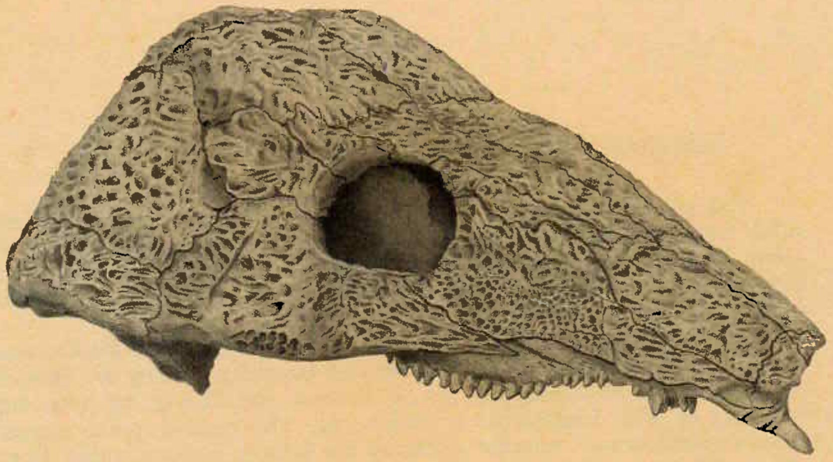
DISPLAY ONLY $1.50 ... YEAR FIFTY CENTS PER COPY



OKLAHOMA GEOLOGY NOTES

Volume 31 October 1971 Number 5

Cover Picture

Labidosaurikos meachami, a Lower Permian Reptile

The pencil drawing on the cover shows the skull of a Lower Permian captorhinomorph reptile, *Labidosaurikos meachami* Stovall, 1950 (Am. Jour. Sci., v. 248, p. 46-54), from the Hennessey Shale near Crescent, Logan County, north-central Oklahoma; about 40 percent of natural size.

The specimen is one of the best preserved reptilian skulls ever found in Oklahoma, and the species was named by John W. Stovall in honor of E. D. Meacham, former dean of the College of Arts and Sciences of The University of Oklahoma. The generic name means "like *Labidosaurus*," another genus of the family Captorhinidae, from which *Labidosaurikos* differs, above all, in size and in having a battery (six rows) of remarkably uniform peglike maxillary and dentary teeth. *Labidosaurikos* is the biggest captorhinomorph known so far, its skull being almost twice as large as that of an average-sized individual of the largest *Labidosaurus* species. Relying on a relative stability in proportions within the family, the skull to postcranial skeleton ratio is estimated to be about 1:6 in mature specimens, and the total length of *Labidosaurikos* thus may be estimated at about 5-5½ feet.

Labidosaurikos was a robust form inhabiting margins of aquatic reservoirs that were still plentiful in Early Permian time. Stovall (1950) stated that "the feebleness of the teeth suggests soft food, and the presence of four large teeth in the anterior portion of the mouth suggests a diet of soft plants." This is difficult to believe, because in *Labidosaurikos,* as in all other captorhinomorphs, the dentition is clearly of a carnivorous type. In 1954, Everett C. Olson (Fieldiana Geology, v. 10, p. 211-217) described another species of this genus, *Labidosaurikos barkeri,* from the Texas Lower Permian. However, Seltin (1959, Fieldiana Geology, v. 10, p. 461-509), in his "Review of the Family Captorhinidae," considered *L. barkeri* to be merely a growth stage of *L. meachami* and stated that "there are no good criteria for placing more than one species in the genus *Labidosaurikos*. That species is *L. meachami,* named and described by Stovall in 1950." Thus *Labidosaurikos* appears to be a monotypical genus represented by the holotype depicted here (lower jaw not shown), another skull found more recently south of Crescent, and the Texas specimens originally described as *L. barkeri* by Olson.

—*Jiri Zidek*

OKLAHOMA GEOLOGICAL SURVEY

Annual Report

July 1, 1970-June 30, 1971

INTRODUCTION

The minerals industry, the largest segment of Oklahoma's economy, continued to expand during the past year. Preliminary figures for 1970 show a gross income of $1.13 billion, representing a 3.7 percent increase over the preceding year. This is the fifth consecutive year that the gross income has exceeded $1 billion. The importance of the minerals industry to Oklahoma's economy was further underscored this past year when additional taxes were imposed on oil and gas production, the gross production tax having been increased from 5 to 7 percent.

Although the gross income of the minerals industry continues to increase, the future should be viewed with guarded optimism. Annual production of oil and gas continues to exceed additions to proved reserves, a trend that has existed for the past several years. Because petroleum and petroleum products account for about 94 percent of the gross annual income of the minerals industry, the future of the industry, and indeed the State's economy, is heavily dependent upon oil and gas production.

Production expansion of other mineral commodities has also added to the State's gross income. Although the effect on the value of total production is small, the importance of these commodities to their local area cannot be minimized. The production of gypsum in the northwestern, copper in the southwestern, limestone and dolomite in the south-central, clay and shale in the central, and limestone (including high-purity stone) and coal in the eastern section of Oklahoma are only a few examples of the impact of mineral production on local areas.

Current national energy requirements, as well as those projected for the next decade, cannot be met with domestic oil and gas production, and foreign imports represent only a temporary solution. For that reason coal is receiving increasing attention as a third source of domestic energy.

In Oklahoma, coal production has increased from about 800,000 tons in 1968 to almost 2,500,000 tons in 1970. Most of this threefold increase in production is being used in electrical-power generation in the Midcontinent. A small portion is being used for metallurgical purposes. Further significant increases in Oklahoma's coal production may be anticipated within the next 3-5 years to satisfy the growing demand for energy in the Midcontinent and to begin to supply some of the domestic-energy requirements of our State.

The Oklahoma Geological Survey serves a principal role in mineral-resources development. The data obtained through field and laboratory investigations provide industry with information basic to the effective development of the State's natural resources. This information is also essential for insuring that the development of these resources will not permanently degrade the natural environment. To meet these prescribed responsibilities, the Survey has a Statewide program of geologic investigations.

BASIC GEOLOGIC INVESTIGATIONS

A fundamental activity of the Survey is the preparation of adequate geologic base maps for all subsequent mineral and water-related investigations. At the present time, approximately 50 percent of the State has been mapped in sufficient geologic detail to provide the basic information necessary for further studies. Geologic investigations in various stages of completion are under way in Custer, Noble, Payne, Alfalfa, Muskogee, Choctaw, and Pushmataha Counties and in parts of several southwestern Oklahoma counties.

In addition to the surface-mapping program, subsurface geologic and geophysical studies are being conducted in several parts of the State to assist in the search for oil and gas. A subsurface investigation of Hunton rocks in the Anadarko basin and a ground magnetic survey of Cleveland and McClain Counties are two examples of such studies.

MINERAL-RESOURCES INVESTIGATIONS

Oklahoma ranks third in the nation in oil and gas production, indicating the mature stage of development of these mineral commodities. However, the State ranks approximately 38th in industrial-mineral production, indicating that further development of these commodities may prove to be a profitable activity. The value of industrial-mineral production has increased from approximately $53 million to almost $75 million in the past 3 years. Survey studies of clays and shales, carbonates, and sulfates were responsible for a substantial portion of the increased production and value of these commodities.

Studies currently under way concern the investigation of the origin and distribution of sedimentary copper in southwestern Oklahoma; the origin and economic assessment of bentonite deposits in northwestern Oklahoma; limestone and dolomite deposits in north-central, northeastern, and south-central Oklahoma; and clay and shale deposits in eastern Oklahoma.

COAL INVESTIGATIONS

Increased interest in coal in Oklahoma has increased the demand on the Survey for information on quantity, quality, and general location of reserves. Most of the published and open-file information on coal reserves is based on scanty data and includes extensive interpretation. Consequently, these reports differ widely, making the validity of the available information questionable. In addition, a feasibility study on the gasification of Oklahoma coal calls for the Survey to supply basic resources information.

The Survey has established a coal-investigation program with funding for the first 2 years to be obtained from the Ozarks Regional Commission. Investigators in this program will first evaluate all previous data to establish their reliability and to determine areas where additional data must be obtained. This phase will be followed by field operations, including drilling where necessary. Results will be published by the Survey as they become available.

WATER INVESTIGATIONS

The Survey has conducted a cooperative water-resources-investigation program with the U.S. Geological Survey for the past 4 years. This program involves a matching-funds contribution from each agency, with the investigations being conducted by the Water Resources Division of USGS.

In 1970 the Survey also entered into a 10-year agreement with USGS to establish a comprehensive water-investigation program for the State. The first 4 years of this program involve the preparation of a series of 9 hydrologic atlases depicting the quantity, quality, and usage of surface and subsurface waters in the State. The first two atlases (Fort Smith and Tulsa quadrangles) have been published as HA-1 and HA-2 and are available from the Survey. Of the remaining 7 quadrangles, 4 are in various stages of completion, and investigations of the remaining 3 quadrangles will be initiated soon.

In addition to the regional investigations being conducted as part of these cooperative programs, detailed ground-water studies will be made in selected areas. One such area involves a cooperative effort among the city of Lawton, the Oklahoma Geological Survey, and the U.S. Geological Survey. This particular study is designed to assist Lawton in its long-range-planning efforts to maintain an adequate supply of municipal water, and funds are being provided by the city of Lawton to help defray the cost of this portion of the program.

BASIC RESEARCH

A continuing program of basic research is vital to the future industrial development of our State. Included in the category of basic research are stratigraphic investigations, trace-element geochemical analyses, and new applications of geophysical techniques. During the past year stratigraphic investigations were conducted on Morrow rocks in northeastern Oklahoma, Silurian and Devonian rocks in eastern and south-central Oklahoma, and Cambrian-Ordovician rocks in the Wichita Mountains.

A trace-element geochemical study on the origin and distribution of sedimentary copper deposits in southwestern Oklahoma is nearing completion. This study is an attempt to determine the origin and accumulation mechanisms of copper in the Permian red-bed environment. We believe that a better understanding of these accumulation mechanisms will aid in further exploration for additional sedimentary copper deposits.

The Oklahoma Geological Survey is participating in geomagnetic investigations being conducted at The University of Oklahoma by providing space and facilities to assist in the study. The possibility of using geomagnetic reversals as a means of stratigraphic correlation is one aspect of the investigations.

Other basic-research projects currently under way include cementation processes in carbonate rocks and alteration mechanisms of volcanic ash to bentonite.

INFORMATION AND ASSISTANCE

An important activity of the Survey is providing information and assistance to professional geologists and the general public. This responsibility is discharged by individual consultation and written communication with professional earth scientists and through consultation, written communication, lectures, and field trips for education and civic groups.

More than 500 written communications are received each year from secondary-school students requesting information on the geology, paleontology, and mineral resources of our State. In addition, professional staff members give between 15 and 20 public lectures each year to various school and civic groups. Finally, the Survey provides a public service to Oklahoma residents who wish to have earth science materials identified and analyzed.

A grant from the National Science Foundation is providing partial support for a 2-year project involving the preparation of a series of 9 field-trip guidebooks for secondary-school earth science teachers. The first guidebook is an introduction to the series, and each subsequent guidebook will cover 1 of 8 sections of the State, providing specific information on several possible field trips that may be taken in the area. The guides will emphasize the geology, water and mineral resources, and environmental problems that are illustrated by the features that may be observed on the trips. This project is to be completed by the end of the current fiscal year.

Additional public-service responsibilities of the Survey include site investigations for the location of sanitary land fills, preparation of geologic information to be used in writing environmental-impact statements that are necessary before initiation of any public-works project within the State, and the evaluation of geologic factors associated with long-range community planning and development.

CORE AND SAMPLE LIBRARY

For more than 10 years, the Oklahoma Geological Survey has maintained a library of cores and samples from wells drilled in various parts of the State. This library represents a valuable historical record of previous exploration activities and, with the increasing demand for additional energy resources, will become an even more important factor in future exploration programs.

Historically, major companies have played an important role in exploration for oil and gas within Oklahoma. In recent years the major companies have transferred their principal exploration efforts to offshore and foreign areas. Consequently, most of the current exploration activities for oil and gas within our State are being conducted by small companies and independent operators. Whereas the major company has access to large files of cores and samples, the small company or independent operator is unable to maintain separate collections. For that reason a central repository of these materials is of increasing value. At the present time the library contains approximately 40,200 boxes of cores from 1,700 wells and samples from approximately 29,000 wells.

The cores and samples are currently housed in a temporary wooden building with no protection against fire damage. Plans are being developed for a new, fireproof facility to house not only the collections but also complete sets of mechanical logs and scout tickets, which are currently available at The University of Oklahoma's Oil Information Center. If funding becomes available for this facility, it will enable the Survey to provide a valuable service to the industry and thus assist in the further development of oil and gas reserves in our State.

Charles J. Mankin, *Director*
August 18, 1971

APPENDIX A

Survey Staff, 1970-71 Fiscal Year

Professional

Thomas W. Amsden
William H. Bellis
Carl C. Branson
Robert O. Fay
William E. Ham[1]
Kenneth S. Johnson
Charles J. Mankin
Malcolm C. Oakes
John F. Roberts
T. L. Rowland
Leonard R. Wilson

Part-Time Professional

David B. Kitts
(The University of Oklahoma)
John A. E. Norden
(The University of Oklahoma)
John W. Shelton
(Oklahoma State University)
R. L. Squires
(California Institute of Technology)
James H. Stitt
(University of Missouri, Columbia)
George T. Stone
(The University of Oklahoma)
Patrick K. Sutherland
(The University of Oklahoma)

[1]Deceased July 1970.

Technical

Editorial

Carol R. Patrick
William D. Rose

Cartographic

Marion E. Clark
Roy D. Davis
David M. Deering[2]
Johnny O. Langford III[3]

Geology and Geophysics Library

Elizabeth A. Ham[4]

X-Ray Laboratory

Linda Hare[5]
Connie A. Heiden[6]

Secretarial and Maintenance

Odus M. Abbott[7]
Helen D. Brown
Margarett K. Civis[8]
Linda K. Hoogendoorn[9]
Eugene R. Parris[10]
Susan L. Seybert[11]
Gwendolyn C. Williamson

Core and Sample Library

Billy D. Brown
Eldon R. Cox[12]
Wilbur E. Dragoo[13]

---

[2]Appointed January 1971.
[3]Resigned June 1971.
[4]Appointed August 1970.
[5]Resigned July 1970.
[6]Appointed August 1970.
[7]Resigned June 1971.
[8]Appointed September 1970.
[9]Resigned September 1970.
[10]Appointed June 1971.
[11]Appointed October 1970.
[12]Appointed June 1971.
[13]Deceased May 1971.

APPENDIX B

List of Survey Publications Issued, 1970-71 Fiscal Year

Educational Publication 2.—Guidebook for Geologic Field Trips in Oklahoma. Book 1: Introduction, Guidelines, and Geologic History of Oklahoma, by Kenneth S. Johnson. Preliminary version, first in 9-part series, 15 pages. Issued February 1971.

Oklahoma Geology Notes.—Six bimonthly issues (August 1970-June 1971), containing 168 pages.

Directory.—Mineral Producers in Oklahoma, 1970. 50 pages (multilith). Issued November 1970.

Guidebook.—Highway Geology in the Arbuckle Mountains and Ardmore Area, Southern Oklahoma, by Kenneth S. Johnson and Willard McCasland. Prepared for 22d Annual Highway Geology Symposium field trip; published jointly with Oklahoma State Highway Department. 31 pages, 18 figures. Issued April 1971.

APPENDIX C

Publications by Survey Staff, 1970-71 Fiscal Year

THOMAS W. AMSDEN

Triplesia alata Ulrich and Cooper, *in* Dutro, J. T., Jr. (ed.), Paleozoic perspectives; a paleontological tribute to G. Arthur Cooper: Smithsonian Contr. Paleobiology, no. 3, p. 143-154.

Silurian and Lower Devonian (Hunton) oil- and gas-producing formations: Am. Assoc. Petroleum Geologists Bull., v. 55, p. 104-109 (with T. L. Rowland).

ROBERT O. FAY

Geology, *in* Appraisal of the water and related land resources of Oklahoma—Region Eight, 1971: Oklahoma Water Resources Board Pub. 34, p. 17-25.

Economic geology, *in* Appraisal of the water and related land resources of Oklahoma—Region Eight, 1971: Oklahoma Water Resources Board Pub. 34, p. 125.

Geologic atlas of Texas, Perryton sheet: Texas Bur. Econ. Geology, scale 1:250,000 (Virgil E. Barnes, project director; geologic mapping in Oklahoma field checked by Fay).

KENNETH S. JOHNSON

William E. Ham, 1916-1970: Oklahoma Geology Notes, v. 70, p. 95-97.

Rock handled efficiently at Texas Gypsum Company quarry, Fletcher, Oklahoma: Oklahoma Geology Notes, v. 70, p. 118-120.

Introduction, guidelines, and geologic history of Oklahoma, *book 1 of* Guidebook to geologic field trips in Oklahoma: Oklahoma Geol. Survey Educ. Pub. 2, 15 p.

Geology and mineral resources of Oklahoma: Compass, v. 48, no. 1, p. 5-18.

Highway geology in the Arbuckle Mountains and Ardmore area, southern Oklahoma: Oklahoma State Highway Dept. and Oklahoma Geol. Survey Field Trip Guidebook, 22d Ann. Highway Geology Symposium, 31 p. (with Willard McCasland).

CHARLES J. MANKIN

Alex. Nicholson, Jr., 1921-1970: Oklahoma Geology Notes, v. 30, p. 151-152.

Oklahoma Geological Survey, annual report, July 1, 1969-June 30, 1970: Oklahoma Geology Notes, v. 30, p. 153-157.

JOHN F. ROBERTS

Oil and gas, *in* Appraisal of the water and related land resources of Oklahoma—Region Eight, 1971: Oklahoma Water Resources Board Pub. 34, p. 125-127.

Statistics of Oklahoma's petroleum industry, 1969: Oklahoma Geology Notes, v. 30, p. 67-74.

Directory of mineral producers in Oklahoma, 1970: Oklahoma Geol. Survey, 50 p.

WILLIAM D. ROSE

Bibliography and index of Oklahoma geology, 1970: Oklahoma Geology Notes, v. 31, p. 23-37.

T. L. ROWLAND

Silurian and Lower Devonian (Hunton) oil- and gas-producing formations: Am. Assoc. Petroleum Geologists Bull., v. 55, p. 104-109 (with T. W. Amsden).

LEONARD R. WILSON

Palynological techniques in deep-basin stratigraphy: Shale Shaker, v. 21, p. 124-139.

Development of palynological computer information at The University of Oklahoma: Oklahoma Geology Notes, v. 30, p. 75-83 (with J. L. Morrison and W. E. Reid).

APPENDIX D

Papers Presented by Survey Staff at Professional Meetings, 1970-71 Fiscal Year

Society of Mining Engineers of AIME, Fall Meeting
St. Louis, Missouri, October 21-23, 1970

KENNETH S. JOHNSON

Geology and development of Republic Gypsum Company's gypsum deposit at Duke, southwestern Oklahoma.

Oklahoma Science Teachers Association, Annual Meeting
Oklahoma City, Oklahoma, October 22, 1970

KENNETH S. JOHNSON

Mineral resources of Oklahoma.

Geological Society of America, Annual Meetings
Milwaukee, Wisconsin, November 11-13, 1970

THOMAS W. AMSDEN

A late Ashgillian (Ordovician) brachiopod fauna from the Edgewood Formation, Illinois and Missouri.

Oklahoma Academy of Science, Annual Meeting
Stillwater, Oklahoma, December 4, 1970

KENNETH S. JOHNSON

Oklahoma's mineral resources and mining reclamation practices.

Geological Society of America, South-Central Section Annual Meeting
Lubbock, Texas, March 26-28, 1971

T. L. ROWLAND

Depositional patterns of the Morrow Series (Lower Pennsylvanian) in northeastern Oklahoma and northwestern Arkansas (with Patrick K. Sutherland and Thomas W. Henry).

LEONARD R. WILSON

Palynological evidence for a Pennsylvanian age assignment of the Gearyan Series in Kansas and Oklahoma (with Muhammad Abdur Rashid).

American Association of Petroleum Geologists—Society of Economic Paleontologists and Mineralogists, Annual Meeting
Houston, Texas, March 29-April 1, 1971

T. L. ROWLAND

Algal mudstone mounds in Morrowan Stage (Lower Pennsylvanian) in northeastern Oklahoma.

Potato Hills Problem Area

William D. Pitt[1]

LOCATION AND PROBLEM

The Potato Hills, a series of ridges in a valley between two synclinal mountains, are within the central Ouachita Mountains of Oklahoma, as shown on the index map (fig. 1). The Potato Hills are one of the three areas of the Ouachita Mountains where rocks older than the Stanley Shale (Mississippian) crop out. The area has long been controversial; some geologists believe that it represents a fenster in a thrust sheet, whereas other geologists believe that it is simply a faulted anticlinorium.

The hypothesis that the Potato Hills area is largely a fenster area was first proposed by Hugh D. Miser in his summary report, *Structure of the Ouachita Mountains of Oklahoma and Arkansas* (Miser, 1929). In this report he stated (p. 18, 20): "I interpret this fault [in the "fenster" area] 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 reasoned that "the actual horizontal displacement by the fault is therefore at least 3 miles" and 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 [1928] that the

[1]Chairman, Department of Geology, Eastern New Mexico University, Portales.

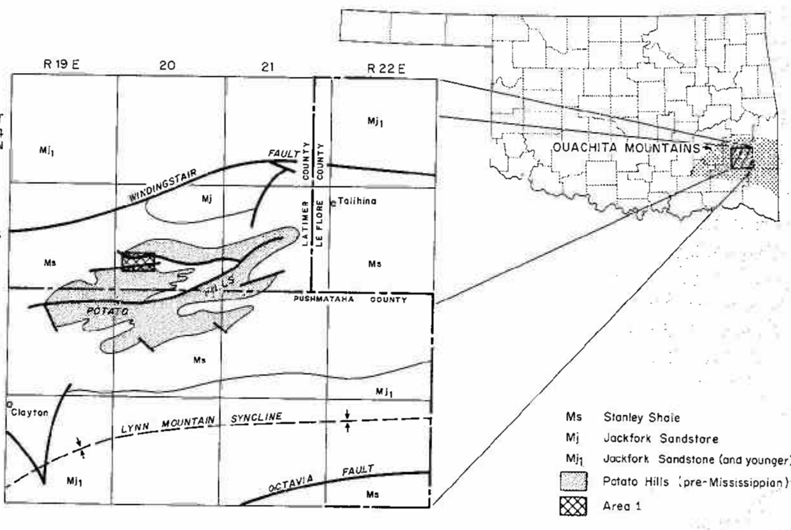


Figure 1. Index map showing geologic setting of Potato Hills.

major parallel faults in the region bound thin slices of the earth's crust."

N. C. Roe and B. W. Miller mapped the eastern and western halves, respectively, of the Potato Hills in 1954. They concluded that the Potato Hills are a fenster of the Jackfork Mountain fault that, they believed, lies between the Potato Hills and the surface trace of the Windingstair fault farther north (*see* fig. 2).

The other structural interpretation of the Potato Hills area is that it is a faulted anticline. The late C. W. Tomlinson (1959, p. 4) compared the Potato Hills to the "rabbit-ears" anticlinoria of the Ardmore, Oklahoma, area. He suggested that the Potato Hills were deformed in two stages. The first stage was one of uplift and included the competent beds of the area, the Bigfork Chert and the Arkansas Novaculite, as well as the thick shales below (Mazarn-Womble Shale sequence) and above (Stanley Shale). Tomlinson 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. The second stage was one in which further compression was confined largely to the "outer folds, flanking the core of the structural high," which did most of the yielding. Also during this stage he considered it likely that "the brittle chert-novaculite section, between the great shales," broke near the crests of those folds and were thrust inward over the core area to some extent.

A structural interpretation of the Potato Hills similar to Tomlinson's was proposed by Allan P. Bennison (pers. comm., 1963, 1970, 1971). Bennison believes that the Potato Hills were a site of "deep geosynclinal accumulation," having received perhaps "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." Bennison (1971) still considers "the faulted anticlinorium concept as the most valid with one exception"; this exception is the subject-area of the present report. He also concluded that "the Potato Hills are a product of extreme isoclinal and vertical folding and overstretching and not of broad horizontal translation." His failure to find a thrust-fault plane in the Ouachita Mountains dipping at an angle of less than 65° lends support, he feels, to his belief that the Potato Hills area is not one of broad horizontal translation. He pointed out that the late Norm Johnson "after two years of searching could not find a surface-fault [plane dipping at an angle] under 65° in the entire Ouachita Mountains."

PROBLEM AREA 1: AREA OF MULTI-INTERPRETATION

The controversy about the structural interpretation of the Potato Hills area continues, partly because critical areas are well covered

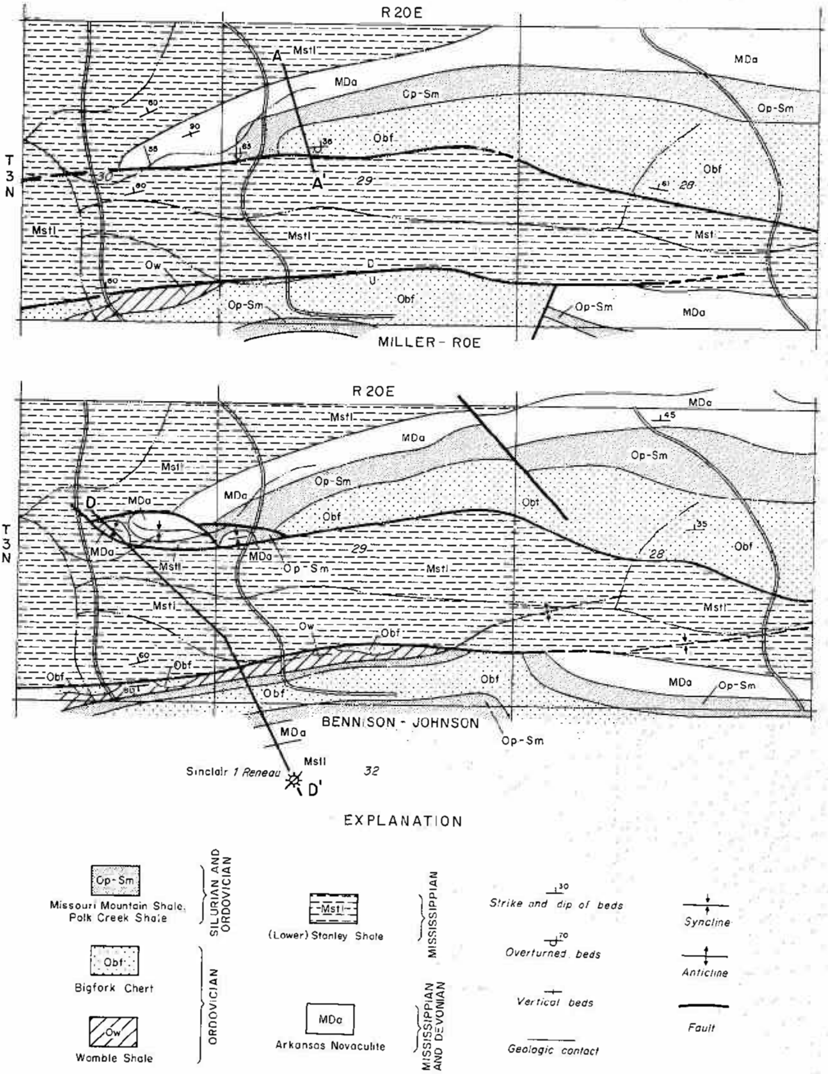


Figure 2. Geologic maps of area 1, Potato Hills. Generalized from interpretations by Miller and Roe (top) and Bennison and Johnson (bottom). Sections A-A′ and D-D′ shown in figure 4.

with vegetation. This brief report is concerned mainly with one small section of the Potato Hills, an area in the north-central part athwart the Potato Hills "fenster" fault. This area centers in the N½ sec. 30, T. 3 N., R. 20 E., and is referred to hereafter as area 1. It is unique because the structure has been interpreted in three different ways;

these three structural interpretations are shown in geologic maps in figures 2 and 3 and in cross sections in figure 4.

Members of the 1959 Ouachita Mountain field conference (sponsored by the Dallas and Ardmore geological societies and held in conjunction with the annual AAPG-SEPM convention) examined this area. Participants included prominent students of the Ouachita Mountains, such as Lewis M. Cline, Hugh D. Miser, C. W. Tomlinson, Thomas A. Hendricks, and Allan P. Bennison, as well as the well-known structural geologists Marland P. Billings and John Rodgers. The examiners concluded that a single structural interpretation was not possible. Perhaps tensor specialists can marshal convincing evidence in favor of one hypothesis, but that possibility seems remote. The interpretation that seems most likely to me is outlined in the discourse that follows.

Variety of mapping.—The westernmost part of the ridge where the Arkansas Novaculite crops out, in the N½ sec. 30, T. 3 N., R. 20 E., has been mapped in three different ways:

1. Homocline terminated by strike fault (Miller—*see* fig. 4).
2. Recumbent syncline overturned toward north and bounding a small fenster on its south flank (Bennison).
3. Anticline overturned toward south and bounded on east by transverse fault zone; thrust faulting (major amount) found only along crest or north flank of anticlinal hill (*see* figs. 3, 4).

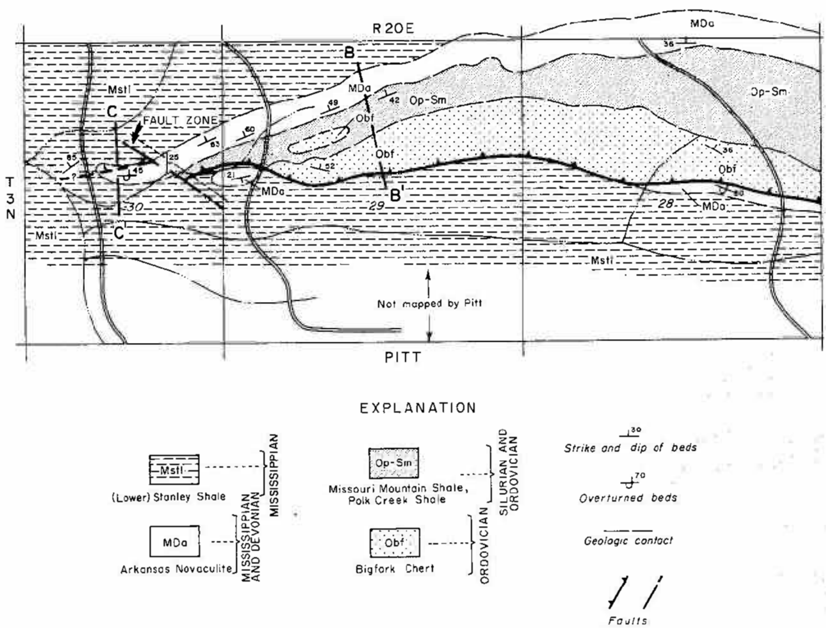


Figure 3. Geologic map of area 1, Potato Hills, by Pitt. Sections B-B′ and C-C′ shown in figure 4.

Homocline terminated by strike fault.—Miller's mapping (1955) was classified as a "homocline" in map appearance (*see* fig. 2). (If the reader wishes to examine the arguments for the fenster hypothesis, he should read the article by Arbenz (1968).) I believe that this ridge area might well be a nosing homocline terminated by a fault, for the

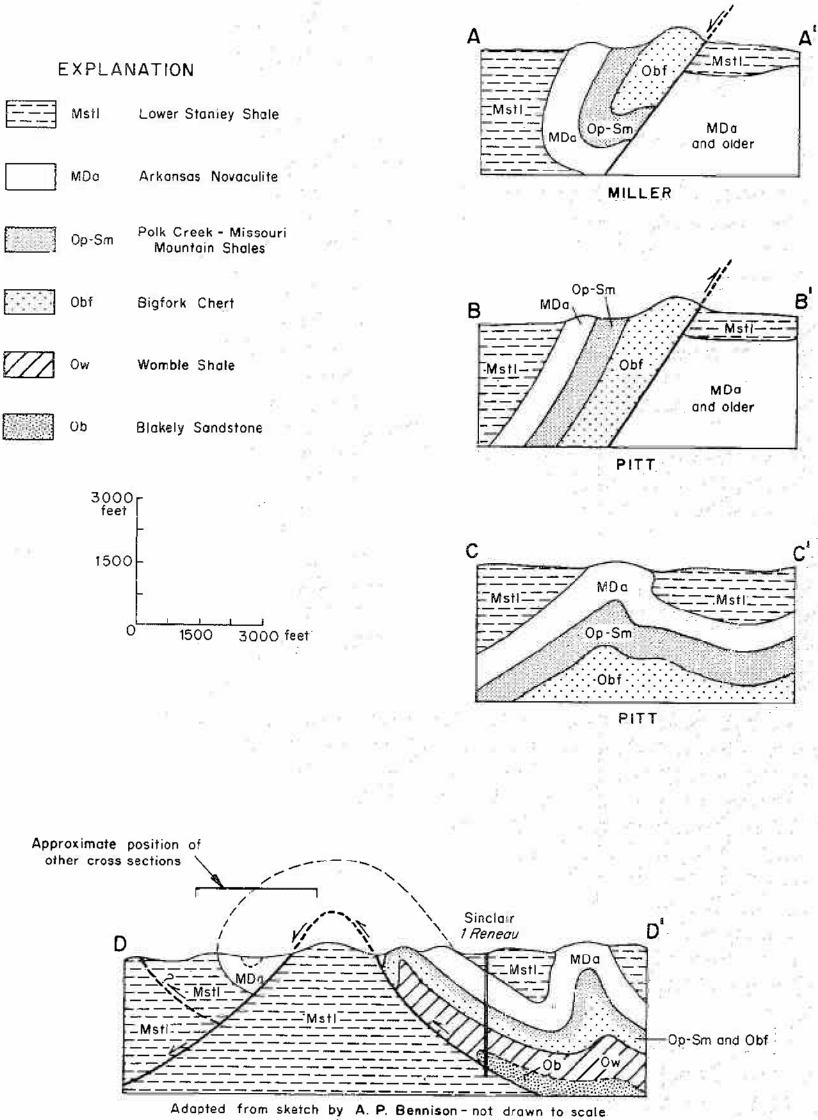


Figure 4. Cross sections in area 1, Potato Hills, by Miller, Pitt, and Bennison. Lines of sections shown in figures 2 and 3.

thrust fault against which Miller "stops" the Bigfork Chert-Arkansas Novaculite sequence is continuous farther eastward. Its demonstrative eastward continuity is a strong argument for its continuation westward to intersect the south side of the westernmost part of the Arkansas Novaculite ridge—and farther westward as well, as Miller mapped it. I conclude that Miller's mapping may possibly be the correct interpretation. I believe, however, that field evidence strongly suggests an anticlinal structure for this westernmost ridge area to be more likely, as explained under the subheading "Anticline overturned toward south."

Recumbent syncline overturned toward north.—This hypothesis, proposed by Allan P. Bennison, includes the idea that a small fenster lies south of an "exceedingly recumbent" syncline, making up the hill area. Bennison believes (pers. comm.) that "the northernmost Arkansas Novaculite outcrop is an upside-down syncline, not in the sense of Miser and followers, but rather as a product of extreme isoclinal and vertical folding and overstretching and not of broad horizontal translation." In other words, the Arkansas Novaculite ridge is a "recumbent nappe with the main nappe or upthrust block being the next Arkansas Novaculite ridge to the south."

He showed on his sketch (fig. 4, *D-D′*) the structural position of the Sinclair No. 1 Reneau well and commented on his examination of the cuttings from this well. "My latest view is that the Reneau test penetrated a short section of Blakely Sandstone after drilling through a probable contorted Womble Shale and possible infolded or infaulted Bigfork Chert, and then bottomed in the Stanley Shale." Bennison concluded that the Arkansas Novaculite ridge of area 1 is the "northernmost isoclinal fold that was overextended vertically and collapsed in recumbent fashion into the south margin of the deeply downfolded Buffalo Mountain syncline." The mapping of this area by Bennison is shown in figure 2.

Anticline overturned toward south.—According to this interpretation, the westernmost part of the ridge in area 1 consists of a westward-plunging anticline bounded on the east by a transverse fault and sheared by one or more thrust faults along the crest and possibly along the north flank. Examination of the rocks at the base of the south side of the ridge indicates that the faulting there is minor at most—certainly folding is the dominant mode of deformation as far as can be determined. Upon the hill itself, in the outcrop area of the Arkansas Novaculite, shearing and folding are both found. Along the south side of this ridge, surface creep is likely to have occurred, for the only outcrops where the Arkansas Novaculite dips northward at a low angle are near its contact with the Stanley Shale. Reasons for believing that this anticlinal interpretation is probably correct follow.

1. Direct evidence of small transverse faults was found along this ridge (*see* fig. 5). This cross-fault zone seems to be confined to a slight topographic sag along the top of the Arkansas Novaculite ridge; east of the sag the ridge is higher and is clearly homoclinal; west of the sag the ridge is mapped as anticlinal. Also supporting the idea

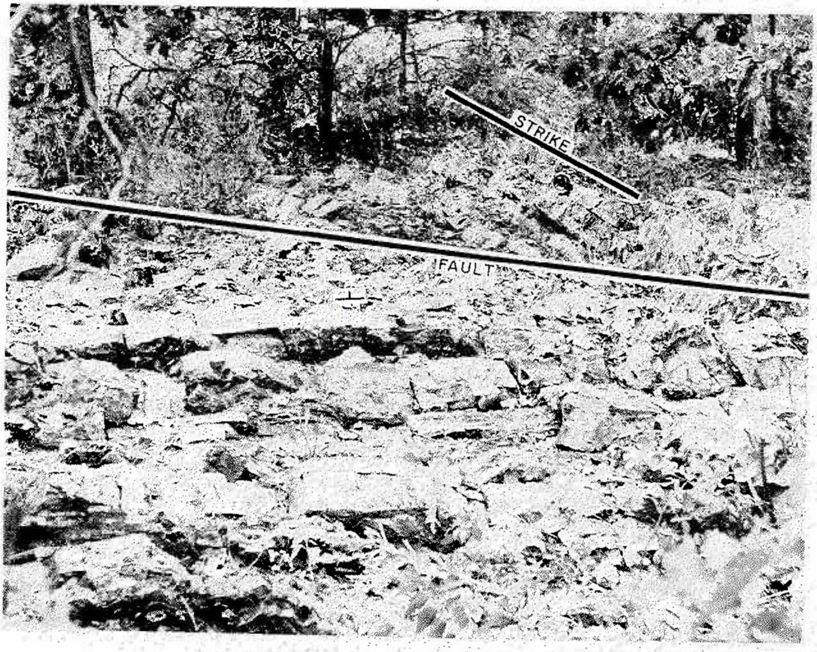


Figure 5. Small transverse fault along crest of Arkansas Novaculite ridge, NE¼ sec. 30, area 1, Potato Hills. Beds in foreground dip north, and in background, across fault, east-southeast. Fault strikes about N. 45° W.

that a significant transverse fault might terminate the homoclinal structure existing east of it is a definite and straight lineation having a northwest strike, which was noted on a large-scale aerial photograph of the ridge. This lineation is believed to represent one of several transverse faults crossing the ridge.

2. As shown in figure 3, the northern Potato Hills ("fenster") fault must bend sharply northwestward only a few hundred yards east of the transverse fault zone that very likely cuts this ridge. This sharp turn northwestward must exist in order that the northern Potato Hills fault be located north of a well-defined anticlinal hill of Arkansas Novaculite in the SW¼ NW¼ sec. 29, as shown in figure 3. Would it not be logical to assume that this northern Potato Hills fault takes another similar bend northwestward across the ridge, rather than westward at the base of it, if there is evidence of transverse faulting across the ridge and of crestal thrust faulting and shearing along the western end?

3. The well-defined anticlinal hill in the SW¼ NW¼ sec. 29, mentioned in paragraph 2 above, is similar to the westernmost part of the ridge in the N½ sec. 30, T. 3 N., R. 20 E., in several ways: both have approximately the same size, height, and direction of elongation. Furthermore, I believe they both exist south of the northern Potato Hills fault and were caused by it. These two hills, therefore, are

"sister structures," differing only in that the westernmost one is broken by minor crestal faulting.

4. C. W. Tomlinson (1959) noted a lack of contrast between the autochthonous core and the supposed allochthonous rim. He commented (p. 7) that the lithologic similarity between these two areas is "perfectly normal if all the folds, inner and outer alike, are members of an autochthonous anticlinorium. But if the rim anticlines are part of a thrust sheet which extends (as claimed) the length of the Windingstair fault and has here moved at least ten miles toward the trace of that fault, is it not a remarkable coincidence that in this fenster, the only place in the 125-mile length of that thrust sheet where the autochthonous rocks beneath it can be seen, these rocks are identical with those in the overlying sheet?"

5. Deformational features found on this ridge end are common along all anticlinal ridges. Miller (1955, p. 38) found that this ridge of area 1 is comparable structurally with one at the west end of the Potato Hills in the NW¼ NW¼ sec. 3, T. 2 N., R. 19 E. These two ridges and these two areas have structural features in common: overturning at the base of each ridge, tight folding at the crest as shown in figure 6, and transverse faulting as seen in figure 5. In fact, if for

Figure 6. Looking east at overturned syncline (which proponents of fenster hypothesis say is inverted anticline) at south base of ridge, area 1, Potato Hills. Arkansas Novaculite, older than Stanley Shale (shown here), crops out directly above (and to north) of this outcrop, along crest of overturned anticline.

the moment we concede that the northern Potato Hills fault does extend from area 1 to the west end of the Potato Hills (as both Miller and Miser mapped it), then compression in area 1 must also be from the north and west because it is demonstratively from the north and west at the west end of the Potato Hills.

6. I believe proponents of the fenster hypothesis must concede that the anticlinal theory is the simpler one and that the fenster hypothesis is the one, therefore, upon which the burden of proof must more heavily rest. In this respect the eastern and western limits of the nappe structure that supposedly exists north of the Potato Hills remain undefined. This problem was recognized by Tomlinson, in the 1959 Ouachita Mountain symposium, and it remains unclear to this day.

References Cited

Arbenz, J. K., 1968, Structural geology of the Potato Hills, Ouachita Mountains, Oklahoma, **in** Cline, L. M. (ed.), A guidebook to the geology of the western Arkoma basin and Ouachita Mountains, Oklahoma: Oklahoma City Geol. Soc. Guidebook, AAPG-SEPM Ann. Mtg. Field Trip, p. 109-121.

Bennison, A. P., and **Johnson, N. L.**, 1959, Supplementary log traverse through Potato Hills, **in** Ouachita field trip guidebook, **part of** Cline, L. M., Hilseweck, W. J., and Feray, D. E. (eds.), The geology of the Ouachita Mountains—a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 65-68.

Miller, B. W., 1955, The geology of the western Potato Hills, Pushmataha and Latimer Counties, Oklahoma: Oklahoma Univ. unpub. M.S. thesis, 55 p.

Miser, H. D., 1929, Structure of the Ouachita Mountains of Oklahoma and Arkansas: Oklahoma Geol. Survey Bull. 50, 30 p.

Powers, Sidney, 1928, Age of the folding of the Oklahoma Mountains—the Ouachita, Arbuckle, and Wichita Mountains of Oklahoma and the Llano-Burnet and Marathon uplifts of Texas: Geol. Soc. America Bull., v. 39, p. 1031-1071.

Roe, N. C., 1955, Geology of the eastern Potato Hills, Pushmataha and Latimer Counties, Oklahoma: Oklahoma Univ. unpub. M.S. thesis, 63 p.

Seely, D. R., 1955, Geology of the Talihina area, Pushmataha, Latimer, and Le Flore Counties, Oklahoma: Oklahoma Univ. unpub. M.S. thesis, 77 p.

Tomlinson, C. W., 1959, Ouachita problems, **in** Cline, L. M., Hilseweck, W. J., and Feray, D. E. (eds.), The geology of the Ouachita Mountains—a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 1-19.

New Theses Added to OU Geology Library

The following M.S. theses were recently added to The University of Oklahoma Geology and Geophysics Library.

Subsurface Stratigraphic Analysis, Morrow (Pennsylvanian), North Central Texas County, Oklahoma, by John William Benton.

The Size Distribution of Quartz Grains in Mudrocks, by Mark G. R. Fleury.

Ground-Water-Pollution Conference to be Held

Research papers indicating new trends or problems in the social or natural aspects of ground-water pollution will be presented at a ground-water-pollution conference to be held October 16-17, 1971, in St. Louis, Missouri. For further information, please write:

Groundwater Pollution Conference
Underwater Research Institute
3411 Hampton Avenue, Suite 202
St. Louis, Missouri 63139

Nation's Strip-Minable Coal Resources Inventoried

In a report recently placed on open file by the U.S. Department of the Interior, coal deposits of the United States that can be economically strip mined by current methods, in compliance with environmental-quality restrictions in the 21 states containing them, have been cataloged by the U.S. Bureau of Mines. The report gives a state-by-state review of strippable coal deposits, listing each state's strippable reserves by county, coal seam, thickness, and sulfur content. Also given are an up-to-date summary of state environmental-quality laws governing surface-mine reclamation and technical definitions of 20 strip-mining terms.

Interested persons can consult open-file copies of "Strippable Reserves of Bituminous Coal and Lignite in the United States" at the Interior Library, 18th and C Streets, N.W., Washington, D.C., and at the following Bureau of Mines offices: 4800 Forbes Avenue, Pittsburgh, Pennsylvania; Federal Center, Building 20, Denver, Colorado; W. 222 Mission Avenue, Spokane, Washington; 450 Golden Gate Avenue, San Francisco, California; 1114 Commerce Street, Room 1908, Dallas, Texas; and Douglas Island, Juneau, Alaska.

OKLAHOMA GEOLOGY NOTES

Volume 31 | October 1971 | Number 5

In This Issue