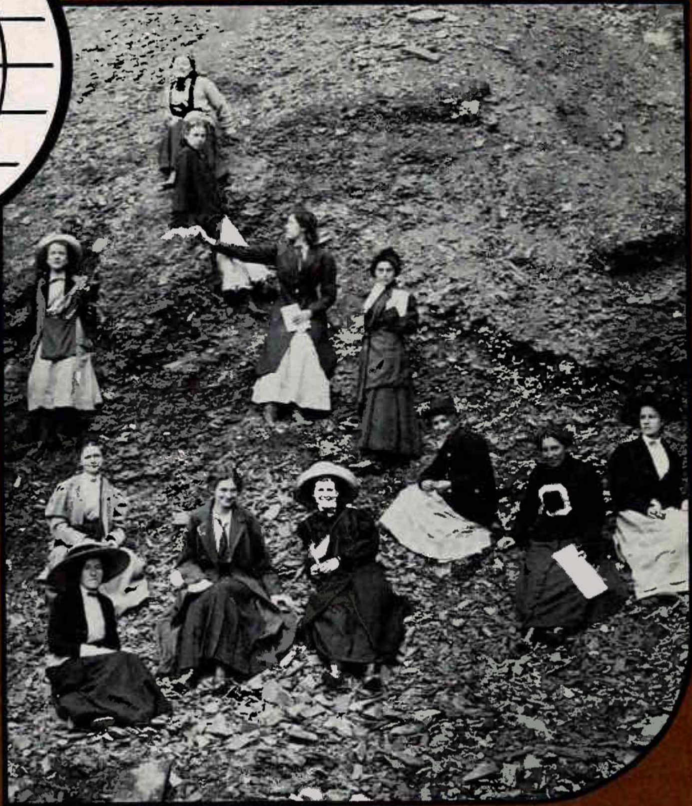

OKLAHOMA GEOLOGY NOTES

VOLUME 34 NUMBER 4 AUGUST 197

Cover Picture

FIELD EXCURSION, CIRCA 1911

This charming photograph, illustrating the proper field garb for the well-dressed lady of yesteryear, was discovered by assistant editor Betty Ham in a thesis in The University of Oklahoma Geology and Geophysics Library. The thesis, by one L. Maimie Brady, was required as partial fulfillment for the Bachelor's degree in geology (a tough requirement by today's standards, even). Dated 1911, it has as its subject the physiography of the Falls Creek region, in the Arbuckle Mountains.

The backdrop for the scene above is shale of the Woodford Formation "in another part of the Arbuckle Mountains," to quote the author. Incidentally, can our author, Maimie, be the one in rather more utilitarian attire, holding the hammer in her right hand, at the left? The group presumably is from The University of Oklahoma, as witness the large "O" on the pullover of the figure second from the right. Perhaps she is wearing her beau's football sweater.

In any case, one can conclude that outcrops hardly change, but the human denizens do. Could anyone possibly imagine coming up on such a group today?

—William D. Rose

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

Oklahoma Geology Notes is published bimonthly by the Oklahoma Geological Survey. It contains short technical articles, mineral-industry and petroleum news and statistics, an annual bibliography of Oklahoma geology, reviews, and announcements of general pertinence to Oklahoma geology. Single copies, seventy-five cents; yearly subscription, $3.00. All subscription orders should be sent to the address on the front cover.

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

STRUCTURE OF THE WESTERN END OF THE POTATO HILLS LATIMER AND PUSHMATAHA COUNTIES, OKLAHOMA

WILLIAM D. PITT[1]

INTRODUCTION

The structural location of the Potato Hills is the center of an "anticlinal" valley in the central part of the Ouachita Mountains of southeastern Oklahoma. The hills are bounded on the north by the Windingstair fault, as are most of the anticlinal valleys in this part of the Ouachitas, and on the south by the Lynn Mountain syncline (fig. 1). The geology of the western end of the Potato Hills is shown in detail in figure 2.

The Potato Hills comprise a series of unevenly weathered homoclinal ridges of the Bigfork Chert of Ordovician age and are so named because of their resemblance to rows of mounded potatoes in a potato patch. Their typical knobby topography is shown in figures 3 and 4.

The first serious investigation of the structure and stratigraphy of the Potato Hills was done by H. D. Miser, who published a small-scale map and a brief description of the area in 1929, interpreting the structure as a fenster, or window, in the Windingstair thrust sheet (Miser, 1929, p. 18-20).

Kramer (1933) doubted the existence of low-angle faulting and interpreted the outcrop as an inlier.

During the summer of 1954, B. W. Miller and N. C. Roe mapped the western and eastern parts, respectively, of the Potato Hills and concluded, as had Miser, that they represent a fenster, differing with his views only in believing the Jackfork Mountain fault, not the Windingstair, to be the fenster fault (Miller, 1955, 1956; Roe, 1955).

Intermittently from 1954 through 1964, Allan P. Bennison and N. L. Johnson of Sinclair Oil and Gas Company mapped the structure and studied the stratigraphy of the Potato Hills (Bennison and Johnson, 1959; Bennison, Tulsa, Oklahoma, personal communication, 1964).

In 1971, I reported on a problem area in the Potato Hills (Pitt, 1971) northeast of the area studied in this report.

The structural geology of the Potato Hills is discussed in this paper in two sections: a description of the major structures of the area and an interpretation that considers the origin of the Potato Hills.

DESCRIPTIVE GEOLOGY

Faulting.—The western end of the Potato Hills is traversed by three major thrust faults (fig. 2) ranging in length from 3 to more than 13 miles. The longest of the three, the Southern Potato Hills fault, extends west of the

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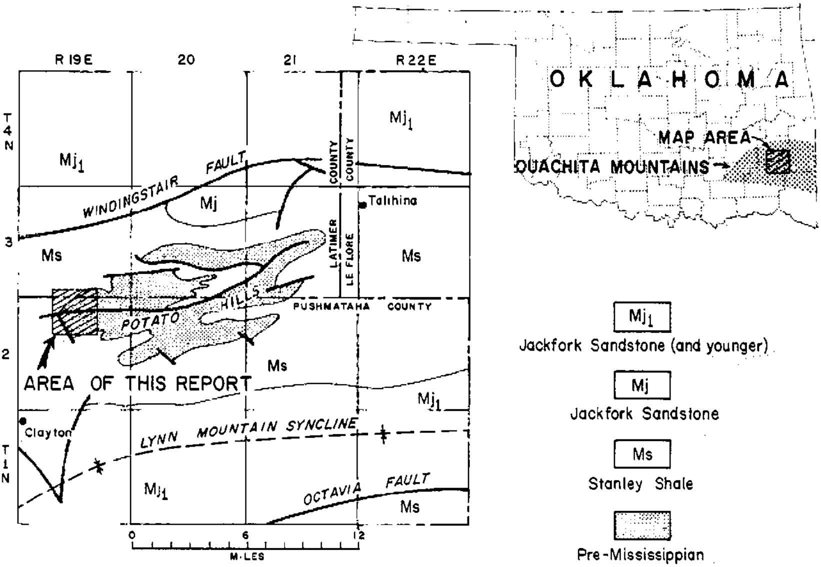


Figure 1. Index map showing geologic setting of Potato Hills.

westernmost outcrops of the Arkansas Novaculite (Devonian and Mississippian). Exposures show the thrust faults to be invariably steep angled, ranging from 45° to vertical (Bennison and Johnson, 1959).

In addition, there are numerous transverse faults in the area, most of which are strike-slip faults, although normal faults (that must have originated long after the initial folding and thrusting) are also found, e.g., in the southwest corner of sec. 22, T. 3 N., R. 21 E.

Few major faults are evident in outcrop, but one well-exposed major fault zone is visible on the east side of the creek in the SE¼ sec. 30, T. 3 N., R. 20 E. This fault, the Cedar Creek fault, is described in the road log of the 1959 Ouachita Mountain symposium as follows (Bennison and Johnson, 1959, p. 67).

> At the base of the section the Womble shale may be seen in nearly vertical fault contact with Stanley beds. Horse blocks of Big Fork and novaculite can be observed in the fault zone. This fault, (although within the area previously mapped as a fenster), has as much displacement as the "fenster" faults, but is merely the result of the overstretching and rupturing along the north limb of an anticline which plunges out toward the east and west.

Folding.—Folds in the Potato Hills generally are sharp, doubly plunging, and genetically related to the associated faults. Two fold structures have been named by Miller (1955, 1956) and Roe (1955): the Albion anticline, named for the town at its eastern end, and the Council House syncline, which lies between the Albion anticline (on the south) and the Potato Hills proper.

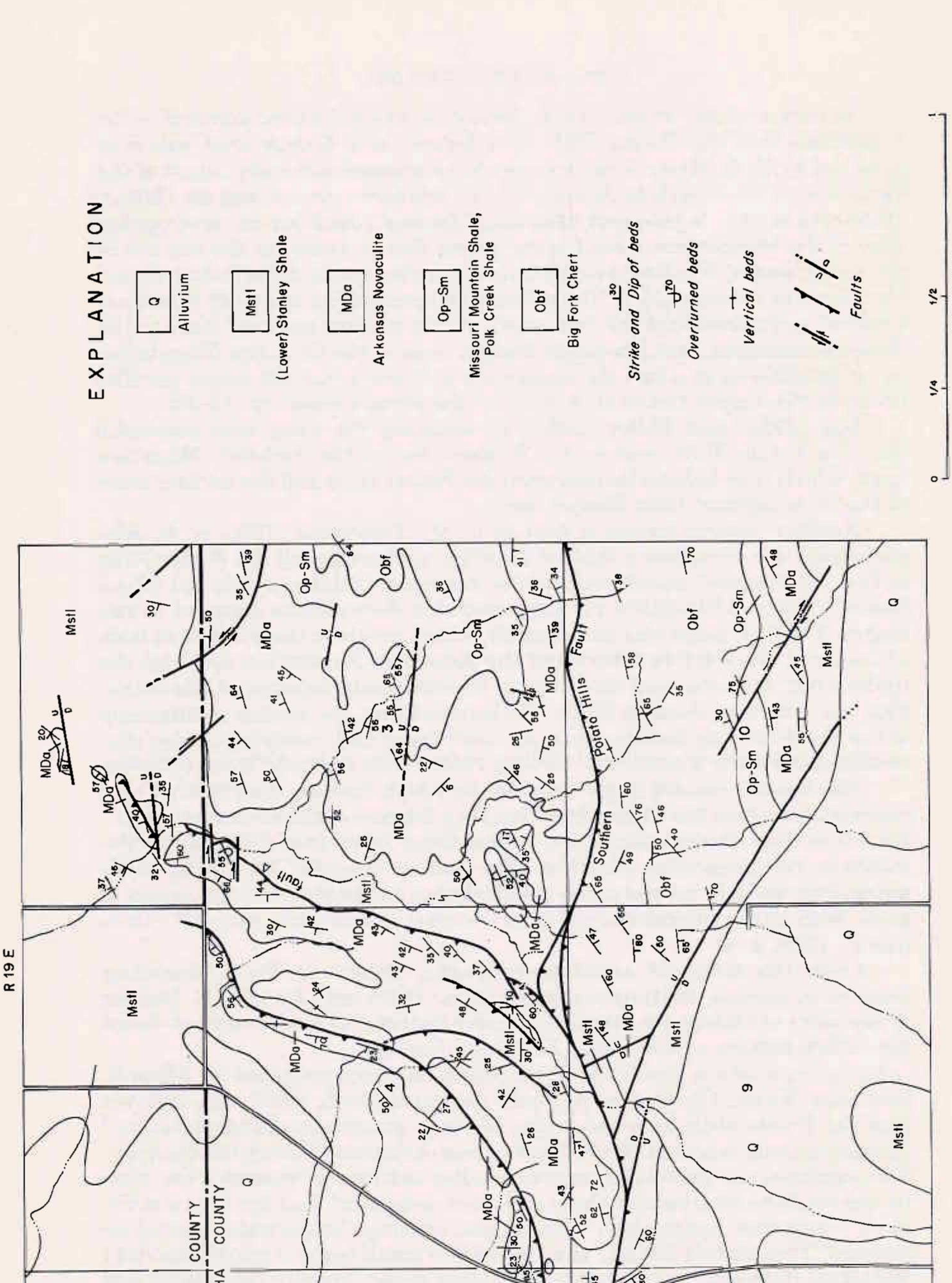


Figure 2. Geologic map of western end of Potato Hills, by Pitt.

Structure of the Potato Hills: fenster or faulted anticlinorium?—The hypothesis that the Potato Hills area largely is a fenster area was first proposed by H. D. Miser in his previously mentioned summary report of the *Structure of the Ouachita Mountains of Oklahoma and Arkansas* (Miser, 1929). He wrote: "I interpret this [the "fenster"] fault as an outcropping edge of the Windingstair fault plane which finally comes to the surface at the south base of Windingstair Mountain, 3 miles north of the Potato Hills." He therefore reasoned that "the actual displacement by the fault is at least 3 miles" and stated that the "discovery of this window not only leads to the obvious conclusion that low-angle thrusts exist in the Ouachita Mountains, but it establishes as a fact the suggestion of Powers that the major parallel faults in the region bound thin slices of the earth's crust" (p. 19-20).

Roe (1955) and Miller (1955), in mapping the area, also concluded that the Potato Hills represent a fenster—but of the Jackfork Mountain fault, which they believe lies between the Potato Hills and the surface trace of the Windingstair fault farther north.

Another interpretation is that of C. W. Tomlinson (1959, p. 4), who considered the structure a faulted anticline and compared the Potato Hills to the "rabbit-ears" anticlinoria of the Ardmore, Oklahoma, district (Tomlinson, 1952, p. 1826-1828). He suggested that deformation occurred in two stages. The first stage was one of uplift, which involved the competent beds of the area, the Bigfork Chert and the Arkansas Novaculite, and also the underlying thick shales of the Mazarn-Womble shale sequence (Ordovician) plus the overlying Stanley Shale. He believed that the spatial relationship of the chert-bearing beds to the thick underlying and overlying shales ultimately caused sharp anticlinal folding, rather than a simple broad anticline.

Tomlinson's second stage was one in which further compression was confined largely to the "outer folds flanking the core of the structural high." He states that during this stage it was these folds that did most of the yielding. He asked what would be more natural than for "the brittle chert-novaculite section, between the great shales, to break near the crests of those folds and be thrust inward over the core area to some extent?" (Tomlinson, 1959, p. 4).

From the study of aerial photographs, Robert O. Fay (Oklahoma Geological Survey, written communication, 1973) and John A. E. Norden (University of Oklahoma, written communication, 1973) also came to doubt the interpretation of the Potato Hills as a fenster.

An interpretation similar to Tomlinson's has been proposed by Allan P. Bennison (Tulsa, Oklahoma, personal communication, 1963) who believes that the Potato Hills area was a site of "deep geosynclinal accumulation," perhaps having received "25,000 feet of post-Arkansas Novaculite clastics." The weight of the post-Arkansas Novaculite sediments "exceeded the elastic stress of the interbedded shale and chert sequence" that lay between the more competent rocks above and below, causing "interstratal convolute folding." This kind of folding "may be seen in small scale in many Ouachita Mountain outcrops . . . and also on a larger scale." During later uplift and "orogeny this sequence was uplifted locally 5 miles, during which time the upper layers experienced tension, and the lower layers, compression."

Mapping of the western end of the Potato Hills.—There have been significant differences in mapping the western "nose" area of the supposed fens-

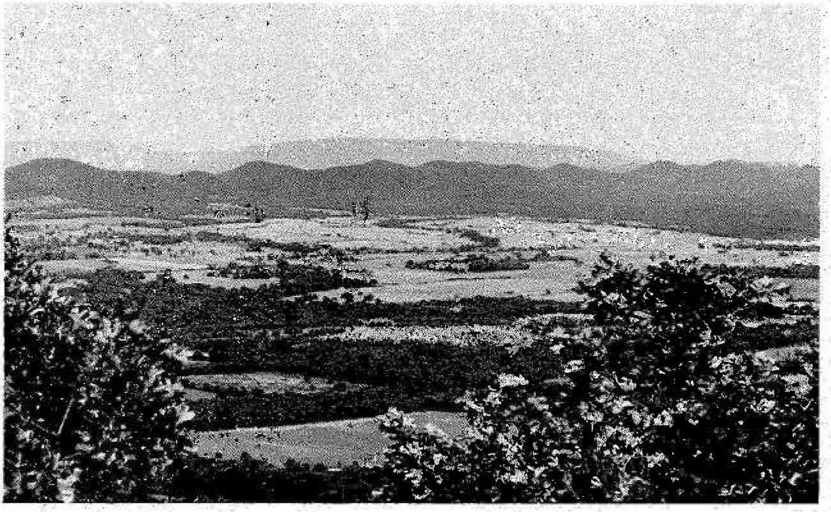


Figure 3. Panoramic view, looking northeastward from north end of Tuskahoma syncline toward western half of Potato Hills.

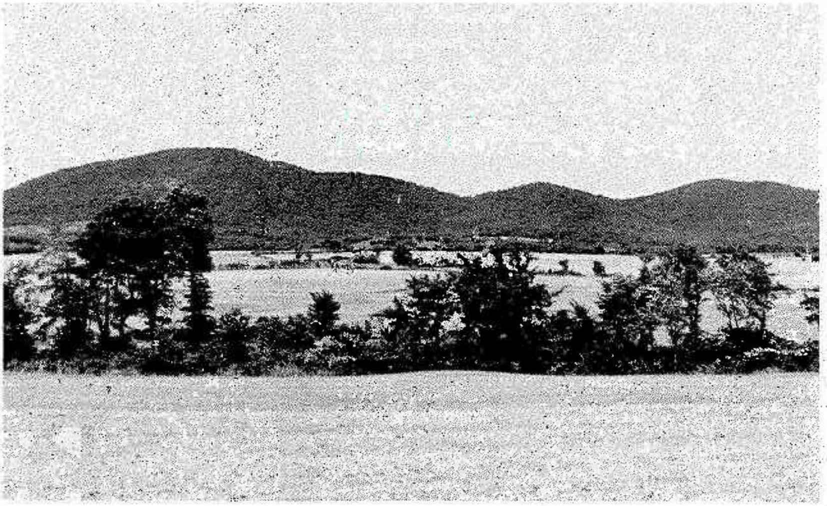


Figure 4. View northward toward western end of Potato Hills. Hills here consist of Bigfork Chert (Ordovician). Arkansas Novaculite (Devonian and Mississippian) crops out along two much lower ridges, which are not visible in picture.

ter, as can be seen by comparing figures 5 and 6 with figure 2. The two most important structural features in this area are the Southern Potato Hills fault and the series of northeast-trending anticlinal ridges bounding the area on the west. These two features are discussed separately.

With respect to the Southern Potato Hills fault, the critical area along the trace of this fault is near the common corner of secs. 3, 4, 9, and 10, T. 2 N., R. 19 E. Most of those who have mapped the area have shown the fault as continuous from this point eastward for a number of miles. Miller (1955, 1956), however, maps it as curving sharply northward to assume a north-

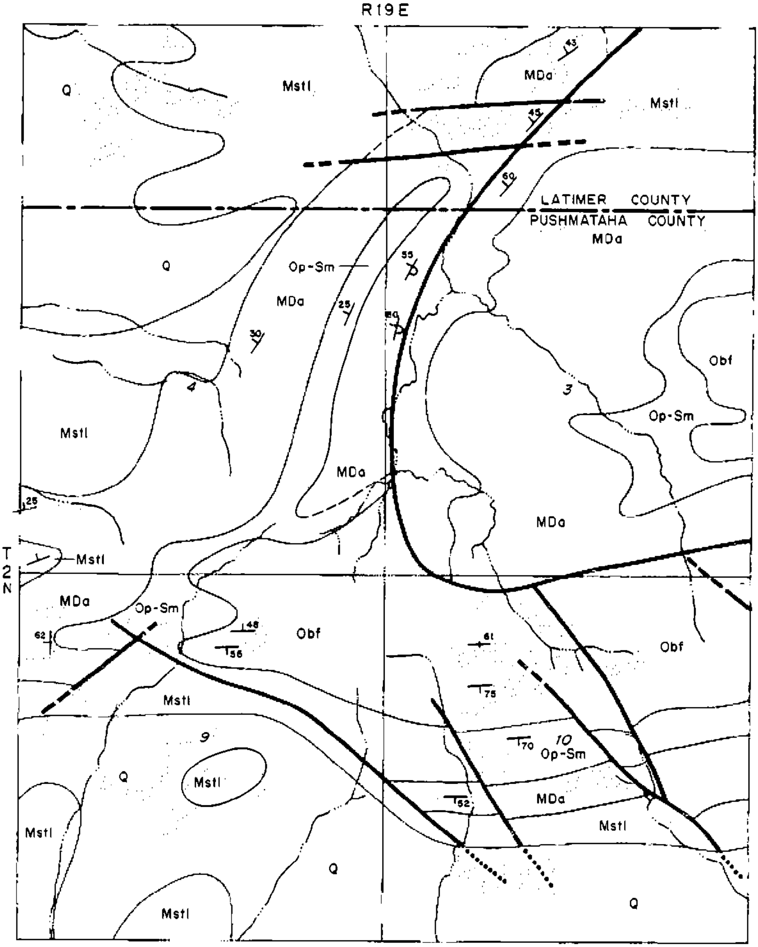


Figure 5. Geologic map of western end of Potato Hills, by Miller (1955). See figure 2 for scale and explanation of symbols.

northeast strike in sec. 3 (fig. 5). Showing the fault to curve in this manner conforms to the fenster hypothesis of Miser (1929). Bennison found that the Arkansas Novaculite does not form a continuous homoclinal loop at the extreme southwestern limit of its outcrop at the southwestern end of the Potato Hills, but that the structure there is an anticlinal ridge north of the fault. Consequently, he mapped the fault as extending west of the critical area (fig. 6), and indeed it does, as can be clearly demonstrated in the field. As shown in figure 2, I have extended this fault beyond the edge of the Potato Hills, which is even farther to the west than Bennison placed it.

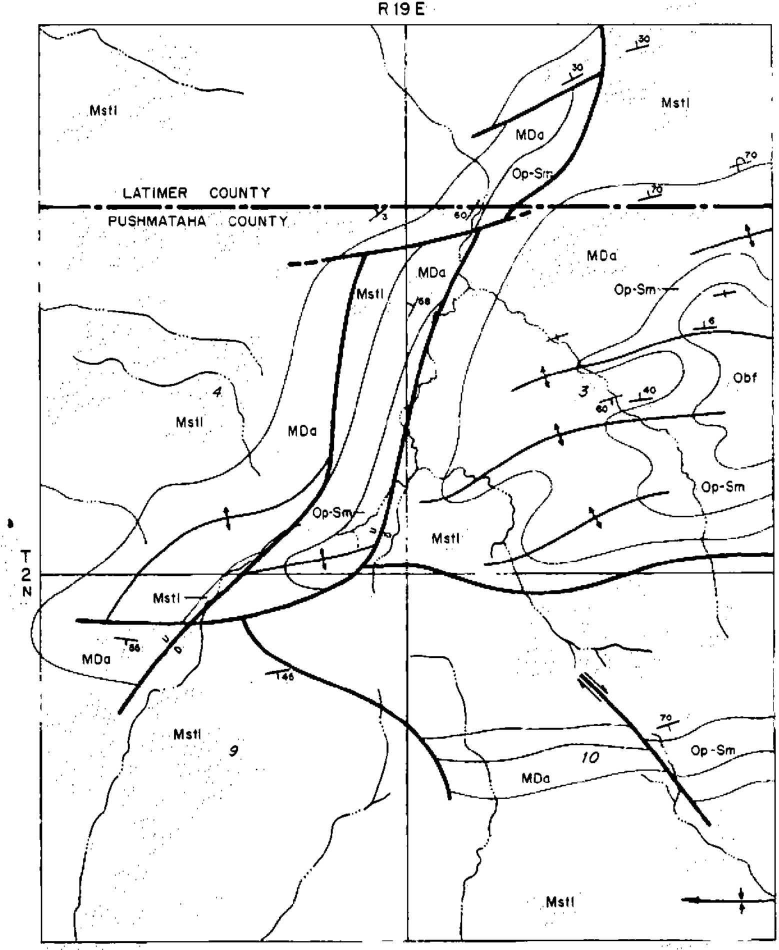


Figure 6. Geologic map of western end of Potato Hills, by Bennison and Johnson. See figure 2 for scale and explanation of symbols.

The three ridges bounding the extreme western part of the Potato Hills trend northeast and are made up of Arkansas Novaculite separated locally by valleys of Stanley Shale. Each of these ridges can be walked out, and one can see their narrowness, their convex curvature westward, and the local discontinuity of the Arkansas Novaculite outcrop, features that are shown in figure 2. Detailed mapping of the ridges indicates that they have several deformational characteristics in common, with most of the deformation occurring along the crests, either in the form of folding (fig. 7) or faulting (fig. 8). Also, the ridges are broken locally by cross faulting and show drag folds along their flanks (figs. 9, 10).

Figure 7. Fold along crest of ridge of Arkansas Novaculite, NW¼ sec. 3, T. 2 N., R. 19 E.

It is my conclusion that the folds must have been caused by compressional movement directed toward the southeast, with the exception of the area of the ridge in the SW¼ sec. 4, directly north of the south line of the section. Here, the north side of this ridge is overturned toward the north, as if the southern part of these west-bounding ridges were compressed or pushed northwestward during movement of the Southern Potato Hills fault, following southwestward compression elsewhere at an earlier time.

As noted by Miller (1955, p. 38) and more recently by Robert O. Fay (Oklahoma Geological Survey, written communication, 1973), a similar mode of deformation is found all along the northern edge of the Potato Hills.

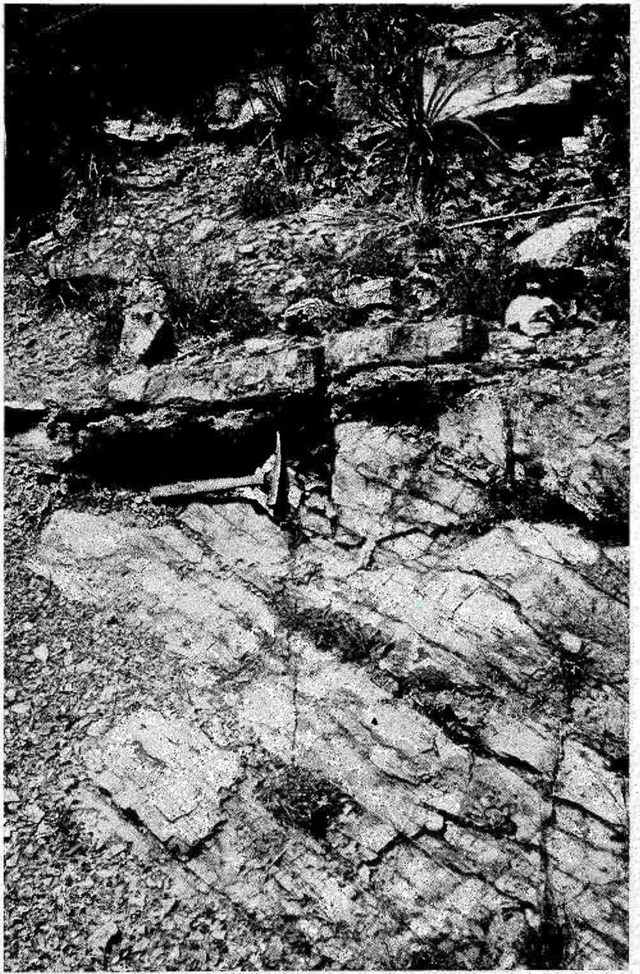
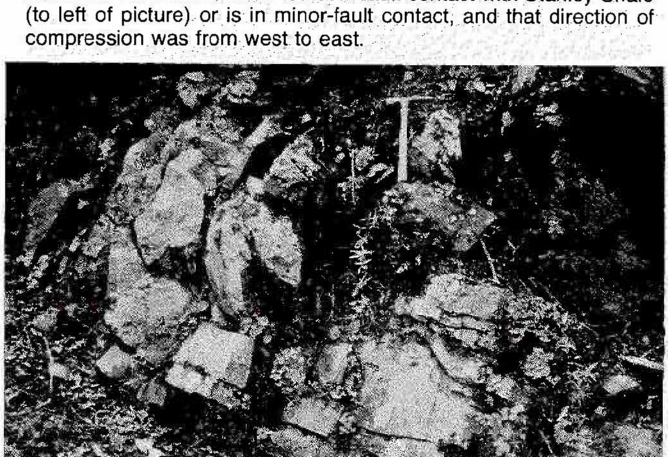


Figure 8. View toward northwest of thrust fault at crest of Arkansas Novaculite ridge, SW¼ sec. 34, T. 3 N., R. 19 E.

Figure 9. View toward northeast of thrust fault in Stanley Shale (Mississippian), SW¼ sec. 34, T. 3 N., R. 19 E. Drag of beds just below fault suggests that beds above moved toward south with respect to beds below.

Figure 10. View toward southwest of overturned drag fold in NW¼NW¼ sec. 3, T. 2 N., R. 19 E. This outcrop indicates that Arkansas Novaculite either is not in fault contact with Stanley Shale (to left of picture) or is in minor-fault contact, and that direction of compression was from west to east.



Fay, in fact, believes that aerial photographs suggest strongly that the northeastern part of the supposed fenster fault is nonexistent, i.e., that there is no fenster fault in either secs. 25, 26, T. 3 N., R. 20 E., or in sec. 30, T. 3 N., R. 21 E., and that this part of the Potato Hills should be remapped.

The faults found along the ridges of the western Potato Hills are minor in scale. Their importance lies not in their size but in the contrast in stratigraphic throw between this faulting and that of the Southern Potato Hills fault. The variation here is significant in that it represents a further basis for not joining the fault bounding the easternmost ridge (fault A, fig. 2) on its east side with the Southern Potato Hills fault. Perhaps the best reason, however, for believing that a fault paralleling the easternmost ridge is not an extension of the Southern Potato Hills fault is the impressive amount of east dip found at the south end of the easternmost ridge (fig. 11). The ridge here must be a simple anticline and not faulted at all.

The north-trending valley where Miller mapped the Polk Creek-Missouri Mountain shale sequence (Ordovician and Silurian) contains green to brown fissile shale and sandstone of the Stanley Shale or of the Arkansas Novaculite. Also, this valley opens out to the north and is not enclosed by an Arkansas Novaculite ridge (compare Miller's map, fig. 5, with fig. 2).

A further point in evidence, in my opinion, is that the drag fold shown in figure 10 strongly suggests that the shale along the base of this ridge is generally Stanley, not Missouri Mountain, and that the fault (fault A, fig. 2) is a minor fault having no appreciable throw or length.

Southeast-directed compression as the origin of the west-bounding ridges.—My interpretation of the structure of the three ridges bounding the Potato Hills on the west is that they are clearly the result of southeastward-directed compression. The bases for this assumption are as follows.

1. The anticlinal ridges are asymmetrical, having their steep (normally faulted) flank on the southeast, as shown in figure 2.
2. Drag folds can be found locally on the east flank, indicating this direction of compression (see fig. 10).
3. At least two thrust faults in the area prove this southeastward direction of compression (see figs. 8, 9); the curvature of beds beneath the fault shown in figure 9 is convincing evidence of this southward-directed compression.

CONCLUSIONS

Evidence collected during detailed mapping of the western end of the Potato Hills indicates that deformation occurred during two episodes. The first compression was southeast directed. The second compression, the main thrust, was directed northward, causing the large Southern Potato Hills fault, which extends across the entire southern flank of the Potato Hills.

In agreement with the anticlinal interpretation of the structure of the Potato Hills, I believe that the southward-directed compression, the first stage, caused anticlinal welts along the entire northern flank (Pitt, 1971). I join with Robert O. Fay of the Oklahoma Geological Survey in urging that part of the north flank be mapped yet again.

Figure 11. View toward north showing east dip along east side of easternmost ridge at western end of Potato Hills, SE¼SW¼SE¼ sec. 4, T. 2 N., R. 19 E.

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Trans-Alaska Pipeline Finally Gets Under Way

At 8:00 a.m. on April 29 the trans-Alaska pipeline became "no longer just a project in name, but a project in fact" when work began on a 360-mile-long road to service pipeline construction north of the Yukon.

Upon completion, anticipated for mid-1977, the crude-oil pipeline will be an 800-mile link from the Prudhoe Bay oil field on the Arctic Coast of Alaska to a marine tanker terminal at the port of Valdez in south-central Alaska. Initial capacity is forecast at 600,000 barrels a day, to be increased to 2 million barrels a day. And that's a lot of crude.

Robert L. Miller, spokesman for Alyeska Pipeline Service Company, says, "We now intend to build the most sound and environmentally safe oil-transportation system ever seen. And we intend to do it on schedule."

Postscripturally, construction jobs are scarce, and questions concerning them can be answered by sending for a booklet, *The Truth About Pipeline Jobs in Alaska,* obtainable from JOBS, Department B, Alyeska Pipeline Service Company, 1815 South Bragaw Street, Anchorage, Alaska 99504.

New Mexico Geological Society Offers Fall Field Conference

The silver anniversary of the New Mexico Geological Society will be a colorful occasion. New Mexico is a colorful place anyway, but especially so in October after the first frost in the high country has cleared the already bright air and has turned the shimmering green of the *Populus tremuloides,* the "trembling aspens," to gold.

The name of the headquarters for the field trip to be offered by the society October 9-12 is colorful also. The entire conference will be conducted from Ghost Ranch, at Abiquiu, one of the most scenic hideaways in the great Southwest.

Areas of north-central New Mexico to be covered during three days of field excursions will include the Nacimiento-San Pedro uplift, featuring oil, gas, and coal deposits of the eastern San Juan Basin and copper and uranium mineralization near Cuba, New Mexico; the Tusas Mountains and environs, for inspection of Precambrian, Jurassic, Cretaceous, and Tertiary rocks, including mineral deposits of the Petaca area; and the Jemez Mountains and Valle Grande caldera, with lectures about geothermal energy.

The Silver Anniversary Guidebook, entitled *Ghost Ranch,* will include over 50 articles on tectonics, stratigraphy, volcanics, mineral deposits, and energy, as well as over 350 miles of comprehensive road logs. The guidebooks of the New Mexico Geological Society are traditionally of high quality, and this one promises to equal past issues. If you want the book and do not plan to join the field trip, the 400-page, hard-cover volume is $15.00 at prepublication price and can be ordered from James B. Yarbrough, 1893 Conejo Drive, Santa Fe, New Mexico 87501 (phone: 505-982-5143).

Information and preregistration forms can be obtained from the same address. Registration is limited, and quick response is suggested if you plan to attend. The $75.00 fee is all-inclusive.

Three GSA Guidebooks Available

Guidebooks are now available for three field trips held in conjunction with the eighth annual meeting of the South-Central Section of The Geological Society of America, which took place at Stillwater, Oklahoma, in March 1974.

Guidebook to the Depositional Environments of Selected Pennsylvanian Sandstones and Carbonates of Oklahoma by John W. Shelton and T. L. Rowland is for sale for $5.00 at the Oklahoma Geological Survey, 830 Van Vleet Oval, Norman, Oklahoma 73069. This guidebook is also available from the Department of Geology, Oklahoma State University, Stillwater, Oklahoma 74074.

Environmental Geology of the Metropolitan Tulsa Area by W. B. Creath and G. D. Howell is available from the Department of Geology, Oklahoma State University, Stillwater, Oklahoma 74074. The price is $2.50 without maps.

Regional Distribution and Nature of Upper Pennsylvanian (Missourian) Coral- and Algae-Bearing Beds in Northeastern Oklahoma by J. M. Cocke can be obtained for $3.00 from the Geology Department, East Tennessee State University, Johnson City, Tennessee 37601.

Origin of Petroleum II
A Summary Review

ROBERT O. FAY[1]

Origin of Petroleum II, Selected Papers Reprinted from AAPG Bulletin, compiled by John D. Haun. The American Association of Petroleum Geologists, 1974, 210 p. AAPG Reprint Series No. 9.

The 17 articles making up this book treat many different aspects of the origin of petroleum. The articles are either geological or geochemical in content, but none of them describe the detailed chemistry of pertinent hydrocarbons in relationship to origin from specific plants or animals.

Because of the diversity of the papers, it is felt that the most appropriate type of review for this volume is a summary review, giving a synopsis of each author's contribution. Thus, each paper is treated in order, with the dates of original publication shown in parentheses.

1. *Theory of Transgressive and Regressive Reef (Bioherm) Development and Origin of Oil,* by Theodore A. Link, p. 4-35 (1950).

Bioherms (vertical organic buildups) and biostromes (lateral organic buildups) may be source rocks for oil and gas. Transgressive and regressive bioherms are discussed, with examples from the Leduc reef, Alberta, and the Guadalupe reef, Texas. Modern corals contain a waxlike substance similar to petroleum hydrocarbons. The wax makes up one-seventh of 1 percent of the corals and becomes entrapped in the reef. Shale probably contains original hydrocarbons, but with low permeability only a small part of the oil probably would move to the reservoir rock.

2. *Origin of Hydrocarbons of Uinta Basin, Utah,* by John M. Hunt, Francis Stewart, and Parke A. Dickey, p. 36-63 (1954).

In the Uinta basin of Utah, Eocene beds consist of 12,000 feet of marginal-deltaic red and green shales and sandstones, with lacustrine bituminous siliceous dolomites and shales in the center of the basin. Distinct hydrocarbons occur in the lacustrine facies of each sedimentary unit. It is thought that the hydrocarbons originated in the lacustrine marlstones, dolomites, and shales and migrated marginally into reservoir rocks. The different hydrocarbons are postulated to have been formed under different original environments of deposition, with an increase in salinity up-section being a major factor.

3. *Geochemical Investigation of Crude Oils,* by Lawrence C. Bonham, p. 64-75 (1956).

Trace elements, especially vanadium, copper, and nickel, were studied from 66 crude oil samples from Ordovician through Eocene rocks in the United States. Of these, 56 samples were from Oklahoma, with 45 from the Pennsylvanian of the Seminole area. In the Seminole district, vanadium and nickel concentrations were higher (.2-.3 ppm V; .6-4.0 ppm Ni) toward the shoreline (toward the Nemaha ridge to the west), and lower (.1 ppm V; .1-.2 ppm Ni) basinward (toward the east). Trace-metal suites in crude oils are distinctive in basins of different ages and environments. The vanadium, copper, and nickel probably are derived from metalo-organic porphyrin compounds of source organisms for petroleum. Chlorophyll and hemoglobin porphyrins have been found in asphaltic petroleum, indicating both plant and animal origin for petroleum. Vanadium and copper are concentrated by animals such as crustaceans, ascidians, holothurians, and gastropods. Vanadium, copper, and nickel have been found in plants.

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[1] Geologist, Oklahoma Geological Survey.

4. *Carbon Isotopic Compositions of Petroleums and Other Sedimentary Organic Materials,* by Sol R. Silverman and Samuel Epstein, p. 76-90 (1958).

Carbon-13 occurs in petroleum, modern plants, and sedimentary organic materials (both marine and nonmarine). Concentrations of carbon-13 are higher in marine plants and in marine-derived petroleum than in nonmarine plants and nonmarine petroleum. The lipid (or fatty-acid and hydrocarbon) portion of a plant is lower in carbon-13 than the carbohydrate and cellulose portions. Geologically older petroleum (i.e., Ordovician) is lower in carbon-13 than younger petroleum, and natural gas has less carbon-13 than petroleum. In recent sediments, the deeper buried hydrocarbons are lower in carbon-13 than the shallow hydrocarbons. Recent plants have a higher carbon-13 content than petroleum. In order for petroleum to be derived from plants, the carbon-13 must be reduced by preservation of the lipid portion only, or by isotope fractionation, or both.

5. *Primary Degradation of Chlorophyll under Simulated Petroleum Source Rock Sedimentation Conditions,* by Gordon W. Hodgson and Brian Hitchon, p. 91-102.(1959).

Chlorophyll is converted to pheophytin in fresh or salt water, under alkaline to neutral pH (6.6-9) conditions and under strongly reducing to neutral redox conditions. Clay minerals, such as illite, montmorillonite, and kaolinite, act as catalysts to adsorb or help occlude or emulsify oil droplets in sediments. Calcium carbonate does not alter these conditions. In reducing environments the redox-potential dividing line is coincident with or slightly above the surface of the sediments, whereas in neutral and oxidizing environments the dividing line is below the surface of the sediments. In the laboratory, pheophytin has been converted to a metal-complexed pheophytin, and the latter has been converted to a porphyrin complex similar to the metal-complexed porphyrins of crude oil. A complete and exact conversion has never been demonstrated.

6. *Can Petroleum Be of Pedogenic Origin?,* by Robert B. Cate, Jr., p. 103-112 (1960).

The downward migration of organic matter, metals, and clays through soils is termed podzolization. Some of the organic matter may be catalyzed to bitumens, and the metals (especially aluminum and iron) may be deposited as laterites by this process. Decayed organic matter and solutions given off by living plants may be altered to many organic substances such as enzymes with a porphyrin structure. However, the transformation to petroleum porphyrins has not been demonstrated.

7. *Ubiquity of Petroleum,* by Kenneth K. Landes, p. 112-115, (1960).

Petroleum occurs in sedimentary rocks of marine or lacustrine origin. Two main factors for the origin and preservation of petroleum are (1) abundant organisms and (2) fine-grained sediments that may trap the petroleum. The petroleum may then move to a reservoir of coarse-grained sediments, over a long period of time, with a minimum of erosion and a lack of metamorphism and volcanism. Most producing basins probably contain many undiscovered fields.

8. *Distribution of Hydrocarbons in Petroleum,* by E. G. Baker, p. 116-124 (1962).

Crude oils contain naphthenes, aromatics, and paraffins. The distribution of the various types of each in crude oils is the result of micellar migration of solutions from the original sediment to the reservoir rock upon compaction and lithification. (A micelle is a group of organic-acid soap molecules, arranged spherically—ionic, mostly small—or cylindrically—neutral, mostly large.) The type and size of the micelle that carries and deposits the hydrocarbons determine the type and amount of each hydrocarbon present in the final crude oil. Recent sediments contain small amounts of petroleum hydrocarbons. No mention is made, however, as to how the original hydrocarbons and micelle molecules were formed in the source sediments.

9. *Implications of Carbon Isotopic Composition of Total Organic Carbon of Some Recent Sediments and Ancient Oils,* by Walter R. Eckelmann, Wallace S. Broecker, David W. Whitlock, and Jerry R. Allsup, p. 125-130 (1962).

Studies were made of carbon-13 to carbon-12 ratios in hydrocarbons from recent sediments and from crude oils. The ratios for most oils are like those of organic material living in the atmosphere or in fresh or brackish waters. Thus, marine sediments that contain petroleum must have had some source of terrestrial or nearshore organic matter.

10. *Organic Geochemistry of Cherokee Group in Southeastern Kansas and Northeastern Oklahoma,* by Donald R. Baker, p. 131-152 (1962).

Petroleum from the shoestring sands of the Cherokee Group of Oklahoma (Burbank field) and Kansas (Thrall field) is compared and found to be similar. The hydrocarbons and organic carbons in the adjacent gray and greenish-gray shales are considered to be the probable source for the petroleum. The shales are composed mostly of quartz, chlorite, and sericite, with siderite in the greenish-gray shale and pyrite in the gray shale.

11. *Stratigraphic Analysis of Source-Bed Occurrences and Reservoir Oil Gravities,* by Harold J. Holmquest, p. 153-161 (1966).

The gravity of each crude oil varies with each source rock and is higher with greater depth of burial in the same bed. About 2,000 feet of overburden is needed to flush hydrocarbons from source beds to reservoir rocks. Three factors that influence migration are (1) gravity, (2) ambient pressure, and (3) capillary pressure (directed toward coarser sediments). Generally, the source beds are greenish-gray to gray to blue to black to dark-brown shales, marls, and limestones. Overlying shales are usually the source beds for oil in the underlying reservoirs, with migration taking place updip but laterally into the reservoir rock. Greenish-gray to gray (nearshore-marine) shales have higher gravity oil than black shales (stagnant water). Dark-brown limestone may serve as source beds for oil in overlying carbonates. Over a period of time, the sequence of migration of hydrocarbons is (1) methane (needing almost no overburden), (2) lower gravity oil, (3) higher gravity oil, and (4) gas condensate (usually occurring 5,000 feet or deeper).

12. *Eometamorphism, and Oil and Gas in Time and Space,* by Kenneth K. Landes, p. 162-175 (1967).

Eometamorphism is the early change in hydrocarbons by temperature and pressure in sediments. By comparing data from present wells, it may be assumed that commercial oil and gas decrease with depth and may not be expected to occur much below 30,000 feet or 600°F. Most oil occurs above 15,000 feet in depth, and much gas alone occurs below 15,000 feet. Oil and gas occur in Lower Cambrian to lower Pleistocene sedimentary rocks. Oil and gas in commercial quantities are absent from upper Pleistocene sediments, probably owing to a lack of eometamorphism. Where the fixed carbon percentage of nearby coal is less than 60, commercial oil may occur, and where less than 70, commercial gas may occur. Offshore marine sedimentary rocks constitute two-thirds of the volume of the earth's sedimentary rocks and offer good prospects for future oil and gas exploration.

13. *Source Rocks and Criteria for Their Recognition,* by R. C. Fuloria, p. 176-182 (1967).

Organic matter, especially plant material, is considered the probable source of oil. The organic matter is deposited in sediments (especially fine-grained sediments), under reducing conditions, and is slowly converted to bitumens (organic matter soluble in organic solvents such as carbon disulfide). The bitumens are converted to oil fractions (soluble in petroleum ether and not adsorbed), then the oil fractions are squeezed into the reservoir rocks.

14. *Carbon Isotope Composition of Natural Methane Occurrences,* by William M. Sackett, p. 183-187 (1968).

Carbon-12 in natural methane (CH_4) varies with original hydrocarbon sources, temperature, and time. Carbon-12 decreases with depth, decreases with increased temperature, decreases with an increase in time, and decreases with an increase in carbon-carbon bond strength. More energy is required to break a carbon-13/carbon-12 bond than a carbon-12/carbon-12 bond.

15. *Significance of High-Wax Oils with Respect to Genesis of Petroleum,* by Hollis D. Hedberg, p. 188-202 (1968).

The high-wax content of crude oils appears to be derived from organic matter of nonmarine or nearshore-marine origin, ranging in age from Devonian through Pliocene. The oils are low in sulfur, and the reservoir rocks may be associated with coal. The waxes are a complex set of solid hydrocarbons, mostly paraffins, with melting points above 86-95°F, which may be derived mostly from land plants.

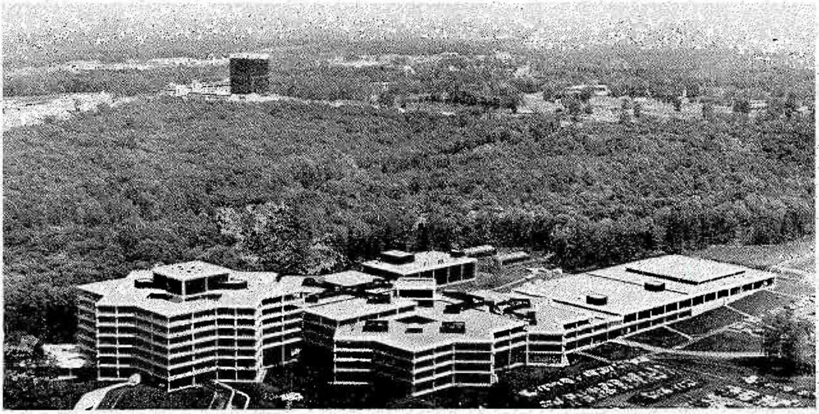
16. *Significance of High-Wax Oils with Respect to Genesis of Petroleum: Commentary,* by E. W. Biederman, Jr., p. 203-205 (1969).

Saturated fatty acids (mostly from land plants) with more than 20 carbon atoms, found in recent soils and nonmarine sediments, are the likely sources for long-chain paraffin hydrocarbons and waxes that occur in crude oil. The acids are altered to paraffins by splitting the carbon-carboxyl carbon bonds. Lagoonal marshes, coastal marshes, and fresh-water swamps may provide the source material for the high-wax oils.

17. *Environment of Deposition of Source Beds of High-Wax Oil,* by Kenneth J. Reed, p. 206-210 (1969).

In his study of Nigerian high-wax oils, the author confirmed that these oils were probably derived from nearshore or land sources.

USGS Opens New Center



Formal dedication ceremonies were held in July to mark the opening of the John Wesley Powell Federal Building, the main part of the U.S. Geological Survey's new National Center at Reston, Virginia. Rogers C. B. Morton, Secretary of the Department of the Interior, was the keynote speaker. Other Federal dignitaries participated, as well as state and county officials and representatives from industry.

Featured at the dedication was a symposium on "Earth Science in the Public Service," stressing earth resources, remote sensing, and the reduction of hazards from natural disasters.

The USGS, established by an Act of Congress in 1879, now employs about 10,000 scientists, engineers, technicians, and administrators. Ultramodern facilities will be available for 2,200 of them in the new complex. We add our congratulations to the Federal survey for its progress and for this new "earth resource."

William A. Fischer, Mrs. William T. Pecora, and Interior Secretary Rogers C. B. Morton, at dedication opening the U.S. Geological Survey's National Center. Dr. Fischer, a senior scientist of the Interior Department's EROS (Earth Resources Observation Systems) program, has just been presented the first annual William T. Pecora Award. Honoring the late William T. Pecora, former USGS director and later under secretary of the Interior, the award was established to recognize "outstanding contributions of individuals or groups toward the understanding of the Earth and its atmosphere by means of remote sensing."

USGS Issues Summary of U.S. Mineral Statistics

A new report, *Mineral Resources: Potentials and Problems,* by Walden P. Pratt and Donald A. Brobst, released in July by the U.S. Geological Survey, emphasizes the crises in supply of 27 important minerals in the United States which will have to be faced if massive efforts are not begun soon to develop domestic resources. The 20-page report, published as USGS Circular 698, is a summarized, easier-to-use version of the 722-page Professional Paper 820, *U.S. Mineral Resources,* and was issued to make the information more readily available to the general public.

Copies of Circular 698 can be obtained free upon request from the U.S. Geological Survey, National Center, Reston, Virginia 22092.

USGS Releases New Earthquake Map

A color-coded *World Seismicity Map* showing locations and depths of over 23,000 earthquakes and their relationship to major physical features of the land and ocean has been issued by the U.S. Geological Survey. The map is wall-sized (48 by 36 inches), published in a Mercator projection with a scale at the Equator of 1:39,000,000, and shows land-surface features in shaded relief, ocean depths at 500-fathom contours, and polar ice caps. It lists the date and magnitude of 121 major earthquakes during the period 1897-1972 that registered 8 or greater on the Richter scale and spots 22,895 earthquakes of 4.5 magnitude or greater that occurred from mid-1963 through 1972. It is "a much refined replacement for a similar map published in 1970," according to its compiler, Arthur C. Tarr, acting chief of the USGS National Earthquake Information Service.

Copies can be obtained for $1.50 each from the USGS Distribution Section, 1200 South Eads Street, Arlington, Virginia 22202.

California Issues Fault Map

In line with the above announcement by the U.S. Geological Survey of the release of its new seismicity map is information received from James E. Slosson, state geologist of California, of the publication of a map of California showing the active faults and geology of that state.

Compilation of the map, under the direction of Charles W. Jennings, has been in progress for several years, and, although still in preliminary form, it is being issued at this time for the immediate use of local governments, land-use planners and developers, engineers, and others. Printing is on two sheets at a scale of 1:750,000. The final version of the fault map is scheduled for 1975; the new geologic map is predicted for 1976.

Issued as Preliminary Report 13, the *Preliminary Fault and Geologic Map of California* can be ordered for $5.00 from the California Division of Mines and Geology, P.O. Box 2980, Sacramento, California 95812.

New Reference Work on Climates Released

Climates of the States, a new publication which should prove a valuable reference to professionals, students, and others interested in hydrology, climatology, and environmental and agricultural sciences, has been released by the Water Information Center. The work is issued in two 8½- by 11-inch volumes containing 1,000 pages, including 395 tables and 310 maps. It is a reproduction of all phases of climatological data collected over the past decade by the National Oceanic and Atmospheric Administration (NOAA) on each of the 50 states and Puerto Rico and the Virgin Islands.

Climates of the States can be ordered from the Water Information Center, Department R, 44 Sintsink Drive East, Port Washington, New York 11050. The total cost for both volumes is $39.50.

Charles Mankin Named President-Elect of AASG

Charles J. Mankin, director of the Oklahoma Geological Survey and of the School of Geology and Geophysics at The University of Oklahoma, was named president-elect of the Association of American State Geologists at the group's annual meeting June 9-14 in Bend, Oregon. Dr. Mankin had served as vice-president of the organization during the preceding fiscal year and as secretary prior to that.

Membership in AASG is composed of the directors of state geological surveys of 49 states and Puerto Rico. Dr. Mankin's responsibilities as president-elect will include service on the liaison committee, in which capacity he will be involved in three meetings in Washington, D.C., with representatives of Federal agencies and Congressional committees concerned with natural resources and land usage.

The next annual meeting of AASG will be held in North Carolina, with Stephen Conrad, state geologist of North Carolina, as host.

STATE OF THE STATE ON TOPO MAP COVERAGE

A release by a syndicated news service recently delivered a full-page message to the effect that here it was camping, fishing, and hiking season, and oh, joy, the U.S. Geological Survey had come out with something new: a timely series of maps to aid those engaged in the aforesaid activities. The issues referred to were topographic-quadrangle sheets.

As we all know, topographic maps have been available for quite a while. USGS Bulletin 100, printed in 1893, lists numerous "Topographic Atlas Sheets" on which the work had been done and the plates for printing made, but for which no "edition for general distribution" had yet been printed. By 1901 the program was clearly defined: "Under the plan adopted the entire area of the country is divided into small quadrangular districts (called *quadrangles*) bounded by certain meridians and parallels, each quadrangle being designated by the name of a principal town or some prominent natural feature within it."[1] Work had advanced by that time to the extent that about three-tenths of what was then the United States had been mapped (excluding Alaska), and sheets were offered to the public at 5 cents each. There was even one quadrangle completed in Oklahoma, namely, Kingfisher. These early maps were small-scale—1:62,500, 1:125,000, and even 1:250,000.

Things have progressed. A nationwide continuing program through the years has added new quadrangles constantly; existing maps are upgraded, remapped, photorevised, changed to the larger scale of 1:24,000 or 1 inch = 2,000 feet; sophistications are added and superimposed.

Things have progressed statewide in Oklahoma as well, so much so that as of December 31, 1973, 86.6 percent of the State had been mapped topographically, with 69.3 percent covered by 7½-minute quadrangle maps (1:24,000) and an additional 17.3 percent by the older, smaller scale 15-minute maps (1:62,500). Other new maps, photorevisions, and resurveys

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[1] Warman, P. C., 1901, *Publications of the United States Geological Survey, 1880 to 1901:* U.S. Geological Survey Bulletin 177, p. 64.

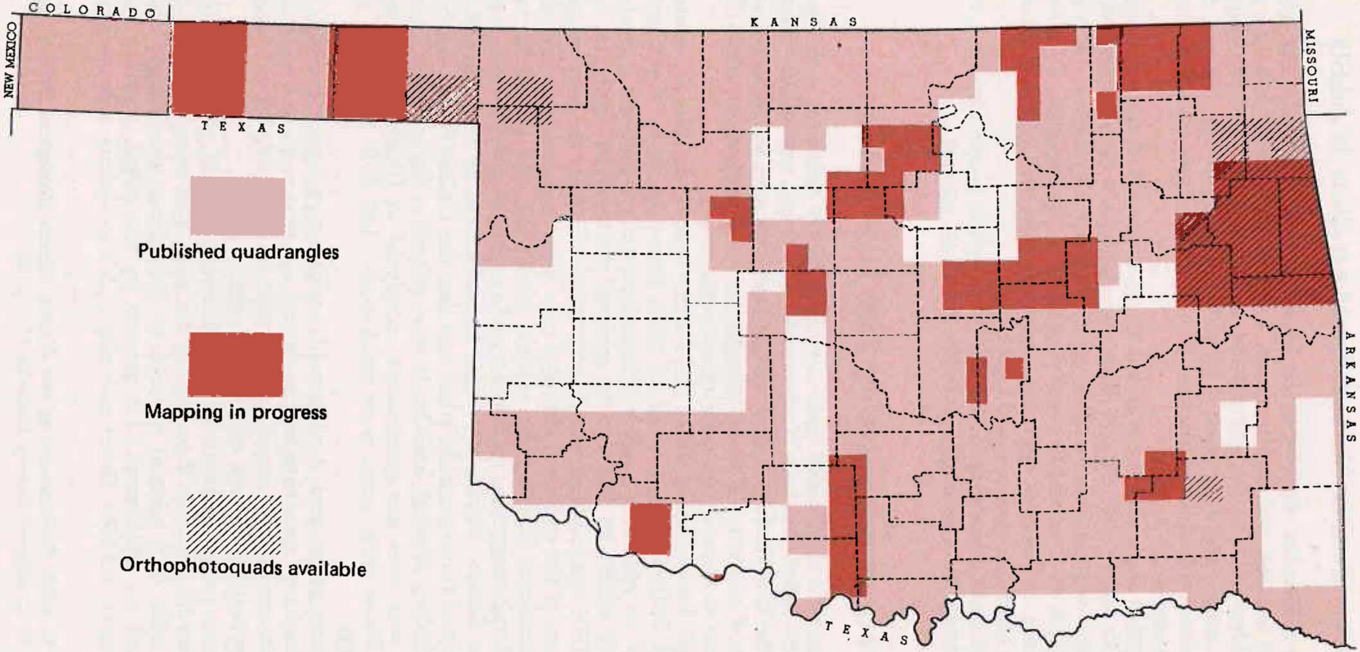

Figure 1. Index map of Oklahoma showing coverage by 7½-minute topographic maps and mapping in progress.

of Oklahoma quadrangles were in progress (see fig. 1). In July 1974 the Oklahoma Geological Survey had on hand "tope" sheets for 857 quadrangles. Some of these are orthophotomaps with an aerial photographic image superimposed. Many are colored to show woodland areas and other features, and some sheets show "flood-prone" areas (see June 1974 issue of *Oklahoma Geology Notes*, v. 34, p. 104).

The topographic maps, although hardly a new invention, truly *are* useful for campers, hunters, and backpackers, since they show not only the height and steepness of a hill and the depth of a valley but also water depths, roads, trails, wooded and cleared areas, streams, springs, ponds, swamps, marshes, game preserves, campsites, historic landmarks, and other natural and cultural features. They don't make it impossible to get lost in the wilds, but they make it easier not to. They have been used for many years by scientists, students, developers, land planners, and others engaged in outdoor pursuits.

Detailed topographic maps of Oklahoma quadrangles are on sale at the Oklahoma Geological Survey for 75 cents each. An index map of Oklahoma is available on request.

Indexes to topographic maps for each of the 50 States, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands, and an information booklet on topo maps and symbols are available free upon request from USGS Distribution Offices: 1200 South Eads Street, Arlington, Virginia 22202; Federal Center, Denver, Colorado 80225; and 310 Fairbanks Avenue, Fairbanks, Alaska 99701; and the National Cartographic Information Center, U.S. Geological Survey National Center, Reston, Virginia 22092.

—*Elizabeth A. Ham*

John E. Kilkenny Named President-Elect of AAPG

Daniel A. Busch, immediate past-president of The American Association of Petroleum Geologists, has announced the election of John E. Kilkenny as president-elect of the organization. A vice-president of Union Oil Company of California, Los Angeles, and a native Californian, Mr. Kilkenny has held prior positions as a geologist and executive with the Texas Company, Superior Oil Company, Olson's Scouting Service, Pure Oil Company, and Chanselor-Canfield Midway Oil Company. He will assume the presidency July 1, 1975, after serving as president-elect for the present interim.

Merrill W. Haas, a vice-president of Exxon Company, Houston, in whose honor a chair was recently established at The University of Kansas, took office as president of the association July 1, 1974.

Other current officers include: vice-president, Duncan A. McNaughton, consultant, Dallas; treasurer, George C. Grow, Jr., consultant, Newark, New Jersey; secretary, Bernold M. (Bruno) Hanson, Hanson Exploration Company, Midland, Texas; editor, Frank E. Kottlowski, New Mexico State Bureau of Mines and Mineral Resources, Socorro; and chairman of the house of delegates, Hugh N. Frenzel, Flag-Redfern Oil Company, Midland, Texas.

As officers of the world's largest geological organization, these dedicated geologists deserve broad support from the entire profession. We wish them well.

OGS Inventories Surface-Mined Coal Lands

GM-17, a set consisting of three map sheets and an accompanying booklet, enclosed in an envelope, was released by the Oklahoma Geological Survey the last of July. The maps show the location of all surface-mined coal lands in Oklahoma, and they are the result of a project undertaken with the cooperation and partial financial support of the Oklahoma Department of Mines.

The maps are published at a scale of 1:125,000 (1 inch = 2 miles) and delineate disturbed lands, mined areas partially reclaimed, and those which have been fully reclaimed. The 12-page, 8-×11-inch report that accompanies the maps contains aerial before-and-after views of surface-mined localities, as well as an index map, cross sections, and production and reclamation figures. The booklet includes discussions of the State's current mining and reclamation activities, procedures followed, costs of reclamation of both newly mined and "orphan," or unreclaimed, mined lands, and a description of the methods used in determining surface-mined areas.

The maps and the report were prepared by Kenneth S. Johnson, geologist with the Oklahoma Geological Survey, who has written and presented papers on mining and reclamation for several organizations in recent years.

Ken's figures show that since surface mining for coal began in Oklahoma in 1915, 35,424 acres in 16 eastern counties have been disturbed. To date, 8,345 acres have been partially or fully reclaimed in compliance with the Oklahoma mining-lands reclamation acts of 1968 and 1971. The 1971 act requires restoration of currently mined lands to a gently rolling topography, but several Oklahoma companies go beyond the letter of the law by replacing the original topsoil over leveled spoil banks, conditioning the land, and seeding.

GM-17, *Maps and Description of Disturbed and Reclaimed Surface-Mined Coal Lands in Eastern Oklahoma,* can be ordered for $2.00 from the Oklahoma Geological Survey, 830 Van Vleet Oval, Norman, Oklahoma 73069.

Friedman to Offer Short Course in Coal Geology

The Oklahoma Geological Survey, in cooperation with Business and Industrial Services of The University of Oklahoma, will sponsor a short course on "Coal Geology Fundamentals" October 14-16, 1974. Classes will be held at the Oklahoma Center for Continuing Education on the Norman campus and will be led by Samuel A. Friedman, coal geologist with the Oklahoma Geological Survey.

Focused on coal as an energy resource, the course is structured to provide timely and relevant information to geologists, engineers, chemists, executives, and government officials not formally trained in the principles and practice of coal geology.

General topics to be covered broadly are the origin, occurrence, and geographic distribution of coal; the principal coal regions of the United States and their remaining coal resources; types of coal mining; and trends in coal production. Selected aspects within these general topics to be covered are coal economics, coal exploration, distribution of sulfur in coal reserves, consideration of sulfur content in coal in view of environmental regulations, and current and future uses of coal. The course will include examples of problems and solutions in applied coal geology.

With the current need at this time for investigations into all sources of energy, this course should prove valuable to all participants.

Mr. Friedman, who recently completed a comprehensive report on *Investigation of the Coal Reserves in the Ozarks Section of Oklahoma and Their Potential Uses,* funded by the Ozarks Regional Commission, has been a specialist in coal geology since 1952, with 30 published papers and numerous reports in his field. Before coming to the OGS in 1971, he was involved in coal-resources work for the U.S. Bureau of Mines and the Indiana Geological Survey.

Information about the short course can be obtained from John E. Boardman, Business and Industrial Services, The University of Oklahoma, 1700 Asp Avenue, Norman, Oklahoma 73069.

AIPG Oklahoma Section Welcomes Frank Conselman

Oklahoma members of the American Institute of Professional Geologists will hold their annual section meeting Saturday, September 7, at the Ramada Inn in Norman. Frank B. Conselman, AIPG's national president, will be the principal speaker.

Dr. Conselman, a professor of geosciences at Texas Tech University, Lubbock, is also director of the university's International Center for Arid and Semi-Arid Land Studies. He is a past president and honorary member of The American Association of Petroleum Geologists and is currently serving as vice-president of the American Geological Institute. In his luncheon address, he will bring his audience up to date on the history of AIPG, its relation to the scientific geological societies, and its outlook for the future.

Section president William D. Rose, geologist-editor for the Oklahoma Geological Survey, will preside over a business meeting in the morning, and a panel discussion on planning for a single, unified professional organization to represent all geologists will highlight the afternoon session. Frank Conselman will serve on the panel, along with Charles J. Mankin (Oklahoma Geological Survey), Suzanne Takken (consultant), and John A. Taylor (independent operator). As many of our readers are aware, a special committee composed of representatives from AIPG, AAPG, the Association of Engineering Geologists, and the Society of Exploration Geophysicists has met several times during the past year to explore ways to establish broader professional representation for all geological scientists. A proposal has been advanced that a Professional Affairs Division of AGI be established for this purpose.

John Fryberger, meeting chairman, feels that the meeting will be of unusual import to all Oklahoma geologists, and the section has extended an invitation to all interested persons to attend. John says that the meeting date will not conflict with the OU football schedule, as the first game will be played the following Saturday. Detailed information, including registration cost, can be obtained by writing or calling John S. Fryberger, P.O. Box E, Norman, Oklahoma 73069; phone, (405) 329-8300.

Abyssocrinus FROM THE HARAGAN FORMATION (DEVONIAN) OF SOUTHERN OKLAHOMA

HARRELL L. STRIMPLE[1]

A small crinoid cup was collected by A. Allen Graffham of Ardmore, Oklahoma, from the Haragan Formation (Devonian) at the old Hunton townsite (name changed to Kite in 1910) northwest of Clarita, in southwestern Coal County, Oklahoma (NE¼NE¼ sec. 8, T. 1 S., R. 8 E.). Preservation of the specimen leaves much to be desired, but it is considered to be closely related to *Abyssocrinus antiquus* (Strimple). There is no mistaking the articular facets of the radial arms, which are typical of the genus and of the family Synbathocrinidae. Crinoids collected from Devonian rocks of Oklahoma are scarce; in fact, no intermediate form between typical *Abyssocrinus* Strimple and *Synbathocrinus* Phillips has been documented previously.

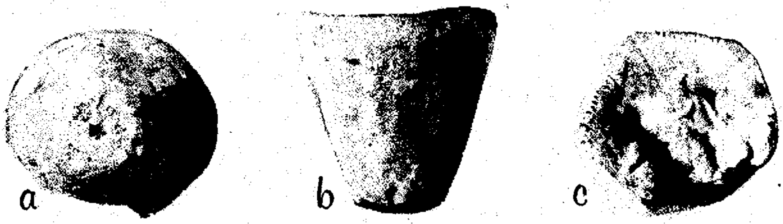

Figure 1. *Abyssocrinus* sp. Hypotype cup (SUI 37727), viewed from base (a), side (b—anterior?), and summit (c), ×2.4.

Exposures of the Haragan Formation form the rim of hills along the east side of the old Hunton site. Numerous trilobites and an abundant molluscan fauna have attracted paleontologists, stratigraphers, and students through the years. Strimple (1963) reported *Scyphocrinites gibbosus* (Springer, 1917); *Scyphocrinites ulrichi* (Schuchert, 1904); *Scyphocrinites ulrichi stellifer* (Schuchert, 1904); *Liomolgocrinus dissutus* Strimple, 1963; *Chidochirus gratiosus* Strimple, 1963; *Edriocrinus dispansus* Kirk, 1911; *Myelodactylus nodosarius* (Hall, 1859), and *Lecanocrinus huntonensis* Strimple, 1952, from exposures of the Haragan Formation of Oklahoma, mostly from the old Hunton site. The bulbous floats found in the Haragan that were originally described as *Camarocrinus* Hall, 1879, by Schuchert, 1904, are generally accepted as belonging to *Scyphocrinites* Zenker, 1833. Very likely *Liomolgocrinus* Strimple (1963, p. 103), which is thought to be a direct derivative of

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

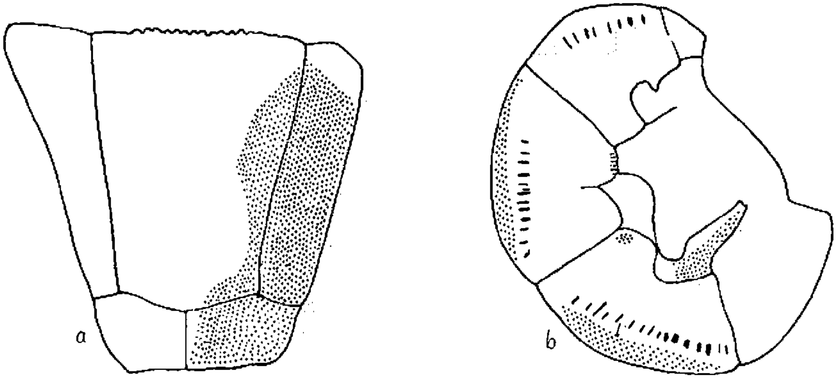

Figure 2. Camera-lucida drawings of *Abyssocrinus* sp. Hypotype cup (SUI 37727), viewed from side (a—anterior?) and summit (b), ×6.

Scyphocrinites, also possessed a bulbous float. Unfortunately, no specimens with the crown and float in direct association have been recovered from Devonian strata, although they have been found in association elsewhere in Silurian rocks.

Strimple (1963, p. 29) proposed the generic name *Abyssocrinus*, with *Synbathocrinus antiquus* Strimple, 1952, as the type species. The genus is distinguished from *Synbathocrinus* by the taller cup and the presence of three compound radials, partially or entirely fused in most cases. Compound radials are in *B, C,* and *E* rays, and division of these plates is almost always marked by a light groove, shaped like an inverted V, rather than a suture. Long articular facets of the radial arms almost close the body cavity. An outer lip is strongly crenulated. Muscle areas are depressed, but inwardly the facets flex upward. The uplifted area is divided into two parts by a long, narrow slit.

The cup of *S. antiquus* has 2 circlets of plates consisting of 3 upflared basals and 5 elongated radials, 3 of which have been noted previously as compound. Sutures between basals are often obscured, but the smaller basal appears to be in the *EA* interray. Radials flare outwardly toward the distal end of the cup. A well-developed notch is present in *CD* interray for reception of a primanal (anal *X*), and specimens have been found with the plate in place.

Most *A. antiquus* specimens have been collected from the upper part of the Henryhouse Formation (Silurian) in Pontotoc County, Oklahoma. The specimen of *Abyssocrinus* sp., collected from the Haragan Formation, Coal County, Oklahoma, has upflared basals, long radials that flare slightly toward the cup's summit, and radial articular facets identical to those of *A. antiquus*. Specimen measurements, in millimeters, are as follows: cup height, 6.7; cup width, 7.0; height of basals, 1.2; width of basals, 3.9. One side of the cup is damaged—presumably the posterior, because no anal notch is observed elsewhere. Only 2 interbasal sutures have been identified with a high degree of confidence, and they show 3 basals. Evidence of compound radials has been obscured or eliminated. The central opening of the body cavity is small, and some obscure cover plates are present.

It appears that *Abyssocrinus* sp. is a direct derivative of *A. antiquus* in which the compound radials have become completely fused. The narrow, tall cup serves to distinguish the two species from stratigraphically younger *Synbathocrinus*.

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New Officers Announced by Oklahoma's Geological Societies

New officers and executive boards for the 1974-75 year have been announced by the following geological and geophysical societies in Oklahoma:

Ardmore Geological Society

President, **James M. Coffman,** independent geologist
Vice-President and Program Chairman, **Robert W. Allen,** consulting geologist
Secretary-Treasurer, **Lawrence S. Morrison,** Westheimer-Neustadt Corporation
Past-President, **Joseph T. Kalkman,** consulting geologist
Executive Committee: **Jim Ray Hallett,** Quinton Little; **B. W. James,** Quinton Little.

Geophysical Society of Oklahoma City

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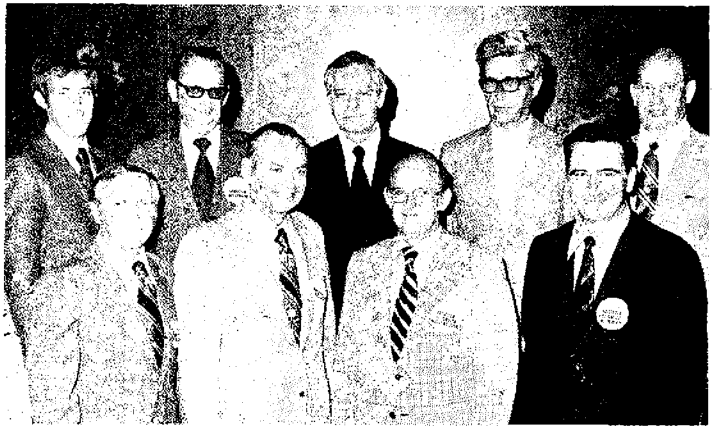

Oklahoma City Geological Society executive committee for 1974-75. Front row, left to right: William E. Jackson, first vice-president; Wilbur E. McMurtry, president; Louis M. Ford, past-president; Harold A. Brown, second vice-president. Back row, left to right: Thomas C. Cronin, secretary; Victor J. Veroda, treasurer; Edwin P. Kerr, social chairman; John H. Gatchell, public relations chairman; Lloyd E. Gatewood, library director. Not pictured: T. L. Rowland, editor.

OKLAHOMA ABSTRACTS

AAPG-SEPM REGIONAL MEETINGS
ROCKY MOUNTAIN SECTION
CASPER, WYOMING, JUNE 9-12, 1974

The following abstracts are reprinted from the May 1974 issue, v. 58, of the *Bulletin* of The American Association of Petroleum Geologists. Page numbers appear in brackets below each abstract from the *Bulletin*. Permission of the authors and of A. A. Meyerhoff, publications manager, is gratefully acknowledged.

Mineralogic Evidence for Buried Hydrocarbons—New Exploration Tool

T. J. DONOVAN, U.S. Geological Survey, Denver, Colorado

Imperfect rock seals above petroleum deposits may allow large volumes of low-molecular-weight hydrocarbons to slowly leak and diffuse to the surface. The seeping hydrocarbons chemically alter and incorporate into near-surface and surface rocks as pore-filling cements that are isotopically and chemically distinctive and geographically identifiable because their compositions and densities markedly contrast with surrounding rocks. Strong empirical evidence indicates that gases diffuse directly through the overburden, and leakage of liquid hydrocarbons is controlled by salinity variations in formation waters which affects their solubilities and promotes chemical reactivity. Highly reducing hydrocarbons and associated compounds cause discoloration of surface strata by reduction and dissolution of iron. Near the surface, hydrocarbons are oxidized; expansion of depressurized gas evaporates ground waters concentrating and precipitating dissolved solutes with unique isotopic signatures.

Such alteration and mineralization phenomena have been documented in outcrops of a Permian redbed sequence overlying several prolific oil accumulations in southern and central Oklahoma, but especially at the Cement anticline. Recognition of similar phenomena elsewhere could lead to new discoveries.

[913]

Braided Rivers and Related Terrigenous Depositional Systems—Useful but Enigmatic Exploration Models

L. G. KESSLER II, Canada-Cities Service, Ltd., Calgary, Alberta, Canada

Closely related Holocene and Pleistocene braided-fluvial, eolian dune-sand flat, and playa-lake depositional systems in the eastern Texas

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

Panhandle represent a useful but complex model for hydrocarbon exploration in ancient continental sediments. The modern South Canadian fluvial system and the Pleistocene Borger fluvial system are braided river deposits which are distinguishable from other sand bodies by multi-lateral sand-body geometry (high width/thickness ratio), low channel sinuosity, few sedimentary structure types, poor lateral and downstream continuity of individual depositional sequences, punctuations of these sequences by thin clay drapes, and a high sand/mud ratio. The main sand body of the South Canadian system averages two mi in width and 125 ft in thickness and cuts into the coarse-grained and sometimes conglomeratic sand of the Borger system. Fine to medium wind-polished sand of the Lake Marvin eolian-dune system and the older vegetated Nix Ranch eolian-sand system is deposited in thin plane-bedded sheets and strongly cross-stratified parabolic and longitudinal dunes. These eolian units are derived from, and often continuous with, South Canadian fluvial deposits of different ages. The strongly vegetated and older Pampa eolian-sand system is related similarly to the Borger fluvial system. In addition, the surface of the Pampa system is pockmarked by small pre-Nix Ranch playa-lake deposits consisting of organically rich and finely laminated beds of clay and sandy silt.

Hydrocarbon discoveries in fluvial and eolian sands illustrate the economic value of this depositional model. Among the many examples of production from fluvial sands are the Lower Cretaceous "J" sand bodies in Nebraska, lower Paleozoic Granite Wash in Alberta, and the Berea sand in Ohio. The Permian Queen sandstone in New Mexico produces from probable eolian deposits.

Limited subsurface information leads to difficulty in recognizing separate depositional systems in sands of similar size and texture. For this reason the explorationist must be careful in application of depositional models. Realization of possible variation in sand-body geometry in a particular type of depositional system is essential.

[914]

THE UNIVERSITY OF OKLAHOMA

Chemical and Isotopic Investigation of Stratigraphic and Tectonic Dolomites in the Arbuckle Group, Arbuckle Mountains, South-Central Oklahoma

KENNETH AARON SARGENT, The University of Oklahoma, Ph.D. dissertation, 1974

In the Arbuckle Mountains of south-central Oklahoma are excellent exposures of limestones and early diagenetic dolomites of Early Ordovician age. In these units are found irregular bodies of late diagenetic dolomite associated with structures produced by a Late Pennsylvanian-Early Permian deformation.

Samples of limestone, early diagenetic dolomite, late diagenetic dolomite, and vein dolomite which cuts across all other structure were analyzed for 10 trace elements in order to determine if chemical differences exist between the early diagenetic and late diagenetic dolomites. On the basis of the trace element analyses 20 samples were selected for carbon and oxygen isotopic analysis. The resulting trace element and isotopic data were studied using standard statistical techniques and the multivariate linear discriminant function technique.

Four trace elements, Na, Li, Ni, and Cu, and the isotopic values δO^{18} and δC^{13} were found to discriminate at a high level between early diagenetic and the late diagenetic dolomite in the study area. A computer program was written for the IBM 1130 to utilize the functions generated by the linear discriminant function statistical technique to test unassigned dolomite samples and place these into the correct dolomite grouping.

The limestones and early diagenetic dolomites were similar in δO^{18} content with δO^{18} averages of -6.9 and -6.8 respectively. This would indicate that the early diagenetic dolomitizing solutions were similar in isotopic composition to sea water. The late diagenetic dolomites were characterized by O^{18} values higher than for the limestones and late diagenetic dolomites indicating that the late diagenetic dolomitizing solutions differed in isotopic composition from sea water.

Stratigraphy and Environment of Deposition of the Lower Dornick Hills Group (Lower Pennsylvanian), Ardmore Basin, Oklahoma

DAVID CROMWELL, The University of Oklahoma, M.S. thesis, 1974

The lower Dornick Hills Group (Lower Pennsylvanian, Morrowan and Atokan Series) occurs in the Ardmore structural basin in south-central Oklahoma. It comprises over 2,000 feet of limestones, sandstones, conglomerates, and shales. The terrigenous clastics portion of this sedimentary sequence was derived from the adjacent Criner Hills anticlinorium and was deposited to the northeast in a shallow, normal marine environment.

The thesis treats the lower Dornick Hills Group on the eastern limb of the axially faulted, overturned Overbrook anticline. The Overbrook anticline was developed and overturned against the Criner Hills (that is, to the southwest) during the Arbuckle orogeny (Virgilian). The strata strike northwest-southeast and dip to the northeast generally 65^{c} to 90^{c} with some overturning to the southwest.

The lower Dornick Hills Group, as used here, includes several mappable members. The oldest is the Primrose Member (Morrowan). It is thick-bedded, relatively unfossiliferous, calcareous siltstone up to 15 feet thick. It is overlain unconformably by the Jolliff Member (Morrowan) which includes a basal limestone and chert conglomerate, and some upper pebby limestones and shales. Above the Jolliff is an Unnamed Unit (1) which comprises almost 800 feet of shales and sandy limestones that are gradational southeastward into conglomerates. The overlying Otterville Member (Morrowan) also becomes conglomeratic toward the southeast: Pebbly, oolitic grainstones become closely-packed, clastic packstones and conglomerates. The Otterville is overlain by an Unnamed Unit (2) which consists of shale and interbedded sandy, fossiliferous limestones. The Bostwick Member (Atokan) unconformably overlies the Unnamed Unit (2). The Bostwick is 600 feet of thick-bedded, lenticular limestone and chert conglomerates that are interbedded with sandy-pebbly limestones, sandstones, and shales. From the north to the south the basal Bostwick lithofacies changes from cherty and sandy conglomerates to limestone, chert, and calcareous conglomerates.

The environment of deposition of the lower Dornick Hills Group was a shallow, normal marine shelf that sloped basinward (northeast and east) from the adjacent source area. The provenance was the Criner Hills anticlinorium that was periodically tectonically affected by the Wichita orogeny that commenced in the Early Morrowan and continued into the Desmoinesian.

New Publications from AAPG

Those who have followed Daniel A. Busch's evolving methodology in exploring for stratigraphic traps will surely welcome his *Stratigraphic Traps in Sandstones—Exploration Techniques,* which has just been released by The American Association of Petroleum Geologists as Memoir 21. The clothbound, 190-page volume sells for $12.00 to AAPG and SEPM members and $15.00 to the general public. Order from The American Association of Petroleum Geologists, P.O. Box 979, Tulsa, Oklahoma 74101.

Alaska and Hawaii are covered in AAPG Geological Highway Map 8, just off the press. Compiled by Allan P. Bennison with the cooperation of the U.S. Geological Survey and state agencies, the color map has been printed at a scale of 1:3,500,000 for Alaska and 1:500,000 for Hawaii. In addition to the general geology and the highway network, features shown include the volcanic history of Hawaii, the glacial history of Alaska, the natural resources of Alaska, and the history of the trans-Alaska pipeline. Folded maps are available from the above address for $2.00 and rolled maps for $2.50, plus a 50-cent handling charge for each order. Folded maps can also be purchased from the Oklahoma Geological Survey.

The latest in AAPG's Reprint Series, no. 11, is *Abnormal Subsurface Pressure,* a 205-page collection of 14 papers from the AAPG *Bulletin* over the last 20 years, compiled by George B. Vockroth. The paperbound volume can be ordered from the above address for $4.00 (members) and $5.00 (nonmembers).

New Thesis and Dissertation Added to OU Geology Library

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

Magnetic Properties of Archeomagnetic Materials, by Eric Paul Baumgartner.

The following Ph.D. dissertation has been added to the library:

Algae and Paleoecology of Algal and Related Facies, Morrow Formation, Northeastern Oklahoma, by David A. Kotila.

AEC Offers Uranium Statistics

A report comprising a compilation of data on the uranium industry in the United States from 1947 through 1973 has been released by the U.S. Atomic Energy Commission. Included in the 67-page publication is information on production, resources, exploration, land holdings, employment, and uranium-concentrate commitments and requirements.

Copies of the report, *Statistical Data of the Uranium Industry*, can be obtained from Lucius Pitkin, Inc., P.O. Box 1889, Grand Junction, Colorado 81501. The price is $1.30 each, with a $3.00 minimum mail-order charge.

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