



BUREAU OF ECONOMIC GEOLOGY

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS
W.L. FISHER, DIRECTOR



1978
ANNUAL REPORT



ECONOMIC
GEOLOGY
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FOREWORD

The Bureau of Economic Geology, established in 1909 as the successor to the Texas Geological Survey and the Texas Mineral Survey, is a research entity of The University of Texas at Austin. It also functions as the State Geological Survey—a quasi-state agency—with membership in the Natural Resources Council of the State of Texas. The Bureau Director serves as State Geologist and represents Texas in the Association of American State Geologists.

The Bureau provides extensive advisory, technical, and informational services relating to the geology and resources of Texas. In addition, it conducts a large number of basic and applied research projects in energy resources, mineral resources and statistics, land resources, systematic geologic mapping, and a variety of other research programs in such areas as hydrogeology, basin analysis, geochemistry, and coastal studies. Certain projects are conducted jointly with other units of the University as well as with State, Federal, and local governmental agencies. The Texas Mining and

Mineral Resources Research Institute functions as an administrative unit of the Bureau.

The Bureau of Economic Geology publishes major reports in The University of Texas Publication series; it also has its own series of Reports of Investigations, Geologic Quadrangle Maps, Geologic Atlas Sheets, Environmental Geologic Atlases, Guidebooks, Handbooks, Geological Circulars, Mineral Resource Circulars, and several Special Publications. Publications are sold for a nominal price designed to recover printing costs. A complete list of publications is available on request.

The Annual Report of the Bureau of Economic Geology outlines the scope and status of current research programs and projects, publications, professional personnel activities, and special services in the area of Texas geology and resources available to agencies, industry, and all citizens of Texas. The Annual Report is available on request.

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RESEARCH

Bureau research programs and projects are designed to address many of the State's major concerns in the areas of geologic, energy, mineral, land, and environmental resources. Through the years, an extensive research program in energy and mineral resources has been maintained. This substantial research emphasis is broadened by comprehensive investigations of land and water resources. The Bureau's projects are directed toward solving existing problems of resource utilization; they are aimed at research programs incorporating geologic concepts that will build toward an understanding of a specific resource and its impact on human activities.

The diverse range of Bureau research is typified by the programs dealing with the evaluation of bedded salt deposits in the Panhandle and interior salt domes in East Texas as potential sites for isolation of nuclear wastes. These projects require in-depth, comprehensive evaluations of subsurface hydrology, resource distribution, depositional systems, and land-surface configurations and denudation rates. Such programs call for expertise in areas such as geomorphology, hydrology, basin analysis, tectonics, environmental geology, geochemistry, and rock physics. This research integrates complex geologic subdisciplines into a coordinated assessment of a critical problem needing scientific, objective review.

The newly established Texas Mining and Mineral Resources Research Institute, embracing both research and training, operates as an administrative unit of the Bureau of Economic Geology. The Land Resources Laboratory coordinates the numerous land resources programs within the Bureau of Economic Geology. Bureau research in 1978 focused on the assessment and analysis of environmental problems concerning geopressured geothermal energy production and uranium utilization, in addition to continuing work on such long-standing projects as the *Environmental Geologic Atlas of the Texas Coastal Zone* and the Guadalupe - San Antonio - Nueces River Basins regional study.

Minerals and energy resources programs continued to be a major part of Bureau research. In addition to resource assessments in uranium, lignite, and geopressured geothermal energy, the Bureau continued research into analysis of governmental policy related to energy. A comprehensive survey of mineral localities in the State was also in progress; this survey proposes to develop detailed information on hundreds of mineral sites across Texas.

Systematic geologic mapping, coastal studies, basin analysis projects, and investigations in other areas of economic geology further indicate the range of research programs carried forward in 1978.

ENERGY RESOURCES INVESTIGATIONS

TEXAS ENERGY RESERVES AND RESOURCES

W. L. Fisher.

Analysis of the total energy reserve and resource base in Texas, including oil, natural gas, natural gas liquids, lignite, coal, uranium, geothermal, unconventional gas, and tertiary oil, by economic and technologic categories of availability was conducted in 1978. Findings of the study were reported to the Texas House Interim Committee on Energy Resources, and published as Geological Circular 78-5.

EFFECTS OF RESOURCE ESTIMATES AND RATES OF FINDING ON PROJECTION OF CRUDE OIL AND NATURAL GAS PRODUCTION

W. L. Fisher, William E. Galloway, and Robert A. Morton.

As part of the Texas Energy Advisory Council's Texas National Energy Modeling Project, geological factors in resource estimations were analyzed. Rates of finding were calculated, and their role in determining future levels of reserve addition and production as a function of price and drilling activity was examined.

RESOURCE ASSESSMENT AND TEST-WELL SITE SELECTION—GEOPRESSURED GEOTHERMAL ENERGY, TEXAS GULF COAST

Don Bebout, project director; A. R. Gregory, Robert G. Loucks, Bonnie R. Weise, and Marc B. Edwards, assisted by Jan S. Posey, Victor J. Gavenda, Jung H. Seo, David A. Budd, Steven D. Mann, Jeffrey D. Potter, Teddy J. Bond, John B. Swanson, and Jong H. Han.

Assessment of the geopressured geothermal resource began in 1974 with funding from the U. S. Atomic Energy Commission and The University of Texas at Austin, Center for Energy Studies. Initially, the project involved only an evaluation of the Frio Formation of South Texas. Later the geothermal project was expanded significantly to include studies of the Frio Formation and the Vicksburg and Wilcox Groups of the entire Texas Gulf Coast and was subsequently funded for more than \$1.5 million by the U. S. Department of Energy, Division of Geothermal Energy.

The project consisted of two major phases: (1) a regional evaluation of the geothermal energy potential of the Tertiary depositional systems of the Texas Gulf Coast and the identification of potentially productive areas, and (2) a study of the prospective areas in order to develop sites for test wells. Extensive geological and petroleum engineering studies were required to meet these objectives. Geological research included regional correlation, regional mapping of

sandstones, regional studies of sandstone diagenesis, analysis of seismic data, and the recognition of growth fault models and their relationship to depositional patterns. Engineering research included a study of reservoir pressure and temperature gradients, interpretation of subsurface porosity and permeability, determination of reservoir performance (deduced from reservoir pressure decline and hydrocarbon production histories), and calculation of fluid salinity and methane content of the reservoirs.

The regional resource assessment of the Frio, Vicksburg, and Wilcox has been completed. Several geothermal fairways were identified in the Frio, but all except one, the Brazoria Fairway, failed to meet minimum requirements considered necessary for a geothermal test. The Austin Bayou Prospect was developed in the Brazoria Fairway, and the first geopressured geothermal test well—General Crude Oil Company and U. S. Department of Energy No. 1 Pleasant Bayou—was being drilled on this prospect during the second half of 1978. The well, scheduled for completion early in 1979, will make possible the testing of fluids from lower Frio reservoirs (at depths of 14,000 to 16,500 feet) to determine water chemistry, amount of methane in solution, and flow rate deliverability over an extended period of time.

Detailed studies of the Wilcox fairways were completed in late 1978, and several test-well sites were identified. (A report outlining the location of the Wilcox fairways was submitted to the U. S. Department of Energy in January 1978.) Further studies indicated that the Vicksburg Group is not a good geothermal prospect because of extremely low permeability.

VOLUME AND ACCESSIBILITY OF ENTRAINED METHANE IN DEEP GEOPRESSURED RESERVOIRS—TERTIARY FORMATIONS OF THE TEXAS GULF COAST

Marianne M. Dodge, A. R. Gregory, and Jan S. Posey, assisted by James H. Anderson, Bryant W. Hainey, Valerie Hunter, Koso Idigbe, Evans Jegbefume, and M. Scott Ritchie.

In recent years, higher natural gas prices have stimulated interest in the methane-saturated geothermal waters of the Texas Gulf Coast as a potential resource of natural gas. Widely varying estimates by different researchers concerning the amount of energy in place in the Texas Gulf Coast have indicated the need for more definitive study.

The objectives of this project are (1) to appraise the total resource of entrained methane in the onshore Texas Gulf Coast sandstone reservoirs within the stratigraphic section extending from the base of significant hydrocarbon production to the deepest significant sandstone occurrence, and (2) to assess the economics of producing methane from this zone. In preparation is a series of structural cross sections (24 dip sections and 3 strike sections with sea level as the datum plane) showing the location of major growth faults. These sections are based on stratigraphic cross sections that were prepared for previous regional geologic investigations. Structural and stratigraphic boundaries and other physical parameters are being used to designate the units of sandstone in the Texas Gulf Coast for which the

total methane content will be calculated. Each unit, or reservoir, of sandstone will be uniquely identified by its representative porosity and permeability and by the temperature, pressure, and salinity of its fluids. Conceptual models based on this information will be developed to describe the distribution of methane in the Gulf Coast and to assess the in-place resource and the economics of producing the methane-saturated water.

This project has been funded for 18 months, beginning September 1, 1978, by the U. S. Department of Energy. It is being conducted jointly by the Bureau of Economic Geology and the Center for Energy Studies, The University of Texas at Austin.

EFFECTS OF A GEOPRESSURED GEOTHERMAL SUBSURFACE ENVIRONMENT ON ELASTIC PROPERTIES OF TEXAS GULF COAST SANDSTONES AND SHALES

A. R. Gregory (Bureau of Economic Geology) and Milo M. Backus (Department of Geological Sciences, The University of Texas at Austin) assisted by Jeffrey D. Potter (Bureau of Economic Geology) and Scharad Kelkar and Akanni Lawal (Center for Energy Studies, The University of Texas at Austin).

The objective of this project is to evaluate the elastic properties and attenuation of the geopressured geothermal sediments that are penetrated by the General Crude Oil Company and U. S. Department of Energy No. 1 Pleasant Bayou well in Brazoria County, Texas. The project involves the use of elastic wave velocity and amplitude data obtained from conventional acoustic logs, long-spaced sonic logs, velocity surveys, and laboratory measurements on cores, as well as density data obtained from density logs to determine the effect of high formation pressures and temperatures on the physical properties of deep sediments. Similar data are obtained in shallow hydropressured formations and in the transitional zone that extends above and below the top of geopressured sediments.

A knowledge of the relationships between measurable parameters and physical properties of rocks is pertinent to understanding subsurface deformation mechanics and the effect of these mechanics on formation evaluation, well productivity, and exploration techniques for selecting favorable geopressured geothermal areas for future wells. The project, which began in 1978, is sponsored by the Center for Energy Studies of The University of Texas at Austin and is funded by the U. S. Department of Energy for a period of 16 months.

ANALYSIS OF THE CONSOLIDATION OF TERTIARY SANDSTONES, TEXAS GULF COAST

Robert G. Loucks, Marianne M. Dodge, and William E. Galloway, assisted by Turner F. Williamson, Charles Ehlers, and Mark E. Yelverton.

This project involved a detailed study of the sandstone consolidation history of the Texas Gulf Coast Tertiary section with emphasis on the formation, preservation, and vertical and lateral distribution of porosity and permeability. The study concentrated on the Tertiary section that

contains the Frio, Vicksburg, and Wilcox geothermal corridors.

During this project, more than 900 samples of sandstone from 197 wells were analyzed to determine mineral composition, diagenetic features, and porosity types. The distribution of sandstone compositions was described for each formation in the Texas Gulf Coast, and an idealized diagenetic sequence was delineated for all Tertiary sandstones in that area. In addition, more than 10,000 porosity and permeability values were collected to determine reservoir quality in the sandstones. Interval transit time, obtained from 87 acoustic logs, was plotted in relation to depth to aid in the interpretation of rock consolidation history throughout the stratigraphic section. These data were used to help determine the location of deep reservoirs of the quality needed for geothermal fluid production. Through this study, areas containing geothermal reservoirs of potentially high quality were located in the Frio Formation of the Upper Texas Gulf Coast and in the Wilcox Group of the Middle Texas Gulf Coast.

This 1-year project, which began in September 1977, was completed in 1978. Funds were provided by the U. S. Department of Energy.

REGIONAL ASSESSMENT AND PROSPECTIVE SITE ANALYSIS OF GEOTHERMAL POTENTIAL ALONG THE BALCONES, LULING-MEXIA-TALCO SYSTEMS, CENTRAL TEXAS

C. M. Woodruff, Jr., project director; and Mary W. McBride, assisted by Lisa E. Craig, Scott A. Holden, James P. Immitt, and Rebecca M. Russo.

A 1-year project to study geothermal resource potential along the Balcones and Luling-Mexia-Talco fault zones was funded in 1978 by the U. S. Department of Energy. These fault zones delineate a broad structural belt that extends in a generally northeast direction from Kinney County near the Mexican border to the Red River at the Oklahoma and Arkansas state lines. Warm waters (temperatures up to approximately 60°C) have been produced for many years from various Cretaceous strata along this trend. Besides providing water for municipal and domestic supply, this low-temperature geothermal resource has also supported local spas and health resorts such as those at Marlin in Falls County. Now, because of increasing costs of fossil fuels, renewed interest is focused on these warm waters as an energy source—specifically for space-heating and water-heating needs.

This project involves two main tasks. The first is the delineation of structural and stratigraphic characteristics of aquifers that are known to yield warm water. This is done in order to locate the most promising areas for future geothermal water production. The second task involves using extant data to evaluate the waters constituting the geothermal resource; this evaluation includes the geographic delineation of the resource in terms of well yields, as well as chemical quality and temperature characteristics of ground water.

A team of consultants from Waco, led by Drs. O. T. Hayward and Robert G. Font, has been employed by the Bureau of Economic Geology to assess the central segment

of the study region. Included among their tasks is a detailed subsurface geologic study of Falls County as support for another (concurrent) demonstration project funded by the U. S. Department of Energy. This demonstration project entails drilling a producing geothermal water well that will supply part of the heating needs of the Torbett-Hutchings-Smith Hospital at Marlin, Texas.

The regional resource assessment project was initiated April 1, 1978, and was to extend through March 1979, at which time a report would be submitted to the U. S. Department of Energy.

EVALUATION OF LIGNITE RESOURCES IN NATIONAL FORESTS OF TEXAS

L. E. Garner, assisted by David A. Pass and Eldon S. West.

This study of the regional distribution of lignite reserves and other minerals on the National Forest lands in Texas was funded by the Forest Service of the U. S. Department of Agriculture. The occurrence of surface and subsurface lignite was investigated in Sabine, Angelina, Davy Crockett, and Sam Houston National Forests.

The project, which began in October 1977, was completed in October 1978. A final report, submitted to the Forest Service, includes (1) estimates of potential lignite resources, (2) a discussion of economic trends in lignite production, and (3) recommendations for further studies.

LIGNITE RESOURCES IN TEXAS

W. R. Kaiser and L. W. LaBrie.

This project, initiated in May 1978, is funded by the Texas Energy Advisory Council and the Bureau of Economic Geology. The goal of the study is to document near-surface lignite resources—those that are under less than 200 feet of cover. The method of estimation is based on proprietary industry data and a firm understanding of regional geology. In areas where data are numerous, critical parameters such as number of seams, thickness, and lateral extent can be established. With the use of tested exploration models, these parameters can then be applied along the lignite trend in areas of limited control and similar geologic settings. The lignite resources are being reported in terms of geologic unit and region, such as the Wilcox unit in the region between the Colorado and Trinity Rivers. Available data on composition of the lignite are being tabulated and reported by geologic unit and by county.

TEXAS PUBLIC LANDS—ESTIMATE OF FUTURE OIL AND GAS PRODUCTION FROM ESTABLISHED FIELDS OF TEXAS GULF COAST, BAYS, ESTUARIES, AND OFFSHORE

W. R. Stearns.

This project, involving an investigation of oil and gas reserves of State-owned lands in the Gulf Coast and offshore areas, is continuing. Production history and reservoir data—such as porosity, permeability, sand thickness, and pressure-volume-temperature relationships—of approximately 800 reservoirs are being compiled. The ultimate aim of this project is to survey and evaluate the mineral resources of all lands owned by the State of Texas.

NATIONAL URANIUM RESOURCE EVALUATION

Marc B. Edwards, Christopher D. Henry, D. K. Hobday, W. R. Kaiser, R. S. Kier, J. H. McGowen, and Mary K. McGowen, principal investigators; Richard L. Andersen, Joyce M. Basciano, Timothy W. Duex, Dawn G. McKalips, Steven J. Seni, and Ann E. St. Clair, assisted by Jesús Dittmar, Debra L. Schiltz, Linda C. Seekins, Jeffrey E. Thurwachter, Floyd G. Rose, Jr., James T. Goodwin, Ray S. Risner, Betty S. Ragland, and Eldon West.

This major new project was begun in the spring of 1978 after the Bureau entered into a subcontract with Bendix Field Engineering Corporation (under contract with the U. S. Department of Energy) to take part in the National Uranium Resource Evaluation program—NURE. The Bureau's part of the program is to determine the uranium potential of all geologic rock units from the surface to a depth of 5,000 feet within all or parts of eight quadrangle areas in Texas. These areas correspond to the Amarillo, Emory Peak, Lubbock, Marfa, Palestine, Presidio, Sherman, and Wichita Falls sheets of the National Topographic Map series (scale 1:250,000). The Emory Peak, Marfa, and Presidio sheets extend into Mexico, and the Sherman sheet extends into Oklahoma. Each of the quadrangles is bounded by 1° of latitude and 2° of longitude. A geologic map of each quadrangle either has been or will be published (within the next 2 years) in the Bureau's *Geologic Atlas of Texas* series.

Bureau chemists are making a geochemical analysis of 1,750 samples from each of the quadrangles. Well cuttings on file at the Bureau's Well Sample and Core Library and samples collected from the surface are being utilized in the analysis.

As part of the uranium evaluation, Bureau geologists are developing information pertaining to various rock units in the eight study areas. For example, they are making systematic studies of the stratigraphy of the Antlers Formation, which occurs in the Sherman quadrangle area, and of the Ogallala Formation and Dockum Group, among others, which are present in the areas covered by the quadrangle studies. The NURE investigations are also being coordinated with the Bureau's two nuclear waste isolation projects, described elsewhere in this Annual Report.

URANIUM POTENTIAL OF THE CATAHOULA FORMATION—PHASE II

William E. Galloway and W. R. Kaiser, assisted by Constance S. Childs and R. Stephen Fisher.

The continuing investigation of the uranium-bearing Catahoula Formation has emphasized reconstruction of the hydrologic and geochemical history of this major uranium-host formation. The structural and stratigraphic framework delineated in Phase I, combined with detailed mineralogic and geochemical studies and reconstructions of modern ground-water flow patterns and hydrochemical trends, has identified factors and processes controlling the solution, migration, and concentration of uranium.

Characterizing the geochemical environment most favorable to uranium concentration in the Catahoula required detailed mineralogic study of uranium ores and host sedimentary facies. Stability diagrams for identified mineral phases were constructed and evaluated with respect to a

suite of hydrochemical parameters known to exist in Catahoula waters.

The project is funded by the U. S. Department of Energy.

FORMATION OF URANIUM ORES BY DIAGENESIS OF VOLCANIC SEDIMENTS

Christopher D. Henry and Anthony W. Walton (University of Kansas), assisted by G. Nell Tyner.

The basic objective of this project was to understand the process by which uranium ore bodies might form in areas of thick accumulation of volcanic tuffs and volcanoclastic sediments. As a part of this study, Walton and Henry mapped and analyzed the lithologic and diagenetic facies in a sedimentary basin surrounded by volcanic centers south and west of Marfa in Trans-Pecos Texas. They also identified source-vent areas and examined flow rocks and tuffs for their relationship to basin sequences. Additional field work in Nevada and Utah allowed comparison with areas of similar volcanic and sedimentary sequences. Laboratory work included petrographic, X-ray, and chemical analysis to determine by what processes uranium is released and concentrated in volcanic areas. In 1978, a final report describing the results of the study was presented to Bendix Field Engineering Corporation, which had previously contracted with the U. S. Department of Energy to develop this information.

URANIUM POTENTIAL AND GENETIC STRATIGRAPHY OF THE TRIASSIC DOCKUM GROUP OF THE TEXAS PANHANDLE

J. H. McGowen, George E. Granata, and Steven J. Seni.

This study of fundamental facies distribution and mineralization within the Dockum Group began in December 1974, funded in part (for 2 years) by the U. S. Geological Survey, Uranium/Thorium Branch. The project involved investigations of the surface and subsurface continental Triassic facies in Texas.

The project was concerned chiefly with the development of a stratigraphic framework model and a depositional model, as well as with the accurate delineation of uranium mineralization and the determination of probable controlling or localizing factors. Both surface and subsurface trends were considered. The entire sequence of terrigenous clastic facies in the Texas Panhandle was evaluated.

Two reports were written and submitted to the U. S. Geological Survey. The first report (February 1978) deals with the depositional framework of the lower half of the Dockum Group, in both outcrop and subsurface, in the area south of the Matador Arch. This report, now in final editing, will be published in the Bureau of Economic Geology Report of Investigations series.

The second report (November 1978) deals with outcrop and subsurface depositional systems of the entire Dockum Group in the Texas Panhandle and adjacent New Mexico, distribution of outcrop and subsurface radiometric anomalies, and ground-water flow-through time. In addition, it presents speculations about areas favorable for uranium exploration. This report will also be published by the Bureau of Economic Geology.

MINERAL RESOURCES INVESTIGATIONS

MINERAL AND ENERGY RESOURCES OF TEXAS ATLAS

L. E. Garner, Thomas J. Evans, and Ann E. St. Clair.

At yearend, the second phase of this atlas project, the *Mineral Resources of Texas* map, was in cartographic preparation. Compilation of information for mineral commodity data sheets was in progress. These two parts of the atlas series have been preceded by the *Energy Resources of Texas* map, published in 1976.

The *Mineral Resources of Texas* map is a companion to the map of Texas energy resources, printed at the same scale (1:1,000,000) and in full color. The mineral resources map will show current and historical production sites and mineral occurrences. Distribution of major rock types used in the mineral industry will also be shown, including limestone, dolomite, ceramic clay, nonceramic clay, iron, sand and gravel, trap rock, granite, industrial sand, extrusive igneous rocks, talc, salt, and sulfur.

Mineral commodity data sheets were initiated in late 1977. These sheets summarize the nature and importance of more than 60 minerals and commodities in the State. Sheets will include information on occurrences, production, uses, geologic setting, and critical references. Cross-indexing of data sheets will permit easy reference to related commodities. Data sheets are designed for individual distribution, as related packages, or as a complete set. The first mineral commodity data sheets are now scheduled for publication in 1979.

MINERAL INDUSTRY LOCATION SYSTEM (MILS) FOR TEXAS

L. E. Garner, Becky S. Wiggins, and Roger D. Sharpe.

The goal of this project is to acquire information about the location of every mineral industry in the State of Texas. Data on mineral occurrences, prospects, pits, mines, and all immediate processors of mineral industry products are also being compiled. Emphasis is on mineral production areas, including both major mineral districts with known mineralization and urban centers. Data collected during this project will complement the progress of the *Mineral and Energy Resources of Texas Atlas* (described elsewhere in this Annual Report). The project, which is funded by the U. S. Bureau of Mines, is scheduled for completion during the fourth quarter of 1979.

LAND RESOURCES INVESTIGATIONS

ENVIRONMENTAL GEOLOGIC ATLAS OF THE TEXAS COASTAL ZONE

L. F. Brown, Jr., project director.

Essentially completed, this atlas series comprises seven publications covering seven areas of the Coastal Zone: Galveston - Houston (1972), Beaumont - Port Arthur (1973), Bay City - Freeport (1976), Port Lavaca (1976), Corpus Christi (1976), Kingsville (1977), and Brownsville - Harlingen. At yearend, the final text for Brownsville - Harlingen was in preparation; maps for this area have been printed and are available. Each atlas of the series consists of a descriptive text, an environmental geologic map (scale 1:125,000), and eight special-use maps (scale 1:250,000). All maps are printed in full color on a specially constructed base.

The *Environmental Geologic Atlas of the Texas Coastal Zone* is the product of an extensive study conducted by the Bureau of Economic Geology during the past 13 years. The entire *Atlas* depicts approximately 20,000 square miles of the Texas Coastal Zone within an area extending from about the 5-fathom line offshore to 50 miles inland. Mapping was accomplished with the use of detailed photographic mosaics, topographic maps, and other existing maps of many types. Photomapping was supplemented by many hours of low-level aerial reconnaissance and selected field studies. The special-use maps were derived from basic mapping and from compilation of a variety of existing data. The *Environmental Geologic Atlas of the Texas Coastal Zone* was designed to provide a thorough inventory of natural and man-made resources and to serve as a basic document in planning, development, and conservation of the Texas Coastal Zone. Much of the basic data for the Coastal Management Program of the Texas General Land Office was provided by the *Atlas*, and it continues to be a principal source of information for citizens, firms, and government agencies involved in Coastal Zone problems and programs. The investigation of State-owned submerged lands by the Bureau of Economic Geology will complete the assessment of coastal environments and land resources out to the offshore 3-league (10.36 statute miles) line on the continental shelf. Other, more specialized Bureau programs derived in part from the *Environmental Geologic Atlas of the Texas Coastal Zone* include studies of shoreline changes, faulting and subsidence, land and water resources, and coastal hazards.

SUPPORT OF NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) APPLICATIONS SYSTEM VERIFICATION AND TRANSFER IN TEXAS

Robert J. Finley, assisted by Sanford C. Marble.

The Bureau of Economic Geology is cooperating with the Texas Natural Resources Information System in evaluating the further application of remote sensing technology to State agency needs. These needs are related to agency responsibilities in the areas of natural resources and the environment. The National Aeronautics and Space Administration provides funding for this project, which is expected to run through mid-1981.

Initial evaluation of a Remote Sensing Information Subsystem for use by State agencies includes examination of Landsat images and aerial photographs of the Texas Coastal Zone. Extensive ground data are being collected simultaneously with data obtained from satellite overpasses and aircraft operations at four different altitudes. These data are being evaluated for application in monitoring land cover/land use, surface-water circulation, bay-water chemistry and temperature distribution, and coastal vegetation. Black-and-white infrared film and aircraft-mounted multispectral scanner imagery are being considered in conjunction with the more typical color and color-infrared films. Test sites in the Texas Panhandle, East Texas, Trans-Pecos Texas, and an urban area of Central Texas will be studied during the next 2 years.

ENVIRONMENTAL MONITORING—GEOPRESSURED GEOTHERMAL TEST WELL, BRAZORIA COUNTY

Thomas C. Gustavson, assisted by James R. Morabito and Douglas A. McGookney.

The Bureau of Economic Geology, under a contract with the U. S. Department of Energy, has undertaken management and coordination of environmental monitoring at the Brazoria County, Texas, geopressured geothermal test-well site. Effects on local ecosystem quality from the accidental release of geothermal brines and from the possible initiation of land-surface subsidence as a result of withdrawal of large volumes of geothermal fluids are the primary concerns of this project.

Baseline environmental studies include repeated analysis of air and water quality, a microseismicity survey, repeated first-order leveling surveys, a liquid tilt-meter survey, an archeological resources survey, and a noise survey. These studies were underway both preceding and during the test-well drilling. The air- and water-quality analysis, microseismicity survey, first-order leveling survey, and liquid tilt-meter survey will be continued during the production phase of the test-well operation.

GEOPRESSURED GEOTHERMAL ENERGY DEVELOPMENT—PROGRAM PLAN FOR ENVIRONMENTAL BASELINE STUDIES

Thomas C. Gustavson and Charles W. Kreidler.

This project, initiated in September 1977 under contract to Lawrence Livermore Laboratory of the University of California, has defined research programs that will address environmental problems posed by geopressured geothermal

energy development. Major tasks of this project included (1) identification of key environmental issues, (2) inventory of available environmental data, (3) assessment of the available data, (4) identification of data gaps, (5) identification of key agencies and resources, and (6) preparation of a program plan for baseline environmental studies of the Texas Gulf Coast area. A final report will be submitted to Lawrence Livermore Laboratory.

LAND RESOURCES AND ENVIRONMENTAL IMPACT: EAST TEXAS LIGNITE BELT

Christopher D. Henry and Joyce M. Basciano, assisted by Sara L. Ulerick.

This project was concerned with providing a geologic mining inventory of the extensive lignite belt in East Texas and evaluating environmental and economic aspects of exploitation of these lignite deposits. Objectives of the project were (1) preparation of a suite of environmental geologic maps for the lignite belt, (2) location of historical, operating, and planned lignite strip mines, and (3) measurement of the physical and chemical properties of overburden and evaluation of its reclamation potential. Funding for this project was provided by the Geological Survey, U. S. Department of Interior.

During 1975 and 1976, environmental geologic maps (scale 1:24,000) were compiled from aerial photographic interpretation of an area extending from the Colorado River to the eastern edge of Franklin County and comprising outcrops of the Wilcox Group and the Carrizo Sand. Mappable units were derived from studies of the substrate, soil, geologic processes, geomorphology, and biologic assemblages. Interpretations were checked in the field and compared with existing data such as geologic, soil, and flood-prone area maps. Supplemental work included (1) descriptions of the biologic assemblages in the southern half of the study region, (2) analysis of water quality of streams in mining areas, and (3) descriptions of algae occurring in streams that drain the actively mined areas. By yearend 1978, four reports had been published.

In late 1978, the maps, drawn at a scale of 1:125,000, were completed and submitted to the U. S. Geological Survey. The seven maps cover the portion of the Texas lignite belt that extends from Bastrop County to Texarkana. In addition to the environmental geology, information presented on the maps includes locations of areas of potentially mineable lignite (to a depth of 200 feet), active and planned lignite mines, active and planned lignite-fired power plants, and abandoned underground lignite mines. The maps and text will be published by the Bureau of Economic Geology in 1979.

TRACE AND POTENTIALLY TOXIC ELEMENTS ASSOCIATED WITH URANIUM DEPOSITS IN SOUTH TEXAS

Christopher D. Henry and Rajesh R. Kapadia, assisted by Janet E. Nilsson.

Several environmentally sensitive trace elements (molybdenum, arsenic, and selenium) are known to be associated with South Texas uranium deposits. A project to investigate the concentrations of these elements was initiated in 1977, supported by funds from the U. S. Environmental Protec-

tion Agency. During the first part of the project, researchers ascertained the background concentration of the elements in soils in the uranium mining area. Subsequent sampling in areas of near-surface mineralization and of former mining operations showed that significantly high concentrations of the elements occur in soils there. The sources of the high concentrations include both natural and mining-related activities. A final report of the study was presented to the U. S. Environmental Protection Agency in late 1978.

ENVIRONMENTAL EFFECTS OF IN SITU GASIFICATION OF TEXAS LIGNITE

T. F. Edgar (Department of Chemical Engineering), project manager; W. R. Kaiser (Bureau of Economic Geology), and M. J. Humenick (Department of Civil Engineering).

This project, funded by the U. S. Environmental Protection Agency and initiated in October 1978, is a joint study with the Departments of Chemical Engineering and Civil Engineering of The University of Texas at Austin. It is a general survey of environmental effects of in situ gasification of lignite in Texas.

The portion of the study conducted by the Bureau of Economic Geology involves the evaluation of deep-basin lignite resources in 5-foot seams that are under less than 2,000 feet of cover. Baseline water quality data are being compiled by geologic unit and geographic area to define areas of superior water quality. The Wilcox, Yegua, and Jackson geologic units will be tested against an ideal gasifier to identify potential gasifier sites; among the criteria are seam thickness, resources, aquifer development and orientation, and location relative to lignite-fired power plants, cities, and petrochemical complexes. On this basis, predictions will be made concerning areas of the Texas environment that are likely to be impacted by in situ gasification.

LAND AND WATER RESOURCES OF THE CORPUS CHRISTI AREA

R. S. Kier and William A. White.

This project was begun in 1972 as part of the Bureau's work with a university-based multidisciplinary research effort, "Criteria for Coastal Zone Management," funded by the National Science Foundation Research Applied to National Needs (RANN) Program and the Governor's Office of Budget and Planning. The project involved the delineation of 39 natural land and water resource units in an area that encompasses Nueces, San Patricio, Aransas, and Refugio Counties in South Texas. The units are depicted on a full-color map at a scale of 1:125,000. An accompanying text, which includes detailed information about the land and water units, was completed during 1978. The map and text were issued as Bureau of Economic Geology Report of Investigations No. 95.

LAND RESOURCE WORKSHOPS

E. G. Wermund, project director; L. E. Garner, R. S. Kier, D. C. Ratcliff, Ann E. St. Clair, and D. M. Stephens.

The purpose of this project was to locate, identify, and photograph land resource units that are representative of the units displayed on the *Land Resources of Texas* map

(published by the Bureau of Economic Geology in 1977). The photographs were then organized into a slide presentation to illustrate the utility of the map for planning. Instructor and participant outlines were prepared to demonstrate applications of the map. The outlines include examples of how special-purpose maps, such as a solid-waste disposal map, can be derived.

These materials were used at four workshops that were conducted with the staffs of Councils of Governments at regional meetings in Del Rio, Harlingen, Longview, and Lubbock, Texas. Each workshop included (1) a discussion of the origin of land resources mapping, (2) a detailed description of the *Land Resources of Texas* map, (3) a discussion of the applications of the map for use by the Councils of Governments, and (4) practical work sessions involving use of the map. The project was supported by the U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning.

THE GUADALUPE - SAN ANTONIO - NUECES RIVER BASINS REGIONAL STUDY

E. G. Wermund and Thomas C. Gustavson, project directors; Robert A. Morton, Richard L. Andersen, Joyce M. Basciano, L. E. Garner, and C. M. Woodruff, Jr., assisted by Maryann M. McGraw, Debra M. DeLong, David M. Brown, and Charles D. Smith. Cartography by Richard L. Dillon.

This long-term project is a comprehensive environmental geologic analysis of 30,558 square miles of the Nueces, San Antonio, Guadalupe, and Lavaca River basins of South Texas. The project was initiated in June 1972 under contract with the Texas Water Development Board. That contract continued through August 1975; thereafter, the Bureau of Economic Geology supported completion of all remaining work.

Products of this program are included in a series of maps, which were hand-colored onto scribed plastic base maps. The bases are reproductions of the standard Army Map Service topographic maps (1:250,000). The hand-colored series includes maps of (1) environmental geology, (2) physical properties, (3) active processes, (4) biologic assemblages, (5) economic resources, (6) land use, and (7) slopes. Environmental geologic maps and slope maps are compiled at a scale of 1:125,000; all other map types are presented at a scale of 1:250,000. Maps of the environmental geology and land use represent original mapping. The biologic assemblage map is essentially original mapping, as the biologic assemblages were identified in the field and their boundaries were located in general conformity to environmental geologic boundaries. Maps of active processes and physical properties were directly derived from the environmental geologic map. The economic geology was synthesized from previous Bureau publications. The slope maps were made only for the northern third of the regions in terrain where Edwards (Lower Cretaceous) through Carrizo (Tertiary) stratigraphic units crop out.

Environmental geologic units were mapped initially on standard topographic sheets (scale 1:24,000) or on black-and-white, aerial photographic, controlled mosaics. Land use was interpreted from 1973 color-infrared aerial photographs (scale 1:120,000). Slope maps were interpreted on topographic maps (scale 1:24,000).

All of the hand-colored maps prepared during the project are currently available for study by interested persons. Topographic maps (scale 1:24,000) and controlled photographic mosaics with original compilation, which will remain at the Bureau of Economic Geology, are also available for study.

In 1978, an up-to-date topographic base map was compiled by transcribing data from topographic quadrangle maps (scale 1:24,000) to facilitate the eventual color separation and publication of all mapping. Published reports and maps resulting from this regional project will deal with separate basins or parts of basins within the region. At yearend, maps for the Lavaca and lower Guadalupe River basins were being prepared for color separation and publication. A descriptive text for these two areas has been completed.

COASTAL STUDIES

GEOLOGY OF STATE-OWNED SUBMERGED LANDS

J. H. McGowen and Robert A. Morton, project coordinators; Thomas R. Calnan, John L. Chin, Jon P. Herber, C. Russell Lewis, and Charles D. Winker.

This comprehensive 2-year geological investigation, which was funded through May 1977, was designed to provide a detailed baseline inventory of State-owned submerged lands prior to the anticipated increase in offshore activities and multipurpose use of these lands. State-owned submerged lands include the inner continental shelf, extending from the Texas Gulf shoreline seaward for 10.36 statute miles (3 marine leagues), and the bays, estuaries, and lagoons of the Coastal Zone from the Rio Grande to Sabine Lake. Research was conducted in cooperation with the Marine Geology Branch of the U. S. Geological Survey and was funded by the General Land Office of the State of Texas.

During 1978, maps of the bays and inner continental shelf showing surface sediment distribution, bathymetry, faults, and salt domes were prepared, and a report to accompany the maps was written and submitted for publication by the Bureau of Economic Geology. Also in 1978, Bureau researchers began a detailed textural analysis of shelf and bay sediments and completed a semiquantitative chemical analysis of selected samples of shelf and bay sediments. In progress were descriptions of Laguna Madre sediment samples, which were being examined with a binocular microscope. Collection of sub-bottom profiling data in bays was completed, and interpretation of bay and shelf geophysical records was underway. At yearend, a report on molluscan distribution in Copano Bay was in

review, and analyses of biological samples from Corpus Christi Bay were in progress.

SURFICIAL BIOLOGY OF MARINE AND ESTUARINE DEPOSITS IN CORPUS CHRISTI VICINITY FOR INTEGRATED ENVIRONMENTAL PLANNING

Thomas R. Calnan, Russell Kimble, Thomas G. Littleton, and J. E. Sullivan.

This 1-year investigation is related to another Bureau project, "Geology of State-Owned Submerged Lands." The investigation involves biological analyses of the approximately 600 benthic samples taken from the State-owned submerged lands in the Corpus Christi area. Such lands in that area include the inner continental shelf, extending from the Gulf of Mexico shoreline seaward for 10.36 statute miles, and all the bays, estuaries, and lagoons from northern Laguna Madre to northern Aransas Bay.

All benthic macro-invertebrates from the samples are being counted and identified to species level when possible. The dominant invertebrate groups found in the samples include the polychaetes, molluscs (live and dead molluscan species are being identified and counted), crustaceans, and echinoderms. Tables, graphs, and maps representing the distribution of benthic fauna will be constructed. The final report will be the basis for the implementation of multiple resource management by State and local governmental agencies.

DISTRIBUTION OF SHELL DEPOSITS AND ROCK FRAGMENTS ON THE TEXAS INNER SHELF

Robert A. Morton and Charles O. Winker.

This project complements the Bureau project, "Geology of State-Owned Submerged Lands," now in progress. Biological samples that were screened and washed during cruises in the Gulf of Mexico to collect sediment samples for that project served as primary data for this investigation of coarse rock fragments and shell material on the inner continental shelf of Texas.

The gravel portion of the sediments on the shelf consists predominantly of whole shells and shell fragments, some caliche nodules, and sandstone and mudstone fragments. By identifying the molluscan shells that normally occur on the shelf, as well as the preexisting brackish-water shells, Bureau researchers have been able to make a gross delineation of the extent of modern, mixed, and earlier or preexisting sediments. Surface features of shells, such as degree of abrasion, boring, encrustation, coloration, and dissolution were used to distinguish modern and ancestral mollusc shells. Maps showing percent of shell (by volume), anomalous species, and rock fragments indicate distinct trends that outline locations of earlier, ancestral deltas of the Rio Grande and Brazos - Colorado and Trinity Rivers. Apparently, shell and rock fragments have been concentrated as beach and nearshore deposits wherever the old deltas have been submerged and covered by waters of the Gulf of Mexico.

At yearend, a series of maps depicting the Texas inner continental shelf and an accompanying report were being prepared for publication.

PADRE ISLAND NATIONAL SEASHORE—A GUIDE TO THE GEOLOGY, NATURAL ENVIRONMENTS, AND HISTORY OF A TEXAS BARRIER ISLAND

Bonnie R. Weise and William A. White.

Initiated in September 1975, under the direction of L. F. Brown, Jr., work on this nontechnical guide to Padre Island National Seashore was completed during 1978. The project involved mapping from recent color-infrared aerial photographs and construction of a full-color environmental geologic map. The map will accompany a guidebook that is scheduled to be published by the Bureau of Economic Geology in 1979. The guidebook will include descriptions of the origin, active processes, and present environments of Padre Island and Laguna Madre, plus historical information provided by Keene Ferguson, a former Bureau staff member. Produced in cooperation with the National Park Service, this guide will stress the dynamic character of the island and the importance of maintaining balances among the sensitive natural environments.

WETLAND DELINEATION AND CLASSIFICATION OF THE COASTAL AND PANHANDLE REGIONS OF TEXAS

William A. White, project manager; Katherine E. Fonken, Homer H. Pachecano, and Carolyn L. Harvel.

Funded by the U.S. Fish and Wildlife Service, this project is part of a national effort to delineate, classify, and map wetlands and deep-water habitats in accordance with a new classification system of the U.S. Fish and Wildlife Service. The project for Texas was initiated November 1, 1978, and is currently funded for 1 year. Wetlands and deeper water habitats in the coastal and Panhandle regions of Texas are being identified and mapped on aerial photographs through the use of stereoscopic techniques supported by information from both field reconnaissance and high-quality collateral data.

HIGH-RESOLUTION SEISMIC INTERPRETATION OF LATE QUATERNARY HISTORY, TEXAS CONTINENTAL SHELF

Charles D. Winker and Robert A. Morton.

High-resolution seismic profiles of the Texas inner continental shelf and central Outer Continental Shelf are being studied as part of a broader investigation of the late Quaternary history of the Texas shelf and Coastal Plain. Spaced at 1-mile intervals, the profiles, obtained with an 800-joule minisparker, cover the inner continental shelf. Fifteen long dip lines provide additional coverage on the central Outer Continental Shelf. Major objectives of this study are to determine (1) thickness of Holocene sediments; (2) thickness and internal stratification of the last, or top, Pleistocene depositional unit; (3) regional structure of the deeper, or lower, Pleistocene sediments; and (4) relationship of lithology and geotechnical properties to strong reflectors. Results are being compared and integrated with a similar study of the south and central Outer Continental Shelf of Texas conducted by the U. S. Geological Survey. Preliminary results indicate that late Pleistocene centers of deposition (depocenters) occur offshore from the mouths of the present Rio Grande and Colorado and Brazos Rivers,

where the sediments increase in thickness from the coast to the Shelf edge.

The final report will consist of a series of structural and isopachous maps, cross sections, and a paleotopographic reconstruction of the Texas shelf prior to Holocene transgression. Emphasis will be on the inner continental shelf, but some interpretation of the Outer Continental Shelf will also be included. This report will document the shifting of depocenters and the activity of growth faults and salt domes during the late Quaternary Period of geologic time.

HYDROGEOLOGY INVESTIGATIONS

PREDICTING RESPONSE OF A NATURAL SYSTEM TO URANIUM EXTRACTION: OAKVILLE AQUIFER SYSTEM, TEXAS

William E. Galloway, project director; Charles W. Kreitler, Christopher D. Henry, and James K. Gluck, assisted by Paul E. Devine, Constance S. Childs, Margaret A. Townsend, and Alan R. Dutton.

Current exploration and mining activity indicates an expanding role for uranium extraction in the economy of South Texas. Deeper exploration dictates that the use of in situ leach mining will continue to increase as a preferred method of extraction.

During the first year of this 2-year project, which was funded by the U. S. Environmental Protection Agency, investigators provided a description of the physical, stratigraphic, and structural framework of the Oakville aquifer. Also completed was a compilation of existing hydrologic and hydrochemical data necessary for a detailed, quantitative description of natural and mining-induced interactions between water and rock in representative parts of this important aquifer system. Results of the study will provide information on the nature and distribution of uranium deposits and, consequently, improve the technical basis for monitoring and clean-up procedures required by the Texas regulatory agencies that are responsible for granting mining permits.

GROUND-WATER HEAT PUMP DEMONSTRATION

Jerold W. Jones (Department of Mechanical Engineering), project director; Charles W. Kreitler (Bureau of Economic Geology), and Philip S. Schmidt (Department of Mechanical Engineering).

This cooperative project of the Bureau of Economic Geology and the Department of Mechanical Engineering of The University of Texas at Austin was begun in 1978 with funding from the Texas Energy Advisory Council and the Center for Energy Studies of The University of Texas at Austin. The aim of the Bureau's portion of the project is to

evaluate the ground-water resources of Texas in terms of their suitability for use in ground-water heat pump systems.

GULF COAST HYDROLOGY

Charles W. Kreitler, assisted by Robert W. McDermott.

The aim of this study is to determine the interrelationships of ground-water flow and ground-water chemistry to facies distribution and faults in the Pleistocene and Pliocene sediments. The project is a continuation of earlier work on subsidence and faulting in Harris and Galveston Counties. Although the initial area of this study has been Harris and Galveston Counties, plans call for studies of additional sections of the Texas Coastal Zone. A primary benefit of this program will be the development of a better evaluation of available ground-water resources in the Texas Coastal Zone.

GROUND-WATER QUALITY IN THE EDWARDS AQUIFER SOUTHWEST OF AUSTIN, TRAVIS COUNTY

Ann E. St. Clair.

The Rollingwood area, southwest of Austin, lies in the Balcones Fault Zone, which is the recharge zone of the Edwards aquifer in this area. Rapid suburban development and increased use of septic tanks have characterized the growth in the area for the past 25 to 30 years. To determine the effects of this development on water quality in the Edwards, water wells in the area were sampled during January through August 1978. Chemical and bacteriological analysis was performed on the samples to evaluate the presence or absence of several parameters that would indicate contamination by septic tanks. In addition, water-quality data were used to evaluate the hydrogeologic relationships among Barton Creek, Barton Springs, the Edwards aquifer, and the Colorado River.

BASIN STUDIES

LOWER CRETACEOUS CARBONATE FACIES, DEPOSITIONAL ENVIRONMENTS, AND DIAGENESIS—SOUTH TEXAS

Don Bebout, assisted by Richard A. Schatzinger.

During 1978, emphasis was placed on a study of the facies relationships and diagenesis of the subsurface Lower Cretaceous Sligo Formation on the South Texas Shelf. The oolite bodies that occur near the top of the Sligo Formation were mapped and described; the results of this part of the investigation were published in the Transactions of the Gulf Coast Association of Geological Societies (volume 28, 1978). In late 1978, a final report on the entire Sligo Formation was being assembled for publication by the Bureau of Economic Geology.

Plans were made to resume work on another phase of the Lower Cretaceous carbonate research project. All available cores—from boreholes and wells—of the Glen Rose Formation will be examined and described. With information derived from the core descriptions, an interpretation of the facies distribution and the depositional environment of the Glen Rose Formation will be made. The procedures to be used are like those employed in the now-completed study of the Sligo Formation.

PENNSYLVANIAN/PERMIAN FACIES, EASTERN SHELF, NORTH-CENTRAL TEXAS

L. F. Brown, Jr., and Raul F. Solis, assisted by Stephen C. Van Dalen.

Approximately 6,000 well logs have been examined in this regional study of the surface and subsurface Pennsylvanian and Early Permian strata in a 30-county area of North-Central Texas. Extensive investigation of Pennsylvanian/Permian depositional features involves the mapping and recognition of fluvial, deltaic, and related marine depositional systems and their component facies. The resulting regional description will serve as a guide in the search for oil, water, clay, coal, and other resources in the North-Central Texas area, as well as in similar depositional systems elsewhere. Final data were being compiled in late 1978.

LOCATING FIELD CONFIRMATION STUDY AREAS FOR ISOLATION OF NUCLEAR WASTE IN THE TEXAS PANHANDLE

William E. Galloway, Thomas C. Gustavson, C. Robertson Handford, Mark W. Presley, Robert J. Finley, Shirley P. Dutton, James R. Morabito, Douglas A. McGookney, Maryann M. McGraw, and Mary A. Bauer, assisted by Kathy A. McGillis, Linda C. Merritt, Bahman Sepassi, Robert I. Chapin, Paul E. Fredericks, Frank M. Mikan, Sunshine C. Sherrell, Carol A. Gray, Stanley M. Sutton, Robert W. Baumgardner, Jr., and Melissa A. Sandstrom.

The goal of this Bureau research project, which is funded by the U. S. Department of Energy, is to produce a comprehensive evaluation of the Palo Duro and Dalhart Basins of the Texas Panhandle to determine if the bedded Permian salt strata in those basins meet fundamental geologic criteria for safe isolation and long-time storage of nuclear waste. One team of Bureau researchers is currently conducting a basin analysis of the Palo Duro Basin; a second research team is investigating the surface landforms and the shallow subsurface stratigraphy of all the Texas Panhandle region.

The entire Panhandle project includes (1) interpretation of the regional subsurface stratigraphic and structural framework of the basins; (2) assessment of potential resources, including oil and gas, uranium, sedimentary metals, evaporite minerals, and ground water; (3) determination of salt-bearing facies and their distribution; (4) analysis of regional and local ground-water flow systems; and (5) investigation of surface geomorphic features and shallow subsurface stratigraphy of the Texas Panhandle.

As an integral part of the study, the U. S. Department of Energy has arranged for the drilling of several stratigraphic core tests. The first two test holes, completed in the Palo

Duro Basin in late 1978, produced more than 7,500 feet of core from Triassic and Upper Permian rock units. Researchers are utilizing the core material for intensive laboratory tests and precise descriptions. Geophysical logs of the test holes, together with logs of older wells drilled previously in the exploration for oil and gas in the area, will be used for determining the structure and extent of the underground salt strata.

The Bureau researchers who are investigating surface land features and shallow stratigraphy have completed the installation of five stations to monitor the climate and the erosion rate in the Panhandle area. The group has also used remote-sensing materials (black-and-white photographs, high-altitude color-infrared photographs, and Landsat scans) to locate linear elements, including stream and scarp segments, aligned playa lakes, and linear tonal anomalies in the Texas Panhandle. In addition, they have recorded the orientation of joints (cracks) that are present in outcrops of Permian, Triassic, and Tertiary rock units to determine if surface linear elements are related to joint orientations.

Zones in the subsurface where the salt has dissolved are apparently related to surface geomorphic features such as playa lakes, streams, and scarp segments. The research group is making detailed structural and stratigraphic studies to understand the stratigraphic and geographic distribution of subsidence induced by salt dissolution. These data and additional hydrologic and geochemical studies will lead to development of a model for shallow ground-water flow. A review of available literature on paleoclimatic cycles of the late Pleistocene through Holocene Epochs of geologic time has been completed. This information will be related to current climatic conditions in the Texas Panhandle.

DEEP-WATER FACIES OF THE SPRABERRY SANDSTONE, MIDLAND BASIN

C. Robertson Handford, assisted by Holly K. Lanan.

For several decades, the Spraberry Sandstone of Early Permian age has been an important exploration target and oil-producing reservoir in the Midland Basin. To date, no comprehensive studies of the Spraberry have been published. The objective of this project is to describe available well cores from the Spraberry, delineate facies sequences and distribution, interpret depositional environments, determine diagenetic processes, and correlate the relationship between oil production and depositional-diagenetic facies.

This project began in late 1978 and will continue through 1979. The initial phases of the project deal with core descriptions, facies determinations, and determination of sandstone geometry through well log correlations.

EVALUATING THE POTENTIAL OF EAST TEXAS INTERIOR SALT DOMES FOR ISOLATION OF NUCLEAR WASTES

Charles W. Kreidler, project director; D. K. Hobday, Edgar H. Guevara, E. G. Wermund, Graham E. Fogg, Alice B. Giles, Edward W. Collins, Mary K. McGowen, and Joyce M. Basciano, assisted by Edward A. Duncan, Richard J. Chuchla, Diana Scott, Russell C. Bunker, Debra J. Wood, Stephen P. Cumella, David A. Pass, Robert C. Cobb, Betty

S. Ragland, Vicki A. Veross, Carol A. Gray, Susan D. Hovorka, Jennifer Lundelius, Melissa J. Lang, and M. Jackson Drodgy.

The goal of this comprehensive investigation is to evaluate the suitability of underground salt domes in the East Texas Basin as possible sites for long-term isolation of nuclear wastes. The project is funded by the U. S. Department of Energy. Major considerations in this evaluation are the hydrologic and tectonic stability of the domes and the potential natural resources in the basin. To develop information related to these concerns, a Bureau research team is making geologic, hydrologic, geomorphic, and remote-sensing investigations of specific salt domes and also of the entire region.

Hydrologic investigations include studies of the ground-water systems of the basin and also of the ground-water flow around the salt domes to determine amount and rate of salt dome dissolution and location of the saline-water plumes (resulting from the dissolution of the salt) in the fresh ground-water supplies.

Studies of the subsurface in the region are in progress to determine the size and shape of specific salt domes, the geology of the strata immediately surrounding the domes, and the regional geology of the East Texas Basin. Such information will enable the research team to interpret the geologic history of the development and growth of the domes and of the filling of the basin with sedimentary rocks. In addition, the research team will use the information to evaluate potential natural resources of the basin.

Studies of the surface geology, including geomorphology, are also in progress. The objective of these studies is to determine if any dome growth or any tectonic movement such as tilting and faulting have occurred in the region during the Quaternary Period (within the past 2 million years). The research team is conducting remote-sensing studies to determine (1) if the regional lineation patterns of Quaternary sediments were altered when the columns of salt pushed upward through the sediments to form the salt domes, and (2) if rugged terrain and numerous streams indicate that structural movement has occurred in the area during the Quaternary Period.

ELLENBURGER CARBONATE FACIES, DEPOSITIONAL ENVIRONMENTS, DIAGENESIS—WEST TEXAS

Robert G. Loucks, assisted by Patricia A. Mench.

This project involves an investigation of the Ellenburger carbonate rocks west of the Llano Uplift. The major objective of the study is to delineate the relationship among high-quality oil and gas reservoirs, depositional facies, and diagenesis.

During 1978, studies centered on data derived from the examination of cores of the Ellenburger. The cores were obtained from boreholes and wells located along a line extending from the Llano Uplift in Central Texas to Presidio County in West Texas. Along this cross-section line, the composition of the Ellenburger grades from total dolomite in the west to dolomite interbedded with limestone in the east. This change in composition along the line of section from west to east is a phenomenon that should

aid in the interpretation of the diagenetic history of the Ellenburger.

DEPOSITIONAL SYSTEMS OF THE UPPER CRETACEOUS SAN MIGUEL FORMATION, SOUTHWEST TEXAS

Bonnie R. Weise.

The sandstones of the Upper Cretaceous San Miguel Formation of southwest Texas have produced oil and gas in a number of fields and under a variety of structural and stratigraphic conditions. The primary goals of this project, initiated in June 1977, are to identify the characteristics, distribution, and relationships of the sedimentary facies of the San Miguel on the basis of core and well log data, to delineate the depositional systems, and to construct depositional models for the sandstone units.

During 1978, well logs, cores, and thin sections were studied; regional cross sections revised; net-sandstone maps completed; and outcrop and subsurface data correlated. A report on the results of this project was in preparation at yearend; completion of the report is expected in early 1979.

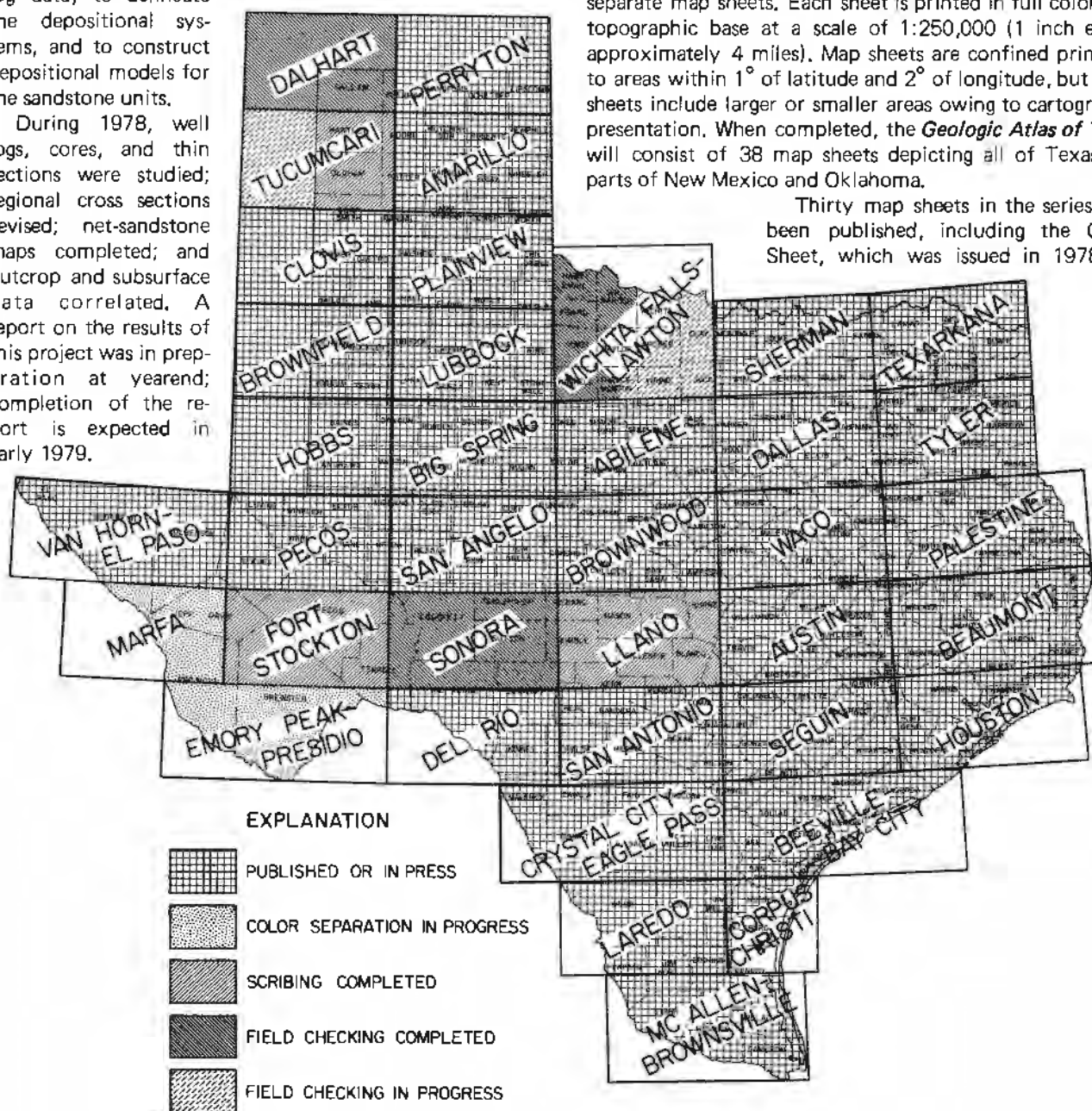
GEOLOGIC MAPPING

GEOLOGIC ATLAS OF TEXAS

Virgil E. Barnes, project director; R. S. Kier and Dawn G. McKalips, Cartography by James W. Macon, Richard L. Dillon, Dan F. Scranton, and Margaret R. McKinney.

A new geologic map of Texas showing the distribution of outcropping rock units is being published as a series of separate map sheets. Each sheet is printed in full color on a topographic base at a scale of 1:250,000 (1 inch equals approximately 4 miles). Map sheets are confined primarily to areas within 1° of latitude and 2° of longitude, but some sheets include larger or smaller areas owing to cartographic presentation. When completed, the *Geologic Atlas of Texas* will consist of 38 map sheets depicting all of Texas and parts of New Mexico and Oklahoma.

Thirty map sheets in the series have been published, including the Clovis Sheet, which was issued in 1978. At



Current Status of Geologic Atlas of Texas

yearend, color separation was in progress for the Marfa and Emory Peak-Presidio Sheets; scribing was completed for the Fort Stockton and Llano Sheets and the eastern half of the Tucumcari Sheet; field checking was completed for the Dalhart and Sonora Sheets and the western half of the Wichita Falls - Lawton Sheet; and field checking was in progress for the western half of the Tucumcari Sheet and the eastern half of the Wichita Falls - Lawton Sheet. The *Geologic Atlas of Texas* project will probably be completed in 1980.

GEOLOGIC MAP OF TEXAS

Virgil E. Barnes

The preparation of a new geologic wall map of Texas began in May 1978. To be published in four quadrants at a scale of 1:500,000, the new map will replace an earlier one that has been out of print for many years.

The new map is being derived from the *Geologic Atlas of Texas* map sheets (scale 1:250,000). At yearend, a set of all completed sheets of the *Geologic Atlas of Texas* in the northeastern quadrant of the State had been marked for use in drafting the new map. The completion date of the new map will depend on completion of the final sheets of the *Geologic Atlas of Texas*.

GEOLOGIC QUADRANGLE MAPPING IN CENTRAL TEXAS

Virgil E. Barnes.

Geologic mapping of 7.5-minute quadrangles in Central Texas was initiated in 1939 to provide basic geologic maps for use in economic, stratigraphic, structural, and geophysical investigation. Thirty-three of the geologic quadrangle maps have been published, including Cap Mountain, Click, Dunman Mountain, Howell Mountain, and Round Mountain quadrangles, which were issued in 1978. The final four maps of this series are scheduled for publication during 1979.

QUATERNARY MAPS OF TEXAS

E. G. Wermund and James W. Macon, project coordinators.

This project, initiated in 1978 with funds from the U. S. Geological Survey, involves the preparation of geologic maps of Texas Quaternary rock units as this State's contribution to the U. S. Geological Survey map series, "Quaternary Geology of the United States" (scale 1:1,000,000). The Bureau's role in this Nationwide program includes the compiling and scribing of the Texas Quaternary maps at a scale of 1:1,000,000 by using previously published Bureau of Economic Geology maps as the basic source material.

At yearend, Bureau cartographers were working on the first scheduled map of the project, the White Lake quadrangle, which includes all or part of the Beeville - Bay City, Houston, Beaumont, and Palestine Sheets of the *Geologic Atlas of Texas* (scale 1:250,000). In addition to

the *Geologic Atlas of Texas*, sources to be utilized in the compilation of the White Lake quadrangle are the (1) *Land Resources of Texas* map, (2) *Environmental Geologic Atlas of the Texas Coastal Zone*, and (3) *Land and Water Resources of the Houston-Galveston Area Council*.

OTHER RESEARCH

TEKTITES AND METEORITES

Virgil E. Barnes

This study of tektites (the small glass objects found in many places throughout the world) and meteorites began in 1935 and has resulted in 66 publications. During 1978, activity on the project was confined to referencing manuscripts, reviewing proposals, and handling correspondence.

CARBONIFEROUS OF TEXAS

R. S. Kier, L. F. Brown, Jr., and Earle F. McBride (Department of Geological Sciences, The University of Texas at Austin).

The objective of this project was to prepare a summary of the geology of Mississippian and Pennsylvanian rocks in Texas. The summary will be combined with similar material contributed by other states; it will be published by the U. S. Geological Survey as Professional Paper 1110-S in conjunction with the Ninth International Congress of Carboniferous Stratigraphy and Geology to be held at the University of Illinois, Urbana, Illinois, in May 1979. The report will be reprinted and issued by the Bureau of Economic Geology. Emphasis in the paper is on surface stratigraphy, biostratigraphy, and economic products. The manuscript was submitted to the U. S. Geological Survey in early 1978 and was being edited at yearend.

DEPOSITIONAL ENVIRONMENTS OF THE MARBLE FALLS FORMATION, CENTRAL TEXAS

R. S. Kier and D. L. Zachry (University of Arkansas).

This study involves a delineation of the carbonate facies and depositional patterns present in the exposed part of the lower Marble Falls Formation of Pennsylvanian age. The project includes the integration of previous studies by Kier and Zachry in eastern San Saba County and western Lampasas County. Additional data pertaining to the Lampasas inlier in central Lampasas County have been gathered. A report on the results of this study was in progress during 1978.

MINING AND MINERAL RESOURCES RESEARCH INSTITUTE ESTABLISHED

On September 15, 1978, a new Mining and Mineral Resources Research Institute was established as an administrative unit of the Bureau of Economic Geology by President Lorene Rogers of The University of Texas at Austin. This Institute and similar institutes in other states were provided for in Title III of the Federal Surface Mining Control and Reclamation Act of 1977.

The Institute functions both in research and in training. Funding, authorized through 1983 by the Act, is provided by the U. S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement. Federal funds for research grants, and for fellowships and scholarships are provided; funds for operation of the Institute are matched by The University of Texas at Austin. Creation and funding of the Institute permit new research directions and facilitate integration, enlargement, and more direct focus of existing mining and research and training programs. The Institute does not award degrees.

Action to establish the Institute in Texas began on August 8, 1977. At that time, Texas Governor Dolph Briscoe designated The University of Texas at Austin as the public university in Texas to apply to the U. S. Department of the Interior for the Institute. The 65th Texas Legislature endorsed the Governor's designation and also resolved that a cooperative program be developed between The University of Texas System and the Texas A & M System. A cooperative agreement has been effected.

A Mining and Mineral Resources Research Committee has been established and will consist of three persons, one each to be designated by the chancellors of the two systems and one to be a representative of the Railroad Commission of Texas. The committee will solicit research proposals and nominations for student fellowships and scholarships and make recommendations to the Institute Director for fund allocations.

Participating members of the Mining and Mineral Resources Research Institute at The University of Texas at Austin include the Bureau of Economic Geology, the College of Engineering, and the Department of Geological Sciences. The Director of the Institute, an Associate

Director of the Bureau of Economic Geology and also Professor of Geological Sciences, has responsibility for research activities and also functions as the academic program coordinator. The Institute Director reports to the Director of the Bureau of Economic Geology, who in turn reports to the Vice-President of The University of Texas at Austin.

At yearend, Dr. W. L. Fisher, Director of the Bureau of Economic Geology, announced that, as of February 1, 1979, Dr. W. C. J. van Rensburg, Head of the Department of Geosciences at West Texas State University, would become Director of the Mining and Mineral Resources Research Institute; he will also serve as an Associate Director of the Bureau of Economic Geology and as a professor in the Department of Geological Sciences, The University of Texas at Austin. Dr. van Rensburg, a native of Bloemfontein, South Africa, holds B.Sc. and M.Sc. degrees in geology from Pretoria University and a Ph.D. degree in geology from the University of Wisconsin. He is a former British Petroleum Professor of Energy Economics at Rand Afrikaans University and Director of the Institute for Energy Studies at that University. His professional background also includes experience as Technical Director of the South African Minerals Bureau, Department of Mines; Head of the Economics and Costing Division of the South African National Institute for Metallurgy; and Deputy Director of the South African Department of Planning and the Environment. He is the author and co-author of numerous articles, reports, and books on mineral resources and mineral economics.

CONTRACTS AND GRANT SUPPORT

The Bureau of Economic Geology maintains formal and informal cooperative arrangements with several governmental entities. Parts of the Bureau's research program are supported by contracts and grants with State agencies, local units of governments, Federal agencies, and other organizations. Contracts and grants in effect during all or part of 1978 included the following:

Federal

Assessment of Geothermal (Geopressured) Resources in the Texas Gulf Coast—Test Site: supported by U. S. Department of Energy.

Environmental Effects of In Situ Gasification of Texas Lignite: supported by U. S. Environmental Protection Agency through the Department of Chemical Engineering of The University of Texas at Austin.

Evaluating the Potential of East Texas Salt Domes for Isolation of Nuclear Wastes: supported by U. S. Department of Energy.

Feasibility Study on Developing Lignite Coal Deposits on National Forests in Texas: supported by U. S. Department of Agriculture, Forest Service.

Formation of Uranium Ores by Diagenesis of Volcanic Sediments: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Fourth United States Gulf Coast Geopressed Geothermal Energy Conference: supported by U. S. Department of Energy through the Center for Energy Studies of The University of Texas at Austin.

Locating Field Confirmation Study Areas for Isolation of Nuclear Waste in the Texas Panhandle: supported by U. S. Department of Energy.

Mineral Industry Location System (MILS) for Texas: supported by U. S. Department of the Interior, Bureau of Mines.

Predicting Response of a Natural System to Uranium Extraction—Oakville Aquifer, Texas: supported by U. S. Environmental Protection Agency.

Predicting Response of a Natural System to Uranium Extraction—Oakville Aquifer, Texas; Phase II: supported by U. S. Environmental Protection Agency.

Quadrangle Evaluation of Uranium Favorability of the Amarillo Quadrangle: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Quadrangle Evaluation of Uranium Favorability of the Emory Peak, Marfa, and Presidio Quadrangles: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Quadrangle Evaluation of Uranium Favorability of the Lubbock Quadrangle: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Quadrangle Evaluation of Uranium Favorability of the Palestine Quadrangle: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Quadrangle Evaluation of Uranium Favorability of the Sherman Quadrangle: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Quadrangle Evaluation of Uranium Favorability of the Wichita Falls Quadrangle: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Regional Assessment and Prospective Site Analysis of Geothermal Potential Along the Balcones, Luling-Mexia-Talco Systems, Central Texas: supported by U. S. Department of Energy.

Sandstone Consolidation Analysis to Delineate Areas of High-Quality Reservoirs Suitable for Production of Geopressed Geothermal Energy: supported by U. S. Department of Energy.

Study Effects of Geopressed Geothermal Subsurface Environment on Elastic Properties of Texas Gulf Coast Sandstones and Shales, Using Well Logs, Core Data, and Velocity Surveys: supported by U. S. Department of Energy through the Center for Energy Studies of The University of Texas at Austin.

Trace and Potentially Toxic Elements Associated with Uranium Deposits in South Texas: supported by U. S. Environmental Protection Agency.

United States Gulf Coast Geopressed Geothermal Program—Special Projects Research and Coordination Assistance: supported by U. S. Department of Energy through the Center for Energy Studies of The University of Texas at Austin.

United States Gulf Coast Geopressed Geothermal Resource: Preliminary Environmental Analysis of Geopressed Geothermal Prospect Areas, Texas Gulf Coast: supported by U. S. Department of Energy.

Uranium Potential of the Catahoule Formation, Texas—A Stratigraphic, Depositional, and Geothermal Evaluation; Phase II: supported by Bendix Field Engineering Corporation, a prime contractor for the U. S. Department of Energy.

Volume and Accessibility of Entrained Methane in Deep Geopressed Reservoirs—Tertiary Formations of the Texas Gulf Coast: supported by U. S. Department of Energy.

Wetland Delineation and Classification Study of the Coastal and Panhandle Regions of Texas: project supported by U. S. Department of the Interior, Fish and Wildlife Service.

State

Base Maps Relating to Environmental Aspects of Coastal Zone Management: supported by General Land Office of the State of Texas.

Continued Study of State Submerged Lands: supported by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning.

Designing a Prototype Multistage Data Collection Procedure Based on Landsat Data, Aircraft Photography, and Surface-Collected Data: supported by Texas Natural Resources Information System.

Determination of Finding Rates and Economic Reserves for Crude Oil and Natural Gas (Texas Energy Modeling Project): supported by Texas Energy Advisory Council.

Geologic Atlas of Texas Project: supported in part by Texas Department of Water Resources.

Land Resources Workshop: supported by the U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning.

Lignite Resources in Texas—Texas Energy Advisory Council Category L-1 (Reserve Estimation): supported in part by Texas Energy Advisory Council.

Natural Hazards Disclosure Statement: supported by Texas Coastal and Marine Council.

Textural, Geochemical, Geophysical, and Biological Analysis of Bottom Samples—Texas Submerged Lands: supported by General Land Office of the State of Texas.

Other

Analyze the Organic Geochemistry of Samples from the Geopressed Geothermal Test Well, U. S. Department of Energy and General Crude Oil Company No. 1 Pleasant Bayou: supported by Gas Research Institute.

Environmental Assessment of Geopressed Geothermal Production in Texas: supported by Lawrence Livermore Laboratory of the University of California.

CONTRACT REPORTS

During 1978, Bureau staff members prepared the following reports on research conducted under contract with various governmental agencies and other organizations. (Some of the reports were issued by those agencies in 1978; some will be published by the Bureau of Economic Geology.)

Bebout, D. G., Gavenda, V. J., and Gregory, A. R., 1978, Geothermal resources, Wilcox Group, Texas Gulf Coast: prepared for and issued by U. S. Department of Energy, Division of Geothermal Energy, as [Report] ORO/4891-3, 82 p.

Bebout, D. G., Gregory, A. R., Loucks, R. G., and Weise, B. R., 1978, A Prospectus—geopressured geothermal prospects and test-well sites—Wilcox Group and Frio Formation, Texas Gulf Coast: prepared for U. S. Department of Energy, Division of Geothermal Energy, under Contract No. EY-76-S-05-4891, 32 p.

Bebout, D. G., Loucks, R. G., and Gregory, A. R., 1978, Geopressured geothermal fairway evaluation and test-well site location, Frio Formation, Texas Gulf Coast: prepared for and issued by U. S. Department of Energy, Division of Geothermal Energy, as [Report] ORO/4891-4, 124 p.

Finley, Robert J., 1978, Applications system verification and transfer project data collection plan: prepared for the Texas Natural Resources Information System and the National Aeronautics and Space Administration under Interagency Contract No. (78-79) 1418, 56 p.

Fisher, W. L., Galloway, William E., and Morton, R. A., 1978, Effects of resource estimates and rates of finding on projection of crude oil and natural gas production: prepared for Texas Energy Advisory Council, Texas National Energy Modeling Project, under Contract No. IAC (78-79)-1510, 16 p., 12 figs.

Galloway, William E., and Kaiser, W. R., 1978, Catahoula Formation of the Texas Coastal Plain—origin, geochemical evolution, and characteristics of uranium deposits: prepared for U. S. Department of Energy under Contract No. 77-063-E, 121 p.

Galloway, William E., Gustavson, Thomas C., Dutton, Shirley P., Finley, Robert J., Handford, C. Robertson, and Presley, Mark W., 1978, Locating field confirmation study

areas for isolation of nuclear waste in the Texas Panhandle—annual report for period October 1, 1977 – September 30, 1978: prepared for U. S. Department of Energy, Office of Waste Isolation, under Contract No. EY-77-S-05-5466 (ORO/5466-10), 109 p.

Garner, L. E., 1978, Evaluation of lignite resources in the National Forests of Texas: prepared for U. S. Department of Agriculture, Forest Service, under Grant No. 38-3145, 93 p., 32 plates.

Gustavson, Thomas C., McGraw, M. M., Tandy, Mills, Parker, Faust, and Wohlschlag, D. C., 1978, Ecological implications of geopressured geothermal energy development, Texas-Louisiana Gulf coast: prepared for and issued by U. S. Fish and Wildlife Service, under Contract No. 14-16-0008-2141, 596 p.

Henry, Christopher D., and Kapadia, Rajesh R., 1978, Trace and potentially toxic elements associated with uranium deposits in South Texas: prepared for U. S. Environmental Protection Agency under EPA Grant/Project No. 80514701, 97 p.

Henry, Christopher D., and Walton, Anthony W., 1978, Formation of uranium ores by diagenesis of volcanic sediments: prepared for Bendix Field Engineering Corporation (a prime contractor for the U. S. Department of Energy), under Subcontract No. 77-067-E, 440 p.

Kreitler, Charles W., Bunker, R. C., Collins, E. W., Fogg, Graham E., Giles, Alice B., Guevara, Edgar H., Hobday, David K., and Wermund, E. G., 1978, Evaluating the potential of East Texas salt domes for isolation of nuclear waste: prepared for U. S. Department of Energy, Office of Waste Isolation, under Contract No. EW-78-05-5681 (ORO-5681-6), 30 p.

Kreitler, C. W., Wermund, E. G., Guevara, E. H., Giles, A., and Fogg, G., 1978, Preliminary evaluation of salt domes in East Texas for National Waste Terminal Storage Program: prepared for U. S. Department of Energy, under Contract No. 32-78-05-5681, 46 p., 17 figs. and 5 tables.

Loucks, R. G., 1978, Geothermal resources, Vicksburg Formation, Texas Gulf Coast: prepared for and issued by U. S. Department of Energy as [Report] ORO/4891-2, 52 p.

McGowen, J. H., Granata, G. E., and Seni, S. J., 1978, Depositional framework of the lower Dockum Group (Triassic), Texas Panhandle: prepared for U. S. Department of the Interior, Geological Survey, under Grant No. 14-08-0001-G-153, 113 p.

McGowen, J. H., Granata, G. E., and Seni, S. J., 1978, Depositional systems, uranium occurrence and postulated ground-water history of the Triassic Dockum Group, Texas Panhandle - Eastern New Mexico: prepared for U. S. Department of the Interior, Geological Survey, under Grant No. 14-08-0001-G410, 104 p.

White, William A., McGraw, Maryann, and Gustavson, Thomas C., 1978, Environmental analysis of geopressured geothermal prospect areas, Brazoria and Kenedy Counties, Texas: prepared for U. S. Department of Energy, Division of Geothermal Energy, under Contract No. EG-77-S-05-5401, 203 p.

PUBLICATIONS

In its role as a public geologic research unit, the Bureau of Economic Geology disseminates the results of research projects and programs primarily through its own publication series. During the 69-year history of the Bureau, more than 700 reports, bulletins, circulars, special publications, and maps have been published covering major aspects of the geology and natural resources of Texas. In addition, more than 400 reports and maps are available to the public through open-file holdings at the Bureau. Publications are sold to interested persons at nominal prices designed to recover printing or duplication costs. To date, approximately 1 million publications have been distributed on a world-wide basis, principally through direct sales. During 1978, the Bureau issued the following publications:

REPORTS OF INVESTIGATIONS

Report of Investigations No. 90. Proceedings, Gulf Coast Lignite Conference: Geology, Utilization, and Environmental Aspects, W. R. Kaiser (editor). 28 papers, plus summary of workshops presented in Austin, Texas, on June 2-4, 1976, 276 p. (\$5.00).

The Conference on Gulf Coast Lignite: Geology, Utilization, and Environmental Aspects, was held in June 1976 in Austin. Presentations by representatives of public and private research groups, State and Federal government, energy exploration and mining companies, industrial users, and energy consulting firms reflect the broad, diversified front on which research, exploration, and development of Gulf Coast lignite is progressing.

Geologic topics included discussions of modern analogs of lignite accumulation, such as the Mississippi Delta peats and swamps, and regional framework of lignite-bearing strata in Texas, Louisiana, Mississippi, and Alabama. Utilization topics ranged from specific mine sites and mining techniques to combustion characteristics and conversion potential. Environmental aspects of lignite use were examined in presentations such as those on applying environmental geologic mapping to lignite lands and flue-gas desulfurization technology to air-quality control.

Report of Investigations No. 91. Frio Sandstone Reservoirs in the Deep Subsurface Along the Texas Gulf Coast—Their Potential for the Production of Geopressed Geothermal Energy, by D. G. Bebout, R. G. Loucks, and A. R. Gregory, 93 p., 106 figs., 1 table (\$4.50).

The Frio Formation of the subsurface Tertiary section in the Gulf Coast Basin has been the focus of extensive evaluation for potential resources of geopressed geothermal energy. This report represents a comprehensive summary of the Bureau's geothermal programs in the Frio, which have culminated in the selection of Texas' first test-well site for geothermal production. A portion of this investigation was published previously by the Bureau as Geological Circulars 75-1, 75-8, and 76-3.

The Hidalgo, Armstrong, Corpus Christi, Matagorda, and Brazoria Fairways are delineated in this report. The Austin Bayou Prospect in the Brazoria Fairway of Galveston and Brazoria Counties is pinpointed as the most suitable site for Frio geothermal production. At this site, 250 to 350 feet of reservoir sandstone occurs with core permeabilities between 40 and 60 millidarcys and fluid temperatures from 300° to 350°F. Detailed geological, geophysical, and engineering studies have been applied to delineate the Austin Bayou test-well site.

Report of Investigations No. 92. Land and Water Resources, Historical Changes, and Dune Criticality—Mustang and North Padre Islands, Texas, by William A. White, Robert A. Morton, Ralph S. Kerr, W. David Kuenzi, and William B. Brogden. 46 p., 26 figs., 7 tables, 1 plate (\$2.00).

Barrier islands along the Texas Coastal Zone are part of a complex and dynamic system represented by many distinct yet interrelated environments that are affected by a variety of natural processes, climatic conditions, and human activities. Because island resources are extremely important both as natural systems and as valuable recreational areas, understanding their complexities and the ways in which man and his activities interact with them becomes more and more urgent.

This report, which focuses on a 20-mile segment of barrier islands along the Texas coast, treats several aspects of the islands, including land and water resources, active processes and natural hazards, historical changes in natural environments, historical changes in Gulf and bay shorelines, and the importance of fore-island dunes.

A large-scale (1:24,000) map of Mustang and north Padre Islands (Nueces County) that depicts 16 land and water resource units (beaches, fore-island dunes, vegetated barrier flats, marshes, etc.) is described by a general definition, and by physical characteristics, active processes,

typical vegetation and/or animals, and importance and/or special concerns.

Historical changes in natural environments, Gulf and bay shorelines, and the Gulf vegetation line were determined using historical monitoring techniques that involve precise cartographic comparison and analysis of chronologic charts, maps, and photographs. Historical changes in natural environments and the position of the vegetation line along the Gulf shoreline are recorded for a period of approximately 36 years ending in 1974. Movement along Gulf and bay shorelines during the past 100 years is tabulated and discussed in terms of the magnitudes and rates of accretion and erosion.

Fore-island dunes are discussed in more detail than other land and water resources because of their importance in protecting back-island areas and the mainland from storm surge. In addition to discussions of dune types, functions, and relative importance, various dunes typically represented on barrier islands are ranked according to their ability to protect against storm scour and overwash along the Gulf shoreline.

Report of Investigations No. 94. Epeiric Depositional Models for the Lower Cretaceous Washita Group North-Central Texas, by R. W. Scott, D. Fee, R. Magee, and Hooman Laali. 23 p., 15 figs., 3 tables (\$1.00).

The study area for this report extends from Fort Worth, Texas, northward to the Red River and southeastern Oklahoma, where the Washita Group exhibits its most complex and extreme facies changes. The Washita Group is the uppermost sedimentary package of the Comanchean Series in North-Central Texas and represents the third and last depositional cycle of the Early Cretaceous transgression from the ancestral Gulf of Mexico.

This investigation examined details of stratigraphic relations among the formations of the Washita Group and defined lithofacies on the basis of current petrographic methods. Lateral and vertical relations among these facies were examined and depositional models that incorporate data from Holocene studies were constructed. This study tested previous hypotheses that interpreted Washita limestones as being of either shallow-water or deep-water origin and reviewed the relative roles that tectonic and climatic processes played in producing the cyclical deposits. This investigation also provides insight into processes that formed lithosomes in epicontinental seas.

Report of Investigations No. 95. Land and Water Resources of the Corpus Christi Area, Texas, by R. S. Kier and William A. White. 22 p., 11 figs., 17 tables, 1 plate (\$2.50).

Development and use of land and water resources consistent with their natural capabilities will minimize or prevent many environmental problems. This report provides the basis for formulating general management policy in the Corpus Christi area through presentation of the characteristics of natural environments in a variety of formats—map, text, tables, and illustrations.

The types, extent, and distribution of land and water resources in the Corpus Christi area (Aransas, Nueces, Refugio, and San Patricio Counties) are analyzed. The

report also provides a description of the Corpus Christi area including geology, physical properties, ground water, mineral and energy resources, and natural hazards.

Forty land and water resource units, defined and mapped in the Corpus Christi area, are classified into the following systems: Coastal Plain; active floodplains; barrier islands; wetlands; man-made features; and bays, lagoons, estuaries, and open Gulf. Fundamental definition and delineation of the units were based on characteristics such as natural processes and hazards and physical, chemical, and biological properties.

The text is accompanied by a Land and Water Resources map at a scale of 1:125,000. Use of the map, text, and tabular information, and construction of special-purpose derivative maps can contribute to planning for future development of the Corpus Christi area.

GEOLOGICAL CIRCULARS

Geological Circular 78-1. Mineral Lands in the City of Dallas, by Ann E. St. Clair. 14 p., 15 figs., 3 tables, 1 plate (\$1.00).

In 1976, the City of Dallas contracted with the Bureau of Economic Geology to study mineral lands within that city. The purpose of the project was to delineate mineral lands, to describe alternatives for reclaiming mined land, and to evaluate the economic impact of zoning mineral lands. This circular provides basic data for policies to ensure availability of mineral resources and to promote the use of these resources with minimal long-term environmental disruption. A map of mineral resources and mined lands within the City of Dallas accompanies the text.

Geological Circular 78-2. Regional Distribution of Fractures in the Southern Edwards Plateau and Their Relationship to Tectonics and Caves, by E. G. Wermund, Joseph C. Cepeda, and P. E. Luttrell. 14 p., 13 figs. (\$1.50).

Surficial fracture zones in the southern Edwards Plateau are composed of older sets probably related to basement and relatively younger sets reflecting the Balcones Fault Zone. Western caves align with the older system, whereas eastern caves are controlled by Balcones sets. Lineations were marked on nearly 200 mosaics the size of a standard 7.5-minute quadrangle with a scale of 1:24,000. Approximately 400 fracture zones were identified on each mosaic. Moving averages of the density and orientation of fracture zones were computed in order to map (1) number of fractures, (2) length of fracturing, (3) distribution of fracture intersections, (4) weighted arithmetic mean of fracture orientation in northeast and northwest quadrants, and (5) standard deviation of the means. All were calculated per

unit area. In addition, rose diagrams were computed for selected areas, generally a standard 7.5-minute quadrangle.

Geological Circular 78-3. Electric Power Generation from Texas Lignite, by W. R. Kaiser. 18 p., 8 figs., 12 tables (\$0.75).

More than 50 million tons of Texas lignite will be burned for electric power generation in 1985. A series of newly prepared maps shows the distribution of near-surface and deep-basin lignite in Texas. New resource estimates and grade data are presented in this circular. Mining methods, future trends, and the outlook for reclamation are reviewed. Boiler design and the problems of air-quality control are discussed in terms of the sulfur and ash content and the wide variation in ash composition of Texas lignite.

Geological Circular 78-4. Sand-Body Geometry and the Occurrence of Lignite in the Eocene of Texas, by W. R. Kaiser, J. E. Johnston, and W. N. Bach. 19 p., 21 figs., 1 table (\$0.75).

Lignite in the Texas Gulf Coastal Plain occurs in three ancient depositional systems—fluvial, deltaic, and strandplain/lagoonal. Examples discussed in this circular are representative of the full range of depositional environments identified to date. Extensive new data on the occurrence of deep-basin lignite in the Wilcox and Jackson Groups north of the Colorado River are presented. Positive correlation between sand-body geometry and lignite occurrence is demonstrated. Exploration models that are developed predict the location of almost all major strippable deposits in Texas.

Geological Circular 78-5. Texas Energy Reserves and Resources, by W. L. Fisher. 30 p., 4 figs., 4 tables (\$1.00).

Calculation, evaluation, and assessment of energy reserves and resources are essential in both governmental and private planning. This circular presents the findings of an analysis of the total energy reserve and resource base in Texas: crude oil, recoverable by primary, secondary, and tertiary techniques; natural gas, conventionally recoverable; unconventional gas, such as methane gas in solution in geopressed, geothermal water and synthetic gas recoverable by gasification of lignite and bituminous coal; natural gas liquids; geothermal waters; uranium; and synthetic liquids. The total historic production of Texas energy is quantitatively assessed, and the future level and mix of production in the State are examined in context of current and potential reserves and recovery technology.

Geological Circular 78-6. Identification of Surface Faults by Horizontal Resistivity Profiles, Texas Coastal Zone, by Charles W. Kreitler and Dawn G. McKalips. 23 p., 17 figs. (\$1.00).

The land surface in the Texas Coastal Zone is interlaced with active and potentially active surface faults. They are subtle features that are difficult to identify until they have caused damage to man-made structures. To date, faults intercept 2 airports, interstate highways at 11 different locations, and railroad tracks at 28 locations; they pass through at least 11 residential communities causing damage to over 200 houses.

Horizontal resistivity profiling is a geophysical technique that can be used to identify the presence of surface faults before structural damage to buildings occurs. The technique is simple, rapid, and relatively inexpensive. Two types of resistivity profiles across faults have been recognized: (1) profiles exhibiting different resistivities on either side of a fault; and (2) profiles exhibiting a resistivity increase at the fault but with similar resistivity values on either side.

GEOLOGIC ATLAS OF TEXAS

Geologic Atlas of Texas. Clovis Sheet, Edwin Theodore Dumble Memorial Edition, Virgil E. Barnes, project director. Scale 1:250,000, in full color, topographic base (\$3.00).

The Clovis Sheet incorporates all or part of Bailey, Castro, Deaf Smith, Hale, Lamb, Parmer, and Randall Counties in Texas, and Chaves, Curry, De Baca, Quay, and Roosevelt Counties in New Mexico. Mapping was compiled by G. K. Eifler, Jr. (Texas), and C. C. Reeves, Jr. (New Mexico). Mapping was reviewed by the Geologic Atlas Committee of the Panhandle Geological Society.

The Clovis Sheet is a memorial edition honoring Edwin Theodore Dumble (1852-1927). Dr. Dumble was the State Geologist of Texas from 1887 to 1896. He was instrumental in establishing the value of a scientific geological survey in Texas. His pioneer efforts in surveying mineral resources remain as early primers of Texas geology. Dumble's research work focused on East Texas and deposits of Texas lignite. Dr. Dumble continued to contribute to Texas geology after 1896 by serving as consulting geologist to the Southern Pacific Company. He is also remembered for his contributions to the introduction of the use of paleontology in the oil industry.

GEOLOGIC QUADRANGLE MAPS

Geologic Quadrangle Map No. 43, Geology of the Click Quadrangle, Llano and Blanco Counties, Texas, by Virgil E. Barnes and R. V. McGehee. Scale 1:24,000, in full color, topographic base, 23-p. text (\$2.50).

Geologic Quadrangle Map No. 44, Geology of the

Dunman Mountain Quadrangle, Llano, Burnet, and Blanco Counties, Texas, by Virgil E. Barnes and R. V. McGehee. Scale 1:24,000, in full color, topographic base, 10-p. text (\$2.50).

Geologic Quadrangle Map No. 45, Geology of the Cap Mountain Quadrangle, Llano County, Texas, by Virgil E. Barnes and R. V. McGehee. Scale 1:24,000, in full color, topographic base, 24-p. text (\$2.50).

Geologic Quadrangle Map No. 46, Geology of the Howell Mountain Quadrangle, Blanco and Llano Counties, Texas, by Virgil E. Barnes. Scale 1:24,000, in full color, topographic base, 11-p. text (\$2.50).

Geologic Quadrangle Map No. 47, Geology of the Round Mountain Quadrangle, Blanco, Burnet, and Llano Counties, Texas, by Virgil E. Barnes. Scale 1:24,000, in full color, topographic base, 12-p. text (\$2.50).

These geologic maps cover areas in the southeastern part of the Llano region of Central Texas that are underlain variously by Precambrian, Paleozoic, Mesozoic, and some Quaternary rocks. The text that accompanies each map contains descriptions of all geologic formations in that map area, and it includes sections on subsurface geology and mineral resources. One of the critical resources in the region is water, and these maps and texts can be used as guides in water well drilling, as well as for the usual geological and engineering purposes.

RESEARCH NOTES

Research Note 8. Faulting and Land Subsidence from Ground-Water and Hydrocarbon Production, Houston-Galveston, Texas, by Charles W. Kreitler. 22 p., 10 figs. Reprinted from Symposium of Anaheim, 1977, Land Subsidence, IAHS Pub. No. 121. (\$0.50).

Land subsidence in the Houston - Galveston area, Texas, has been attributed primarily to ground-water withdrawal. Extensive hydrocarbon production from approximately 75 fields has also occurred in the two-county area. As early as 1918, land subsidence and fault activation from hydrocarbon production were observed in the Goose Creek field, Baytown, Texas, and subsidence and faulting have been documented over six fields in the Greater Houston area.

The Houston - Galveston area is interlaced with over 240 km of active faults exhibiting topographic escarpments, as well as with several hundred kilometers of faults that, although not marked by escarpments, control drainage networks and coincide with photographic lineations. Fluid production activates a given fault by differential compaction on either side of the fault. The faults appear to be partial fluid barriers that compartmentalize subsidence.

This report describes the interrelationship of fault activation, ground-water and hydrocarbon production, and land subsidence.

Research Note 9. Engineering Properties of Land Resource Units in the Corpus Christi Area, by R. S. Kier, D. L. Bell, and P. C. Patton. 90 p., 17 figs., 27 tables, 2 appendices (\$1.50).

This note demonstrates that land resource units can be characterized quantitatively through the use of engineering test data obtained from public agencies and private firms. Information about substrate properties confirms and augments qualitative statements about the physical aspects of land resource units. The results were obtained in a pilot study in the Corpus Christi area—Nueces, San Patricio, Refugio, and Aransas Counties, Texas. The data are presented in both graphic and tabulated forms.

Research Note 10. Lower Cretaceous Carbonate Tidal Facies of Central Texas, by R. G. Loucks, A. J. Scott, D. G. Bebout, and P. A. Mench. 45 p., illus. Reprint of a field trip guidebook prepared for Gulf Coast Association of Geological Societies, 27th Annual Meeting, 1977, Austin, Texas (\$1.00).

This Research Note was first prepared as a guidebook for a field trip on October 26, 1977, for participants in the 27th Annual Meeting of the Gulf Coast Association of Geological Societies held in Austin, Texas. Because of the limited distribution of the field guide, the book was reprinted in the Bureau's Research Notes series.

The Austin-area field trip is designed to illustrate and contrast the carbonate rock types that resulted from deposition on low-energy supratidal flats and marshes and intertidal flats, where marine conditions were restricted, with those of high-energy open-marine conditions, where grainstone bars and rudist banks were abundant. The low-energy restricted-marine carbonates are well illustrated at the first two stops in the Glen Rose Limestone. High-energy open-marine limestones of Fredericksburg age are studied at the third stop in the Whitestone quarries northwest of Austin.

Research Note 11. Evaluating the Environmental Geology Map, Environmental Geologic Atlas of the Texas Coastal Zone, by Robert J. Finley. 26 p., 10 figs., 8 tables (\$0.50).

This report compares parts of the Environmental Geology maps from the *Environmental Geologic Atlas of the Texas Coastal Zone* with aerial photographs taken by the National Aeronautics and Space Administration in February 1975. The comparison revealed changes related to economic development of the region and to ongoing natural processes. The areal extent of these changes, however, amounts to only 0.9 percent of the 11,820 square miles (30,610 km²) covered by the 1975 photographs. Nearly half of the 1,105 changes detected involved channel dredging, spoil disposal, reworking of existing spoil, and creation of made land. The greatest number of natural changes involving a single environmental geologic unit resulted from dune migration in Kenedy County. The changes detected do not detract from the role of the

Environmental Geologic Atlas of the Texas Coastal Zone as a thorough, detailed, but open-ended compilation of resource information, since the average total change area for that part of each sheet examined was only 0.94 percent across all seven folios of the *Atlas*.

Research Note 12. Hydrology of the Corpus Christi Area, Texas, by J. T. Woodman, R. S. Kier, and D. L. Bell. 56 p., 17 figs., 14 tables, 3 appendices (\$1.00).

Ground-water resources in the Corpus Christi area were investigated as part of a broader study of land and water resources in Nueces, San Patricio, Refugio, and Aransas Counties. Although surface water, primarily from Lake Corpus Christi, is the principal fresh-water supply for the City of Corpus Christi and numerous other communities in the region, ground water is a significant resource in the area. More than 24 million gallons a day, or approximately one-third of the demand for fresh water in the early 1970's, was met by ground-water supplies.

Although ground-water pumpage already exceeds recharge in some parts of the Corpus Christi area, additional quantities of fresh to slightly saline ground water (dissolved solids less than 3,000 milligrams per liter) can be developed. This report delineates the occurrence and availability of fresh to slightly saline ground water in the four-county area. Data were derived from electric logs of oil and gas wells, records of water wells (through 1972), surficial geologic maps, and previous ground-water investigations.

FINAL EDITING/IN PRESS

Report of Investigations No. 93. Landsat Analysis of the Texas Coastal Zone, by Robert J. Finley.

Report of Investigations. Geologic Setting and Geochemistry of Thermal Water and Geothermal Assessment, Trans-Pecos Texas, by Christopher D. Henry.

Report of Investigations. Depositional Framework of the Lower Dockum Group (Triassic), by J. H. McGowen.

Report of Investigations. Land Resource Overview of the Capital Area Planning Council Region, Texas—A Nontechnical Guide, by C. M. Woodruff, Jr.

Report of Investigations. Depositional Patterns of the Miocene Facies, Middle Texas Coastal Plain, by James David Doyle.

Geological Circular 79-1. Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle, A Report on the Progress of Nuclear Waste Isolation Feasibility Studies (1978) by S. P. Dutton, Robert J. Finley, W. E. Galloway, Thomas C. Gustavson, C. Robertson Handford, and Mark W. Presley.

Geological Circular 79-2. Geochemistry of Sediment Distribution, Matagorda Bay System, Texas, by J. H. McGowen.

Geological Circular. Precambrian Rocks of the Southeastern Llano Region, Texas, by R. V. McGehee.

Guidebook 18. South Texas Uranium Province—Geologic Perspective, by W. E. Galloway, Robert J. Finley, and Christopher D. Henry.

Guidebook 19. Cenozoic Geology of the Trans-Pecos Volcanic Field of Texas, Anthony W. Walton and Christopher D. Henry, Editors.

Special Publication. Depositional and Ground-Water Flow Systems in the Exploration for Uranium, by William E. Galloway, Charles W. Kreidler, and J. H. McGowen. Syllabus for Research Colloquium held in Austin, September 8-9, 1978.

Special Publication. Sediment Distribution, Bathymetry, Faults, and Salt Diapirs on the Submerged Lands of Texas, by J. H. McGowen and Robert A. Morton.

Geologic Quadrangle Map No. 48. Geology of the Marble Falls Quadrangle, Burnet and Llano Counties, Texas, by Virgil E. Barnes. Scale 1:24,000.

Geologic Quadrangle Map No. 49. Geology of the Pedernales Falls Quadrangle, Blanco County, Texas, by Virgil E. Barnes. Scale 1:24,000.

Geologic Quadrangle Map No. 50. Geology of the Spicewood Quadrangle, Blanco, Burnet, and Travis Counties, Texas, by Virgil E. Barnes. Scale 1:24,000.

Geologic Quadrangle Map No. 51. Geology of the Hammetts Crossing Quadrangle, Blanco, Hays, and Travis Counties, Texas, by Virgil E. Barnes. Scale 1:24,000.

Geologic Quadrangle Map No. 52. Geology of the Purdy Hill Quadrangle, Mason County, Texas, by Emilio Mutis-Duplat. Scale 1:24,000.

Mineral Resource Circular No. 60. The Mineral Industry of Texas in 1975, by Murphy E. Hawkins and Thomas J. Evans.

Mineral Resource Circular. The Mineral Industry of Texas in 1976, by Murphy E. Hawkins and Thomas J. Evans.

REPRINTED PUBLICATIONS

Bulletin No. 3232. *The Geology of Texas, Volume I, Stratigraphy*, by E. H. Sellards, W. S. Adkins, and F. B. Plummer. 1007 p., 54 figs., 10 plates, including frontispiece, 1932 [1933] (7th printing accompanied by Geological Highway Map of Texas provided by American Association of Petroleum Geologists; \$8.00).

Geological Circular 69-4. *Geometry and Distribution of Fluvial and Deltaic Sandstones (Pennsylvanian and Permian), North-Central Texas*, by L. F. Brown, Jr. Reprinted from *Transactions* of the Gulf Coast Association of Geological Societies, Volume XIX, p. 23-47, 22 figs., 1969 (3rd printing; \$1.00).

Guidebook 2. *Texas Fossils, An Amateur Collector's Handbook*, by W. H. Matthews III. 123 p., 26 figs., 49 plates., 1960 (7th printing; \$1.00).

Guidebook 11. *Recent Sediments of Southeast Texas—A Field Guide to the Brazos Alluvial and Deltaic Plains and the Galveston Barrier Island Complex*, by H. S. Bernard, C. F. Major, Jr., B. S. Parrott, and R. J. LeBlanc, Sr.; and [Appendix] *Resume of the Quaternary Geology of the Northwestern Gulf of Mexico Province*, by H. A. Bernard and R. J. LeBlanc, Sr., 132 p., 97 figs., 1970. Reprinting of *Field Guide* prepared by Shell Development Company (4th printing; \$5.00).

Report of Investigations No. 74. *Edwards Group, Surface and Subsurface, Central Texas*, by P. R. Rose, 198 p., 35 figs., 19 plates, 1972 (2nd printing; \$5.50).

Delta Systems in the Exploration for Oil and Gas, by W. L. Fisher, L. F. Brown, Jr., A. J. Scott, and J. H. McGowen. Syllabus for Research Colloquium held in Austin, August 27-29, 1969, 212 p., 168 figs., 1969 (9th printing; \$5.00).

SERVICES

MINERAL STUDIES LABORATORY

Rapid expansion of Bureau research activity requires the support of a capable geochemical laboratory that can provide highly sensitive and accurate data on a variety of geological and biological materials and water samples. The Mineral Studies Laboratory meets these research needs.

In 1978, the laboratory made strides toward improved and expanded service. Reorganization of its physical facility minimized sample contamination and maximized efficiency. Introduction of new analytical techniques and training of laboratory personnel promoted a higher level of service. The purchase of new supplies and equipment and repair and cleaning of existing equipment also contributed to laboratory operations.

Included among new instruments are a Pye-Unicam SPB-100 UV spectrophotometer, a Farran Mark I double-

beam spectrofluorometer, a Coleman mercury analyzer, a superspeed Savoll centrifuge, a Barnstead still, a Monroe programmable calculator, a top-load electronic balance, an automatic analytical balance, a 40-sample-holder Technicon block digester, a large temperature-controlled drying oven, a distillation apparatus, and numerous other items.

The most powerful instrument, the inductively coupled plasma jet spectrometer for multiple element analysis (manufactured by Applied Research Laboratory) was scheduled to be in operation in early 1979. The new IL651 atomic absorption spectrophotometer, equipped with a flameless graphite furnace and a microprocessor, was fully activated for major and trace metal determinations.

New techniques were developed to analyze selected trace elements. New techniques and modification of old methods increased sensitivity, accuracy, precision, and efficiency in data acquisition. Development of a proper dissolution procedure for geological materials for multiple elements analysis using the plasma jet spectrometer is in progress.

Laboratory personnel are trained in trace chemical analysis. In addition to Dr. Clara L. Ho, Chemist-in-Charge, the laboratory's chemistry staff includes three full-time chemists, Steven W. Tweedy, Josephina M. Calvo, and Brian Dupre, and a number of student assistants. At the end of 1978, student assistants included James D. Williams, Yet-

ming Hung, John G. DuPont, P. Roland Chan, James Choi, Thomas K. Yeung, Peter J. McGee, Betty Yau, and Mark Garner.

The Mineral Studies Laboratory now has specialized rooms to house all major instruments. The new grinding room is separated from the wet-chemistry laboratory to prevent dust spreading. A large room adjacent to the grinding room is used for storage of National Uranium Resource Evaluation (NURE) samples. The space adjacent to the wet-chemistry laboratory is used for storing samples for other projects. The old grinding room is used for hydrometric analysis.

Work completed during 1978 included (1) determination of total uranium in samples of West Texas volcanic rocks; (2) determination of uranium and many other trace elements in samples of the Catahoula Formation; (3) determination of molybdenum and selected trace elements and hydrometric analysis in South Texas soils; (4) an investigation of selected trace elements in East Texas waters drained from lignite fields and natural streams; (5) determination of acid-soluble U_3O_8 in samples of the Triassic Dockum Group project; (6) total organic-carbon analysis of samples collected for the inner continental shelf and Texas bays, estuaries, and lagoons project; (7) trace element analysis on the U. S. Environmental Protection Agency's standard water samples; (8) analysis for major and minor elements in samples submitted by the public.

Work in support of the following Bureau projects is in progress: (1) nuclear waste isolation; (2) "Predicting Response of a Natural System to Uranium Extraction—Oakville Aquifer System, Texas"; (3) "National Uranium Resources Evaluation"; (4) public service.

Sedimentological analysis, another function of the Mineral Studies Laboratory, has been expanded with new equipment and reorganization. Seay Nance is responsible for the operation of the sedimentological area. Jon A. Robin and Ricky J. Dautat perform sample processing and analysis. A Coulter counter and a rapid sediment analyzer were installed in 1978 to provide detailed grain-size analysis. A rapid sediment analyzer-computer link is being planned to allow immediate display of the data.

WELL SAMPLE AND CORE LIBRARY

The Bureau's Well Sample and Core Library was authorized by the Texas Legislature in 1937, and it has been located at Balcones Research Center since 1945. The library is one of the Nation's largest public collections of subsur-

face geological materials. To date, it lists cores from 2,213 wells and drill cuttings from more than 90,000 wells.

Included in the library's collections are subsurface materials from all regions of Texas and from wells in Arkansas, Florida, Lesser Antilles, Louisiana, Mexico, Mississippi, Montana, New Mexico, Oklahoma, and the Persian Gulf. The library also contains electric, driller's, sample, and strip logs; scout tickets; and assorted maps. All of the library's holdings have been donated by companies, government agencies, and individuals. During 1978, the library received contributions of subsurface materials from Core Laboratories, Inc.; Core Services, Inc.; Dennis Bell; General Crude Oil Company; General Petroleum Corporation; Getty Oil Company; Hunt Oil Company; Dr. A. M. Reid III; Shell Oil Company; Sunmark Exploration Company; Superior Oil Company; Tesoro Petroleum Corporation; the Texas Department of Water Resources; Texaco Oil Company; and the U. S. Geological Survey.

Increased growth of the collections and increased need for ready access to the rock materials have led to the computerization of all available well core records; the computerization of records of drill cuttings also continued during the year. Printouts cataloging all well cores are now available to the public through the Bureau's publications department.

The library's core slabbing and processing facilities as well as shelving space were greatly increased during 1978. This has made possible the processing and cataloging of a wide variety of core types. More than 2,800 thin sections were prepared in 1978; both simple and impregnated sections were produced. Although thin sections are prepared primarily for Bureau of Economic Geology projects, they can also be produced, on a fee basis, for persons outside the Bureau. Harry J. Madsen heads the production operation.

The Well Sample and Core Library is supervised by E. Dow Davidson, Technical Staff Assistant-in-Charge. Davidson, who joined the Bureau staff in December 1978, holds a B.A. degree in anthropology from the University of Hawaii, Manoa Campus (1976). His work background includes experience as the engineered-product manager for an industrial rubber and plastic supply house in Honolulu. That position involved numerous contacts with all military branches through their purchasing organizations, as well as with the major shipping, plantation, and industrial corporations of Hawaii.

At the close of 1978, members of the Well Sample and Core Library staff, in addition to Davidson, included Harry J. Madsen, Suzanne Montano, Robert Sherrill, Lloyd Vickery, Victor Wuerch, Estuardo Alvarez-Calderon, Nancy Allen, Joe DuBose, Dick Bransford, and Sheryl Hejl.

The library is open from 8:00 a. m. until 5:00 p. m. Monday through Friday. Visitors may examine and study the subsurface materials at that facility, where microscopes and other equipment are provided and library staff members are available to assist interested persons. Cores and cuttings may also be checked out of the library; the borrower must pay shipping costs.

PUBLIC INFORMATION SERVICES

In addition to conducting basic and applied research programs, the Bureau of Economic Geology provides a variety of advisory, technical, and information services related to the geological, mineral, and land resources of the State. These services are available to individuals, companies, and governmental bodies and agencies. Staff members respond to individual requests for information received daily by letter and phone, and from visitors. In particular, two members of the Bureau's research staff respond to the many requests for information from the general public.

Roselle Girard handles many of the written requests for information on Bureau programs, publications, and general Texas geology, and responds to a steady flow of visitors seeking available information. She is in charge of the Reading Room, which is located in the Bureau's offices on the fifth floor of the Geology Building on the main campus of The University of Texas at Austin. This facility is open to the public and houses a variety of publications pertinent to Texas geology and natural resources.

L. E. Garner responds to requests for rock and mineral identification and handles all public-sample testing in cooperation with the Mineral Studies Laboratory. He also coordinates the Bureau's participation in the review of environmental impact statements and similar preliminary project reports as part of the interagency cooperation necessary for complete and adequate review of proposed State projects.

EDUCATION SERVICES

The Bureau of Economic Geology continued its participation in a public school education program through workshops and numerous public addresses. Richard L. Andersen, Dawn G. McKalips, Mark W. Presley, Bonnie R.

Weise, and William A. White of the Bureau of Economic Geology staff participated in the program during the year.

A set of curriculum materials to accompany the Bureau's *Energy Resources of Texas* map is being produced. *Unit I, Energy from Start to Finish*, has been published; *Unit II, Energy, Economics, and Environment*, is being prepared; *Unit III, Energy in the Future*, is being reviewed. Dawn G. McKalips is coordinator of the project.

Requests for information, resource materials, and references are welcome; suggestions and comments from Texas earth science teachers are also needed and welcomed.

OPEN-FILE MATERIAL

The Bureau of Economic Geology maintains an open file of reports, maps, manuscripts, and other materials obtained from various private and governmental sources. Most are unpublished, although a few are progress reports of research that will eventually be published. Work maps and data developed in connection with Bureau of Economic Geology projects currently underway may be examined and studied at the Bureau offices.

Some of the open-file reports of the U. S. Energy Research and Development Administration (ERDA), which on October 1, 1977, was included in the new U. S. Department of Energy (DOE), have been placed on file at the Bureau of Economic Geology, and some have been transferred to the Geology Library of The University of Texas at Austin. Information concerning ERDA and DOE open-file reports may be obtained from the Technical Library, Grand Junction Office, U. S. Department of Energy, Grand Junction, Colorado 81501 (telephone: 303-242-8621, ext. 278).

Copies of open-file reports of the U. S. Geological Survey may be ordered from the Open-File Services Section, Branch of Distribution, U. S. Geological Survey, Box 25425, Federal Center, Denver, Colorado 80225 (telephone: 303-234-5888).

PERSONNEL

RESEARCH STAFF

NEW RESEARCH STAFF MEMBERS

The Bureau research staff increased in 1978 with the addition of 3 research scientists and 19 research scientist associates. The diverse educational and professional backgrounds of these new staff members have measurably strengthened the Bureau's overall research capabilities.

Edward W. Collins

Edward W. Collins joined the Bureau staff as a research scientist associate in April 1978. Since that time, he has been investigating the surface geology of the East Texas area for the East Texas nuclear waste isolation project.

Collins received a B.A. degree in geology from Trinity University in 1975 and an M.S. degree in geology from Stephen F. Austin State University in 1978. He is a member of the Geological Society of America and a junior member of the American Association of Petroleum Geologists.

Timothy W. Duex

Timothy W. Duex became a full-time research scientist associate at the Bureau in September 1978. He is currently working in the National Uranium Resource Evaluation (NURE) program in West Texas. His professional experience includes work during the summer of 1967 for Bear Creek Mining Company and research in 1968-1969 as part of an Atomic Energy Commission Fellowship. During 1975, he worked as a part-time research assistant at the Bureau.

Duex received a B.S. degree in geology from the University of Wisconsin at Oshkosh and an M.A. degree in geology from Rice University, where his thesis research focused on the uranium deposits of South Texas. He now is completing requirements for a Ph.D. degree in geology at The University of Texas at Austin. Duex's research interests are geochemistry, igneous petrology, and stratigraphy of volcanic rocks.

Marc B. Edwards

Marc B. Edwards joined the staff as a research scientist in August 1978. His initial involvements have been outcrop and subsurface studies in the Wichita Falls quadrangle for the National Uranium Resource Evaluation (NURE) program and subsurface studies of parts of the Texas Gulf

Coast Tertiary section for the geopressed geothermal resources project. His research interests include basin reconstruction, facies analysis, and petrography of clastic sedimentary rocks.

Edwards received a B.S. degree in geology from City College in New York in 1968 and a Ph.D. degree in geology from Oxford University in 1972. He previously worked for the Continental Shelf Institute of Norway, where his chief task was a regional analysis of Mesozoic and upper Paleozoic strata of the Spitzbergen Archipelago and the Barents Shelf.

Edwards is a member of the Norwegian Geological Society, the Norwegian Petroleum Society, the Society of Economic Paleontologists and Mineralogists, and the International Association of Sedimentologists.

Graham Fogg

Graham Fogg joined the Bureau staff as a research scientist associate in January 1978. He has been conducting hydrogeological studies of East Texas salt domes for the East Texas nuclear waste isolation project.

Fogg received a B.S. degree in hydrology from the University of New Hampshire in 1975 and an M.S. degree in hydrology from the University of Arizona in 1978. His graduate research focused on the hydraulics of unsaturated water flow in porous media and the use of recently developed numerical techniques for modeling unsaturated and ground-water flow systems. Fogg's other research interests include solute transport and the interrelationships among geology, hydraulics, and chemistry in ground-water systems. He is a member of the Austin Geological Society, the National Water Well Association, and the American Water Resources Association.

Katherine E. Fonken

Katherine E. Fonken received her B.S. degree in zoology from The University of Texas at Austin in 1976. She also completed one year of graduate studies in fungal genetics at the University of Vermont. Her chief professional interest is environmental research.

Fonken joined the Bureau staff as a research scientist associate in October 1978. She is currently involved in the Bureau project, "Wetland Delineation and Classification of the Coastal and Panhandle Regions of Texas."

James K. Gluck

James K. Gluck, who is currently working on the project, "Predicting Response of a Natural System to Uranium Extraction: Oakville Aquifer System, Texas," received a B.S. degree in geology from Florida State

University in 1969. As a graduate student, he worked on the West Flower Garden sampling project at Texas A & M University in 1970. Other professional experience includes work in field geophysics during 1974-1977. Gluck joined the Bureau of Economic Geology as a research scientist associate in November 1978.

Clara L. Ho

Clara L. Ho joined the Bureau of Economic Geology as a research scientist in February 1978. She is Chemist-in-Charge of the Bureau's Mineral Studies Laboratory, succeeding Daniel E. Schofield who retired in 1977.

Ho received a B.S. degree in agricultural chemistry from National Taiwan University in 1954, an M.S. degree in soil chemistry from Oregon State University in 1956, and a Ph.D. degree in soil chemistry (with a minor in chemistry and mathematics) from North Carolina State University in 1959. While employed as a postdoctoral research associate at Iowa State University from 1959 to 1965, her research studies focused on soil biochemistry and soil engineering. She was an assistant professor at the Coastal Studies Institute of Louisiana State University from 1966 to 1969, and was an associate professor in the Department of Marine Sciences and Sea Grant Development of the Center for Wetland Studies at Louisiana State University from 1969 to 1978.

Ho is a fellow of the American Institute of Chemists. She is also a member of the International Society for Geochemistry and Cosmochemistry, the American Geochemical Society, the National Clays and Clay Minerals Society, the Gulf Coast Estuarine Society, and the Society of the Sigma Xi.

Ho's research interests include diagenesis of sediments, trace element geochemistry, organic geochemistry, environmental geochemistry, soil chemistry, geochemistry of surface and interstitial (or pore) waters, clay mineralogy and clay chemistry, scanning electron microscopy, application of geochemical investigation to foundation stability (landslides), chemical stabilization of soils and sediments, and the relationship of the formation of pozzolanic reaction products to the increase in strength of lime-treated foundation materials—especially the organically rich type of materials that occur in the Coastal Zone.

David K. Hobday

David K. Hobday joined the Bureau staff as a research scientist in April 1978. Since that time he has been involved in surface studies relating to the East Texas nuclear waste isolation project and in the evaluation of uranium favorability of the Sherman quadrangle for the National Uranium Resource Evaluation (NURE) program.

Hobday received his B.S. and M.S. degrees in geology from the University of Natal, South Africa, and, in 1969, a Ph.D. degree in geology from Louisiana State University. Following 2 years at Oxford on a postdoctoral fellowship, he joined the faculty of the University of Natal. He was a visiting professor at the University of South Carolina during 1975.

Hobday's current interests are in the field of shallow-water clastic sedimentation. He is a member of the Society of Economic Paleontologists and Mineralogists, the Inter-

national Association of Sedimentologists, the Geological Society of South Africa, the South African Society for Quaternary Research, and the American Association of Petroleum Geologists.

Rajesh R. Kapadia

Rajesh R. Kapadia joined the Bureau staff as a research scientist assistant in March 1978; in September, he was promoted to research scientist associate. Kapadia was initially involved in computerization and statistical analysis for the project, "Trace and Potentially Toxic Elements Associated with Uranium Deposits in South Texas." At yearend, he was working on data entry, data preparation, and data analysis for various Texas quadrangle areas being investigated for the National Uranium Resource Evaluation (NURE) program.

Kapadia received a B.S. degree in electrical engineering from the University of Bombay, India, in 1971. He also received an M.S. degree in electrical engineering in 1973 and an M.B.A. degree in information systems management in 1978 from The University of Texas at Austin. His Ph.D. dissertation, which he is writing at this university, concerns microcomputer applications.

Prior to joining the Bureau, Kapadia worked on several research projects at The University of Texas at Austin, ranging from computer hardware and software development to transportation investment modeling. He also taught a course in computer programming at The University of Texas at Austin for about 2 years. His industrial experience includes the designing of automatic data acquisition devices, systems engineering, and consulting. Kapadia is a member of the Institute of Electrical and Electronic Engineers and the Association of Master of Business Administration Executives.

Russell S. Kimble

Russell S. Kimble received a B.S. degree in biology from Centenary College of Louisiana in 1972 and an M.S. degree in zoology from Louisiana Technological University in 1976. From 1976 until joining the Bureau staff as a research scientist associate in October 1978, he worked for Allan Hancock Foundation of The University of Southern California. He is currently involved with the Bureau project, "Surficial Biology of Marine and Estuarine Deposits in Corpus Christi Vicinity for Integrated Environmental Planning."

Kimble's research interests include the ecology and systematics of marine crustaceans, especially marine Amphipoda; he is also interested in fresh-water ecology. Kimble is a member of the Southwestern Association of Naturalists and the American Association for the Advancement of Science.

Thomas G. Littleton

Thomas G. Littleton joined the staff as a research scientist associate in September 1978. He is now working on one of the Bureau's new projects, "Surficial Biology of Marine and Estuarine Deposits in Corpus Christi Vicinity for Integrated Environmental Planning."

Littleton received a B.S. degree in biology from Pan American University in 1968 and is a candidate for an M.S.

degree in biology at Texas A & M University. His research interests are molluscan systematics and ecology. Littleton is a member of the American Malacological Union and the Southwestern Association of Naturalists.

Mary W. McBride

Mary W. McBride joined the Bureau staff in May 1978 as a research scientist associate. Her initial assignment has been to assess the general geologic framework of the Lower Cretaceous sandstones for the Bureau project, "Regional Assessment and Prospective Site Analysis of Geothermal Potential Along the Balcones, Luling-Mexia-Talco Systems, Central Texas."

McBride received a B.A. degree in geology from The University of Texas at Austin and an M.S. degree in geology from the University of Oklahoma. Her previous work experience includes general subsurface geology, petrographic analysis, and analysis of earthquake signals. She is a member of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists.

H. Seay Nance

H. Seay Nance joined the Bureau's full-time staff as a research scientist associate in August 1978 and is responsible for sedimentological analysis at the Bureau's Mineral Studies Laboratory at Balcones Research Center. He previously was a part-time employee at the Bureau's Well Sample and Core Library and, later, was a laboratory research assistant for the Bureau's State-owned submerged lands project, serving as a textural analyst.

Nance received a B.S. degree in geology from The University of Texas at Austin in 1978. His main research interests are paleomarine communities and geomorphology.

Homer Pachecano

Homer Pachecano, a native of San Antonio, Texas, graduated in August 1978 from The University of Texas at Austin with a B.A. degree in geology. He joined the Bureau staff as a research scientist associate in October 1978 and is currently working on the project, "Wetland Delineation and Classification of the Coastal and Panhandle Regions of Texas." Pachecano's professional interests include environmental geology and water resource management.

David A. Pass

David A. Pass became a research scientist associate at the Bureau in September 1978. He was previously associated with the Bureau as a research assistant on the project, "Evaluation of Lignite Resources in the National Forests of Texas." His prior professional experience includes service as a geologist and instrument technician for Geochem Laboratories, Inc., in Houston, Texas.

Pass is currently working on the Bureau project, "Evaluating the Potential of East Texas Interior Salt Domes for Isolation of Nuclear Wastes." As a part of that project, he is studying carbon isotopes of the ground waters in the Carrizo-Wilcox aquifers in the vicinity of the East Texas salt domes to determine the ages and interaquifer relationships of those waters.

Pass received his B.A. degree in geology in 1978 from

The University of Texas at Austin. His research interests include organic geochemistry and the depositional systems approach to basin analysis. Pass is a member of the American Association of Petroleum Geologists.

Jan S. Posey

Jan S. Posey joined the Bureau staff in March 1978. Her initial involvement was with the project, "Resource Assessment and Test-Well Site Selection--Geopressured Geothermal Energy, Texas Gulf Coast." In September 1978, she became a research scientist associate and began constructing structural cross sections of the Texas Gulf Coast area for another Bureau project, "Volume and Accessibility of Entrained Methane in Deep Geopressured Reservoirs--Tertiary Formations of the Texas Gulf Coast."

Posey received her B.S. degree from The University of Texas at Austin. Before joining the Bureau staff she was employed in the Geophysical Department of Tesoro Petroleum Corporation in San Antonio, Texas. She also taught earth science classes in San Antonio. Her professional interests include geophysical interpretation and subsurface correlating and mapping.

Ray S. Risner

Ray S. Risner joined the Bureau staff as a research scientist associate in October 1978. His initial assignment is with the National Uranium Resource Evaluation (NURE) program in the Amarillo and Lubbock quadrangles. His work includes sampling rock and soil and assisting with subsurface depositional analysis in those NURE quadrangle areas.

Risner received a B.S. degree in geology, with honors, from The University of Texas at Austin during the summer of 1978.

Floyd G. Rose, Jr.

Floyd G. Rose, Jr., joined the Bureau staff as a research scientist associate in September 1978. Since that time, he has been working on the National Uranium Resource Evaluation (NURE) program in the Palestine and Sherman quadrangle areas. His duties have included collecting soil and sediment samples for laboratory analysis and also helping with the subsurface work.

Rose received his B.S. degree in geology from The University of Texas at Austin in 1978. He is a member of the American Association of Petroleum Geologists.

Steven J. Seni

Steven J. Seni rejoined the Bureau staff as a research scientist associate in September 1978. He is currently working with the National Uranium Resource Evaluation (NURE) program in the Amarillo quadrangle area.

Seni was formerly associated with the Bureau from 1973 to 1977 as a research assistant. After receiving a National Science Foundation Energy-Related Traineeship in 1977, he left the Bureau for 1 year to complete requirements for his M.A. degree in geology at The University of Texas at Austin. His thesis focused on the genetic stratigraphy of the uranium-bearing Dockum Group in West Texas.

Roger D. Sharpe

Roger D. Sharpe joined the staff of the Bureau as a research scientist associate in November 1978. He has been involved with the Mineral Industry Location System (MILS) project since that time. His research interests are exploration and evaluation of mineral commodities, particularly industrial minerals. His previous professional experience includes environmental planning for the City of Greensboro, North Carolina, and evaluation of kaolin deposits for Stauffer Chemical Company.

Sharpe received his B.A. degree in geology from the University of North Carolina at Greensboro in 1976 and has completed requirements for his M.S. degree in geology from the University of Georgia. His graduate research dealt with the petrology, geochemistry, and metamorphic history of an alpine-ultramafic body in the Blue Ridge Mountains of North Carolina. Sharpe is a member of the Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Jeffrey E. Thurwachter

Jeffrey E. Thurwachter joined the Bureau staff in April 1978. Thurwachter is involved with the National Uranium Resource Evaluation (NURE) program for the Lubbock and Wichita Falls quadrangles. His work has included rock sampling, subsurface correlations with well logs, and preliminary land status mapping.

Thurwachter received a B.S. degree in geology, with a minor in computer science, from Northern Illinois University. He is a member of the American Association of Petroleum Geologists.

Becky Wiggins

Becky Wiggins joined the Bureau staff as a research scientist associate in September 1978. Her initial assignment is with the Mineral Industry Location System (MILS) project.

Wiggins received a B.S. degree in geology from Wayne State University (Detroit, Michigan) in December 1974. During 1975, she studied geothermal energy in Wellington, New Zealand, on a Fulbright-Hayes Scholarship. In 1976 and 1977, she took extra courses in mathematics and computer science while working as a software consultant for Wayne State University Computing Services Center. From September 1977 through May 1978, she attended the School of Law at The University of Texas at Austin. Wiggins' professional interests include computer applications in geology and geothermal energy.

PAPERS BY BUREAU OF ECONOMIC GEOLOGY STAFF IN OUTSIDE (NON-BUREAU) PUBLICATIONS

In addition to reports published by the Bureau of Economic Geology, staff members also write papers that are issued by other organizations in journals, proceedings, and other professional publications. During 1978, the following papers by Bureau staff members were published outside of the Bureau:

Basciano, J. M., and Henry, C. D., 1978, Application of environmental geology to ground-water hydrology of the

Wilcox lignite belt, *in* Gulf Coast Lignites Conference, The Woodlands, Texas, May 1978, Proceedings, Preprint for meeting: NUS Corporation, p. 221-230.

Bebout, D. G., and Loucks, R. G., 1978, Deltaic depositional style in salt-withdrawal basin, Frio Formation, Brazoria County, Texas (abstract): American Association of Petroleum Geologists Bulletin, v. 62, no. 3, p. 494-495.

Bebout, D. G., Loucks, R. G., and Gregory, A. R., 1978, Evaluation of an energy resource—geopressured geothermal zone, Texas Gulf Coast: Society of Petroleum Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Annual Technical Conference and Exhibitions, 53d, Houston, 1978, Transactions, Preprint for meeting, 8 p.

Bebout, D. G., Loucks, R. G., and Gregory, A. R., 1978, Geopressured geothermal energy from the Gulf Coast Frio Formation (abstract), *in* American Association of Petroleum Geologists, Southwest Section, Annual Meeting, Midland, Texas, 1978, Transactions: West Texas Geological Society Publication No. 78-69, p. 90-91.

Bebout, D. G., Loucks, R. G., and Gregory, A. R., 1978, Geothermal energy from the geopressured zone—Texas Gulf Coast (abstract): South Texas Geological Society Bulletin, v. 19, no. 1, p. 5.

Bebout, Don, and Schatzinger, Richard A., 1978, Distribution and geometry of an oolite-shoal complex—Lower Cretaceous Sligo Formation, South Texas: Gulf Coast Association of Geological Societies Transactions, v. 28, p. 33-45. Abstract *in* American Association of Petroleum Geologists Bulletin, v. 62, no. 9, p. 1753-1754.

Brown, L. F., Jr., and Fisher, W. L., 1978, Seismic-stratigraphic interpretation of depositional systems—examples from Brazilian rift and pull-apart basins, *in* Seismic stratigraphy—application to hydrocarbon exploration: American Association of Petroleum Geologists Memoir 26, p. 213-248.

Duex, T. W., and Henry, C. D. (with McDowell, F. W., and Long, L. E.), 1978, Age and strontium isotope chemistry of the Sierra Madre Occidental volcanic province, Western Mexico, *in* International Conference on Geochronology, Cosmochronology, and Isotope Geology, Fourth, Aspen, Colorado, 1978, Short Papers: U. S. Geological Survey Open-File Report 78-701, p. 289-291.

Dutton, S. P. (with Land, L. S.), 1978, Cementation of a Pennsylvanian deltaic sandstone—isotopic data: Journal of Sedimentary Petrology, v. 48, no. 4, p. 1167-1176.

Dutton, S. P. (with Land, L. S.), 1978, Diagenesis of a Pennsylvanian deltaic sandstone—isotopic data (abstract): International Congress on Sedimentology, Tenth, Jerusalem, 1978, Abstracts, p. 368.

Edwards, Marc B., 1978, Composition, provenance and diagenesis of sandstones in the Lower Cretaceous Helvetiafjellet Formation, Svalbard: Continental Shelf Institute, Trondheim, Norway, Publication No. 98, 29 p.

Edwards, Marc B., 1978, A regional survey of composition, provenance and diagenesis of sandstones in the Lower Cretaceous Helvetiafjellet Formation, Svalbard: Norwegian Polar Institute Yearbook, 1977, p. 343-345.

Edwards, Marc B., 1978, Glacial environments, *in* Sedimentary environments and facies: Oxford, England, Blackwells, p. 416-438.

- Edwards, Marc B., Edwards, P. R., and Colbert, E. H., 1978, Carnosaurian footprints in the Lower Cretaceous of eastern Spitsbergen: *Journal of Paleontology*, v. 52, no. 4, p. 940-941.
- Finley, Robert J., 1978, Classification of Texas coastal environments from photo interpretation of Landsat imagery (abstract): *Geological Society of America, Abstracts with Programs*, v. 10, no. 7, p. 401.
- Finley, Robert J., 1978, Ebb-tidal delta morphology and sediment supply in relation to seasonal wave energy flux, North Inlet, South Carolina: *Journal of Sedimentary Petrology*, v. 48, no. 1, p. 227-238.
- Finley, Robert J. (with Hine, A. C., and Hayes, M. O.), 1978, Tidal-current deposits, in Fairbridge, R. W., and Bourgeois, J., editors, *Encyclopedia of sedimentology*: Stroudsburg, Pennsylvania, Dowden, Hutchinson, and Ross, Inc., p. 795-798.
- Finley, Robert J. (with Nummenda, D.), 1978, Wind generated longshore currents: *American Society of Civil Engineers, Conference on Coastal Engineering*, 16th, Hamburg, Germany, Proceedings, Preprint for meeting, 11 p.
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- Fisher, W. L., 1978, Lignite in the National Coal Option, in *Proceedings, Lignite Conference, Ozarks Regional Commission*, Little Rock, Ark., p. 107-111.
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- Fisher, W. L. (with Rostow, W. W., and Woodson, H. W.), 1978, National energy policy—an interim overview, in *National energy policy—a continuing assessment*: Austin, Texas, The University of Texas at Austin, Council on Energy Resources, p. 1-62.
- Galloway, William E., 1978, Catahoula Formation of the Texas Coastal Plain—depositional systems, ground-water flow history and uranium distribution: *Economic Geology*, v. 73, no. 8, p. 1655-1676.
- Gregory, A. R., Bebout, D. G., and Loucks, R. G., 1978, Evaluation of gas resource in geothermal geopressed reservoirs—Gulf Coast area, in *Symposium on Alternative Resources and Technologies for Fuel Production*, Pittsburgh, Pennsylvania, 1978, Proceedings, Preprint for meeting: University of Pittsburgh, Office of Continuing Education, 22 p.
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- Gustavson, Thomas C., Finley, R. J., and Woodruff, C. M., Jr., 1978, Geomorphic studies applied to the evaluation of potential nuclear waste isolation sites (abstract): *Geological Society of America, Abstracts with Programs*, v. 10, no. 1, p. 17.
- Gustavson, Thomas C., and McGraw, M. M., 1978, Potential environmental concerns associated with the development of geopressed-geothermal resources, United States Gulf Coast, in *Geothermal energy, a novelty becomes resource*, Hilo, Hawaii, 1978, Transactions: Geothermal Resources Council (Davis, California), p. 245-248.
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Wermund, E. G., 1978, Texas land resources mapping for public policy transfer (abstract): Geological Society of America, Abstracts with Programs, v. 10, no. 7, p. 514.

White, William A. (with Bartholomew, R. B., Lene, G., and Smith, D.), 1978, Imaginary continents—a geologic puzzle: Journal of Geological Education, v. 26, no. 5, p. 195-197.

Woodruff, C. M., Jr., and Abbott, P. L., 1978, Cavern development, stream piracy, and aquifer evolution in the Edwards Limestone, south-central Texas (abstract): National Speleological Society, Annual Meeting, New Braunfels, Texas, 1978, Program Abstracts, p. 41.

Woodruff, C. M., Jr., Longley, W. L., and Reed, A. E., 1978, Inland boundary determinations for coastal management purposes—an ecological systems approach to requirements of the Federal Coastal Zone Management Act of 1972: Coastal Zone Management Journal, v. 4, nos. 1/2, p. 189-211.

LECTURES AND PUBLIC ADDRESSES

A measure of the interest in Bureau of Economic Geology research programs and their results is shown by the number of public lectures presented each year. Lectures are given to a wide audience, including professional societies, universities, and Federal, State, and local units of government.

Although the prime method of disseminating the results of Bureau research is through publication, formal and informal lectures are important means of presenting information prior to final publication.

Following are lectures given by Bureau staff members during 1978.

Richard L. Andersen

Scientific evidence of evolution: presented at Austin Latter Day Saints Institute, Sandwich Seminar, Austin, Texas.

Texas minerals and our environment: presented at Environmental Conservation Seminar (sponsored by Angelo State University), San Angelo, Texas.

Joyce M. Basciano

Application of environmental geology to ground-water hydrology of the Wilcox lignite belt in Texas: presented at Gulf Coast Lignites Conference (sponsored by NUS Corpo-

ration), The Woodlands, Texas; and Geological Society of America, Annual Meeting, Toronto, Ontario, Canada.

Don Bebout

Current status of research in geopressured geothermal energy: presented at Short Course No. 6, Geothermal Resources—Survey of an Emerging Industry (sponsored by Geothermal Resources Council), Houston, Texas.

Deltaic depositional style in salt-withdrawal basin, Frio Formation, Brazoria County, Texas: presented at American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists Annual Meeting, Oklahoma City, Oklahoma.

Distribution and geometry of an oolite-shoal complex, Lower Cretaceous Sligo Formation, South Texas: presented at Gulf Coast Association of Geological Societies, Annual Meeting, New Orleans, Louisiana.

Evaluation of an energy resource—geopressured geothermal zone, Texas Gulf Coast: presented at Society of Petroleum Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, 53d Annual Technical Conference and Exhibition, Houston, Texas.

Exploration for geopressured geothermal energy—a progress report: presented before Geopressured Geothermal Industrial Advisory Committee, the Railroad Commission of Texas and the U. S. Department of Energy, Houston, Texas.

Geopressured geothermal energy from the Gulf Coast Frio Formation: presented at American Association of Petroleum Geologists, Southwest Section, Annual Meeting, Midland, Texas.

Geopressured geothermal energy—Texas Gulf Coast: presented at Tulsa Geological Society, Meeting, Tulsa, Oklahoma.

Geopressured geothermal resources—Frio Formation, Texas Gulf Coast: presented at South Texas Geological Society, Meeting, San Antonio, Texas.

Geopressured geothermal resources—Texas Gulf Coast: presented before Department of Geology, Baylor University, Waco, Texas.

Geothermal test-well site, Austin Bayou Prospect: presented before Rotary Club of Pearland, Pearland, Texas.

Lower Cretaceous carbonates—South Texas: presented before Department of Geology, Baylor University, Waco, Texas.

Role of Bureau of Economic Geology in selection of the General Crude Oil Company and U. S. Department of Energy Pleasant Bayou No. 1 geothermal well: presented at Well Dedication Ceremonies (sponsored by U. S. Department of Energy), at well site in Brazoria County, Texas.

Testing energy potential of deep geopressured geothermal zones of Texas—geology: presented at Public Seminar sponsored by the Energy Research and Education Foundation and Rice University, Houston, Texas.

L. F. Brown, Jr.

Depositional systems: presented before a delegation from the People's Republic of China visiting the Bureau of Economic Geology and the Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Seismic stratigraphy: presented before class in Geo-

physics *and* class in Stratigraphy at the Department of Geological Sciences, The University of Texas at Austin, *and* before a delegation from the People's Republic of China visiting the Bureau of Economic Geology and the Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

What is seismic stratigraphy?: presented at Southeastern Geophysical Society, Meeting, New Orleans, Louisiana.

Shirley P. Dutton

Depositional models and resource potential, Pennsylvanian System, Palo Duro Basin, Panhandle Texas: presented at Abilene Geological Society, Meeting, Abilene, Texas; *and* at Panhandle Geological Society, Meeting, Amarillo, Texas.

Marc B. Edwards

Growth faulting in Triassic deltas, Svalbard: presented at Department of Geology, University of South Carolina, Columbia, South Carolina.

Robert J. Finley

Classification of Texas coastal environments from photo-interpretation of Landsat imagery: presented at Symposium on Geological Applications of Remote Sensing, Geological Society of America, Annual Meeting, Toronto, Ontario, Canada.

W. L. Fisher

Aspects of National energy policy: presented at Society of Exploration Geophysicists, Academic Liaison Seminar, Banquet, Houston, Texas.

The dilemma of natural gas: presented at Texas Independent Producers and Royalty Owners Association, Meeting, Lakeway, Texas.

Energy and mineral resources—National capability in production: presented at El Paso Geological Society, Meeting, El Paso, Texas.

Energy—is our government policy adequate?: presented at Texas Union Ideas and Issues Committee, Meeting, The University of Texas at Austin, Austin, Texas.

Energy issues in Texas: presented at Pre-session Legislative Conference (sponsored by Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin), Austin, Texas.

Exploration, science, and public policy—conflicts in the making: presented as an American Association of Petroleum Geologists Distinguished Lecture before the Illinois Geological Society, Fairfield, Illinois; *and* the Indiana Geological Society, Evansville, Indiana; *and* the Permian Basin Geophysicists Society, Midland, Texas.

Factors in natural resource reorganization in the Federal Government: presented at Office of Management and Budget, Office of the President, The University of Texas at Austin, Task Force, Meeting, Austin, Texas.

Geologic exploration and energy development: presented as keynote address at Rocky Mountain Association of Geologists, 1978 Field Conference and Symposium on Energy Resources, Colorado Springs, Colorado.

Geologists and domestic energy development: presented

at Geological Society of America, Rocky Mountain Section, Annual Meeting, Banquet, Provo, Utah.

Geology and resources of Texas—basis for varied development: presented at Institute of Texas Studies (sponsored by The University of Texas at Austin and the Texas State Historical Association) Austin, Texas.

Geothermal resources—the great methane debacle: presented at American Association for the Advancement of Science, Symposium on Impact of the Geosciences on Critical Energy, Washington, D. C.

Lignite and the National coal option: presented at Ozarks Regional Commission, Conference on Lignite, Little Rock, Arkansas.

National issues in energy: presented at 12th Annual Texas Legislative Conference, New Braunfels, Texas.

National oil strategy: presented at Utility Regulatory Conference, Washington, D. C.

Natural gas issues: presented at American Gas Association, Communication Workshop, Houston, Texas.

Oil, gas, and land: presented at Houston Association of Petroleum Landmen, Meeting, Houston, Texas.

Perspectives on current energy policy and legislation: American Petroleum Institute, Production Meeting, Denver, Colorado.

Seismic stratigraphy and facies analysis in exploration: presented at Abilene Geological Society, Meeting, Abilene, Texas; *and* Department of Geological Sciences, The University of Texas at El Paso, El Paso, Texas; *and* South Texas Geological Society, Meeting, San Antonio, Texas; *and* West Texas Geological Society, Meeting, Midland, Texas.

Status of oil and gas in the continuing energy dilemma: presented at Fifth International Trade Conference, Houston, Texas.

William E. Galloway

The concept of natural systems: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Early Tertiary—Wyoming intermontane basins: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Erosion, transport, and deposition of sediment: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Examples and applications: presented at Stratigraphic Interpretation of Seismic Data School (sponsored by American Association of Petroleum Geologists and Society of Exploration Geophysicists), Biloxi, Mississippi, *and* Tucson, Arizona.

Fluvial depositional systems: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Ground-water/rock interactions: presented at Deposi-

tional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Jackson and Catahoula systems—Texas Gulf Coastal Plain: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Morrison Formation—Colorado Plateau: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Relationships between depositional system; ground-water flow history; and origin, migration, and concentration of uranium—Catahoula Formation of Texas Coastal Plain: presented at Houston Geological Society, Meeting, Houston, Texas; *and* University of New Orleans, New Orleans, Louisiana; *and* Michigan Technological University, Houghton, Michigan; *and* Boise State University, Boise, Idaho.

L. E. Garner

Guidelines to use of geology in urban planning: presented before class in Urban Planning, School of Architecture, The University of Texas at Austin, Austin, Texas.

The *Land Resources of Texas* map: presented at Workshop for Councils of Governments in the Texas Gulf Coast region (sponsored by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning), Harlingen, Texas; *and* Workshop for Central Texas and Edwards Plateau Councils of Governments in the Central Texas and Edwards Plateau areas (sponsored by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning), Del Rio, Texas.

Projects and progress of the Bureau of Economic Geology: presented at Soil Survey Work-Planning Conference (sponsored by Texas Agricultural Experiment Station, Texas Agricultural Extension Service, and U. S. Soil Conservation Service, College Station), College Station, Texas.

Thomas C. Gustavson

Environmental problems from subsidence induced from geopressed geothermal resource production: presented at Geothermal Subsidence Workshop (sponsored by Lawrence Berkeley Laboratory, University of California), Pacific Grove, California.

Geomorphic studies applied to evaluation of nuclear waste isolation sites: presented at Geological Society of America, South-Central Section, Annual Meeting, Tulsa, Oklahoma.

Structural controls of drainage development on the southern High Plains and Rolling Plains of the Texas Panhandle: presented at Geological Society of America, Annual Meeting, Toronto, Ontario, Canada.

C. Robertson Handford

Carbonate sedimentation in the Belize Barrier Reef

tract: presented before class in Carbonate Depositional Systems, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Lower Permian facies tracts and evolution of carbonate shelf margins, Palo Duro Basin, Texas: presented at Abilene Geological Society, Meeting, Abilene, Texas; *and* Panhandle Geological Society, Meeting, Amarillo, Texas.

Monteagle Limestone—oolitic tidal bar sedimentation in northern Alabama and south-central Tennessee: presented at Tennessee Oil and Gas Association, Annual Meeting, Gatlinburg, Tennessee.

Oolitic tidal bar deposits of the Monteagle Limestone (Mississippian) in Alabama and Tennessee: presented before class in Carbonate Depositional Systems, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Christopher D. Henry

Crustal structure deduced from geothermal studies, Trans-Pecos Texas: presented at Cenozoic Geology of the Trans-Pecos Volcanic Field of Texas, Field Conference, (sponsored by Bureau of Economic Geology, The University of Texas at Austin, Department of Geology of the University of Kansas, Sul Ross State University, and Meeker and Company), Alpine, Texas.

Environmental geology of the East Texas lignite belt: presented at Energy Development—New Challenges for Texas Communities, Conference (sponsored by Texas Energy Advisory Council), Tyler, Texas.

Geochemistry of thermal waters and geothermal assessment, Trans-Pecos Texas: presented at Geothermal Energy—A Focus on New Mexico, Symposium (sponsored by New Mexico Energy Institute), Las Cruces, New Mexico.

Geologic setting and uranium potential, Virgin Valley, Nevada: presented before staff of Bendix Field Engineering Corporation, Grand Junction, Colorado.

Uranium release from rhyolitic igneous rocks: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

W. R. Kaiser

Geochemical habitat of Catahoula uranium deposits: presented at South Texas Uranium Seminar (sponsored by South Texas Minerals Section of American Institute of Mining, Metallurgical and Petroleum Engineers), Corpus Christi, Texas.

Geological factors in the in situ gasification of Texas lignites: presented at Gulf Coast Lignites Conference (sponsored by NUS Corporation), The Woodlands, Texas.

The impact of coal utilization in Texas under the National Energy Plan: presented at Air Pollution Control Association, 71st Annual Meeting, Houston, Texas.

R. S. Kier

Land resources of Texas: presented at Workshop for Councils of Governments in the East Texas region (sponsored by U. S. Department of Housing and Urban Development through the Office of the Governor of Texas), Kilgore, Texas; *and* Workshop for Councils of Governments

in the Panhandle and West Texas regions, Lubbock, Texas (sponsored by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning), Lubbock, Texas.

Overview of surface geology in Texas: presented at Soil Scientist Work Conference (sponsored by U. S. Department of Agriculture), Tyler, Texas.

Overview of Texas geology: presented at Soil Survey Work Planning Conference (sponsored by Texas Agricultural Experiment Station, Texas Agricultural Extension Service, and U. S. Soil Conservation Service), College Station, Texas.

Charles W. Kreitler

Application of nitrogen isotopes to water pollution problems: presented before Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona.

Consideration of the Edwards aquifer in land use planning, City of West Lake Hills: presented before the Zoning and Planning Commission of the City of West Lake Hills, West Lake Hills, Texas.

δN^{15} of surface-water nitrogen species, Colorado River, Texas: presented at Geological Society of America, Annual Meeting, Toronto, Ontario, Canada.

Earthquakes in Texas: presented on KTBC Television Program, News Scene, Austin, Texas.

Ground-water hydrology of depositional systems: presented at Depositional and Ground-Water Flow Systems in the Exploration for Uranium, Research Colloquium, (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Potential subsidence from geothermal geopressured energy production: presented at Geothermal Subsidence Workshop (sponsored by Lawrence Berkeley Laboratory, University of California), Pacific Grove, California.

Problems in Gulf Coast hydrology: presented before Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona.

Subsidence in the Gulf Coast: presented at Space-borne Laser System Workshop, Austin, Texas.

Robert G. Loucks

Differentiation of early and late equant calcite cements: presented before Society of Economic Paleontologists and Mineralogists Carbonate Research Group at American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting, Oklahoma City, Oklahoma.

Factors controlling hydrocarbon and geopressured geothermal reservoir quality in lower Tertiary sandstone along the Texas Gulf Coast: presented at West Texas Geological Society, Meeting, Midland, Texas.

Late silica diagenesis in the subsurface Lower Cretaceous Pearsall Formation, South Texas: presented at Geological Society of America, South-Central Section, Annual Meeting, Tulsa, Oklahoma.

Sandstone distribution and potential for geopressured geothermal energy production in Vicksburg Formation along Texas Gulf Coast: presented at Gulf Coast Association of Geological Societies, Annual Meeting, New Orleans, Louisiana.

Texas geopressured geothermal project: presented at Potential Gas Committee, Meeting, Monterey, California.

J. H. McGowen

Alluvial fan systems: presented at Depositional and Ground-Water Flow Systems in Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Coastal Plain systems: presented at Depositional and Ground-Water Flow Systems in Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Depositional framework of the Dockum Group (Triassic), Texas Panhandle: presented at Society of Economic Paleontologists and Mineralogists, Permian Basin Section, Meeting, Midland, Texas.

Modern and ancient alluvial fans—processes and facies: presented at Second Biennial Short Course on the Fluvial System (sponsored by Colorado State University), Fort Collins, Colorado.

Triassic lacustrine basins—Texas: presented at Depositional and Ground-Water Flow Systems in Exploration for Uranium, Research Colloquium (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

Dawn G. McKalips

Mineral resources of Texas: presented at Environmental Education Workshop (sponsored by Abilene Christian University), Abilene, Texas.

Mountain building: presented before classes at Hill Elementary School, Pillow Elementary School, and Cunningham Elementary School, Austin, Texas.

Patricia A. Mench

Diagenesis related to Miocene faulting in the Edwards aquifer, San Antonio area, Texas: presented at Geological Society of America, South-Central Section, Annual Meeting, Tulsa, Oklahoma.

Occurrence of porosity in Lower Ordovician Ellenburger dolomite, Puckett Field, Pecos County, Texas: presented at American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists, Annual Meeting, Oklahoma City, Oklahoma.

Robert A. Morton

Coastal Zone mapping in Texas: presented at Coastal Mapping Symposium (sponsored by National Oceanic and Atmospheric Administration), Rockville, Maryland.

The Guadalupe River and delta of Texas, a modern analogue for some ancient fluvial-deltaic systems: presented at Center for Sedimentology, Department of Geology, Texas A & M University, College Station, Texas.

The roles of geologic processes and environmental mapping in coastal management and planning programs: presented before class in Community and Regional Planning (CRP 383), School of Architecture, The University of Texas at Austin.

Surface and shallow subsurface geology of the Texas

submerged lands: presented at Tenth Annual Offshore Technology Conference, Houston, Texas.

Mark W. Presley

A depositional systems analysis of the Pottsville Group in northern West Virginia: presented at Geological Society of America, Southeastern Section, 27th Annual Meeting, Chattanooga, Tennessee.

Upper Permian evaporites and red beds of the Palo Duro Basin [Texas]—facies patterns through time: presented at Austin Geological Society, Meeting, Austin, Texas.

Ann E. St. Clair

The *Land Resources of Texas* map: presented at Workshop for Councils of Governments in the Texas Gulf Coast region (sponsored by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning), Harlingen, Texas; *and* Workshop for Councils of Governments in the Central Texas and Edwards Plateau areas (sponsored by U. S. Department of Housing and Urban Development through the Office of Budget and Planning), Del Rio, Texas.

Bonnie R. Weise

Barrier island and lagoon environments, Padre Island National Seashore: presented before an Ecology field class, Richardson [Texas] High School, visiting the Bureau of Economic Geology, Austin, Texas.

Geopressed geothermal energy resources, Texas Gulf Coast: presented at Geopressed Geothermal Energy Symposium (sponsored by the Center for Energy Studies of The University of Texas at Austin) Houston, Texas.

Texas mountains and how they were formed: presented before class in Earth Science, Walnut Creek Elementary School, Austin, Texas.

E. G. Wermund

Bureau of Economic Geology Program on potential of East Texas salt domes for nuclear waste isolation: presented at Public Meeting, Palestine, Texas.

The *Land Resources of Texas* map: presented at Workshop for Councils of Governments in the North Texas region (sponsored by U. S. Department of Housing and Urban Development through the Governor's Office of Budget and Planning), Lubbock, Texas.

Missourian carbonate banks on Eastern Shelf, North-Central Texas: presented at Abilene Geological Society, Meeting, Abilene, Texas; *and* Dallas Geological Society, Meeting, Dallas, Texas.

Potential of Palo Duro Basin for nuclear waste isolation: presented at Panhandle Geological Society, Meeting, Amarillo, Texas.

Texas land resources map: presented at Workshop on Building a Map of Texas Natural Lands, Natural Lands Conference (sponsored by the Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin), Winedale, Texas.

Texas land resources map for planning: presented at Workshop for East Texas Council of Governments (sponsored by U. S. Department of Housing and Urban Develop-

ment through the Governor's Office of Budget and Planning), Tyler, Texas.

William A. White

Environmental aspects of geopressed geothermal fluid production in Brazoria County, Texas: presented before an Ecology field class, Richardson [Texas] High School, visiting the Bureau of Economic Geology, Austin, Texas.

Environmental considerations of geopressed geothermal fluid production: presented at Geopressed Geothermal Energy Symposium (sponsored by the Center for Energy Studies of The University of Texas at Austin), Houston, Texas.

Preliminary environmental analysis of a geopressed geothermal test well in Brazoria County, Texas: presented at Geopressed-Geothermal, Subsidence-Seismicity, and Ecosystem Quality Workshop (sponsored by Bureau of Economic Geology, The University of Texas at Austin), Austin, Texas.

C. M. Woodruff, Jr.

Bedrock and water—interactions between surface- and ground-water supplies: presented at Motlow State College, Lynchburg, Tennessee.

Cavern development, stream piracy, and aquifer evolution in the Edwards Limestone, south-central Texas: presented at National Speleological Society, Annual Meeting, New Braunfels, Texas.

Geomorphic mapping on the Llano Estacado: presented at Soil Survey Work-Planning Conference (sponsored by Texas Agricultural Experiment Station, Texas Agricultural Extension Service, and U. S. Soil Conservation Service), College Station, Texas.

Stream piracy and the Edwards aquifer: presented at Austin Geological Society, Meeting, Austin, Texas; *and* Technical Session, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas; *and* Department of Geology, Vanderbilt University, Nashville, Tennessee.

LEGISLATIVE COMMITTEE HEARINGS

Bureau of Economic Geology staff members are invited to testify as expert witnesses by Federal and State legislative committees when bills on resource and environmental matters are under consideration. During 1978, W. L. Fisher, the Bureau's director, appeared before the Texas House of Representatives Interim Committee on Energy (James R. Nowlin, Chairman) and presented testimony on "Energy Reserves and Resources of Texas" and "Energy Research Activities at The University of Texas at Austin."

COMMITTEE SERVICES, OFFICES, AND OTHER PROFESSIONAL RESPONSIBILITIES

Don Bebout

Delegate (representing Austin Geological Society), House of Delegates, American Association of Petroleum Geologists.

Member of the Committee for the Preservation of

Samples and Cores, American Association of Petroleum Geologists.

Member of the Membership Committee, American Association of Petroleum Geologists.

Vice chairman of the Publications Committee of the Geothermal Group of the Energy Minerals Division, American Association of Petroleum Geologists.

L. F. Brown, Jr.

Associate editor, American Association of Petroleum Geologists Bulletin.

Co-leader of field trip, "Missourian Carbonate and Clastic Depositional Systems of the Eastern Shelf, North-Central Texas," Dallas Geological Society.

Lecturer for Continuing Education Program, American Association of Petroleum Geologists.

Marianne M. Dodge

Judge of presentations, Gulf Coast Association of Geological Societies, 28th Annual Meeting, New Orleans, Louisiana.

Member of Public Relations Committee, Austin Geological Society.

Shirley P. Dutton

Judge of presentations, Gulf Coast Association of Geological Societies, 28th Annual Meeting, New Orleans, Louisiana.

Member of Entertainment Committee, Austin Geological Society.

Robert J. Finley

Alternate member, Texas Mapping Advisory Committee.

Member of Remote Sensing and Cartographic Committee of the Task Force for the Texas Natural Resources Information System.

Vice chairman of Citizens Board of Natural Resources and Environmental Quality of Austin, Texas.

W. L. Fisher

Chairman of Executive Committee, Council on Energy Resources, The University of Texas at Austin.

Chairman of Governmental Liaison Committee, Association of American State Geologists.

Distinguished Lecturer, American Association of Petroleum Geologists.

Lecturer for Continuing Education Program, American Association of Petroleum Geologists.

Member of Academic Liaison Committee, American Association of Petroleum Geologists.

Member of Advisory Board, Association of Professional Geological Scientists.

Member of Advisory Committee, Institute for Latin American Studies, The University of Texas at Austin.

Member of Advisory Council for Marine Science and Technology, Texas A & M University.

Member of Advisory Panel on Stockpile Disposal Policies, U. S. General Services Administration.

Member of Environmental Geology Committee, Association of Professional Geological Scientists.

Member of Executive Committee, Association of Professional Geological Scientists.

Member of Executive Committee, Geology Foundation, The University of Texas at Austin.

Member of General Exploration Committee, American Petroleum Institute.

Member of Geothermal Industrial Advisory Committee, the Railroad Commission of Texas and U. S. Department of Energy.

Member of Government, Energy, and Mineral Affairs Committee, American Institute of Mining, Metallurgical, and Petroleum Engineers.

Member of Lignite Research, Development, and Demonstration Committee, Texas Energy Advisory Council.

Member of Mineral Resources Committee, National Association of State Universities and Land Grant Colleges.

Member (*ex officio*) of Natural Resources Council, State of Texas.

Member of Nominating Committee, Geological Society of America.

Member of Nuclear Energy Committee, Texas Energy Advisory Council.

Member of Public Affairs Committee, Association of American State Geologists.

Member of Publications Committee, Society of Economic Geologists, Inc.

Member of Publications Policy Committee, The University of Texas at Austin.

Member of Research Committee, Interstate Mining Compact Commission.

Member of Research Committee, Interstate Oil Compact Commission.

Member of Texas Energy Advisory Committee, Texas Energy Advisory Council.

Member of University Coordinating Committee, Texas Energy Advisory Council.

President-elect of Texas Section, Association of Professional Geological Scientists.

William E. Galloway

Co-organizer of research colloquium, "Depositional and Ground-Water Flow Systems in the Exploration for Uranium," sponsored by the Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas.

Lecturer for Stratigraphic Interpretation of Seismic Data School, sponsored by American Association of Petroleum Geologists and Society of Exploration Geophysicists.

L. E. Garner

Chairman (1977-1978) of Publication Committee, Austin Geological Society.

Member of Board of Directors, Austin Natural Science Association.

Alice B. Giles

Judge of presentations, Gulf Coast Association of Geological Societies, 28th Annual Meeting, New Orleans, Louisiana.

Edgar H. Guevara

Delegate (representing Venezuela), House of Delegates, American Association of Petroleum Geologists.

Thomas C. Gustavson

Co-leader of field trip to examine geopressed geothermal test well in Brazoria County, Texas, for Third Meeting of the Environmental Laboratory Research Working Group of the U. S. Department of Energy/Industry Geopressed Geothermal Resource Development Program.

Co-organizer of Geopressed-Geothermal, Subsidence-Seismicity, and Ecosystem Quality Workshop, sponsored by the Bureau of Economic Geology, The University of Texas at Austin.

Member of Commission on Genesis and Lithology of Quaternary Deposits, International Association for Quaternary Research (INQUA).

Member of Texas Advisory Committee on Conservation and Environmental Education, Texas Education Agency.

Christopher D. Henry

Co-organizer and leader of field conference, "Cenozoic Geology of the Trans-Pecos Volcanic Field of Texas," sponsored by the Bureau of Economic Geology of The University of Texas at Austin, Department of Geology of the University of Kansas, Sul Ross State University, and Meeker and Company.

Liaison representative (of the Bureau of Economic Geology) on surface mining to the Surface Mining and Reclamation Division of the Railroad Commission of Texas.

Panelist and rapporteur for Planning Session on Surface Mining for Coal and Protection of Aquifers, sponsored by the National Academy of Sciences—National Research Council, Washington, D. C.

Clara L. Ho

Member of Council of the National Clay Mineral Society.

W. R. Kaiser

Expert witness on behalf of the State of Texas (at the request of the Texas Attorney General's Office) at the Interstate Commerce Commission Administrative Hearing concerning Southern Pacific Transportation Company abandonment of railroad service between Bonita Junction and Seagoville, Texas.

Expert witness on behalf of the State of Texas (at the request of the Texas Attorney General's Office) at the Interstate Commerce Commission Administrative Hearing concerning Southern Pacific Transportation Company abandonment of railroad service between Giddings and Brenham, Texas.

Member of the Lignite Subcommittee of the Fossil Energy Advisory Committee of the U. S. Department of Energy.

Charles W. Kreidler

Co-leader of field trip, "Coastal Plain of Southeast Texas and Louisiana," preceding 1978 Annual Meeting of the American Association of Geographers.

Co-organizer of Geopressed-Geothermal, Subsidence-Seismicity, and Ecosystem Quality Workshop, sponsored by the Bureau of Economic Geology, The University of Texas at Austin.

Panelist at Geothermal Subsidence Workshop in Pacific Grove, California, sponsored by Lawrence Berkeley Laboratory of the University of California.

Panelist at Spaceborne Geodynamics Ranging Systems Workshop in Austin, Texas, sponsored by Goddard Space Flight Center of the National Aeronautics and Space Administration.

Robert G. Loucks

Business representative of the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists.

Member of the Carbonate Rock Subcommittee, American Association of Petroleum Geologists.

Member of the Geopressed Geothermal Site Selection Subcommittee, U. S. Department of Energy.

Secretary of Austin Geological Society.

J. H. McGowen

Co-leader of field conference, "Clastic Sedimentary Environments, Modern and Ancient," sponsored by the U. S. Geological Survey, Corpus Christi, Texas.

Co-organizer of research colloquium, "Depositional and Ground-Water Flow Systems in Exploration for Uranium" sponsored by the Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas.

Mary K. McGowen

Delegate (representing Austin Geological Society), House of Delegates, American Association of Petroleum Geologists.

Dawn G. McKalips

Coordinator and organizer of a presentation, "Coastal Geology," as part of an Ecology Field Course for students of Richardson [Texas] School District.

Robert A. Morton

Author of an unpublished report, "Approximate Inlet and Shoreline Positions in 1685, Matagorda Bay Area, Texas," for the Antiquities Committee of the Texas Historical Commission.

Author of an unpublished report, "Changes in Gulf Shoreline and Lines of Sparse and Dense Vegetation Along a Segment of Mustang Island Between 1937 and 1978," for Texas Attorney General's Office.

Member of the Sea Grant Proposal Review Panel of Texas A & M University.

Member of User Advisory Group of the Texas Natural Resources Information System and National Aeronautics and Space Administration Joint Project, conducted by Texas Natural Resources Information System.

Mark W. Presley

Advertising contact for Austin Geological Society for the 1978 Annual Meeting of the Gulf Coast Association of Geological Societies.

Ann E. St. Clair

Chairman of Entertainment Committee, Austin Geological Society.

Bonnie R. Weise

Member of Entertainment Committee (1978-1979), Austin Geological Society.

Member of Publications Committee (1977-1978), Austin Geological Society.

E. G. Wermund

Co-leader of field trip, "Missourian Carbonate and Clastic Depositional Systems of the Eastern Shelf, North-Central Texas," Dallas Geological Society.

Member of Awards Committee of the Department of Geological Sciences, The University of Texas at Austin.

Member of COSUNA (Correlation of Stratigraphic Units in North America) Committee, American Association of Petroleum Geologists.

Member of Environmental Geology Committee, American Association of Petroleum Geologists.

Member of Executive Committee (1978-1979), Austin Geological Society.

Member of the Task Force of the Texas Natural Resources Information System.

President (1977-1978), Austin Geological Society.

William A. White

Co-leader of field trip to examine geopressured geothermal test well in Brazoria County, Texas, for Third Meeting of the Environmental Laboratory Research Working Group of the U.S. Department of Energy/Industry Geopressured Geothermal Resource Development Program.

C. M. Woodruff, Jr.

Chairman of Nominating Committee, Austin Geological Society.

Member of Geothermal Task Force, Texas Energy Advisory Committee.

TEACHING ACTIVITIES

Several members of the Bureau of Economic Geology research staff participate in teaching, either through courses offered in university departments or in continuing education or special short courses sponsored by the Bureau, the Department of Geological Sciences, or professional societies. These activities for 1978 included:

ACADEMIC COURSES:

Department of Geological Sciences, The University of Texas at Austin:

Don Bebout (with A. J. Scott)—Biogenic and Evaporitic Depositional Systems (Geology 383N).

L. F. Brown, Jr., (with Milo M. Backus and Ralph O. Kehle)—Seismic Stratigraphy (Geology 380N).

William E. Galloway and **W. R. Kaiser**—Sedimentary Economic Geology (Geology 391).

W. L. Fisher—Energy and Mineral Resources (Geology 391).

Department of Marine Studies, The University of Texas at Austin:

R. A. Morton—Marine Geology (Marine Science 384F).

SHORT COURSES:

American Association of Petroleum Geologists Continuing Education Seminars:

Don Bebout—Subsurface Logging Problems, An Exercise in Recognition of Carbonate Facies and Depositional Environments (presented in Austin, Dallas, Houston, and Salado, Texas).

L. F. Brown, Jr.—Seismic Stratigraphy and Depositional Systems (presented in Biloxi, Mississippi; Tucson, Arizona; London, England; Paris, France; and Pau, France).

L. F. Brown, Jr., and **W. L. Fisher**—Facies Analysis and Its Role in Seismic Stratigraphic Interpretation (presented in Oklahoma City, Oklahoma, and Houston, Texas).

W. L. Fisher—Seismic Stratigraphic Exploration for Deep-Water Reservoirs (presented in Houston, Texas).

William E. Galloway—Depositional Systems in the Exploration for Uranium (presented in Houston, Texas; New Orleans, Louisiana; and Oklahoma City, Oklahoma).

William E. Galloway—Exploration for Sandstone Stratigraphic Traps (presented in Casper, Wyoming); and Seismic Modeling Examples (presented at Seismic Stratigraphy School in Tucson, Arizona).

Bureau of Economic Geology Research Colloquium:

William E. Galloway, **Charles W. Kreitler**, and **J. H. McGowen**—Depositional and Ground-Water Flow Systems in the Exploration for Uranium (held in Austin, Texas).

Bureau of Economic Geology, Department of Geological Sciences, and Geology Foundation, The University of Texas at Austin:

Don Bebout—Carbonates (presented with R. L. Folk, L. S. Land, R. G. Loucks, and A. J. Scott in Austin, Texas).

Southeastern Geophysical Society:

L. F. Brown, Jr.—Seismic Stratigraphy (presented in New Orleans, Louisiana).

University of Bergen Geological Institute:

L. F. Brown, Jr.—Depositional Systems, Seismic Stratigraphy, and Environmental Geology (presented in Bergen, Norway).

SUPPORT STAFF

ADMINISTRATIVE/SECRETARIAL

The administrative/secretarial staff fulfills an important role in achieving the goals of the Bureau. These staff members are, in many respects, the Bureau's closest contact with a majority of the public. As Bureau research programs grow in numbers and complexity, staff members help with aspects of program administration and complete an ever-

increasing volume of secretarial tasks necessary for the day-to-day operation of the Bureau. Mrs. Eloise Hill, Executive Assistant, coordinates the work of the administrative/secretarial staff.

CARTOGRAPHY

James W. Macon, Chief Cartographer, directs the work of the Cartography Section for the Bureau. Much of the Bureau's reputation in the areas of geologic and land resource mapping is a reflection of the excellent cartographic support provided by these staff members. Besides the high-quality full-color map products which are the hallmark of the Cartography Section, the present staff also produces a full range of other maps, illustrations, slide copy, and display materials.

PHOTOGRAPHY

David Stephens provides technical photographic support for the Bureau's publications, lectures and public addresses, and research projects. Most of the photographic work

consists of preparation of slides, cover photos, and text photos.

PUBLICATIONS PREPARATION

A central part of the Bureau's function as a public geological research organization is to make available the results of its research programs. This is accomplished chiefly by means of its publications. Preparing Bureau reports for publication involves manuscript typing, editing, composing, graphics design, and layout.

At yearend 1978, the editorial staff included Susann V. Doenges, Acting Editor-in-Charge; R. Marie Jones and Martha C. Wright, editors; and Amanda R. Masterson and Laura Douglas, proofreaders. Lucille Harrell was in charge of the manuscript typing and composing section, consisting of Deborah Jakobovits, María Isabel Mendoza, Kathleen A. O'Neill, and Fannie M. Sellingsloh. Bobbie S. Couch, under the direction of James W. Macon, handled the graphics design and layout.

Part-time Research Assistants

The Bureau of Economic Geology augments its research staff through the employment of students as part-time research assistants. These students not only contribute to the research effort but also gain experience in organized research as part of their academic training. During 1978, 107 students, chiefly graduate students in geology, chemistry, biology, and engineering, were so employed.

Paul Anaejionu
James H. Anderson
William W. Bath
Robert W. Baumgardner
Teddy J. Bond
David M. Brown
David A. Budd
Russell C. Bunker
Robert I. Chapin
Constance S. Childs
John L. Chin
Richard J. Chuchla
Stephen C. Claypool
Robert C. Cobb
Lisa E. Craig
Robert E. Crain
Stephen P. Cumella
Richard W. Debus
Debra M. De Long
Paul E. Davine
Jesus Dittmar
M. Jackson Drodgy
Edward A. Duncan
Alan R. Dutton
R. Stephen Fisher
Paul E. Fredericks
Deborah A. Garcia
Victor J. Gavenda
Lee E. George
James T. Goodwin
Carol A. Gray
Bryant W. Halney
Jong H. Han
Carolyn L. Harvel
Jon P. Herber
Jonathan C. Herwig
Scott A. Holden
David A. Hooks
Susan D. Hovorka
Valerie A. Hunter
Koso I. Idigbe
James P. Immitt
James A. Jacobs
Evans V. Jegbefume
Lee A. Jirik
Itzhak E. Kornfeld
Lloyd W. LaBrie
Holly K. Lanan
Melissa J. Lang
C. Russell Lawis
James L. Lockley
Jennifer Lundelius
Lawrence E. Mack
Robert L. Maddox

Steven D. Mann
Sanford C. Marble
John C. McBryde
Lon A. McCauley
Robert W. McDermott
Kathy A. McGillis
Douglas A. McGookey
Maryann M. McGraw
Christine McPhail
Patricia A. Mench
Linda C. Merritt
Francis M. Mikan
Janet E. Nilsson
Elliott Pew
Eugene T. Pisasale
Jeffrey D. Potter
Betty S. Ragland
Karen Ramsey
M. Scott Ritchie
Julie P. Rogers
Rebecca M. Russo
Margaret A. Sanders
Kenneth M. Sands
Melissa A. Sandstrom
Richard A. Schatzinger
Debra L. Schiltz
Diana M. Scott
Sherry L. Scott
Linda C. Seekins
Jung H. Seo
Behman Sepassi
Sunshine C. Sherrell
James M. Siegmenn
Charles D. Smith
Rebecca Smyth
Raul F. Solis
Dianne R. Sullivan
Joseph E. Sullivan
Stanley M. Sutton
John B. Swanson
Margaret A. Townsend
Grace N. Tyner
L. Scott Underwood
Stephen C. Van Dalen
Vicki A. Verross
Eldon S. West
David Wiggins
Turner P. Williamson
Charles D. Winker
Debra J. Wood
Robert E. Woronick
Stephen S. Wright
Mark E. Yelverton

BUREAU OF ECONOMIC GEOLOGY

Dr. William L. Fisher, Director
Dr. L. F. Brown, Jr., Associate Director
Dr. E. G. Wermund, Associate Director
Douglas C. Ratcliff, Assistant Director
Eloise Hill, Executive Assistant

Research Scientists

Dr. Virgil E. Barnes	Dr. David K. Hobday*
Dr. Don G. Bebout	Dr. William R. Kaiser
Dr. Marc B. Edwards*	Dr. Robert S. Kier
Dr. Robert J. Finley	Dr. Charles W. Kreidler
Dr. William E. Galloway	Dr. Robert G. Loucks
Dr. Edgar H. Guevara	Dr. Joseph H. McGowen
Dr. Thomas C. Gustavson	Dr. Robert A. Morton
Dr. Clara L. Ho*	Dr. Charles M. Woodruff, Jr.

Research Scientists Associates

Richard L. Andersen	Russell S. Kimble*
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