

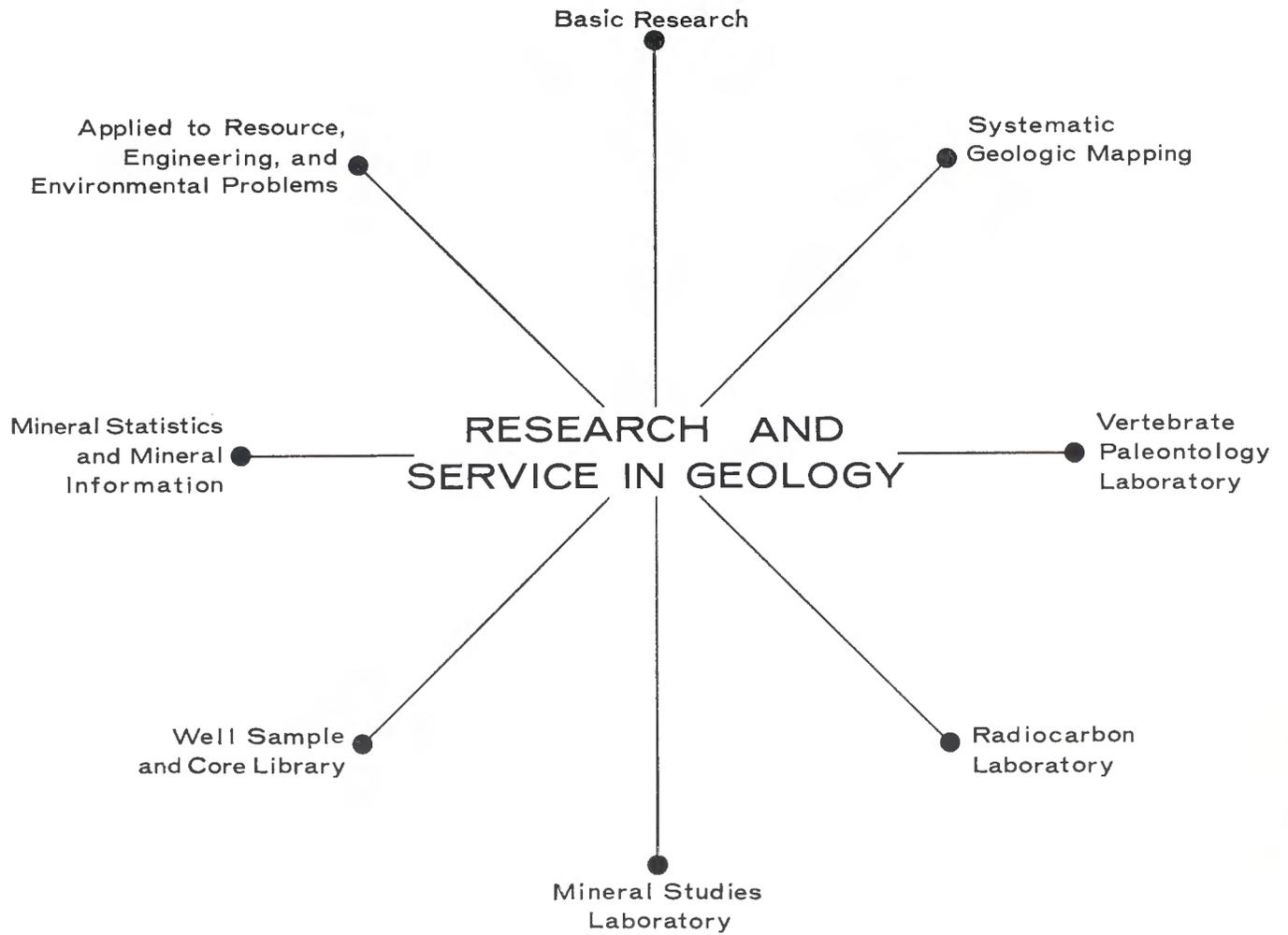


BUREAU OF ECONOMIC GEOLOGY

Report For 1967



BUREAU OF ECONOMIC GEOLOGY



Cover: The Secretary of the Interior, Stewart L. Udall, Speaker at the Dedication of the new Geology Building at The University of Texas at Austin.

THE BUREAU OF ECONOMIC GEOLOGY is one of the organized research bureaus of The University of Texas. Established in 1909, it has for 58 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, engineering, and environmental 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.

Dedication Symposium Draws Large Crowd

Limitations of the earth—a compelling focus for geology was the theme of the symposium that accompanied the formal dedication of the new Geology Building—the Bureau's new home—in November 1967. In addition to the dedicatory address by the Honorable Stewart L. Udall, Secretary of the Interior, a group of distinguished speakers addressed themselves to the resource and environmental problems facing society and the contributions geologists can make to their solution. Topics considered were:

The Role of Geological Concepts in Man's Intellectual Development, James Gilluly
Consequences of Man's Alteration of Natural Systems, Robert F. Legget

Earth's Tolerance for Wastes, P. H. McGauhey
Population, Food and Environment: Is the Battle Lost?, Paul R. Ehrlich
Geological Information for Managing the Environment, John C. Frye
Energy Resources, Charles F. Jones
Geologic Hazards, Richard H. Jahns
Raw Materials Unlimited, Alvin M. Weinberg
Realities of Mineral Distribution, Preston E. Cloud, Jr.
Future Metal Supplies, The Problem of Capability, Thomas S. Lovering
Searching Out Resource Limits, William T. Pecora



Charles Jones, President, Humble Oil & Refining Company, addresses the dedication symposium on energy resources.

Publications in 1967

University of Texas Publication 6711. GEOLOGY OF BIG BEND NATIONAL PARK, BREWSTER COUNTY, TEXAS, by Ross A. Maxwell, John T. Lonsdale, Roy T. Hazard, and John A. Wilson. 320 pp., 152 text figs., 11 pls. including geologic map in color, August 1967.

Paper cover \$12.00 Cloth binding \$14.00

Culmination of almost 30 years of study by many scientists of the geology of the Big Bend National Park, Publication 6711 contains a vast amount of information on the fascinating area it covers. A memorial to the late Dr. Lonsdale, Director of the Bureau from 1945 to 1960, prefaces the scientific text. Main subdivisions of the report are titled "Land Forms," "Stratigraphy," "Early Tertiary Mammals," "Geology of Intrusive Igneous Rocks," and "Structural Geology." The publication is profusely illustrated with 152 line drawings and photographs, one of which is a panoramic view of the Chisos Mountains Basin. The 11 plates, in a separate holder, include a large colored geologic map on a scale of 1:62,500 as well as structure and stratigraphic sections. Sixteen tables of chemical analyses and other data are an integral part of the publication. A bibliography of 209 references adds to the usefulness of the report, which also includes a comprehensive index.

Report of Investigations No. 59. LOWER CRETACEOUS SANDS OF TEXAS; STRATIGRAPHY AND RESOURCES, by W. L. Fisher and Peter U. Rodda. 116 pp., 12 text figs., 3 pls., including geologic map in color, 5 tables, March 1967 \$1.75

Report of Investigations No. 60. SAND RESOURCES OF TEXAS GULF COAST, by L. E. Garner. 85 pp., 12 text figs., 6 pls., including geologic map in color, 8 tables, March 1967 \$1.50

These two reports are concerned with industrial sand resources in Texas. Industrial sands include abrasive sand, glass and chemical sand, molding and furnace sand, refractory sand, filter sand, hydraulic fracturing sand, and sand for production of silica flour.

Report of Investigations No. 59 deals with the occurrences of sand in Central and North Texas including deposits in the Twin Mountains, Paluxy, and Travis Peak Formations. About 175 samples were collected and analysed from 114 localities in Bosque, Callahan, Coleman, Comanche, Cooke, Coryell, Denton, Erath, Hamilton, Hood, Montague, Nolan, Parker, Somervell, Tarrant, Taylor, and Wise counties. A few deposits will meet purity and grain size specifications for certain industrial uses with simple washing and sizing; about one-third of the deposits could be brought to acceptable grades with more extensive beneficiation.

Report of Investigations No. 60 covers a survey area which includes Pleistocene and Recent deposits of alluvial, deltaic, beach and aeolian sands in Aransas, Austin, Brazoria, Calhoun,

Cameron, Colorado, Chambers, Fort Bend, Galveston, Hardin, Harris, Hidalgo, Jackson, Jefferson, Kleberg, Kenedy, Liberty, Matagorda, Nueces, Orange, Refugio, San Patricio, Victoria, Waller, Wharton, and Willacy counties. The report includes a summary of the areal geology; description of physical and chemical properties of sands; discussion of prospecting methods and beneficiation procedures; and data on production, consumption, and value of silica sands in Texas. Analyses of 170 samples, descriptions of laboratory techniques, and sample locality descriptions are also presented.

Report of Investigations No. 61. HURRICANES AS GEOLOGICAL AGENTS: CASE STUDIES OF HURRICANES CARLA, 1961, AND CINDY, 1963, by Miles O. Hayes. 56 pp., 30 text figs., 2 tables, August 1967 \$1.25

Tropical storms, which cross the Texas coastline with a frequency of 0.67 storms per year, play a major role in nearshore sedimentation. Greatest geological effects are produced by wind-driven waves and storm surges that change the configuration of the coast. *Carla* removed a belt of dunes 20 to 50 yards wide from the seaward side of Padre Island, formed a hurricane beach, and left a wave-cut cliff up to 10 feet high.

Report of Investigations No. 62. LATE CAMBRIAN AND EARLY ORDOVICIAN FAUNAS FROM THE WILBERNS FORMATION OF CENTRAL TEXAS, by Don Winston and Harry Nicholls. Reprinted from *JOURNAL OF PALEONTOLOGY*, vol. 41, no. 1, pp. 66-96, January 1967 [March] \$0.75

The San Saba Member of the Wilberns Formation of Central Texas is mostly coarse-grained, trilobitic limestone that grades eastward to dolomite and contains sandstone intervals in its westernmost exposures. Faunas from the limestone place the middle part of the San Saba within the Trempealeaan Stage of the Upper Cambrian but the uppermost part belongs to the Lower Ordovician. Seventeen new trilobite species are described and illustrated on five plates.

Geologic Atlas of Texas. LUBBOCK SHEET. Scale: 1:250,000. Halbert Pleasant Bybee Memorial Edition. April 1967 \$2.50

Geologic Atlas of Texas. SHERMAN SHEET. Scale: 1:250,000. Walter Scott Adkins Memorial Edition. October 1967 \$2.50

These colored geologic maps, with a scale of 1 inch equals 4 miles, cover areas of 1° of latitude by 2° of longitude and were compiled under direction of Dr. V. E. Barnes, project director. They were reviewed and edited by the Geologic Atlas Project Committee of the West Texas Geological Society and Dallas and Fort Worth Geological Societies, respectively. All maps show topography, roads, and culture in addition to geology.

The Lubbock Sheet honors the late Dr. Bybee, distinguished Texas geologist, professor at The University of Texas at Austin from 1914 to 1925 and 1936 to 1957, and the man who organized and for many years directed the University Lands Office in Midland, Texas. Dr. Bybee's supervision of the early oil and gas leasing of University of Texas lands in West Texas contributed greatly to growth of The University's permanent fund.

The Lubbock Sheet covers all or parts of Hale, Floyd, Motley, Cottle, King, Dickens, Crosby, Lubbock, Lynn, Garza, Kent, and Stonewall counties.

The Sherman Sheet honors the late Walter Scott Adkins, distinguished Texas geologist, who was on the Bureau of Economic Geology staff from 1919 to 1921 and from 1926 to 1934. Mr. Adkins specialized in Cretaceous stratigraphy and paleontology and was internationally known for his contributions in these subjects.

The Sherman Sheet includes parts or all of Clay, Collin, Cooke, Denton, Faunin, Grayson, Hunt, Montague, and Wise counties.

Geologic Quadrangle Map No. 32. GEOLOGY OF THE CAVE CREEK SCHOOL QUADRANGLE, GILLESPIE COUNTY, TEXAS, by V. E. Barnes. Map with 11-page text. Scale: 1:24,000. March 1967 \$1.75

Geologic Quadrangle Map No. 33. GEOLOGY OF THE MONUMENT HILL QUADRANGLE, BLANCO COUNTY, TEXAS, by V. E. Barnes. Map with 7-page text. Scale: 1:24,000. March 1967 \$1.50

Geologic Quadrangle Map No. 34. GEOLOGY OF THE YEAGER CREEK QUADRANGLE, BLANCO AND HAYS COUNTIES, TEXAS, by V. E. Barnes. Map with 6-page text. Scale: 1:24,000. April 1967 \$1.50

These three maps are of 7.5-minute quadrangles and are published on new topographic bases. They are in color and continue the series of Central Texas geologic quadrangle maps. The texts describe geology, rock and mineral resources, and water resources of the subject areas.

Geological Circular GC 67-1. URANIUM IN TEXAS—1967, by Peter T. Flawn. 16 pp., January [March]. Reprinted August 1967 \$0.50

This paper summarizes the history of the uranium industry in Texas, describes the current situation, and notes that prospects for new uranium discoveries in the Gulf Coastal Plain appear to be good. The Texas High Plains also warrant prospecting. A bibliography of 110 references concludes the circular.

Geological Circular GC 67-2. FLUORSPAR IN BREWSTER COUNTY, TEXAS, by William N. McNulty, Sr. 16 pp., 3 text figs., June [August] 1967 \$0.50

This paper describes deposits in Texas in the Big Bend areas of the Christmas Mountains, Mariscal Mountains, and Terlingua where fluor spar is known to occur. In the past Marathon, Texas has become one of the principal fluor spar shipping points of the world, but the ore shipped comes from Mexican mines across

the Rio Grande. Fluorspar is an important metallurgical mineral used in steel and aluminum working processes.

Geological Circular GC 67-3. HISTORY OF GEOLOGY AT THE UNIVERSITY OF TEXAS, by Keith Young. 40 pp., 4 text figs., 1 pl. and frontispiece. November 1967 ... \$0.50

This circular was prepared as a special issue for the dedication of the new Geology Building on the Main Campus of The University of Texas at Austin. The frontispiece is a photograph of Old Main Building taken about 1901, and the one plate depicts the geology rig of W. B. Phillips, first Director of the Bureau of Economic Geology, and the first car (a one-cylinder Brush) which the Bureau owned.

Mineral Resource Circular No. 49. THE MINERAL INDUSTRY OF TEXAS IN 1966, by F. F. Netzeband and Roselle M. Girard. December 1967 Free on request

Bulletin 3701 Reproduced

University of Texas Bulletin 3701, THE GEOLOGY OF TEXAS, Vol. III, Upper Paleozoic Ammonites and Fusulinids, by F. B. Plummer, Gayle Scott, C. O. Dunbar, and J. W. Skinner, published by the Bureau in 1937, has been out of print and unavailable for many years. During 1967 it was reproduced by Xerography by University Microfilms, Inc., 313 North First Street, Ann Arbor, Michigan 48106. Their reference number is OP 26,729 and the cost is \$13.25 per copy.

Open-File Reports

During 1967 the U. S. Atomic Energy Commission, Grand Junction, Colorado, placed on open-file with the Bureau of Economic Geology "Preliminary Reconnaissance Reports on Uranium Investigations in the United States in 1950-1958." Film copies, known as microfiche, each 4 x 6 inches, contain an average of 30 reports. The total number for Texas is 170 reports on 33 cards. A microfilm reader is available at the Bureau office for use of these microfiche cards.

A preliminary report entitled "Physical and Associated Properties of Uranium-bearing Rock in Five Drill Holes in Karnes County, Texas," by G. Edward Manger and D. Hoyer Eargle, was placed on open-file with the Bureau in May 1967 by the U. S. Geological Survey. This 19-page typewritten report is accompanied by a section showing correlation of beds core-drilled in the vicinity of Deweesville, Karnes County, Texas.

Publications in Press

Report of Investigations No. 63. Lithology and Petrology of the Gueydan (Catahoula) Formation in South Texas, by E. F. McBride, W. L. Lindemann, and P. S. Freeman.

Guidebook No. 7. The Big Bend of the Rio Grande, A Guide to the Rocks, Landscape, Geologic History, and Settlers of the Area of Big Bend National Park, by Ross A. Maxwell.

Geological Circular GC 67-4. Depositional Systems in the Wilcox Group of Texas and Their Relationship to Occurrence of Oil and Gas, by W. L. Fisher and

J. H. McGowen. Reprint from Transactions of the Gulf Coast Association of Geological Societies, vol. 17.

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

Geologic Quadrangle Map No. 36. Igneous Geology of the Central Davis Mountains, Jeff Davis County, Texas, by J. E. Anderson, Jr.

Geologic Atlas of Texas. Van Horn—El Paso, Palestine, Beaumont, Houston, and Plainview Sheets.

Publications by Bureau of Economic Geology Staff in Scientific Journals

Brown, L. F., Jr., with O. T. Hayward (1967) Comanchean Cretaceous rocks of Central Texas: Society of Economic Paleontologists and Mineralogists, Permian Basin Section, Publication No. 67-8, pp. 31-48.

Brown, L. F., Jr., with J. H. McGowen, M. J. Seals, T. H. Waller, and J. R. Ray (1967) Role of compaction in development of geometry of superposed elongate sandstone bodies (abst.): American Association of Petroleum Geologists Bulletin, vol. 51, no. 3, pp. 455-456.

Fisher, W. L., and J. H. McGowen (1967) Depositional systems in the Wilcox Group of Texas and their relationship to occurrence of oil and gas: Gulf Coast Association of Geological Societies, Transactions, vol. 17, pp. 105-125.

Fisher, W. L., and J. H. McGowen (1967) Lower Eocene lagoonal systems in the Texas Gulf Coast Basin: Resúmenes, UNESCO Simposio Internacional Sobre Lagunas Costeras, p. 30, Mexico City.

Fisher, W. L., and P. U. Rodda (1967) Stratigraphy and genesis of dolomite, Edwards Formation (Lower

Cretaceous) of Texas, in Proceedings, Third Annual Forum on Geology of Industrial Minerals: State Geological Survey of Kansas, Special Distribution Publication 34, pp. 52-75.

Flawn, P. T. (1967) The other road: Journal of Geological Education, vol. 15, no. 1, pp. 5-7.

Flawn, P. T., et al. (1967) Basement map of North America: U. S. Geological Survey, Washington, D.C.

Flawn, P. T., et al. (1967) Wells penetrating basement in North America: Microfiche Card File, Basement Rocks Project Committee, American Association of Petroleum Geologists, Tulsa, Oklahoma.

Nagle, J. S. (1967) The illustrated key as a paleontology teaching aid: Journal of Geological Education, vol. 25, no. 4, pp. 160-161.

Nagle, J. S. (1967) Wave and current orientation of shells: Journal of Sedimentary Petrology, vol. 37, pp. 1124-1138.

Rodda, P. U., and W. L. Fisher (1967) Dolomite depositional models, Edwards Formation (Lower Cretaceous), Texas (abst.): Program of Annual Meeting of Geological Society of America, p. 187.

Projects

Texas Geologic Atlas Project

Sheets published or in press during the year, with names of counties entirely or partly within the sheet, are listed in order of date of publication or completion, as follows:

Lubbock sheet—Hale, Floyd, Motley, Cottle, Foard, Lubbock, Crosby, Dickens, King, Lynn, Garza, Kent, and Stonewall counties.

Sherman sheet—Clay, Montague, Cooke, Grayson, Fannin, Jack, Wise, Denton, Collin, and Hunt counties in Texas and Jefferson, Love, Marshall, and Bryan counties in Oklahoma.

Van Horn-El Paso sheet—El Paso, Hudspeth, Culberson, Reeves, and Jeff Davis counties.

Palestine sheet—Freestone, Anderson, Cherokee, Rusk, Panola, Shelby, Leon, Houston, Trinity, Angelina, Nacogdoches, San Augustine, Sabine, Madison, Walker, Polk, Tyler, Jasper, and Newton counties.

Beaumont sheet—Madison, Houston, Walker, Trinity, San Jacinto, Polk, Tyler, Jasper, Newton, Grimes, Montgomery, Waller, Harris, Liberty, Hardin, Orange, and Jefferson counties.

Honston sheet—Waller, Harris, Liberty, Jefferson, Orange, Chambers, Fort Bend, Brazoria, Galveston, Matagorda, and Wharton counties.

Plainview sheet—Randall, Armstrong, Donley, Collinsworth, Swisher, Briscoe, Hall, Childress, Hale, Floyd, Motley, Cottle, and Foard counties.

Field checking was completed during the year for the Abilene, Dallas, Waco, Amarillo, and the Texas portion of the Perryton, Dalhart, and Tucumcari sheets. Field checking for the Brownsville sheet and for the Quaternary portions of the Seguin and Beeville—Bay City sheets has also been completed.

Bureau staff members who worked on the Atlas Project during the year under the direction of Dr. V. E. Barnes included Dr. G. K. Eifler, Jr. (Plainview, Amarillo, and the Texas portion of the Perryton, Dalhart, and Tucumcari sheets); Dr. L. Frank Brown, Jr., and Mr. J. L. Goodson (Abilene sheet); Mr. J. H. McGowen (Dallas and Waco sheets); Mr. D. F. Reaser

(Dallas sheet); and Mr. C. V. Proctor, Jr. (Waco sheet).

Two former Bureau staff members returned to the Geologic Atlas Project for several weeks during the summer. Dr. Thomas E. Brown, Professor of Geology at Stephen F. Austin State University in Nacogdoches, spent July and August field-checking the eastern portion of the Austin sheet. Mrs. Charles (Mary Kathryn) Pieper returned from Nashville, Tennessee to work on the Seguin sheet during June and July before accompanying her husband to Brazil.

Mr. P. B. Rose, graduate student in geology at The University of Texas at Austin, has mapped Fredericksburg and younger rocks in most of the southern half of the Llano sheet and the northern half of the San Antonio sheet in connection with his Ph.D. dissertation. This mapping was compiled and scribed at a scale of 1:250,000 by the Bureau for Mr. Rose in exchange for the use of the mapping for the Atlas Project.

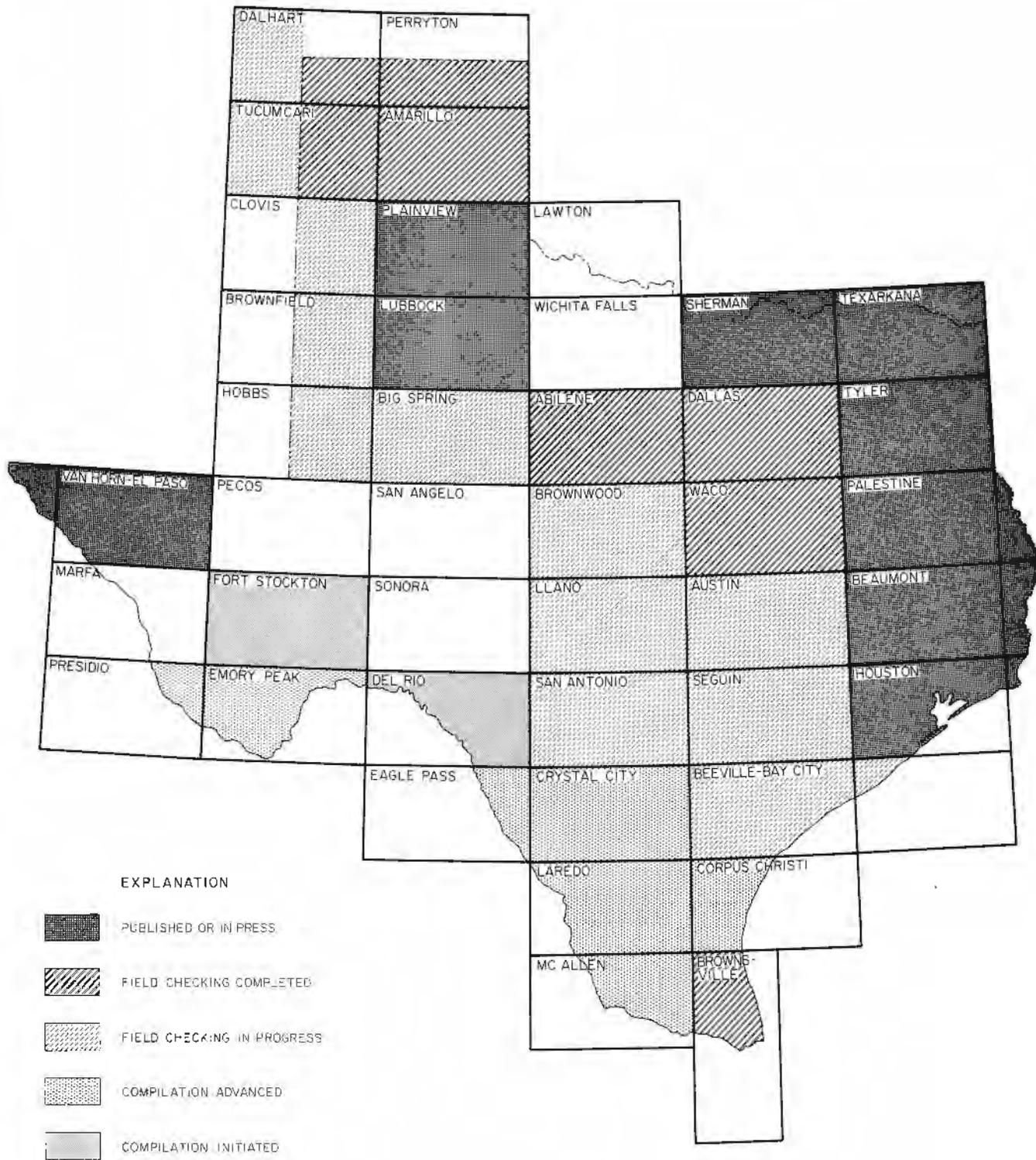
During the summer, Dr. Saul Aronow, of Lamar State College of Technology, completed office compilation of the Quaternary portions of the Beeville-Bay City and Seguin sheets.

Mr. D. F. Reaser's mapping on the Dallas sheet was done while completing requirements for a Ph.D. degree in geology at The University of Texas at Austin. He accepted a position in September at West Texas State University in Canyon.

Mr. C. V. Proctor, who mapped on the Waco sheet, left for Fort Collins in September where he will work on his Ph.D. degree at Colorado State University.

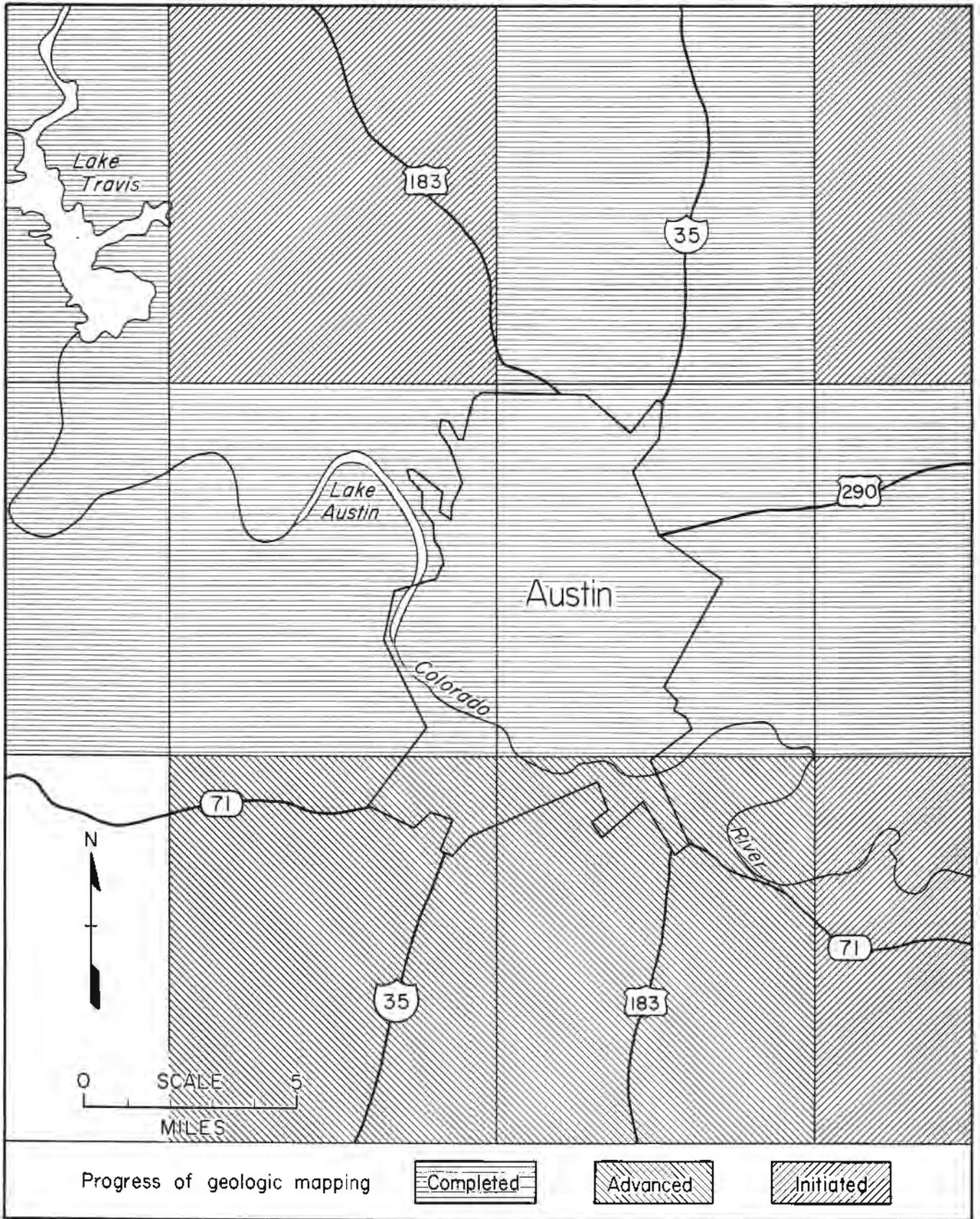
Mr. J. L. Goodson entered the graduate school of The University of Texas at Austin in September to work on his Ph.D. in geology and will continue with the Atlas Project part time.

The Geologic Atlas Committee of the West Texas Geological Society has undertaken compilation and field-checking of the Big Spring sheet. This work was initiated while Dr. L. W. Bridges was chairman; when Dr. Bridges was transferred to New Orleans, it was carried on under the direction of Mr. William McBee, Jr. When Mr. McBee left Midland, Mr. W. R. Larsen accepted the chairmanship of the committee, which now



includes as members Mr. Robert Pavlovic (Mobil Oil Company) and Mr. W. L. Ammon (Pan American Petroleum Corporation). Mr. G. L. Evans (Louisiana Land and Exploration Company) resigned from the committee when he moved to Calgary.

During the coming year field checking is scheduled for the Brownwood sheet by Dr. L. Frank Brown and Mr. Goodson; for the Texas portions of the Clovis, Brownfield, and Hobbs sheets by Dr. Eifler; for the Austin sheet by Mr. McGowen; and for the Seguin sheet



by Mr. McGowen and Dr. T. E. Brown. It is hoped that sheets published during 1968 will include the Abilene, Dallas, Waco, and Amarillo sheets and perhaps some of the Panhandle sheets shared by New Mexico and Oklahoma.

Mr. J. W. Macon, the Bureau's cartographer, continues supervision of scribing, color separation, and preparation of all Geologic Atlas sheets for the press.

Urban Geology of Austin and Vicinity

A study of the geology and resources of the Austin area. P. U. Rodda, K. P. Young, and others. The resulting report will focus on environmental and engineering geology and will provide basic data for planners, engineers, and others. Geologic mapping is scheduled for completion in 1968. Status of mapping of quadrangles at the close of 1967 is indicated in the accompanying figure. Surface mapping of terrace deposits has been completed by L. E. Garner. Collection and analysis of samples are advanced. Two special maps are being prepared: (1) thickness (isopach) map of sand and gravel deposits, and (2) contour map on base of sand and gravel deposits. These maps are being compiled from surface mapping, unpublished engineering test hole data, portable seismograph data, and earth resistivity meter data. Scale is same as geologic quadrangle maps (1:24,000). Engineering data obtained from State and Municipal agencies and private laboratories have been plotted on base maps, compiled by stratigraphic unit, and summarized in tables and graphs. Such data include density, moisture content, plasticity index, shrink-swell, compressive strength, and penetrometer tests. Resistivity measurements for establishing corrosion potential are now being made.

Depositional Systems in the Wilcox Group of Texas

A comprehensive study of the Wilcox Group (including Carrizo Formation) in outcrop and downdip through extent of existing well penetration, encompassing an area of approximately 40,000 square miles throughout the Texas Gulf Coast. W. L. Fisher and J. H. McGowen. Investigation has been under way for about 3 years, involving study of about 3,000 well records along with description of about 300 outcrop sections and surface mapping of principal rock units. Sixty-five stratigraphic dip and stratigraphic strike

cross sections have been prepared at 8–10 mile intervals throughout the Texas Gulf Coast for the purpose of three-dimensional delineation of principal rock units. These facies, in turn, have been studied in regard to composition, distribution, relationship to other rock units, and depositional history in light of modern analogues. At present 10 depositional systems have been recognized, described, and mapped in the Texas Wilcox. Special emphasis is being placed on criteria for recognizing ancient depositional systems, including two varieties of delta systems, fluvial systems, barrier bar systems, strandplain systems, lagoon-bay systems, and shelf systems, as well as the recognition of defining component facies within these systems. Wilcox depositional systems and their component facies show distinct relationships to the occurrence, distribution, and quality of mineral deposits, including oil and gas (sub-surface), fresh water (subcrop), and lignite, ceramic clay, and industrial sand (outcrop).

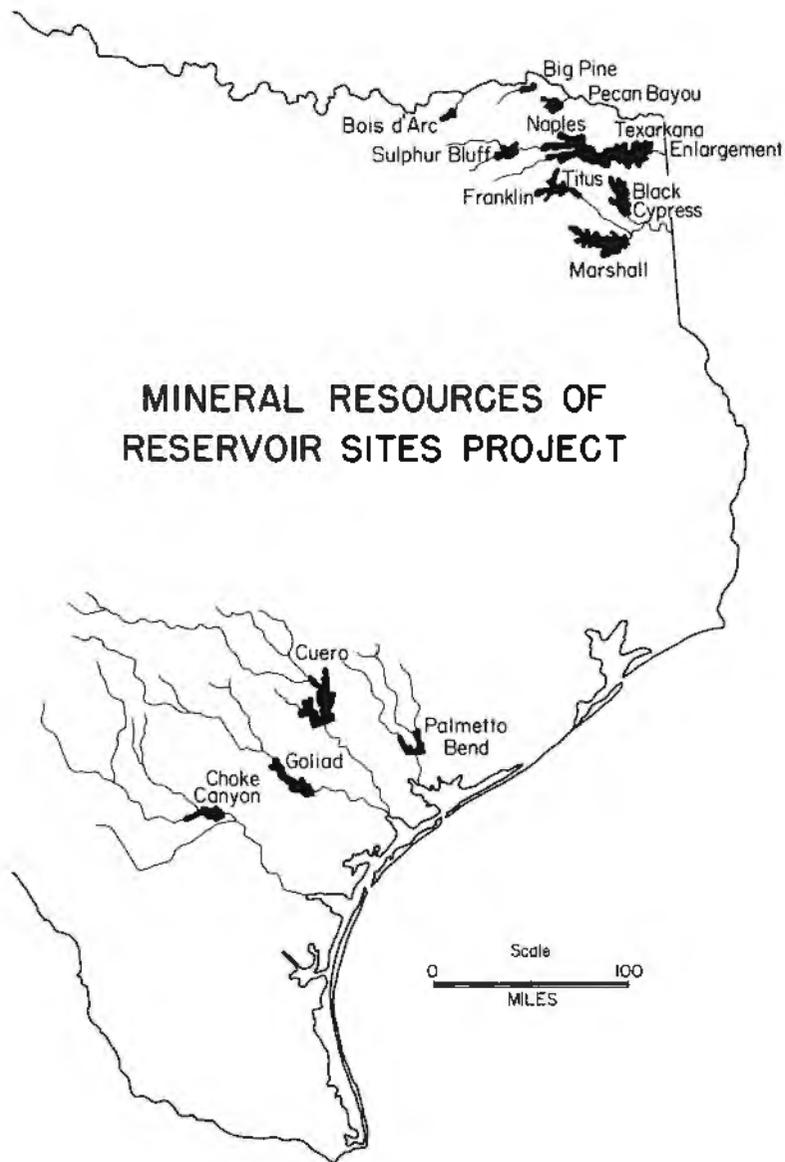
A preliminary report of the depositional systems of the lower part of the Wilcox Group in Texas was published during the year in volume 17 of the Gulf Coast Association of Geological Societies Transactions; it will be reprinted in the *Bulletin* of the American Association of Petroleum Geologists and as Bureau of Economic Geology Geological Circular 67–4. Publication of the completed study as a Bureau of Economic Geology report is anticipated by late 1968 or early 1969.

Mineral Resources of South and Northeast Texas Reservoir Sites

Contract between Bureau of Economic Geology and Texas Water Development Board. Directed by W. L. Fisher, assisted by W. R. Stearns (oil and gas), L. E. Garner, and G. L. Dawe. The project involves mineral inventory and evaluation of the following South Texas and Northeast Texas proposed reservoir sites:

<i>Northeast Texas</i>	<i>South Texas</i>
Bois d'Arc	Goliad
Big Pine	Cuero
Pecan Bayou	Palmetto Bend
Sulphur Bluff	Choke Canyon
Naples	
Texarkana Enlargement	
Titus	
Franklin	
Black Cypress	
Marshall	

Investigation includes mapping (1:50,000 aerial



photograph base) of principal surface rock units within and adjacent to proposed reservoir sites. Approximately 200 samples of deposits from surface-mapped units are currently being tested and evaluated in terms of potential commercial value. Mineral resources include, principally, ceramic and nonceramic clay, industrial and construction sand, constructional gravel, lignite, volcanic ash, crushed stone (quartzite, ironstone, sandstone, caliche), uranium ore, and iron ore. Limits and total reserves of currently productive oil and gas fields within proposed sites are being determined, and problems concerning production after inundation are being evaluated.

Final project report, scheduled for completion in the

early part of 1968, will include lithologic and mineral deposit maps of each reservoir site, and inventory, description, and evaluation of mineral deposits by reservoir site.

Areal Geologic Studies

The Moore Hollow Group of Central Texas. V. E. Barnes and W. C. Bell. A study of the paleontology and stratigraphy of outcropping Cambrian rocks and contiguous overlying strata. Work is progressing on the systematic paleontology and paleoecology for this long-term project.

Relict Paleozoic of Central Texas. V. E. Barnes, A. J. Boucot, P. E. Cloud, Jr., Helen Duncan, R. H.

Flower, and Mackenzie Gordon. A comprehensive investigation of the rocks that make up the sequence from the top of the Ellenburger to the base of the Marble Falls. These strata now are preserved only at scattered localities. Specialists in various fossils are studying the paleontology of the sequence; Cloud and Barnes are studying the stratigraphy. Work is progressing on this long-term project, which is expected to be finished in about four 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. A study that has as its aim the development of a stratigraphic model in near-shore facies. Work includes detailed geologic mapping of an area of approximately 1,200 square miles. The manuscript and cartography for the first part of this four-part project are now in preparation.

Geometry of superposed elongate Pennsylvanian-Permian sandstone bodies, North-central Texas. L. F. Brown, Jr. A study of the effect of compaction and geologic structure on the real and vertical distribution of Pennsylvanian-Permian elongate sandstones. The surface and near-surface investigations have resulted in the delineation of the channel patterns within an area of approximately 2,000 square miles. Work on the project is complete; the manuscript is in preparation.

Stratigraphic problems and depositional patterns in the Upper Pennsylvanian and Lower Permian of North-central Texas. L. F. Brown, Jr., and former graduate students. A project that focuses on the definition of a depositional model. Stratigraphic relationships are summarized. They include carbonate and clay-shale facies, vertical sequences, and sandstone-distribution patterns. The project is complete, and the manuscript is in preparation.

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

Depositional history of Gum Hollow delta (a fan delta), Nueces Bay, Texas. J. H. McGowen. The definition of the depositional model for a fan delta. Studies of primary sedimentary structures of this modern delta will aid in the interpretation of depositional environments of ancient sediments. Work on the project is complete and the manuscript is now in preparation.

Stratigraphic studies of Lower Cretaceous rocks. P. U. Rodda and W. L. Fisher. A long-term study of the stratigraphy, paleontology, and resources of Lower Cretaceous rocks in Texas. Recently completed stratigraphic and resource studies of basal Cretaceous sands between the Red and Colorado Rivers have been published as Bureau of Economic Geology Reports of Investigations 58 and 59. The stratigraphy and origin of dolomite in the Edwards Formation have been described by Fisher and Rodda in the Proceedings of the 3rd Forum on Geology of Industrial Minerals. Investigations of the origin of Edwards chert are in progress. Study of certain well-preserved Edwards rudist-reef fossil assemblages was initiated; preliminary analyses have been made of collections of the Bureau of Economic Geology and the U. S. National Museum. Additional stratigraphic studies are in the planning stage.

Mineral Resource Studies and Mineral Statistics

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 extensive talc deposits in the Precambrian rocks of the region.

Geology and Recreation

Geologic guide to the State Parks of Texas. R. A. Maxwell. A non-technical description of the geology of the parks that also includes information about areas of historical and scenic interest. Designed to provide information for park visitors. Editing of the manuscript and preparation of illustrations are nearing completion.

Geology of Palo Duro State Park. W. H. Matthews III, Professor of Geology, Lamar State College of Technology, Beaumont. A non-technical geological guide designed for visitors to the park. Editing of the manuscript is nearing completion.

Bibliographies and Catalogs

Bibliography and index of Texas geology, 1951-1960. Indexed by M. D. Brown. The bibliographic listing,

with index, of publications pertaining to Texas geology. This is a continuation of earlier bibliographies and indices (Univ. Texas Bull. 3232, pt. 4, and Pub. 5910).

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. Editing of the manuscript is in progress.

Public Service

One of the important services of the Bureau is that of disseminating information about Texas geology and mineral production. This is accomplished not only by

published reports of Bureau studies, but also by personal assistance to individuals and organizations.

During the year, all members of the Bureau research staff continued to provide information by conference and by correspondence. Two staff members who spent a large portion of their time in such direct public service 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 inquiries from all over the State and Nation.

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.

Mineral Studies Laboratory

The Mineral Studies Laboratory continued to test, analyze, and evaluate the possible commercial use of samples of Texas rocks and minerals in support of research projects of the Bureau of Economic Geology, the Department of Geology, and other departments of The University of Texas at Austin.

The Bureau projects in which this Laboratory has participated include the Austin Urban Geology Project and the Reservoir Inventory and Evaluation Project, which are in progress. Completed this year have been a series of core samples submitted for grain-size analyses and heavy mineral separations for Dr. W. L. Fisher and a series of chemical analyses of limestones for Dr. Peter U. Rodda. Samples of Texas rocks submitted to the Bureau for physical testing, chemical or spectrographic analysis, and evaluation included clay, sand, volcanic ash, perlite, wollastonite, gypsum, asphalt, and rocks suspected of containing silver or rare earths.

The Laboratory also investigated (1) the possibility of building a sensitive mercury vapor detector and (2) the possibility of analyzing for one ppm of tin in silicate matrix. The Department of Geology faculty used the facilities as follows: (1) Professor F. E. Ingerson sent an assistant to prepare a series of samples; (2) Professor L. E. Long received 5 grams of U.S.G.S. standard granite G-1 (no longer available from the U.S.G.S.) to be used as a standard for rubidium and strontium; (3) Dr. Long's assistants used sample

preparation facilities (54 rock samples); (4) Dr. Keith Bell, post-doctoral fellow, used sample preparation facilities (31 rock samples) and the electromagnetic separator.

D. A. Schofield and Tom Etheredge visited the chemistry laboratory of the Texas State Health Department for the purpose of observing the performance of a dual-purpose flame emission and atomic absorption spectrophotometer of the same kind as the one later purchased for the Mineral Studies Laboratory.

Visitors to the Mineral Studies Laboratory in 1967 included Mr. Fowler, Shamrock Oil and Gas Company, Amarillo, Texas; Dr. Charles Howard and two of his students in analytical chemistry in San Antonio College (Miss Nancy Hatzenbuehler and Mr. John Shutz); Mr. William Rossman, William Rossman Mineral Exploration, Fredericksburg, Texas; Mr. Barney C. McCasland, Jr., Senior Geologist, Bear Creek Mining Company, Midland, Texas; and Mr. Aref M. Gawich, graduate student of Dr. E. L. Powers, Radiation Biology Laboratory, Balcones Research Center.

The following new equipment was added to the Laboratory: (1) A Precision Scientific Co. Blaine air permeability fineness tester. This instrument will make possible the determination of the fineness of pulverized pozzolanic materials by ASTM Designation: C204-55 as specified by the U. S. Bureau of Reclamation.

(2) A Corning PC-100 thermostatically controlled



Chemist J. T. Etheredge and the Mineral Studies Laboratory's new Jarrell-Ash Atomic Absorption unit.

hot plate. The top of this hot plate is made of a corrosion-resistant ceramic material which avoids the possible aluminum or iron contamination of the usual hot plate.

(3) A dual-scale master plate to be used in conjunction with an ARL densitometer. This plate is designed for DC arc excitation and covers the wave length ranges of 2380 to 4595 Å in the ultraviolet region and 4580 to 6794 Å in the visible spectrum.

(4) A new dimension was added to the Mineral Studies Laboratory by the installation of a Jarrell-Ash dual-purpose atomic absorption and flame emission spectrophotometer Model No. 82-526 SP with all major accessories. This instrument will add the advantages of flame atomic absorption to the quantitative determination of the 25 elements for which this technique is superior to flame emission spectrophotometry. For example, by atomic absorption it will be possible to detect 0.1 ppm of gold while the limit of detection of the laboratory's emission spectrograph is about 10 ppm (\$10.00 per ton of rock).

Well Sample and Core Library

The Well Sample and Core Library at Balcones Research Center offers facilities for geologists and other interested persons to examine and study Texas well samples and cores.

The Library's collections contain more than 286,000 feet of core material and about 6½ million cutting samples from oil, gas, and water wells of Texas, together with about 10,000 sample logs, 1,000 electric logs, and 150,000 drillers' logs.

Additions to the collections during 1967 include Phillips Petroleum Company's (Amarillo office) donation of samples from Carson, Gray, Hansford, Hemphill, Hutchinson, Lipscomb, Moore, Potter, Roberts, Sherman, and Wheeler counties; Amerada Petroleum Corporation's (Midland office) gift of samples from 150 wells in Scurry, Stonewall, Gaines, and adjacent counties. A few samples were furnished by Tenneco Oil Company of Corpns Christi and Montgomery's Stratigraphic Service, San Antonio. The Pan American Petroleum Corporation (Oklahoma City) donated cores from 10 wells in Lipscomb and Wheeler counties, and the Emarco Production Laboratories, Inc. (Houston) contributed about 10,000 feet of ½-inch core plugs from the Gulf Coast.

During January 1967 the Well Sample Library changed its method for processing and storing samples. One sample only is now packaged in a 2-dram glass vial and placed in a metal cabinet. The new method saves much time when processing the sample material, is expected to save about 60 percent on storage space, and the samples are kept more safely from fire, rats, and termites.

At the close of 1967, construction of additional space for the Library's collection is nearing completion.

Staff Activities

Scientific Meetings

Staff members represented the Bureau of Economic Geology at numerous scientific and professional meetings in 1967. Principal meetings attended during the year include:

Abilene Geological Society, Meeting, May, Abilene, Texas—L. F. Brown, Jr.

American Association of Petroleum Geologists, Annual Meeting, April, Los Angeles, California—L. F. Brown, Jr., P. T. Flawn, P. U. Rodda

- American Association of Petroleum Geologists, Special Meeting of Research Committee to plan a Geothermal Study Project, July, Houston, Texas—P. T. Flawn
- American Geological Institute, Board of Directors Meeting, January, Washington, D.C.; April, Los Angeles, California; June, Dallas, Texas; October, Oklahoma City, Oklahoma; November, New Orleans, Louisiana; *and* House of Representatives, April, Los Angeles, California; November, New Orleans, Louisiana—P. T. Flawn
- American Institute of Professional Geologists, Texas Section, Meeting, October, Houston, Texas—G. K. Eifler, Jr., P. T. Flawn
- Association of American State Geologists, Annual Meeting, May, Lincoln, Nebraska—V. E. Barnes, P. T. Flawn
- Association of Engineering Geologists, Annual Meeting, October, Dallas, Texas—P. T. Flawn
- Forum on Geology of Industrial Minerals, 3d Annual, April, The University of Kansas, Lawrence, Kansas—W. L. Fisher, P. U. Rodda
- Geological Society of America, Annual Meeting, November, New Orleans, Louisiana—V. E. Barnes, L. F. Brown, Jr., W. L. Fisher, P. T. Flawn, P. U. Rodda
- Geoscience Information Society, Annual Meeting, November, New Orleans, Louisiana—R. M. Girard
- Gulf Coast Association of Geological Societies, Annual Meeting, October, San Antonio, Texas—G. K. Eifler, Jr., W. L. Fisher, J. W. Macon, J. H. McGowen
- Gulf Universities Research Corporation, Workshop on Marine Geology, March, Bayview, Texas; *and* Meeting of Advisory Board, October, Dallas, Texas—P. T. Flawn
- International Science Information Services, Inc., Seminar and Workshop on Large Scientific Data Files, July, Dallas, Texas—R. M. Girard
- Lafayette Geological Society, Meeting, November, Lafayette, Louisiana—W. L. Fisher
- Meteoritical Society, 30th Annual Meeting, October, National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California—V. E. Barnes
- Mississippi Geological Society, Meeting, December, Jackson, Mississippi—W. L. Fisher
- National Academy of Science—National Research Council, Meeting of Committee on Space Programs for Earth Observations, Advisory to the U. S. Geological Survey, March, Washington, D.C.; Meeting of Committee on Resources and Man, September, Vancouver, B.C.—P. T. Flawn
- Resource Use Education Workshop, February, Fort Worth, Texas—W. L. Fisher
- Smithsonian Summer Institute in Systematics, June, July, Washington, D.C.—P. U. Rodda
- Society of Economic Paleontologists and Mineralogists, Annual Meeting, April, Los Angeles, California—L. F. Brown, Jr.
- Soil Survey Technical Work-Planning Conference, Texas A&M University, April, College Station, Texas—L. F. Brown, Jr., L. E. Garner
- Southwestern Legal Foundation, Symposium on Exploration and Economics of the Petroleum Industry, March, Dallas, Texas—P. T. Flawn
- Texas Advisory Committee on Conservation Education, Semi-Annual Meeting, November, Lake Whitney, Texas—G. K. Eifler, Jr., P. T. Flawn
- Texas Conference on Soil, Water, and Suburbia, sponsored by Department of Housing and Urban Development and Soil Conservation Service, U. S. Department of Agriculture, October, Austin, Texas—L. E. Garner, P. U. Rodda
- Texas Small Schools Project, Summer Workshop, July, Austin, Texas—W. L. Fisher
- UNESCO Symposium on Coastal Lagoons, November, Mexico, D.F.—W. L. Fisher, J. H. McGowen, P. U. Rodda
- West Texas Geological Society, Meeting, March, Midland, Texas; *and* Symposium on Cyclic Sedimentation in the Permian Basin, October, Midland, Texas—L. F. Brown, Jr.

Lectures and Public Addresses

- V. E. Barnes—
- Tektites: Secondary School National Science Foundation Students, Texas A&M University, College Station, Texas—August
- Petrography of moldavites: Meteoritical Society, Annual Meeting, sponsored by National Aeronautics and Space Administration, Ames Research Center, Moffett Field, California—October
- L. F. Brown, Jr.—
- Geometry of superposed elongate sandstones, North-central Texas: West Texas Geological Society, Midland, Texas—March
- Progress and plans in the Bureau of Economic Ge-

- ology: Soil Survey Technical Work-Planning Conference, Texas A&M University—April
- Role of compaction in development of geometry of superposed elongate sandstone bodies: Society of Economic Paleontologists and Mineralogists, Annual Meeting, Los Angeles, California—April
- Geometry of superposed elongate sandstones, North-central Texas: Abilene Geological Society, Abilene, Texas—May
- Virgil—Lower Wolfcamp repetitive depositional environments in North-central Texas: West Texas Geological Society, Symposium on Cyclic Sedimentation in the Permian Basin, Midland, Texas—October
- G. L. Dawe—
- Rocks, minerals, fossils, and general geology of Lake Travis area: Residents and visitors, Lakeway Inn, Lake Travis, Texas—June
- Rocks, minerals, and fossils of Austin area: Youth Group at St. Michael's Episcopal Church, Austin, Texas—July
- W. L. Fisher—
- The minerals of Texas—a nonrenewable resource: Resource-Use Education Workshop, Fort Worth, Texas—February
- Stratigraphy and genesis of Edwards Dolomite of Texas: Forum on Geology of Industrial Minerals, 3d Annual, The University of Kansas, Lawrence, Kansas—April
- Mineral resources of Texas: Texas Small Schools Project, 8th Summer Workshop, Austin, Texas—July
- Depositional systems in lower part of Wilcox Group, Eocene, Texas: The University of Texas at Austin, Department of Geology, Technical Session, Austin, Texas—October
- Depositional systems in the Wilcox Group of Texas and their relationship to occurrence of oil and gas: Gulf Coast Association of Geological Societies, Annual Meeting, San Antonio, Texas—October
- Depositional history and oil and gas trends in the Lower Wilcox Group: Lafayette Geological Society, Lafayette, Louisiana—November
- Lower Eocene lagoonal systems in the Texas Gulf Coast Basin: UNESCO Symposium on Coastal Lagoons, Mexico, D.F.—November
- Depositional systems in the Wilcox Group and their relationship to oil and gas occurrence: Mississippi Geological Society, Jackson, Mississippi—December
- P. T. Flawn—
- Concepts of resources—their effects on exploration and U. S. mineral policy: Southwestern Legal Foundation, Symposium on Exploration and Economics of the Petroleum Industry, Dallas, Texas—March
- The environmental geologist and the body politic: Association of Engineering Geologists, Annual Meeting, Dallas, Texas—October
- Geologic consequences of industrialization: Rice University, Houston, Texas—October; and Texas A&M University, College Station, Texas—November
- L. E. Garner—
- Use of the GT-2 portable seismograph: Austin Geological Society, Austin, Texas—March
- Status and goals of Austin Urban Project: City of Austin Planning Commission, Austin, Texas—October
- Use of the refraction seismograph in engineering and geologic work: The University of Texas at Austin, Department of Geology, class in Engineering Geology, Austin, Texas—November
- R. M. Girard—
- Sources of geologic information: The University of Texas at Austin, Department of Geology, class in Petroleum Geology, Austin, Texas—March
- R. A. Maxwell—
- Geologic history of the Blanco area: Science classes, Blanco High School, Blanco, Texas—January
- Geology of the Big Bend National Park: Science classes, Alamo Junior High School, Midland, Texas—April
- P. U. Rodda—
- Dolomite depositional models, Edwards Formation (Lower Cretaceous), Texas: Geological Society of America, Annual Meeting, New Orleans, Louisiana—November
- Geological influence of an ancient carbonate lagoon, Lower Cretaceous, Texas: UNESCO Symposium on Coastal Lagoons, Mexico, D.F.—November
- Academic Assignments, Committee Service, and other Professional Responsibilities**
- V. E. Barnes—
- Geological Society of America, Annual Meeting: Co-

- Chairman of the section on Sedimentology I.
The University of Texas at Austin, Department of Geology: Professor of Geology.
- L. F. Brown, Jr.—
Hardin-Simmons University: Leader of geology students May field trip to Shackelford and Callahan counties.
The University of Texas at Austin, Department of Geology: Lecturer.
- G. K. Eifler, Jr.—
American Institute of Professional Geologists, Texas Section: Legislative Committee.
Austin Geological Society: Public Relations Committee, 1966–67, Chairman; Nominations Committee, 1966–67, Chairman; Program Committee, 1967–68, Chairman.
College Alumni Support Program (CLASP): Division chairman for the Department of Geology of The University of Texas at Austin.
Dedication of the new Geology Building at The University of Texas at Austin: Food and Entertainment Committee.
- W. L. Fisher—
Forum on Geology of Industrial Minerals: Steering Committee, General Chairman of 4th Annual Forum to be held in 1968.
Southern Illinois University: Visiting Professor in Geology, Spring Semester (teaching assignment: Seminar on terrigenous depositional systems; and development of a junior-senior course on mineral resources of the modern technological world).
The University of Texas at Austin, Department of Geology: Lecturer.
- P. T. Flawn—
American Association of Petroleum Geologists: Research Committee; Trustee, Group Insurance Program.
American Geological Institute: Board of Directors.
American Institute of Professional Geologists: Commission on Geologic Hazards.
Association of American State Geologists: Vice President.
Austin Geological Society: Executive Committee (1966–67).
Gulf Universities Research Corporation: Advisory Board.
- National Academy of Science—National Research Council: Committee on Resources and Man; Committee on Space Programs for Earth Observations, Advisory to U. S. Geological Survey.
Texas Advisory Committee on Conservation Education: Chairman (1967–68).
Texas Mapping Advisory Committee.
The University of Texas at Austin: Institute of Latin American Studies Advisory Committee; Library Committee; Professor of Geology (1967 teaching assignment, Geology 341, "Mineral Resources.")
- L. E. Garner—
Austin Geological Society: Committee on Scouting and Recreation (1966–67); Secretary (1967–68); Executive Committee (1967–68).
Forum on Geology of Industrial Minerals: Field Trip Committee of 4th Annual Forum to be held in 1968.
- R. M. Girard—
Austin Geological Society: Treasurer (1966–67); Executive Committee (1966–67).
Forum on Geology of Industrial Minerals: Registration Committee of 4th Annual Forum to be held in 1968.
International Science Information Services, Inc., Dallas, Texas, Workshop on Large Scientific Data Files: Coordinator of Workshop Session on State and Federal Data Files.
- J. W. Macon—
Gulf Coast Association of Geological Societies: Designed and supervised the preparation of Bureau of Economic Geology exhibit at the Annual Meeting at San Antonio, Texas.
- R. A. Maxwell—
Boy Scouts of America, Capitol Area Council: Executive Board Member; Committee Chairman of Troop 11; Counselor for Capitol Area Scouts.
National Science Association of Austin: Board of Directors.
Parks and Recreation Advisory Board of the City of Austin: Board member.
Texas Academy of Science, Visiting Scientist Program: Lecturer to Secondary School Students (through April).

P. U. Rodda—

Austin Geological Society: Committee on Scouting and Recreation, Chairman (1966-67).
Forum on Geology of Industrial Minerals: Program

Committee Chairman of 4th Annual Forum to be held in 1968.

The University of Texas at Austin, Department of Geology: Lecturer.

Bureau of Economic Geology to Host 4th Annual Forum on Geology of Industrial Minerals

During the year the Bureau of Economic Geology made preparations for hosting the 4th Annual Forum on Geology of Industrial Minerals. The Forum will meet March 14-15, 1968, in Austin. Technical sessions will be held in the Villa Capri Motor Hotel, near the University campus. A pre-Forum evening business meeting will convene at the Geology Building on the campus. A half-day field trip is scheduled following the Forum and will be conducted in the Central Texas Mineral Region. W. L. Fisher is general chairman and P. U. Rodda is program chairman for the 1968 Forum.

Two themes will make up the technical sessions of the Forum: (1) Geology of Chemical Raw Materials, emphasizing these resources in the Gulf Coast area, and (2) Depositional Models in Economic Stratigraphy. Fifteen technical papers relevant to these themes will be presented by scientists from private industries, universities, and State and Federal surveys.

Technical Program

Keynote address: John B. Patton, State Geologist, Indiana Geological Survey, and Chairman, Department of Geology, University of Indiana

Theme 1. Geology of Chemical Raw Materials

1. Resource and economic importance of Gulf Coast salt deposits, M. E. Hawkins, Acting Chief, Dallas Field Office, U. S. Bureau of Mines.

2. Economic geology of phosphate deposits of the Atlantic Coastal Plain, James B. Cathcart, Senior Geologist, U. S. Geological Survey.

3. Chemicals from the sea, W. F. McIlhenny, Research Specialist, Dow Chemical Company.

4. Industrial carbonates of the Texas Gulf Coastal Plain,

C. K. Eifer, Jr., Research Scientist, Bureau of Economic Geology, The University of Texas at Austin.

5. Gulf Coast sulfur resources, John C. Myers, Consultant, Houston, Texas.

6. The Louann Salt of the Gulf Coastal region, George C. Hardin, Jr., Vice President, Exploration, Kerr-McGee Corporation.

7. Caprock genesis and occurrence of sulfur deposits, Ralph E. Taylor, Director, Frontier Sulphur Company.

8. Internal structure of salt domes, William R. Muehlberger, Chairman, Department of Geology, The University of Texas at Austin.

9. Exploration program of a major chemical company, W. N. McNulty, Head, Department of Geology, The University of Texas at El Paso.

10. The structure of the Gulf Coast chemical industry, Stanley A. Arbingast, Professor of Resources, Department of Marketing Administration, and Associate Director, Bureau of Business Research, The University of Texas at Austin.

Theme 2. Depositional Models in Economic Stratigraphy

1. Michigan evaporite deposits, Louis I. Briggs, Professor, and Darinka Zigic-Toshich, Department of Geology and Mineralogy, The University of Michigan.

2. Environments of phosphorite deposition in the central Florida phosphate district, Donald H. Freas, Manager—Geologic Projects, International Minerals and Chemical Corporation, and Stanley R. Riggs, Assistant Professor of Geology, East Carolina College.

3. Environmental factors controlling oyster shell deposits, Texas coast, Alan J. Scott, Associate Professor, Department of Geology, The University of Texas at Austin.

4. Gravel deposits of the Minneapolis quadrangle, Minnesota, Rudolph K. Hogberg, Assistant to the Director and Geologist, Minnesota Geological Survey.

5. Utilization of depositional models in exploration for non-metallic minerals, J. H. McGowen, Research Scientist, Bureau of Economic Geology, The University of Texas at Austin.

Bureau Takes on Administrative Responsibility for Radiocarbon Laboratory and Vertebrate Paleontology Laboratory

In 1967 the Bureau of Economic Geology was given administrative responsibility for two additional research units at Balcones Research Center—the previously independent Radiocarbon Laboratory and the Vertebrate Paleontology Laboratory, which has had a long existence without a formal budget. Both laboratories will operate as semi-autonomous units. Professor E. Mott Davis continues as Director of Radiocarbon and Professor John A. Wilson continues as Director of Vertebrate Paleontology. Director Davis is assisted by Associate Director Sam Valastro, Jr.

Radiocarbon Laboratory

The Radiocarbon Laboratory has facilities for the measurement of the C^{13} content of organic materials, principally for purposes of making close estimate of the time that has elapsed since the organism died. The C^{14} measurement is done by liquid scintillation counting of benzene; this laboratory was one of those which pioneered in the development of this technique. The practical range of the technique covers the last 40,000 to 50,000 years. In its work the Laboratory has functioned principally as a collaborator in research projects in archeology, late Pleistocene geology and paleontology, ground-water studies, geochemistry, and several aspects of oceanography. In addition to contributing to research reports, the Laboratory publishes its data regularly in the journal *Radiocarbon*.

Such a laboratory requires highly specialized equipment and personnel, and although work on the Radiocarbon Laboratory began in the 1950s and regular operation started in 1960, a firm base for permanent operation was established only recently. In 1966, Mr. S. Valastro, Jr., who has had long experience in C^{14} work, took charge of technical operations.

In 1967 the Laboratory collaborated in four major projects in geochemistry and archeology. A large series of caliche samples from profiles in the Finlay area of far western Texas was dated by C^{14} assays corrected by C^{13}/C^{12} measurements made at the U. S. Geological Survey in Denver. The work was done in collaboration

with Craig T. Rightmire, a graduate student in the Department of Geology of The University of Texas at Austin, who used the data in writing an M.A. thesis under the supervision of Dr. Earl Ingerson. As part of the work, Mr. Rightmire was trained in C^{14} techniques in the Radiocarbon Laboratory, and he and Mr. Valastro jointly carried out one phase of the field work, the collection of samples of soil air CO_2 . The results of this work will be published in a paper by Mr. Rightmire and Dr. Ingerson.

In connection with archeological salvage work in the Wallisville Reservoir area at the mouth of the Trinity River, Mr. Valastro collaborated with Dr. J. Richard Ambler of the Texas Archeological Salvage Project in assaying a series of paired samples of *Rangia* shell and charcoal. It was possible to establish a basis for the use of *Rangia* in dating archeological features in that environment. The results of this study are to be published in a paper by Dr. Ambler and Mr. Valastro.

A similar project, still in progress, is concerned with the comparison of C^{14} assays on paired samples of snail shells and charcoal from a stratified archeological site near Austin. The work is being done in collaboration with Dr. Dee Ann Story of the Texas Archeological Research Laboratory.

A major study which began early in 1967 is concerned with the radiocarbon chronology of the Caddoan archeological area in northeastern Texas and environs. Dr. E. Mott Davis, Director of the Laboratory, whose field of research is Caddoan archeology, is handling the archeological aspects of this project and will publish the results jointly with Mr. Valastro. It is planned that more than 100 samples will be assayed before full appraisal is made. The samples are being assembled with the cooperation of archeologists at The University of Texas at Austin, the Universities of Oklahoma and Arkansas, and others in Louisiana.

In addition to these projects, numerous small series of samples were run during 1967 for other archeological and geologic projects within Texas, as well as a few outside the State, and many control samples have been

counted for continued monitoring of the stability of the chemical and electronic apparatus. About 170 publishable dates were produced during the year.

The expense of the radiocarbon technique (\$150-\$200 per sample), and the fact that the nature of C^{14} decay produces results in terms of statistical probabilities rather than actual dates, necessitates a rigorous policy on the acceptance of samples. All applications for submissions of samples for dating are subject to screening by the Advisory Committee of the Laboratory, which is made up of staff members from the Departments of Anthropology and Geology, the Bureau of Economic Geology, and the Marine Science Institute. Only samples which have specific bearing on chronological problems of research projects are accepted, and as a general rule only series of samples—preferably no less than three or four per context—are accepted, since single assays normally mean too little to be worth the expense and attention. In addition the results of the radiocarbon assays are not considered as publishable dates until they have been appraised jointly by the submitter of the samples and Radiocarbon Laboratory personnel, in the light of the total laboratory and field evidence.

Vertebrate Paleontology Laboratory

In the late 30s and early 40s, with the help of W.P.A. funds, a collection of vertebrate fossils was brought together under the direction of Dr. E. H. Sellards, then Director of the Bureau of Economic Geology. The collection was and still is by far the largest south of a line

joining Washington, D.C., Lawrence, Kansas, and Los Angeles, California. In the early 40s a series of papers on parts of the collection were published by Glen L. Evans, Joseph T. Gregory, Grayson E. Meade, and H. T. Sawin. In 1949 this Bureau collection, which had been scattered in parts of three buildings on the Little Campus, was brought to Balcones Research Center and re-scattered through parts of three other buildings. In 1955 the collection was put under one roof and shortly thereafter the collection of the Texas Memorial Museum was integrated with it.

More than half of the surface area of Texas is underlain by rocks of continental origin. Teeth and bones, some fossil, some not, come to the Bureau for identification. Horse teeth, cow teeth, mastodon tusk fragments from rancher, farmer, and even professors of geology arrive almost every week with the query, what and how old?

The Vertebrate Paleontology Laboratory was formed in 1949 as a cooperative arrangement between the Bureau, the Museum, and the Department of Geology. Dr. John A. Wilson of the Department of Geology was the lone staff member from 1949-1955. He performed curatorial service on the Bureau collection in exchange for using it for teaching and research. As the years passed, an organized program of teaching and research and publication was developed. In recognition of this, the Laboratory's importance and achievements, The University in 1967 granted the Laboratory a budget under the Bureau with salaries for a full-time preparator and curator-secretary, and funds for travel, maintenance, and assistants.

New Quarters Occupied in June

June was moving month for the Bureau. After 40 years on the Little Campus, the Bureau now occupies the fifth floor of the Geology Building, just west of San

Jacinto at 23rd Street. Mailing address and telephone numbers remain the same.

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