



THE UNIVERSITY OF TEXAS

BUREAU OF ECONOMIC GEOLOGY

REPORT FOR 1966

BUREAU OF ECONOMIC GEOLOGY

Applied to Resource and
Engineering Problems

Basic Research

RESEARCH AND SERVICE IN GEOLOGY

Systematic Geologic
Mapping

Well Sample and
Core Library

Mineral Statistics and
Mineral Information

Mineral Studies
Laboratory

Cover: Isopach map of the Necessity Shale containing the Big Bear Lake Sandstone distributary system (dashed axial lines), one of numerous deltaic complexes of Upper Pennsylvanian age on the east flank of the West Texas Basin. Differential compaction of distributary sands and interdistributary clays and silts is indicated by the deltaic pattern. From "Geometry of Superposed Elongate Pennsylvanian-Permian Sandstone Bodies, North-Central Texas," by L. F. Brown, Jr. (in preparation).

THE BUREAU OF ECONOMIC GEOLOGY is one of the organized research bureaus of The University of Texas. Established in 1909, it has for 57 years carried out the function of a State Geological Survey; its Director fills the position of State Geologist. The Bureau is engaged in a four-point program of research and public service in earth science and Texas mineral resources as follows: (1) basic geological research, (2) geology applied to resource and engineering problems, (3) systematic geologic mapping, and (4) public-service mineral information, identification and testing, and compilation of mineral statistics. The Bureau participates in other University research efforts in the fields of resources and earth sciences, such as the Center for Research in Water Resources. As a part of its effort, the Bureau publishes major reports in The University of Texas Publication series; it also has its own series of Reports of Investigations, Geologic Quadrangle Maps, Guidebooks, Geological Circulars, and Mineral Resource Circulars. The Guidebooks include non-technical publications of general interest.

The basic geologic data developed by the Bureau of Economic Geology in the form of scientific reports and geologic maps are used by many State and Federal organizations in carrying out investigations in the public service. These include the Texas Water Development Board, Railroad Commission of Texas, Parks and Wildlife Department, Texas Highway Department, Texas Industrial Commission, and numerous other State boards, conservation organizations, water districts, and Chambers of Commerce. The Bureau also cooperates formally and informally with Federal agencies, such as the Geological Survey, Bureau of Mines, Bureau of Reclamation, Corps of Engineers, and National Park Service. The mineral and geological information service offered by the Bureau of Economic Geology is used by public and private groups, corporations, and citizens through correspondence and conference.

Publications in 1966

Report of Investigations No. 56. LIMESTONE AND DOLOMITE RESOURCES, LOWER CRETACEOUS ROCKS, TEXAS, by Peter U. Rodda, W. L. Fisher, W. R. Payne, and D. A. Schofield. 286 pp., 22 text figs., 4 pls., 7 tables, February 1966 \$4.50

This report contains the results of a study of Lower Cretaceous limestones and dolomites from approximately 250 localities in 49 counties in North and Central Texas, the Callahan Divide, Edwards Plateau, southeastern Balcones Escarpment, southern High Plains, and Trans-Pecos Texas. Chemical analyses of some 1,000 samples were made in connection with this study, which delineates the occurrence, distribution, quality, reserves, and availability of these rocks as industrial raw materials.

The mining and processing of limestone for various industrial uses is one of the largest mineral industries in Texas. Products are consumed mostly by the construction and heavy chemical industries. Lower Cretaceous rocks are the source of about 20 percent of all limestone and limestone products produced in the State and prospects are for utilization of this resource to increase.

In the chemical analyses, acid neutralization values are reported for all samples. CaO , MgO , SiO_2 , Al_2O_3 , and Fe_2O_3 are reported for selected samples. The analyses are referred to measured stratigraphic sections which are presented diagrammatically with brief rock descriptions. Each section includes a locality description and a locality map; localities are also included on the geologic maps of Edwards and associated formations and of the Goodland Formation of North Texas. Other plates show stratigraphic units of Lower Cretaceous limestones and distribution of dolomite in the Edwards Formation.

Report of Investigations No. 57. SEDIMENTARY PETROLOGY AND HISTORY OF THE HAYMOND FORMATION (PENNSYLVANIAN), MARATHON BASIN, TEXAS, by Earle F. McBride. 101 pp., 14 figs., 25 pls., March 1966 \$2.50

The Haymond Formation, which is part of a 12,000-foot sequence of flysch that was deposited in late Paleozoic time in the Marathon segment of the Ouachita geosyncline in Trans-Pecos Texas, has a maximum preserved thickness of 4,300 feet and is chiefly a monotonous sequence of intercalated fine-grained sandstone and gray shale beds less than 6 inches thick. The Haymond flysch was deposited in a marine basin several hundred to several thousand feet deep.

Exotic and erratic cobbles and boulders up to 130 feet long

encased in mudstone beds and contorted flysch beds crop out along the northern and eastern edges of the basin.

The orientation of more than 500 directional current structures, chiefly groove casts, flute casts and parting lineations, was measured to determine the paleocurrent pattern of sediment transport.

The appendices contain petrographic descriptions of erratic and exotic rocks from Haymond boulder beds and locations of numbered data localities. The latter are shown on one of the text figures, and stratigraphic sections and other pertinent information are included on several plates. Photomicrographs of shales, flysch sandstones, other sedimentary rocks, and metamorphic rocks are included in the illustrations. Statistical information is reported in the accompanying tables.

GEOLOGIC ATLAS OF TEXAS, TEXARKANA SHEET.
Scale: 1:250,000. Elias Howard Sellards Memorial Edition.
August 1966 \$2.50

This geologic map, the second sheet published in the Geologic Atlas, is in color on a scale of 4 miles equal 1 inch. It includes Lamar, Red River, Bowie, Delta, and Titus counties as well as parts of Fannin, Hunt, Hopkins, Franklin, Morris, and Cass counties. That part of Oklahoma and Arkansas along the Red River south of the 34° parallel and west of the 94° meridian is also included. Total area is one degree of latitude by two degrees of longitude. Topography, roads, railroads, cities, towns, and other culture are also shown.

The map honors Dr. E. H. Sellards, Director of the Bureau of Economic Geology from 1932 to 1945.

The Texarkana Sheet was compiled by Dr. V. E. Barnes with assistance from Mrs. Mary Kathryn Pieper and other members of the Bureau staff. A committee of the East Texas Geological Society acted in an advisory capacity, and the Oklahoma Geological Survey and Arkansas Geological Commission contributed data on their respective parts of the sheet.

Geologic Quadrangle Map No. 28. GEOLOGY OF PRESIDIO AREA, PRESIDIO COUNTY, TEXAS, by John W. Dietrich. Map with 45-page text. Scale: 1:48,000. July 1966 \$2.50

This geologic quadrangle map covers the western end of famous scenic Ranch Road 170 which passes through spectacular volcanic formations between Presidio and Big Bend National Park. Tascotal Mesa and the Bofecillos Mountains are included on the map.

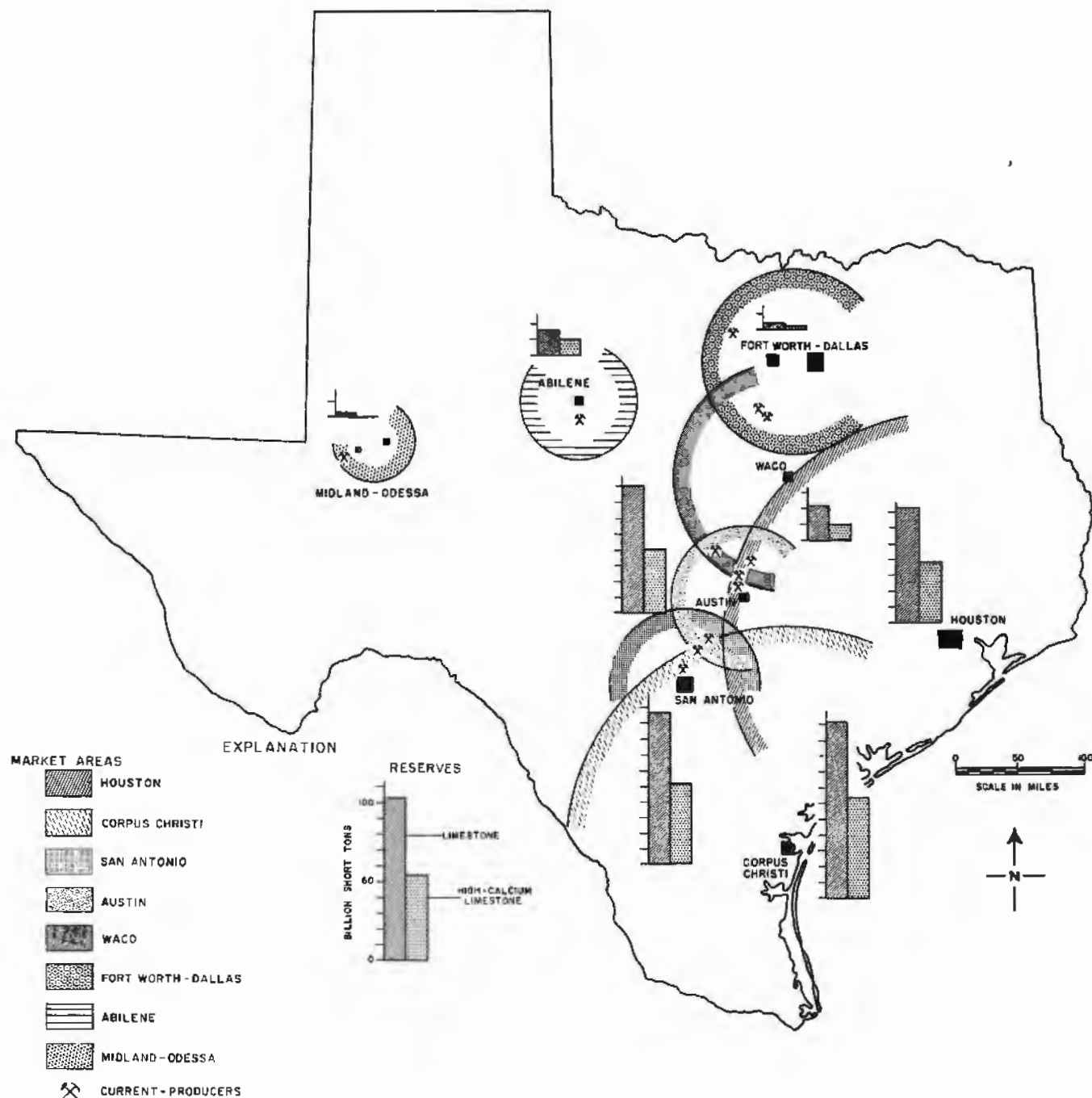
In addition to Tertiary volcanic and intrusive igneous rocks,

the map and text discuss water resources, petroleum possibilities, lead-silver, manganese, and uranium prospects, and deposits of guano, sand and gravel, stone, perlite, and bentonitic clay.

Geologic Quadrangle Map No. 30. GEOLOGY OF BLACK GAP

AREA, BREWSTER COUNTY, TEXAS, by Bill E. St. John. Map with 18-page text. Scale: 1:62,500. April 1966
\$2.50

The wedge-shaped Black Gap region in southern Brewster County, Texas, is east of the Big Bend National Park and includes parts of four physiographic units: the Sierra del Carmen



Limestone and high-calcium limestone reserves in the Edwards Formation within 5 airline miles of railroads and available to principal market areas as defined by competitive haulage costs (Bureau of Economic Geology Report of Investigations No. 56, fig. 11, p. 20, 1966).

to the southwest, the Cupola Mountain highland in the northeast, a low area extending from the Rio Grande northwest through the middle of the area and characterized by hills capped with basalt, and a gravel-covered lowland to the northwest.

Outcropping strata are principally Cretaceous but include Tertiary volcanic rock and Quaternary alluvium. Structurally, the area is a large northwest-trending graben flanked by a stable block to the northeast and a series of tilted fault blocks to the southwest. Main headings for discussion are stratigraphy, structure, geologic history, and economic geology; an isopachous map of the Del Rio Formation in the Black Gap area is included as a text figure. The geologic map is in color; a structure contour map on top of the Santa Elena Limestone and a composite stratigraphic section from the area are also included.

Geologic Quadrangle Map No. 31. GEOLOGY OF THE STONEWALL QUADRANGLE, CILLESPIE AND KENDALL

COUNTIES, TEXAS, by V. E. Barnes. Map with 10-page text. Scale: 1:24,000. February 1966 \$1.50

The Stonewall quadrangle includes part of the southern margin of the Llano region and part of the eastern margin of the Edwards Plateau; the area is mostly drained by the Pedernales River and its tributaries with some drainage southward to Blanco River. The major fault in the quadrangle is related to the subsurface Ouachita structural belt and trends northeast-southwest.

Elevations in the Stonewall quadrangle range from about 1,395 to 1,995 feet. Mineral resources known in the quadrangle are construction materials and water; much of the area is ranch land. A stratigraphic section along South Grape Creek, 2.25 miles south-southwest of Blumenthal, is given in the text.

Mineral Resource Circular No. 48. THE MINERAL INDUSTRY OF TEXAS IN 1965, by F. F. Netzeband and Roselle M. Girard. December 1966 Free on request

Publications in Press

University of Texas Publication. Geology of Big Bend National Park, Brewster County, Texas, by Ross A. Maxwell, John T. Lonsdale, Roy T. Hazzard, and John A. Wilson.

Report of Investigations No. 58. Nomenclature Revision of Basal Cretaceous Rocks Between the Colorado and Red Rivers, Texas, by W. L. Fisher and Peter U. Rodda.

Report of Investigations No. 59. Lower Cretaceous Sands of Texas: Stratigraphy and Resources, by W. L. Fisher and Peter U. Rodda.

Report of Investigations No. 60. Sand Resources of Texas Gulf Coast, by L. E. Garner.

Report of Investigations No. 61. Hurricanes as Geological Agents: Case Studies of Hurricanes *Carla*, 1961, and *Cindy*, 1963, by Miles O. Hayes.

Report of Investigations No. 62. Late Cambrian and Early Ordovician Faunas from the Wilberns Formation of Central Texas, by Don Winston and Harry Nicholls.

Geologic Quadrangle Map No. 32. Geology of the Cave Creek School Quadrangle, Gillespie County, Texas, by V. E. Barnes.

Geologic Quadrangle Map No. 33. Geology of the Monument Hill Quadrangle, Blanco County, Texas, by V. E. Barnes.

Geologic Quadrangle Map No. 34. Geology of the Yeager Creek Quadrangle, Blanco and Hays Counties, Texas, by V. E. Barnes.

Geologic Quadrangle Map No. 35. Geology of Apache Mountains, Trans-Pecos Texas, by John W. Wood.

Publications by Bureau of Economic Geology Staff in Scientific Journals

Barnes, V. E. (1966) Memorial to Frank A. Herald (1887-1965): Bull. Amer. Assoc. Petrol. Geol., vol. 50, pp. 1064-1066.

Barnes, V. E., with R. V. Russell (1966) Devitrifica-

tion of glass around collapsed bubbles in tektites: *Geochimica et Cosmochimica Acta*, vol. 30, pp. 143-152.

Barnes, V. E., with A. J. Boucot, P. E. Cloud, Jr., R. H.

- Miller, and A. R. Palmer (1966) Silurian of Central Texas: A first record for the region: *Science*, vol. 154, pp. 1007-1008.
- Flawn, P. T. (1966) Geology and the new conservation movement: *Science*, vol. 151, no. 3709, pp. 409-412.
- Flawn, P. T. (1966) Geology and urban development: *Baylor Geological Studies Bull. No. 8*, pp. 5-7.

Reprinted in Engineering geology in Southern California: Special Pub. Assoc. Engineering Geologists, Los Angeles Section, October 1966, pp. 209-213.

Girard, R. M., with F. F. Netzeband (1966) The mineral industry of Texas: U. S. Bureau of Mines, *Minerals Yearbook 1965, Vol. III* (reprint).

Projects

Texas Geologic Atlas Project

The fifth year of the Texas Geologic Atlas Project was completed during 1966. The Texarkana sheet, published in July, is the second sheet of the Atlas to appear.

The Lubbock sheet was reviewed by the Geologic Atlas Committees of the West Texas Geological Society and Abilene Geological Society during the period March to July. The Sherman sheet was reviewed by the Geologic Atlas Committees of the Dallas Geological Society and the Fort Worth Geological Society during the period August to October. These sheets should be completed for printing early in 1967. Review of the Van Horn-El Paso sheet has been completed by the Geologic Atlas Committee of the West Texas Geological Society and by members of the U.S. Geological Survey—P. B. King, J. F. Smith, Jr., and R. L. Harbour—whose mapping was used. Because of the complexity of this sheet, publication is not anticipated until late in 1967.

The Palestine-Alexandria sheet was sent for review to the Geologic Atlas Committee of the East Texas Geological Society in September, and the Houston-Port Arthur and Beaumont-Lake Charles sheets were sent for review to the Geologic Atlas Committee of the Houston Geological Society in November. It is hoped that these sheets will be published during mid-1967.

Field checking has been completed for the Plainview sheet and is advanced for the Dallas, Beeville-Bay City, and Amarillo sheets. Completion of field checking for the Waco sheet is planned during the first half of 1967. The Quaternary part of the Seguin sheet has been field checked.

Bureau members who worked on the Atlas Project during the year under the direction of Dr. V. E. Barnes included Mrs. C. A. Pieper (Sherman and Beaumont sheets), Dr. G. K. Eifler, Jr. (Lubbock, Plainview,

and Amarillo sheets), Mr. C. A. Shelby (Palestine-Alexandria and Beaumont-Lake Charles sheets), Dr. J. W. Dietrich (Van Horn-El Paso sheet), Mr. J. H. McGowen (Sherman and Dallas sheets), Mr. D. F. Reaser (Dallas sheet), and Dr. L. F. Brown, Jr. (Abilene sheet).

Dr. L. F. Brown, Jr., who joined the Bureau staff in August, has been doing office compilation and field checking for the Abilene sheet. It is anticipated that work on the Abilene sheet will be coordinated with work on the Wichita Falls-Lawton sheet, although completion of the Abilene sheet is the first target in this North-Central Texas Pennsylvanian-Permian province.

In August Mrs. Pieper and her husband moved to Nashville, Tennessee, where he is teaching at George Peabody College. In February Mr. Shelby joined the Texas Water Development Board, Austin, and in July Dr. Dietrich joined the Lunar Surface Technology Branch at the NASA Manned Spacecraft Center in Houston.

During the summer, Dr. Saul Aronow, of Lamar State College of Technology, did field checking of the Quaternary portions of the Beeville-Bay City and Seguin sheets. Dr. Aronow had previously field checked the Quaternary mapping of the Houston-Port Arthur, Beaumont-Lake Charles, and McAllen-Brownsville sheets.

Mr. J. W. Macon, the Bureau's cartographer, supervises scribing, color separation, and preparation of all geologic atlas sheets for the press.

Areal Geologic Studies

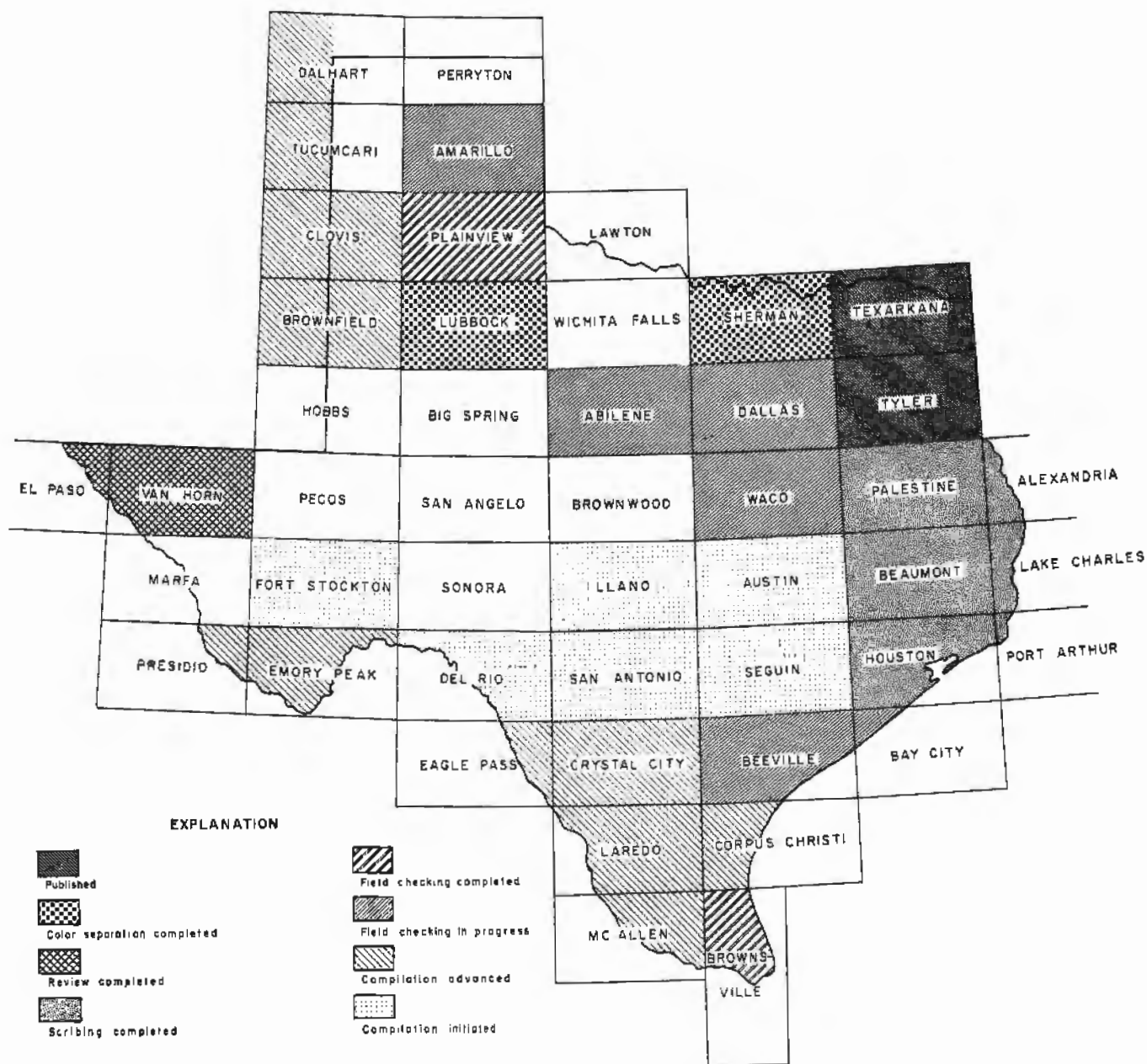
The Moore Hollow Group of Central Texas. V. E. Barnes and W. C. Bell. A stratigraphic and paleontologic study of Cambrian and immediately overlying rocks of Central Texas. This long-term project,

which is now complete except for sections on systematic paleontology and paleoecology, is expected to be published within the next two years.

Relict Paleozoic of Central Texas. V. E. Barnes, A. J. Boucot, P. E. Cloud, Jr., Helen Duncan, R. H. Flower, Mackenzie Gordon, and perhaps others. A stratigraphic and paleontologic study of the erratically preserved rock sequence from the top of the Ellenburger to the base of the Marble Falls. The

paleontologic part of the study is by specialists in various groups of fossils; the stratigraphic part is by Cloud and Barnes. This is a long-term project that is expected to result in a comprehensive report within five years.

Stratigraphy of the type Cisco area (Upper Pennsylvanian and Lower Permian) in North-central Texas. L. F. Brown, Jr., in cooperation with former graduate students of Baylor University. The development



Status of Texas Geologic Atlas.

of a stratigraphic model in near-shore facies by means of detailed geologic mapping of an area of approximately 1,200 square miles in North-central Texas. The study involves the use of aerial photographs and field mapping. Work on the project is advanced, but additional field mapping is required.

Geometry of superposed elongate Pennsylvanian-Permian sandstone bodies, North-central Texas. L. F. Brown, Jr., and former graduate students of Baylor University. The delineation of Pennsylvanian-Permian channel patterns and a study of the effect of compaction and geologic structure on areal and vertical distribution of the channels. The investigation includes surface and near-surface studies of an area in North-central Texas comprising approximately 2,000 square miles. Work on the project is advanced.

Stratigraphic problems and depositional patterns in the Upper Pennsylvanian and Lower Permian of North-central Texas. L. F. Brown, Jr., and former graduate students of Baylor University. A summary of sandstone distribution patterns, carbonate and clay-shale facies, vertical sequences, and other stratigraphic relationships in North-central Texas which define the depositional model. The project is in an early phase and requires further studies.

The Wilcox Group in Texas. W. L. Fisher and J. H. McGowen. An investigation of the Carrizo-Wilcox sequence of strata in outcrop and downdip subsurface occurrences throughout the Texas Gulf Coastal Plain. The study includes stratigraphic delineation, interpretation of depositional history, geometry and lithology of principal rock units. Measured outcrop sections, descriptions of well cuttings and cores, and electric logs are being used. This long-term project is expected to be completed during 1968.

Geology of Bofecillos Mountains area, Presidio and Brewster counties, Texas. J. F. McKnight. An areal geologic study with emphasis on the stratigraphy and origin of extrusive volcanic rocks in the region.

Depositional history of Gum Hollow delta (a fan delta), Nueces Bay, Texas. J. H. McGowen. A study of the primary sedimentary structures of a fan delta whose initial growth began 34 years ago. The resulting data, which will define the depositional model, will aid in interpreting the depositional environments of ancient

sediments. Field procedures include the digging of trenches and the sampling of sediments by means of a fixed-piston coring device. Aerial photographs and plane-table maps also are used. The project is in an early phase.

Stratigraphic and paleontologic studies of Lower Cretaceous rocks. P. U. Rodda. A study of the stratigraphy, depositional pattern, paleontology, and history of surface and subsurface rock sequences with special emphasis on the Central Texas area. This is a long-term project that is now in the planning stage.

Urban geology of Austin and vicinity. P. U. Rodda, Keith Young, and others. A study of the structure, stratigraphy, and resources of the Austin area. The resulting report will provide information for city planners, engineers, architects, and others. Geologic mapping for the project is scheduled for completion during 1967. Status of mapping in the quadrangles of the area at the close of 1966 was as follows: (1) *Austin East quadrangle*—mapped by Keith Young, gravel deposits mapped and sampled by L. E. Garner, and preliminary size analysis of the samples completed; (2) *Austin West quadrangle*—mapped by W. N. McNulty, Jr., gravel deposits mapped by L. E. Garner; (3) *Austin 15' quadrangle*—north half mapped by Keith Young (northwest quarter, scribbling completed), southeast quarter being mapped by Keith Young; (4) *Buda quadrangle*—northwest quarter being mapped by G. L. Dawe; (5) *Lake Travis quadrangle*—west half being mapped by G. L. Dawe; (6) *Montopolis 7.5' quadrangle*—Pilot Knob area mapped by T. H. Brown, remainder to be mapped by Keith Young; (7) *Montopolis 15' quadrangle*—northeast quarter to be mapped by Keith Young, gravels mapped by L. E. Garner; (8) *Oak Hill quadrangle*—being mapped by L. E. Garner and P. U. Rodda. On completion of geologic mapping, engineering data will be summarized by stratigraphic units.

Mineral Resource Studies and Mineral Statistics

Mineral resources of Southeast Texas. L. E. Garner. An inventory of the mineral raw materials of counties within an area of the Gulf Coastal Plain extending south and southeastward from Travis County to the

Gulf of Mexico and including Austin, Bastrop, Brazoria, Brazos, Burleson, Chambers, Colorado, Fayette, Fort Bend, Galveston, Grimes, Hardin, Harris, Jefferson, Lee, Liberty, Matagorda, Orange, Waller, Washington, and Wharton counties. The project involves field studies, sampling and analyses of industrial-mineral deposits, and a review of published and unpublished data. This is a long-term project that is still in the planning stage.

The annual compilation of Texas mineral production statistics and other mineral information. R. M. Girard in cooperation with the U.S. Bureau of Mines. In progress as a continuing project.

Talc deposits of the Allamore district, Culberson and Hudspeth counties. R. G. Rohrbacher. A study of the origin and distribution of the extensive talc deposits of the region.

Geology and Recreation

Geologic guide to the State parks of Texas. R. A. Maxwell, editor. Designed to present non-technical descriptions of the geology of the parks and to point out areas of historical and scenic interest. The project is expected to be completed in 1967.

Geology of Palo Duro State Park. W. H. Matthews III, Professor of Geology, Lamar State College of Technology, Beaumont. A geological guide designed for visitors to the park. Scheduled for publication during 1967 in the Bureau's Guidebook series.

Bibliographies and Catalogs

Bibliography and index of Texas geology, 1951-1960. Indexed by M. D. Brown, edited by R. M. Girard. A bibliographic listing, with index, of publications

pertaining to Texas geology. A continuation of previous bibliographies and indices (Univ. Texas Bull. 3232, pt. 4, and Pub. 5910). Scheduled for completion in 1968.

Catalog of type specimens of invertebrate fossils in the collections of the Bureau of Economic Geology. P. U. Rodda. An annotated catalog of approximately 5,000 separate specimens that have been described, figured, or listed in scientific publications. Much of the catalog has been completed, but a large amount of library research remains to be done.

Public Service

The Bureau not only disseminates the results of its studies of Texas geology and mineral production data through published reports but also provides assistance to individuals and organizations as a public service.

All members of the Bureau research staff provided information during 1966, either by conference or correspondence. Two members who spent a large portion of their time in this activity are L. E. Garner, who examined rock and mineral specimens submitted to the Bureau for identification, and R. M. Girard, who replied to hundreds of letters of inquiry received from persons in Texas and elsewhere.

Last spring, G. K. Eifler, Jr., R. M. Girard, R. A. Maxwell, and other Bureau staff members prepared a memorandum report for the Texas Water Development Board, "Inventory of Mineral Resources in Proposed Reservoir Sites, Texas."

Other public services included preliminary testing and evaluation of industrial rocks and minerals at the Mineral Studies Laboratory under the supervision of D. A. Schofield, chemist-in-charge. The Well Sample and Core Library provided facilities for the examination and study of subsurface material from Texas wells.

Well Sample and Core Library

The Well Sample and Core Library, located at Balcones Research Center at the north edge of Austin, offers facilities for geologists and other interested persons to examine and study Texas well samples and cores.

The Library's collections contain more than 60,000 feet of core material and more than 6 million cutting samples from oil, gas, and water wells of Texas. Additions to the collections during the year included Gulf

Oil Company's donation of 3,000 feet of core material from two wells—one in Caldwell County, the other in Guadalupe County; Shell Oil Company's contribution of 8,000 feet of core material from Bandera, Bexar, Blanco, Burnet, Caldwell, Cherokee, Comal, Crockett, Edwards, Falls, Gillespie, Guadalupe, Hamilton, Hays, Hood, Johnson, Kendall, Kinney, Lee, McLennan, Medina, Menard, Milam, Tarrant, Travis, Val Verde, and Williamson counties; and Standard Oil of Texas Division of Chevron Oil Company's gift of 2,238 feet of core material from 27 wells in Andrews, Borden, Glasscock, Knox, Midland, Mitchell, Pecos, Ward, and Winkler counties.

Mr. P. S. Morey, formerly geologist-in-charge of the Library, left the Bureau as of August 31, 1966, and on September 1, a Well Sample and Core Library Committee—Ross A. Maxwell, Chairman, Gus K. Eifler, Jr., and Samuel P. Ellison, Jr.—began functioning as an advisory and planning group for the Library. Under the supervision of Mr. Marce L. Morrow, Administrative Clerk, the Library staff consists of Messrs. G. M. Alexander, G. T. Millegan, and J. O. Robinson.

At the close of 1966, construction was in progress on additional space for the Library's collections.

Mineral Studies Laboratory

The Mineral Studies Laboratory has facilities at Balcones Research Center for sample preparation, mineral separation, physical testing, chemical analysis, and spectrographic analysis. During 1966, the Laboratory performed tests and analyses in support of Bureau of Economic Geology research projects as well as for the Department of Geology and other departments of The University of Texas.

Chemical analysis ranged from approximate determination of one or two elements in a rock to precise and complete rock analysis of major and minor elements. Precise analysis of a series of samples submitted by Professor E. F. McBride of the Department of Geology was completed during the year. Chemical analysis of a series of 81 samples of limestone for Dr. P. U. Rodda of the Bureau of Economic Geology is in progress.

Other analyses included the quantitative estimation of 55 elements and time-sequence semiquantitative analyses of 8 elements in a sample of plastic material for the Drug-Plastics Research and Toxicology Laboratories; determination of a trace element in crystals grown by the Department of Physics; and the determination of nickel content in a possible meteorite and the determination of the composition of an alloy of possible archeological significance for the Texas Memorial Museum.

Various persons visited the Mineral Studies Laboratory to observe equipment and techniques. They included Mr. Otto H. Bohenberger, geologist for the Instituto Centroamericana de Investigación y Tecnología Industrial, and three members of the staff of Petroleos Mexicanos—Ing. Federico Mina U., assistant exploration manager; Ing. Francisco Viniegra O., chief of the paleontology and petrography laboratory; and Ing. Mario Trejo, chemist.

A central air-conditioning and heating system for the Laboratory was completed during August. New laboratory apparatus installed during 1966 included a Barnstead still, capable of producing 1½ gallons of distilled water per hour; a 48-inch all-plastic fume hood; a hydrometer-jar constant-temperature water bath; and an electrically heated water bath, which can be operated continuously at any of three temperatures as required for chemical analyses.

The Beckman DU spectrophotometer, with its flame photometry attachment and constant voltage power supply, was overhauled. A new red-sensitive photomultiplier tube and an energy-recorder adaptor were added to the instrument. Also overhauled by the Beckman Instrument Company in Houston was the Laboratory's Beckman expanded-scale pH meter.

Staff Activities

Scientific Meetings

Staff members represented the Bureau of Economic Geology at numerous scientific and professional meetings in 1966. Principal meetings attended during the year include:

American Association of Petroleum Geologists, Annual Meeting, April, St. Louis, Missouri—V. E. Barnes, P. T. Flawn

American Geological Institute, Committee on Coordination of Certification, January, Dallas—P. T. Flawn

American Geological Institute, House of Representatives (as a representative of the Association of American State Geologists), April, St. Louis, Missouri—P. T. Flawn

American Geophysical Union, Annual Meeting, April, Washington, D.C.—V. E. Barnes.

American Institute of Professional Geologists, Commission on Geologic Hazards, April, St. Louis, Missouri—P. T. Flawn

American Institute of Professional Geologists, Texas Section, Executive Committee, June, San Antonio, Texas—P. T. Flawn

Association of American State Geologists, Annual Meeting, May, Bloomington, Indiana—P. T. Flawn

Association of Engineering Geologists, Dallas-Fort Worth Section, Annual Meeting, March, Arlington, Texas—P. T. Flawn

Conference on Shock Metamorphism of Natural Materials, Goddard Space Flight Center, April, Greenbelt, Maryland—V. E. Barnes

Forum on Geology of Industrial Minerals, April, Bloomington, Indiana—W. L. Fisher

Geoscience Information Society, Annual Meeting, November, San Francisco, California—R. M. Girard

International Congress of Electron Microscopy, 6th, August-September, Kyoto, Japan—V. E. Barnes

Southwestern Federation of Geological Societies, Annual Meeting, February, Fort Worth, Texas—V. E. Barnes, G. K. Eifler, Jr., P. T. Flawn

Texas Advisory Committee on Conservation Education, Semi-annual Meetings, April, Lake Travis, Texas, and October, Lake Whitney, Texas—P. T. Flawn

Texas Christian University, Field Trip, Lower Canyon Stratigraphy in North-Central Texas, March, Palo Pinto and Wise Counties, Texas—V. E. Barnes, G. K. Eifler, Jr.

University of California, 98th Charter Day Exercises, March, Berkeley, California—V. E. Barnes

West Texas Geological Society, Symposium on Economics and Petroleum Geologists, October, Midland, Texas—G. K. Eifler, Jr., W. L. Fisher

Lectures and Public Addresses

V. E. Barnes—

Bureau publications useful to water well drillers: Lone Star Water Well Drillers Association, Austin Chapter, Austin, Texas—July

Tektites: Hyde Park Christian Church, Austin, Texas—February; and A&M Geological Society, College Station, Texas—March; and Secondary School National Science Foundation Students, Department of Geology and Geography, Texas A&M University, College Station Texas—August

L. F. Brown, Jr.—

Careers in earth science: Sidney Lanier High School, Austin, Texas—November

Stratigraphy of Upper Pennsylvanian and Lower Permian in north Texas: The University of Oklahoma and The University of Kansas Graduate Students' Field Trip, Wichita Falls, Texas—October

P. T. Flawn—

Environmental geology: Association of Engineering Geologists, Dallas-Fort Worth Section, Annual Meeting, Arlington, Texas—March

Planners in flatland—a tragedy of many dimensions: Sigma Gamma Epsilon, The University of Oklahoma, Norman, Oklahoma; and Sigma Xi, Stephen F. Austin State College, Nacogdoches, Texas—November

Macon, J. W.—

Photogrammetry and photo-interpretation: The University of Texas, Graduate Class in Civil Engineering, Austin, Texas—March

R. A. Maxwell—

Earthquakes and volcanoes: Texas Academy of Sci-

ence, Visiting Scientist Program, Groves High School, Groves, Texas—February

Geological history of the parks in Texas: Conference for the Advancement of Science and Mathematics Teaching, Austin, Texas—October

Geology and natural resources of Camp Tom Wooten Boy Scout area: Camp Tom Wooten, Travis County, Texas—talk given several times, March through August

P. U. Rodda—

Fossils as economic mineral deposits: Austin Gem and Mineral Society, Austin, Texas—April

Academic Assignments, Committee Service, and other Professional Responsibilities

V. E. Barnes—

Corpus Christi Geological Society: Leader of a section of the May 1966 Field Trip, Paleozoic Rocks of the Llano Region.

The University of Texas, Department of Geology: Professor of Geology.

L. F. Brown, Jr.—

Conference on Pennsylvanian Stratigraphy for The University of Kansas and The University of Oklahoma Graduate Students: Leader of October 1966 Field Trip, North Texas.

G. K. Eifler, Jr.—

American Institute of Professional Geologists, Texas Section: Legislative Committee.

Austin Geological Society: Public Relations Committee, Chairman.

W. L. Fisher—

The University of Texas, Department of Geology: Lecturer.

P. T. Flawn—

American Association of Petroleum Geologists: Basement Rocks Project Committee, Chairman; Committee on Preservation of Well Samples and Cores; Federal, State, and Local Agencies Advisory Committee, Vice-Chairman; Research Committee.

American Geological Institute: Committee on Coordination of Certification; House of Society Representatives; elected a Director of the Institute in November 1966.

American Institute of Professional Geologists: Commission on Geologic Hazards.

Association of American State Geologists: Representative to the American Geological Institute.

Austin Geological Society: President (through April 30); Executive Committee.

Witness for Attorney General's Office and General Land Office of Texas, August, Rankin, Texas.

Texas Advisory Committee on Conservation Education.

Texas Mapping Advisory Committee.

The University of Texas: College of Arts and Sciences, Faculty Council Representative; Committee of Faculty Council to Review "No-Protest" Legislation, Chairman; Department of Geology, Professor of Geology (1966 teaching assignment: "Mineral Resources"); Publications Committee, Chairman; Special Group to Join With The University's Standing Committee on Academic Advising, Admissions, and Registration, to Consider a New Admission Policy.

U.S. Corps of Engineers, Committee for a Comprehensive Study of the Red River Below Denison Dam: Mineral Resources Study Group.

L. E. Garner—

Austin Geological Society: Committee on Scouting and Recreation (1966-67); aided Natural Science Center of Austin by helping prepare exhibits for the Center's semi-annual Safari Trail.

R. M. Girard—

Austin Geological Society: Treasurer (1966-67); Executive Committee.

J. W. Macon—

Designed and supervised the preparation of Bureau of Economic Geology exhibit at the Southwestern Federation of Geological Societies meeting, Fort Worth, and at The University of Texas Round-Up, Austin.

R. A. Maxwell—

Austin Geological Society: Committee on Scouting and Recreation, Chairman (through April 30); aided in the establishment of a nature trail at Camp Tom Wooten, Travis County, and prepared the trail guidebook; aided Natural Science Center of Austin by helping prepare exhibits for the Center's semi-annual Safari Trail.

Boy Scouts of America, Capitol Area Council: Executive Board Member.

Natural Science Association of Austin: Board of Directors.

Texas Academy of Science, Visiting Scientist Program: Lecturer to High School Groups.

U.S. National Park Service: Special Consultant to aid in the preparation of a research program for Carlsbad Caverns and Big Bend National Parks and the proposed Guadalupe Mountains National Park; prepared questionnaire report on dinosaur tracks near Glen Rose, Texas.

P. U. Rodda—

Austin Geological Society: Committee on Scouting and Recreation, Member (through April 30); Chairman (1966-67); aided Natural Science Center of Austin by helping prepare exhibits for the Center's semi-annual Safari Trail.

The University of Texas, Department of Geology: Lecturer.

Barnes Awarded NSF Grant

V. E. Barnes received word in December from the National Science Foundation that another grant is being made to support his tektite work for two additional years. During this time the large quantity of material collected on his recent journeys will be examined for further clues on tektite origin. The only additional field work contemplated is in the moldavite strewnfield of Czechoslovakia, and this will be done following the International Geological Congress which is being held in Prague during August 1968.

Flawn's Book on Mineral Resources Published in December

Mineral Resources: Geology, Engineering, Economics, Politics, and Law, by Peter T. Flawn, was published by Rand McNally late in the year. Intended as an upper division text, it provides a broad interdisciplinary background for students of mineral resources.

Geology of Texas—Fifth Printing

The University of Texas Bulletin 3232, "The Geology of Texas," by E. H. Sellards, W. S. Adkins, and F. B. Plummer, originally published in 1932, is again available from the Bureau of Economic Geology in a fifth printing. The fourth printing was exhausted early in 1966.

Since the publication of the first printing in 1933, there has been a great deal of geologic work in Texas. An enormous footage of exploratory drilling for oil, gas, and other mineral deposits, and for engineering purposes, has provided a greatly expanded three-dimensional view of Texas geology. New stratigraphic units have been defined and old ones modified or abandoned. New structural elements have been mapped, and the geometry of the upper part of the earth's crust in Texas is far better known than in 1930. Paleontological collections are more extensive and correlations are more secure. Geochemical and geophysical data have permitted a more sophisticated approach to many geo-

logical problems. Many radiometric ages have become available. They are mostly from Precambrian basement rocks and from Quaternary and Recent rocks. Chemical analyses of Texas rocks and minerals are more abundant. Texas mineral resources are, of course, more thoroughly known than they were 35 years ago.

A revision of "The Geology of Texas" is clearly in order, but it will require several years to complete the task. Because this Bulletin remains the basic reference in Texas geology, it was decided that it should be made available up until the time that a revised edition is published. Hence, a fifth printing was undertaken. It is accompanied by the 1963 edition of the Geological Highway Map of Texas compiled by Philip F. Oetking and Dan E. Feray for the Dallas Geological Society. The map was made available to the Bureau of Economic Geology by the Dallas Geological Society without cost as a public service contribution.

New Geology Building on Schedule—Almost

The new Geology Building, originally scheduled for completion at the end of 1966, is two to three months behind schedule but finishing touches on the Bureau's quarters on the fifth floor are so close to complete that the staff has started packing. Estimated moving date is

late February or early March. All of the Bureau's research and administrative offices will be housed in the new structure; the Mineral Studies Laboratory and the Well Sample and Core Library will remain at Balcones Research Center.



The new Geology Building in December 1966.
View toward northwest.

Foreign Visitors to the Bureau

During 1966 the Bureau was privileged to receive visitors from Latin America, Egypt, Hungary, and Yugoslavia. Latin Americans included Ing. Otto H. Bohenberger of Guatemala representing the Instituto Centroamericana de Investigación y Tecnología Industrial, Ing. Antonio Garcia Rojas of Mexico's new Instituto de Petroleo, and a group of geologists from Petroleos Mexicanos headed by Ing. Federico Mina U., Assistant Exploration Manager, accompanied by Ing. Francisco Viniegra O. and Ing. Mario Trejo. Ing. Mina arranged for one of Petroleos Mexicanos' cartographers to spend two weeks at the Bureau learning map-making techniques employed by J. W. Macon and his staff. Ing. Arturo R. Geyne of the Cia. Real de Monte y Pachuca, Mexico, also called at the office.

Prof. Rogic of Zagreb University in Yugoslavia visited in May. Dr. Gyula Bora from the Budapest University of Economics was in Austin in June. Dr. Bakr Elnaasan of Egypt's Bureau of Mines, Cairo, visited in August, and Mr. Mostafa K. Ayouti, a geologist with the Egyptian General Petroleum Corporation of Cairo, spent several days at the Bureau in December during which time Drs. Fisher and Rodda showed him some of the geology in the Austin area. Dr. George Baker of Melbourne, Australia, spent a short time with Dr. Barnes in December in connection with tektite investigations. Dr. Baker is a research scientist with the Commonwealth Scientific and Research Organization and is also an expert on the subject of tektites.

Portable Refraction Seismograph Acquired for Environmental Geology Studies

In 1966 the Bureau purchased a model GT-2 GSC Portable Refraction System, with developmental funds from a National Science Foundation institutional grant to The University. This instrument is now in use in the current environmental geology project for Austin,

Texas, and vicinity. It will provide data on the thickness of terrace and other alluvial deposits. It will also be used to establish a series of profiles across the Balcones fault system to aid in resolving complex structural problems in the western part of the city.

Brown and McGowen Join Bureau's Staff

Dr. L. F. Brown, Jr., formerly a research scientist with the Bureau of Economic Geology from 1957 to 1960, rejoined the Bureau's staff as of August 1966. In the interim period, 1960 to 1966, he was Associate Professor of Geology at Baylor University. From 1955 to 1957, Dr. Brown served as exploration geologist for Standard Oil Company of Texas in Amarillo. He received his Bachelor of Science degree from Baylor University in 1951, a Master of Science from University of Wisconsin in 1953, and a Ph.D. in Geology with a soils

minor from the same school in 1955. While at Wisconsin, Dr. Brown was a Research Associate of the Alumni Research Foundation, working on clays.

Dr. Brown is the author of a number of papers on Pennsylvanian stratigraphy of North-central Texas and plans to continue his research in this area.

McGowen completed requirements for the Ph.D. degree in Geology at The University of Texas in the fall of 1966 except for final work on his dissertation. His doctoral research is a study of the Gum Hollow delta, an



L. F. Brown, Jr.



J. H. McGowen

active delta building in Nueces Bay. Mr. McGowen had been previously employed by the Bureau as a research assistant in the years 1963 to 1966 when most of his duties were in connection with the Texas Geologic Atlas Project. He received a Bachelor of Arts degree from Hardin-Simmons University in 1960 and a Master

of Arts degree from Baylor University in 1964. In 1957 and 1958 he worked as a mud-logger for Southwestern Oil Well Survey Company. Mr. McGowen is currently engaged in studies of the Wilcox Group (with Dr. Fisher), in compilation for the Geologic Atlas, and in Recent sediment work along the Texas Gulf Coast.

Governor Connally Recognizes Petroleum Geologists

Three members of the Bureau of Economic Geology staff were present March 18, 1966, when Governor John Connally recognized the petroleum geologist and his contributions to Texas in the semicentennial year of the American Association of Petroleum Geologists (see photo). The Governor said:

"I am pleased to recognize the petroleum geologist and the semicentennial year of the American Association of Petroleum Geologists.

"More than 4,000 members of this Association live and work in Texas. Their creativeness and resourcefulness in applying the science of geology to the search for petroleum is attested to by the continuing discoveries which have made Texas the leading producer of oil and gas in the United States.

"Organized into professional societies in 13 Texas cities, petroleum geologists make a major contribution to the Texas economy and to community life."



On March 18, 1966, in Austin, Texas, Governor John Connally presented to Peter T. Flawn, Director of the Bureau of Economic Geology, a statement recognizing the contributions of the petroleum geologist in the Semicentennial Year of the American Association of Petroleum Geologists. Members of the Association present at the signing, from left to right, are W. R. Stearns, Gus K. Eifler, Jr., Ronald W. Byram, Carroll E. Cook, Edgar W. Owen, Peter T. Flawn, S. P. Ellison, Jr., and Virgil E. Barnes.

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