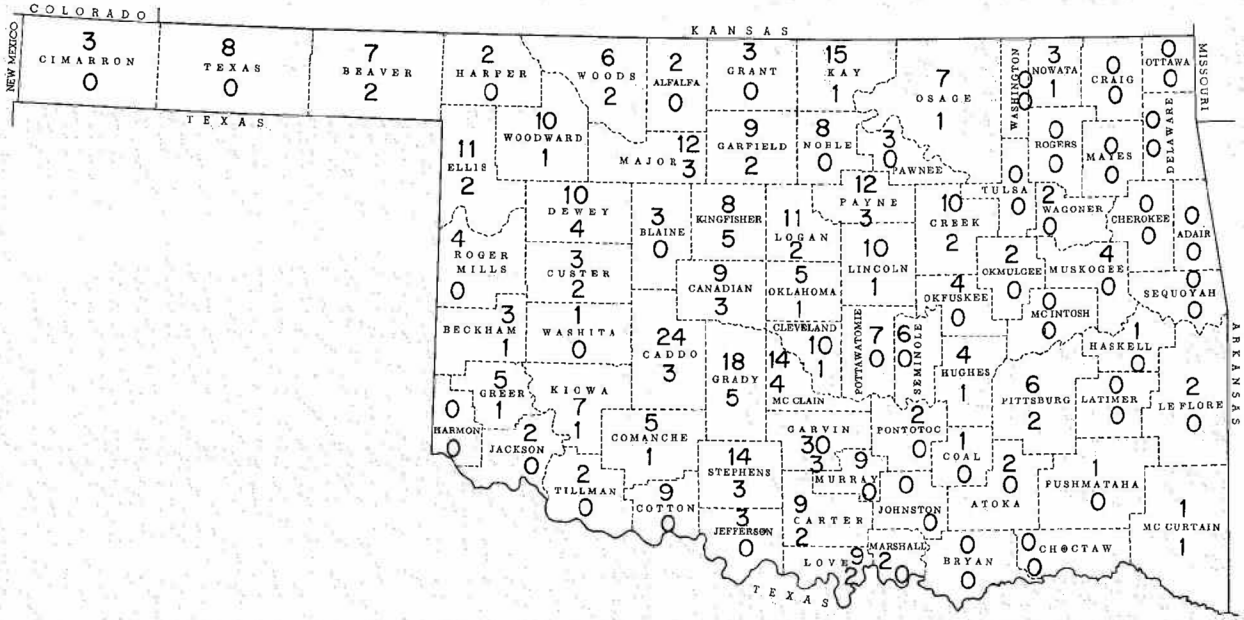

Figure 2. Exploratory drilling by counties during 1971. Upper figures give the number of exploratory wells drilled; lower figures give the number of successful completions. Source: American Petroleum Institute in cooperation with the U.S. Bureau of Mines.

TABLE 3.—CUMULATIVE (THROUGH 1955) AND YEARLY (1956-1971) 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	223,574	712,419	1,594,943	248,811	622,146	39,933	1,177,218	52,975
1971[1]	218,900	746,449	1,594,000	251,852	615,132	35,736	1,146,600	46,683
Total	10,602,389	21,505,003	31,407,408	3,807,745	23,126,315	1,428,962	17,692,541	662,495

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.
[1]Preliminary figures for 1971.

cally attractive. Even though the independent operators drill more wells, find more reserves, and produce more oil than the major companies, the support and information furnished by the majors enable the independents to accomplish these results. Several major oil companies have recently moved their offices and support from Oklahoma.

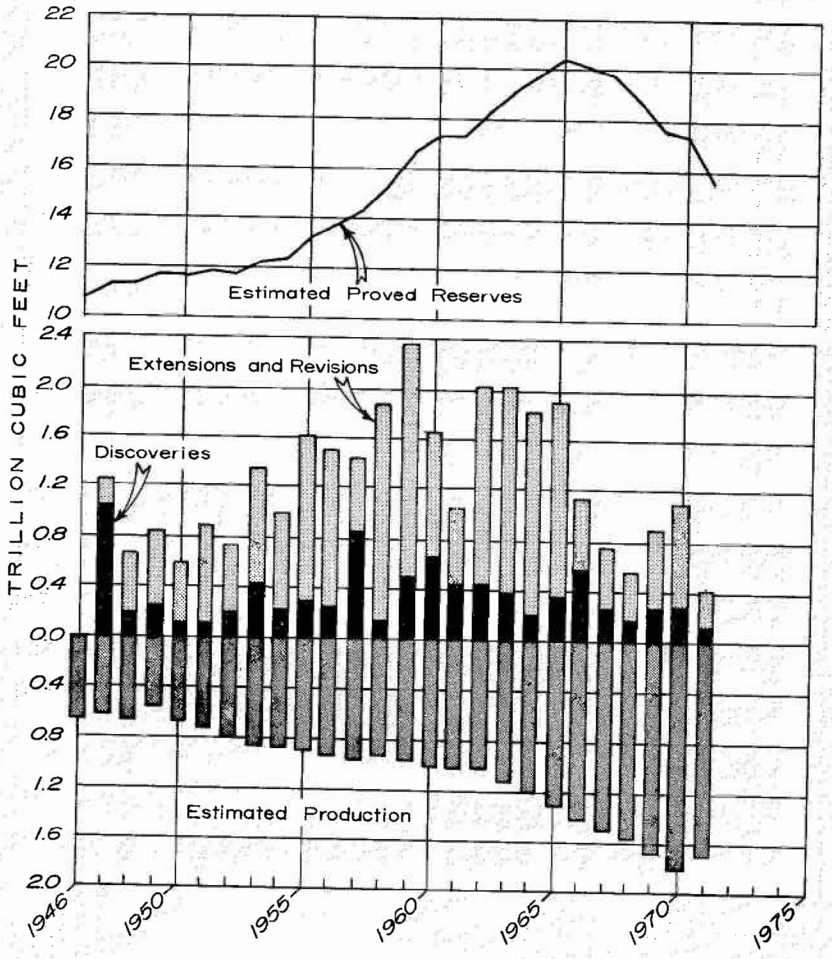

Figure 3. Graph showing statistics on estimated proved reserves of natural gas in Oklahoma, 1946-1971. Source: American Gas Association, annual reports.

Federal control of the price of gas in interstate commerce has discouraged normal gas exploration and development. Actions by the State regarding pollution, proliferation of required reports, and added taxes have been factors in the abandonment of many marginal producing wells—and with them the reserves they represent.

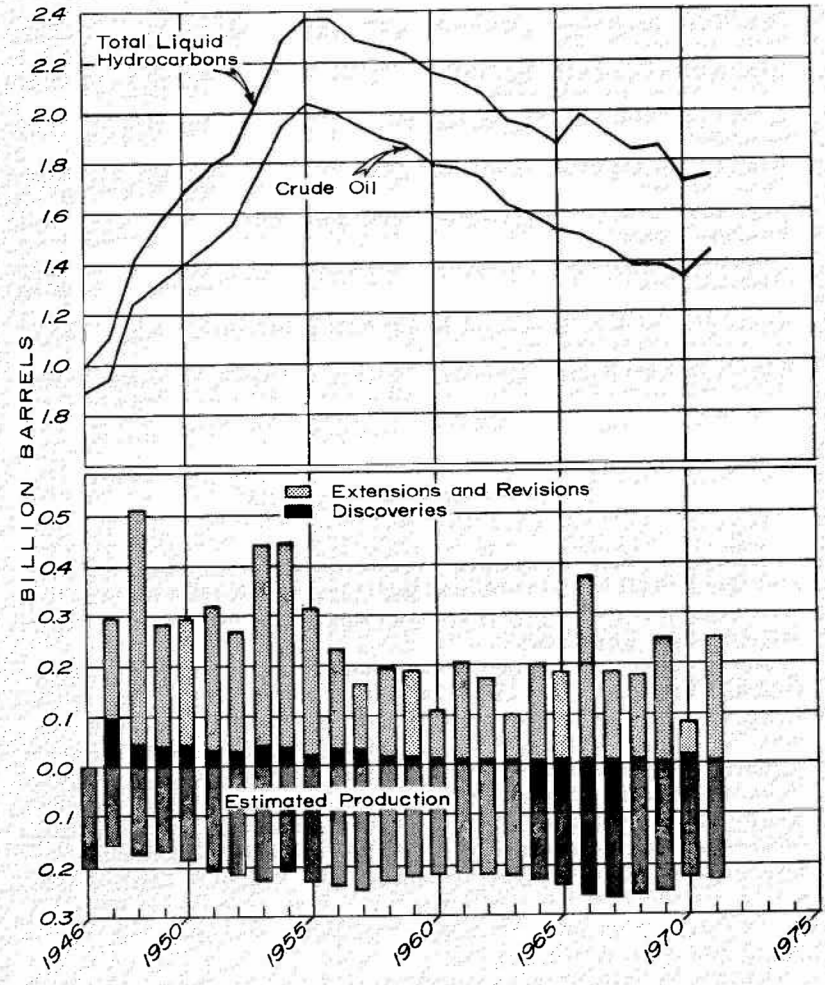

Figure 4. Graph showing statistics on estimated proved reserves of total liquid hydrocarbons in Oklahoma, 1946-1971. Source: American Petroleum Institute, annual reports.

Oklahoma continues to rank third in the nation in gas production and fourth in crude-oil production; however, the inclusion of the Alaskan reserves of oil and gas has forced the State into fourth place in gas reserves and fifth place in oil reserves.

TABLE 4.—HYDROCARBON PRODUCTION IN OKLAHOMA

	1970	1971
Crude oil and lease condensate		
Total annual production (1,000 bbls)[1]	223,574	218,900
Value ($1,000)[1]	712,419	746,449
Cumulative production 1891-year (1,000 bbls)	10,384,415	10,602,389
Daily production (bbls)	615,060	599,726
Total number of producing wells[2]	78,212	75,549
Daily average per well (bbls)	8.3	7.9
Oil wells on artificial lift (estimated)[2]	74,212	71,549
Natural gas		
Total annual marketed production (MMCF)[1]	1,594,943	1,594,000
Value ($1,000)[1]	248,811	251,852
Total number of gas and gas-condensate wells[2]	8,557	8,141
Natural-gas liquids		
Total annual marketed production (1,000 bbls)[1]	42,842	41,946
Value ($1,000)[1]	92,908	82,419

[1]Item for 1970 is U.S. Bureau of Mines final figure. Item for 1971 is U.S. Bureau of Mines preliminary figure.
[2]**World Oil**, annual forecast and review issue, v. 174, no. 3, February 15, 1972.

Survey Director Reelected

Charles J. Mankin, director of the Oklahoma Geological Survey and of the School of Geology and Geophysics, has been elected to a fourth consecutive term as secretary-treasurer of the Association of American State Geologists.

New officers were named at the 64th annual meeting of the association, held May 15-17, 1972, at Moab, Utah. In addition to Dr. Mankin the slate consisted of: president, Norman F. Williams, Arkansas Geological Commission; president-elect, Kenneth N. Weaver, Maryland Geological Survey; vice-president, James L. Calver, Virginia Division of Mineral Resources; historian, Charles G. Doll, Vermont Geological Survey; editor, Edwin A. Noble (reelected), North Dakota Geological Survey; and statistician, Robert R. Jordan, Delaware Geological Survey. Officers were announced by Philip E. LaMoreaux, outgoing president of the association and state geologist of Alabama, who will continue on the executive committee as past president. Terms began at the close of the meeting.

William P. Hewitt, state geologist of Utah, served as principal host for the Moab meeting; the group will assemble next year in Georgia, under the auspices of the Georgia Department of Mines, Mining and Geology.

OCGS Sponsors Field Seminar

The Oklahoma City Geological Society recently sponsored an excellent 3-day seminar and field study of the genesis and geometry of sandstones. Dr. John W. Shelton, professor of geology at Oklahoma State University, organized and led the sessions, which began May 18 with a 1-day workshop in Tulsa and concluded with a 2-day field trip to outcrops of Pennsylvanian and Permian sandstones in eastern and north-central Oklahoma. Dr. Shelton was assisted in the "logistics" of the trip by William E. Jackson and Gary A. McDaniel. The seminar and field trip were attended by 31 persons, primarily petroleum geologists from the Oklahoma City area; 2 geology students from Oklahoma State University were able to attend because of financial assistance supplied by Herbert G. Davis and David L. Murphy.

Participants visited 20 sites where sandstones deposited in alluvial piedmont, alluvial plain, deltaic distributary, delta fringe, tidal-flat channel, shallow marine, proximal deep marine, and distal deep marine environments were available. Rock units examined included the Atoka Formation, McAlester Formation, Savanna Formation, Bluejacket Sandstone, and Vamoosa Formation, all of Pennsylvanian age, plus the Eskridge Formation and the Winfield Formation of Permian age. Previous study by Dr. Shelton and his co-workers involved gathering data on the geometry of particular sand bodies from many sites, whereas emphasis on the field trip was placed on examining internal features such as texture and sedimentary structures.

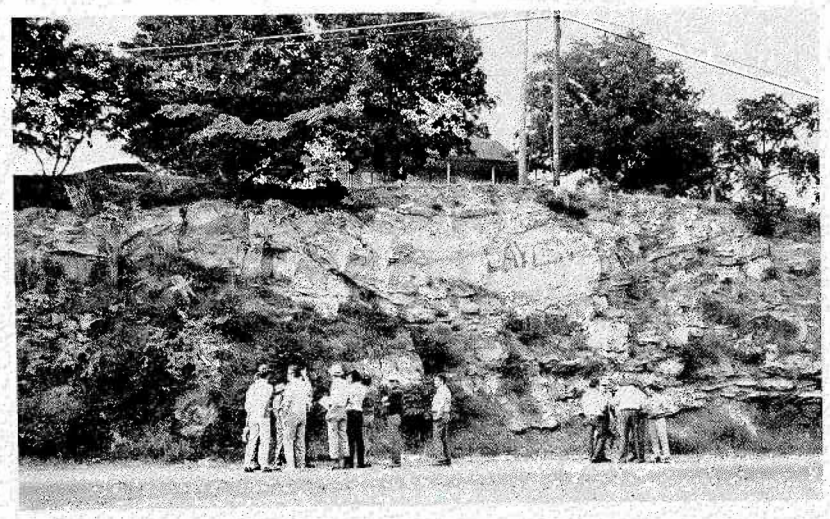

Figure 1. Deltaic distributary sandstone of the Savanna Formation just east of McAlester, Oklahoma.

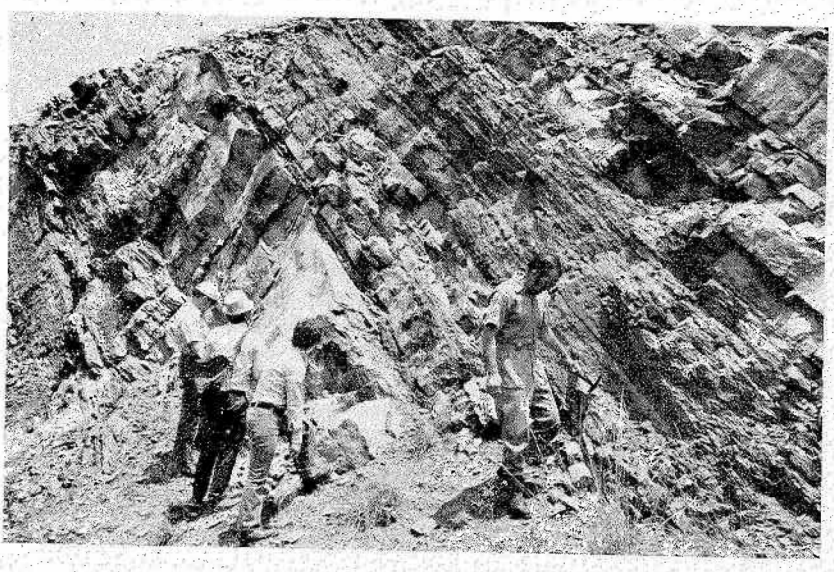

Figure 2. Shallow-marine shales and delta-fringe sandstones in the Atoka Formation at Backbone Mountain, northeast of Poteau, Oklahoma.

Figure 3. Delta-fringe sandstone in the Bluejacket Member of the Boggy Formation just east of Enterprise, Oklahoma.

Figure 4. John W. Shelton standing by delta-distributary sandstone in the Elgin Sandstone Member of the Vamoosa Formation at Drumright, Oklahoma.

The guidebook prepared in conjunction with this field trip, *A Guidebook to the Genesis and Geometry of Sandstones,* by John W. Shelton, Don M. Terrell, and Michael D. Karvelot, can be purchased for $7.50 plus postage from the Oklahoma City Geological Society, 1020 Cravens Building, Oklahoma City, Oklahoma 73102.

—*Kenneth S. Johnson*

New AAPG-SEG Volume Released

The American Association of Petroleum Geologists' Memoir 16, *Stratigraphic Oil and Gas Fields—Classification, Exploration Methods, and Case Histories,* has just been published in cooperation with the Society of Exploration Geophysicists as SEG Special Publication no. 10. Edited by Robert E. King, the 720-page volume contains 51 papers by 69 authors, 535 figures, 28 tables, and a useful and usable index—truly a fine joint effort by geologists and geophysicists. An article on the Star-Lacey field, Oklahoma, should be of special interest to readers from this area.

A special price, $24.00, is available to AAPG-SEPM-SEG members; the cost will be $30.00 for others.

New Mexico Geological Society Plans Field Trip

The New Mexico Geological Society will sponsor a field trip into east-central New Mexico and adjoining Texas on September 28-30, with registration September 27 at Tucumcari, New Mexico. A comprehensive field study of the area is anticipated, incorporating all aspects of geology and related fields.

A guidebook, edited by Vincent Kelley, professor emeritus of the University of New Mexico, and Fred Trauger, geologist with the Water Resources Division of the U.S. Geological Survey, will be available to participants at a cost of $13.00 plus registration.

At the request of the New Mexico Geological Society, Charles J. Mankin, director of the Oklahoma Geological Survey, has submitted a paper, "Jurassic Strata in Northeastern New Mexico," to be included in the guidebook. Dr. Mankin will be involved also in 3 of the 5 stops on the first day of the trip, lecturing on the Jurassic. Leonard R. Wilson, George Lynn Cross Research Professor of Geology at OU, has submitted material on Cretaceous spores which will be included in a paper on Cretaceous strata in northeast New Mexico in the guidebook. This contribution will add to a better understanding of stratigraphic relationships of this period in the area.

Additional information on this field trip can be obtained by contacting A. J. Budding, New Mexico Tech, Socorro, New Mexico 87801. Geologists familiar with past excursions of the society look forward to a rewarding trip and a superior guidebook.

Lefty Ellsworth Retires

Elmer W. ("Lefty") Ellsworth, convention manager for 26 years for The American Association of Petroleum Geologists, retired at the end of June. His future activities include operating his own convention-consulting firm, Elmer Ellsworth and Associates, to be based in San Francisco. He will be retained by AAPG as convention consultant.

The Society of Economic Paleontologists and Mineralogists awarded Dr. Ellsworth a plaque of recognition at the 1972 AAPG-SEPM convention this spring. He was also elected to honorary membership in AAPG. In addition to AAPG and SEPM, his memberships include the National Association of Exposition Managers, the Tulsa Society of Association Executives, and the Society of Exploration Geophysicists; he is a fellow of The Geological Society of America and a retired colonel in the U.S. Air Force Reserve. He has been a speaker at various meetings of these organizations and has written a convention manual for AAPG which has become a standard reference in trade magazines.

On leaving his position at AAPG, Dr. Ellsworth praised the expanding service of that organization, not only in mineral exploration but in responsibility for ecological problem-solving.

His move to the West Coast will be a happy return for Dr. Ellsworth to a region he enjoyed while working toward his Ph.D. at Stanford.

New Officers Announced by Oklahoma's Geological Societies

New officers and executive boards for the 1972-73 year have been announced by the following geological and geophysical societies in Oklahoma:

Ardmore Geological Society
- President, HARRIS S. SMITH, independent geologist
- Vice-President, JOE KALKMAN, consulting geologist
- Secretary-Treasurer, GORDON D. CLARK, independent oil operator
- Past-President, VIRGIL H. ROAN, consulting geologist
- Executive Committee: VIRGIL H. ROAN; JOHN W. MAYES, consulting geologist; R. P. WILKINSON, J. M. Huber Corporation

Geophysical Society of Oklahoma City
- President, BILL DULANEY, Mobil Oil Corporation
- First Vice-President, HAROLD HARPER, consultant
- Second Vice-President, WAYNE CARRIER, Union Oil Company of California
- Secretary, HARRY GOEBEL, Lone Star Production Company
- Treasurer, HARRY ALLEN, Gulf Oil Corporation
- Past-President, D. G. WESTOVER, Tenneco Oil Company

Geophysical Society of Tulsa
- President, HOMER W. LAWRENCE, Birdwell Division of Seismograph Service Corporation
- First Vice-President, F. W. (BILL) LAU, Skelly Oil Company
- Second Vice-President, GRAYDON L. BROWN, Continental Oil Company
- Secretary, EWEN D. HAIL, Amoco Production Company
- Treasurer, ROBERT L. GEYER, Seismograph Service Corporation
- Editor, GERALD H. NEALE, Omni Tech Corporation
- Editor-Elect, KARL E. BAER, Seismic Reference Service, Inc.

Oklahoma City Geological Society
- President, GARY A. MCDANIEL, Clark Canadian Exploration Company
- First Vice-President, TOM G. ROBINSON, Vanderbilt Resources Corporation
- Second Vice-President, LOUIS M. FORD, Walter Duncan, Inc.
- Secretary, SHERRILL D. HOWERY, Union Oil Company of California
- Treasurer, WILLIAM E. JACKSON, Eason Oil Company
- *Shale Shaker* Editor, HAROLD A. BROWN, Anadarko Production Company
- Library Director, CHARLES E. BRANHAM, Calvert Funds, Inc.
- Social Chairman, HAROLD W. HANKE, Texas Oil and Gas Company
- Public Relations, THOMAS B. CURLEE, Phillips Petroleum Company
- Past-President, JOHN W. ERICKSON, Gulf Oil Corporation

Tulsa Geological Society
- President, T. LEO BROIN, Cities Service Oil Company
- First Vice-President, JOSEPH F. MUELLER, Wanenmacher & Mueller

Second Vice-President, RICHARD J. LOGSDON, Dresser Atlas
Secretary, PEGGY J. RICE, AAPG
Treasurer, LEWIS F. JENKINSON, Marathon Oil Company
Editor, JAMES R. DERBY, Amoco Production Company
Newsletter Editor, RALPH H. SMITH, Apache Corporation
Counselors:
THOM GREEN, Wilcox Operating Company
PHILIP A. CHENOWETH, consulting geologist
DAVID A. MORRIS, Phillips Petroleum Company
LARRY S. GRUBBS, Texaco, Inc.

1972 INTERNATIONAL GEOLOGICAL CONGRESS; OGS GEOLOGIST TO PRESENT PAPER

The International Geological Congress will meet for its 24th session August 21-30, 1972, in Montreal, Canada. Registration begins August 19 at the Windsor Hotel.

The program, which is divided into 17 sections covering all traditional phases of geology and geophysics plus sections on planetology, computer-based storage, and geological education, opens August 21 with a plenary session on "Earth Sciences and the Quality of Life."

Papers will be offered by scientists from around the world, and four symposia on "Earth Sciences and the Quality of Life" and "Earth Science Aid to Developing Countries," as well as symposia sponsored by various scientific organizations, will be included.

Kenneth S. Johnson, geologist with the Oklahoma Geological Survey, will present a paper on Tuesday, August 29, as part of the section dealing with earth science education at the pre-university level. His paper is titled "Preparation of Nontechnical Guidebooks for Conducting Geological Field Trips," a work which grew out of his involvement with the eight-part series *Guidebook for Geologic Field Trips in Oklahoma,* a series of educational guidebooks being prepared through the cooperative efforts of the Oklahoma Geological Survey, the National Science Foundation, and the Oklahoma State Department of Education.

Numerous geological excursions and scenic and historical nongeologic tours—in Montreal and the surrounding area, and as far afield as the Maritime Provinces in the east and the Northwest Territories, the Yukon, and British Columbia in the west—will be held in connection with the Congress, both before and after the technical sessions. They will cover stratigraphy, structure, economic geology, engineering geology, geomorphology, and tectonics.

A total of 48 pre-Congress and 35 post-Congress excursions have been scheduled. The first field trip begins July 23, and the last ones end September 11 and 12. Pre-Congress trips will study the structure and geomorphology of the Southern Canadian Cordillera and the plutonic rocks of the Coast Mountains of British Columbia. There will also be a steamship cruise along the Pacific coast of Canada, and an aerial reconnaissance of the Eastern Cordillera and Arctic Islands. Post-Congress trips will duplicate some of the same studies, while adding many others.

The next International Geological Congress is expected to be in Australia. These meetings are always memorable, and the papers resulting from the technical sessions are a valuable addition to the literature of science.

Carl Branson Retires

Carl Colton Branson retired in July, adding another milestone to a geological career spanning 49 years. The last 22 of those years were spent in service to the School of Geology and Geophysics of The University of Oklahoma and to the Oklahoma Geological Survey. In 1954 he was named director of the Survey, and in 1955 he assumed additional responsibilities as chairman of the geology department (officially changed to the "School of Geology and Geophysics" in 1967). In recent years he has been a geologist for the Survey and a professor of geology for the School.

Dr. Branson received his B.A. (1926) and M.A. (1927) degrees from the University of Missouri; his Ph.D. (1929) was from the University of Chicago. His publications are too numerous to list, and they display not only industrious dedication but also a variety of interests within the field of geology. His category, as named in *American Men of Science,* is stratigraphy, but in addition to this specialty he has written on vertebrate and invertebrate paleontology, structure, physiography, taxonomy, mineral industries, and the history of geology; he has prepared guidebooks, compilations, bibliographies, indexes, biographies, and memorials. He has edited various publications, an outstanding example being *Pennsylvanian System in the United States, a Symposium,* an AAPG special volume. He even collaborated in writing the Boy Scout book for the merit badge in geology.

Dr. Branson has presented papers for many national, state, and local organizations. He is a member or fellow of many organizations—GSA, AAAS, SEPM, AIME, Society of Vertebrate Paleontologists, Paleontological Society of America and also of India, Paleontological Research Institute, the geological societies of Oklahoma City, Tulsa, and Ardmore, to name a "few"—and he has held many offices within these societies.

One of Carl Branson's most valuable contributions to OU students and to all researchers in geology and geophysics was his assistance in providing one of the best collections of geologic references in the country. He added many valuable volumes to the shelves of OU's School of Geology and Geophysics Library from his own library and that of his father, and his guidance was invaluable to the geology librarian, Mrs. Lucy Finnerty, in selecting material to order. Use of this library is not restricted to OU students and faculty members; interested parties can check out books through interlibrary loan facilities of their company or their city library.

Dr. Branson has done much to increase the understanding of Oklahoma geology and to enhance the repute of Oklahoma geologists. We wish him well.

AESE Conference Scheduled for Boulder

All geologists who have been involved in editing (willingly or not) should find the upcoming convention of the Association of Earth Science Editors of interest.

The association's sixth annual conference—but the first since becoming a member society of the American Geological Institute—will be October 15-17, 1972, in Boulder, Colorado, with The Geological Society of America as host. Sessions October 16 and 17 will be in the new GSA headquarters building.

Following a welcoming address October 16 by Ed Eckel, executive secretary of the GSA, a series of panel discussions will be presented. Subjects to be dealt with by the panels include: style manuals; "Some New Production Techniques"; "Format, Design, and Illustrations for Producers and Users"; and "Think Small—Microforms."

The program also includes a field trip to the Lyons sandstone quarries, the Cretaceous oil resource areas of the region, and possibly the Precambrian basement rocks.

William D. Rose, geologist-editor, and Rosemary Kellner, associate editor and a new member of AESE, will represent the Oklahoma Geological Survey.

For further information on this conference, contact Patricia Dickerson, AESE, Box 31571, Dallas, Texas 75231.

OURI Contract for Oil and Gas Data

The OU Research Institute (OURI) has received $152,617 from the U.S. Geological Survey for the continuance of the Generalized Information Processing System (GIPSY) developed at OU to retrieve oil and gas data. The computerized data base is intended to make available all public information on oil and gas fields in the United States.

The present contract confers permanent status on a program begun in 1969 by the OURI and the Oil Information Center as a feasibility study. At the end of fiscal year 1971 the file included records on over 60,600 oil and gas fields and pools, 4,500 natural gas analyses, 2,700 oil-field brine analyses, and 6,000 crude oil analyses. Statistics included in the data bank are obtained from various state agencies and numerous geological and engineering societies throughout the United States, as well as from publications of the International Oil Scouts Association.

Dr. Richard F. Meyer of the Office of Oil and Gas (OOG), U.S. Department of the Interior, Washington, D.C., is technical advisor for the project; Jerlene Bright is coordinator at the Center; and Gary Whitley is in charge of computer systems.

Information on the study can be obtained from "Oil and Gas Field Study: A Two-Year Progress Report" (OOG Technical Report 71-1). Copies are available free from OOG, Interior Department, Washington, D.C. 20240.

THE GENUS *Parazophocrinus* FROM THE HENRYHOUSE FORMATION (SILURIAN), PONTOTOC COUNTY, OKLAHOMA

H. L. STRIMPLE[1]

A recent examination of the genus *Parazophocrinus* Strimple, 1963, from the Henryhouse Formation (Silurian) of southern Oklahoma revealed that the original illustrations were inadequate (see Strimple, 1963, pl. 2, figs. 10, 11). New photographs have been prepared and are presented herein as figure 1. Also, several features of *P. callosus* Strimple, 1963, type species, that were not documented in the original description are discussed here.

Careful re-examination of the type specimens has failed to disclose any evidence of arm-attachment facets. Thus feeding apparently was accomplished through the oral aperture, which is moderately large and covered by five oral plates. This type of feeding arrangement is not uncommon among the young of the Allagecrinidae and even for adults of some hypocrinids. A significant difference does exist in that the orals of allagecrinids and similar forms are usually much larger proportionately than in *Parazophocrinus*. If regular (plated) arms are found to exist in *Parazophocrinus*, these arms should be quite small and should be attached near the perimeter of the tegmen; this area is much smaller than the overall diameter of the cup.

Growth increments are visible in the distal portions in most of the five basal plates. They are parallel to the regular plate outline.

Radial plates are large, are curved sharply inward at the cup perimeter, and extend inward for a considerable distance. Irregular-sized tegmen plates cover the body cavity and surround the five moderately large oral plates (fig. 1B). Angulation of the orals causes the sutures to be elevated. At the proximal ends of the oral sutures the oral plates are adjoined by a small specialized pair of tegmen plates with slightly curved rather than straight distal edges.

The proximal columnal rests in a socketlike impression, is small compared to the size of the cup, and is subpentagonal in the holotype. Two columnals are preserved in the paratype, the first considerably larger than the second and both having a circular outline.

Measurements (given in mm)	Holotype S5504	Paratype S5078
Width of calyx (max.)	29.4	58.5[a]
Width of calyx (min.)	28.4	
Height of calyx	27.8[a]	
Width of basal circlet	11.5	22.7[a]
Diameter of proximal columnal	2.5	4.0
Width of basal plate	5.9	10.9
Length of basal plate	5.0	9.5
Width of radial plate	16.6	
Length of radial plate	9.3	17.9[a]
Width of oral circlet		8.0

a = approximate

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

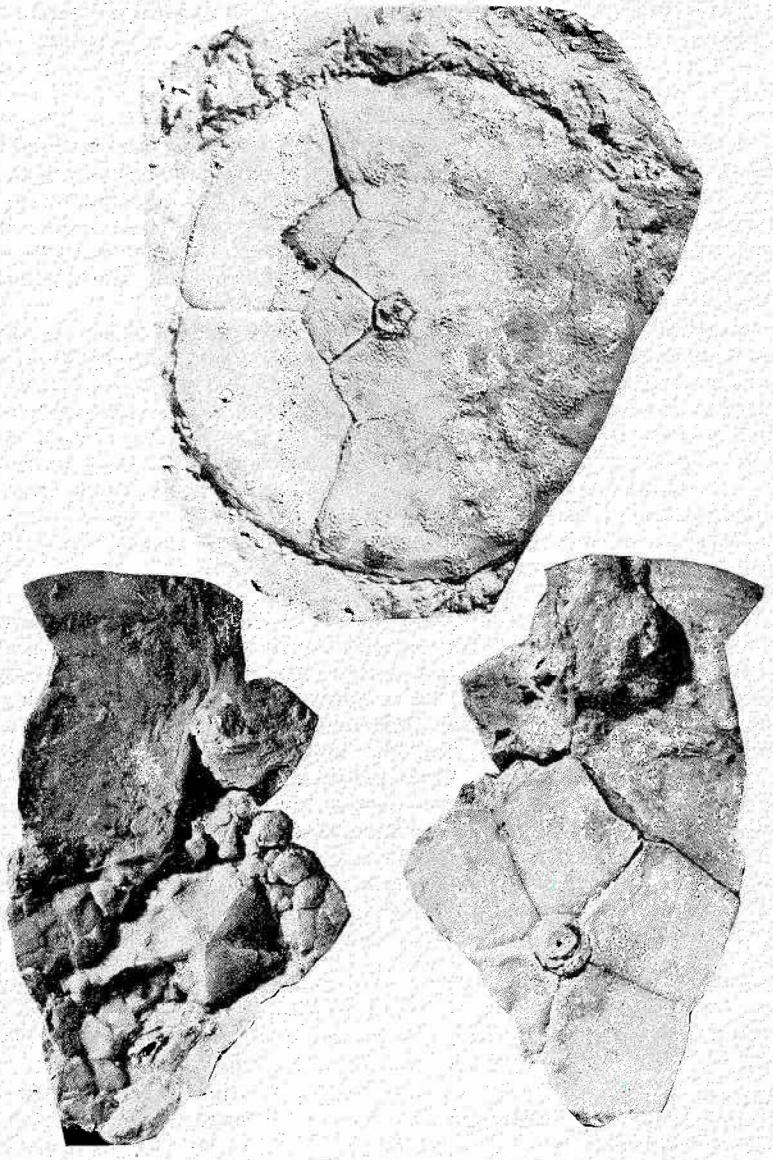

Figure 1. Parazophocrinus callosus **Strimple from Henryhouse Formation (Silurian), Pontotoc County, Oklahoma. A, holotype (USNM S5504), complete cup from base, ×2.3; B, C, paratype (USNM S5078), partial cup from summit (B) and base (C), ×2.3.**

Remarks.—The writer is not aware of any closely comparable forms.

Types.—Holotype, U.S. National Museum (USNM) S5504 (not 6224); paratype, USNM S5078 (not 6212a).

Occurrence.—Upper part of Henryhouse Formation, Silurian, Pontotoc County, Oklahoma; holotype, NW¼ SW¼ sec. 4, T. 2 N., R. 6 E.; paratype, SW¼ NW¼ NW¼ sec. 33, T. 3 N., R. 6 E.

Reference Cited

Strimple, H. L., 1963, Crinoids of the Hunton Group (Devonian-Silurian) of Oklahoma: Oklahoma Geol. Survey Bull. 100, 169 p., 12 pls.

Oklahoma Map Atlas Released

In July *Geology and Earth Resources of Oklahoma—An Atlas of Maps and Cross Sections* was released by the Oklahoma Geological Survey, culminating a project several years in the making. The 8-page color atlas comprises 1 page of introductory text and 7 pages of maps and cross sections showing the topography, geomorphic provinces, geology, and mineral and water resources of Oklahoma. All maps and cross sections are at a scale of 1:2,000,000 (1 inch = 32 miles).

Designed primarily for teachers and students of earth science at the junior- and senior-high-school levels, the atlas is expected to be of value to graduate geologists and interested laymen as well. It is being distributed within the public schools of Oklahoma cooperatively with the Oklahoma Curriculum Improvement Commission and Curriculum Section, Subject Specialist of Instructional Division, State Department of Education.

The atlas project was supervised by Kenneth S. Johnson, director of the Survey's educational programs and senior author of the publication. Other authors are Carl C. Branson, Neville M. Curtis, Jr., Melvin V. Marcher, John F. Roberts, and the late William E. Ham. The maps were prepared by cartographer David M. Deering.

The dimensions of the atlas are approximately 17 by 9 inches, a size necessary to accommodate the Oklahoma maps and text explanations. Robert S. Checorski, director of graphic services for the OU Research Institute, designed the atlas cover, which features a thermal infrared radiation map of Oklahoma prepared from data transmitted by satellite.

Released as Educational Publication 1, the 8-page atlas can be ordered from the Survey for $1.00 a copy (80 cents a copy if ordered in quantities of 20 or more). A limited number of map pages are available separately for 25 cents each.

Survey Completes Cartographic Work for TGS *Digest*

Under a cooperative agreement with the Tulsa Geological Society, the Survey has recently completed cartographic work on four large maps that will be printed in color in the society's *Digest,* Volume 37, a special issue emphasizing the environmental geology of Tulsa County. The four maps consist of an areal geologic map with Bouguer gravity contours, a general soil map, a construction map, and a map showing the locations of oil and gas wells and fields.

Cartographic preparation began 2 years ago under the direction of Marion E. Clark, senior cartographer with the Survey and principal cartographer for the project. Other cartographers were Sondra Underwood and John Langford. The bases for the color maps were compiled at a scale of 1:63,360 from 27 detailed topographic maps (scale 1: 24,000) covering the Tulsa County area. The geologic map is especially intricate and therefore took longer to prepare than the other three maps combined. Some 80 map units are depicted, requiring 14 color separations.

For the Tulsa Geological Society, Allan P. Bennison served as map editor and was assisted by W. V. Knight, W. B. Creath, Robert H. Dott, Sr., and C. L. Hayes. John F. Roberts, petroleum geologist for the Survey and a TGS member, acted as liaison between the society and the Survey—and got a bit abraded in the process—but his good efforts bore fruit and are greatly appreciated.

Other Survey and School contributors to this volume of the *Digest* include L. R. Wilson, Jiri Zidek, and Carl C. Branson, who have written paleontological articles on the Tulsa County area. Publication of the complete volume is scheduled for the fall.

Northwest Oklahoma Guidebook Now Available

The Survey announces publication of *Book II: Northwest Oklahoma,* from the eight-part series *Guidebook for Geologic Field Trips in Oklahoma.* Written by Kenneth S. Johnson, Survey geologist and director of the project, the publication opens with a general discussion of the geology of northwest Oklahoma and contains detailed descriptions of the local geology at 26 selected sites from Alfalfa, Blaine, Dewey, Ellis, Harper, Major, Woods, and Woodward Counties. Included in these field-trip sites are portions of the Great Salt Plains, Roman Nose State Park, Lake Vincent, the Glass Mountains, Big Salt Plain, Little Sahara Recreation Area, Alabaster Caverns State Park, and Boiling Springs State Park. In addition, information is provided on viewing oil and gas wells in the area.

Geologic information presented in this series is intended to give earth-science teachers sufficient background to direct student field studies, but it can also be used directly by students in preparation for trips or by the general public to improve their knowledge and appreciation of Oklahoma points of interest. The guidebooks are being pre-

pared and distributed by the Oklahoma Geological Survey in cooperation with the National Science Foundation and the Oklahoma Curriculum Improvement Commission plus the Instructional Division and the Curriculum Section of The Oklahoma State Department of Education. Compilation and preparation of material are financed through a grant from the National Science Foundation (Grant GW-5725), and publication is made possible by funds from Title V, Section 503, of the Elementary and Secondary Education Act of 1965 through The Oklahoma State Department of Education.

Copies of guidebooks in this series are being issued free within the Oklahoma school system as they are completed. *Book I*, the introductory guidebook, was released in January 1971 and contains a nontechnical discussion of the geologic history of Oklahoma as well as general information and suggestions on pre-trip planning, the responsibilities of leading a field trip, safety precautions, and recommended activities in investigating sites. Both the introductory guidebook and the Northwest Oklahoma guidebook are available to the general public —the former at 25 cents a copy and the latter at 50 cents. Requests should be addressed to the Oklahoma Geological Survey, 830 Van Vleet Oval, Room 163, Norman, Oklahoma 73069.

USGS Names New Chief Geologist

Dr. Richard P. Sheldon was recently named chief geologist of the U.S. Geological Survey and will head the Survey's Geologic Division. He succeeds Dr. Vincent E. McKelvey, who has been the Survey's director since last December.

A native of Tulsa, Dr. Sheldon received a B.S. degree with honors in geology from Yale University in 1950, attended the University of Chicago in 1951, and received his Ph.D. degree from Stanford University in 1955.

Except for a brief period of industrial employment, Dr. Sheldon has been with the U.S. Geological Survey since 1947. Prior to his present appointment, he was chief of the Survey's Organic Fuels Branch, and later, assistant chief geologist for mineral resources. As chief geologist, he will direct the operations of one of the major divisions of the USGS, which represents the largest single group of geologic-science professionals in the United States.

An internationally recognized economic geologist, Dr. Sheldon is the author of numerous scientific articles dealing with the geology of mineral deposits and energy sources—particularly phosphate deposits. In addition to his work in this country, his many foreign assignments have included service in Turkey, Chile, Iran, Saudi Arabia, Australia, the Philippines, Thailand, India, Pakistan, and Nepal. In recognition of his work in Turkey, and for the discovery of phosphate and other minerals, he received a Special Act Award from the USGS in 1962.

USGS Evaluates National Energy Resources

The U.S. Geological Survey has released a 27-page report, "Energy Resources of the United States," containing estimates of the Nation's coal, petroleum liquids, natural gas, uranium, geothermal energy, and oil from oil shale. Prepared by P. K. Thoebald, S. P. Schweinfurth, and D. C. Duncan of the USGS staff, the estimates are illustrated by scaled diagrams.

As used in the report, resources encompass all rocks and minerals potentially usable by man, including currently known and recoverable reserves, undiscovered resources which are estimated geologically or mathematically and which would be recoverable if found, and energy sources (identified and undiscovered) whose exploitation will require more favorable economic or technologic conditions than those of the present.

The total resource base for coal is estimated at 3,200 billion tons, of which 200-390 billion tons is considered identified and recoverable; the resource base for petroleum liquids is given as 2,900 billion barrels, of which 52 billion is recoverable; the natural-gas resource is estimated at 6,600 trillion cubic feet, of which 290 trillion cubic feet is recoverable; the total amount of uranium oxide is listed as about 1.6 million tons, of which 250,000 tons is recoverable; oil shale contains approximately 26 trillion barrels of oil, none of which is currently considered economic, although price increases could shift this resource into the identified-recoverable category. Information needed to determine the total resource base for heat in potential geothermal energy sources is sketchy, but the base is considered to be greater than 10 calories, where a calorie is the amount of heat required at a pressure of 1 atmosphere to raise the temperature of 1 gram of water 1° centigrade.

The report has been published as USGS Circular 650 and can be obtained free of charge by writing to the U.S. Geological Survey, Washington, D.C. 20242.

Remote-Sensing Photos Available

The U.S. Geological Survey is now offering high-altitude aerial photographs of 23 cities in the United States. Available in black and white and in color-infrared, the photographs were taken from 50,000 feet as an experiment in the use of remote-sensing techniques in monitoring change in urban land use. The program is continuing after ERTS-A, NASA's first Earth Resources Technology Satellite, was launched this year. Cities in the southwest region of the United States covered by the project are Dallas, Denver, El Paso, Houston, Galveston, Lawrence, Midland, Phoenix, Salt Lake City, Tucson, and Wichita Falls. Details on cost and format are available from: EROS Data Center, Sioux Falls, South Dakota 57198.

OKLAHOMA ABSTRACTS

GSA Annual Meeting, North-Central Section
Dekalb, Illinois, May 10-14, 1972

The following abstracts are reprinted from the North-Central Section Program of The Geological Society of America and Associated Societies, v. 4, no. 5. Page numbers are given in brackets below each abstract. Permission of the author and of Mrs. Jo Fogelberg, managing editor of GSA, to reproduce these abstracts is gratefully acknowledged.

Geochemical Variation in Pennsylvanian Shale

J. J. CONNOR and RICHARD J. EBENS, U.S. Geological Survey, Denver, Colorado 80225

The regional geochemical variability of Pennsylvanian rocks in two areas of the United States is currently being investigated; one area is in Kentucky and the other is in Missouri, Kansas, and Oklahoma. In each area, shale of Pennsylvanian age was collected from outcrop in a geographically nested sample design established for estimating the relation between sampling interval and percent of mappable geochemical variation. The design in each area permits apportioning the observed variance into a part representing local variation (variation at scales less than about 5 miles) and a part representing regional variation (variation at larger scales). Al, B, Be, Ca, Cr, Cu, Mg, Mn, Na, Si, Pb, and Y exhibit significant regional variation in one or both areas and additional sampling is needed to describe their geographic distributions. The elements listed below exhibit no significant regional variation in either area, and their expected concentration (given as the geometric mean-GM) and their expected variation (given as the geometric deviation-GD) may prove useful in assessing the unusualness of surface samples of Pennsylvanian shale from any part of either area.

	Kentucky		Mo-Kan-Okla			Kentucky		Mo-Kan-Okla	
Element	GM	GD	GM	GD	Element	GM	GD	GM	GD
Ba, ppm	410	1.5	430	1.5	Ni, ppm	30.00	1.8	38.00	1.5
Zr, ppm	230	1.6	110	1.5	Sc, ppm	18.00	1.2	15.00	1.2
Sr, ppm	110	1.7	200	1.6	Co, ppm	6.30	2.1	12.00	1.7
V, ppm	110	1.6	140	1.4	Fe, percent	4.50	2.0	4.00	1.6
Ga, ppm	25	1.7	30	1.5	Ti, percent	.58	1.4	.42	1.4

[314-15]

OKLAHOMA ABSTRACTS is intended to present abstracts of recent unpublished papers relating to the geology of Oklahoma and adjacent areas of interest. The editors are therefore interested in obtaining abstracts of formally presented or approved documents, such as dissertations, theses, and papers presented at professional meetings, that have not yet been published.

Lower Ordovician Conodonts from the Stonehenge Formation of Pennsylvania and Maryland

RAVINDRA S. TIPNIS and PETER W. GOODWIN, Department of Geology, Temple University, Philadelphia, Pennsylvania 19122

A sequence of conodonts recovered from the intertidal and shallow subtidal limestones of the Stonehenge Formation confirms the existence of Lower Ordovician Faunas A through C in the Appalachian Basin. However, overlapping ranges of key genera and species indicate the need for some modification of the definitions and boundaries of these informal biostratigraphic units.

The basal Stoufferstown Member yields a primitive fauna consisting of *Oneotodus nakamuri, Acontiodus lavademensis, Acodus housensis, Paltodus utahensis* and *Proconodontus.* These elements of Fauna A indicate a partial correlation with the Notch Peak Limestone (Utah) and Signal Mountain Limestone (Oklahoma).

Fauna B is represented in the upper beds of the Stoufferstown Member by *Cordylodus angulatus, C. oklahomensis, Plectodina* sp., *Acodus sevierensis, Oneotodus variabilis* and *Paltodus* sp. Stratigraphically above the Stoufferstown Member, elements of Fauna B are joined by typical elements of Fauna C such as *Loxodus, Acontiodus propinquis, A. iowensis, A. staufferi, Paltodus bassleri, Acodus oneotensis* and *Clavohamulus.*

In the uppermost Stonehenge, Fauna C elements along with *Acanthodus* occur with abundant Fauna D elements including *Scolopodus cornutiformis, Scolopodus quadriplicatus, Distacodus stola* and *Scandodus.* This occurrence of Fauna D elements with Fauna C elements limits the stratigraphic significance of these units, and implies a need for more precise biostratigraphic zonation.

[352-53]

GSA Annual Meeting, South-Central Section Manhattan, Kansas, April 6-8, 1972

The following abstracts are reprinted from the South-Central Section Program of The Geological Society of America and Associated Societies, v. 4, no. 4. Page numbers are given in brackets below each abstract. Permission of the author and of Mrs. Jo Fogelberg, managing editor of GSA, to reproduce these abstracts is gratefully acknowledged.

Recent Archeomagnetic Results for the United States

ROBERT L. DU BOIS and DANIEL WOLFMAN, The University of Oklahoma, Earth Sciences Observatory, Norman, Oklahoma 73069

Accurate measurement of geomagnetic secular variation for different areas on the surface of the earth is an important step leading to understanding the nature of the earth's magnetic field. The results from more than 300 archeomagnetic samples collected in the South-

western United States have led to the development of a Polar Data Representation Curve for this area for the time range A. D. 600-1600 and provide preliminary data for earlier and later time periods. Some results have been obtained from a smaller group of samples collected in the Central United States in the time range A. D. 800-1400. Comparison of the data from the two areas supports the hypothesis of westward drift at the rate of 0.2° per year. This research has also led to the development of an archeological dating method with an error on the order of ±10 to ±30 years at the 95% confidence level.

[277-278]

Using Long Period Earth Potentials as Strain Indicators

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Earth potentials were measured and recorded during the drilling of a salt water disposal well by the U.S. Corps of Engineers, near Hollis, Oklahoma. The purpose of this work was to determine if the changes in the earth potentials, caused by the mechanical stress of the formations by the injection of salt water, could be used to monitor the strains in the formations. If these effects can be monitored, then the rates of injection could be limited and adjusted to prevent displacement of the formations with the resulting disturbance at the earth's surface, such as that which occurred near Denver, Colorado.

Previous recordings of the earth potentials at the Earth Sciences Observatory at Leonard, Oklahoma, are used as a base for these studies and interpretations of these results from the Hollis area are encouraging and suggest continued research in the field of earth potentials as strain indicators.

[279]

A New Program of Coal Investigations in Oklahoma

S. A. FRIEDMAN, Oklahoma Geological Survey, Norman, Oklahoma 73069

A new coal-investigations program, initially funded by the Ozarks Regional Commission, has been undertaken by the Oklahoma Geological Survey at a time when the mining of Oklahoma's bituminous coal appears increasingly desirable because of (1) the opening of the Arkansas River Navigation System, permitting transportation by barge to St. Louis, Memphis, and New Orleans on the Mississippi River, (2) a greatly increased demand for low-sulfur coal for electric power generation and a moderately increased demand for metallurgical coal for coke and steel manufacture, and (3) the likelihood of commercial coal gasification.

Projects have been started to (1) determine the present bituminous coal resources and reserves of Oklahoma, emphasizing potential consumer uses, particularly sulfur content in view of regulations against air and water contamination, and (2) delineate 100 million tons of

recoverable coal reserves for a coal-gasification plant whose feasibility is under consideration by a major energy producer.

Future projects will (1) annually update Oklahoma's coal reserves, emphasizing the sulfur percentage of the coal, (2) systematically depict on 7½-minute topographic quadrangle maps the distribution, structure, and extent of major coals, (3) explore for deep coal deposits (500-3,000 feet), (4) study stratigraphic relations and depositional environments of the major coals to aid in correlation and in exploration for low-sulfur coal, and (5) study the occurrence and distribution of sulfur in Oklahoma's coals to determine the potential for reducing the amount of sulfur.

[279-280]

Fossil Assemblages and Their Distribution in the Ervine Creek Limestone (Late Pennsylvanian) of the Midcontinent

ALLAN D. GRIESEMER, University of Nebraska State Museum, Lincoln, Nebraska 68508

The Ervine Creek Limestone is a richly fossiliferous and variable "Upper Limestone" of the Deer Creek Megacyclothem (Virgilian), and is well exposed along a 300 mile outcrop belt from southeastern Nebraska to northeastern Oklahoma.

In recent years, multivariate statistical techniques have come into increasing use and have proven their usefulness in objective biofacies and biotope analysis. Due to the availability of Ervine Creek material, and its organic rich nature, a combination of factor and cluster analyses were utilized to help define and interpret the observed biofacies and lithofacies variability which occurs both vertically and laterally at all studied localities. These techniques allowed for a R-mode analysis of the interrelationships of 66 selected variables, and a Q-mode analysis of samples, from 14 localities, selected at three foot intervals. The Q-mode analysis revealed a continual spatial realignment of locality similarities, as the major transgressive phase of the Deer Creek Megacycle progressed.

These multivariate techniques generally substantiate an earlier, more subjective, assemblage classification for the Ervine Creek by the author, but significantly clarify the physical and biological relationships both regionally and temporally.

[280]

Clay Mineralogy of Havensville Shale

MOON J. LEE, Department of Geology, Kansas State University, Manhattan, Kansas 66502

Several samples of stratigraphically equivalent shales, sandstones

and limestones were collected at 7 localities from the Havensville Shale Member (Lower Permian) for the investigation of clay mineral assemblage by means of X-ray analyses. The sample localities cover more than 200 miles in distance from northern Oklahoma to northern Kansas. The data show little variation in vertical clay mineral assemblage in a given locality, but indicate significant lateral change from those representing near-shore marine environments to offshore deposits.

Kaolinite is present only at southern near-shore facies. Montmorillonite is gradually decreased northward and possibly converted to illite by potassium fixation through transitional stage of mixed-layer illite. Presence of both 2M and 1Md illite polymorphs indicate that not all of illite was derived from montmorillonite. Mixed-layer chlorite which shows swelling character is found at all localities with abrupt change in abundance toward north. Both regular and random interstratification with vermiculite or montmorillonite is present. Cation and heat treatment show that the mixed-layer chlorite received structural evolution upon gradual entry into deeper depositional environment. It is believed that both detrital and diagenetic effects were significant for the clay mineral assemblage in the Havensville Shale.

[283-284]

An Ecoevaluation of the Francis Formation Near Ada, Oklahoma, Through Cluster Analysis

MARY GLENN LOCKWOOD, Department of Geology, The University of Oklahoma, Norman, Oklahoma 73069

Cluster analysis was used on data of 53 species collected from 51 localities from the Francis Formation in the Superior Clay Products Claypit at Ada, Oklahoma, in order to perform a biofacies study and an ecoevaluation. Samples were collected every 40 feet horizontally and every 4 feet vertically on three quarry wall faces and in one nearby gully. The total fauna, both macro and micro, was considered in this study and separated from the shale for identification and analysis.

Five distinct communities were found that had mappable distribution both horizontally and vertically. These were primarily molluscan and brachiopod communities with an abundance of ostracods. Species diversity and relative abundance were the parameters for the clusters and thus the five communities. The communities change through time indicating perhaps community evolution due to environmental changes. There is a trend to evolve from a *Nucula wewokana-Pseudozygopleura* sp. community to a *Straparolus* (A.) *catilloides* community. In some of the vertical sample localities the trend is to pass through a brachiopod community stage before going on to the *Straparolus* community. Diversity is also decreased going from the *Nucula* community to the *Straparolus* community.

[284-285]

Feasibility of Underground Waste Disposal in Northeastern Oklahoma

LOUIS R. REEDER, Consulting Geologist, 6017 South Joplin, Tulsa, Oklahoma 74135

The Arbuckle Group including the Lamotte (Reagan) Sandstone is the only geologic horizon underlying northeastern Oklahoma that is capable of safely receiving sustained injection of large volumes of liquid waste. The criteria for injection into the Arbuckle are met in limited areas in Craig, Nowata, Mayes, Rogers, Washington, Tulsa, Wagoner and Osage Counties. Younger strata are rejected as potential waste receptacles because of inherently low reservoir volume, low permeability or clay minerals sensitive to contact with foreign fluids. However, these strata provide the aquicludes vitally essential in confining the injected wastes within Arbuckle rocks. The greatest hazard present is that of inadequately plugged wells; a factor to be considered even in areas otherwise acceptable for injection.

The Precambrian topography controls the geometry of the porous and permeable Arbuckle Group and exerts a definite but progressively diminishing influence upon the hydrogeology of the superposed beds through the Pennsylvanian System. Equally important controlling factors are the major faults which constitute hydrogeologic barriers and reduce effective reservoir volume.

Protection of the potable water and other natural resources of the state is of prime importance when considering the installation of a disposal system. Waste should not be injected into reservoirs where the connate waters contain less than 10,000 ppm total dissolved solids.

[289-290]

Distribution of Several Lithologies in Late Paleozoic Sedimentary Rocks of the Northern Midcontinent

JOHN L. RUSSELL, Department of Geology, Texas A&I University, Kingsville, Texas 78363

An investigation of outcropping post-Desmoines, pre-Leonard strata in the northern Midcontinent reveals the stratigraphic and geographic distribution of red shale, black shale, coal, gypsum, and sandstone occur in a pattern caused by regression of the Late Paleozoic Sea and coincident increased aridity. These conditions mark the regressive phase of the Absaroka Sequence in the area investigated. In Missouri, Virgil, and Geary time conditions most favorable for the deposition of black shale, coal, and red shale, respectively, occurred. Red shales are most abundant in the Chase Group. Many of these can be traced from southern Nebraska to northern Oklahoma. The southernmost limit of most red shales is progressively more northward in older rocks. Many Pennsylvanian shales contain red pigment only in Nebraska and northern Kansas. The red shales were deposited on intertidal or supratidal mud flats which were most common in Nebraska

and northern Kansas during Geary time. Bedded gypsum is present exclusively in Gearyian strata. Gypsum was deposited on high intertidal mud flats in depressions which were periodically flooded with marine water. Sandstone occurs in most abundance in Pennsylvanian rocks of southern Kansas.

[293-294]

Molluscan Diversity Gradients and Biomes in Late Albian (Cretaceous) Gulf Coast Province

ROBERT W. SCOTT, Department of Geology, University of Texas at Arlington, Arlington, Texas 76010

The Gulf Coast biotic province is one of two provinces in the Early Cretaceous seaway in the interior of the United States separated by a fluvial plain-deltaic-littoral complex. It is characterized by branco-ceratid ammonites and bivalve and gastropod species of Tethyian affinities. The northern Temperate Province is distinguished by hoplitid ammonites. Within the Gulfian Province the number of mollusk species increases along a north to south ecocline from ten to one-hundred and thirty. Ammonoids are the major contributor to this diversity gradient and bivalves and gastropods are secondary. The change in relative proportions of infaunal and epifaunal bivalves, of carnivorous to herbivorous and suspension feeding gastropods, and of various ammonoid forms partitions this fauna into biomes. These biomes are characterized by dominant life forms and represent major sedimentary environments. Environmental parameters that change along this ecocline are substrate type, distance from shore, level of normal current energy, depth, and salinity.

The northernmost biome in the Gulfian Province is the *sandy shelf* in Kansas, Colorado, and New Mexico; it is characterized by infaunal bivalves, herbivorous gastropods, and sparse ammonoids. The *muddy shelf biome* in southern Kansas, Oklahoma, and northeastern and part of west Texas contains nearly equal species of infaunal and epifaunal bivalves, many ammonoids, and few gastropods. The *carbonate shelf biome* in central Texas is dominated by epifaunal bivalves and ammonoids. The *reef biome* in south Texas contains epifaunal bivalves, many carnivorous gastropods, and few ammonoids. Biomes reflect community structure and biomass.

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New Thesis Added to OU Geology Library

The following M.S. thesis was recently added to The University of Oklahoma Geology and Geophysics Library:

Subsurface Stratigraphic Analysis, Lower Hoxbar Group (Pennsylvanian), Dutton-Verden-Norge Trend, Caddo and Grady Counties, Oklahoma, by Olumuyiwa A. Sawyerr.

THE UNIVERSITY OF IOWA

The Stratigraphy of the Hale Formation (Morrowan) in its Type Region, Northwestern Arkansas

WALTER LEROY MANGER, The University of Iowa, Ph.D. dissertation, 1971

The Hale Formation of Pennsylvanian age comprises the base of the type Morrowan Series. In its type region, the Hale Formation may be subdivided into the Cane Hill and Prairie Grove Members. The Cane Hill Member is restricted to a sequence of interbedded shale and sandstone with a limestone pebble or clay pebble conglomerate at its base. Lithologic variation within the clasts comprising these conglomerates suggests that the base of the Cane Hill Member may be diachronous.

The Prairie Grove Member is a sequence of variable lithology, predominantly very sandy biosparite, sandy bryozoan-echinoderm biosparite, and calcareous sandstone. The Cane Hill-Prairie Grove contact is taken at the base of the first calcarenite or calcareous sandstone not succeeded by interbedded shale and sandstone. Physical and faunal evidence suggests that this boundary represents an unconformity of zonal magnitude. The Prairie Grove-Bloyd boundary is drawn at the base of the first dark, fissile shale greater than two feet in thickness. Where this shale is absent, the contact is taken at the base of the first dark calcarenite overlying honeycomb weathering sandstone.

Two zones may be recognized in the Prairie Grove Member, based on the occurrence of ammonoid cephalopods. Approximately the lower half of the Prairie Grove Member constitutes the *Retites semiretia* zone. The upper half of the Prairie Grove Member represents the *Arkanites relictus* zone. In addition, the *A. relictus* zone may be further subdivided into the *A. relictus-Baschkirites librovitchi* subzone and the upper *A. relictus-Gastrioceras* n. sp. subzone. The *Retites semiretia* zone and the *A. relictus-Baschkirites librovitchi* subzone appear to be equivalent to the *Declinognathodus* (= *Idiognathoides*) *noduliferus* conodont zone of Lane (1967). The *A. relictus-Gastrioceras* no. sp. subzone is equivalent to the Hale portion of the *Neognathodus* (= *Gnathodus*) *bassleri symmetricus* conodont zone of Lane (1967). Precise limits of these ammonoid zones cannot be established because of the lack of superposition. In addition, no diagnostic fossils have been recovered from the Cane Hill Member, as restricted herein.

The Prairie Grove ammonoid zones resemble those of the Namurian of Britain, Ireland, and Poland. The *Retites semiretia* zone is probably equivalent to the Kinderscoutian R_{1a}-R_{1b} zones. The *Arkanites relictus* zone probably represents the Marsdenian R_{2c} zone of Britain or the Yedonian G_{1a} of Poland. At the present time, no faunas representative of the Namurian R_{1c}-R_{2b} zones are known, although strata which do not contain ammonoid may represent this interval.

Systematic discussion of the following taxa is also included in this study: *Arkanites relictus* (Quinn, McCaleb and Webb), New genus A *textum* (Gordon), New genus A *henbesti* (Gordon), *Gastrioceras* new species A, *Pygmaeoceras pygmaeum* (Mather), *Reticuloceras tiro* Gordon, *R. wainwrighti* Quinn, *Retites semiretia* McCaleb.

(Reprinted from Dissertation Abstracts International, Pt. B, v. 32, no. 9, p. 5258-B)

Upper Mississippian (Chesteran) Ammonoids from the Pitkin Formation in Arkansas

JOHN DALLAS TAYLOR, The University of Iowa, Ph.D. dissertation, 1972

Ammonoid assemblages of the Pitkin Formation of northern Arkansas and Oklahoma are approximately equivalent in age to the fauna from the Sand Branch Member of the Caney Formation of southeastern Oklahoma. The ammonoid fauna from the upper Barnett Formation of central Texas also contains comparable taxa. The Pitkin ammonoids include *Eumorphoceras bisulcatum* (Girty, 1909); *Carvenoceras richardsonianum* (Girty, 1909); *Arcanoceras furnishi* (Saunders, 1964); *Metadimorphoceras* aff. *saleswheelense* (Moore, 1939); *Cravenoceras lickensis* Taylor, n. sp.; *Newtonoceras maccutcheoni* Taylor, n. gen., n. sp. The Sand Branch and upper Barnett assemblages also include *Eumorphoceras bisulcatum, Cravenoceras richardsonianum* and *Arcanoceras* sp. *Paracravenoceras* sp., *C. hesperium* and *C. nevadense* are additional taxa found in the Sand Branch and upper Barnett assemblage but they have not been found in the Pitkin assemblage. Comparable ammonoid assemblages are known from Great Britain, France, Belgium, Germany, Poland, Spain, and the Algeria-Morocco border. In the Soviet Union they are known from the Arctic island of Novaya Zemlaya, the southern Ural Mountains in the Aktyubinsk Province.

The *Eumorphoceras bisulcatum-Cravenoceras richardsonianum* assemblage is represented in the upper part of the Pitkin Formation of Arkansas and in the Sand Branch Member of the Caney Formation, Oklahoma. The interval represented by the ammonoid fauna from the lower portion of the Pitkin Formation should be known as the *Newtonoceras maccutcheoni-Cravenoceras lickensis* assemblage zone. The *E. bisulcatum-C. richardsonianum* and *N. maccutcheoni -C. lickensis* assemblage zones correlate with the upper *Eumorphoceras* (E_2) Zone, lower Namurian, Arnsbergian Stage within the *E. bisulcatum* s.s. (E_2 a) Zone of the standard European succession.

(Reprinted from Dissertation Abstracts International, Pt. B, v. 32, no. 12, p. 7120-B)

National Petroleum Council Completes Phase I of U.S. Energy Analysis

The National Petroleum Council has now completed the first phase of its *U.S. Energy Outlook: An Initial Appraisal—1971-1985*, a report requested by the Department of the Interior. This stage projects energy demands for the next 15 years based on minimal changes from the present economic climate and current government policies and regulations. Newly released reports from the task groups on energy demand, nuclear energy, and new energy not covered by separate assignment wrap up this part of the project.

The group studying energy demand analyzes primary and total energy by consuming sectors—residential, commercial, industrial, transportation, electric utilities, and miscellaneous. They foresee a shift from industrial to electric utilities as the largest energy consumer, but indicate that total consumption will continue to increase in every category each year. The average annual rate of increase is estimated to be 4.2 percent.

The Nuclear Task Group concludes that uranium resources will be sufficient to meet nuclear-energy requirements for the next 15 years, but that a capital investment of approximately $5 billion will be required for exploration, mining, and processing of uranium for use as fuel in the projected level of nuclear-power plants in the United States. The newness of the technology and the uniqueness of the nuclear-fuel cycle are cited as significant factors considered in calculating estimated capital expenditures.

Some of the resources investigated by the task group on new energy forms were hydroelectric, tidal, geothermal, and solar energy. Several potential new energy forms will become increasingly important beyond 1985, according to their report, but except for geothermal energy, which looks promising for some western states, new energy forms are not likely to provide sufficient primary energy to produce much impact on the use of fossil and nuclear fuels prior to 1985. Extensive research, however, must continue, in the light of rising energy needs and the problem of meeting them with fossil fuels and nuclear power, or the new energy sources will never realize their full potential.

All three reports, *An Initial Appraisal by the Energy Demand Task Group, 1971-1985* ($5.00), *An Initial Appraisal by the Nuclear Task Group, 1971-1985* ($3.00), and *An Initial Appraisal by the New Energy Forms Task Group, 1971-1985* ($10.00), are available from the National Petroleum Council, 1625 K Street, N.W., Washington, D.C. 20006. Prepayment is required.

The next phase of the council's study will involve predictions on how changes in industry and (or) government programs and regulations would affect the United States energy outlook.

McLaughlin Named Director of USGS Central Region

Vincent E. McKelvey, U.S. Geological Survey director, has announced the establishment of three new field regions for overall administrative purposes. The three regions—Eastern, Central, and Western—will replace the four regions previously maintained by the USGS, and each new region will have a director who will carry the rank and authority of an assistant director of the Survey. Regional headquarters will be in Washington, D.C., Denver, Colorado, and Menlo Park, California, to coincide with established USGS field centers. Offices in St. Louis and Rolla, Missouri, will continue as major support field centers.

Thad G. McLaughlin has been named director for the Central Region, which includes Oklahoma. Dr. McLaughlin is a native of Kansas and resides currently in Lakewood, Colorado. He is a hydrologist, holding a Ph.D. degree from the University of Kansas (1939). In his new position he will have the responsibility of a budget of over $30 million annually and a work force of at least 2,000 employees involved in geological research and mapping, topographic mapping, water-resources investigations and research, and the supervision of mineral leases on federal lands.

Other regional directors appointed are Montis R. Klepper for the Eastern Region and Roy F. Thurston for the Western Region.

Oklahoma to Host Meeting of Interstate Mining Compact Commission

The semiannual meeting of the year-old Interstate Mining Compact Commission will be held in Tulsa, Oklahoma, October 12 and 13 at the Mayo Hotel. The first day's activities will include a field trip to at least three surface-mining operations in an effort to relate reclamation efforts in Oklahoma to those in other states. A banquet will be held that night at the Mayo, followed by technical sessions the next day. From 14 to 16 states are expected to be represented at the conference.

Interested persons are urged to attend. Additional information can be obtained by contacting Ward Padgett, chief mine inspector, State Capitol Building, Room 251, Oklahoma City, Oklahoma (phone 405/521-3859).

AGI Offers Bibliographic File

GEO-REF, the geological-bibliographic file of the American Geological Institute, is now available under a lease agreement to universities, libraries, research institutions, and corporate information centers equipped with computerized data centers. This file contains references to world-wide geological literature published in nearly 3,000 serial journals in 35 different languages and is updated monthly from current publications. This year approximately 45,000 references will be added to the present 130,000 citations. GEO-REF also offers retrospective reference-search services. Further information on this file may be obtained from Mr. Bruce H. Adkins, Marketing Manager, American Geological Institute, 2201 M Street NW, Washington, D.C. 20037.

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