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Cover Picture

WATERFLOOD MONUMENT DEDICATED IN ROGERS COUNTY

John Steiger (left), chairman of the Oklahoma Petroleum Council's historical committee, and G. R. Brainard, Jr., president of the organization, view the historical marker unveiled in Rogers County December 3 (on U.S. Highway 169, near its intersection with Winganon Road, south of Nowata and west of Chelsea) to commemorate Oklahoma's first waterflood project. Representatives of the Oklahoma Historical Society, the Oklahoma Petroleum Council, and the cities of Chelsea and Nowata were present at the dedication.

The 7-foot marker, made of red Oklahoma granite, is engraved with the story of the first waterflood operation. Basically, the process involves injecting water under high pressure through oil-bearing formations to "sweep" the oil to nearby producing wells. Waterflooding was introduced in this state in 1931, on a shallow producing property in the Chelsea oil field in northern Rogers County (NE¼ sec. 22 and NW¼ sec. 23, T. 24 N., R. 16 E.), on a Carter Oil Company lease. This company arranged for Bert Collins, who had operated waterflood ventures in Pennsylvania, to attempt the secondary-recovery method in the Bartlesville Sandstone of Pennsylvanian age, the main producing formation of the area. His success in adapting the technique to Oklahoma conditions prompted application of the procedure in adjoining states and throughout the world.

At a luncheon meeting that preceded the dedication, Kenneth J. Hughes, superintendent of the U.S. Bureau of Mines energy research center at Bartlesville, said that engineers use the Nowata-Rogers County oil fields as a classic example of the value of waterflooding. He estimated that in 1931 the 30 acres selected for flooding produced about 6 barrels of oil per day. By 1934, production had increased to 80 barrels a day.

The monument was erected 5.8 miles west of the waterflood site, now at the edge of Lake Oologah. It is one of a series of historical markers co-sponsored by the Oklahoma Historical Society and the Oklahoma Petroleum Council.

Editorial staff: William D. Rose, Rosemary Croy, Elizabeth A. Ham

Oklahoma Geology Notes is published bimonthly by the Oklahoma Geological Survey. It contains short technical articles, mineral-industry and petroleum news and statistics, an annual bibliography of Oklahoma geology, reviews, and announcements of general pertinence to Oklahoma geology. Yearly subscription, $2.00. All subscription orders should be sent to the address on the front cover.

Short articles on aspects of Oklahoma geology are welcome from contributors. A set of guidelines will be forwarded on request.

Statistics of Oklahoma's Petroleum Industry, 1972

John F. Roberts[1]

Total drilling of wells in search of oil and (or) gas increased slightly in 1972 (table 1, fig. 1). More gas wells, more dry holes, and fewer oil wells were completed in both exploratory and development categories. The average depth of oil wells increased from 4,987 feet in 1971 to 5,347 feet in 1972. Sixty counties were explored for new reservoirs. Caddo and Garvin Counties each had 26 exploratory wells drilled, and each had 3 discoveries (fig. 2). The statewide success ratio for exploratory wells was 22 percent. During 1971, the success ratio was 20 percent.

The most concentrated drilling of development wells was on the north flank of the Anadarko basin in Kingfisher, Major, Woodward, Dewey, and Blaine Counties. These wells, in addition to those in adjacent counties, resulted in extensions of existing fields and discoveries in lower Pennsylvanian sandstones of Desmoinesian and Morrowan age and in Mississippian sandstones and limestones.

Two record-breaking wells were completed in Beckham County. The Lone Star Producing Co. 1 Baden Unit, in sec. 28, T. 10 N., R. 22 W.,

[1]Geologist, Oklahoma Geological Survey.

Table 1.—Drilling Activity in Oklahoma, 1972

	1972 Crude	1972 Gas	1972 Dry	1972 Total	1971 Total
All wells					
Number of completions	1,025	341	934	2,300	2,255
Footage				12,297,180	11,247,143
Average footage				5,347	4,987
Exploration wells					
Number of completions	37	55	324	416	415
Percentage of completions	8.9	13.2	77.9	100	
Footage				2,907,925	2,440,577
Average footage				6,990	5,880
Development wells					
Number of completions	988	286	610	1,884	1,840
Percentage of completions	52.4	15.2	32.4	100	
Footage				9,389,255	
Average footage				4,984	4,786

Source: *Oil and Gas Journal*, v. 77, no. 13, March 26, 1973.

was drilled to a total depth of 30,050 feet, man's deepest penetration into the Earth. The well was plugged back to production at a shallower depth. The Union Oil Co. of California 1-33 Bruner, sec. 33, T. 11 N., R. 25 W., drilled to 24,548 feet, became the world's deepest producer from rocks of the Hunton Group of Devonian-Silurian age. These 2 wells cost more than $10 million, but the technology gained by the entire industry in solving problems encountered in drilling and completing them is incalculable.

A significant new-zone discovery, the Helmerich and Payne, Inc. 1 Mobil, was made in Stephens County, sec. 13, T. 1 S., R. 4 W. The well flowed at a rate of 2,754 barrels of oil and 2.7 million cubic feet of gas per day from the Sycamore Limestone of Mississippian age. A total of 200 feet of the formation was exposed to the well bore. The area was developed with 80-acre spacing, and by the end of the year several offset wells had been completed, an indicator of a substantial reservoir.

Table 1 summarizes drilling activity during 1972. The increase in average drilling depth was due to activity in the deep part of the Anadarko basin.

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

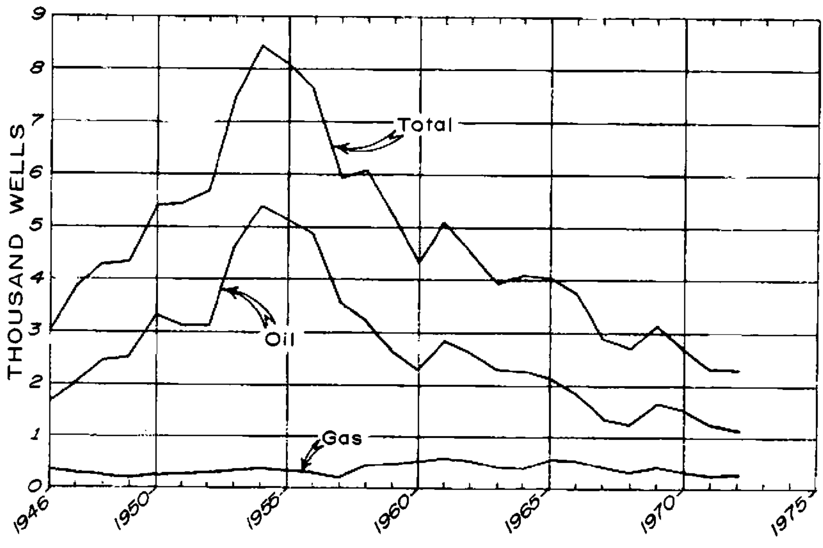


Figure 1. Graph showing total wells drilled, oil wells completed, and gas wells completed in Oklahoma, 1946-1972. Source: *Oil and Gas Journal.*

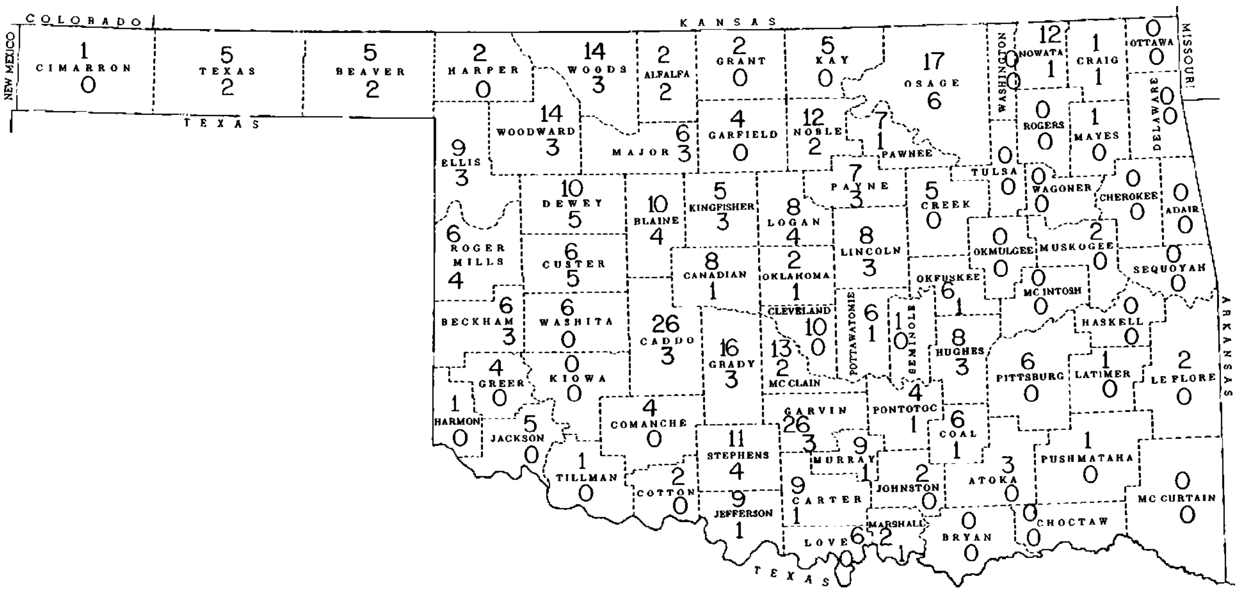


Figure 2. Exploratory drilling by counties during 1972. Upper figures give the number of exploratory wells drilled; lower figures give the number of successful completions. Source: American Petroleum Institute in cooperation with the U.S. Bureau of Mines.

barrels of oil.) These giant fields produced 48 percent of the year's total oil and accounted for 48 percent of the estimated ultimate yield and remaining recoverable reserves in the State. This production came from 36 percent of the State's total number of producing wells.

Table 3 lists cumulative and yearly production and the value of all petroleum products to January 1, 1973. Table 4 compares the petroleum production of the past 2 years. Crude-oil production decreased, even though the proration factor continued at 200 percent during the year. As it has for the past several years, the rate of production failed to meet market demands.

TABLE 2.—GIANT OIL FIELDS OF OKLAHOMA, 1972

FIELD	1972 PRODUCTION (1000 BBLS)	CUMULATIVE PRODUCTION (1000 BBLS)	ESTIMATED RESERVES (1000 BBLS)	NUMBER OF WELLS
Allen	2,880	121,736	18,264	1,482
Avant	365	105,832	3,168	615
Bowlegs	1,345	155,077	9,923	173
Burbank	4,715	496,484	43,516	1,091
Cement	2,390	136,486	18,514	1,476
Cushing	2,980	456,972	18,028	1,715
Earlsboro	560	215,344	4,656	203
Edmond West	730	153,807	6,193	471
Eola-Robberson	4,585	99,902	40,098	484
Fitts	1,600	146,128	13,872	624
Glenn Pool	2,090	305,291	14,709	1,015
Golden Trend	11,955	384,001	15,999	1,308
Healdton	5,595	279,785	40,215	2,004
Hewitt	5,590	205,511	34,489	1,187
Little River	445	159,206	5,794	170
Oklahoma City	1,850	730,036	19,964	295
Seminole, Greater	1,345	197,256	12,744	265
Sho-Vel-Tum	33,800	934,886	215,114	7,950
Sooner Trend	14,390	178,124	71,876	2,984
St. Louis	1,290	213,860	11,140	610
Tonkawa	270	134,662	2,338	182
Totals	100,770	5,810,386	620,614	26,304

Source: *Oil and Gas Journal,* v. 71, no. 5, January 29, 1973.

TABLE 3.—CUMULATIVE (THROUGH 1955) AND YEARLY (1956-1972) 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	213,312	725,610	1,684,260	273,945	595,854	40,856	1,156,680	56,732
1972[1]	208,400	708,560	1,733,000	299,809	617,400	43,660	1,134,000	59,100
Totals	10,805,201	22,192,724	33,230,668	4,129,647	23,724,437	1,477,742	18,836,621	731,644

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 1972.

Figure 3 shows a decrease in natural-gas reserves from 15.7 trillion cubic feet in 1971 to 14.5 trillion cubic feet. Extensions and revisions, as well as discoveries, increased slightly, but increased production offset these nominal increases.

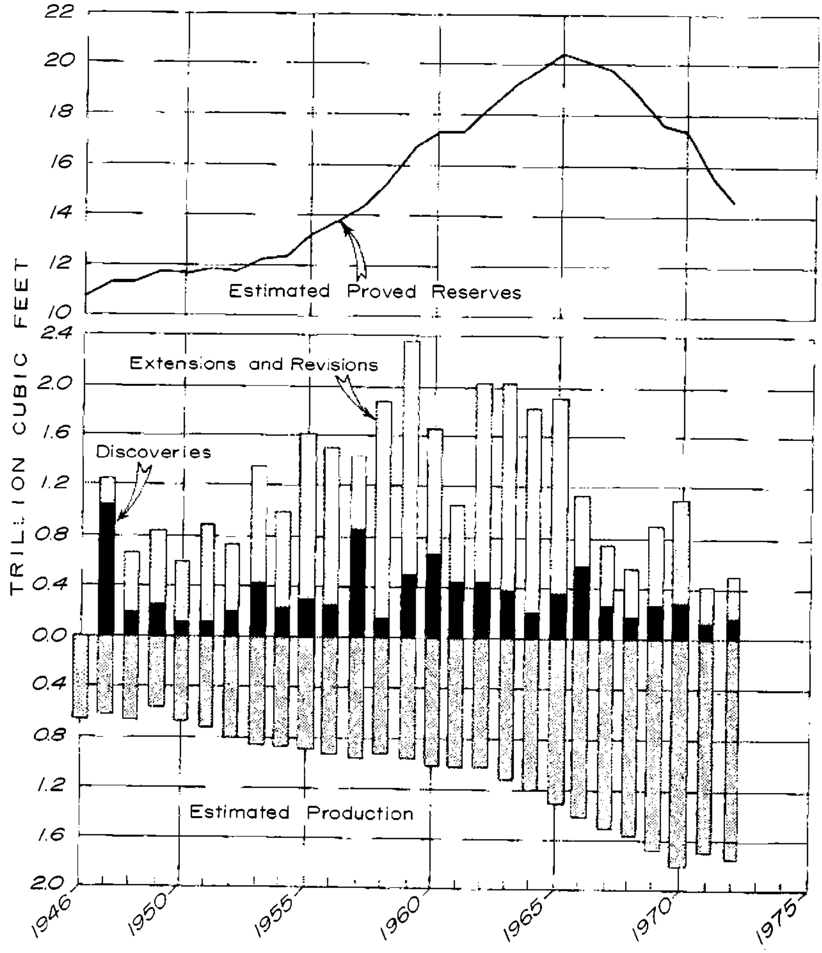


Figure 3. Graph showing statistics on estimated proved reserves of natural gas in Oklahoma, 1946-1972. Source: American Gas Association, annual reports.

Figure 4 displays decreases in extensions and revisions, production, and reserves of total liquid hydrocarbons. These decreases were due in part to increased tax burdens. Higher taxes caused abandonment of marginal wells that normally combine to account for significant production and

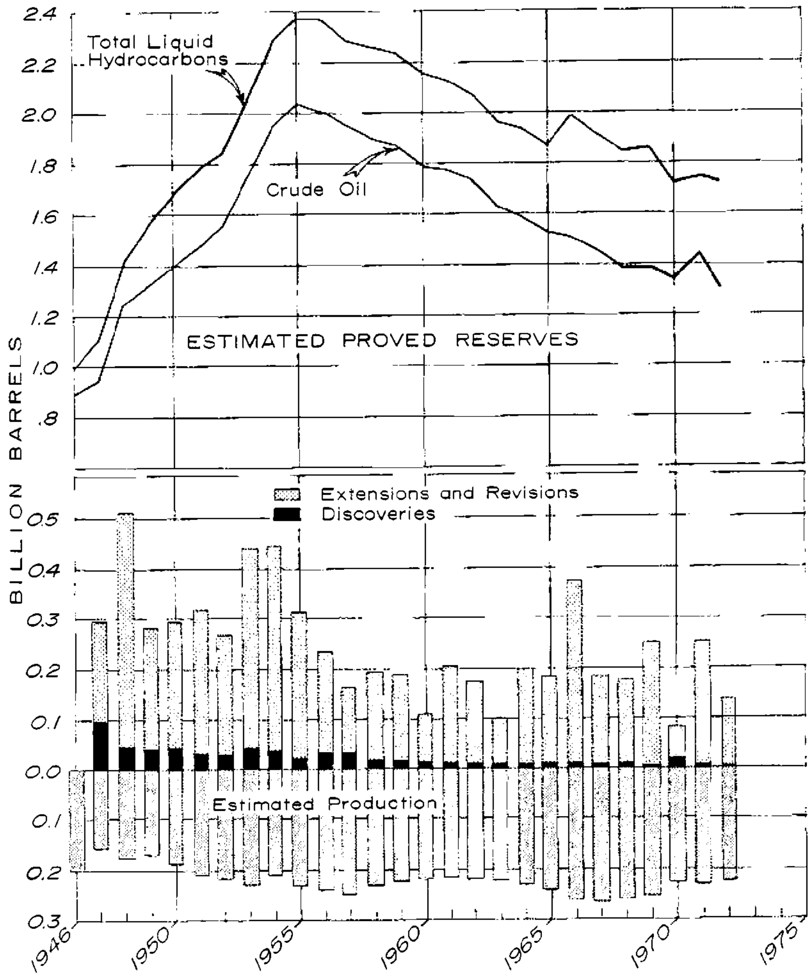


Figure 4. Graph showing statistics on estimated proved reserves of total liquid hydrocarbons in Oklahoma, 1946-1972. Source: American Petroleum Institute, annual reports.

reserves. The price of crude oil remained firm throughout the year, even though natural-gas prices began to rise, particularly in intrastate sales.

Oklahoma continues to rank third in the nation in gas production and fourth in crude-oil production. The State is in fourth place in terms of natural-gas reserves and fifth in oil reserves.

TABLE 4.—HYDROCARBON PRODUCTION IN OKLAHOMA

	1971	1972
Crude oil and lease condensate		
Total annual production (1,000 bbls)[1]	213,312	208,400
Value ($1,000)[1]	725,611	708,560
Cumulative production 1891-year (1,000 bbls)	10,602,389	10,805,201
Daily production (bbls)	584,416	570,958
Total number of producing wells[2]	75,549	73,807
Daily average per well (bbls)	7.7	7.7
Oil wells on artificial lift (estimated)[2]	71,549	69,807
Natural gas		
Total annual marketed production (MMCF)[1]	1,684,260	1,733,000
Value ($1,000)[1]	273,945	299,809
Total number of gas and gas-condensate wells[2]	8,141	8,453
Natural-gas liquids		
Total annual marketed production (1,000 bbls)[1]	41,727	42,300
Value ($1,000)[1]	97,588	102,760

[1]Item for 1971 is U.S. Bureau of Mines final figure. Item for 1972 is U.S. Bureau of Mines preliminary figure.

[2]*World Oil,* annual forecast and review issue, v. 176, no. 3, February 15, 1973.

Guidebooks for Arbuckle and Wichita Mountains Now On Sale

Guidebooks for two of Oklahoma's most scenic areas, the Arbuckle and Wichita Mountains, are now available from the Oklahoma Geological Survey. The OGS publications were prepared for field trips held prior to The Geological Society of America's November meeting in Dallas. The price of the Arbuckle guide is $3.00, and the Wichita guide is $2.00.

Compiled by T. L. Rowland, Survey geologist, *Regional Geology of the Arbuckle Mountains, Oklahoma,* is based on OGS Guide Book 17, authored by the late William E. Ham and published 4 years ago. It contains new material, however, including geologic descriptions of roadcuts along Interstate Highway 35 by Survey geologists R. O. Fay and T. W. Amsden.

Kenneth S. Johnson of the Survey and Rodger E. Denison, Mobil Research and Development Corporation, are principal authors of *Igneous Geology of the Wichita Mountains and Economic Geology of Permian Rocks in Southwest Oklahoma.* Natural salt deposits and gypsum resources are discussed, as are copper deposits near Altus presently mined by Eagle-Picher Industries.

Coal Will Help, but—

Vincent E. McKelvey, director of the U.S. Geological Survey, in a paper presented November 12 as part of a symposium at the annual Geological Society of America meetings in Dallas, concluded that Western coal resources can ease but not solve our nation's energy-environmental dilemma.

At the symposium, "Western Coal: Energy Crisis Versus Environmental Impact," Dr. McKelvey told his colleagues that coal resources in the Western States total about 850 billion tons and represent more than half the coal resources in the country that lie within 3,000 feet of the surface. Although these huge deposits have the potential for helping to alleviate our energy shortage, he said, their development poses difficult challenges for a national energy policy. As most of the Western coal is low in sulfur content, it is much superior to Midwestern and Appalachian coal with respect to sulfur pollution, but problems are inherent with policy determinations for its recovery.

Coal production for the Western States was about 39.7 million tons in 1972. The National Academy of Sciences (NAS) projects a cumulative production of 3.7 billion tons over the period 1972-2000, which is a significant figure to consider. Dr. McKelvey explained that the difficulties of making this source of energy available for consumption, however, are representative of the problems of establishing policies for the development of all categories of our energy sources.

Dr. McKelvey's views on specific aspects of coal development follow.

Surface-mining and underground-mining impacts.—Three percent of the resources are in beds considered strippable, and many of the beds are more than 50 feet thick, representing highly concentrated energy sources. A bed 50 feet thick would yield 1.5 trillion btu per acre, if fully recoverable. Actual recovery is limited to 10 to 90 percent, however, with the highest recoveries obtained by surface mining. To reach the production figures projected by the NAS by the year 2000, 188,000 acres, or 290 square miles, would have to be disturbed by surface mining. Some 20,700 acres, or 33 square miles, has been disturbed already as of January 1, 1972. At current consumption rates, 48,000 acres, or 75 square miles, of surface-mined land would be required to provide our nation's annual energy needs.

Although the effects of mining without regard for the environment are well known—such as subsidence, sedimentation, erosion, water pollution, air pollution, a general blight on the affected region and its people—this does not have to be. Present practices of mining and reclamation in this country and in Europe demonstrate the advances in minimizing environmental impacts.

Resource conservation.—Waste must be avoided, both of unrecovered coal and of other resources disturbed or destroyed by mining operations.

Energy loss and water consumption in conversion methods.—Coal gasification is expected to begin soon in New Mexico, Wyoming, and North Dakota. Each plant would produce about 250 million cubic feet of gas per day, or 90 billion cubic feet per year, and would consume 9 million tons of coal plus 20,000 to 30,000 acre-feet of water per year. It would take 11 such plants to yield only 5 percent of the nation's current annual consumption of natural gas, and each plant, if working 20-foot-thick beds, would require reclamation of nearly 12 square miles of land after 30 years.

Another conversion method, the production of synthetic oil from coal, from a plant of the same capacity would use 40,000 acre-feet of water per year; a dry-tower thermal power plant would require 5,000 acre-feet per year, and one using an evaporation tower would require 45,000 acre-feet per year. Thus water availability would be a highly limiting factor in conversion. Also, water would be lost in the mining of those coal beds that are presently aquifers

It is clear, as Dr. McKelvey points out, that "development of Western coal is going to require a far greater effort in advance acquisition and analysis of geologic, hydrologic, and biologic data than has been customary in the past." It will take time, consideration, and, in the meantime, reduction of energy consumption.

Exploration Geologists Get Assist from OU

The School of Geology and Geophysics at The University of Oklahoma, in cooperation with Business and Industrial Services, is sponsoring a short course for explorationists January 7-11. Entitled "Origin of Porosity and Permeability in Sandstones," the course will be taught by Harvey Blatt, associate professor of geology at OU. Dr. Blatt's fields of interest are the sedimentology, petrology, and geochemistry of sandstones, and he has published a textbook, *Origin of Sedimentary Rocks,* in collaboration with G. V. Middleton of McMaster University and R. C. Murray of Rutgers University.

While the thrust of the course is assisting exploration geologists in understanding how to predict the location of commercially significant petroleum reserves and the fact is stressed that diagenetic changes that alter depositional porosity and permeability are to a large degree chemical in nature, the course assumes that petroleum geologists are not necessarily chemists or geochemists and need not be to understand diagenesis in sandstones. Lectures will be supplemented by slides and laboratory sessions using the polarizing microscope.

The $225 fee required for the course covers all course material and is tax deductible. Refunds will be allowed for canceled reservations. Provisions have been made for lodging and meals. For registration forms and further information, contact Charles J. Mankin, School of Geology and Geophysics, The University of Oklahoma, 830 Van Vleet Oval, Norman, Oklahoma 73069.

Forum Discusses Oklahoma's Energy Needs and Outlook

The Honorable Carl Albert, keynote speaker.

Members of Congress joined with energy specialists at a forum on "Living Energy in Our Future," held September 29 at the Oklahoma State Fair in Oklahoma City. The forum was a wrap-up of the fair's theme, "Exposition of Energy," as developed by this year's president, Dean A. McGee, chairman of Kerr-McGee Corporation.

The 1-day meeting featured a keynote address by the Honorable Carl Albert, Speaker of the U.S. House of Representatives, and a panel on energy fuels chaired by Robert A. Hefner III (also chairman of the Oklahoma Energy Advisory Council). Donald S. Kennedy, chairman of Oklahoma Gas & Electric Company, served as general chairman of the forum.

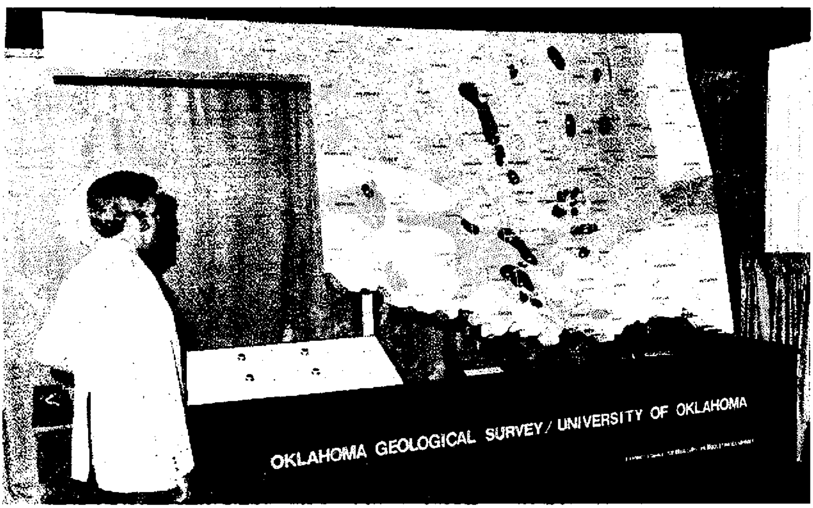
On display in other parts of the hall were exhibits prepared by groups representing industry, academic institutions, and government. The Oklahoma Geological Survey presented three displays (see accompanying photographs), the most elaborate of which was a large map constructed for the Survey by Phillips Petroleum Company, showing the energy-fuels deposits of Oklahoma. The map is a larger version of one printed at a scale of 1:2,000,000, also prepared as a public service by Phillips Petroleum Company in cooperation with the Survey and distributed at the fair.

Most of the forum's participants agreed that the long-term outlook for Oklahoma's, and the nation's, energy needs was sobering, and several speakers stressed the necessity for increasing imports—this in the light of assumed continuing availability of petroleum supplies from the Middle East, before the embargo by the Arab producing states.

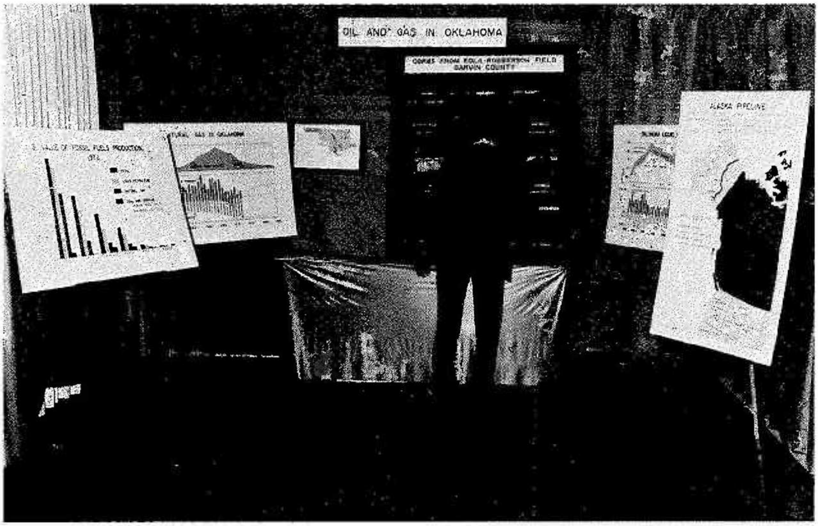
Speaker Albert reminded the audience that at current oil and gas production rates, on the one hand, and discovery rates on the other, Oklahoma would become a net importer of energy in 10 years' time. He applauded Congress for approving construction of the trans-Alaska pipeline, however, and closed on a note of optimism about America's future and its ability to solve its energy problems.

Representative C. Melvin Price of Illinois, chairman of the Joint Congressional Committee on Atomic Energy, acknowledged Kerr-McGee Corporation's leadership in the nuclear-energy field, mentioning its Sequoyah and Cimarron facilities. He went on to say that plans had been formulated for construction of a prototype fast-breeder reactor—to be supported by the federal government—designed to generate more fuel than it consumes.

Jack H. Bridges, technical director for energy resources of the Joint Congressional Committee on Atomic Energy, demonstrated an energy display he had prepared to familiarize U.S. Representatives and Senators with the nation's long-range outlook on the energy spectrum. His projections included the relative proportions the major energy sources were expected to contribute toward satisfying demand through 1990. He emphasized the need for increased imports in order to meet future demand. In explaining how our growing domestic shortage had developed, he said that in the past—in a time of surplus—the consumer had been getting fuel at the



Map display showing energy-fuels deposits of Oklahoma, prepared by Oklahoma Geological Survey and constructed by Phillips Petroleum Company. Buttons at left activate electric lights representing gas-processing plants (shown lit here), oil refineries, petrochemical plants, coal mines, and natural-rock-asphalt deposits. World's deepest well and deepest producing well are also shown by lights; both are in Beckham County. Broad shaded areas represent general areas of oil and (or) gas production, and eastern Oklahoma area delineated by diagonal lines represents coal field. Giant oil fields (darker shading) and giant gas fields (lighter shading) are also shown.



Oil and gas display. Prepared by John F. Roberts and OGS cartography section.

Display on coal mining and reclamation in Oklahoma. Prepared by Kenneth S. Johnson and OGS cartography section.

cheapest possible price; but with demand expected to increase exponentially, other domestic energy sources would require development. He proposed a compromise solution: reduce future demand, with all the objections and drawbacks this would entail, and develop all current and potential domestic sources of energy.

In introducing the energy panel, at the beginning of the afternoon session, Robert Hefner III stated that one of the main contributors to the energy problem was government's overprotection of the consumer, causing prices to be held at artificially low levels.

Robert P. Luke, manager of minerals planning and evaluation for Kerr-McGee Corporation, praised the active exploration for nuclear ores, especially uranium, by Oklahoma companies Kerr-McGee, Phillips, and Skelly. He predicted that by 1990, 20 to 40 percent of Oklahoma's energy needs would be supplied by the nuclear segment.

Wayman Humphrey, president of Oklahoma Natural Gas Company, blamed federal controls for many current gas-supply problems. He felt that higher intrastate gas prices had boosted exploration significantly in places like the Anadarko basin, and he recommended decontrol of prices at the wellhead for interstate sales.

Bill Cleary, chairman of Cleary Petroleum Corporation, recommended two steps in meeting Oklahoma's energy needs: cutting oil consumption (partly by permitting a natural rise in prices to meet the level of increasing world prices) and improving profit incentive for discovering and developing new reserves.

Ward Padgett, chief mine inspector, Oklahoma Department of Mines, forecasted a role of increasing importance for coal in meeting Oklahoma's energy needs.

Charles J. Mankin, director of the Oklahoma Geological Survey, enumerated various energy sources for the future: (1) potential natural sources, such as water power, wind power, and ocean tides and currents; (2) synthetic sources, such as conversion of fossil fuels (utilizing oil shale and coal); and (3) natural thermal sources, such as geothermal and solar energy. He stated that researchers at Oklahoma State University and The University of Oklahoma are currently studying ways in which wind power can be utilized. With regard to work on synthetic energy sources, he cited development to date of oil-shale resources and the growing interest in coal gasification and liquefaction. Dr. Mankin referred to a completed feasibility study for coal gasification in eastern Oklahoma that called for the use of high-sulfur, high-Btu coal; the OGS had determined that sufficient coal resources of this type are present in at least three areas. He covered the present utilization of geothermal energy in Italy, New Zealand, Iceland, Mexico, and California, and predicted that this form of energy would continue to expand in such areas. He felt, however, that there was little promise for traditional geothermal applications in Oklahoma. In closing, he added that he considered the prospects for solar energy enormous, though untapped, and that Oklahoma's climate was favorable for development of such applications.

New Special Papers Issued by GSA

Conodont Paleozoology, edited by Frank H. T. Rhodes, has been released by The Geological Society of America as Special Paper 141. The issue contains papers resulting from a 2-day symposium held at the North-Central Section Meetings in May 1970 and shows the dramatic growth in this field of paleobiology. Scanning-electron microscopy has added significant knowledge of both the internal and surface structure of conodonts. Facies relationships and geographic restrictions are clarified, taxonomic questions are raised, and provisional multi-element taxonomy is discussed, as well as further evidence concerning the nature of the conodont animal. The cost of the 296-page book is $12.75.

Special Paper 143 is a *Bibliography of Theses in Geology, 1967-1970,* compiled by Dederick C. Ward. It is the first of a series of monographs on theses for advanced degrees in geology and related sciences in the United States and Canada and should prove a valuable reference source. Theses are grouped in 21 categories and are also indexed by subject, author, geologic names, and colleges and universities. The cost of the 160-page book is $15.00.

Both volumes can be ordered from The Geological Society of America, Publication Sales Department, 3300 Penrose Place, Boulder, Colorado 80301.

National Petroleum Council Reports on Coal and Nuclear Availability

The National Petroleum Council, an industry advisory body to the Secretary of the Interior, has announced publication of two reports prepared in connection with its previously issued study on U.S. Energy Outlook (see February 1973 issue of *Oklahoma Geology Notes,* v. 33, p. 13-14).

The first of the two reports, *U.S. Energy Outlook–Nuclear Energy Availability,* examines various projected nuclear growth rates and factors that influence these growth rates; the adequacy of the domestic resource base of nuclear fuels, uranium and thorium; required exploration, mining, and milling activity to supply U_3O_8 from the resource base; nuclear-fuel processing requirements; cost of nuclear fuels in power generation; and the necessary capital expenditures for the nuclear-fuel-supply industry.

The report emphasizes that sharp increases in exploratory efforts must be registered immediately if any impact is to be felt on uranium supply during the 1970-85 period under study by the task group, because there is an 8- to 10-year lag between initial exploration and uranium production.

The task group on coal availability also calls for immediate action; one of the group's major conclusions is that the nation's coal resources can make a major contribution to our country's energy needs, but only if technology is applied to solve environmental problems created by its use. According to the report, in 1972 surface-mined coal accounted for more than 50 percent of total coal production. Surface mining is attractive, at the present time, because it is not subject to the health and safety problems associated with deep underground mines. But the group concludes that the coal industry's ability to do its part to meet future energy needs will depend upon the ability to produce coal from deep mines in an acceptable manner.

The report, *U.S. Energy Outlook–Coal Availability,* also examines United States coal consumption and exports, coking-coal requirements, coal reserves, selected coal-industry statistics, and coal-mining economics. Additional material includes discussions of rail and water transport of coal, coal-slurry pipelining in the Western United States, electric-power generation, manufacture of pipeline gas from coal, and the manufacture of hydrocarbon liquids from coal.

Both reports are available from the National Petroleum Council, 1625 K Street NW, Washington, D.C. 20006. The nuclear-availability report is $10.00, and the coal report is $18.00; prepayment is requested.

USGS to Publish New Large-Scale Maps

The U.S. Geological Survey announced in October that it is launching a program involving preparation of a series of new "orthophotographic" maps at a scale of 1:2,400, or 1 inch = 200 feet. This scale is 10 times larger than the largest scale maps (1:24,000) currently published by the Survey. The new scale provides sufficient detail for the maps to be effective in urban areas for planning, zoning, property records, law enforcement, sanitation, transportation, and other public-service and land-use needs.

The orthophotographic maps, the USGS explains, are photoimage maps containing all the information appearing on aerial photographs, accurately positioned. The combination of aerial photography and conventional mapping techniques thus provides distortion-corrected black-and-white photoimage maps that portray an up-to-date and realistic picture of the land's surface. In addition to their own utility, the maps are expected to serve as an excellent foundation for more specialized maps and, eventually, for a computer-supported urban information system.

Charleston, South Carolina, has been selected as the site of the first large-scale orthophotographic mapping project. A total of 500 maps will cover about 500 square miles of urbanized portions of Berkeley, Charleston, and Dorchester Counties. These counties are also sharing the cost of the project. The first maps are expected to be available by March 1974.

Additional information on orthophotographic mapping and the Charleston project can be obtained from the Chief, Topographic Division, U.S. Geological Survey, Washington, D.C. 20244.

OCGS to Offer Environmental-Geology Course

The Oklahoma City Geological Society will offer a short course on environmental geology beginning in mid-January 1974. The course will meet in Oklahoma City one evening a week for 12 to 15 weeks, and for several hours on 3 or 4 Saturdays in April and May for field work at Lincoln Park. Conducting the course will be Kenneth S. Johnson of the Oklahoma Geological Survey and Gary F. Stewart of Oklahoma State University.

The course was conceived by the OCGS Environmental Geology Committee, which consists of Ralph H. Espach, Jr. (chairman), Charlotte J. Boone, Greg Cook, Dr. Johnson, and Dr. Stewart. It is being offered in conjunction with graduate-study programs at The University of Oklahoma and Oklahoma State University, and both schools will offer 2 hours' credit to those who wish to enroll in the course for credit. The course will be open to professional geologists, graduate students at both universities, and to other persons interested in the program.

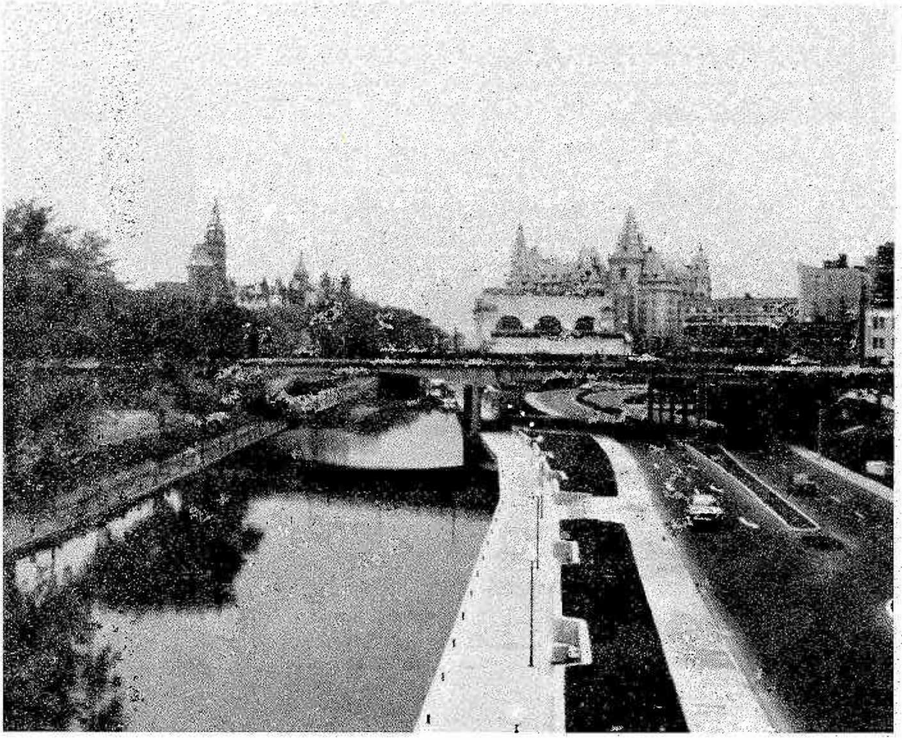
The complete course has not yet been established, but it will cover such subjects as ground-water pollution, surface-waste disposal, liquid-waste disposal, surface-water runoff, foundation-construction materials, geologic mapping for the nongeologist, mineral resources, and environmental-impact statements. Specialists in a number of these and other fields will be invited to direct class activities in their specialties.

Those interested in obtaining information on the course should contact Espach (405/236-3436), Johnson (405/325-6541), or Stewart (405/372-6211, ext. 597).

Earth Science Editors Trip to Fantastic Canada

The Association of Earth Science Editors held its seventh annual meeting September 30-October 3 in Ottawa, Ontario, Canada. Technical sessions were sandwiched between a field trip into the Gatineau Hills of neighboring Quebec and individual excursions along the Rideau Canal and through the Canadian Parliament building.

A treat was in store for participants immediately upon registering, as each conference packet contained *Geowriting, a Guide to Writing, Editing, and Printing in Earth Science*. Published by the American Geological Institute's Council on Education in the Geological Sciences (and funded by the National Science Foundation), the guide should prove useful to seasoned editors, students, and scientists alike. Much of the early work on it was done by the association, and most of its contributors are AESE members, as are the editors—Wendell Cochran, Peter Fenner, and Mary Hill. Single copies from the first printing can be obtained free of charge from AGI, 2201 M Street, NW, Washington, D.C. 20037. After the initial supply is exhausted, copies will sell for $3.00 each; a microfiche edition will be available for $1.50.



Ottawa's old-world charm, as seen along the Rideau Canal. Parliament Buildings are at left, on skyline.

Composition systems, alternatives to journal publication, automated cartography, information systems, and publication financing were topics discussed at the meeting. Rosemary Croy, Oklahoma Geological Survey associate editor, chaired a session on the activities and services of GEO·REF (AGI's data-retrieval system) and the Canadian Centre for Geoscience Data.

One of the high points of the meeting was presentation of the AESE Award for Outstanding Contributions in the Earth Sciences to Edwin B. Eckel, executive secretary of The Geological Society of America. Ed was the unanimous choice for the award and its first recipient. He was a joint author of the first (Professional Paper 541) of a series of well-edited, informative U.S. Geological Survey reports on the Alaskan earthquake of 1964, sole author of the summary and conclusions (Professional Paper 546) in this series, and editor for the intervening six chapters on the quake. He was editor of GSA Memoir 110 on the Nevada Test Site and editor of the landslide book of the Highway Research Board. As Marie Siegrist, editor of GSA's *Bibliography and Index of Geology,* said in announcing Ed's selection, "an even more significant facet of his editorial contribution has been his effect on those who have been associated with him in the editorial process. His influence has been responsible for the quality and integrity of much of the geologic writing of today."

New officers introduced at the Ottawa meeting were Mary Hill, geologic data officer for the California Division of Mines and Geology, chairman; George Becraft, chief of the Office of Scientific Publications for the U.S. Geological Survey, vice-chairman and chairman-elect; and Robert W. Kelley, editor for the New Mexico State Bureau of Mines and Mineral Resources, director-at-large. OGS editors Bill Rose and Rosemary Croy agreed to serve as editors for one more issue of the association's quarterly newsletter before relinquishing the task to a new team, Kathleen Salzberg, University of Colorado, and Harrison Shaffer, GSA.

The next AESE annual meeting will be October 13-16, at the convention center in Asilomar Beach State Park, near Monterey, California. AESE members and prospective members should send recommendations about subjects for the next meeting to the program chairman, Janyth Tolson, Editor, Geological Survey of Alabama, P.O. Drawer O, University, Alabama 35486.

It will be hard to top Ottawa—with its vibrant fall colors and Canadian charm—but California will have a chance to try its magnificent best, so earth-science editors had better plan early and beat the rush.

Pat Wood Dickerson, on a rainy AESE field trip, assessing the geology of a quarry in the Gatineau Hills north of Ottawa. The quarry was formerly worked by the Aluminum Company of Canada for the mineral brucite, a hydroxide of magnesium, which occurs in the marbles of the region. Now with the Texas Bureau of Economic Geology at Austin, Pat will be remembered by many readers as a former associate editor for the Oklahoma Geological Survey.

Happy 25th to the AGI

In the beginning there was Carey Croneis, who in 1942 at Chicago tossed out a proposal to his colleagues at a meeting of The American Association of Petroleum Geologists, advocating formation of an "American Geological Association."

In the beginning, actually, there were several concerned and learned professionals—like A. I. Levorsen, W. B. Heroy, Sr., E. L. DeGolyer, D. W. Bronk, Henry Aldrich—whose field was the solid earth. But Croneis was one of the first to voice nationally his dismay over the fragmentation of what should be, if not a completely unified, at least a coordinated, science.

It was not until November 15, 1948, that the American Geological Institute was founded officially, toward the purposes of professional, unified cooperation of branches of the earth sciences, public dissemination of discoveries in the earth sciences, and closer interrelations with other sciences. It began as an affiliate under the wing of the National Academy of Sciences-National Research Council with the goal of becoming an independent organization which would remain related to the NRC. Eleven national groups joined for the inaugural meeting.

Ten years ago the institute became independent, emerging from the protective wing of the NAS. And now 18 scientific and professional societies make up the nonprofit federation. Following is an account of some of its projects and publications over the past 10 years.

The Earth Science Curriculum Project produced a secondary-school textbook, *Investigating the Earth,* with a 2-volume teachers guide. Closely related is the Earth Science Teacher Preparation Project; the School of Geology and Geophysics at The University of Oklahoma has contributed significantly to the establishment and furtherance of this project. The Council on Education in the Geological Sciences, sponsored by the National Science Foundation to develop undergraduate programs, has released some 40 publications. One of the most recent of these is *Geowriting, a Guide to Writing, Editing, and Printing in Earth Science,* a joint effort with the Association of Earth Science Editors.

A Minority Participation Program was established with the objective of increasing professional opportunities and developing earth-science education for minority groups with the hope of encouraging more Blacks, Chicanos, and American Indians to enter the field. The U.S. Geological Survey's mobile earth-sciences exhibit, which recently visited the OU campus, is part of this program (see February and October 1973 issues of *Oklahoma Geology Notes,* v. 33, p. 2, 200).

A most important program in making vast amounts of information readily available is the computerized bibliographic file GEO · REF, which provides camera-ready copy for bibliographies and indexes, computer printouts, and magnetic tapes.

Other fine services and publications include the new *Glossary of Geology,* the biennial *Directory of Geoscience Departments,* the monthly

Geotimes, and the upcoming second edition of *Geology and Earth Science Sourcebook.*

As AGI has grown and evolved, the science, too, has grown and evolved, becoming even more fragmented than when Croneis voiced his unease. But as Linn Hoover, executive director, states in his editorial in the October 1973 *Geotimes* (p. 21): "AGI has survived for 25 years because in concept, if not always in practice, it's essential to the welfare of the geological sciences. With your help and cooperation, its next 25 years will be even more rewarding."

See:

American Geological Institute, 1973, American Geological Institute since 1963: Geotimes, v. 18, no. 4, p. 22-25.

Bronk, D. W., 1973, Looking back 25 years: Geotimes, v. 18, no. 10, p. 34-36.

Hoover, Linn, 1973, 25 years: past and future: Geotimes, v. 18, no. 10, p. 21.

Russell, R. D., 1973, What is the future for AGI?: Geotimes, v. 18, no. 4, p. 15.

AAPG Publishes Pacific Northwest Map, Releases *Arctic Geology*

The American Association of Petroleum Geologists has released the long-awaited geological highway map of the Pacific Northwest region. Issued as number 6 of a series of 11, this map covers the states of Washington and Oregon and includes Idaho cross sections. It follows the format of its predecessors, having been printed in full color at a scale of 1 inch = approximately 30 miles. Allan P. Bennison, a consultant in Tulsa, is in charge of compilation of the maps, and the project is under the supervision of R. H. Dott, Sr.

In addition to the geological highway map's structural framework and landform map, it provides columnar sections (charts of time and rock units), geologic history (summarized in a series of small maps), geologic cross sections, fossil localities, gemstone localities, parks, museums, other points of interest, and a mileage chart.

AAPG has also released a study of the geology, geophysics, and historical development of the Arctic regions of the world. The treatise contains 70 papers, including 24 by Russian scientists, covering Alaska, Canada, Siberia, European Russia, Greenland, Iceland, and the Nordic countries. Entitled *Arctic Geology,* the 747-page book is number 19 in the AAPG memoir series.

One of the authors predicts that by 1990 the Arctic, a vast area of more than 14 million square miles, must be producing 20 to 25 million barrels of oil per day in order to meet world energy requirements. The scientific, economic, environmental, and political problems that must be solved to meet this goal are treated in the book.

Arctic Geology can be ordered from AAPG headquarters, P.O. Box 979, Tulsa, Oklahoma 74101, for $30.00; geological highway maps can be ordered from the same address at a price of $2.00 each for folded maps and $2.50 each for rolled maps. Folded maps are also available from the Oklahoma Geological Survey.

AIPG Honors Jerry Newby, Elects National and State Officers

Jerry B. Newby, recipient of Ben H. Parker Memorial Medal.

The American Institute of Professional Geologists, at its annual meeting in New Orleans October 10-13, bestowed on Jerry B. Newby of Oklahoma City its highest award, the Ben H. Parker Memorial Medal. Also named recipient of the medal was James Boyd of Washington, D.C. The medal was established in 1969 by the institute in posthumous honor of Ben H. Parker, one of the great leaders of the geological profession, and is awarded at the discretion of the executive committee to individuals who have given "outstanding service to the profession." This year marks the first occasion on which two award winners have been selected. The medal had been awarded three times previously, to Martin Van Couvering (AIPG's first president) in 1969, to Ian Campbell in 1970, and to Allen C. Tester in 1972.

At the award ceremony, Jerry Newby was cited by fellow Oklahoman Wilbur E. McMurtry for his 63 years of service in the professional practice of petroleum geology—as a founder of AIPG, a founder and honorary member of The American Association of Petroleum Geologists, and a founder, past president, and honorary member of the Oklahoma City Geological Society. He was among the first to identify the positive structure at Oklahoma City that resulted in discovery of the giant Oklahoma City oil field.

Also at the annual meeting, 1974 national officers and executive committee members were announced. Wilbur E. McMurtry, Oklahoma City consultant, was elected secretary-treasurer, and Edward L. Johnson, U.S. Geological Survey, Tulsa, was elected to the executive committee as a representative from the institute's advisory board. Other officers are: president, Frank B. Conselman, Lubbock, Texas; vice-president, John D. Haun, Evergreen, Colorado; editor, Allen F. Agnew, Pullman, Washington; and president-elect, Arthur O. Spaulding, Los Angeles, California. The outgoing president is Adolf U. Honkala of Richmond, Virginia.

At the institute's annual banquet, geologist-astronaut Harrison H. Schmitt addressed members and guests on the evolution of the moon as determined from the findings of the Apollo program.

At the annual business meeting, a resolution was adopted to recognize the dedicated and faithful service of executive director Arthur F. Brunton over the past 9 years. Also, the institute, under president Honkala's leadership, went on record as favoring stronger efforts to implement specialty recognition for members and to improve opportunities for participation by younger geologists in institute affairs by decreasing the years of experience required for membership. It was also felt that the advisory board would henceforth be more effective by limiting the institute's state sections to one representative each while retaining the sections' voting status according to numbers of members. For instance, the Oklahoma Section, with 115 members, would be limited to 1 representative on the advisory board instead of the customary 2, but would retain its 2 votes.

The Oklahoma Section of AIPG held its annual meeting September 8 in Oklahoma City. New section officers announced at the meeting were, president, William D. Rose, Oklahoma Geological Survey, Norman; first vice-president and president-elect, Thomas L. Thompson, Amoco Production Company, Tulsa; second vice-president, Ralph H. Espach, Jr., consultant, Oklahoma City; and secretary-treasurer, Gary A. McDaniel, Clarcan Petroleum Corporation, Oklahoma City. District representatives are Don E. Brown (Tulsa), Frederick H. Hartman (Oklahoma City), and Charles W. Johnston, Jr., of Seminole, representative-at-large. Past-president Edward L. Johnson will serve as the section's delegate to the national advisory board and as a member of the national executive committee.

SEG to Sponsor Arkansas-Texas Trip

A 2-day field trip covering metallic, nonmetallic, and lignite deposits in Arkansas and east Texas is scheduled by the Society of Economic Geologists for February 22-24, 1974.

The trip will begin with dinner and orientation Friday, February 22, at Little Rock, Arkansas, and will proceed the next day to Texarkana, Arkansas, with stops to include bauxite and barite deposits and mines, vanadium mines, and a gypsum mine. It will terminate in Dallas, Texas, on Sunday evening, February 24, in time for the beginning of the AIME winter meeting February 25-28 in Dallas.

Committee members in charge of the field trip are John C. Dunlap, chairman, Norman F. Williams, Arkansas Geological Commission, and William L. Fisher, Texas Bureau of Economic Geology.

Registration will close February 1. The $45 fee includes 2 dinners, 2 lunches, guidebook, 2 geological highway maps, and transportation. Checks should be sent to the Arkansas-Texas SEG Field Trip, in care of Norman F. Williams, Arkansas Geological Commission, 3815 West Roosevelt Road, Little Rock, Arkansas 72204. For further information, contact Robert A. Laurence, Secretary, Society of Economic Geologists, P.O. Box 1549, Knoxville, Tennessee 37901.

AAPG Honors Carl Branson; Mid-Continent Section Selects Officers, Presents Award to T. W. Amsden

Carl Colton Branson, formerly chairman of The University of Oklahoma School of Geology and Geophysics and director of the Oklahoma Geological Survey, has been awarded honorary membership in The American Association of Petroleum Geologists. Dr. Branson joined the OU faculty in 1950, beginning an association with the University that lasted until his retirement in July 1972. He joined AAPG in 1940 and served as an associate editor of the *Bulletin* for 14 years. He also served on many AAPG committees, including the one that prepared the study guide used by the Boy Scouts of America for the merit badge in geology.

The Mid-Continent Section of AAPG, which held its biennial meeting in Tulsa October 3-5, recently announced that the A. I. Levorsen Award for the best paper given at its regional meeting goes to Dr. Thomas W. Amsden, geologist with the Oklahoma Geological Survey. Tom's topic was "Porosity and Permeability in Silurian Carbonate Rocks of Hunton Group, Anadarko Basin, Oklahoma" (see abstract on p. 231 of this issue). The award was presented at the November 29 meeting of the Oklahoma City Geological Society.

New officers for the Mid-Continent Section are, president—Robert W. Frensley, consultant, Wichita, Kansas; vice-president—Jerry M. Shelby, Amarillo Oil Company, Amarillo, Texas; secretary—Donald J. Malone, independent geologist, Wichita, Kansas; treasurer—Sherrill D. Howery, Union Oil Company of California, Oklahoma City. Garth W. Caylor, a consulting geologist from Tulsa, is the past president.

Our congratulations to Dr. Branson and Dr. Amsden and to the new officers of the Mid-Continent Section, AAPG.

Kerr-McGee to Provide Nuclear Fuel to Eastern Plants

Kerr-McGee Corporation announced in November the signing of a contract calling for delivery of nuclear fuel to plants in Ohio and Pennsylvania for electric-power generation. Dean A. McGee, board chairman, said that the contract, for more than $150 million, provides for the sale of more than 12 million pounds of uranium oxide (U_3O_8), or yellow cake, after its conversion to uranium hexafluoride (UF_6) at the company's Sequoyah plant in eastern Oklahoma.

The group of companies purchasing the nuclear fuel is known as the Central Area Power Coordinating Group and includes Cleveland Electric Illuminating Company, Duquesne Light Company, Ohio Edison Company, Pennsylvania Power Company, and Toledo Edison Company. Delivery of the uranium hexafluoride is scheduled to begin in 1977 and continue through 1985.

OKLAHOMA ABSTRACTS

AAPG Regional Meeting, Mid-Continent Section Tulsa, Oklahoma, October 3-5, 1973

The following abstracts are reprinted from the September 1973 issue, v. 57, of the *Bulletin* of The American Association of Petroleum Geologists or from the meeting program. Page numbers appear in brackets below each abstract from the *Bulletin*. Permission of the authors and of A. A. Meyerhoff, publications manager, is gratefully acknowledged.

Porosity and Permeability in Silurian Carbonate Rocks of Hunton Group, Anadarko Basin, Oklahoma

T. W. AMSDEN, Oklahoma Geological Survey, Norman, Oklahoma 73069

Ninety Hunton cores have been studied, from which 82 Silurian samples from 22 wells were tested for porosity and permeability. Each sample was examined in thin section and was chemically analyzed for $CaCO_3$, $MgCO_3$, and HCl insolubles. The specimens range from limestone and calcareous mudstone having less than 1% $MgCO_3$ to crystalline dolomite with more than 43% $MgCO_3$. Porosity ranges up to 21%, and permeability to 305 md. Rocks with appreciable porosity and permeability have a circumscribed range in texture and composition—specimens with more than 5% porosity are confined to crystalline dolomites with more than 35% $MgCO_3$ (65% dolomite), and those with more than 10% porosity to dolomites with more than 37% $MgCO_3$ (80% dolomite). Much of the pore space is in the form of fossil molds and vacuities in the matrix surrounding oolites. The fossil molds are due to leaching, and the porous oolites probably result from a primary porosity increased by dissolution. Not all dolomites have high porosity, and several specimens with more than 35% $MgCO_3$ have less than 1% porosity; the latter condition appears to result at least in part from preservation of the fossils by calcspar and dolospar rather than as molds. Leaching of fossils and preservation by spar are confined to crystalline dolomite, thus indicating a genetic relation to dolomitization. A suggested sequence of events in the development of porosity is dolomitization and leaching, followed by some secondary cementation of pore space by spar.

Present information indicates a geographic concentration of these porous Silurian dolomites in the north-central and western parts of the Anadarko basin in Oklahoma.

[1821]

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.

Stratigraphic Analysis of Cherokee Group, Pennsylvanian (Desmoinesian), North-Central Oklahoma

J. G. COLE, Amoco Production Company, Tulsa, Oklahoma, and O. R. BERG, Phillips Petroleum Company, Oklahoma City, Oklahoma

Cherokee rocks in an area of approximately 14,000 sq mi of north-central Oklahoma were investigated utilizing 1,850 mechanical logs and 110 sample logs. Correlations were established from stratigraphic profiles, constructed so as to form a control network throughout the area.

The Cherokee "genetic sequence" of strata can be defined at its base by a regional unconformity and at its top by the base of the Oswego or Fort Scott Limestone. The Oswego disappears southward into the Calvin Formation and the top of this latter unit (although slightly higher in the section) was used for the top of the sequence in the southeastern part of the area. Based on marker beds the sequence was subdivided into 6 "genetic increments" of strata—Gilcrease, Booch, Bartlesville, Red Fork, Skinner, and Prue-Calvin. These were named, in ascending order, for a prominent sandstone body therein. Isopach maps were constructed for each increment. These showed a general thickening toward the Cherokee, Arkoma, and Anadarko basins, and also indicated that an old drainage system was developed on the underlying eroded surface which flowed into these basins. Isolith maps were constructed for the sandstone bodies within each increment. These showed a general elongated and branching pattern that trends into the Arkoma basin.

It is concluded that the Cherokee sequence was an onlapping, cyclical unit that was deposited on an eroded, stream-dissected surface formed on southeasterly and southwesterly tilted older rocks, and that the sandstone bodies constituted a part of a sediment dispersal system that contributed to the alluviation of parts of the Cherokee, Arkoma, and Anadarko basins.
[1821]

Reconstructing a Pennsylvanian Delta System

S. B. EKEBAFE and G. S. VISHER, Department of Geology, University of Tulsa, Tulsa, Oklahoma

The Coffeyville interval within the Missourian Series of the Pennsylvanian System in northeastern Oklahoma was studied to determine its origin. The interval is an isochronous unit underlain by the Checkerboard limestone key bed and overlain by the Hogshooter limestone. Through most of the area these transgressive limestone marker beds define a time-rock unit.

Stratigraphic characteristics within the interval are illustrated by cross sections, and specific data obtained from more than 500 well logs were used to make isopachous, sandstone-shale ratio, and isolith maps. Core, E log, and outcrop observations provided information on sedimentary structures, textures, and vertical sequences.

The primary depositional framework is deltaic. From the available data it is possible to delineate 8 separate environmental facies within

the delta complex, and to correlate each facies with particular S.P. curve shapes. Outcrop and core studies of trace fossils, textures, and sedimentary structures were correlated to individual facies. Criteria were established to recognize ancient deltaic deposits and methods of environmental analysis.

[1821]

Algal Bank Complexes of Mid-Continent

J. G. FROST, Cities Service Company, Tulsa, Oklahoma

Algal banks are widely distributed, are important in late Paleozoic carbonate provinces, and commonly are good reservoirs for accumulation of hydrocarbons. The term "bank" as used herein indicates an unusually thick sequence of carbonate mudstone built by in-place organisms.

Algal banks are formed primarily by phylloid algae; other organisms may also contribute to the development of the banks. Other than algae, fenestrate bryozoans and crinoids are the major contributors. Other organisms are commonly present but probably contributed little to the development of the banks.

Phylloid (leaflike) algae aid in formation of banks in 3 major ways: by baffling, trapping sediments, and binding sediments. Phylloid algae may have grown free on the substrate, may have locally attached to the substrate, or may be encrusting.

Algal banks may occur in the shape of a simple mound, a broad lens, or a complex combination of the two forms. Thicknesses of banks or bank complexes range from about 10 to 115 ft; horizontal distances range from less than 0.1 mi to more than 40 mi. The banks stood slightly above the surrounding sea floor. Algal banks occur in shallow, well-illuminated waters along the flanks of structures, along shelf margins, adjacent to deltas, and in shallow epicontinental seas.

There are 4 major types of porosity associated with algal banks: (1) between algal leaves, (2) within algal leaves, (3) beneath algal leaves (umbrella structure), and (4) as a result of dolomitization of algae and/or matrix.

[1821]

Structural Relations of Arbuckle and Ouachita Facies

J. H. KEMPF, Atlantic Richfield Company, Tulsa, Oklahoma

Rocks of the Ouachita facies are thrust out over the Arkoma basin. As expected, part of the crustal shortening is taken up in the Arkoma basin by folding parallel with the strike of the thrust faults. This shortening can be observed in the outcrops. Unfortunately, the intersection of the Ouachita front with the Arbuckle Mountains, the Ardmore basin, and the Marietta-Sherman basin is covered by the Cretaceous overlap. Therefore, the relation of the Ouachita facies with the Arbuckle facies can be determined only by subsurface information.

There is a regional southwest trend to the Ouachita front from where it disappears beneath the Cretaceous northeast of the Arbuckle Mountains to the Llano uplift in central Texas, indicating, in general, that the Ouachita facies was thrust from the southeast.

In the Ardmore and the Marietta-Sherman basins there are no indications of thrusting from the southeast. Rocks of the Ouachita facies are in contact with the Arbuckle facies by means of northwest-trending, high-angle reverse faults. The trend of folding in these basins is also northwest, with no northeast trending folding as one would expect in front of a thrust from the southeast. The Ardmore and Marietta-Sherman basins are characterized by large northwest-trending strike-slip faults. The best examples of these are the Reagan and Washita Valley faults which bound the Tishomingo uplift on the northeast and southwest, and the Mannsville-Madill-Aylesworth fault which parallels the Washita fault.

It is concluded that in the Ardmore and Marietta-Sherman basins, the Ouachita facies is not in contact with Arbuckle facies by means of low-angle thrusting, but instead the Ouachita rocks have been shoved from the southeast in northwest-trending wedges. This action drove blocks of Arbuckle facies into confined spaces on the northwest and caused great crustal shortening along a southwest-northeast line resulting in the northwest trending structures of the Ardmore and Marietta basins.

[1822]

Source Changes During the Marmaton—Northeast Oklahoma

G. W. KRUMME, Krumme Oil Company, Bristow, Oklahoma

Lower and Middle Pennsylvanian sandstones have produced oil from almost every zone across the northeastern Oklahoma shelf. Understanding of the distribution pattern of these sediments was hampered by the difficulty of correlating southward across the western end of the Arkoma basin. Electric logs permit improvements of older correlations, generally based on surface outcrops, interrupted by several wide river valleys. Subsurface study of the section from the Verdigris lime (upper Desmoinesian) to the Checkerboard lime (lower Missourian) establishes the following approximate equivalencies: (1) Verdigris lime-Henryetta coal, (2) Prue sand-Calvin sand, (3) Oswego lime-lowermost Wewoka, (4) Cleveland sand zone-Holdenville shale, (5) Checkerboard lime-Sasakwa lime.

The Prue sandstone is the last important Pennsylvanian sandstone of the northeastern Oklahoma shelf with a northern source. The Calvin sands came from the south. The succeeding Oswego lime and Big lime record a long period during which little clastic material was introduced onto the shelf from any source. Contemporaneous deposits from Ouachita uplifts built a clastic wedge (Wewoka) northwestward to within 20 miles of the southern borders of the limestone banks.

The succeeding Holdenville-Cleveland Formations record a surge of clastics northward and westward from the Ouachitas. Chert pebbles appear in sandstone channels in the outcrop from Ada to Beggs. (The Dawson and other coals indicate that Tulsa is near the ancient shoreline.) The Cleveland sandstones thus mark the first incursion of coarse Pennsylvanian clastics from southern sources onto the shelf.

Oil and gas appear mostly in marginal marine beds. Since the marginal marine sections of two important reservoir beds, the Prue and Cleveland, both occurred on the shelf, a double portion of oil and gas was bestowed on Northeastern Oklahoma.

Depositional and Directional Features of Braided-Meandering Stream

J. W. SHELTON, R. L. NOBLE, and H. R. BURMAN, JR., Oklahoma State University, Stillwater, Oklahoma

The Cimarron River in north-central Oklahoma shows characteristics intermediate between typical braided and meandering streams. The gradient is 1.8 ft/mi at Perkins; the sinuosity is 1.5; the monthly average discharge ranges from 2 to 17,800 cu ft/second; and average channel depth at bankful stage is 15 ft.

The deposits are generally fine- to medium-grained, well-sorted sand, with scattered quartz and intraformational pebbles and thin beds of coarse-grained sand. Several clay drapes are present as thin discontinuous layers. Medium-scale crossbedding, horizontal bedding, and small-scale crossbedding are the dominant sedimentary structures. Compositionally the sand is an arkose, which suggests the Wichita uplift and the southern Rocky Mountains as ultimate source areas.

Irregularities and discontinuities in the sand deposits are due primarily to channel shifts during times of major floods and secondarily to deposition of clay during recession of high-water stages. The irregularities resulting from dissection of transverse dunes and superposition of ripples on dunes are thought to be of minor significance in causing reservoir variations.

Crossbedding, parting lineation, and grain orientation all define the sand trend very well and indicate that directional features in this type of sand deposit are useful in estimating reservoir trend. Directional imbibition parallels the dip of the crossbeds and grain orientation (and parting lineation) in horizontal beds.

Compared with typical meandering-stream deposits, the Cimarron River sand is thinner and contains less fine-grained clastics in the upper part of the sequence and as clay interbeds. It is finer grained than typical braided-stream sands, and current indicators show a wider directional range. The type of deposit represented by the Cimarron River sand may be similar to certain Pennsylvanian alluvial sandstones which were deposited as the gradient was reduced during the initial stages of eustatic rise in sea level.

[1823]

Comparative Analysis of Hunton Oil and Gas Fields in Oklahoma and Texas

JOHN A. TAYLOR, Petroleum Consultant and Independent Operator, Oklahoma City, Oklahoma

The various Siluro-Devonian, Hunton limestone fields of the Anadarko Basin of Oklahoma and Texas Panhandle provide a unique opportunity for a comparative analysis of their structure, entrapment mechanism, and related productive quality. Production ranges from a depth of 6,000 ft on the upper reaches of the Anadarko Basin Shelf to a depth of 21,000 ft in the Anadarko Basin Deep. Strong drilling activity continues at depths of from 22,000 to 30,000 ft in the Anadarko Basin, with this formation as the principal objective. Numerous examples of entrapment types may be found in one form or another among the Hunton fields of this Basin. Truncation with strike-overlap at the top of the Hunton by the Woodford shale provides several varieties of entrapment at this interface in concert with the presentation of the alternating lithologic types within the Hunton. The uneven topography impelled by differential weathering during exposure at the end of Hunton time has led to some unusual examples of entrapment. Limestone and dolomite porosity, some primary, some secondarily induced, and some emerging from fracturing, provide a variable mixture of reservoir porosity types within the different areas of production. This mixture has been capable of generating recoveries that range up to a field average as high as 50 BCF per well or more.

Let us look first at the series of shallow fields generated by total truncation of the Hunton a short distance south of the Kansas line in such fields as N. W. Avard, E. Selman, and Hopeton. Now we move southward to S. E. Ames, Cheyenne Valley, and Star-Lacey fields. Here are excellent examples of rapid pinchout of thick hydrocarbon-bearing dolomite porosity sometimes accommodated with lateral closure by faulting. On the east edge of the Basin we see the early W. Edmond discovery, noted for its classic exhibition of truncation and strike overlap, on the west flank of the Nemaha ridge. Similar candidates for "W. Edmond type entrapment" may be pointed to at N. W. Cashion and Short Junction that point the way to additional future discoveries of this type. Fresh discoveries currently drilling at the east edge of the Basin are demonstrated by the highly active S. E. Dibble and Mustang areas, each of which depend heavily upon fractured Hunton for deliverability and perhaps entrapment also.

The deeper Basin fields of Aledo, Custer City, Washita Creek, Mathers Ranch, Buffalo Wallow, and Gageby Creek, etc., offer highly interesting case histories of the interrelation of faulting, sometimes of considerable magnitude, and intergranular porosity plus the variable influence of fracturing. Mathers Ranch may be a unique example of stratigraphic entrapment, a large porosity enclosure, abetted somewhat by low relief folding and modest fault interruption.

A sufficient number of Hunton fields have now been discovered that a comparative analysis as to entrapment types may be systematically prepared and conclusions drawn as to the probable types of future Hunton discoveries in the Anadarko Basin.

Land-Resource Capability Units of the Wagoner County Area, Northeastern Oklahoma

GREGORY LEE COOK, Oklahoma State University, M.S. thesis, 1973

The Wagoner County area in northeastern Oklahoma includes 570 sq mi in western and central Wagoner County and the southern part of Rogers County. This area, stimulated by the completion of the McClellan-Kerr Arkansas River Navigation System and the eastward expansion of metropolitan Tulsa, will continue to undergo industrial and residential growth. Flood plains of the Arkansas and Verdigris Rivers, with deposits of unconsolidated gravel, sand, silt, and clay, compose 20 percent of the area. The other parts consist of alluvial terraces, Pennsylvanian bedrock, and abandoned strip mines.

This study provides the decision-makers involved in land-use planning with an inventory, evaluation, and assessment of the land and mineral resources in the Wagoner County area. The study area contains only a moderate amount of mineral resources; sand and gravel, however, are plentiful. Further study may also reveal favorable conditions for development of coal, expanding clay, and volcanic ash. Ground water is fairly abundant for domestic use. Abundant surface water is available for heavy-industry and urban use from lakes east of the study area. Land-resource capability units are grouped into the sediment-dominant system, soil-dominant system, bedrock-dominant system, and artificial system. Each of the 18 units is characterized by specified lithology, sediment or soil, soil thickness and texture, and other basic properties. Each unit is qualitatively evaluated for a variety of man's activities and properties by means of a matrix, which should assist those persons who are nonscientists. Units of the sediment-dominant system generally are unfavorable hosts for waste disposal, whereas two clayey units of the soil-dominant system are thought to provide favorable conditions for waste disposal. The bedrock-dominant system contains three units which are generally suited for construction even though the rock may be nonrippable. After reclamation the artificial system should be available for a variety of activities.

Depositional and Directional Features of a Braided-Meandering Stream

RAYMOND LEE NOBLE, Oklahoma State University, M.S. thesis, 1973

The Cimarron River in north-central Oklahoma shows characteristics intermediate between typical braided and meandering streams. In the Perkins area, the gradient is 1.8 ft per mi; the sinuosity is 1.5; the monthly average discharge varies from about 2 cfs to 17,800 cfs; and average channel depth at bankfull stage is 15 ft. During the period of aerial photography the river has tended to become more sinuous. Accretion ridges which form mainly on the downstream sides of bars characterize the straighter reaches, whereas accretion ridges which form on both the upstream and downstream sides of bars occur in the more sinuous reaches. Permian red beds, which have been channeled and terraced, underlie the alluvial deposits.

The deposits show upward fining; they are generally fine- to medium-grained, well-sorted sand, with scattered quartz and intraformational pebbles. Porosity is about 35 percent. Horizontal bedding and medium-scale and small-scale cross-bedding are the dominant sedimentary structures; clay drapes are present as thin discontinuous layers. The sand is an arkose, which suggests the southern Rocky Mountains and the Wichita uplift as ultimate source areas.

Irregularities and discontinuities in the sand deposits are due primarily to channel shifts during times of major floods and secondarily to deposition of clay during recession of high-water stages. Irregularities resulting from the dissection of transverse dunes and superposition of ripples on dunes are thought to be of minor significance.

Cross-bedding, parting lineation, and grain orientation all define the sand trend very well and indicate that directional features of this type are useful in estimating reservoir trend.

Compared to typical meandering-stream deposits, the Cimarron River deposits are thinner but possibly wider, and they contain less fine-grained clastics in the upper part of the sequence and as clay interbeds. The Cimarron sediments are finer grained and better sorted than sands of typical braided streams. They contain more horizontal bedding than either braided- or meandering-stream deposits. The type of sand deposit represented by the Cimarron River sand may be similar to certain ancient alluvial sandstones which were deposited during either subsidence or eustatic rise in sea level.

THE UNIVERSITY OF IOWA

Sedimentary Analysis of Artesian Spring Sands, Meade County, Kansas

DONALD GENE REBERTUS, The University of Iowa, Ph.D. dissertation, 1972

Unconsolidated sediments from six locations in Meade County, Kansas, and two from Boiling Springs State Park, Woodward, Oklahoma, were examined to determine the characteristics of Pleistocene and Modern Artesian sediments. Pleistocene springs in the Meade County area have considerable paleontologic and biostratigraphic importance as contained fossils are revealing much about ancient environments.

Field identification of ancient vent structures is dependent on recognition of columnar deposits of fine sands, characteristic limonite staining, and associated fossils of aquatic snails. Bits of polished bone and teeth from a variety of vertebrates also are indicative of these deposits.

Laboratory methods of analysis included mechanical determination of particle size with sieves and hydrometer, and optical identification, with grain counts of both heavy and light minerals, and X-ray analysis. Histograms and cumulative curves with probability ordinates for each of the sampled locations indicated that three modern artesian vents were nearly rectilinear, a characteristic of normal distribution. However, Big Springs, a modern spring of Meade County, did show some deviation in the finer ranges. The graphical data further suggested that the Oklahoma samples contained more particles in the coarse ranges. Graphical parameters also revealed that modern artesian springs investigated were quite variable, ranging from coarse to fine sands, moderately to moderately well sorted, having mesokurtic or leptokurtic particle size distributions that were either symmetrical, or slightly skewed. Heavy mineral analysis demonstrated some similarity in the minerals present and suggested the possibility of selective transport.

Pleistocene deposits generally were not as well sorted, more leptokurtic, and had more asymmetrical particle size distributions. The Pleistocene deposits also differed from the modern sediments in that the probability curves showed more deviations from a straight line and particle size was not normally distributed. The presence of finer silts and clay, as well as the difficulties associated with the particle size measurement, were the probable causes of deviation from normal distribution. The greater weight percentage of fine silts and clay encountered in the older deposits was attributed to long periods of feldspar weathering. X-ray analysis of the older deposits also revealed clay-size quartz and calcite not present in modern springs. Deer Park, the oldest deposit on the basis of faunal evidence, showed the highest quartz to feldspar ratio.

X-ray diffractograms detected that the modern and ancient spring sediments of Meade County all contained some illite, kaolinite, and montmorillonite while a Pleistocene lacustrine deposit of the area contained only illite.

Heavy mineral analysis also separated Cragin Quarry sediments from most of the other sediment. Higher incidence of micas and slightly different mineral assortment lacking garnet indicated a different source for these materials. Deposits of Pearlette Ash in the area would suggest that the source probably contains more igneous material.

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Pt. B, v. 33, no. 7, p. 3146-B)

THE UNIVERSITY OF NEW MEXICO

Channel Sequences and Braided Stream Development in the South Canadian River, Hutchinson, Roberts, and Hemphill Counties, Texas

L. GIFFORD KESSLER II, The University of New Mexico, Ph.D. dissertation, 1972

Studies of ancient depositional systems indicate that braided streams were quite common in pre-Cretaceous times, perhaps due to a difference in areal distribution of vegetational cover. Modern braided streams and rivers should be studied in order to find criteria which are useful for recognition of these deposits in the geologic record.

The South Canadian River in Hutchinson, Roberts, and Hemphill Counties, Texas, is a large complex braided fluvial depositional system which is related to, and strongly affected by, other Tertiary and Holocene depositional systems. These depositional systems, which include playa lakes, older river deposits, aeolian dunes, and aeolian sheet sands, control vegetational distribution and hence runoff into the South Canadian Fluvial System. They also supply some sediment to the system due to river bank instability.

Aerial photographic analysis of the South Canadian River flood plain reveals at least eight aggradational or degradational channel sequences (including the present active channel) of varying relative ages. These sequences were delineated on the basis of vegetational differences. Correlation coefficient (r) analysis showed that the position in the river valley of the three youngest channel sequences was strongly controlled by the valley walls and the position of each progressively older channel sequence. Analysis of 1953, 1959, and 1967 aerial photographs of the river demonstrates that younger channel sequences were usually eradicated by catastrophic flooding within a very few years whereas older sequences are relatively untouched.

Examination of channel surface features such as longitudinal bars, ripple marks, and elongate scour features yielded directional data generally parallel to the orientation of the South Canadian River Valley.

Scour trough fills, longitudinal bars, and a very few transverse bars are the dominant large depositional features in the river flood plain. Transverse bars are distinguished from longitudinal bars by the dominance of planar cross-stratification over planar bedding. Transverse bars are dominant only in the distal portions of the fluvial system in eastern and central Oklahoma.

The study of daily discharge records reveals that the major aggradational and degradational features observed in the active portions of the South Canadian River Valley are the result of catastrophic flooding (defined as daily discharge average greater than 10,000 cubic feet per second) which represents less than one percent of the time from 1938-1970. This extreme variation in daily discharge plus excess sediment supplied from unstable river bank material are the principal causes of braiding in the South Canadian River.

(Reprinted from *Dissertation Abstracts International*,
Pt. B, v. 33, no. 10, p. 4864-4865-B)

Guidebooks in French Now Available from 24th International Geological Congress

French linguists take note: French editions of the guidebooks from the 24th International Geological Congress, held in Canada in 1972, have recently been published. The 64 guidebooks, totaling more than 5,000 pages, cover all parts of Canada and deal with almost all aspects of geology, including mineral deposits, stratigraphy, structure, petrology, and paleontology.

The guidebooks are available now in either English or French as a set ($100 plus $10 for mailing and handling charges) or as individual volumes. A complete list of titles and prices of all the publications of the 24th Congress is obtainable on request to the Secretary-General, 24th International Geological Congress, 601 Booth Street, Ottawa, Ontario K1A OE4, Canada.

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It's "Cape Canaveral" Again

The U.S. Board on Geographic Names, acting through its 5-man committee on domestic geographic names, has recently restored the historic name "Cape Canaveral" to the east Florida promontory which was renamed "Cape Kennedy" in 1963 following the tragic death of President Kennedy.

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