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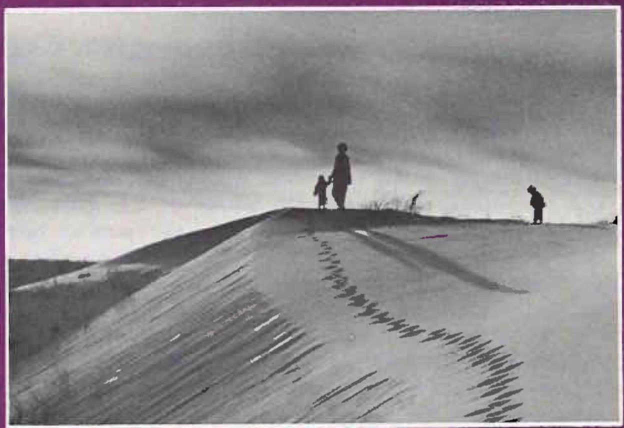


OKLAHOMA GEOLOGY NOTES

VOLUME 28, NUMBER 3 JUNE 1968

Cover Picture

Dunes of Pleistocene Sand along Cimarron River

The Little Sahara Recreation Area is one of active dunes built up of sands deposited by the Cimarron River system. Deposits of Pleistocene gravels, sands, silts, and clays form three, perhaps more, terrace levels on the northeast side of the river, the same side on which the prevailing southwesterly winds of the area have developed dune fields. Southwest of the present river course lies a silt- and clay-veneered flood plain, and the 30- to 50-foot-thick sand and gravel deposits beneath the veneer are thought to have been accumulating along the Cimarron and its tributaries since early Wisconsin time.

The dune pictured is in the Little Sahara Recreation Area in Woods County, roughly 3 miles south of Waynoka and west of U. S. Highway 281 (SW¼ SE¼ sec. 23, T. 24 N., R. 16 W.). The photograph is from Oklahoma Geological Survey Bulletin 106, *Geology and Mineral Resources of Woods County, Oklahoma,* by R. O. Fay, and was taken by Bob Taylor of Cordell, Oklahoma.

—*P. W. W.*

Geology of the North Mustang and South Yukon Fields, T. 11 N., R. 5 W., Canadian County, Oklahoma

John T. Bado*

Gas production was established in T. 11 N., R. 5 W., Canadian County, Oklahoma, with the completion of the Phillips 1-A Mosteller well (C NE¼ SE¼ sec. 22) on May 11, 1956; this one-well field is designated the North Mustang field. Production is from the Lower Pennsylvanian Prue sand, with the top of the sand at 7,880 feet and the base at 7,900 feet. Perforations were made between 7,884 and 7,896 feet; initial gas production was gauged at 316,000 cfd.

First recorded withdrawal of gas was in May 1958, when the shut-in pressure of the reservoir was indicated to be 1,940 psi. The latest reported shut-in pressure was 1,209 psi in April 1967. Total cumula-

* Gulf Oil Corporation, Oklahoma City, Oklahoma.

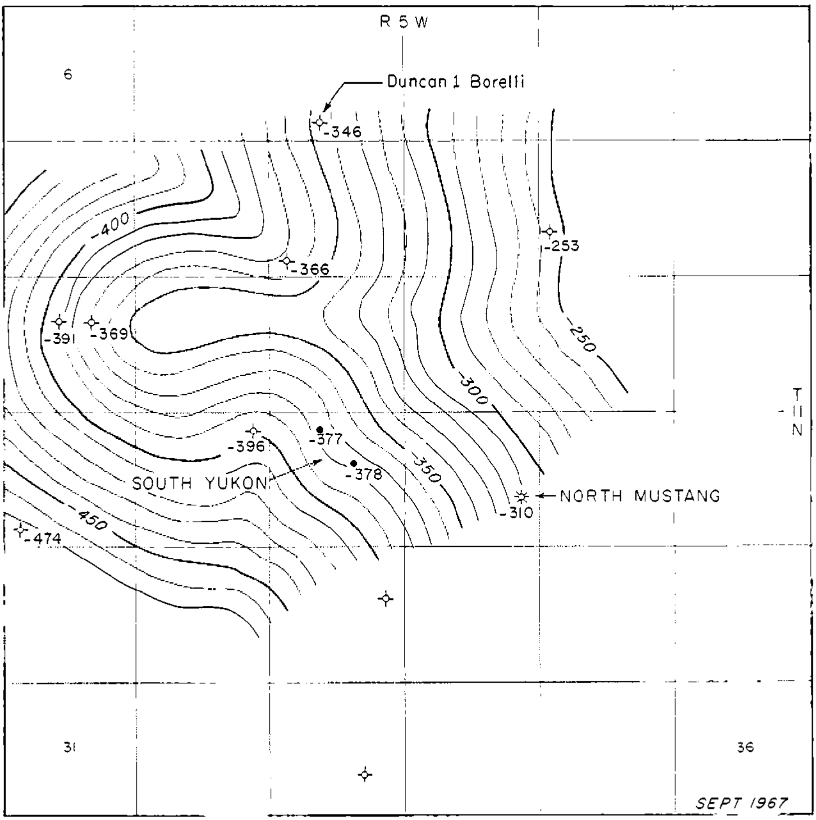


Figure 1. Structure map of shallow porous Permian sand, T. 11 N., R. 5 W., Canadian County, Oklahoma. Contour interval: 10 feet; datum: sea level.

tive production from May 1958 to April 1967 was 278,386 Mcf, with 5,760 barrels of condensate.

Production is from a thin, porous section of the Prue sand, which is a gray to light-brown, fine- to medium-grained, micaceous, slightly carbonaceous, slightly shaly sandstone with spotted to light oil stain. Figures 2 and 3 are structure and porosity isopach maps of the Prue sand unit.

No further production was found in T. 11 N., R. 5 W., until April 1965, when Union of California completed its 1-21 Semtner well (C NE¼ NW¼ sec. 21) as the discovery well of the South Yukon field. The well flowed 177 barrels of oil per day from rocks of the Hunton Group (Silurian-Devonian). The top of the Hunton was called at 8,450 feet and production was established through perforations between 8,460 and 8,484 feet.

In September 1965, Union of California confirmed production with its 1-21 Purdin well (C SW¼ NE¼ sec. 21). The Hunton was found

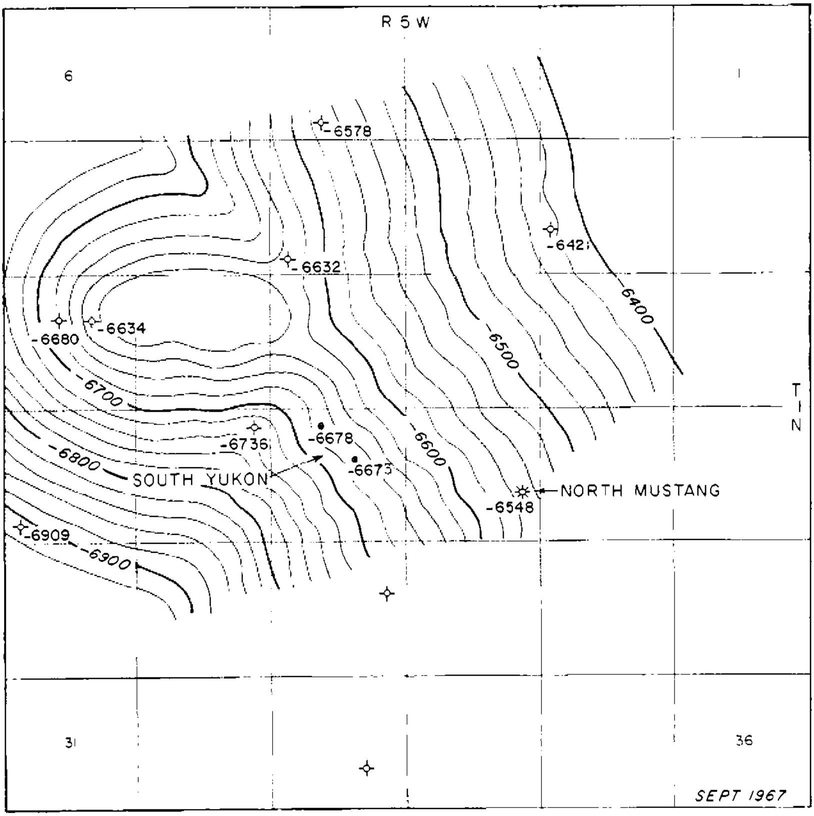


Figure 2. Structure map of top of Prue sand, T. 11 N., R. 5 W., Canadian County, Oklahoma. Contour interval: 20 feet; datum: sea level.

at 8,421 feet and the zone from 8,429 to 8,450 feet was perforated; initial production of 282 bpd was indicated.

Subsequently, the Union of California 1-20 Mitchell well (NE¼ NE¼ sec. 20) was drilled as a dry hole with a total depth of 8,620 feet in the Hunton Group.

Total production from the two wells in the South Yukon field was reported to be 46,970 barrels through June 30, 1967.

Geologic Discussion

Surface outcrops in the North Mustang and South Yukon fields are of the Flowerpot Shale of the Permian El Reno Group. A porous sandstone of Permian age (fig. 1) was drill-stem tested from 1,642 to 1,652 feet in the Duncan 1 Borelli well (C SE¼ SW¼ sec. 4), and flowed 6 barrels of salt water per hour with a reported 250,000 cubic feet of gas in 3 hours.

The division between the Permian and Pennsylvanian beds is called at 3,464 feet. Pennsylvanian beds of the Virgil Series (Wabaun-

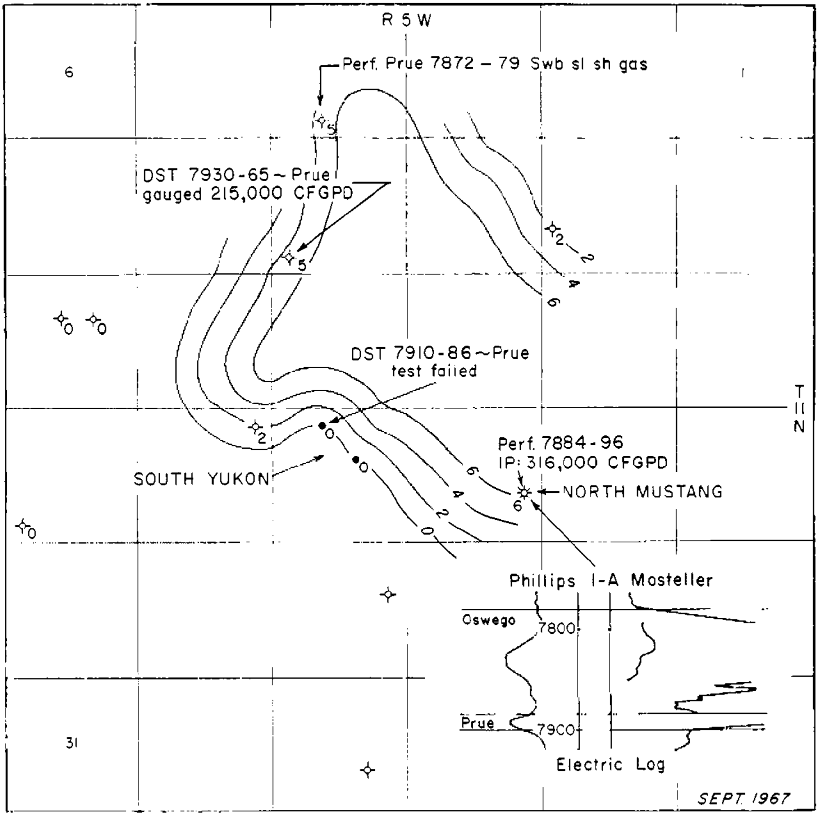


Figure 3. Isopach map of Prue sand porosity, T. 11 N., R. 5 W., Canadian County, Oklahoma. Contour interval: 2 feet.

see, Shawnee, and Douglas) are present to a depth of 5,930 feet. The Pennsylvanian Missouri Series (Ochelata and Skiatook) is present to a depth of 7,375 feet.

The Des Moines Series, which includes the Marmaton, Oswego, Prue, Skinner, and Red Fork zones, is present to 8,140 feet.

A veneer of Atoka beds is present to 8,200 feet. It is underlain by

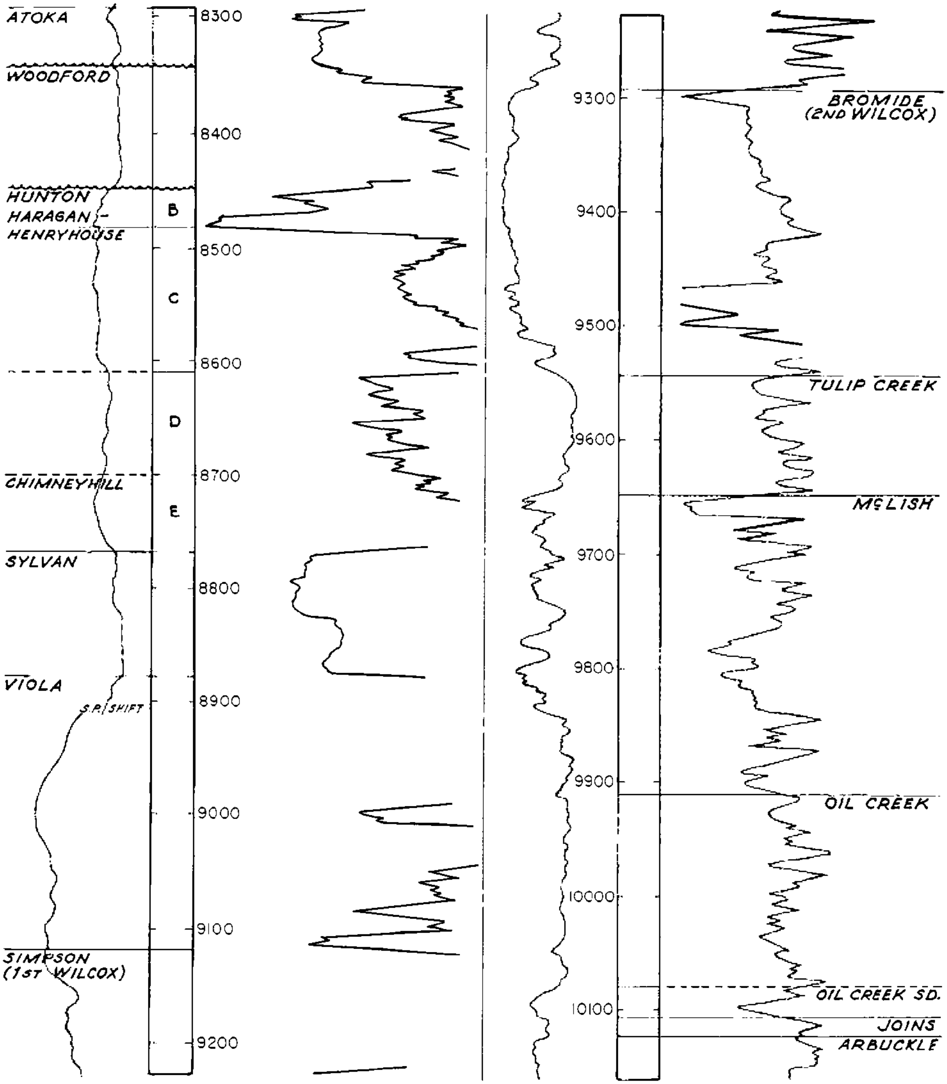


Figure 4. Typical electric log of the South Yukon field, sec. 21, T. 11 N., R. 5 W., Canadian County, Oklahoma.

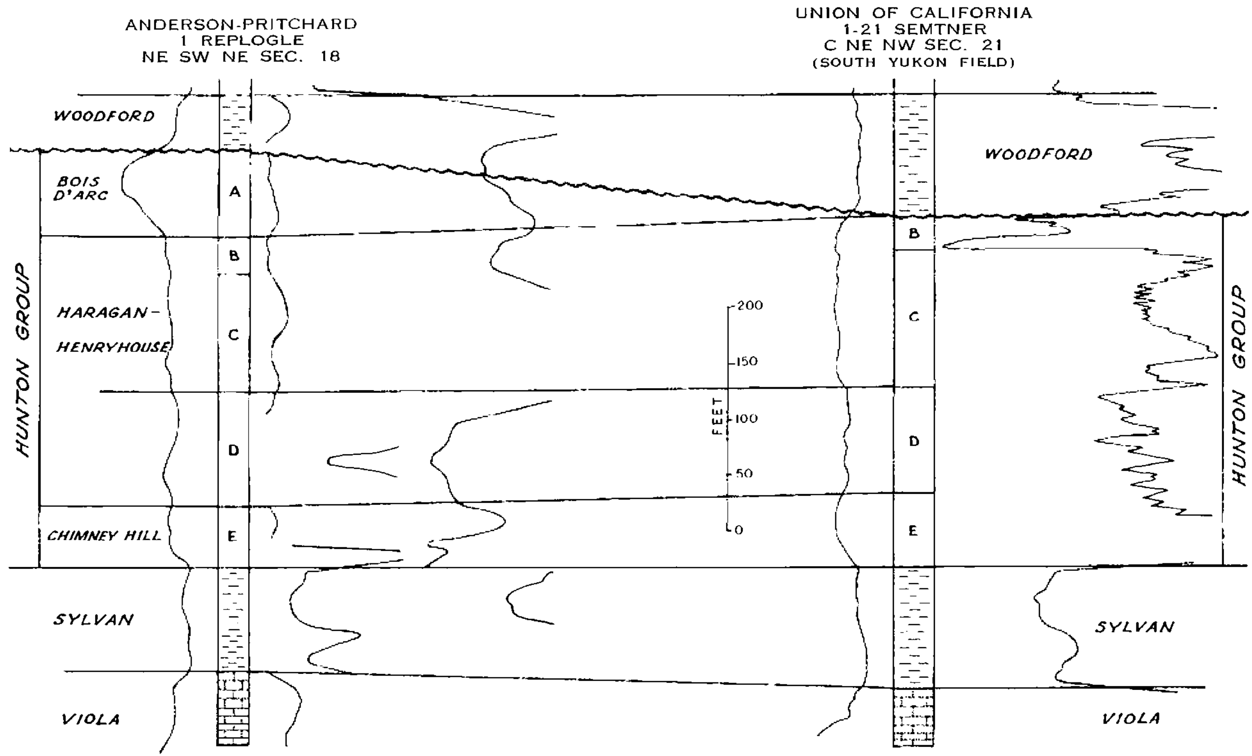


Figure 5. Electric-log correlation of the Hunton Group, western part of T. 11 N., R. 5 W., Canadian County, Oklahoma.

the Mississippian limes to 8,240 feet and the Woodford shales to 8,370 feet.

Immediately underlying the Woodford shales are the Silurian-Devonian limestones and dolomites of the Hunton Group. The Hunton beds are found from a depth of 8,066 feet in the eastern part of the township to a depth of 8,765 feet in the western part.

The typical electric-log section of the South Yukon field (fig. 4) indicates that the Ordovician rocks (Sylvan, Viola, First Wilcox, Second Wilcox, Tulip Creek, McLish, Oil Creek, Joins, and Arbuckle) are present from a depth of 8,780 feet to below 10,100 feet. A full penetration of the Arbuckle rocks has not been made in this township.

The Hunton ranges in thickness from 282 to 405 feet in the township, becoming progressively thicker westward. Figure 5 is an electric-log correlation of the Hunton Group across the western part of the township and is an attempt to explain the presence of production in the South Yukon field. The production established within the Hunton

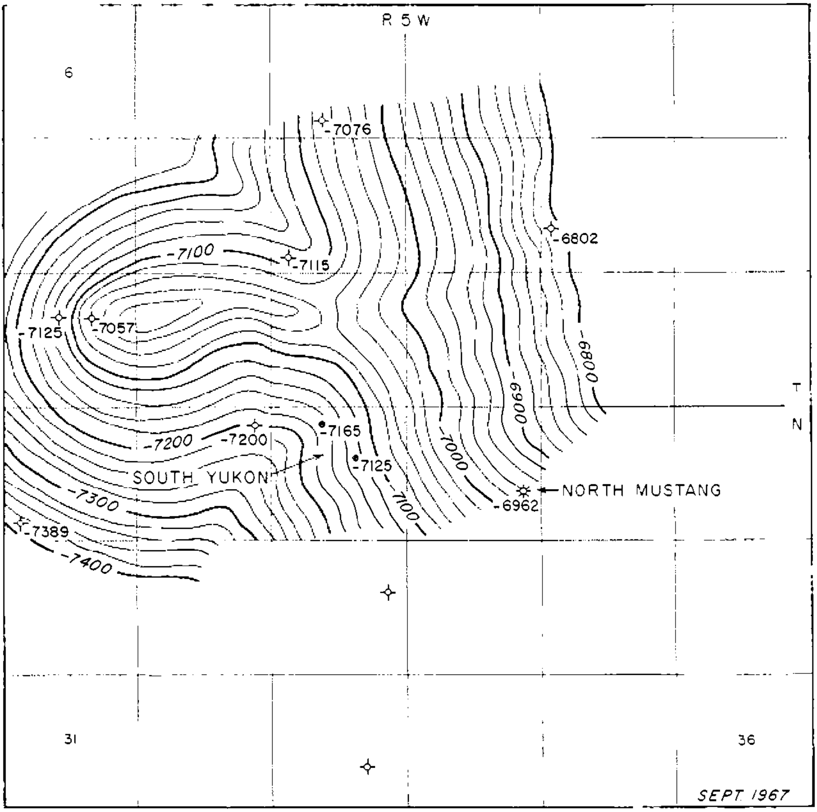


Figure 6. Structure map of base of Woodford Formation, T. 11 N., R. 5 W., Canadian County, Oklahoma. Contour interval: 20 feet; datum: sea level.

Group is assigned to the Haragan-Henryhouse unit, which is divided into units B, C, and D. Most of the production found in the West Edmond field and adjacent producing areas is from unit A of the Bois d'Arc section of the Hunton Group.* Production in the South Yukon field is from the unit B of the Haragan-Henryhouse section and appears to be from a stratigraphic trap. Figure 7 is an isopach map of the Hunton unit B zone (Haragan-Henryhouse). Unit A has been removed by truncation and is absent in the South Yukon field area. Although unit B is present in the western part of the township, it is nonporous. However, as it thins eastward it becomes porous and is the producing reservoir, possibly as a result of secondary solution.

* Recent work by Amsden and Rowland (1967) suggests that unit A of the Hunton Group in the Anderson-Pritchard 1 Replogle well (fig. 5) may include some Frisco strata. In their interpretation of the Hunton of the West Edmond field, they have indicated that what is called Bois d'Arc (unit A) in that area is entirely Frisco.

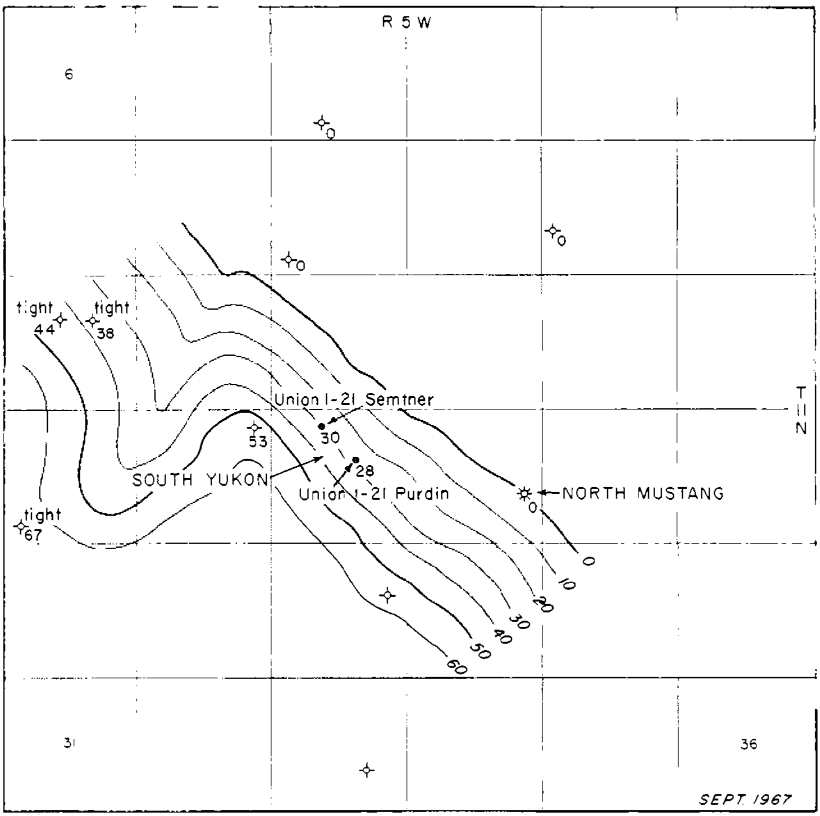


Figure 7. Isopach map of the Hunton B zone, T. 11 N., R. 5 W., Canadian County, Oklahoma. Contour interval: 10 feet.

Table I.—Drilling and Development History, T. 11 N., R. 5 W., Canadian County, Oklahoma

Operator Well Name Completion Date	Location Elevation (Feet)	Producing Horizon	Perforations	Initial Potential	Total Depth Deepest Penetration Remarks
Caldwell 1 Jones July 15, 1922	SE SE NW SE 33				3,425 feet Permian Dry & abandoned
Ramsey Bros. 1 Hermann June 21, 1927	SE NE 28				4,775 feet Upper Pennsylvanian Dry & abandoned
Amerada 1 Lawson Feb. 28, 1945	NE SE NW 18 1,362 DF				9,385 feet 2nd Wilcox Dry & abandoned
Anderson-Pritchard 1 Replogle Dec. 4, 1951	NE SW NE 18 1,341 DF				10,102 feet Joins Dry & abandoned
Duncan 1 Borelli March 11, 1956	SE SW 4 1,294 DF				8,556 feet Hunton Dry & abandoned

Phillips 1-A Mosteller May 11, 1956	NE SE 22 1,331 DF	Prue sand (Cherokee)	7,884-7,896′	316,000 cfd	8,450 feet Hunton Discovery-North Mustang field
J. S. Woodward 1 Sterrett April 16, 1958	SW SW 9 1,310 DF				9,225 feet 2nd Wilcox Dry & abandoned
Humble 1 American First Nov. 17, 1964	SW NW SW 11 1,264 DF				9,345 feet McLish Dry & abandoned
Sinclair 1 Horlivy March 2, 1965	SW SW 19 1,376 GL				9,788 feet 2nd Wilcox Dry & abandoned
Union of California 1-21 Semtner April 27, 1965	NE NW 21 1,314 DF	Hunton	8,460-8,484′	F 177 bopd Grav. 38°	10,153 feet Arbuckle Discovery-South Yukon field
Union of California 1-21 Purdin Sept. 3, 1965	SW NE 21 1,296 DF	Hunton	8,429-8,450′	F 282 bopd Grav. 42°	9,298 feet 2nd Wilcox Confirmation-South Yukon field
Union of California 1-20 Mitchell Jan. 31, 1966	NE NE 20 1,332 DF				8,620 feet Hunton Dry & abandoned

Unit B is a pink, tan, light-gray, fragmental to coarse-crystalline to chalky limestone, with slight shows of live oil stain and fluorescence in the samples. Porosity and permeability are difficult to evaluate by visual examination.

Conclusions

Variations in porosity and permeability have confined the development of the Haragan-Henryhouse reservoir to a relatively small area.

Evidence for possible oil production is present in the Viola Limestone of Ordovician age. The Union Oil of California 1-21 Semtner well flowed 86 barrels of oil in 8 hours through perforations in the Viola Limestone from 9,090 to 9,140 feet.

The Prue sand of Pennsylvanian age appears to have a limited areal distribution and productive capabilities. In other areas nearby, the Prue sand approaches a thickness of 50 feet and offers worthwhile reserves.

One of the more promising zones of possible production is present in the Bois d'Arc unit of the Hunton Group. To date, production has not been found in this zone in the township. The porosity and permeability characteristics, plus evidence of hydrocarbon shows in the immediate area, suggest further testing may be warranted. Both structural and stratigraphically controlled entrapment possibilities appear to be present.

Table I is a summary of the drilling and development history of T. 11 N., R. 5 W., Canadian County, Oklahoma.

Reference Cited

Amsden, T. W., and **Rowland, T. L.**, 1967, Geologic maps and stratigraphic cross sections of Silurian strata and Lower Devonian formations in Oklahoma: Okla. Geol. Survey, Map GM-14, scale, 1:750,000.

Patricia Wood Moves to AGI

Patricia W. Wood has resigned her associate editorship with the Oklahoma Geological Survey to accept the position of assistant editor of translation journals with the American Geological Institute, Washington, D. C. Her appointment to the new position became effective at the beginning of this month.

During her all too brief tenure with the Survey Miss Wood has contributed substantially to the improvement of the editorial effort. She has been responsible for adding diversity to the content of the *Notes* and has spent much time is assisting Patrick K. Sutherland in his editorship of the Paleontological Society's new Memoir series, the first number of which is to appear this month.

The staff of the Survey wishes her well in her new position and continued good fortune for her future.

Earth Science Instruction in Oklahoma High Schools

Edward C. Stoever, Jr.

Surprisingly, in a state owing so much to its mineral resources, the widespread inclusion of earth science courses in the curricula of Oklahoma high schools is a relatively recent phenomenon. However, a survey just completed demonstrates that the growth of earth science course offerings as an integral part of the education of all future citizens has not only been occurring steadily in the State in recent years, but is rapidly accelerating.

Earth science as taught in the secondary schools may be defined as "The science which considers the earth, its materials, processes, history, and environment in space" (ESCP* Newsletter, no. 1, 1963, p. 1), and as such includes elements of astronomy, geology, meteorology and climatology, oceanography, and physical geography. It is most commonly taught in the junior high school at the eighth- or ninth-grade level, where it replaces the traditional general science course and is commonly required of all students. Indeed, it is the terminal science course for a significant number of high school students.

A state-wide survey made in the 1962-1963 school year (Stoever and Trask, 1964, p. 38) revealed 18 schools in Oklahoma that offered an earth science course. The survey made this year (1967-1968) showed that earth science is being taught as a separate course in 85 schools in the State, more than twice the number of the previous year (table I, fig. 1).

Most of this growth has occurred within the past three years as attested to by the years of earth science teaching experience reported (table II). This growth may well be correlated in large part with two events that occurred in 1965: the establishment of the Oklahoma City Earth Science Curriculum Project Test Center and the development at The University of Oklahoma of both Academic Year and Summer Institute Earth Science Teacher Preparation Programs; supported by the National Science Foundation. More recently, in 1967, Oklahoma State University initiated a National Science Foundation College-School Program in ESCP Earth Science, involving a Summer Sequential Institute, which is also stimulating interest in this field.

Equally dramatic is the response concerning future interest in earth science teaching. A questionnaire was mailed to 870 Oklahoma teachers listed in the 1966 National Science Teachers Association Registry as either general science or earth science teachers. There were 193 responses (22% of the mailing), which is probably a fair reflection of the current interest of Oklahoma teachers in earth science. These teachers represent 162 different schools. Of the schools represented, 85 are now offering at least one earth science course. Eighteen schools will definitely add the course next year (1968-1969) and 25 other schools either have definite plans or hope to add the course by 1970-1971. Certainly these plans are tentative to a degree, but, consider-

* Earth Science Curriculum Project.

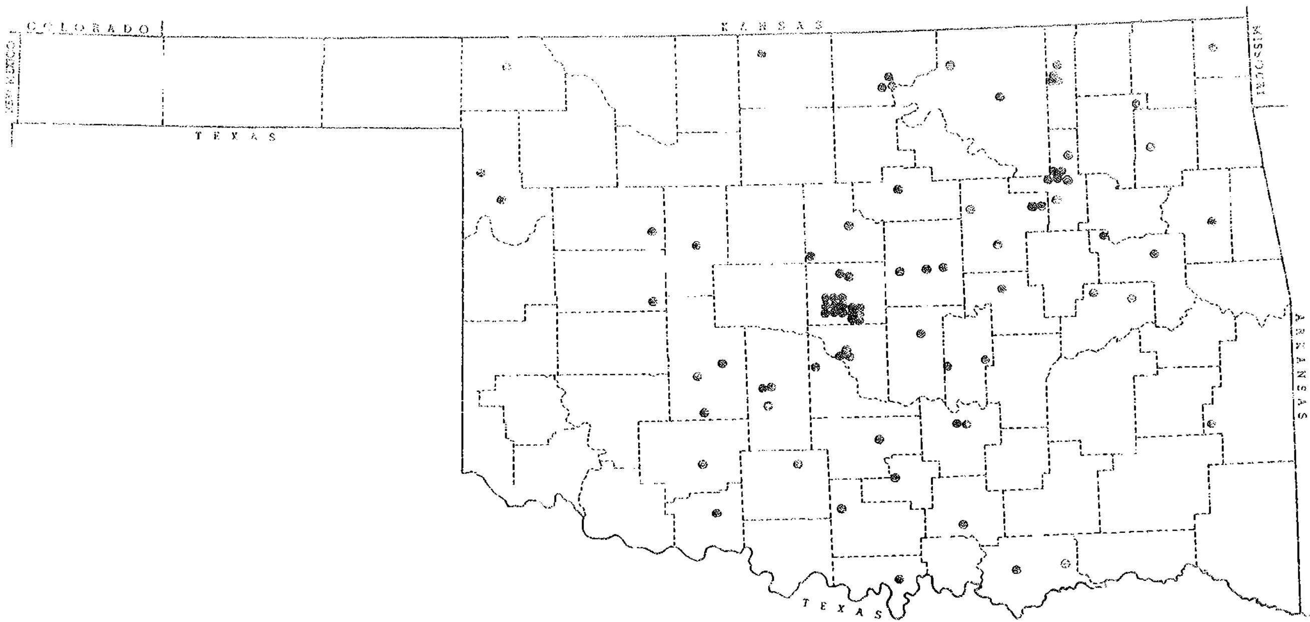


Figure 1. Locations of high schools in Oklahoma at which earth science was taught during the 1967-1968 school year.

TABLE I.—GROWTH OF EARTH SCIENCE PROGRAMS FROM 1966-1967 TO 1967-1968 SCHOOL YEARS

	1966-1967[1]	1967-1968	PERCENT INCREASE
Number of schools	40	85	112
Number of teachers	78	96	23
Number of classes	182	315	73
Number of students	5224	9476	81
Averages:			
Number of students per class	28.7	30.0	5
Number of classes per teacher	2.33	3.28	41

[1] 1966-1967 figures from Oklahoma State Department of Education Research Bureau.

ing the increase over the past year alone, these figures could be reliably considered as minimums. The questionnaire responses do not reflect, for instance, the fact that the Oklahoma City school system has recently moved to adopt the Earth Science Curriculum Project course throughout its system in 1968-1969, adding 12 more new schools to the list of those who will be teaching earth science next year for the first time.

The figures cited above also do not indicate the even more rapid rise to be expected in the number of students taking an earth science course by 1970-1971. Teacher and student response is commonly extremely enthusiastic, and the typical pattern is for enrollment to increase greatly after one or two years of pilot development of the course. A dramatic example of this is one school in Norman, Oklahoma, where the course went from one class involving approximately 30 students in 1965-1966 to twelve classes involving more than 300 students during the current year. This pattern is shown in table I, where it will be noted that, although the number of schools and number of students have approximately doubled this year, the number of teachers has increased by only 23 percent. Considering that approximately 45 schools in Oklahoma are teaching earth science for the first time this year, the percentage growth by 1970 in numbers of students can reason-

TABLE II.—YEARS OF EARTH SCIENCE TEACHING EXPERIENCE

(Data through 1967-1968 school year)

NUMBER OF YEARS	NUMBER OF TEACHERS
1	37
2	27
3	15
4	4
5	3
6	4
7-12	6

ably be expected to surpass the percentage growth in numbers of schools.

The current enrollment in earth science in Oklahoma represents 19 percent of the current total ninth-grade enrollment (47,943). The Earth Science Curriculum Project has predicted that at least one-third of the nation-wide ninth-grade enrollment will be taking an earth science course by 1970 (ESCP Newsletter, no. 10, 1966, p. 2). Figures obtained from the Oklahoma State Department of Education predict a ninth-grade enrollment in Oklahoma for 1970 of 49,692 students. Based on the ESCP prediction, this would suggest that at least 16,564 Oklahoma students would be taking an earth science course by 1970. However, considering the growth during the past year alone, during which the number of students taking an earth science course almost doubled, it would appear that the growth in Oklahoma by 1970 would greatly exceed that predicted by the ESCP.

A particularly significant aspect of the growth of earth science instruction in Oklahoma has been the parallel growth of interest in the new earth science course developed by the Earth Science Curriculum Project. This is a massive course-content improvement program sponsored by the American Geological Institute and supported by the National Science Foundation. Initiated in 1963, the development by ESCP of a laboratory-centered, inquiry-oriented, interdisciplinary course in earth science, cumulating in the production of a hard-cover version of their textbook, *"Investigating the Earth,"* (Houghton-Mifflin and Company, 1967), has further stimulated the already established trend toward integrating an earth science course into the junior high school science curriculum.

The ESCP course itself is receiving enthusiastic acceptance from Oklahoma teachers and students. Eight schools in the state are currently teaching "Investigating the Earth." Seventy-one schools are definitely planning to add the course by 1970 (38 of them in 1968-1969), and 44 additional schools have tentative plans to adopt the course at some time within the next few years. In other words, by the 1970-1971 school year, there may be as many as 125 schools in Oklahoma teaching the ESCP course. This response is particularly encouraging in that the Houghton-Mifflin book is not yet on the state-adopted textbook list, which at present is revised only once every four years. Although efforts are being made to alter this procedure, it is probable that the revised list will not be made effective until the 1970-1971 school year, at which time Oklahoma can hopefully anticipate a renewed upsurge of interest in the ESCP.

Two major effects of this increasingly rapid rise in high school earth science teaching on the geological profession warrant emphasis. First, an ever-increasing number of future citizens are going to be aware of earth science, including geology, and its relationship to man's social, economic, and political activities. As voting citizens, they can be expected to have a better awareness of air and water pollution problems, man's exploration in space, attempts at weather modification, the exploitation of natural resources, and the exploration and utilization of the ocean floor, in short, all of the many ways in which the study of the Earth is related to man's activities. Along with this increased awareness there will be, of course, the stimulation of interest in the geological profession as a career on the part of many college-bound students, an effect already being noted in many geology departments throughout the nation. The improved backgrounds of these students are already exerting considerable pressure toward revision of the traditional college geology curricula.

A second major effect is in the additional employment opportunity for professional geologists as members of the secondary school earth science teaching corps. The rapid rate at which earth science has been added to high school curricula has caught the geological profession asleep, and there now exists a critical shortage of adequately qualified earth science teachers. It has been estimated that by 1970 at least 12,000 *new* earth science teachers will be needed throughout the nation (ESCP Newsletter, no. 10, 1966); the anticipated production of teachers by university and college pre-service and in-service training programs cannot meet this need.

Not only will more qualified teachers be needed, but these teachers will need all of the support that they can obtain from the geologic profession. Many individuals and local geological societies in Oklahoma have in the past provided much such support in the form of in-service short courses and lecture series, resource assistance, tours, field-trip guidance, etc., and these activities are continuing. Much, much more will need to be done in the future, in view of the rapid increase in the teaching of earth science in Oklahoma high schools. A splendid opportunity for rewarding service, both to the public and to the profession, exists.

Reference Cited

Stoever, E. C., Jr., and Trask, Juel, 1964, Earth science: Oklahoma Teacher, vol. 45, no. 9, p. 38-39.

New Theses Added to OU Geology Library

The following master's theses and doctoral dissertations have been added to The University of Oklahoma Geology Library recently:

Master of Science Theses

Stratigraphy and areal geology of southwestern Bryan County, Oklahoma, by John D. Currier.

Alteration of igneous rocks in the Lugert area, Kiowa County, Oklahoma, by Clayton Ralph Nichols.

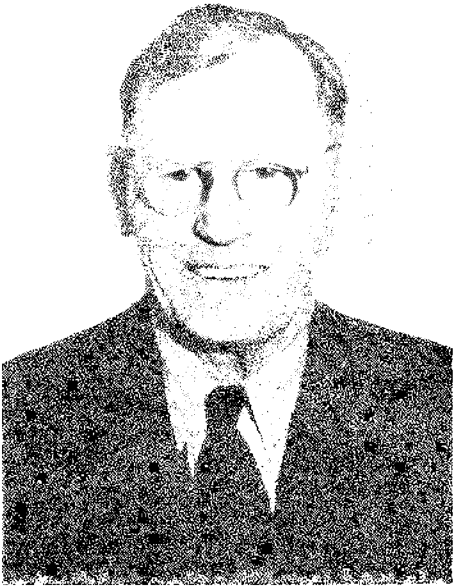
Palynology of the Bostwick Member of the Lake Murray Formation (Pennsylvanian), of southern Oklahoma, by Muhammad Abdur Rashid.

Doctoral Dissertations

Quantitative study of the Cherokee-Marmaton Groups, west flank of the Nemaha ridge, north-central Oklahoma, by Orville Roger Berg.

Petrology of the Upper Permian Cloud Chief Formation of western Oklahoma, by Gerald Guy Nalewaik.

—*L. F.*



Everett Carpenter
1884-1968

Everett Zenith Carpenter, a geologist who played a large part in oil and gas development in Oklahoma and Kansas, died suddenly on February 23, 1968, at his home in Oklahoma City. He was born in Holton, Kansas, on May 24, 1884. Carpenter attended the University of Oklahoma and earned a B. A. degree in geology in 1911. The title of his bachelor's thesis was *The Stratigraphy and Structural Geology of the Pawhuska Quadrangle.* While at the University he met and later married Neva Merle Swan, whose older sister Nina had married C. N. Gould in 1903.

During the summer of 1908 he was in an Oklahoma Geological Survey party led by H. A. Everest in the Ponca City area. During the 1909 field season he assisted in Ohern's field party near Pawhuska, then worked with a Federal field group. In 1910 he was with a State-Federal cooperative field project in the Bartlesville-Nowata area, after which he was with the U. S. Geological Survey from June 5, 1911, to July 23, 1913. His work resulted in the publication of Water-Supply Papers 333 and 365.

In 1913 Everett worked for both the Quapaw Gas Company as chief geologist and for the Wichita Natural Gas Company and, with Gould (then a consultant), discovered the Augusta oil field. Gould stated that it was the first geologically surveyed oil field. With company reorganization, Wichita Natural Gas Company became Empire Gas and Fuel Company, with Carpenter as chief geologist. In 1915 he discovered the Eldorado oil field. The company then let him build the geological staff to about 200 men, years before other oil-company management recognized the need for geologic work. L. C. Snider supervised the training school, and Carpenter expanded exploration into several additional states, placing Alex W. McCoy in charge.

He left Empire and was at times associated with Emerald Oil Company, Mississippi Valley Oil Company, Panhandle Eastern Pipe Line Company, and Watchorn Oil and Gas Company. He joined Porter Oil and Gas Company and was chief geologist and vice-president until his retirement. He wrote articles on the geology of Washington County and on Morrison oil field for the Oklahoma Geological Survey.

Everett was made honorary life member of the Oklahoma City Geological Society in 1958 and wrote the fine article *As I Remember It* for the society's journal in June 1957. He was a founder of the American Association of Petroleum Geologists and was elected honorary member in 1958. His widow and three sons survive him.

Carpenter's influence on oil exploration was extensive. In 1924 he wrote to Gould, "I do not regard anticlines as the only controlling factor in the accumulation of oil. There are other factors equally important. To my mind, Petroleum Geology is a study of the rocks in their relation to the accumulation of oil and gas. Anticlines furnish only one condition under which oil and gas may accumulate. Other conditions equally important are furnished by Sand Lenses, Faults, Shoe-string Sands, etc."

In these thoughts he was years ahead of others and made his companies highly successful. —*Carl C. Branson*

Sources

Aurin, F. L., 1959, Everett Carpenter, honorary member: Amer. Assoc. Petroleum Geologists, Bull., vol. 43, p. 1744-1747.

Branson, C. C., 1957, Petroleum notes from the twenties: Okla. Geol. Survey, Okla. Geology Notes, vol. 17, p. 93-94.

McMurtry, W. E., 1958, Everett Carpenter elected to honorary life membership: Oklahoma City Geol. Soc., Shale Shaker, vol. 8, no. 8, p. 4-5.

Water Resources of Cleveland and Oklahoma Counties

Oklahoma Geological Survey Circular 71, *Ground-Water Resources in Cleveland and Oklahoma Counties, Oklahoma*, was published on April 8, 1968. The report, written by P. R. Wood and L. C. Burton, both of the U. S. Geological Survey, is the culmination of a long-term study undertaken as a cooperative project between the U. S. Geological Survey and the Oklahoma Geological Survey. It comprises 75 pages, 8 figures, 9 tables, and 2 plates. Plate I is a colored geologic map of Cleveland and Oklahoma Counties, compiled by L. C. Burton and C. L. Jacobsen, at an approximate scale of ⅝ inch = 1 mile. In addition to the geology, the map shows the locations of several hundred water wells, for which data are presented in the text. The principal source of water in the two-county area is the Garber and Wellington Formations, which together constitute a single aquifer.

The book may be purchased from the Oklahoma Geological Survey for $3.75 (paper bound only). An abridged abstract follows.

ABSTRACT

Rocks exposed at the surface are Permian and Quaternary in age. The Permian rocks include the Wellington Formation, Garber Sandstone, Hennessey Shale, Duncan Sandstone, and Chickasha Formation. The Quaternary rocks include terrace deposits at one or more levels along the valleys of the principal streams, alluvium, and dune sand.

The terrace deposits and alluvium supply ground water for domestic and stock use at many places in the two counties, yielding up to 200 or more gallons of water per minute to properly developed wells. The Chickasha Formation, Duncan Sandstone, and Hennessey Shale yield small quantities of hard water to wells.

The principal sources of ground water used for municipal and industrial purposes are the Garber Sandstone and the Wellington Formation. The two formations were deposited under similar conditions, and both consist of lenticular beds of sandstone alternating with shale.

At variable depths below the land surface the Garber and Wellington contain water too highly mineralized for most uses. Hence, the depth to which wells may be drilled in search of potable water supplies is largely determined by the depth at which salt water is encountered. In southeastern Cleveland County salt water occurs about 100 feet below land surface. In eastern Cleveland and Oklahoma Counties salt water occurs at depths ranging from 200 to 660 feet below land surface. In the Oklahoma City, Lake Hefner, and Edmond areas salt water is 700 to 800 feet below land surface; in the Midwest City area, more than 1,000 feet; at Norman, 700 feet; and at Noble, 400 feet.

The depths of municipal, institutional, or industrial wells perforated or screened in the Garber and Wellington range from 300 to about 1,000 feet. Yields range from 50 to 450 gallons per minute and average 240. Pumping drawdowns range from 50 to 430 feet and average 200 feet. Coefficients of transmissibility, determined from pumping tests, range from 3,000 to 7,000 gallons per day per foot and average 5,000. The coefficients of storage average 2.0×10^{-4}. Specific capacities range from 0.6 to 3 gallons per minute per foot of drawdown, and average 1.3.

Throughout most of the area water levels in the Garber and Wellington have changed little since the 1940's, but they have declined substantially in the Norman and Midwest City areas.

Recharge is estimated to be about 5 percent of the precipitation, or 90 acre-feet per square mile for the outcrop area. Annual recharge averages about 72,000 acre-feet.

Ground-water withdrawals from the Garber and Wellington for all purposes through 1959 are estimated to have been 280,000 acre-feet.

Ground-water withdrawals for municipal, institutional, and industrial use during 1963 are estimated to have been 25,000 acre-feet.

Water from the Garber and Wellington is suitable for drinking, but locally is high in sulfate, chloride, or other mineral constituents. At most places it is suitable for irrigation, but locally it has an excessive amount of sodium.

The Garber and Wellington Formations in the two counties are estimated to contain 50 million acre-feet of fresh water, of which about 34 million is available for development. Thus additional supplies are available through development, but wells should be properly spaced to minimize interference between wells.

Speleological Society Field Trip in Major County

The National Speleological Society is sponsoring a preconvention field trip in Oklahoma as a prelude to its national meeting at Springfield, Missouri, August 18-24, 1968. The field trip, scheduled for August 17, will be a visit to a newly mapped gypsum cave in Major County. The Oklahoma event is being conducted by the Central Oklahoma Grotto of the Society, which extends an invitation to all, members and nonmembers alike. Full information may be obtained from:

Mr. Jerry Fogleman
Central Oklahoma Grotto
National Speleological Society
1101 Berwyck Drive
Moore, Oklahoma 73060

The national convention of the Society will be held at Southwest Missouri State College and is being cosponsored by the Missouri Geological Survey and Water Resources and the Missouri Speleological Survey, Inc. Information on the Springfield meeting can be obtained from:

Mr. J. D. Vineyard
Missouri Geological Survey
Box 250
Rolla, Missouri 65401

New Oklahoma Core Catalog Issued

The University of Oklahoma Core and Sample Library has issued its new *Core Catalog 2,* February 1968, which supersedes all earlier lists. The catalog is a direct reproduction of the readout from the punch cards that constitute the accession file of the library. The listing is in the order of township, range, and section for the entire holdings. The catalog is available upon request from The University of Oklahoma Core and Sample Library, School of Geology and Geophysics, The University of Oklahoma, Norman, Oklahoma 73069.

Since the issue of *Core Catalog 1* in February 1967, cores from 152 wells have been added to the library. Many of these are from wells drilled recently but some are from older wells. Cities Service Oil Company contributed cores (mostly chips) from a number of wells drilled in the Oklahoma City field during its early development. The Oliphant interests donated a substantial number of cores from wells in Kay and Osage Counties. Cores from several older wells drilled by the Atlantic Refining Company were properly identified and shelved.

The Core and Sample Library is in building 139, Jenkins Ave. south of Constitution St., South Campus of The University of Oklahoma, Norman. It now has on file more than 75,500 feet of core from 920 wells. Well-cutting samples from approximately 28,000 wells are also on file, but only those not obtainable through commercial libraries are available for examination.

Mr. Wilbur E. Dragoo is manager of the library, which is open 8:00 A.M. to 12:00 noon and 1:00 P.M. to 5:00 P.M., Monday through Friday. His phone is area code 405, 325-4386. For any additional information communicate with John F. Roberts, Oklahoma Geological Survey, room 161 Gould Hall, phone area code 405, 325-3031.

Cores may be examined at the library for a service charge of $1.00 per box. Cores will be shipped to borrower, who pays all shipping charges, for a service charge of $1.50 per box for 21 days. Permission to use in excess of 21 days should be obtained; otherwise, a charge of $1.50 per box will be made for each additional 21 days or portion thereof.

Cores are added to the library through automatic contribution by numerous operators as the cores become available. Other operators, particularly those with storage problems, are urged to avail themselves of the storage facilities of the library (where the cores will be readily accessible) through donation of their Oklahoma cores. As the library is a nonprofit organization, assumption of the delivery costs by the donor would benefit both the donor and the library. In the cases of large donations, financial aid for the cost of shelving would also be mutually beneficial.

OKLAHOMA ABSTRACTS

GSA South-Central Section Meeting, Dallas, Texas March 29-31, 1968

The South-Central Section GSA abstracts are reproduced photographically from the program of the meeting, and the permission of the authors and of Jo Fogelberg, managing editor, is gratefully acknowledged. The proper citation for these abstracts is Geol. Soc. America, South-Central Sec., 2nd Ann. Mtg., Program, p. ... Page numbers are in brackets at the end of each abstract.

Atoka Series of the Oklahoma Region

Branson, Carl C., *Oklahoma Geological Survey, University of Oklahoma, Norman, Okla.*

The Atoka Formation as a rock-stratigraphic unit is defined as those rocks overlying the Morrowan rocks (Wapanucka, Bloyd) in the Arkoma Basin and vicinity. The biostratigraphic unit is the Zone of *Fusulinella,* excepting the highest part. The time-stratigraphic unit is the Atokan Series, which underlies rocks of Desmoinesian age and overlies rocks of Morrowan age. [12]

Geology of the Lynn Mountain Syncline, Ouachita Mountains, LeFlore County, Oklahoma

Briggs, Garrett, *Dept. Geology, Tulane University, New Orleans, La.*

The Lynn Mountain syncline in southern LeFlore County is an east-west-trending fold which plunges gently westward from its nose on the Oklahoma-Arkansas line. The Upper Mississippian and Lower Pennsylvanian rocks of the syncline comprise approximately 22,000 feet of alternating thin layers of sandstone and shale. The predominance of sandstone layers in the synclinal sequence causes the syncline to stand out in bold relief above the predominantly shale sequence of the valleys to the north and south. The northern limb of the syncline exhibits an almost complete and undisturbed section of, from oldest to youngest, the upper part of the Stanley Group, the Jackfork Group, the Johns Valley Formation, and the lower part of the Atoka Formation. Few of the dark siliceous shales used to subdivide the Stanley and Jackfork groups to the west in the Ouachita Mountains extend into the area. The rocks of the southern limb of the syncline were dragged northward and overturned by thrusting along the Octavia fault which bounds the syncline on the south. The marker beds used to correlate the

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OKLAHOMA ABSTRACTS is intended to present abstracts of recent unpublished papers on Oklahoma geology. 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.

rocks of the northern limb are buried beneath the overturned rocks of the southern limb. A large splinter of undifferentiated Jackfork has been dragged up along one of the bifurcations of the Octavia fault and now parallels the southern edge of the syncline as a prominent ridge which stands out in relief above the Stanley Shale which surrounds it. *(Presented with the permission of the Director of the Oklahoma Geological Survey.)* **[12]**

Zonal Ammonoids of the Atokan Stage

FURNISH, W. M., *Dept. Geology, University of Iowa, Iowa City, Ia.*

Certain Pennsylvanian ammonoid groups can be arranged into phylogenetic sequences, with those of the Atokan Stage constituting a significant step of equal importance to others recognized. Those goniatites evolving most spectacularly so as to provide key evolutionary links of generic importance occur in the Schistoceratidae. The subfamilial group including the type genus can be visualized as a relatively simple trend. This single lineage, involving the Atokan *Paralegoceras,* displays progressive changes in sutural complexity and proportion, shell sculpture, and conch form. Earlier genera, *Branneroceras* and *Diaboloceras,* characterize rocks in the upper Morrowan Stage, and two more advanced representatives of the subfamily, *Eoschistoceras* and *Schistoceras,* occur in later Desmoinesian and Missourian-Virgilian rocks, respectively. A parallel development in the Welleritnae is represented in the Atokan Stage by *Winslowoceras* and *Eowellerites.*

Initially, Lower and Middle Pennsylvanian ammonoid taxa were founded on isolated specimens. The earlier designations can generally be defined, but recognition is complicated by intraspecific variation and gradational differences in abundant newer collections. There is, therefore, some practical problem in assigning a definition of the Atokan Stage on a strictly faunal basis. Such a difficulty is believed to be inherent, and it can be solved arbitrarily. **[21]**

Paleomagnetism of Cretaceous Rocks from North America

HELSLEY, CHARLES E., *Southwest Center for Advanced Studies, 2400 N. Armstrong Parkway, Dallas, Texas*

Paleomagnetic studies of rocks from eleven widely separated localities in North America have provided additional evidence for the position of the Cretaceous paleomagnetic pole. These data, when combined with the published data from other localities in North America, give a virtual pole position in the Arctic Ocean at 72°N 178°W with an α_{95} of 6°. All of the poles from structurally uncomplicated areas are highly consistent, thus strongly supporting the assumption of a dipolar field during most, if not all, of Cretaceous time. The polarity of all samples of Cretaceous rocks is normal except for those whose age is given as Cretaceous-Jurassic or Cretaceous-Paleocene. This suggests that the Cretaceous period was characterized by a field of uniform normal polarity in contrast to the Permian when the field was generally of reversed polarity.

An analysis of all available Cretaceous data from North America in terms of Upper Cretaceous and Lower Cretaceous, using the best available age criteria, provides two pole positions seven degrees apart each having an α_{95} of 6°. Although this difference may not be significant, it suggests that the pole did move during Cretaceous time. The movement of the pole is from south to north along approximately 180°W. This direction and rate of movement connects smoothly with the results from Tertiary rocks of North America. Thus, if the polar wandering is interpreted as drifting of North America, the drift has been in a constant direction and appears to have been more or less continuous since early in the Cretaceous. [24]

Microfossils and Integrated Faunal and Sedimentary Cycles in the Atoka Series (Pennsylvanian) near Winslow, Arkansas

HENBEST, LLOYD G., *U. S. Geological Survey, East 116, U. S. National Museum, Washington, D. C.*

Species of *Komia, Millerella, Fusulinella,* and of a few other microfossils occur at two horizons roughly 150 and 1500 feet above the base of the Winslow Formation as mapped by Purdue, 1907, in its type area in the Boston Mountains, Arkansas. These fossils support the cephalopod evidence in indicating an early Middle Pennsylvanian age for these rocks in the Atoka Series.

An orderly, cyclic repetition in the succession of sediments is recognizable in the Winslow rocks. An orderly zonation in the faunal and environmental succession is integrated with the sedimentary sequence. The lateral extent and continuity of these cyclical units in the shelf zone to the east and the relation of these cyclothems to the channeloid quartz-gravel-bearing sandstones of the same age in the northern and eastern parts of the Boston Mountains have not been determined, but the cyclical features provide a means of identifying and mapping the rock bodies, of inferring environments of deposition, and of locating the most favorable horizons for fossils.

Shallow water sedimentary structures and "normal" marine faunas are interbedded with the *Scalarituba-"Arthrophycus"* assemblage zone, showing that such problematica are not necessarily indicators of an abyssal environment. The scarcity, more apparent than real, of "normal" marine fossils resulted partly from an unfavorable substrate of mud and sand in a high energy environment and from subsequent deep-seated leaching of carbonates by sulfurous acid derived from oxidized pyrite. The leaching leaves characteristic features that aid in locating fossiliferous zones. The growing fossil record and the critical location of the Winslow Formation enhance the use of the Winslow as a standard of reference for lower Middle Pennsylvanian stratigraphy. *(Publication authorized by Director, U. S. Geological Survey).* [24-25]

The Atoka Problem

QUINN, JAMES H., *Dept. Geology, Univ. of Arkansas, Fayetteville, Ark.*

The Atoka problem is concerned with acceptable application of the term Atoka as a formational name and as a stage or series name, and with whatever segment of the geological column and the scale of geological time the formation and series may represent or include. Meaningful solution rests on acceptance of a type locality and some elucidation of the range of the unit. It must be understood that *type locality* is merely a point of reference and not a "unit of measurement" in the sense of "typical" locality. A beginning has been made by suggestion of a type section and locality by Branson and Elias. The base of the Atoka section should not include Morrowan rocks, which we can now distinguish paleontologically in most places.

The areal extent of the formation ought to be clarified. The practicality of spreading the formational name over much of Arkansas and northeastern Oklahoma is questionable. There is no advantage in the term, "Boston Mountain Atoka" over Winslow Formation, or "Arkansas Valley Atoka" *versus* the "Oklahoma Atoka." Rocks in the Muskogee-Braggs Mountain area are doubtless a western extension of the Boston Mountain section; they probably should not be confused with the Atoka proper.

Should the Atoka Formation be restricted to the rocks in the Atoka, Oklahoma, area, and should an Atokan Stage be recognized; or shall the Atoka Series be accepted, and if so, shall it be considered lower Middle Pennsylvanian or upper Lower Pennsylvanian? **[33]**

Biostratigraphy of the Atokan Stage

STRIMPLE, HARRELL L., *Dept. Geology, Univ. of Iowa, Iowa City, Iowa*

The term "Atokan Stage" is widely accepted and well established. The Atokan has a distinctive fauna and is a useful time-stratigraphic unit. Since the type Atoka Formation is apparently barren, the fossiliferous equivalent of Coal County (between the Wapanucka Formation below and the Hartshorne Sandstone above) serves as a satisfactory reference. *Profusulinella* and *Fusulinella,* which are present in the lower Atoka Formation of Coal County, are representative of an Atokan Age (especially in the absence of *Fusulina* spp.). Ammonoids at Barnett Hill in Coal County (in the zone of *Fusulinella)* are similar to those found at Winslow, Arkansas, in the "Winslow" Formation.

Synerocrinus cf. *S. farishi* Laudon, *Paradelocrinus atoka* Strimple, and *Synarmocrinus fundundus* Strimple are known to occur in the Atokan of Coal County (in the zone of *Profusulinella)* together with several undescribed species of crinoids.

Correlation of Atokan equivalents over widespread areas is possible through comparison of known fusulinids and ammonoids. Current studies of crinoids and conodonts substantiate information previously acquired. **[37-38]**

Palynology of the Drywood and Bluejacket Coals (Pennsylvanian) of Oklahoma

URBAN, LOGAN L., *242 F. P. B., Phillips Petroleum Company, Bartlesville, Okla.*

The Bluejacket coal occurs in the Boggy Formation, and the Drywood coal is the topmost coal of the Savanna Formation. Both are included in the Krebs Group of the Des Moines Series.

The spore and pollen assemblage in one section of Drywood coal and two sections of Bluejacket coal contain 33 genera and 70 species. *Endosporites* *angulatus* appears as a facies fossil in the Bluejacket coal, and the high relative percentage of this form (10 percent of the total assemblage) may be a diagnostic feature of the Bluejacket coal. Relative percentages of 19 of the more common genera indicate that plant succession occurred in the Bluejacket coal in Craig County, but that the same succession did not develop in the marginal deposit at Inola Mound. [39-40]

Palynological Evidence for the Age of the Bostwick Member of the Dornick Hills Group (Pennsylvanian) of Oklahoma

WILSON, L. R., and MUHAMMAD A. RASHID, *School of Geology, Univ. of Oklahoma, Norman, Okla.*

The Bostwick Member consists of conglomerate, sandstone, shale, coal, and limestone beds. It is stratigraphically placed in the middle portion of the Dornick Hills Group which includes Morrow, Atoka, and the lower half of the Des Moines Series. The Bostwick sediments, deposited contemporaneously with the uplift of the nearby Criner Hills, contain a varied assemblage of palynomorphs. The youngest forms are Des Moines species, which suggests that the Bostwick Member is essentially Desmoinesian in age, and thus raises the question about the validity of an Atoka Series in the area. [40]

AAPG-SEPM ANNUAL MEETING, OKLAHOMA CITY, OKLAHOMA

April 22-25, 1968

The following abstract is of a paper presented at the SEPM Research Symposium of the SEPM annual meeting. The paper was added to the program at a late date and therefore was not included among the published abstracts of that meeting (AAPG *Bulletin,* March 1968; *Oklahoma Geology Notes,* April 1968).

Control of the "Microenvironment" on the Clay Mineralogy of an Alteration Sequence

NICHOLS, CLAYTON R., School of Geology and Geophysics, University of Oklahoma, Norman, Oklahoma.

The alteration of diabase dikes at King Mountain, Kiowa County, Oklahoma, illustrates the diversity of clay-mineral alteration products that may result from local variations in the "microenvironment." Three diabase dikes exhibiting various degrees of argillation are exposed in a 100-foot-deep railroad cut. The diabase and its alteration products were examined by means of petrographic microscopy, x-ray diffractometry, and electron microscopy. Chemical analyses were obtained by x-ray fluorescence, differential thermal analysis, and effluent-gas analysis. Diabase from the center of the railroad cut contains

52% labradorite (An_{59}) and 31% chlorite. The chlorite is interpreted as a deuteric alteration product of the original pyroxene. As a weathering surface is approached at the east end of the railroad cut, the relatively fresh labradorite, chlorite, and magnetite are replaced by goethite, interstratified illite-montmorillonite, and kaolin. The oxidization and leaching have been accomplished by the downward percolation of ground water along a steeply dipping dike. The same diabase dike contains interstratified chlorite-montmorillonite where relief is low and alkaline conditions persist. The clay mineralogy, clay-mineral distribution, and chemical data all indicate that the argillation is the result of weathering. The diversity of clay minerals has resulted from local, relief-controlled variations in the chemical environment.

Board on Geographic Names Decision

Hauani Creek has been adopted as the name for a stream that heads about six miles northwest of Madill in Marshall County and flows into Lake Texoma east of Lebanon. Hauani (not Haiyona, Hiayona, or Houani) Creek is about twelve miles long and terminates at 33°59′00″ north latitude and 96°54′10″ west longitude.

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