American Association of Petroleum Geologist
MID-CONTINENT REGIONAL MEETING

Oklahoma City, Oklahoma

November 6, 7, 8, 1963

TECHNICAL PROGRAM

November 7, 1963

Presiding: J. S. "Scot" McDavid, Pres., Okla. City Geol. Society
Victor J. Veroda, Member, Kansas Geol. Society

Invocation and Welcome Richard L. Roberts
Introduction of 1964 Nominees AAPG J. C. Sproule
Address by Chester H. Lauck, Continental Oil

"Some Regional Aspects of the Upper Mississippian — Lower Pennsylvanian of the Mid-Continent."
Edward Barrett, Continental Oil

"The Chester, Morrow and Atoka Series in Western Arkansas and Eastern Oklahoma."
E. A. Merewether*, Bond R. Haley, and Sherwood E. Frezon, U.S.G.S.

"The Atoka Formation in the Central Ouachita Mountains, Oklahoma"
Phillip H. Stark, Mobil Oil

"Marine Transgression of the Atoka Formation in the Eastern Arbuckle Mountains Region, Okla."
C. L. Rowett, University of Alaska; Patrick K. Sutherland*, University of Oklahoma

Round Table Discussion
Speakers and
Clifford B. Branan — Independent
Sherwood Frezon — U.S.G.S.
John H. Marshall — Mobil Oil

November 7, 1963

Presiding: James M. Forgotson, Pres., Tulsa Geol. Society
Lyle E. Case, Pres., Ardmore Geol. Society

"Professional Standards and the Geologist"
Jack A. Taylor, Mobil Oil

"Geologic Maps Versus Other Geologic Theories — Northern Arkansas"
Ernest E. Glick, U.S.G.S.

"Biostratigraphic Correlation of Chester and Morrow Rocks of Northern Arkansas"
Mackenzie Gordon, Jr., U.S.G.S.

Type Section of Morrow Series, Lower Pennsylvanian, Washington Co., Arkansas
Lloyd G. Henbest, U.S.G.S.

"Caney, Goddard, and Springer Palynological Equivalents in Europe"
L. R. Wilson, University of Okla.

Pre-Springeran unconformity and oil accumulation, Madill-Aylesworth trend, Marshall & Bryan Counties, Oklahoma.
W. A. Beckman, Jr. and L. L. Sloss*, Northwestern Univ.

Round Table Discussion
Afternoon Speakers,
Norman Williams — Ark. State Geologist
Richard M. Riggs — Huffman & Malloy
John W. Mayes — L. H. Hunte Oil Div.
Robert W. Allen — Consultant

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Presiding: Delbert J. Costa, Pres. Wichita Geol. Society
Arthur N. Jacques, Pres. Liberal Geol. Society

"Diagenetic Aspects of Lower Morrow Sandstones, Northwestern Oklahoma"
W. L. Adams, Pan American Pet.

"Springer Sandstone Variability"
Lynn C. Jacobson, Standard Oil Co. of Ohio

"Effects of Hinge Line Deposition and Truncation in the Anadarko Basin, Oklahoma"
Robert R. Klinger and Richard D. Ash, Sun Oil Co.

"The Influence of Regional Tectonics and Local Structure on Deposition of the Morrow Formation in the Western Anadarko Basin"
James M. Forgotson, Anthony Statler* & Marthann K. David, Pan American Petroleum

"Kinsler-Morrow Gas Field, Morton Co., Kansas"
Herbert G. Davis, Pan American Pet.

Round Table Discussion
Speakers,
Kenneth E. Gibbons — Independent
Charles E. Weaver — Continental Oil
Gerald C. Maddox — Consultant

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Presiding: J. David Tinsley, Pres. Panhandle Geol. Society
Lloyd Pippin, Member Panhandle Geol. Society

"Aspects of Petroleum Evaluation in Cherokee Group of Southeastern Kansas and Northeastern Oklahoma."
Donald R. Baker, Marathon Oil Co.

"Burgess Sand Reservoirs of Kansas"
F. W. Morgan* and M. Eugene Torline, Morgan & Torline

"Chester-Upper Meramec Problems in Texas and Oklahoma Panhandles"
Ira D. (Don) Taylor — Panhandle Geol. Soc.
Texas Panhandle Sample Log Service

"Identification and Use of Conodonts from Meramecian Rocks (Upper Mississippian) Recovered from Well Cores of Western Kansas"
Thomas Thompson and Edwin D. Goebel*, Kansas Geol. Survey
"Pre-Pennsylvanian Sub Crop of the Mississippian 'Osage' on the Flanks of the Central Kansas Uplift."
Robert M. Euwer
"Pre-Pennsylvanian Structure and Paleogeology of Palo Duro Basin in the Texas Panhandle"
John B. Best, Jr., Amarillo Oil Co.
Round Table Discussion
Speakers, and
George Dobervich, Independent
Robert J. Gutru, Beardmore Drlg. Co.
Wendell S. Johns, Consultant

ABSTRACTS OF TECHNICAL PAPERS

1. Opening Address

CHESTER H. LAUCK

Chester H. Lauck, executive assistant, Continental Oil Company, is an unusual combination of businessman and entertainer.

Better known as "Lum" of the popular radio and movie team of "Lum and Abner," Mr. Lauck travels more than 130,000 miles annually for Conoco from coast to coast. Constantly on the "Conoco circuit," he has talked at countless business meetings and state and national conventions since joining the firm in 1955.

In one week he delivered eight speeches in five different states. He is booked months in advance. And in between appearances, the tireless executive manages to handle special assignments for Continental Oil Company.

Mr. Lauck, although known primarily as a radio and movie personality, was first successful as a banker and businessman. A native of Allene, Ark., he attended grade and high schools in Mena, Ark. A graduate of the University of Arkansas, he majored in journalism and edited the school's humor magazine. Students loved his homespun wit.

Following graduation he became associated with the Union Bank of Mena and later served as manager of the Citizen's Finance Corporation in that City. He was active for several years in the business and civic life of Mena, where he was president of the Lion's Club and the Retail Credit Association and a director of the Chamber of Commerce.

In 1931, together with Norris Goff, his boyhood friend, he formed the team of "Lum and Abner." They began their radio career in Hot Springs, Ark., and in less than two months signed a network contract, broadcasting first from Chicago and later from Cleveland and New York. Their popular folksy humor took them to Hollywood, where in addition to their radio work, they starred in motion pictures for RKO Studios.

"Lum and Abner" are credited with a number of "firsts" in the entertainment world. They made the first major network broadcast in 1933 from Radio City in New York; the first marathon broadcast for charity (more than 12 hours); the initial show for the Mutual radio network; and the first international broadcast by a radio team.

Mr. Lauck also is a director of the American Capitol Life Insurance Company, Houston. In 1962, he received an Honorary Doctor of Laws degree from the Atlanta Law School and a Freedom Foundation Award for a speech entitled, "The Eleventh Hour."

*Indicates Speaker

2. Some Regional Aspects of the Upper Mississippian — Lower Pennsylvanian of the Mid-Continent

EDWARD BARRETT
Continental Oil Co.

The regional aspects of stratigraphy as related to the tectonic pattern development of the mid-continent are discussed. A subjective view as derived from geologic syntheses is expressed in an attempt to illustrate some of the more vexing problems of correlation at and near the Mississippian-Pennsylvanian contact. Emphasis is placed upon the development of the tectonic framework during the late Mississippian and early Pennsylvanian time interval thus exposing the relationships of the "Arbuckle" and "Ouachita" Facies.

EDWARD BARRETT

Edward Barrett is Regional Research Geologist for the Continental Oil Company, having been with the company for the last 15½ years. He has, for the last 12 years, been concerned with exploration involving the central and eastern United States, with emphasis placed upon stratigraphy and tectonic history. He received a B.S. in geology at Nebraska University in 1948, graduating with membership in Phi Beta Kappa, Sigma Xi, and Sigma Gamma Epsilon.

Mr. Barrett majored in meteorology, geography, and the social sciences at Southern Illinois University before World War II. He served with the USAF from 1942 to 1946, starting in meteorology, and mustering out as radar observer, bombardier-navigator.

3. The Chester, Morrow, and Atoka Series in Western Arkansas and Eastern Oklahoma

E. A. MEREWETHER, BOYD R. HALEY, and SHERWOOD E. FREZON

U.S. Geological Survey, Denver, Colorado

Rocks of Chester, Morrow, and Atoka age in western Arkansas and eastern Oklahoma present many unsolved problems, particularly in regional correlation and depositional history.

The Chester Series in this area consists mainly of the Fayetteville Shale and the Pitkin Limestone. The series thickens southward from the Ozark Dome even though the Pitkin Limestone appears to thin southward. The Fayetteville and the Pitkin are probably facies of the same sedimentary unit.

The Morrow Series is composed of the Hale Formation and the overlying Bloyd Formation. The Hale consists of the Cane Hill and Prairie Grove Members. The thickness of the Morrow Series increases southward from the Ozark Dome. In general the thickening trends of the Cane Hill and of the undivided Prairie Grove and Bloyd are parallel. The Cane Hill sedimentary basin received sandy sediments from the northeast and north in Arkansas and northeastern Oklahoma and perhaps from the south in east-central Oklahoma. The Prairie Grove and Bloyd sedimentary basin received sandy sediments from the north and northeast. The dissimilar rock types, including limestone, conglomerate, phosphorite, and coal, within the Morrow indicate a complex depositional history.

The Atoka Formation is the only part of the Atoka Series present in this area. The Atoka thickens southward from the Ozark Dome and the rate of thickening increases sharply southward from at least one eastward-trending hinge line. The percentage of sandstone in the Atoka generally decreases southward, mostly because of a large increase in the amount of shale. The middle part of the formation thickens more rapidly and has generally thicker sandstone units than the upper and lower parts. The Atoka Formation consists of shelf-type sediments in the Ozark Mountains and the Arkansas Valley, and basin- and flysch-type sediments in the Ouachita Mountains.

BOYD R. HALEY

Boyd R. Haley was born in Independence, Oregon on November 25, 1922. He enlisted in the United States Navy in 1941 and was accepted into NROTC in 1944. He received a B.A. degree in geology from Princeton University in February 1948, and joined the U.S. Geological Survey in July 1948. Mr. Haley worked on rocks of Pennsylvanian age in the anthracite fields of Pennsylvania until 1952, and then joined Truman's police action for 17 months. Since 1953 he has been working on the surface and subsurface rocks of west-central Arkansas. Mr. Haley has been a member of the AAPG since 1953 and has contributed to the publications of the U.S. Geological Survey, the Arkansas Geological Commission, and the University of Oklahoma.

E. A. MEREWETHER

E. A. Merewether was born in Portland, Oregon in 1930. He is a graduate of the University of Oregon, receiving a B.S. degree in geology in 1951 and an M.S. degree in 1953. Upon graduation he entered the United States Army and served for 2 years. He has been employed by the U.S. Geological Survey since 1955 and has assisted in studies of uraniferous coaly rocks, the distribution of uranium deposits and igneous rocks, and the geology of the Arkansas Valley basin. During the past 5 years he has mapped the surface geology and investigated the subsurface geology near the eastern end of the Arkansas Valley coal basin. Mr. Merewether has contributed to the publications of the U.S. Geological Survey and the Arkansas Geological Commission. He is a member of the Geological Society of America and the Rocky Mountain Association of Geologists.

SHERWOOD E. FREZON

Geologist, Organic Fuels Branch, U.S. Geological Survey, Denver, Colo. Has held this position since July 1951.

Primarily engaged in mapping studies in northern Arkansas and in subsurface studies in the Arkoma basin in Arkansas and Oklahoma. The results of some of these studies have been published by the U.S. Geological Survey and the Oklahoma Geological Survey.

Received B.S. degree in geology from the University of Michigan in 1950 and did one year of graduate work.

Member of the following professional societies: AAPG, AAAS (Fellow), GSA, Paleontological Society, SEPM, Tulsa Geological Society, and Rocky Mountain Association of Geologists.

4. Distribution and Significance of Foraminifera In the Atoka Formation in the central Ouachita Mountains of Oklahoma

PHILIP H. STARK

Foraminifera in the Atoka Formation were studied to demonstrate their usefulness in stratigraphic zonation and to attempt interpretation of the environment of deposition and paleoecology of the Atoka beds in which Foraminifera occur.

Five stratigraphic sections of the Atoka Formation, the greatest 5,600 feet thick, were described and shale samples were collected for microfaunal analysis. No Foraminifera were found in Atoka sandstones.

The Atoka Formation in the central Ouachitas is typical black shale flysch. It consists of a thick series of alternating beds of fine-grained, graded sandstones and black shales. The lower half of the formation is sandstone facies featured by thick massive sandstones. The upper half of the formation is shale facies featured by thin turbidite sandstones.

The Atoka microfauna is composed of a few conodont specimens, abundant monaxonid, and hexactinellid seliceous sponge spicules, Radiolaria, and a rich assemblage of siliceous arenaceous Foraminifera consisting of 20 genera and 42 species. The foraminiferal assemblage is a typical flysch assemblage dominated by species of four genera: *Thuramminoides, Ammodiscus, Hyperammina,* and a new species of *Agathammina.*

Thurammina diforamens, robust specimens of *Hyperammina bulbosa* and *Reophax fittsi,* small specimens of *Hyperammina casteri,* and *Hyperammina expansa, Ammodiscus constrictus, Glomospira* cf. *"G. pusilla," Textu-*

laria "eximia Eichwald," and *Paleotextularia grahamensis* are diagnostic of lowermost Atoka strata.

Foraminifera were not found in the Atoka sandstone facies where the sandstone:shale ratio exceeds 0.50.

Small specimens of *Hyperammina bulbosa* and of *Glomospira articulosa*, and robust specimens of *Hyperammina casteri* are diagnostic of the lower part of the shale facies. *Spiroplectammina parva, Trochammina rudis, Mooreinella biserialis*, and species of *Ammobaculities* are diagnostic of the lower part of the shale facies.

Only the lower 1,000 to 2,000 feet of the Atoka Formation in the central Ouachitas is Morrowan; all of the overlying Atoka strata are Atokan.

All of the Atoka strata in the Kiamichi Range and the sandstone facies in the Winding Stair Range were deposited in an outer neritic to upper bathyal basin. The allocthonous sandstones were deposited by a combination of overloaded normal marine currents and turbidity currents. The upper shale facies in and north of the Winding Stair Range was deposited in a deep bathyal reducing basin. The allocthonous sandstones were deposited by turbidity currents.

PHILIP H. STARK

Philip H. Stark is an Exploration Geologist for Mobil Oil Company in Wichita, Kansas. After attending the State University of Iowa, he continued studies at Oklahoma University, receiving a B.S. degree in 1958, and completed graduate work in geology at the University of Wisconsin, receiving an M.S. degree in 1961 and a Ph.D. in January, 1963. His experience in the petroleum industry includes stratigraphic studies in the San Juan and Permian Basins, in north central Texas, southern Oklahoma and the Hugoton Embayment in Kansas. Mr. Stark is a member of Sigma Gamma Epsilon, Sigma Xi, S.E.P.M., G.S.A. and A.A.P.G.

5. Evidence for Marine Transgression at the base of the Atoka Formation in the eastern Arbuckle Mountains Region, Oklahoma

CHARLES L. ROWETT
and PATRICK K. SUTHERLAND

University of Alaska and University of Oklahoma

The Atoka Formation in the eastern and northeastern Arbuckle Mountains region represents a transgressive sequence deposited in a sea which advanced generally from east to west, overlapping and partly truncating the subjacent Wapanucka Formation. Implicit in this statement is the suggestion that slight eastward tilting of Wapanucka strata took place before or during the Atoka transgression. The depth and vigor of marine erosion along the advancing shoreline was affected by the variable relief of the invaded areas, and the basal deposits of the Atoka Formation reflect this variation.

The character of the basal beds of the Atoka Formation is highly variable throughout the area but consist commonly of interbedded shales, siltstones and cross-bedded sandstones. In Coal and Johnston Counties laterally discontinuous limestone conglomerates occur at the base. This conglomerate is up to five feet thick at Delaware Creek and includes clasts of boulder size. Petrographic, petrofabric and paleontologic studies were made of both the limestone clasts which make up this conglomerate and also of the limestones which occur in the underlying Wapanucka Formation. The results show that the basal Atoka conglomerate was derived almost entirely from erosion of the underlying limestones of the Wapanucka Formation. Measurement and evaluation of the degree of roundness and the orientation of limestone clasts in the conglomerate indicate that this rock had its origin as an accumulation of gravel along an advancing or transgressive beach which trended generally northwest to north.

Visible relief along the contact of the Atoka and Wapanucka Formations does not exceed two or three feet at any single outcrop but field relations in one area suggests erosion to a depth of at least 30 feet locally. The limestone at the top of the Wapanucka Formation show local oxidation to a depth of one foot.

PATRICK K. SUTHERLAND

Patrick K. Sutherland is Associate Professor of Geology at the University of Oklahoma where he teaches courses in biostratigraphy, stratigraphy and paleoecology. He received his B.S. Degree in Geology from the University of Oklahoma in 1946 and his Ph.D. degree in Geology from Cambridge University, England in 1952. He worked for the Phillips Petroleum Company in northwest Canada from 1946 to 1949 and in west Texas from 1952 to 1953. He was on the faculty of the Department of Geology at the University of Houston for four years before joining the faculty of the University of Oklahoma in 1957.

Dr. Sutherland has published papers on aspects of Mississippian and Pennsylvanian stratigraphy and paleontology in northeast British Columbia, northern New Mexico and Oklahoma. He is a fellow of the Geological Society of America and the Geological Society of London and a member of the American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, the Paleontological Society, the Oklahoma City Geological Society and various other organizations.

CHARLES LLEWELLYN ROWETT

Charles Llewellyn Rowett was born at Miami, Arizona, June 11, 1931. The son of a mining engineer, his early years were spent in mining regions such as the Miami-Globe copper district of Arizona, the Cerro de Pasco copper mines of Peru, and the tin mines at Potosi, Bolivia. His family subsequently moved to Mexico City, where he attended the American High School. His high school training was completed at the Peacock Military Academy in San Antonio, Texas. He completed a Bachelor of Science at Tulane University in New Orleans in 1958 and a Master of Science in geology at that institution in 1959. His Ph.D. in geology was taken at the University of Oklahoma in 1962.

Dr. Rowett is primarily interested in the paleontology and stratigraphy of rocks of Carboniferous age, and most of his research and publications have been in this field. His doctoral dissertation was a biostratigraphic study of a Lower Pennsylvanian Formation in Oklahoma. He has taught geology at Tulane University, the University of Oklahoma, and the University of Tulsa. He is at present a member of the Department of Geology at the University of Alaska at College, Alaska.

Dr. Rowett is a member of Sigma Xi, the American Association of Petroleum Geologists and the Paleontological Society.

6. Professional Standards and the Geologist

J. A. TAYLOR

All professions have been undergoing a period of critical self examination in recent times. Some are seeking a definition of their objectives; others, their area of endeavor; and still others their relative position among all this. The profession of geology, if we may call it a profession, is one of those undergoing self examination. Many consider that it suffers from considerable indecision of purpose and definition in the area of its application. The admixture of two separate approaches in the practice of petroleum geology leads to some difficulty in defining the profession. On one hand, we have the idea man, the scientist if you may, whose innovations generate exploratory ventures far removed from normal control data. On the other hand, we have the more usual case of the geologist who deals with more information and compiles it into interpretations from which action is taken. These interpretations may vary from exploratory ventures to field development problems. The latter geologist has a practice in more direct contact with other professions and the shifting economic forces now existent, and he believes he is unduly assailed by these forces and that his profession has not advanced as well as it should.

The importance of ethical conduct and appropriate educational preparation has become a subject of increasing attention of late. The geologist is seeking ways to upgrade his profession. The presence of some directing force or object of leadership is usually required for a profession to advance or elevate itself. The geological profession has no spokesman that can serve this purpose. Some are attempting to solve this problem by forming organizations for regulating professional conduct and definition of professional qualifications. These, emerging throughout the country, demonstrate the interest among geologists in improving their condition. Some of these adventures appear ill-advised, but others appear to have promise.

The college preparation of many geologists is inadequate. The training received during the initial work years of many is incomplete. In response to a temporary high demand for manpower, too many of our universities allowed their standards to depreciate following World War II and the Korean conflict. Industry must share some of the blame for their pressure on the schools to supply this demand, and then for permitting ineptitude in their own ranks.

But these things are behind us and we can't change them now. Strong action is required to remedy the situation. The geologist must probe and examine himself, drag his faults out in the open, and then do something about them. It will do no good to place the blame on others for his condition. The geologists have not asserted themselves as a group; they are divided. The geologist has prided himself on his independence of thought and action, and this is admirable. But if he continues to express this freedom as he has without more responsibility for his standards and definition of purpose he will accomplish nothing. The profession of geology, or science of geology if you must, has been encroached upon or had some lobes of its area of endeavor severed entirely by other professions that are more clearly defined as to their purpose and practice.

The major company employee should not consider that the problem of professional standards is one peculiar only to the consultant or independent geologist. Geologists will, in the final analysis, stand or fall together, and the company geologist does not occupy a position that is unassailable by those problems that bedevil the consultant or independent geologist. Each geologist has a moral obligation to advance and improve his profession and the quality of his science.

Now all has not been sombre. The petroleum geologist has had a remarkable history of success and has invested more hours and energy than most professions in accomplishing this success. His has not been the forty-hour work week. He, with the geophysicist, has provided the framework of ideas, the definition, and direction of an exploration and development program that has continued to inject new reserves into the producing systems of this country and others for half a century. And he has flaunted this success repeatedly in the face of the purveyors of petroleum shortages and doom. He will continue to lead in this endeavor. Look about you bystander, note that the geologist is doing something about his condition without resort to the charity of government or others.

JOHN ALLEN TAYLOR

John Allen Taylor. Born April 22, 1926, Oklahoma City, in pioneer oil family of Oklahoma. MS of Geological Engineering from University of Oklahoma. Naval Service 1943-46 in South Pacific and discharged Lt. (jg). Shell Oil Company 1946-47 in Rocky Mountains; Lane Wells Company 1947, Wichita Falls; instructor of geology 1948-49, University of Oklahoma; Magnolia Petroleum Company 1949-54 at San Antonio, Houston and Dallas; district geologist for Magnolia in Lake Charles, Louisiana, and Mt. Vernon, Illinois 1954-59; district exploration superintendent, Mobil Oil Company, Oklahoma City 1959 to present. Member Executive Committee and Chairman of Professional Standards Committee of Oklahoma City Geological Society, Vice-Chairman of Research Committee of Interstate Oil Compact Commission, served as A.A.P.G. district representative and President of South Louisiana Geological Society, Sigma Xi, Sigma Gamma Epsilon, AIME, SEG.

7. Geologic maps versus other geologic theories — northern Arkansas

ERNEST E. GLICK

U.S. Geological Survey, Denver, Colo.

Detailed geologic mapping and paleontological investigations in an area of about 500 square miles in north-central Arkansas have indicated that rock-stratigraphic units and faunal zones coincide for the most part. However, at least one important discrepancy has not been entirely resolved.

Field mapping indicates that the lowermost member of the Hale Formation, the Cane Hill, is bounded above and below by regional unconformities and that the member grades from nearshore marine deposits to the north and northwest into open marine deposits to the south. A brachiopod fauna is present in the northern facies and a goniatite fauna in the southern facies—locally within 5 miles of each other.

The theory now accepted by many paleontologists indicates a Pennsylvanian age for the northern brachiopod fauna and a Mississippian age for the southern goniatite fauna. This theory requires either that two discrete rock units of different ages have been lumped together by the field mappers or that the single rock unit mapped is transgressive.

North-central Arkansas is 200 miles from the type Chester Series in southern Illinois. The Upper Mississippian and Lower Pennsylvanian sequences in those two areas are somewhat similar—the Lower Pennsylvanian of Arkansas does, however, contain more marine beds. In 1904 Adams and Ulrich placed the Mississippian-Pennsylvanian boundary in northern Arkansas at the unconformity at the top of the Pitkin Limestone, which marks the base of the Cane Hill Member. Ulrich considered the post-Pitkin regional unconformity to correspond with the unconformity at the top of the Chester sequence in its type area of southern Illinois. Most geologists have accepted Ulrich's theory and field evidence alone would still tend to support it; paleontological evidence apparently does not.

ERNEST E. GLICK

Ernest E. Glick is a geologist with the United States Geological Survey, Denver, Colorado. He received a B.A. degree in 1949 from the University of Southern California and attended the University of Illinois 1949-1951. He has been employed by the U.S. Geological Survey since 1951.

Mr. Glick, prior to being transferred to Denver, spent 8 years in Tulsa, Oklahoma where he was engaged in regional subsurface studies and quadrangle mapping in northern Arkansas. He is a member of the AAPG, GSA, and several local societies.

8. Biostratigraphic correlation of Chester and Morrow rocks of northern Arkansas

MacKENZIE GORDON, JR.

U.S. Geological Survey, Washington, D.C.

The Chester Series is defined on the section near Chester, Illinois. Rocks of northern Arkansas that contain Chester faunas include, in ascending order, the Ruddell Shale(?), Batesville Sandstone, Fayetteville Shale, Pitkin Limestone and, locally, a shale overlying the Pitkin. The base of the Chester Series generally is placed at the base of the Batesville Sandstone, which contains *Agassizocrinus* sp. and *Diaphragmus fasciculatus* (McChesney). But because the *Goniatites granosus* zone is common to the Ruddell Shale and Batesville Sandstone, the base of the Ruddell might be preferable. Absence of *Agassizocrinus* and *Diaphragmus* in the Ruddell might be due to facies, rather than to time control.

The Morrow Series is defined on the section in Washington County, Arkansas. The Morrow rocks consist of the Hale Formation and the Bloyd Shale. The Cane Hill Member, the lower member of the Hale, contains the *Hustedia miseri* fauna down to its basal conglomerate. In Newton and Searcy Counties, however, the lower third of a shale in the stratigraphic position of the Cane Hill contains a fauna of approximately 100 invertebrates, only one of which is common to the Morrow of Washington County. This fauna is more like that of underlying Pitkin Limestone and is Mississippian in age.

Correlations with northwest European sections by means of goniatites show that the Ruddell Shale, Batesville Sandstone and, locally, part of the Fayetteville Shale are late Visean in age. Most of the Fayetteville Shale, the Pitkin Limestone and, locally, part of the shale above the Pitkin are early Namurian in age. What rocks correlate with middle Namurian rocks is open to question, but these are probably represented in the Hale Formation. Upper Namurian equivalents are found in the upper part of the Hale Formation and in the Bloyd Shale.

MacKENZIE GORDON, JR.

Born April 4, 1913 in San Francisco, California. Inherited an interest in geology and paleontology from Grandmother, now 103 years of age, who as a girl had known Powell, Russell, and other early members of the U.S. Geological Survey. Received A.B. in Geology from Stanford University, Calif. in 1934, continuing on in graduate work there in 1935 and 1936. From late 1936 to mid-1937, was geologist for Nevada Rare Metals Corp. Joined the U.S. Geological Survey in September 1939 and continued with that organization up to the present. In 1952, married Barbara Ann Walker of Banes, Cuba.

U.S.G.S. career varied, beginning in the high Sierra and its foothills mapping tungsten deposits. In March 1940, began work on Carboniferous stratigraphy in the American Midcontinent, studies which have continued intermittently to present time. In charge of field work in large federal wartime exploration program for aluminum ore in central Arkansas. Foreign assignments included a study of the geology and metalliferous deposits of the Maimon-Hatillo district, Dominican Republic, from November 1941 to June 1942, stratigraphic studies in the Parana basin of Brazil from October 1945 to June 1948, and a period as Professor of Stratigraphy and Sedimentology at the University of Rio Grande do Sul in Porto Alegre, Brazil in 1959 and early part of 1960. Received a citation in 1962, along with other American geologists, for his Brazilian work.

Principal field since 1950 is Late Paleozoic stratigraphy and paleontology, specializing in cephalopods and brachiopods, particularly in the Ozark region of northern Arkansas and Great Basin of Nevada and Utah. Recent publications include the following.

1957, Mississippian cephalopods of northern and eastern Alaska: U.S. Geol. Survey Prof. Paper 283, 61 p., 6 pls., 26 figs.

1959, (with J. I. Tracey, Jr. and M. W. Ellis), Geology of the Arkansas bauxite region: U.S. Geol. Survey Prof. Paper 299, 268 p., 39 pls., 63 figs.

1959, (with R. H. Flower), More Mississippian belemnites: Jour. Paleontology, v. 33, no. 5, p. 809-842, pls. 112-116.

1960, Some American Midcontinent Carboniferous cephalopods: Jour. Paleontology, v. 34, no. 1, p. 133-151, pls. 27, 28, 3 figs.

1962, Species of Goniatites in the Caney Shale of Oklahoma: Jour. Paleontology, v. 36, no. 2, p. 355-357, 1 fig.

(in press) Carboniferous cephalopods of Arkansas: U.S. Geol. Survey Prof. Paper 460.

(in press) California Carboniferous cephalopods: U.S. Geol. Survey Prof. Paper 483A.

9. Type Sections of Morrow Series, Lower Pennsylvanian, Washington County, Arkansas

LLOYD G. HENBEST

U.S. Geological Survey, Washington 25, D.C.

The type section of the Morrow Series, Lower Pennsylvanian, in Washington County, Arkansas, contains an abundant marine and land fossil record in a relatively undisturbed stratigraphic sequence—a combination not found elsewhere in thicker and more complete sections of Early Pennsylvanian age. The type Morrow lies within a similarly

varied and relatively undisturbed sequence of fossiliferous formations of Mississippian, Pennsylvanian, and Early Permian age that are overlapped like shingles from the Ozark uplift to central Oklahoma and Kansas. These properties have made the type Morrow and adjacent series a standard of reference for late Paleozoic stratigraphy. The term Pennsylvanian was first applied by H. S. Williams, 1891, in Washington County.

The type Morrow consists of marine clastics and limestone and minor units of terrestrial clastics and coal. The sedimentary content and structures are marked with the usual channeloid deposits and lateral variations that are to be expected on a marine shelf subjected to interrupted sinking, variations in sea level, and beginnings of heavy, Pennsylvanian alluviation from the north. Lateral variations pose numerous problems in mapping Morrow units outside the type area.

Secondarily enlarged quartz sand is abundant. The source of the free silica is a problem, considering the seeming maturity and recycled nature of the original Morrow sediments together with the evidence against outside sources or hydrothermal action, the extreme rarity of chert, and the normal occurrence of silica-fixing organisms. The suggested source is diffused ash, but the only direct evidence for ash is a small area of chalcedony that lacks shards but resembles the seat rock of bentonite beds. The diagenesis of supposedly magnesian calcite shells of *Ottonosia*, *Osagia*, and sedimentary Cornuspiridae is suggested as the cause for exfoliation of the Kessler Limestone Member of the Bloyd Formation. Interpenetration of ooliths by micrstylolitic action gives a measure of shrinkage in some limestone beds and suggests the cause for "bread crumb" textures in some limestones. The abundant spoor of arthrophycids and *Conostichus* in the Hale Formation and of *Scalarituba*, *Laevicyclus*, and *Taonurus* in the Atoka show that these fossils are not necessarily indicators of deep, barren, marine bottoms, as some specialists on flysch deposits have urged.

LLOYD G. HENBEST

Lloyd G. Henbest, U.S. Geological Survey, was born on a farm 5 miles south of Cassville, Missouri, January 9, 1900. He claims that his first geologic employment began at an early age behind the plow, tilling refractory, flinty soil derived from Mississippian chert.

After graduating at the University of Arkansas in 1924 and at the University of Kansas in 1927, Henbest became an assistant of G. H. Cady on the Illinois State Geological Survey in 1926. In 1928, he served as a consultant of the Mississippi Coal Corporation; married Fanny M. Ross, concert pianist; and the same year began graduate study at Yale where with Carl O. Dunbar he published "Pennsylvanian Fusulinidae of Illinois". In 1930, he joined the U.S.G.S. as an assistant of J. A. Cushman for work on Foraminifera. On the U.S.G.S. his interests have also included general problems in historical geology, and numerous publications have resulted.

He is past-President and a founder of the Cushman Foundation for Foraminiferal Research. In 1954, he received the SEPM award for the best paper in the Journal of Paleontology; in 1956 the citation of Distinguished Alumnus of the University of Arkansas; and in 1959, the Haworth Citation, University of Kansas. He has given more than 30 shows of pictorial photographs before audiences of the National Park Service and various art, photographic and other societies.

10. Caney, Goddard, and Springer Palynological Equivalents in Europe

L. R. WILSON
Research Professor of Geology, University of Oklahoma

The Caney, Goddard, and Springer Formations of the Ardmore, Oklahoma region have been variously assigned to Mississippian and Pennsylvanian ages. Invertebrate fossil studies have not been in entire agreement, therefore an attempt has been made to determine the ages of these formations by palynological assemblages. Comparative studies of the fossil spores in the three Oklahoma formations with Lower Carboniferous assemblages from Great Britain, Spitzbergen, and Russia indicate that the Caney, Goddard, and Springer units have considerable palynological similarity with Visean and Namurian A.

L. R. WILSON

L. R. Wilson received his academic training at the University of Leeds, England, and the University of Wisconsin, where he received the Ph.D degree in 1935. He has taught at the University of Wisconsin, Coe College, the University of Massachusetts, and New York University, as well as the Geological Center, Nova Scotia Bureau of Mines, and Massachusetts Institute of Technology. As a consultant, he has served several oil companies in both North and South America. In 1953, Professor Wilson was leader of the Greenland Expedition of the American Geographical Society. At present, Professor Wilson is on the staff of the Oklahoma Geological Survey and is Research Professor of Geology at the University of Oklahoma.

11. Pre-Springeran Unconformity and Oil Accumulation, Madill-Aylesworth trend, Marshall and Bryan Counties, Oklahoma

W. A. BECKMAN, JR., and L. L. SLOSS
Evanston, Illinois

Previous reports on the complex Madill-Aylesworth area of Marshall and Bryan Counties, Oklahoma, have emphasized the role of faulting in explaining relationships between the Goddard Shale (Lower Springer) and older stratigraphic units. The writers find a systematic pattern at the base of the Goddard such as would be formed by deep erosion of a pre-Springeran anticline. Thick sections of Goddard Shale are found in off-structure positions and in a belt presumed to occupy a deep valley along the axis of the old anticline. Detailed cross sections and reconstructions to an early Pennsylvanian datum indicate an axial valley over 2500 feet deep (cut largely in Simpson and Arbuckle) between strike ridges formed by the limbs of the anticline.

According to the writers' hypothesis the area had a very considerable erosional relief at the time of onlap of Goddard sedimentation and, in fact, had a strong resemblance to the "sheepherder structures" exposed today in the Rocky Mountain province. Sedimentary reflections of the buried topography are not obvious. However, there are isolated instances of conglomerate with pebbles of older units at the base of the Goddard. Further, productive sands within the Goddard form a trend along the southerly limb of the assumed anticline as though reflecting the influence of a buried topographic ridge. The absence of a similar sand

build-up on the northern flank of the old structure is partially explained by the depth of pre-Dornick Hills erosion.

Major high-angle faulting is a prominent feature of the present-day structure, but the extent of faulting associated with the pre-Springeran structure is difficult to estimate. If there was active fault movement with the older structural development, the numerous Simpson oil accumulations are primarily fault traps. However, if faulting was unimportant in pre-Springeran time the Simpson pools represent truncation traps, presumably filled by younger migration.

W. A. BECKMAN, JR.

W. A. Beckman, Jr., has been a geologist with the Evanston Exploration Corp. since graduation from Northwestern University in 1958. In addition to work in southern Oklahoma, he has been actively engaged in the geology of the Michigan Basin and with the crystalline rocks of central Wisconsin.

L. L. SLOSS

L. L. Sloss has been on the faculty of Northwestern University since 1947, combining an interest in the geology of southern Oklahoma with other more strictly academic pursuits.

12. Diagenetic Aspects of Lower Morrow Sandstones, Northwestern Oklahoma

W. L. ADAMS

Diagenesis has profoundly altered the reservoir capacity of some Lower Morrowan sandstones in the Anadarko Basin. Definition of sandstone geometry, depositional environment, etc., comprise only part of the information necessary to intelligently explore for hydrocarbons in these rocks.

Bulk of the Lower Morrow sandstones were deposited in a marine transgressive sea. Two basic types of sandstone are recognized: Type I is a very nearshore, clean, well sorted, nonglauconitic, noncalcareous sandstone deposited in a high energy environment; Type II is a slightly offshore facies of Type I, deposited under lower energy conditions and is normally poorly sorted, "glauconitic", calcareous and sometimes shaley.

Petrographic analyses indicates Type I sandstones have either (1) extreme pressure solution and no permeability, or (2) moderate to minor pressure solution with secondary quartz overgrowth cement. These rocks are generally permeable when medium to coarse grained and impermeable if fine grained. Upper and lower edges of some sand bodies are tightly cemented with $CaCO^3$ apparently through ionic impedence at the sand-shale boundary.

Type II sandstones have been diagenetically altered by minor secondary quartz overgrowths and pressure solution, extensive carbonate cementation, and some authigenic clay. Commercial permeability is associated with secondary leaching of carbonate cements. Such reservoirs have random shapes and are difficult to predict or evaluate.

A qualitative petrographic rock fabric classification based on relative degree of pressure solution, type of grain outlines and contact, amount and type of cement and porosity is useful in mapping their geographic distributions. Integration of this type data in conjunction with normal subsurface exploration methods is beneficial for the Lower Morrow in the area studied.

WILLIAM L. ADAMS

William L. Adams was born May 29, 1929, in Clay Center, Kansas. He was granted the BS degree in geology from the University of Kansas in 1951 and an MA degree in geology from the University of California at Los Angeles in 1956. He served as a Naval Officer during and after the Korean War from 1951 through 1954.

Mr. Adams joined the Pan American Petroleum Corporation in 1956 in their exploration department, Wichita, Kansas. In 1958 he moved with Pan American to Liberal, Kansas, where Anadarko Basin activities were consolidated in one office. Much of his time has been spent studying the Morrowan rocks throughout the Anadarko Basin. He currently is a geological supervisor for Pan American as a project geologist in the Liberal Exploration District.

13. Springer Sandstone Variability

L. C. JACOBSEN

In the general Velma district of Southern Oklahoma Springer sandstones occur in five moderately well defined zones in the upper half of a thick dark shale sequence. These sandstones are broadly similar in that they are very fine to fine grained, and the only abundant constituents are quartz and clay. In detail, however, they show a great deal of diversity.

Two end member types can be recognized. The first is massively bedded, highly quartzose, fine-grained, and commonly is fossiliferous or has calcite cement. The second is thin-bedded, shaley, very fine grained, non-fossiliferous, and commonly has siderite cement. The first type makes up the oil reservoirs of the area, and each oil field appears to be bounded by a transition from the first to the second type.

A striking correlation exists between the character of the sandstones and their structural position. The best development of the reservoir sandstones is on the larger uplifts, and on each local uplift the better reservoirs are characteristically in the structurally higher positions.

As an interpretation of these relationships it is suggested that appreciably topographic relief was present in the basin during sedimentation, and that the type 1 reservoir sandstones were deposited on the topographic highs, and the type 2 sandstones in the lows. Further, the systematic relationship of sandstone character to structure suggests that much of the basin-floor relief was caused by early structural growth.

L. C. JACOBSEN

L. C. Jacobsen joined Sohio Petroleum Co. in 1955 as Senior Research Geologist. Since 1960 he has been Assistant to the Senior Vice President in charge of Exploration and Production. Previous to 1955 he was Assistant Professor of Geology at the University of Kentucky.

His education was received at the University of Minnesota (B.A.), Oklahoma University (M.S.), and the Pennsylvania State University (Ph.D.). His professional interests include petroleum geology, sedimentation, statistics, and petroleum economics.

14. Effects of Hinge Line Deposition and Truncation in the Anadarko Basin, Oklahoma

RICHARD D. ASH and ROBERT KLINGER

Hydrocarbon accumulation along the northeast flank of the Anadarko Basin, Oklahoma, is found in stratigraphic traps formed by (1) truncation and (2) deposition, adjacent to the hinge line of the basin.

Production from the Mississippian Chester formation

indicates a relationship between hydrocarbon accumulation and the truncation of porous limestone units within the formation. Possible productive trends can be projected by determining which units of the Chester are penetrated below the Pre-Pennsylvanian unconformity.

Morrow sandstone hydrocarbon accumulation is found in a series of "shingel type" sands deposited as the transgressing Morrow seas crossed the area. The best potential stratigraphic traps were deposited basinward from the hinge line. Here, the sandstones are generally thicker, more abundant and pinch out more abruptly than those encountered on the shelf.

The study area presents an excellent potential for future exploration. In addition to Morrow and Chester production, there are at least 5 younger and older zones which produce hydrocarbons from stratigraphic traps.

RICHARD D. ASH

Richard D. Ash graduated with a B.S. degree from the University of Oklahoma in 1953.

He was employed with Gulf Oil Corporation from July, 1955, until December, 1957, when he joined Sun Oil Company.

ROBERT KLINGER

Robert Klinger is a native of Adrian, Michigan. He graduated with a B.S. degree in Geology from the University of Michigan in 1950 and joined Sun Oil Company in 1952 where he is presently District Geologist for Northwest Oklahoma.

15. The Influence of Regional Tectonics and Local Structure on Deposition of the Morrow Formation in the Western Anadarko Basin

JAMES M. FORGOTSON, JR.
ANTHONY T. STATLER*
MARTHANN DAVID
Pan American Petroleum Corporation
Research Center, Tulsa, Oklahoma

In the panhandles of Texas and Oklahoma, the Morrow Formation is the basal transgressive, predominantly clastic unit of the Pennsylvanian system unconformably overlying the Mississippian. The upper and lower boundaries are delineated by the base of the "Thirteen-Finger" limestone, an electric log marker, and by the Pennsylvanian-Mississippian contact. The panhandle area is bordered on the west by the Sierra Grande uplift and on the south by the Amarillo uplift. The major tectonic features within the area are the western Anadarko basin, southern Hugoton embayment, Cimarron arch-Keyes dome, Dalhart basin, and a number of smaller structures in the unstable belt marginal to the deeper Anadarko basin.

The Morrow Formation was subdivided into three lithologically distinct units recognizable on electrical and sample logs. The lower unit, a wedge of predominantly clastic material, is overlapped by the relatively calcareous middle unit. In the predominantly shaly upper Morrow, marine or lagoonal shales grade upward into nonmarine shales and coals near the top of the unit. This suggests filling of the basin which caused a temporary retreat of marine environments prior to renewed transgression in the post-Morrow units.

Regionally, Mississippian rocks are progressively truncated away from the basin axis. The absence of Chesterian beds over several structures suggests local pre-Pennsylvanian movement. Lower Morrow sand accumulations correlate strongly with the configuration of the pre-Pennsylvanian surface. Apparently, significant structure existed before, or developed during, deposition of the lower unit. Isopach and structure data indicate continued activity of these structures throughout Morrow deposition.

Distribution of coarse clastics within the predominantly fine clastic Morrow Formation suggests one source of sands west of the panhandle area and a second source to the northeast. In the lower unit widespread sheet sands and sands parallel with trends of early Morrow shorelines are interpreted as nearshore marine sediments deposited as the early Morrow sea overlapped onto the shelf area. The thin, lenticular upper Morrow sands are interpreted as having been deposited by a complex distributary system flowing southeastward toward the basin axis.

JAMES M. FORGOTSON

James M. Forgotson, Jr. is a graduate of the University of Texas, Washington University, and Northwestern University where he earned a Ph.D. in Geology in 1956. Since 1956 he has been in the Research Department of Pan American Petroleum corporation in Tulsa. He has published on the stratigraphy and depositional history of Jurassic and Lower Cretaceous rocks of the Gulf Coast, quantitative mapping techniques, stratigraphic nomenclature, and applications of electronic computers to exploration problems. He is President of the Tulsa Geological Society for 1963-64.

ANTHONY T. STATLER

Anthony T. Statler holds A.B. and M.S. degrees from Vanderbilt University and also did graduate work at Northwestern University. His professional career includes geologic mapping and economic work for the Tennessee Division of Geology and topographic surveying with the U.S. Army Corps of Engineers. In 1958 he joined the Research Department of Pan American Petroleum Corporation where he has worked largely in the fields of stratigraphy and sandstone petrology.

MARTHANN K. DAVID

Marthann K. David is a native of Tulsa, Oklahoma, and a graduate of the University of Texas. From 1943 to 1944 she was a geologist for Carter Oil Company in Tulsa and since 1944 she has been Research Geologist for Pan American Petroleum Corporation. Her field of interest is primarily subsurface correlations and interpretations.

16. Kinsler Morrow Gas Field — Morton County, Kansas

HERBERT G. DAVIS

The Kinsler Gas Field in Morton County, Kansas, is located in the Hugoton Embayment on a faulted structure and covers a productive area of approximately 14,000 acres. The primary gas production is from stratigraphic traps in the Pennsylvanian Morrow sandstones flanking the structure and on the downthrown side of the "Kinsler Fault". Structural Pennsylvanian Des Moines, Pennsylvanian Atoka, and Mississippian St. Louis carbonates account for the remainder of the reserves. Oil reserves are negligible to date. Field rules for well spacing and allowables have been established by the Kansas Corporation Commission. The gas is currently being purchased by the Kansas Power & Light Co. for an intrastate market.

HERBERT G. DAVIS

Herbert G. Davis was born June 23, 1930 in Buffalo, New York. He was granted the BS degree in geology from the Oklahoma State University in January 1953. He served as a Military Geologist in the U. S. Army Corps of Engineers in Heidelberg, Germany from 1953 through 1955.

Mr. Davis joined the Pan American Petroleum Corporation in 1955 in their exploration department, Central Division, Wichita Kansas District. In 1959 he moved with Pan American to Liberal, Kansas where Kansas, Northwest Oklahoma, Oklahoma Panhandle, Texas Panhandle and Southeast Colorado activities were consolidated in one office. He currently is the Kansas and Southeast Colorado operations geologist.

Mr. Davis is a member of the A.A.P.G., Kansas Geological Society, Oklahoma City Geological Society, Vice President of the Liberal Geological Society, and Sigma Gamma Epsilon.

17. Aspects of Petroleum Evolution in the Cherokee Group of Southeastern Kansas and Northeastern Oklahoma

DONALD R. BAKER

Marathon Oil Company, Littleton, Colorado

Recent studies by physicists, chemists, biologists, and geochemists have yielded new information which has important implications to concepts of petroleum evolution. For example, studies of carbon isotopes in sediments and crude oils suggest that terrestrial plants, instead of marine plants and animals, may be the principal primary substance from which petroleum is derived. Further, the discovery of hydrocarbons in Recent sediments demonstrated the early formation and availability of petroliferous materials in depositional basins. However, characterization has revealed differences in the nature and abundance of hydrocarbons in Recent sediments compared to crudes and ancient rocks, indicating that modification and formation of hydrocarbons during diagenesis may be essential for the development of a source rock.

The distribution and character of hydrocarbons in rocks of the Cherokee Group indicate that some environments generate more hydrocarbons than others, confirming the geologic opinion that there is a range of variation in the nature of petroleum source beds. However, studies of the Cherokee Group indicate that the recognition and evaluation of source rocks on the basis of absolute hydrocarbon content may be an oversimplification because the hydrocarbons may not be indigenous, or may have formed subsequent to primary migration, or that some rocks may have yielded only a small part of their hydrocarbons. Finally, comparison of crude oil-source rock pairs in the Cherokee Group indicates that the development of geochemical correlation techniques will be complicated because primary migration is inefficient, selective, and probably causes considerable modification of hydrocarbons en route.

The problem of petroleum evolution seems ripe for an integrated attack by geologists supported by physicists, chemists, biologists, and geochemists. The belief that an ultimate comprehension of petroleum evolution can only be developed by the interpretation of experimental and analytical data on a sound geological basis is the underlying philosophy of research on petroleum evolution in the Cherokee Group of southeastern Kansas and northeastern Oklahoma.

DONALD R. BAKER

Donald R. Baker is a graduate of California Institute of Technology (B.S., 1950), and Princeton University (Ph.D., 1955). He also attended the University of Oslo, Norway, as a Fulbright Student in 1950-51.

His professional experience includes work with the U.S.G.S., and with Northwestern University as an Instructor in the Department of Geology. Since 1956 he has been Research and Advanced Research Geologist with Marathon Oil Co. (formerly the Ohio Oil Co.) in the Denver Research Center. His exploration research has been primarily in the area of organic geochemistry.

18. Burgess Sand Reservoirs of Kansas

F. W. MORGAN and M. E. TORLINE

The area studied is in northeast Sedgwick County, eastern Harvey County, and the west edge of Butler County, Kansas. Geologically this area lies in the northeast part of the Sedgwick Basin. The name "Burgess" is an Oklahoma term and was used as early as 1921 to denote a sand body in the upper part of the Mississippian. The sand is actually an unconformity sand lying just above the Mississippian and just below the very thin Cherokee section of the Pennsylvanian.

The lithology of the Burgess zone is that of a conglomerate section, consisting of varigated shales above and below the sand. The sand itself is very poorly sorted, angular, clear to frosted, pitted quartz sand. It may drill several feet per minute and appear in rotary cuttings as loose, uncemented sand. In such cases it carries little or no shows of oil except gilsonitic or dead staining in the pits of the coarse grains. Where it is cemented the cementing material is usually calcareous in nature.

A study of the Oil Pools from which this sand produces indicates that accumulation of sand on broad, low, flat Mississippian noses with up-dip facies changes or reversal is largely responsible for trapping the oil. Recoveries in the older pools average about 2,500 barrels per acre. In a reservoir where the sand is as permeable as the Burgess twenty acre spacing or possibly greater is sufficient to drain the reservoir. This means about 45,000 barrels of oil net to the working interest. Wells cost no more than $25,000.00.

Detailed subsurface investigations using the tools of sample examination, electric log correlation and interpretation, drilling time logs, and subsurface maps seem to suffice in finding accumulations of Burgess oil. In view of the expected recoveries versus cost of exploring, economics seem to favor working this area.

F. W. MORGAN

Born in Rogers, Texas and attended Rogers Public Schools through high school. He then went to the University of Texas and graduated in 1939 with a Bachelor's Degree in Geology. The next school year was spent in El Paso, Texas as Laboratory Instructor in Geology. The year 1941 was spent in El Dorado, Kansas as Geology instructor at the El Dorado Junior College. In 1942 he moved to Ponca City, Oklahoma as ground school instructor in the Darr School of Aeronautics, training Royal Air Force and United States Army Air Corps pilots.

In 1944 he started active service in the Army Air Corps. After discharge in 1946 he took a summer course at the

University of Kansas at Canon City, Colorado. In August of that year he went to work for Stanolind Oil and Gas Company (now Pan American) in Wichita, Kansas. In February 1951 he went to work for the Lario Oil and Gas Company, Wichita, Kansas. In September 1951 he formed the Geological Consulting Firm of Morgan & Torline, Geologists, with M. Eugene Torline, co-author of this paper. He is still a partner in this organization. In 1953 he helped incorporate the Acme Oil Corporation. Acme is engaged in exploring for, drilling for, and producing crude oil and gas. He has served as president of Acme since its formation.

At present he resides in Wichita, Kansas and continues as partner in Morgan & Torline and as president of Acme. He was a member of Sigma Gamma Epsilon, geological fraternity in college and helped establish a new chapter at the Texas College of Mines and Metallurgy (now Texas Western) when at El Paso. He is a member of the Kansas Geological Society and the American Association of Petroleum Geologists. He is married and has one son.

M. EUGENE TORLINE

Born in Wichita, Kansas and attended Parochial Schools through high school. Entered the service in 1944, served on a tanker in the Pacific, and was discharged in 1946. Entered University of Wichita in 1946, attended University of Colorado during the summer of 1949 and graduated from the University of Wichita with a Bachelor of Arts degree in Geology in 1950. While attending high school and college he worked for Stanolind Oil and Gas Company (now Pan-American).

In May, 1951, he opened an office as a Consulting Geologist and Lease Broker and in September, 1951 formed the Geological Consulting Firm of Morgan & Torline, Geologists, with F. W. Morgan. In 1953 he helped incorporate Acme Oil Corporation. He is still a partner in Morgan & Torline, Geologists and serves as Vice President and Treasurer of Acme Oil Corporation.

Mr. Torline resides in Wichita with his wife, Cecilia. He has been Editor of the Kansas Geological Society Bulletin since 1953 and is a member of this organization as well as the American Association of Petroleum Geologists.

19. Chester — Upper Meramec Problems in Texas and Oklahoma Panhandles

PANHANDLE GEOLOGICAL SOCIETY
Ira D. Taylor, Chairman

Problems encountered in petroleum exploration and exploitation of the Chester and Upper Meramec of the Oklahoma Panhandle and parts of the Texas Panhandle are many and varied. Lateral variations of lithologic units, accompanied with porosity and permeability changes largely determines commercial accumulations of oil or gas in the Chester. Positive structural position, at present, probably determines St. Louis accumulation although local lateral lithologic changes may occur to form separate reservoirs on the same structure.

Carbonate reservoirs present unique problems in well completion, and the well completion methods vary as greatly as the individuals who do the work.

Producing carbonates must reach their optimum facility in regard to capacity and pressure so that excessive production will not ruin the well.

A low initial potential or low rate of production does not necessarily mean a small reservoir.

IRA D. TAYLOR

Ira D. Taylor, B.S., 1950, M.A., 1952, Indiana University.

Employed by Indiana State Geological Survey, Pure Oil Company and has been with the Texas Panhandle Sample Log Service since 1955.

Member of AAPG, G.S.A. and Panhandle Geological Society.

20. Identification and use of Conodonts from Meramecian Rocks (Upper Mississippian) Recovered from Well Cores from the Subsurface of Western Kansas

THOMAS L. THOMPSON and EDWIN D. GOEBEL

Because the usefulness of conodonts as guide fossils has been demonstrated in the type Mississippian section, a pilot study was established by the State Geological Survey of Kansas to determine if rock cores, previously correlated primarily on the basis of lithologic features and assigned to the Meramecian Stage in western Kansas, contained sufficient conodonts to make age determinations possible.

Conodonts of the Meramecian Stage of the Mississippian System (7 species, 6 genera) were collected from the Warsaw, Salem, St. Louis, and Ste. Genevieve Limestones from the subsurface of western Kansas. Specimens studied and collected from 455 samples taken from 376 feet of limestone cores were recovered from 6 wells in Haskell, Scott, Logan, Gove, Lane, and Ness Counties, Kansas. Comparison of the Meramecian strata in western Kansas with the standard section through the use of conodonts as a tool of correlation seems to be feasible and seems to substantiate previously established lithologic correlations. Four conodont species recovered in this pilot study shows sufficient restrictions to have probable stratigraphic significance to the Meramecian.

THOMAS L. THOMPSON

Thomas L. Thompson completed the Bachelor of Science and Masters of Science degrees at the University of Kansas in 1960 and 1962, respectively. While a graduate student at the University of Kansas, he was employed part-time in the Oil and Gas Division of the Kansas Geological Survey. Presently, he is a candidate for the PhD and an assistant in the Department of Geology at The State University of Iowa, Iowa City, Iowa.

EDWIN D. GOEBEL

Edwin D. Goebel graduated from Augustana College in 1949 with an A.B. in Geology. He completed a Masters of Science degree in 1951 from The State University of Iowa, and has been employed at the State Geological Survey of Kansas as Head of the Oil and Gas Division since 1951. He is presently a candidate for the PhD degree in Geology at The University of Kansas.

21. Pre-Pennsylvanian Subcrop of the Mississippian Osage on the Flanks of the Central Kansas Uplift

ROBERT M. EUWER
Wichita, Kansas

During late Mississippian time a series of major regional movements took place resulting in two pronounced subsurface features that we now refer to as the Central Kansas Uplift and Nemaha Ridge. Subsequent post-Mississippian

erosion gives us the present day configuration of Osagian rocks, subcropping beneath Pennsylvanian sediments.

A facies change in Mississippian rocks of south central Kansas, known as the "Cowley", makes definition of the Osage-Meramec contact difficult. The Osagian series consists of the Keokuk and Burlington cherty limestones. These rocks produce gas and/or oil in fifteen central Kansas counties. There are twelve major Mississippian Osage pools in this area. The largest oil and gas fields have estimated ultimate recoveries of 60 million barrels of oil and 450 billion cubic feet of gas respectively.

The Osage produces from stratigraphic and/or structural traps. Areas that are more suitable for a specific type of entrapment can be regionally defined. Problems of reservoir development exist near the truncation of basal Osage reservoirs.

In the past ten years Osage reservoirs have yielded approximately 75% of its total oil and gas production. Exploration concepts gained in this aggressive period assures the future of Osage rocks in Kansas as a principal producing horizon.

ROBERT M. EUWER

Robert M. Euwer graduated from Louisiana State University in 1951 where he received a B.S. degree in Petroleum Geology.

He was with Shell Oil Company for ten years as an exploration geologist with assignments in Texas, Oklahoma and Kansas. For the past two and one-half years he has been geologist for Kenneth Rupp, Independent Oil Producer, Wichita, Kansas.

He is a member of the American Association of Petroleum Geologists and the Kansas Geological Society and is currently on the Board of Directors of the Kansas Geological Society.

22. Pre-Pennsylvanian Structure and Paleogeology of the Palo Duro Basin in the Texas Panhandle

JOHN B. BEST, JR.
Amarillo Oil Company, Amarillo, Texas

The north boundary of the Palo Duro basin in the Texas Panhandle is the buried Amarillo-Wichita Mountains. Southern limits lie along the crest of the Matador archipelago. Western limits in New Mexico are less clearly defined or understood. The eastern portion of this basin in Oklahoma has been variously called the "Hollis, Hardeman or eastern Palo Duro basin". The areal extent of this basin in the Texas Panhandle approximates 17,000 square miles and includes parts or all of twenty counties.

Pennsylvanian rocks rest unconformably on Mississippian sediments in the southern two-thirds of the area and on granite in the northern one-third and over the Matador peaks. The Mississippian is divided into the Chester, Meramec, Spergen-Warsaw and Osage series. This system varies from a wedge edge to a 1000 feet in thickness. Mississippian rocks rest unconformably on the basement in the central portion of the basin and unconformably on the Ellenburger dolomite in the eastern one-third and the southwest one-quarter. This is evidence to support the premise that there existed a pre-Mississippian post-Ellenburger erosional period that removed much of the Ellenburger and younger pre-Mississippian rocks from the Palo Duro basin. The age of this unconformity is unknown positively but thought to be Devonian in age.

The Ellenberger system varies from a few feet to 1000 feet in thickness and consists principally of dolomite except for the basal sand.

From structural studies of the basement, Ellenburger and Mississippian, the present attitude of these erosional surfaces occurred at the same geological time as the Amarillo-Wichita Mountains and the Matador complex.

Detailed structural, stratigraphic and historical geological studies of this area could by drilling, prove the existence of stratigraphic, structural and combination stratigraphic-structural traps in the porous portions of rock systems from Permian to basement.

This area in the Texas Panhandle has been poorly prospected and offers quite a challenge to the domestic oil industry and to imaginative subsurface geology and modern exploration techniques.

JOHN B. BEST, JR.

Mr. Best graduated from the University of Oklahoma in August, 1950 with a Bachelor of Science degree in Geology and immediately entered the U. S. Army and served there until August, 1952. He left the service with the rank of Captain. September 1, 1952 Mr. Best moved to Amarillo, Texas and began working with the geological department of Phillips Petroleum Company. In June, 1954 he joined Amarillo Oil Company and is presently employed as Chief Geologist. Mr. Best is a member of the American Association of Petroleum Geologists and the Panhandle Geological Society.