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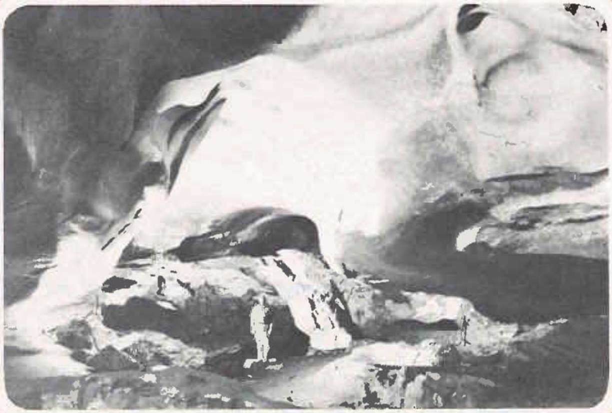

OKLAHOMA GEOLOGY NOTES

VOLUME 29 NUMBER 5 OCTOBER 1969

Cover Picture

EFFECTS OF THE UNDERGROUND STREAM IN ALABASTER CAVERN

In September the Survey issued Guide Book XV, *Guide to Alabaster Cavern and Woodward County, Oklahoma,* by Arthur J. Myers, A. M. Gibson, Bryan P. Glass, and Carol R. Patrick. The cover illustration shows part of Alabaster Cavern's channel section, where the abrasive action of the underground stream in the cave is best shown. This section of the cave lies entirely within the Medicine Lodge Gypsum, the lowest gypsum bed in the Blaine Formation (Permian), and has an average width of 15 feet.

The cavern itself is almost entirely within the Medicine Lodge, although its maximum depth reaches into the Flowerpot Shale and its maximum height extends to the base of the Nescatunga Gypsum. The cavern is of special interest because it is one of the largest known gypsum caves and has numerous features not found in the more common limestone caves.

Guide Book XV contains the first detailed account of Alabaster Cavern's formation and the surrounding strata. The 38-page guidebook, with 41 illustrations, also includes a history of the Woodward County area and a guide to the bats found in the cavern, and it may be purchased from the Survey for $1.00.

—*Carol R. Patrick*

OKLAHOMA GEOLOGICAL SURVEY

ANNUAL REPORT

July 1, 1968-June 30, 1969

Because of the lack of anticipated increases in funding and personnel and the temporary loss of three professional staff members through illness and sabbatical leave, the activity planned for the 1968-1969 fiscal year was only partly completed. In the area of basic mapping, Dr. Shelton's report on Noble County is complete and in editorial review. Dr. Briggs has completed and submitted for review his geologic map of the Lynn Mountain syncline, with the written report to follow shortly. The geologic map of Choctaw County is complete; Dr. Huffman is currently engaged in resolving final details and in writing the report. The cooperative program with the U. S. Bureau of Mines to evaluate the suitability of Oklahoma clays and shales in the manufacture of vitrified clay pipe, lightweight expanded aggregate, and structural ceramic materials was initiated as planned. This project, under the direction of Mr. Bellis, will continue during the coming year at an accelerated pace. The scientific salvage program along the Interstate 35 right-of-way through the Arbuckle Mountains was essentially completed by Dr. Fay at the end of the fiscal year, and the final report will be ready shortly. Dr. Johnson began a study of the geology of Alfalfa County in cooperation with the U. S. Army Corps of Engineers.

Much progress was achieved in planning a cooperative water-resources program with the Water Resources Division of the U. S. Geological Survey. The first of a series of nine hydrologic atlases is now in press, one is in editorial review, and three are in progress. These atlases, the last of which will be published by 1973, are to constitute the basis for more thorough and detailed special studies planned for the future. It is estimated that at least 20 special projects should be undertaken as soon as possible to provide essential information for economic activity in the State. It is hoped that these projects can be done through a matching-fund arrangement with the U. S. Geological Survey.

In the area of public information and assistance the Survey has continued to provide service on both the professional and public levels. Numerous lectures and talks were given to school and civic groups. The mineral-resources map of Oklahoma has been revised and will go to press shortly. The educational-series maps are being revised and should be published within the coming fiscal year. Among future projects formulated during the fiscal year is a series of regional geologic guidebooks intended for use in Oklahoma secondary schools. These guidebooks will also be of interest and value to the general public.

The holdings of the core and sample library continue to expand and now comprise more than 78,600 feet of cores from 984 wells and cutting samples from 28,000 wells. The present library building is inadequate, and plans call for its replacement with a new, fire-proof facility that will provide subscribers greater convenience and more efficient service.

One of the cooperative projects initiated during the fiscal year was the Geothermal Survey of North America in cooperation with the American Association of Petroleum Geologists. Mr. Roberts is chairman for the Oklahoma District and expects to complete his task by the end of the 1969-1970 fiscal year. The Survey also completed a uranium-occurrence map of the State for the Southern Interstate Nuclear Board, a compact agency that includes 17 southern and Mid-continent states.

It had been hoped that the Survey could initiate an active environmental geology program during the fiscal year. Despite the urgent need for information derived from such studies, lack of funds and personnel preclude early implementation of such a program. However, a short report on the geology of Lake McMurtry was prepared for the City of Stillwater by Dr. Shelton, and several members of the Tulsa Geological Society have produced a detailed geologic map of the City of Tulsa. Because Tulsa will undergo rapid industrial and urban development as a result of the Arkansas River Navigation Project, an urban-geology study of the area is urgently needed. It is still hoped that the geologic map voluntarily produced and submitted by the Tulsa geologists will become the core of such a report.

During the fiscal year, the Survey published one guidebook, one bulletin, a directory of mineral producers, a catalog for the core and sample library, and six issues of *Oklahoma Geology Notes* (appendix A). The Survey also provided editorial services for Memoirs 2 and 3 of the Paleontological Society. Guide Book XV, *Guide to Alabaster Cavern and Woodward County, Oklahoma,* and Hydrologic Atlas HA-1, *Reconnaissance of the Water Resources of the Fort Smith Quadrangle, East-Central Oklahoma,* were in press at the end of the fiscal year.

Despite solid accomplishments, the activity of the Survey during the 1968-1969 fiscal year can be regarded only as a custodial operation. Much that needed to be done could not be done under present circumstances; too often we have been forced to assign priorities on the basis of what is possible rather than what is necessary. The need for a thorough appraisal of the economic potential of Oklahoma's nonpetroleum mineral industry is most urgent. Yet we are forced to deal with this matter in piecemeal fashion as funds and personnel become available. However strenuous and competent our efforts, we cannot succeed on such an appraisal without a strong, well-funded, long-range program. The lack of such a program can mean many lost economic opportunities for the State of Oklahoma.

Charles J. Mankin

Charles J. Mankin, Director
August 18, 1969

APPENDIX A

List of Survey Publications Issued, 1968-1969 Fiscal Year

Bulletin 116.—Ostracodes of the Haragan Formation (Devonian) in Oklahoma, by Robert F. Lundin. 121 pages, 51 text-figures, 22 plates. Issued December 26, 1968.

Guide Book XVII.—Regional geology of the Arbuckle Mountains, Oklahoma, by William E. Ham. with contributions by James H. Stitt, James R. Derby, Robert O. Fay, and A. Allen Graffham. 52 pages, 41 figures, 1 plate (colored geologic map), 1 table. Issued June 2, 1969.

Directory.—Mineral producers in Oklahoma, 1968. Prepared by the Oklahoma Geological Survey for the Center for Economic Development —State of Oklahoma and the Oklahoma Economic Development Foundation. 53 pages (multilith). Issued December 1968.

Catalog.—Core catalog 3. Complete list of cores acquired by the University of Oklahoma Core and Sample Library through February 1969. 32 pages (multilith).

Oklahoma Geology Notes. Six bimonthly issues (August 1968 through June 1969), containing 176 pages.

APPENDIX B

Publications by Survey Staff, 1968-1969 Fiscal Year

THOMAS W. AMSDEN

Articulate brachiopods of the St. Clair Limestone (Silurian), Arkansas, and the Clarita Formation (Silurian), Oklahoma: Paleont. Soc., Mem. 1 (Jour. Paleontology, vol. 42, no. 3, supp.), 117 p.

WILLIAM H. BELLIS

The scanning electron microscope: Okla. Geology Notes, vol. 29, p. 26.

CARL C. BRANSON

Recently published Oklahoma topographic maps: Okla. Geology Notes, vol. 28, p. 170-171.

Progress of topographic mapping in Oklahoma: Okla. Geology Notes, vol. 28, p. 188-190.

Historic Wilson Rock—A Keota Sandstone outcrop: Okla. Geology Notes, vol. 29, p. 14-17.

New Oklahoma topographic maps: Okla. Geology Notes, vol. 29, p. 56-57.

Kansas rock column: Okla. Geology Notes, vol. 29, p. 85-87.

ROBERT O. FAY

Geology of Region III, *in* Appraisal of the water and related land resources of Oklahoma—Region Three, 1968: Okla. Water Resources Board, Pub. 23, p. 12-18.

Economic geology, *in* Appraisal of the water and related land resources of Oklahoma—Region Three, 1968: Okla. Water Resources Board, Pub. 23, p. 19-20.

Geology of Region IV, *in* Appraisal of the water and related land resources of Oklahoma—Region Four, 1969: Okla. Water Resources Board, Pub. 24, p. 21-24.

Economic geology, *in* Appraisal of the water and related land resources of Oklahoma—Region Four, 1969: Okla. Water Resources Board, Pub. 24, p. 113.

Bromide Formation on Tulip Creek and in the Arbuckle Mountains region, *in* Regional geology of the Arbuckle Mountains, Oklahoma: Okla. Geol. Survey, Guide Book 17, p. 37-39 (with A. Allen Graffham).

WILLIAM E. HAM

Industrial minerals in the United States in 1968—Lime, limestone, and dolomite: Mining Engineering, vol. 21, no. 1, p. 62-63.

Regional geology of the Arbuckle Mountains, Oklahoma: Okla. Geol. Survey, Guide Book 17, 52 p.

KENNETH S. JOHNSON

Sand-barite rosette—Oklahoma's state rock: Okla. Geology Notes, vol. 28, p. 162.

Calcined petroleum coke produced at Enid: Okla. Geology Notes, vol. 29, p. 55.

CHARLES J. MANKIN

Oklahoma Geological Survey, annual report—July 1, 1967-June 30, 1968: Okla. Geology Notes, vol. 28, p. 123-133.

ALEX. NICHOLSON

Bibliography and index of Oklahoma geology, 1968: Okla. Geology Notes, vol. 29, p. 27-54 (with Patricia W. Wood).

Louise Jordan (memorial): Amer. Assoc. Petroleum Geologists, Bull., vol. 52, p. 2058-2059.

JOHN F. ROBERTS

Statistics of Oklahoma's petroleum industry, 1967: Okla. Geology Notes, vol. 28, p. 138-145.

Directory of mineral producers in Oklahoma, 1968: Okla. Geol. Survey, 53 p.

Oil and gas, *in* Appraisal of the water and related land resources of Oklahoma—Region Three, 1968: Okla. Water Resources Board, Pub. 23, p. 100-101.

Oil and gas, *in* Appraisal of the water and related land resources of Oklahoma—Region Four, 1969: Okla. Water Resources Board, Pub. 24, p. 112-113.

LEONARD R. WILSON

New water-miscible mountant for palynology: Micropaleontology, vol. 14, p. 247-248.*

Diatom succession in a Laverne (Pliocene) deposit of Oklahoma: Okla. Acad. Science, Proc. 1966, vol. 47, p. 210-213.*

Palynology, *in* Moore, R. C., et al., Developments, trends, and outlooks in paleontology: Jour. Paleontology, vol. 42, p. 1346.

Thin-section technique for fossil wood: Turtox News, vol. 47, no. 1, p. 15-17.

Computer research in palynology demonstrated by use of Oklahoma University General Information Processing System (GIPSY); Permian palynology of North America and some associated problems: Okla., Univ., Information Science Ser., Mon. 2, 143 p. (with J. L. Morrison and W. E. Reid).

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* Published in 1967-1968 fiscal year.

APPENDIX C

Papers Presented by Survey Staff at Professional Meetings, 1968-1969 Fiscal Year

Third International Symposium on the Silurian-Devonian Boundary
Leningrad, U. S. S. R., July 18-20, 1968

THOMAS W. AMSDEN

Upper Silurian (Wenlockian and Ludlovian) and Lower Devonian brachiopod faunas in the central United States.

Geological Society of America, South-Central Section Annual Meeting
Lawrence, Kansas, April 26-29, 1969

L. R. WILSON

The growth and development of palynology in North America.

American Chemical Society, Tetrasectional Meeting
Bartlesville, Oklahoma, March 15, 1969

KENNETH S. JOHNSON

Oklahoma raw materials for chemical industry (exclusive of petroleum and coal).

Oklahoma Academy of Science, Annual Meeting
Tulsa, Oklahoma, December 7, 1968

L. R. WILSON

Geomorphology and radiocarbon dates in Tesesquite Creek valley, Cimarron County, Oklahoma.

Ardmore Geological Society, Monthly Meeting
Ardmore, Oklahoma, April 1969

ROBERT O. FAY

Geology and archeology of the North Pole Region, Cornwallis Island (April 1969).

Oklahoma City Geological Society, Monthly Meeting
Oklahoma City, Oklahoma, May 22, 1969

CHARLES J. MANKIN

Oklahoma's mineral resources—Asset or liability?

APPENDIX D

Survey Staff, 1968-1969 Fiscal Year

Professional

Thomas W. Amsden
William H. Bellis
Carl C. Branson
Robert O. Fay
William E. Ham
Kenneth S. Johnson
Charles J. Mankin
Malcolm C. Oakes
John F. Roberts
Leonard R. Wilson

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Lewis M. Cline
(University of Wisconsin)
George G. Huffman
(The University of Oklahoma)
John A. E. Norden
(The University of Oklahoma)
John W. Shelton
(Oklahoma State University)
George T. Stone
(The University of Oklahoma)
Patrick K. Sutherland
(The University of Oklahoma)
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Editorial

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Carol R. Patrick

Drafting

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Odus M. Abbott
Helen D. Brown
Candelas M. DeLuca[3]
Jean M. Fiore[4]
Pamela J McCoy[5]
Gwendolyn C. Williamson

Core and Sample Library

Billy D. Brown[6]
Wilbur E. Dragoo
Jerry F. Prescher[7]

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[1] Part-time.
[2] Appointed March 1969.
[3] Resigned May 1969.
[4] Appointed January 1969.
[5] Resigned December 1968.
[6] Appointed August 1968.
[7] Resigned June 1968.

Concentration of Palynomorphs by Use of Sieves

E. J. Kidson* and G. L. Williams*

In the past, sieving has been utilized in palynology preparations to remove coarse debris (Gray, 1965) and to eliminate fine material (Eager and Sarjeant, 1963). According to the above authors, sieving is of limited value in the concentration of palynomorphs because of the unavailability of sieves with a mesh size of less than 37 microns. Loss of palynomorphs is therefore unavoidable, whether the coarse or the fine fraction is retained.

The authors recently became aware of the availability of sieves with screen-size openings down to 5 microns (with an accuracy of ±2 microns). These are manufactured by the Buckbee Mears Company of St. Paul, Minnesota. Standard sieves are available in 20 and 30 micron openings at a cost of $50.00 each for a 3-inch-diameter brass frame. Other micron openings (and frame diameters) are available on special order at an increased cost. These sieves make it possible to size-grade palynomorphs into various close-tolerance units, thus permitting the concentration of different groups of palynomorphs on a finer scale than previously possible.

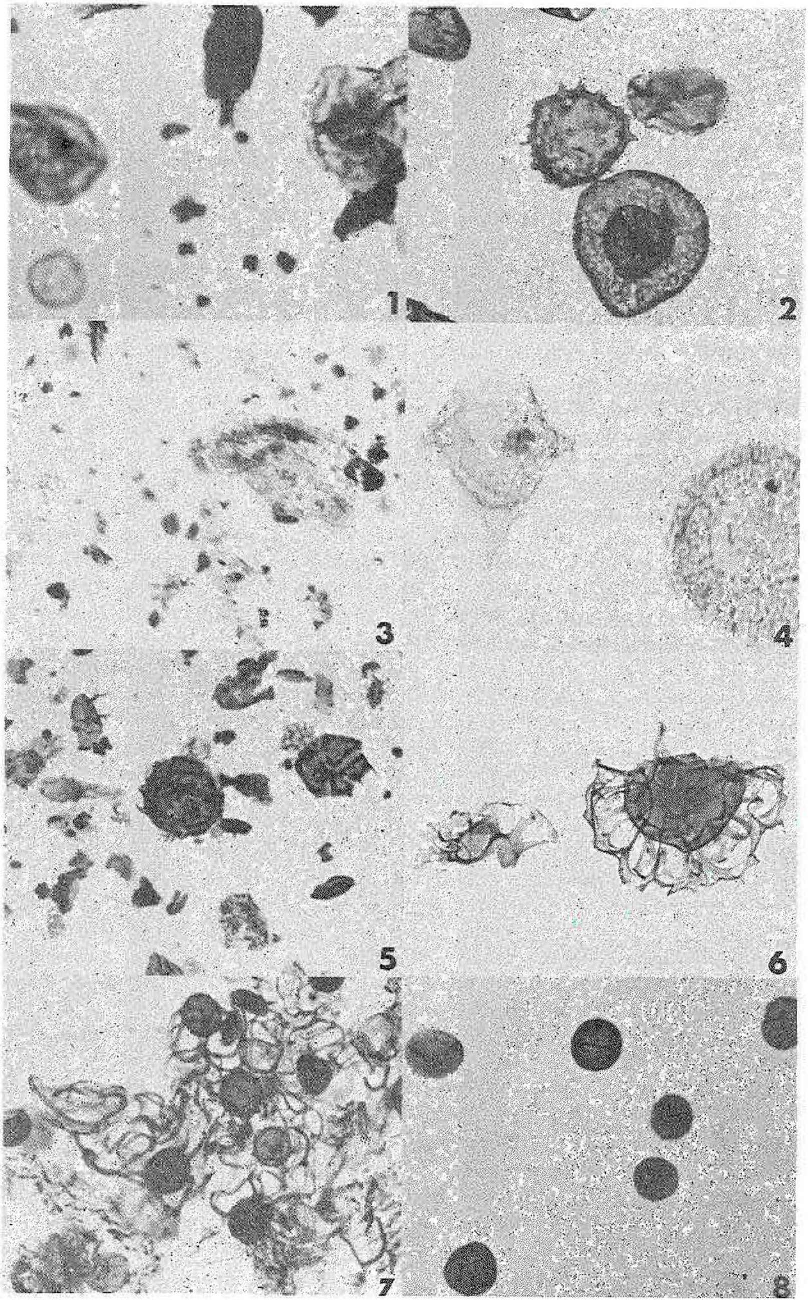
Over a period of 6 months two sieves, 20- and 30-micron mesh respectively, have been used by the authors in the laboratory. Samples are macerated in the usual way, then screened through both the 30- and 20-micron sieves. Alternately, samples may be screened through only one of the sieves, the choice depending on the preference of the palynologist. During the sieving operation strong water pressure must never be applied. The —20-micron fraction normally contains small organic debris and clay-size particles. As a rule, few palynomorphs are present, and the fraction is discarded after brief examination in wet mounts. The +20 —30 micron fraction consists mainly of pollen and small spores, and the +30-micron fraction represents a concentration of dinoflagellates, larger spores, and bivesiculate pollen. The various fractions are illustrated in plate I.

With some samples, sieving eliminates the necessity of heavy-liquid separation. With others, the +30-micron fraction can be further cleaned by heavy-liquid separation without fear of specimen loss or excessive damage. If a sample contains a large amount of fine debris, the sieving operation can often be facilitated by using sieves of larger aperture upstream from the fine-mesh sieves.

Sieving has not been confined to samples currently undergoing maceration. The residues from numerous samples, macerated in past years, have been screened through the 30- and 20-micron sieves respectively or through the 30-micron sieve only. This has provided a rapid concentration of palynomorphs, especially dinoflagellates, many of which, because of sparseness, were overlooked in the initial analysis. Screening is also useful to concentrate palynomorphs prior to picking for examination with the scanning electron microscope. In addition, screening has resulted in an improvement in the quality of modern

*Pan American Petroleum Corporation, Tulsa, Oklahoma.

Plate I



pollen and spore slides prepared by the acetylization technique (see plate I).

Cleaning the sieves has presented no problems. Strong acids are never used in order to avoid damage to the sieve. Placing the sieve in the ultrasonic transducer for a few seconds and then washing it with a fine, high-pressure water jet is usually sufficient. Use of distilled contamination, the sieve may, after cleaning, be dipped in a suitable water is preferable in all cleaning operations. To safeguard against stain (e. g., safranin O) and again washed. When a fresh sample is run through, the stained palynomorphs present in the sample can then be recognized as contaminants. Results to date have indicated that contamination is not a problem.

The aesthetic advantages of sieving are convincingly demonstrated in plate I. It is apparent that the judicious use of sieves has provided a cleaner sample without loss of palynomorphs. This permits more detailed examination and improved illustration. Other less cognizant advantages of the technique are that it minimizes the chemical treatment necessary, it permits the concentration of size groups, and it is a rapid procedure that is not dependent on the skill of the operator. The selective use of these sieves is recommended, in combination with chemical techniques, for most palynologic preparations.

The writers would like to express their thanks to D. R. Cromer and C. W. Steinsiek, who prepared the samples for this study.

References Cited

Eager, S. H., and **Sarjeant, W. A. S.**, 1963, Fossil hystrichospheres concentrated by sieving techniques: Nature, vol. 198, no. 4875, p. 81.

Gray, J., 1965, Palynological techniques, in Kummel, B., and Raup, D. (eds.), Handbook of paleontological techniques: San Francisco, H. W. Freeman & Co., p. 471-481.

Explanation of Plate I

(All figures x250)

Figures 1, 2. Sample from Upper Devonian shale.
- **1. Before sieving.**
- **2. Fraction retained on 20μ sieve.**

Figures 3, 4. Sample from Lower Cretaceous shale.
- **3. Permanent slide prepared from macerated sample in 1964.**
- **4. Fraction of same sample retained on 30μ sieve.**

Figures 5, 6. Sample from Lower Tertiary shale.
- **5. Before sieving.**
- **6. Fraction retained on 30μ sieve.**

Figures 7, 8. Modern Populus.
- **7. After acetolysis/before sieving.**
- **8. -30μ fraction.**

Age of Basement Rocks in Northeastern Oklahoma

R. E. Denison,* E. A. Hetherington, Jr.,* and J. B. Otto*

INTRODUCTION

Numerous bore holes have been drilled to basement in the area of northeastern Oklahoma, southeastern Kansas, and southwestern Missouri. Denison (1966) has placed most of the igneous rocks into one of five major units. The same information is more available and considerably condensed in Muehlberger et al. (1967). The Precambrian-age framework of these basement rocks was defined by Muehlberger et al. (1966). Additional ages from two wells have been provided by Denison et al. (1966).

We have determined 12 rubidium-strontium ages of rocks and minerals from 10 basement rock samples (table I) that have become available in the last few years. Our data can be used with published data to generate isochron plots for various petrographic rock groups.

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Table I.—Analytical Data for Isotopic Ages

Sample[1]	Rb (ppm)	Sr (ppm)	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Age (× 10^6 years)	Sample location and type
1059F	443.1	206.2	6.20	0.8192	1248±30[2]	McGinnis 1 Fee, 25-26S-12E; granite cuttings @ 2935-2937.5′, Greenwood Co., Kans.
1060F	367.6	38.35	27.67	1.268	1372±20[3]	Morris and Whorton 2 Davis, 6-255-6E; granite cuttings @ 3330-3345′, Butler Co., Kans.
1060M	1015.	13.05	224.65	4.953	1256±20[4]	
1060M	2122.	10.96	558.85	11.141	1249±15[4]	
1177F	185.3	177.6	3.01	0.7585	1216±30	Amax HC-1, 27-21N-33W; micrograpnite core @ 1920′, McDonald Co., Mo.
1179F	149.8	200.4	2.16	0.7436	1234±40	Amax DAC-2, 6-20N-23E; rhyolite core @ 1704′, Delaware Co., Okla.
1180F	188.2	148.0	3.67	0.7729	1262±25.	Amex DAC-3, 23-20N-23E; microgranite core @ 947′, Delaware Co., Okla.
1183F	184.4	98.75	5.39	0.8061	1273±20	Amax SP-2, 8-22N-20E; micrographic granite core @ 1816′, Mayes Co., Okla.
1200W	142.5	239.9	1.71	0.7358	1247±50	Henderson 1 Kelly, 18-17N-17E; rhyolite cuttings @ 2500-2505′, Wagoner Co., Okla.
1201W	231.2	21.78	30.63	1.268	1238±20	Texaco 1 Osage, 24-20N-11E; rhyolite core @ 3685-3690′, Osage Co., Okla.
1202W	162.5	159.1	2.95	0.7592	1259±30	Henderson 1 Carter 26-19N-18E; rhyolite cuttings @ 2005′ cir., Mayes Co., Okla.
1227F	601.7	54.66	31.77	1.269	1195±20	Pawnee 1 Kentie, 23-9N-6E; granite cuttings @ 7261′ cir., Seminole Co., Okla.

(1) F = Feldspar, M = Muscovite, W = whole rock.
(2) Initial Sr87/86 ratio = 0.704 except where noted.
(3) Initial Sr87/86 = 0.706.
(4) Sr87/86 at time of reheating, 0.7532, is used in age calculation.

The results suggest that a redefinition of the time of major igneous activity in northeastern Oklahoma is justified.

Muehlberger et al. (1966, p. 5420-5421) defined the Spavinaw igneous activity with 15 determinations as the period 1,150-1,300 m.y. by using the apparent ages from samples. However, an isochron plot based on the same determinations yielded an age of 1,200±30 m.y. with an initial Sr87/86 ratio of 0.705.

An isochron plot is a graphical representation of rubidium-strontium data. Figure 1 shows the plot of Sr87/Sr86 versus Rb87/Sr86. Each point represents an isotopic age determination for a rock or mineral. An isochron age is obtained by drawing a line through these points. This line, called an isochron, can be drawn by visual inspection or in one of several mathematical ways. The slope of the line is directly related to the age of the sample—the greater the slope, the greater the age. This method enables the geologist to obtain a single "best" age for any number of related samples. The error associated with the line slope can be expressed in millions of years.

The initial Sr87/86 ratio is determined by the intercept on the Sr87/86 axis. The value of the intercept gives useful information in regard to the origin and history of the rocks. In general values of Sr87/86 between 0.700 and 0.709 suggest a primary igneous origin, and values above this range suggest a complex origin or history.

An example of the usefulness can be demonstrated by using nine determinations taken from table I (figure 1). The apparent ages vary from 1,195 to 1,273 m.y. The isochron age is 1,238±17 m.y. The error in age on the line slope is less than for any of the individual determinations.

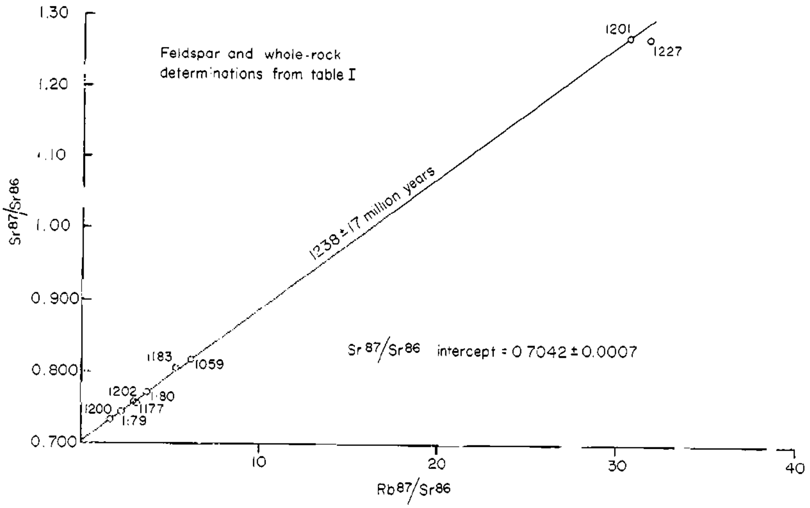

Figure 1. Isochron plot of Sr^{87}/Sr^{86} versus Rb^{87}/Sr^{86} for samples listed in table I.

A complete explanation of the isochron method of treating data can be found in Hamilton and Farquhar (1968).

RESULTS

Five igneous basement-rock petrographic units appear to have been formed during the Spavinaw igneous activity. Of the five, no additional samples were obtained from one, the microgranite in central

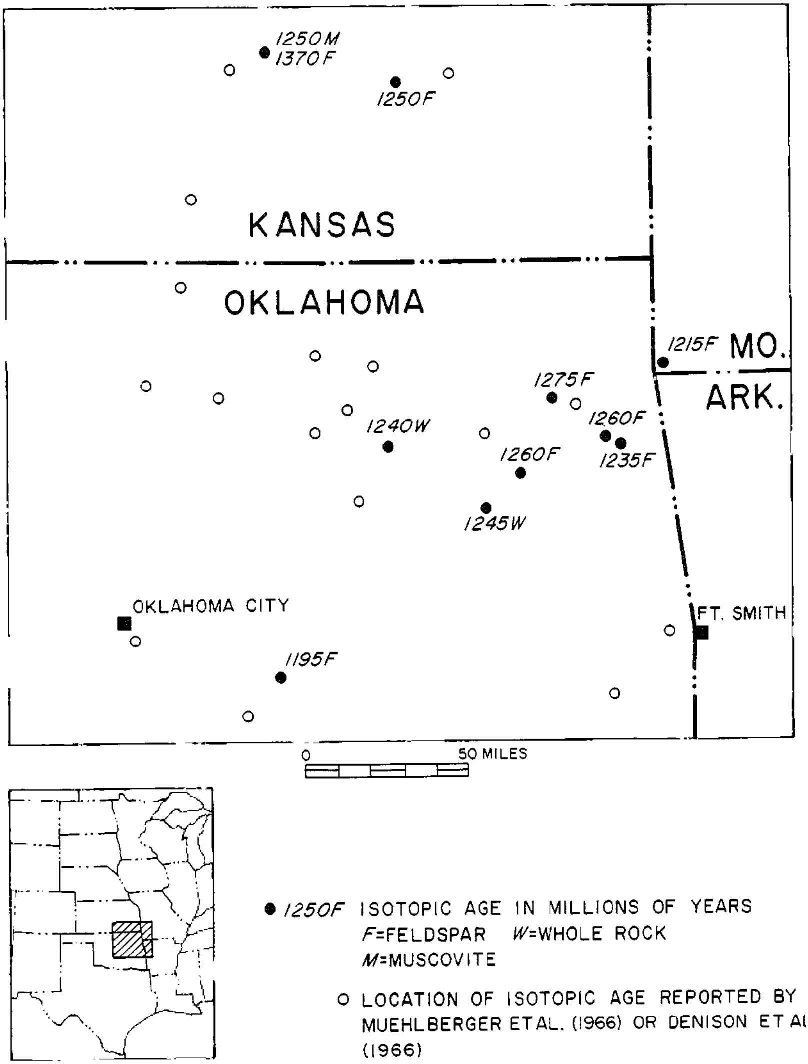

Figure 2. Location of samples for isotopic age determinations.

Osage County, Oklahoma. The Woodson County Granite and the Spavinaw Granite are petrographically and geographically related and are here grouped together in order to obtain sufficient determinations for a distinct isochron plot. There are enough determinations from each of the other two units, rhyolite-metarhyolite and the Central Oklahoma Granite Group, to provide isochrons for each.

The first task was to determine if the least squares cubic fit isochron program (York, 1966) used here yielded the same answer as the least squares fit used by Muehlberger et al. The isochron obtained using the newer program yielded an age of 1,203±17 m.y., with an initial Sr87/86 ratio of 0.7048±0.0011. Thus, essentially identical results were obtained.

A total of nine isochrons were determined using various rock types or combinations of rock types. A summary of the results of these isochrons is presented in table II: A brief discussion of each of the isochrons follows in the numerical order used in table II. Figure 3 shows graphically the results and errors.

With one exception, each of the rocks examined is a primary igneous type with no petrographic evidence of later reheating. The exception is a muscovite granite (sample 1060) from the Morris and Whorton 2 Davis well in Butler County, Kansas. The abundance of muscovite and a generally recrystalled appearance suggested an older age of original formation might be expected. The feldspar yielded an age of 1,372±20 m.y., which is in the age range of the Nemaha igneous activity (Muehlberger et al., 1966, p. 5419). Two separations of muscovite had substantially different isotope ratios (table I). The isochron from the three points yields an age of 1,252±4 m.y. with an Sr87/86 intercept of 0.7532±0.0030. This is interpreted as the time of muscovite formation or last reheating. The samples are cuttings and the rock is rather coarse; as a consequence, a satisfactory whole rock could not be picked. The rock is interpreted to have been formed as a normal granite during the Nemaha igneous activity and later recrystallized and reheated during the Spavinaw igneous activity. This is the only clear-cut example of a rock showing the two ages that has yet been found and dated.

The best defined basement-rock unit in the northeast Oklahoma area consists of rhyolites together with lesser andesites. None of the andesites has been dated but some pyroxene-bearing rhyolites have. Nine determinations, feldspars and whole rocks, have been made on these rocks, four in this study and five by Muehlberger et al. (1966). The isochron generated by these points yields an age of 1,234±14 m.y., with an initial Sr87/86 of 0.7043±0.0005. The isochron is strongly influenced by the most favorable determination (sample 1201W).

Granites similar to those exposed near Spavinaw in Mayes County, Oklahoma, constitute a major rock unit. Related to the Spavinaw Granite is the granite exposed at Rose Dome in Woodson County, Kansas, and found in drill holes in the surrounding area. Eight feldspar and whole-rock ages, four in this study and four by Muehlberger et al. (1966), have been determined. The isochron yields an age of 1,271±37 m.y., with an initial Sr87/86 ratio of 0.7025±0.0021. It should be noted

TABLE II.—SUMMARY OF ISOCHRON RESULTS

	ISOCHRON	AGE × 10^6 YEARS	NUMBER OF DETERMINATIONS	INITIAL RATIO
1.	Spavinaw igneous activity determinations of Muehlberger et al. (1966), recalculated	1203±17	15	0.7048±0.0011
2.	All Spavinaw-Rose dome type granites	1271±37	8	0.7027±0.0021
3.	All rhyolites	1234±14	9	0.7043±0.0005
4.	All Spavinaw-Woodson type granites and rhyolites	1244±13	17	0.7040±0.0006
5.	Spavinaw-Woodson type granites and rhyolites used in this study	1257±17	8	0.7036±0.0007
6.	Coarse, two-feldspar granites generally found along the Nemaha uplift, less sample 1060M	1232±35	11	0.7054±0.0024
7.	Same as isochron 6, with sample 1060M included	1248±22	13	0.7045±0.0018
8.	All determinations believed equivalent to Spavinaw igneous activity	1248±12	33	0.7039±0.0006
9.	Muscovite-feldspar from sample 1060 (time of reheating)	1252±4	3	0.7532±0.0030

that this isochron has the fewest determinations, the largest error in slope, and second largest error in Sr87/86 intercept.

The rhyolites and Spavinaw-Woodson type granites are believed, based on geologic reasoning, to be time equivalents—an analogy for the silicic part of the Wichita Province (Ham et al., 1964). The rhyolites are almost certainly slightly older, in part, than the granites and were the host rock into which the granites were intruded. The isochron results are in agreement within analytical error. The isochron generated by using both the granite and rhyolite determinations (on the assumption they are comagmatic) demonstrates how much rhyolite determinations dominate. The resulting isochron yields an age of 1,244±13 m.y., with an initial Sr87/86 ratio of 0.7040±0.0006, exceptionally close to the rhyolite results.

Coarse two-feldspar granites found mainly along the Nemaha uplift in Oklahoma (the Central Oklahoma Granite Group, Denison, 1966; Muehlberger et al., 1967) is the last unit for which there is sufficient data for an isochron determination. Eleven determinations from seven rock samples are available, one from this study, six by Muehlberger et al. (1966), and four by Denison et al. (1966). These data yield an isochron of 1,232±35 m.y., with an initial Sr87/86 ratio of 0.7054±0.0024.

If the mica from the Morris and Whorton 2 Davis well was reset during the later igneous activity, then it is related to the Central Okla-

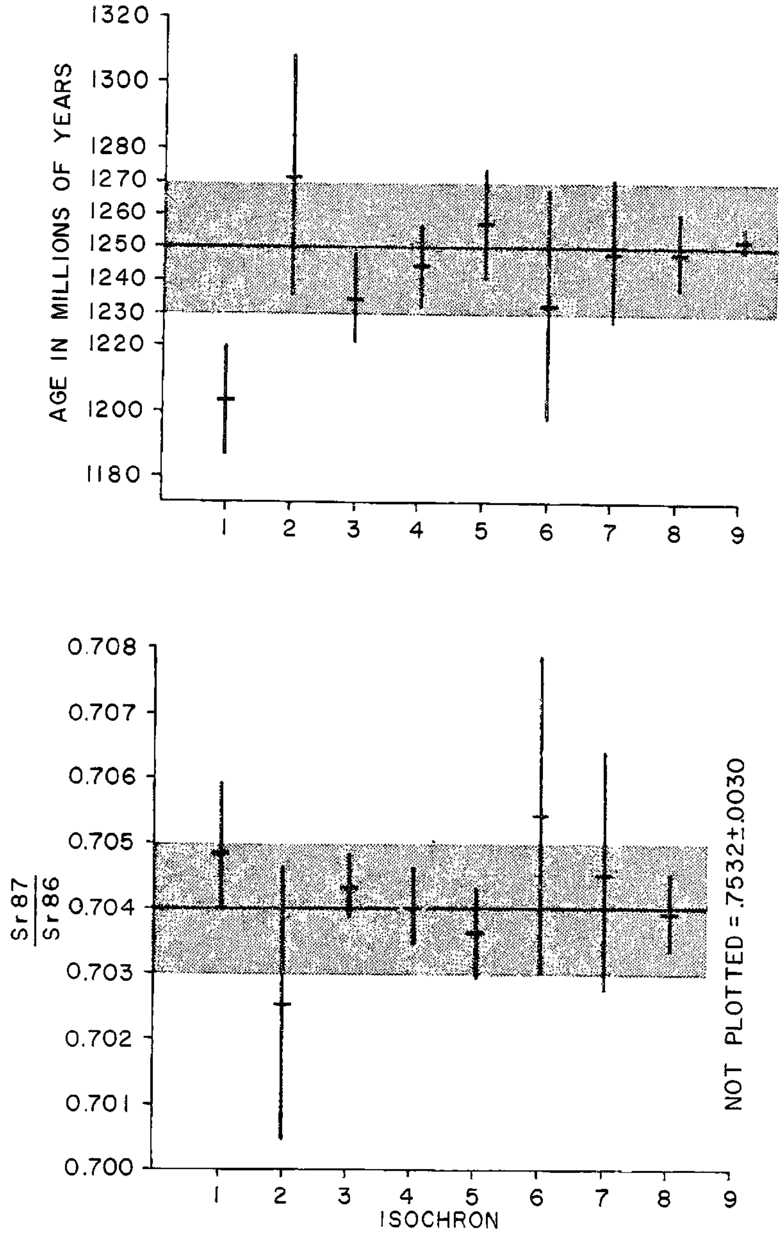

Figure 3. Graphic representation of isochron results from table II. Central lines and shaded areas represent the defined age, initial ratio, and associated errors for the Spavinaw igneous activity.

homa Granite Group because rocks of this group are interpreted as being responsible for the reheating. It can be argued that an isochron assumes an identical initial Sr87/86 ratio and this mica does not have the same as primary ignecus rocks. However, the micas are extremely favorable (table I), indeed so favorable that the Sr87/86 at the time of resetting is relatively unimportant in the less favorable determination and insignificant in the more favorable separation. The isochron generated by adding the muscovite determinations yields an age of 1,248$\pm$22 m.y., with an initial Sr87/86 ratio of 0.7045$\pm$0.0018. This is an age increase of about 1.3 percent, with a decrease in the intercept from 0.7054$\pm$0.0024. Significantly, the errors overlap easily and the change is not really large. We believe that the mica determinations belong with the other determinations in the definition of the age of formation of the coarser grained two-feldspar granites that characterize the Nemaha uplift in Oklahoma.

Based on petrography and geographic distribution, 33 determinations from rocks and minerals are considered equivalent to the Spavinaw igneous activity. The isochron from these determinations yields an age of 1,248$\pm$12 m.y., with an initial Sr87/86 ration of 0.7039-$\pm$0.0006. The results are thus in agreement within analytical error with each of the other isochrons, as might be expected from the relative uniformity of the other isochron plots.

An isochron age of 1,115$\pm$57 m.y. was determined on whole rock samples from the Rose Dome outcrop by Bickford et al. (1969). We believe that this is not a meaningful age because of the altered character of the granite in the exposures. In our opinion the "true" age is most likely that of other rocks assigned to the Spavinaw igneous activity, about 1,250 m.y. This opinion is based on regional considerations and petrographic correlations.

CONCLUSIONS

It is clear that the isochron plots based on the new and published data are significantly different from the 1,200 m.y. isochron of Muehlberger et al. (1966). The difference, in our opinion, is caused by the fact that the new dates are older, that is, generally in agreement with the isochron results and the fact that the analytical errors assigned to the data of Muehlberger et al. (see Goldich et al., 1966) are large in comparison to the errors cited here. The least squares cubic fit isochron program, therefore, discriminates against the published data in favor of the data presented here. This can be shown to be the case if the 17-determination Spavinaw-Woodson-rhyolite isochron (1,244-$\pm$13 m.y., with a 0.7040$\pm$0.0006 intercept) is recalculated with the errors assigned equal to those of Goldich et al. The isochron age drops to 1,218$\pm$15 m.y., with an initial ratio of 0.7049$\pm$0.0009. Although the analytical errors overlap it is clear the new determinations have an effect, both in age and in the errors assigned.

The discrepancy between the original Spavinaw igneous activity isochron and the results of the isochrons presented here require a redefinition of the time of this activity. Fortunately, although the data are treated in a number of ways, the results are in substantial agreement (fig. 3). On the basis of the results obtained here we redefine the Spavinaw igneous activity as having occurred 1,250±20 m.y. ago. The initial Sr87/86 ratio is almost certainly in the range of 0.7040-±0.0010.

This makes the activity in northeastern Oklahoma and adjoining areas equivalent in age to one of the major periods of activity in the St. Francois Mountains. Bickford and Odom (1968) and Anderson et al. (1969) reported the younger rhyolite and three granites in the St. Francois Mountains to be 1,244 m.y. old (recalculated with the decay constant used herein). That the igneous activity of the two areas is of the same age is reasonable because the rocks of the two areas share many petrographic characteristics.

ANALYTICAL TECHNIQUES

Preliminary determinations of Rb and Sr contents were made by x-ray-fluorescence analysis. Samples selected for this study were then spiked with enriched Sr86 and Rb87 and dissolved in HF, allowed to dry, and brought back into solution by complexing the fluorides with a mixture of H_3BO_3 and HCl. Unspiked portions of the samples with low radiogenic Sr enrichment were dissolved in the same manner. Separations were made on ion-exchange columns with the aid of Rb and Sr tracers.

All strontium isotopic measurements were made on a 13-inch-radius 60° magnetic sector, 15.8-inch-radius 91° electrostatic sector, second-order double-focusing mass spectrometer, using dual faraday cup collectors. Rubidium measurements were made on a symmetric 6-inch, 60° single-focusing Nier type mass spectrometer equipped with dual faraday cup collectors.

Sample data obtained from the mass spectrometers were processed by computer using an original program to calculate ratios, quantities, ages, and the standard errors associated with these measurements.

The constants used are:

$$\lambda_\beta = 1.47 \times 10^{-11}/\mathrm{Yr}$$
$$\mathrm{Rb}^{87} = 0.283\ \mathrm{gm/gm\ Rb}$$
$$\mathrm{Sr}^{86}/\mathrm{Sr}^{88} = 0.1194$$

ACKNOWLEDGMENTS

The samples from Oklahoma were provided by the Oklahoma Geological Survey, largely through the efforts of William E. Ham and John F. Roberts. The Kansas samples were given by Virgil Coles of Wichita, Kansas. Without this cooperation this study could not have been carried out.

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New Theses Added to O. U. Geology Library

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

Master of Science Thesis

Petrology of the Thurman sandstone (Desmoinesian), Hughes and Coal Counties, Oklahoma, by Ben D. Hare.

Doctoral Dissertations

Carbonate petrography of the Red Eagle limestone (Lower Permian), southern Kansas and north-central Oklahoma, by Hashim Al-Khersan.

Clay mineralogy and geochemistry of the upper Flowerpot Shale in Major and Blaine Counties, Oklahoma, by Dah Chen Wu.

Hugh Dinsmore Miser
1884-1969

The geological profession has lost another of its grand old men—Hugh Dinsmore Miser. Dr. Miser worked at his desk as usual Thursday, July 31, 1969. He was found dead but fully dressed in his home at 455 South Dakota Avenue, Washington, D. C., on Friday morning, August 1. So far as is known, he had not been ill, and it is presumed that he died of a heart attack. He worked right down to the end, just as he had often said he wanted it to be.

Dr. Miser was born in Pea Ridge, Arkansas, on December 18, 1884. His father was Jordon Stanford Miser, of the Tennessee Misers, and his mother was Eliza Caroline Webb Miser. After attending the public schools of Pea Ridge, he entered the University of Arkansas at Fayetteville, where he studied geology under Dr. A. H. Purdue, who had a large part in shaping his early career. Dr. Miser received the B. A. degree in 1908 and the M. A. degree in 1912, both in geology. In the meantime he had joined the U. S. Geological Survey staff on July 1, 1907, as field assistant to Dr. Purdue. He married Mary Kate Goddard of Fayetteville on September 21, 1910.

In 1919-1920, Dr. Miser was acting professor of geology at Fayetteville and acting state geologist of Arkansas. In 1921 he assisted in the exploration of the San Juan River Canyon in southeastern Utah. However, despite much creditable work in other areas, his chief love was the Ouachita Mountains of Arkansas and Oklahoma.

In July 1923 he was assigned to prepare the first geologic map of Oklahoma (published in 1926). In large part, it was a compilation from the confidential maps of the oil companies and independent geologists operating in Oklahoma at that time, and probably no other geologist could have commanded the trust and loyalty that made it possible for him to have access to so much confidential information.

He became state geologist of Tennessee in 1926 but soon returned to the U. S. Geological Survey. Low-angle thrust faults had been postulated for the Ouachita Mountains earlier, but Dr. Miser's field work in 1927 definitely established their presence. He was appointed chief of the fuels section in 1927 and during the next 20 years held the reputation of getting worthwhile investigations completed on time and getting the information published while it was still useful.

At his own request he was relieved of the arduous chore as chief of the fuels section on July 1, 1947. Shortly thereafter he was invited to Oklahoma by the Oklahoma Geological Survey and the geological fraternity of the State to undertake the preparation of the second geologic map of Oklahoma (published in 1954). Once again the great esteem in which he was held enabled him to gain access to many confidential data without which the compilation could not have been made. When the map was published, Dr. Miser was 70 years old, the age for mandatory retirement, but he continued to work on a part-time basis to the day of his death.

Dr. Miser's hobby was collecting Arkansas quartz crystals. He had an enormous collection and from it donated certain special crystals to be used in the manufacture of radio equipment for World War II. He also donated large collections to the University of Arkansas and The University of Oklahoma.

Over 80 publications are credited to him, with approximately one-fourth of them covering material pertinent to Oklahoma. His professional memberships were established in the following 12 societies:

American Association of Petroleum Geologists—honorary member
Society of Economic Geologists—member
Geological Society of America—member
Geological Society of Washington—member; president, 1938
Tennessee Academy of Sciences—member; vice-president, 1939
Mineralogical Society of America—member
Oklahoma Academy of Sciences—member
Oklahoma Geological Society—honorary member
Tulsa Geological Society—honorary member
New Mexico Geological Society—honorary member
Oklahoma Gem Society—honorary member
Sigma Gamma Epsilon—honorary member

In 1949 he received an honorary doctor of law degree from the University of Arkansas.

He and his wife, Mary, enjoyed 53 happy years together before her death in 1963. They are survived by a daughter, Mrs. Catherine Kayser of Fort Worth, Texas, one grandson, Roger H. Sheriff, and three great-grandchildren.

—*Malcolm C. Oakes*

Administrative Stream Piracy

Without the intervention of any geological agent, the Cimarron River recently lost 78 miles of its length. This stream piracy was accomplished by an administrative act of the U. S. Board on Geographic Names, which published a redefinition of the Cimarron in the most recent issue of *Decisions on Geographic Names in the United States* (Decision List 6901, January through March 1969, p. 14). As now defined, the Cimarron River heads in Oklahoma at the junction of Dry Cimarron River and Carrizozo Creek in NE¼ NE¼ sec. 18, T. 5 N., R. 1 ECM, Cimarron County (lat. 36°54′20″N, long. 102°59′10″W). In an earlier definition, the north fork of the junction, now Dry Cimarron River, was part of the Cimarron, with the head in northwestern Union County, New Mexico. The redesignation of the north fork (also known informally as Cimarron Creek and Oak Creek) was needed to eliminate duplication of the name in New Mexico, where another stream, heading in Eagle Nest reservoir, is also called Cimarron River.

A second decision in the new list confirms the name Cleo Springs for the town in northern Major County, 10 miles north-northwest of Fairview; some maps give the name simply as Cleo.

Kerr-McGee Begins Coal Production

Figure 1. The first load of coal from the Kerr-McGee Corporation Choctaw Mining Facility travels by conveyor belt on its way to the preparation plant.

The Choctaw Mining Facility of the Kerr-McGee Corporation began operation on June 4, 1969. The operation, located near Stigler, Haskell County, is the second major underground coal-mine development undertaken in Oklahoma since World War II and is expected to become the largest of its kind in State history. Its 20-foot-diameter shaft, which was completed in the 4-foot-thick Hartshorne coal at a depth of 1,420 feet, is the deepest vertical coal-mine shaft in North America. When it reaches full production in 1971, the facility, with approximately 30,000,000 tons of reserves, will have a capacity of 1,000,000 tons per year.

Initial production will be marketed as a metallurgical coal product, although the company hopes eventually to produce coke as well. Mining is carried on with the most modern techniques, combining heavy equipment and automation. Hugh continuous miners (low-slung vehicles with ripper heads) will mine as much as 1,000 tons per day each, conveyor belts are used instead of rail cars, and roof bolts replace timbers in the underground mine. At the surface, the coal goes to a preparation plant, where a single operator, by pushing buttons and turning dials, cleans the coal and classifies it according to size and quality.

The Kerr-McGee facility and that of the Howe Coal Company near Heavener, Le Flore County, will have a combined capacity of 2,000,000 tons per year. Approximately 12 other coal companies will produce another 1,000,000 tons per year. Thus, by 1971, Oklahoma coal production should reach 3,000,000 tons, three times that of 1968 and near that of the 1948 postwar peak of 3,400,000 tons.

Gem and Mineral Show in Oklahoma City

The Oklahoma Mineral and Gem Society will hold its 1969 show at the Womens Building, Oklahoma City Fairgrounds, on October 25 and 26. Showtime is 10:00 AM to 10:00 PM on Saturday and 10:00 AM to 6:00 PM on Sunday.

On exhibit will be collections of rocks, minerals, fossils, and jewelry of excellent quality, and several dealers will have retail booths set up at the show.

Admission is $0.75 for adults, $0.25 for teenagers, and children under 12 will be admitted free. Sponsored youth groups and uniformed military personnel will also be admitted free.

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