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BUREAU OF ECONOMIC GEOLOGY

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# ANNUAL REPORT 1973

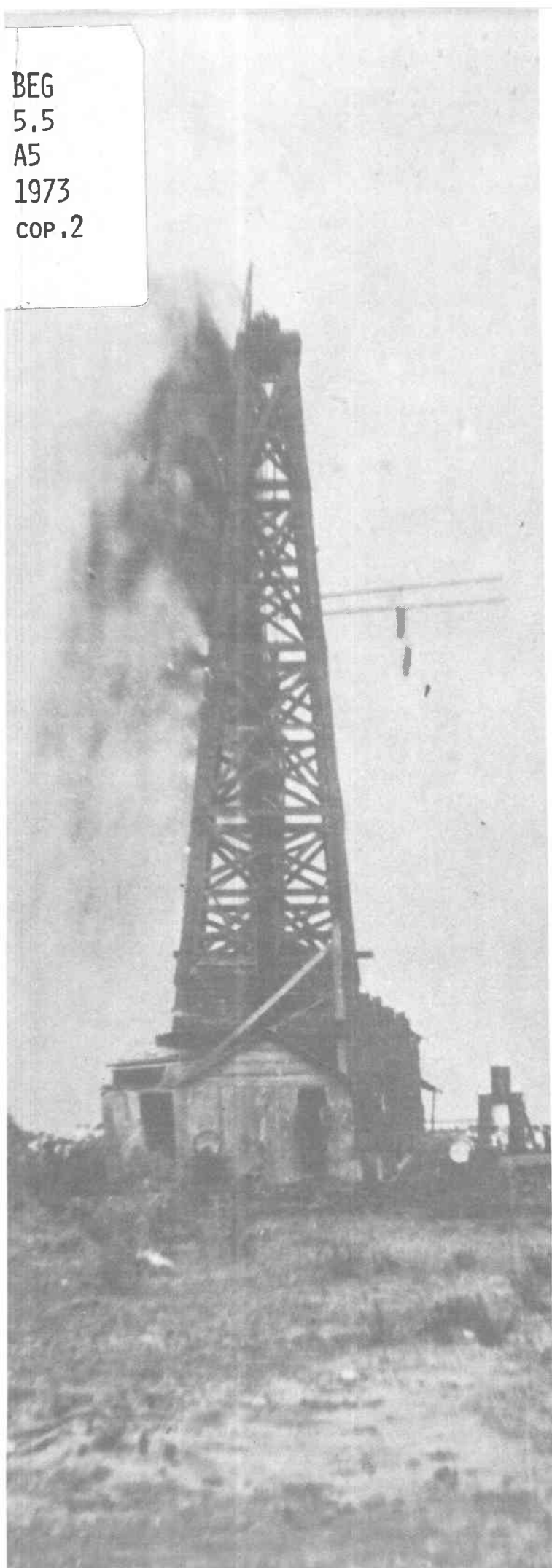


**Bureau of Economic Geology**

The University of Texas at Austin

Austin, Texas

W. L. Fisher, Director



# BUREAU OF ECONOMIC GEOLOGY

## RESEARCH AND SERVICE IN GEOLOGY

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# BUREAU OF ECONOMIC GEOLOGY

## ANNUAL REPORT – 1973



RESEARCH AND ADMINISTRATIVE OFFICES  
Geology Building, Main Campus

LABORATORIES  
Balcones Research Center

THE UNIVERSITY OF TEXAS AT AUSTIN

W. L. FISHER, DIRECTOR

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## BUREAU OF ECONOMIC GEOLOGY

The Bureau of Economic Geology is a research bureau of The University of Texas at Austin; it also functions as a quasi-state agency. Established in 1909, it has for 64 years been recognized as the Texas State Geological Survey; its Director fills the position of State Geologist. The Bureau of Economic Geology also serves as a member agency of the State Interagency Council on Natural Resources and the Environment.

The Bureau is engaged in research, both basic and applied, and public service in Texas geology and natural resources. The program of applied research is focused on mineral and land resources, environmental and conservation problems, and engineering problems. The Bureau's efforts in systematic geologic mapping are designed to produce geologic and special derivative maps at several scales for all those concerned with resources and land use in Texas. The Bureau participates in other University research efforts in the fields of resources and earth sciences, including those of the Center for Research in Water Resources and the Marine Science Institute at Port Aransas. These two organizations, with the Bureau, constitute The University's Division of Natural Resources and Environment.

The Bureau publishes major reports in The University of Texas Publication series and maintains its own series of Reports of Investigations, Atlases, Geologic Quadrangle Maps, Geological Circulars, Mineral Resource Circulars, and Special Publications. A complete list of publications is available on request.

The geologic data developed by the Bureau of Economic Geology, in the form of scientific reports and geologic maps, are used by many state and federal organizations in carrying out investigations in the public service. The Texas Water Development Board, Texas Highway Department, Parks and Wildlife Department, Texas Industrial Commission, Railroad Commission, General Land Office, Governor's Office, Attorney General's Office, and numerous other state departments, boards, conservation organizations, water districts, councils of government, and chambers of commerce utilize Bureau publications and services on both a formal and informal basis through interagency contracts and staff conferences. The Bureau also cooperates with federal agencies, such as the Geological Survey, National Aeronautics and Space Administration, Environmental Protection Agency, Bureau of Reclamation, Corps of Engineers, and National Park Service. The mineral and geological information service offered by the Bureau of Economic Geology is used by public officials, private groups, corporations, and citizens through correspondence and conference.

## PUBLICATIONS IN 1973

In its role as a public geologic research unit, the Bureau of Economic Geology disseminates the results of research programs and projects primarily through its own publication series. During the 64-year history of the Bureau, nearly 700 reports, bulletins, and maps have been published covering all major aspects of the geology and natural resources of Texas. To date, approximately one million publications have been distributed, principally through direct sales. Distribution and publication inventory have steadily increased through the years.

Bureau publications are made available to interested persons at a price determined to recover printing costs. A complete list of publications of the Bureau of Economic Geology is available on request.

**Environmental Geologic Atlas of the Texas Coastal Zone. Beaumont-Port Arthur Area**, by W. L. Fisher, L. F. Brown, Jr., J. H. McGowen, and C. G. Groat. 93 pp., 23 figs., 9 maps, 13 tables (\$6.75).

This publication, the second of a series of seven atlases of the Texas Coastal Zone, presents an inventory of environments and resources of the Beaumont-Port Arthur area. Comprising Jefferson, Orange, and parts of Newton, Jasper, Hardin, Liberty, Chambers, and Galveston Counties, the study area extends from the 5-fathom line in the Gulf of Mexico to approximately 50 miles inland.

The Beaumont-Port Arthur Atlas contains 9 full-color maps, consisting of a basic environmental geologic map and 8 special-use environmental maps. The basic environmental geologic map—published at a scale of 1:125,000—shows resource and environmental units (geologic substrate and soils), biologic units, active and potentially active physical process units, and man-made units. The special-use environmental maps are prepared at a scale of 1:250,000. These maps include (1) physical properties, (2) environments and biologic assemblages, (3) current land use, (4) mineral and energy resources, (5) active processes, (6) man-made features and water systems, (7) rainfall, stream discharge, and surface salinity, and (8) topography and bathymetry. The Environmental Geologic Atlas is designed for use in regional planning for improved use of coastal resources. Additional sections of the Atlas are scheduled for publication in the near future.

**Special Publication. Toward a National Policy on Energy Resources and Mineral Plant Foods**, Samuel P. Ellison, Jr., Editor. 128 pp., 48 figs., 22 tables (\$3.00).

This special publication contains papers that were presented at a forum on Energy Resources

and Mineral Plant Foods, May 15-17, 1972, at the Joe C. Thompson Conference Center, The University of Texas at Austin. Joint sponsors of the Forum were the National Materials Policy Commission, Washington, D. C., and The University of Texas at Austin. Included in the publication are: (1) Statement on Energy Supply and Demand, by John J. McKetta; (2) Public Policy and the Future Adequacy of Oil and Gas Supplies, by Stephen L. McDonald; (3) Appetite Versus Technology: Prospects for Oil Supply in the U. S., by John M. Hills; (4) Natural Gas and U. S. National Policy, by Frank B. Conselman; (5) What Our International Petroleum Policy Should Be, by Sherman A. Wengerd; (6) Energy Policy and the Long Run, by James W. McKie; (7) Petroleum, Public Policy, and Pollution, by John D. Haun; (8) Summary of Petroleum and Natural Gas Panel Discussion, by Samuel P. Ellison, Jr.; (9) Mineral Resources: The Quality of Public Policy, by Peter T. Flawn; (10) A National Policy for Minerals Used in Plant Foods, by M. B. Gillis; (11) Mineral Plant Foods Policy, by G. L. Bridger; (12) Sulfur Resource Policy, by Jared E. Hazleton; (13) Summary of Mineral Plant Food Policy Panel Discussion, prepared by G. Donald Emigh; (14) Coal Problems, by Hubert E. Risser; (15) Coal's Role in a National Materials Policy, by Richard L. Gordon; (16) Summary of Coal Policy Panel Discussion, prepared by Howard B. Palmer; (17) Materials Policy, Energy, and the Environment: A Problem for Synthesis in Higher Education, by Lynton K. Caldwell; (18) Nuclear Energy Policy, by Herbert H. Woodson; (19) Power from Nuclear Fusion—Problems and Promises, by Howard Drew and William E. Drummond; (20) Solar Power—Is It a Feasible Option?, by Aden B. Meinel and Marjorie P. Meinel; (21) Summary of Nuclear, Thermonuclear, Thermal, and Solar Energies Policies Panel Discussion, prepared by Samuel P. Ellison, Jr.; and (22) Conclusions, by Samuel P. Ellison, Jr.

Guidebook 13. *Geology of the Llano Region and Austin Area—Field Excursion*, by V. E. Barnes, W. C. Bell, S. E. Clabaugh, P. E. Cloud, Jr., R. V. McGehee, P. U. Rodda, and K. P. Young. 77 pp., 29 figs., 3 tables (\$1.50).

This guidebook covers a field excursion of 310 miles in the Llano region of Central Texas where rocks ranging in age from Precambrian through Early Cretaceous are exposed. Seventeen representative sites are described in detail within the text, and geologic maps are provided for 10 areas, including Marble Falls and vicinity, Inks Lake and State Park, and the Sunrise Beach and Hoover Point areas of Lake Lyndon B. Johnson. Guidebook 13 is an updating of Bureau Guidebook 5—published in 1963 and now out of print—and a modification of "Geology of the Llano Region and Austin Area, Texas," by the Shreveport Geological Society (1971).

Guidebook 14. *Pennsylvanian Depositional Systems in North-Central Texas: A Guide for Interpreting Terrigenous Clastic Facies in a Cratonic Basin*, by L. F. Brown, Jr., A. W. Cleaves II, and A. W. Erxleben. 122 pp., 79 figs., 1 plate, 1 table (\$3.00).

Bureau Guidebook 14 was prepared for a three-day field trip of the 1973 Annual Meeting of the Geological Society of America in Dallas. The field guide provides an opportunity to observe a full spectrum of fluvial, deltaic and strike depositional systems. Surface and subsurface data for the Strawn, Canyon, and Cisco Groups—principal Middle and Upper Pennsylvanian depositional systems of North- and West-Central Texas—are discussed and summarized. Precise geographic location, stratigraphic position, regional and local geology, observed processes and environments are described for each field locality. Facies observed at field stops are tied to the regional distribution of the sequence in outcrop and subsurface. The guidebook includes a comprehensive list of references.

Guidebook 15. *The Edwards Reef Complex and Associated Sedimentation in Central Texas*, by H. F. Nelson. 36 pp., 5 figs., 7 plates (\$1.00).

Guidebook 15 describes the major physical features of the Edwards Reef Complex (Lower

Cretaceous) and its transition into adjoining back-reef sediments and restricted lagoon deposits at six localities in four Central Texas counties. The Edwards Reef Complex forms almost the entire Fredericksburg Group in field trip localities. The relationship of interreef and reef facies as well as the lithology of the reef facies and interreef facies are discussed in the guidebook. Written for a field trip of the 1973 Annual Meeting of the Geological Society of America, the guidebook includes a resume of regional stratigraphic descriptions and geologic history, and pertinent references.

Geological Circular 73-1. *Asbestos in the Allamoore Talc District, Hudspeth and Culberson Counties, Texas*, by R. G. Rohrbacher. 17 pp., 2 figs., 1 table (\$0.75).

In 1960, long-fiber asbestos was found in association with talc deposits of the Allamoore district. Preliminary exploratory work in the area indicated the possible presence of commercially exploitable quantities of asbestos.

Included in the circular are discussions of the regional geology, mineralogy, and conditions of formation of the Allamoore deposits, which are amphibole asbestos rather than chrysotile. The potential of the district also is described.

Special Publication. *Clastic Depositional Systems—A Genetic Approach to Facies Analysis, Annotated Outline and Bibliography*, by W. L. Fisher and L. F. Brown, Jr. 211 pp. (\$5.00).

A modern depositional system is an assemblage of related facies, environments, and associated processes. An ancient depositional system, therefore, is a three-dimensional assemblage of sedimentary facies linked genetically by inferred sedimentary environments and depositional processes. Nine principal types of clastic depositional systems are considered: fluvial; delta; barrier bar-strandplain; lagoon, bay, estuary, and tidal flat; continental and intracratonic shelf; continental and intracratonic slope and basin; eolian; lacustrine; and terrigenous fan (alluvial fan and fan delta). This publication, utilized in short courses presented by the Bureau, includes an annotated outline, a brief summary, and an extended bibliography of each of the systems.

Mineral Resource Circular No. 54. The Mineral Industry of Texas in 1971, by S. O. Wood, Jr., and Roselle Girard. 34 pp., 1 fig., 24 tables (free on request).

This preprint from the *Minerals Yearbook 1971* of the U. S. Bureau of Mines was prepared through a cooperative arrangement between the U. S. Bureau of Mines and the Bureau of Economic

Geology. Included are a table showing value of mineral production in individual Texas counties during the year, a review of production of mineral fuels, industrial minerals (nonmetals), and metals in 1971, and a list of principal mineral producers in Texas. The circular is an annual issue of the Bureau.

## PRELIMINARY REPORTS

The following reports were prepared for limited distribution, and are not a part of the Bureau of Economic Geology regular series of publications. They are, however, available for the cost of reproduction.

**Inventory and Environmental Effects of Surface Mining in Texas—Preliminary Report**, by C. G. Groat. 19 pp., incl. 3 figs., 1 table.

Surface mining of materials, such as sand, gravel, limestone, clay, gypsum, lignite, uranium, and iron ore, has resulted in the disturbance of about 60,000 acres of land in Texas—0.04 percent of the total land area of the State. This preliminary report is based on a comprehensive study of surface mining in Texas. It includes summarized information about the kinds of commodities produced by surface mining, the methods of surface mining, the environmental effects of surface mining in Texas, and the reclamation of mined land. A more detailed report, "Inventory and Environmental Effects of Surface Mining in Texas," is now in preparation.

**Lignite Geology, Mining, and Reclamation at Big Brown Steam Plant Near Fairfield, Texas—Field Trip Guidebook for November 1973 Annual Meeting**, Geological Society of America, Dallas, Texas, by W. R. Kaiser and C. G. Groat. 27 pp., incl. 7 figs., 1 table.

This field trip guidebook contains descriptions of the Big Brown lignite mining area near Fairfield in Freestone County and the outcrop area of the Simsboro Formation 11 miles southeast of Mexia in Limestone County. It also contains summarized discussions of the history of development of Texas lignites, the regional geology of Tertiary lignite-bearing units, the stratigraphy and sedimentation of the Wilcox Group (important lignite deposits occur in the Calvert Bluff Formation of the Wilcox Group), the surface mining of coal and lignite, and the reclamation of strip-mined areas.

## PUBLICATIONS IN PRESS OR IN FINAL PREPARATION

**Environmental Geologic Atlas of the Texas Coastal Zone. Kingsville Area**, by L. F. Brown, Jr., C. G. Groat, J. H. McGowen, and W. L. Fisher.

**Environmental Geologic Atlas of the Texas Coastal Zone. Port Lavaca Area**, by J. H. McGowen, C. V. Proctor, Jr., L. F. Brown, Jr., W. L. Fisher, and C. G. Groat.

**Environmental Geologic Atlas of the Texas Coastal Zone. Bay City-Freeport Area**, by J. H. McGowen, L. F. Brown, Jr., W. L. Fisher, and C. G. Groat.

**Geological Circular 74-1. Depositional Episodes: Their Relationship to the Quaternary Stratigraphic Framework in the Northwestern Portion of the Gulf Basin**, by D. E. Frazier.

**Geological Circular. Historical Changes in the Texas Gulf Shoreline—Bolivar Roads to the San Bernard River**, by R. A. Morton.

**Geological Circular. A Numeric Code for Describing Rocks in Sedimentary Basins**, by E. G. Wermund and C. A. Caughey.

**Geological Circular. Zeolites in Texas**, by A. W. Walton and others.

**Geological Circular. Potential Geothermal Resources in Texas**, by M. Dorfman and R. O. Kehle.

**Geologic Atlas of Texas. Austin Sheet. Francis Luther Whitney Memorial Edition**, geologic mapping by C. V. Proctor, Jr., T. E. Brown, J. H. McGowen, and N. B. Waechter, under the direction

of V. E. Barnes. Scale 1:250,000, in color, with 12-page explanation.

**Geologic Atlas of Texas.** San Antonio Sheet. Robert Hamilton Cuyler Memorial Edition, geologic mapping by T. E. Brown and N. B. Waechter, under the direction of V. E. Barnes. Scale 1:250,000, in color, with 8-page explanation.

**Geologic Atlas of Texas.** Seguin Sheet. Donald Clinton Barton Memorial Edition, geologic mapping by C. V. Proctor, Jr., T. E. Brown, N. B. Waechter, and Saul Aronow, under the direction of V. E. Barnes. Scale 1:250,000, in color, with 8-page explanation.

**Geologic Atlas of Texas.** Brownfield Sheet, under the direction of V. E. Barnes.

**Geologic Atlas of Texas.** Big Spring Sheet, under the direction of V. E. Barnes.

**Geologic Quadrangle Map No. 41.** Kingsland Quadrangle, Llano and Burnet Counties, Texas, by V. E. Barnes.

**Handbook No. 3.** Fluorspar in Texas, by W. N. McAnulty, Sr.

**Handbook No. 4.** Bituminous Coal in Texas, by T. J. Evans.

**Report of Investigations No. 78.** The Gulf Shoreline and Barriers of Texas: Processes, Characteristics, and Factors in Use, by J. H. McGowen.

**Report of Investigations No. 79.** Texas Lignite Resources, by W. R. Kaiser.

**Report of Investigations No. 80.** The Moore Hollow Group of Central Texas, by V. E. Barnes and W. C. Bell.

**Report of Investigations No. 81.** Approaches to Environmental Geology: A Colloquium and Workshop, E. G. Wermund, Editor.

**Report of Investigations No. 82.** Stuart City Trend (Lower Cretaceous), South Texas, A Carbonate Shelf Margin Model for Hydrocarbon Exploration, by D. G. Bebout.

**Report of Investigations.** Environmental Geology of the Austin Area, by L. E. Garner and Keith Young.

**Report of Investigations.** Inventory and Environmental Effects of Surface Mining in Texas, by C. G. Groat.

**Report of Investigations.** Land Use and Geology—Lake Travis Vicinity, Travis and Burnet Counties, Texas, by C. M. Woodruff, Jr.

**Report of Investigations.** Land and Water Resources of the Corpus Christi Area, by Robert S. Kier, Dennis Bell, Michael Dildine, James Woodman, and William L. Fisher.

**Report of Investigations.** Land Resources of Texas, by R. S. Kier and others.

**Report of Investigations.** Depositional Systems and Facies Control of Copper Mineralization, San Angelo Formation (Permian), North Texas, by Gary Smith.

**Special Publication** (to be issued jointly with the General Land Office of Texas). Coastline Changes, Matagorda Bay and Environs: Historical Monitoring of Coextensive Geologic and Legal Boundaries, by J. H. McGowen.

## **PUBLICATIONS REPRINTED**

The following publications were reprinted during 1973 and are again available for distribution.

**Guidebook 2.** Texas Fossils: An Amateur Collector's Handbook, by W. H. Matthews III. 123 pp., 26 figs., 49 pls., 1960 (4th printing; \$1.00).

**Guidebook 3.** Field Excursion, Central Texas: Tertiary Bentonites of Central Texas, by R. L. Folk, M. O. Hayes, and T. E. Brown; Uranium-Bearing Clays and Tuffs of South-Central Texas, by D. H. Eargle and A. D. Weeks; Vermiculite

Deposits Near Llano, by V. E. Barnes and S. E. Clabaugh. 53 pp., 8 figs., 1961 (2nd printing; \$1.25).

**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. A. Bernard, C. F. Major, Jr., B. S. Parrott, and R. J. LeBlanc, Sr. Includes appendix,



Resume of the Quaternary Geology of the Northwestern Gulf of Mexico Province, by H. A. Bernard and R. J. LeBlanc, Sr. 132 pp., 98 figs., 1970. Reprinting of a field guide prepared by Shell Development Company (2nd printing; \$5.00).

Report of Investigations No. 77. Fossil Vertebrates from the Late Pleistocene Ingleside Fauna, San Patricio County, Texas, by Ernest L. Lundelius, Jr. 74 pp., 59 figs., 1 pl., 52 tables, 1972 (2nd printing; \$3.00).

### OPEN-FILE MATERIAL

The Bureau of Economic Geology maintains an open file of reports, maps, and manuscripts obtained from various sources. Most are unpublished, although a few are progress reports of projects that ultimately will be published. These materials may be examined and copied, but publication rights are reserved. Placed on open file during 1973 were: (1) "Report on Texas Ex-

ploration for Bentonite (1946-1947) and Field Notes on Exploration for Bentonite in Gonzales County," by W. S. Rogers, 437 pp., typewritten; and (2) cross sections, strip logs of wells, and maps prepared in 1973 by E. H. Guevara for his dissertation, "Pleistocene Facies in the Subsurface of the Southeast Texas Coastal Plain," at The University of Texas at Austin.

### PAPERS BY BUREAU OF ECONOMIC GEOLOGY STAFF IN OUTSIDE PUBLICATIONS

Barnes, V. E., and Barnes, M. A., 1973, Tektites: Dowden, Hutchinson, & Ross, Inc., Stroudsburg, Pennsylvania, 445 pp.

Bebout, D. G., and Maiklem, W. R., 1973, Ancient anhydrite facies and environments—their role in the reconstruction of the geologic history of the Middle Devonian Elk Point Basin, Alberta: Bulletin of Canadian Petroleum Geology, 50 pp.

Bebout, D. G., 1973, Anhydrite facies and environments—their role in reconstructing the geologic history of the Middle Devonian Elk Point Basin, Alberta (abstract): American Association of Petroleum Geologists Bulletin, vol. 54, pp. 769-770.

Bebout, D. G., 1972, Golden Lane and Poza Rica Trend, Mexico—an alternate interpretation (abstract): South Texas Geological Society Bulletin, vol. 13, no. 4, p. 3.

Bebout, D. G., 1973, Golden Lane, Mexico, and Stuart City Trend, South Texas—a comparison (abstract): Houston Geological Society Bulletin, vol. 16, no. 3, pp. 2-3.

Brown, L. F., Jr., 1973, An evaluation of geologic analysis for environmental planning in Texas (abstract): Alaska Geological Society, Symposium on Resource Development and Environmental Conservation, Program Abstracts, p. 18.

Brown, L. F., Jr., (with W. E. Galloway), 1973, Depositional systems and shelf-slope relations on

cratonic basin margin, uppermost Pennsylvanian of North-Central Texas: American Association of Petroleum Geologists Bulletin, vol. 57, pp. 1185-1218.

Brown, L. F., Jr., 1973, Environmental geology and land management (abstract): Geological Society of America, Abstracts with Programs, vol. 5, no. 5, p. 381.

Cannon, P. J., 1973, Quantitative expressions of stream adjustment (abstract): Geological Society of America, Abstracts with Programs, vol. 5, no. 7, p. 567.

Cannon, P. J., 1973, The application of radar and infrared imagery to quantitative geomorphic investigations, in Remote Sensing of Earth Resources, Vol. II: Tullahoma, Tennessee, University of Tennessee Space Institute, pp. 503-520.

Cannon, P. J., 1973, The application of radar and infrared imagery to quantitative geomorphological problems, in International Conference on Remote Sensing in Arid Lands, Proceedings: Tucson, Arizona, Office of Arid Land Studies, University of Arizona.

Cannon, P. J., 1973, The generation of explicit parameters for quantitative geomorphic investigations (abstract): Oklahoma Geological Survey, Oklahoma Geology Notes, vol. 33, no. 3, pp. 122-123; and Geological Society of America, Abstracts with Programs, vol. 5, no. 3, pp. 249-250.

- Dickerson, P. W., 1973, [sections on usage and references], in Cochran, W., Fenner, P., and Hill, M. R., *Geowriting: American Geological Institute, Council on Education in the Geological Sciences Programs Publication 17*, pp. 16-22, 65-76.
- Epps, L. W., 1973, A geologic history of the Brazos River: *Baylor Geological Studies Bulletin 24*, Baylor University Press, 44 pp.
- Fisher, W. L., 1973, Deltaic sedimentation, salt mobilization, and growth faulting in Gulf Coast Basin (abstract): *American Association of Petroleum Geologists Bulletin*, vol. 57, p. 779.
- Fisher, W. L., 1973, Environmental carrying capacity: A geologic basis for management in the Texas Coastal Zone (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 7, p. 621.
- Fisher, W. L., Kier, R. S., Bell, Dennis, Dildine, Michael, and Woodman, J. T., 1973, Establishment of operational guidelines for Texas Coastal Zone management—interim report on resource capability: The University of Texas at Austin [prepared for] Research Applied to National Needs Program, National Science Foundation Grant No. GI-34870X and Division of Planning Coordination, Office of the Governor of Texas, Interagency Cooperation Contract No. IAC (72-73) 806, 249 pp.
- Girard, R. M. (with Wood, S. O., Jr.), 1973, The mineral industry of Texas, in *Minerals Yearbook 1971*, vol. II: Bureau of Mines, United States Department of the Interior (preprint, November 1973, 34 pp.).
- Groat, C. G., 1973, Holocene faulting and subsidence in the Texas Coastal Zone (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 7, p. 645.
- Gustavson, T. C., 1973, Paleotemperature analyses of several Sangamon and Early Wisconsin marine faunas from Long Island, N. Y., and Nantucket Is., Mass. (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 2, p. 171.
- Kier, R. S. (with Zachry, R. L.), 1973, Carbonate deposition of the lower part of the Marble Falls Formation, Central Texas (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 3, p. 290.
- Kier, R. S., and Zachry, R. L., 1973, Platform carbonate deposition of the lower Marble Falls Formation, Central Texas (abstract): *American Association of Petroleum Geologists, Southwest Section and Society of Economic Geologists, Midwestern Societies, Joint Annual Meeting, Abstract No. 21*.
- Kier, R. S., 1973, Resource capability units, Chapter V [of] Summary [of] Interim Report, Establishment of operational guidelines for Texas Coastal Zone management, The University of Texas at Austin, [prepared for] Research Applied to National Needs Program, National Science Foundation Grant No. GI-34870X and Division of Planning Coordination, Office of the Governor of Texas, Interagency Cooperation Contract No. IAC (72-73) 806, pp. V-1-V-14.
- Kreitler, C. W., and Jones, D. C., 1973, Nitrogen isotope ratios: new technique for determining the source of nitrate in ground water (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 7, p. 699.
- Wermund, E. G., 1973, Conduits in the Edwards Limestone recharge and aquifer beds (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 7, p. 860.
- Wermund, E. G. (with Ferguson, D. L., Call, F. J., and Fox, S. V.), 1973, Progress report on the establishment of a natural resources information system for the State of Texas: Interagency Council on Natural Resources and Environment, Austin, Texas, 83 pp.
- Wermund, E. G., Morton, R. A., Cannon, P. J., Woodruff, C. M., Jr., and Deal, D. E., 1973, Test of environmental geologic mapping, southern Edwards Plateau, Southwest Texas (abstract): *Geology*, vol. 1, no. 4, p. 169.
- Woodruff, C. M., Jr., and Lentz, R. C., 1973, Geologic factors related to land use in a predominantly crystalline rock terrane (abstract): *Geological Society of America, Abstracts with Programs*, vol. 5, no. 7, p. 871.

## NEW STAFF

The Bureau gained eight additional research scientists in 1973, as well as two full-time research assistants.

### E. J. Dickerson

E. J. Dickerson joined the Bureau of Economic Geology staff as a research scientist in March. He spent the previous eight years as a petroleum exploration geophysicist with Mobil Exploration Services Corporation in Dallas and London, and with Amoco Production Company in West Texas.

Dickerson received his M.A. (1966) and B.S. (1957) degrees in geology from The University of Texas at Austin. Between degrees, he was employed by various companies as a seismic computer, a mud logger, an electronics technician, and as a geologist in petroleum exploration, drilling, geophysical research, and seismograph-array site selection.

During 1973, he worked on the South Texas environmental geology project and conducted acoustic subbottom profiling in Lavaca Bay.

Dickerson is an active member of the Society of Exploration Geophysicists and is a member of several local geological and geophysical societies in Texas and Great Britain. His description of the Cieneguita Formation will be included in the Permian Lexicon, to be published by the West Texas Geological Society.

### Patricia Wood Dickerson

Patricia Wood Dickerson became a member of the Bureau research staff in March, following six years as a geosciences editor, information specialist, and consultant for the Oklahoma Geological Survey, American Geological Institute, Esso Production Research Company, and Earth Sciences Editing. She holds a B.A. (1970) degree in anthropology/geology from The University of Texas at Austin.

During the year, Mrs. Dickerson edited publications by Bureau researchers and, among other projects, worked on the preparation of a videotape feature on the Austin environmental geologic mapping program. Besides serving as Secretary-Treasurer of the Association of Earth Science Editors, she holds active membership in the Geological Society of America, Austin Geological Society, and other local geological societies.

### Lawrence W. Epps

Lawrence W. Epps joined the research staff in July. He previously had been employed by Angelo State University at San Angelo, Texas as an instructor of geology. Epps received his B.S. (1968) and M.S. (1972) degrees in geology from Baylor University. His thesis involved a geomorphic study of the Brazos River System. Epps is a member of the National Association of Geology Teachers and has worked with the American Geological Institute in developing new teaching material for introductory geology courses.

He presently is participating in the Bureau's Texas shoreline monitoring project. Other research interests include Pleistocene and Holocene geology of Texas, especially fluvial processes.

### Thomas J. Evans

Thomas J. Evans joined the Bureau of Economic Geology research staff in June. He received his A.B. (1968) degree from Wittenberg University and M.S. (1971) degree from the University of Arizona. His thesis pertained to depositional environments of the Toroweap Formation (Permian) along the Mogollon Rim in North-Central Arizona. Evans taught for two years at Ohio Wesleyan University before coming to the Bureau.

Evans is a member of the American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, and the Geological Society of America. During the year, he completed a survey of bituminous coal in Texas; the report is to be published in 1974.

### Thomas C. Gustavson

Thomas C. Gustavson completed doctoral studies at the University of Massachusetts in June 1973, and joined the Bureau staff in July; he earlier received his B.S. (1961) degree from Massachusetts and then earned his M.S. (1964) degree at the University of North Dakota. Between graduate degrees, Gustavson worked two years for Humble

Oil & Refining Company and taught three years at Long Island University.

Fluvial and lacustrine sedimentation, Pleistocene and Holocene stratigraphy, geomorphology, and glacial geology are his principal research interests. At present, he is working on the South Texas environmental geology project, in addition to compiling information on Texas sand and gravel resources.

Gustavson is a member of the Geological Society of America, the Society of Economic Paleontologists and Mineralogists, and The Society of the Sigma Xi.

#### **Charles W. Kreitler**

Charles W. Kreitler joined the Bureau of Economic Geology research staff in September. He received a B.S. (1969) degree in geology from St. Lawrence University and an M.A. (1972) degree in geology from The University of Texas at Austin. From 1970 to 1972, he worked as a geologist for Radian Corporation in Austin. He currently is completing the final requirements for a Ph.D. degree in geology from The University of Texas at Austin. His dissertation is concerned with the application of nitrogen isotopes in determining the source of nitrate in ground water.

Kreitler is a member of Phi Kappa Phi and Sigma Gamma Epsilon. His research interests are hydrogeology and environmental geology. At present, he is studying the active faulting in the Houston region.

#### **Mary Jarrell Pieper**

Mary Jarrell Pieper, who worked on the Geologic Atlas of Texas project seven years ago, returned to the Bureau and to the Atlas project in November. She holds B.S. (1959) and M.S. (1961) degrees in geology from the University of Houston.

In her earlier work with the Bureau, Mrs. Pieper contributed to the Palestine, Texarkana, and Tyler Sheets of the Atlas. She also has held positions in micropaleontology, stratigraphy, photogeology, and geoscience information with Shell Oil Company, Exploration Engineering, and Esso Production Research Company.

#### **Ann E. St. Clair**

Ann E. St. Clair received her B.A. degree in geology from Trinity University in May 1973, and became a full-time Bureau research assistant the following month. Her principal research interest is in environmental geology and land-use planning, and she currently is working on the Environmental Geologic Atlas of the Texas Coastal Zone and the Texas land resources mapping project. In October, Miss St. Clair began a study on the location of mineral-resource deposits as a consideration in the planning process. She is serving as Treasurer of the Austin Geological Society.

#### **F. Beverley Vann**

Beverley Vann joined the Bureau staff as a full-time research assistant in February, and is working on projects dealing with environmental geology and resource capability. Miss Vann holds a B.S. (1970) degree in geology from Baylor University and is completing requirements for a Master's degree, also from Baylor. Her thesis, "Environmental Study of the South Bosque River Basin," includes studies of water chemistry, erosion rates, and pesticide residues.

#### **William A. White**

William A. White joined the Bureau of Economic Geology research staff in June on a summer appointment which was extended to a one-year appointment in September 1973. He received a B.S. degree in geology in 1962 from The University of Texas at Austin. Following four years service as an officer in the United States Air Force, he returned to The University of Texas to receive a Texas Teacher Certificate (1968) and a Master's degree (1972) in science education with emphasis on earth and life sciences. He has four years of experience as an earth science teacher in secondary education with the Austin Independent School District.

White's interest in environmental geology is reflected in his Master's research, which was concerned with geologic formations in the Austin area, their capabilities, and their responses to specific urban activities. Formerly involved in the Bureau's Matagorda Bay project, he presently is participating in the RANN project.

## R. KEITH ARNOLD NAMED DIRECTOR, DIVISION OF NATURAL RESOURCES AND ENVIRONMENT

In September 1973, Dr. R. Keith Arnold began serving as Director of the Division of Natural Resources and Environment, The University of Texas at Austin, of which the Bureau of Economic Geology is part.

Dr. Stephen H. Spurr, President of The University, served as Director of the Division between the departure of Dr. P. T. Flawn, a former director of the Bureau who accepted a post as President of The University of Texas at San Antonio, and the arrival of Dr. Arnold.

Dr. Arnold's academic background includes B.S., M.S., and Ph.D. degrees in forestry from the University of California at Berkeley, Yale University, and the University of Michigan, respectively. Before coming to Austin, he was Deputy Chief for Research with the Forest Service, U. S. Department of Agriculture.



## GUS K. EIFLER, JR., RETIRES

Dr. Gus K. Eifler, Jr., retired from the Bureau at the end of August 1973, after nine years of dedicated work on the Geologic Atlas of Texas project. He has contributed significantly to the compilation of this new geologic map of the State, having done field mapping for the Amarillo, Big Spring, Brownfield, Clovis, Dalhart, Hobbs, Lubbock, Pecos, Perryton, Plainview, San Angelo, and Tucumcari Sheets of the Atlas.

Dr. Eifler holds B.A. (1929) and M.A. (1930) degrees in geology from The University of Texas and a Ph.D. degree in geology (1941) from Yale University. A paper based on his doctoral dissertation, "Geology of the Santiago Peak Quadrangle, Texas," was published in the Bulletin of the Geological Society of America, vol. 54, pp. 1613-1643, October 1, 1943. A later study by Dr. Eifler, "Geology of the Barrilla Mountains, Texas," also was published by the Geological Society of America (Bulletin, vol. 62, pp. 339-359, April 1951) and was reissued as Bureau of Economic Geology Report of Investigations No. 8.

Dr. Eifler was associated with the teaching staff of The University of Texas Department of Geology from 1929 to 1950, except for the time that he spent in graduate studies at Yale and the three years that he served in the United States Air Force during World War II. Prior to joining the Bureau of Economic Geology staff in 1964, Dr. Eifler was an independent consulting geologist with offices in Austin. During that period, he made geological



investigations in the United States, Mexico, Canada, and Australia.

On August 23, 1973, approximately fifty of Dr. Eifler's friends and co-workers from the Bureau, the Department of Geological Sciences, and elsewhere gathered at the Bureau to wish him well. On that occasion, Dr. W. L. Fisher presented him a leather map case containing the Atlas sheets published to date. On the case, designed to hold the complete Geologic Atlas series, were engraved Dr. Eifler's name, his years of Bureau service, and an expression of appreciation for his contributions.

## BUREAU OF ECONOMIC GEOLOGY RESEARCH PROGRAMS AND PROJECTS

Bureau research programs and projects address many of the major concerns of the State in areas of natural resources and environment. Through the years, an extensive program has been maintained in **Mineral and Energy Resources**. Bureau of Economic Geology projects in this area range from inventory and evaluation of the distribution, grade, and potential development of resources, to regional and local studies aimed at fuller understanding of the State's resources and development of concepts basic to exploration and conservation. Currently, projects include basin analysis of important oil and gas trends, research in the occurrence and potential utilization of deep-basin lignites, inventory of the scope, type, and impact of surface mining, and investigation of a number of hard mineral resources such as talc, zeolites, and sedimentary copper.

In recent years, environmental concerns and resource conservation have become items of major

consideration. In anticipation of these concerns, the Bureau developed early a program in **Land Resources Inventory**, currently one of the most extensive programs of its kind in the United States. Principal objective of this program is inventory through mapping and analysis. The basic concept of land and water capability has been developed as a technical base for development and conservation of the State's natural resources. Current projects in the Land Resources Inventory program are being conducted by the Bureau in three critical areas of the State: the Coastal Zone, the major metropolitan and industrial centers, and land areas directly related to surface and ground-water resources.

In addition to projects that are parts of these two major programs, a variety of studies in basic geologic research, in systematic geologic mapping, and in resource statistics and information are maintained. Current research by the Bureau of Economic Geology includes the following projects.

### Energy and Mineral Resources Program

**Texas Lignite Resources.**—W. R. Kaiser, assisted by C. L. Burton.

Solid fossil fuels are receiving much attention because they provide a significant alternative energy source during the current crisis. Coals and lignites are being mined at increasing rates for use in fueling power plants throughout the United States. Extensive near-surface reserves in Texas are supplemented by huge concentrations of deep-basin resources that can be tapped for *in situ* processing for the production of gas.

Texas has vast reserves of lignite at minable depths and in deeper parts of the Gulf Basin. Near-surface deposits presently are mined at three locations, and three additional installations have been announced. The deep-basin reserves hold great promise for future utilization as technology in this area advances. This study is an extension and expansion of an earlier survey of Texas lignites (Report of Investigations No. 50, now out of print), and stresses the gathering of detailed stratigraphic information relating to the deep-basin lignite occurrence. Precise and detailed geological information of this type will be needed for the *in situ* development and utilization of Texas lignites.

A final report is currently in press and will be published early in 1974 as a Report of Investigations.

**Bituminous Coal in Texas.**—T. J. Evans.

In response to increasing interest from private and public organizations, the Bureau has compiled all available information on bituminous coal occurrences in Texas. A report is now in press, and will be published shortly by the Bureau. The report includes summaries of past production and mining history; geologic setting of coals and coal-bearing strata; future development potential; and a compilation of measured sections, outcrop localities, and chemical analyses.

**Surface Mining in Texas: Inventory and Environmental Effects.**—C. G. Groat, assisted by W. B. Anderson and Carl Teinert.

In October 1971, the Bureau of Economic Geology undertook a broad study of surface mining in Texas. As a result, comprehensive information has been developed.

An open-file collection of county maps showing the location of surface mines, supplemented by detailed maps of the mines and descriptive information—including surface area affected, mine dimensions, commodity produced, and present reclamation programs—is now available for use at the Bureau. A formal, summary report to be published as a Report of Investigations is being prepared. A preliminary report, entitled "In-

ventory and Environmental Effects of Surface Mining in Texas," was released by the Bureau in 1973.

**Stuart City Trend (Lower Cretaceous), South Texas, A Carbonate Shelf Margin Model for Hydrocarbon Exploration.**—D. G. Bebout, assisted by R. G. Loucks.

The location of the Deep Edwards Reef Trend has been well established during the past 20 years both by drilling and by careful examination of seismic profiles by petroleum companies. Wells in this trend, however, have been noncommercial because of cementation of original primary porosity and lack of leaching to develop secondary porosity. A better understanding of the diagenetic changes that have taken place should aid in the future exploration for Cretaceous carbonate reservoirs in the Deep Edwards Trend.

More than 10,000 feet of core from 20 wells was obtained from Amoco Production Company, Chevron Oil Company, Exxon Company, U.S.A., Mobil Oil Corporation, Shell Oil Company, and Tenneco Oil Company. All cores were logged and these basic data were assembled into facies cross sections and maps. The project was initiated in December 1972 and is now complete. A final report is in press and will be issued as a Report of Investigations early in 1974.

**Virgil-Wolfcamp Facies, Eastern Shelf, North-Central Texas.**—L. F. Brown, Jr., assisted during 1973 by Arthur Cleaves, Raul Solis, G. E. Smith, and A. W. Erxleben.

This regional study of the surface and subsurface in a 30-county area of North-Central Texas involves the examination of approximately 10,000 well logs. The goal of the project is the mapping and recognition of fluvial, deltaic, and related marine depositional systems and their component facies. The resulting regional picture of Late Pennsylvanian and Early Permian depositional features will serve as a guide in the search for oil, water, clay, and other resources in the study area and in similar depositional systems elsewhere.

Two graduate students, supported in part by the Bureau, completed studies of North-Central Texas geology and submitted Master's theses in 1973 that contributed to the project. A. W. Erxleben studied Canyon (Pennsylvanian) depositional systems, and G. E. Smith investigated depositional systems and copper mineralization in the San Angelo Formation (Permian). One of the publications resulting

from this project is Bureau Guidebook 14, "Pennsylvanian Depositional Systems in North-Central Texas," by L. F. Brown, Jr., A. W. Cleaves, and A. W. Erxleben, published this year; other publications are in preparation.

**Upper Pennsylvanian and Middle Permian Limestones of the Central Basin Platform in Texas.**—E. G. Wermund, assisted in 1973 by Charles A. Caughey and Thomas Henderson.

This project was initiated in November 1971 to study subsurface carbonate environments in a major oil- and gas-producing province.

During the initial phase of the project, a numeric code was developed to digitize lithologic descriptions of rock outcrops, of rock cores and well cuttings, and of mechanical logs of wells. Use of the code permits any individual lithologic entity to be located and described on a single punched card. The code will be useful both in facies mapping and in natural resources inventorying.

**Sand and Gravel Resources of Texas.**—T. C. Gustavson.

In the course of this project, begun in fall 1973, sand and gravel occurrences of the State are being documented, with special emphasis on accumulations near areas of high population and rapid urban growth. The economics and environmental aspects of sand and gravel production are being considered, along with the sedimentology and geologic history of major deposits. The study is scheduled for completion in early 1975.

**Depositional Systems and Facies Control of Copper Mineralization, San Angelo Formation (Permian), North Texas.**—Gary E. Smith.

This investigation of Permian red-bed copper deposits of North Texas is a Master's thesis prepared at The University of Texas at Austin and supported in part by the Bureau of Economic Geology. It was completed in late 1973.

The thesis includes results of geochemical studies and maps of surface and subsurface stratigraphic units of the San Angelo Formation and other formations in the area. Aim of the investigation was to determine the depositional history of sand and mud facies in which the copper occurs and to define depositional controls and distribution of the copper mineralization. A report based on information presented in the thesis is being readied for publication by the Bureau of Economic Geology.



of Texas. Results of the comparison indicate that the ancient Grafton fluvial system closely resembled some of the Texas coastal plain rivers. The depositional model, constructed from facies of the Guadalupe Delta and used for interpreting shallow-water deltaic sedimentation in the Appalachian Basin, now can be expanded to include the fluvial part of the depositional system. The project was initiated in 1971, and research was completed in late 1972. A manuscript describing results of the study was being written in 1973.

**Depositional Environments of the Marble Falls Formation, Central Texas.**—R. S. Kier and R. L. Zachry.

This study involves a delineation of the carbonate facies and depositional patterns present in the exposed part of the lower Marble Falls Formation. 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 will be gathered. A report on the results of this phase of a long-term study of the Lower Pennsylvanian of Central Texas was in progress during 1973.

**Depositional Models, Lower Pennsylvanian of Central Texas.**—R. S. Kier.

The purpose of this study is the development of a regional depositional model for Lower Pennsylvanian strata of Central Texas. Previous studies in eastern San Saba County and western Lampasas County will be augmented by data derived from additional field and subsurface studies of Lower Pennsylvanian strata in the area south of the Callahan Divide (West-Central Texas). The project, which is part of a long-term study, was initiated in 1968. A report on the project was in preparation during the year.

**Tektites.**—V. E. Barnes, Director of Tektite Research at The University of Texas at Austin, with Mrs. M. A. Barnes, and Kelley Kennedy.

In this project, research on tektites and natural glasses was continued under a 1973 National Science Foundation Grant.

The book *Tektites*, by V. E. Barnes and M. A. Barnes, was published in 1973 by Dowden, Hutchinson & Ross in their Benchmark series of reference books in geology.

**Bibliography and Index of Texas Geology, 1961-1972.**—Elizabeth T. Moore.

This project is a compilation, with detailed index, of publications pertaining to Texas geology. Initiated in 1973, this is a continuation of earlier bibliographies (University of Texas Bulletin 3232—Part 4, Publication 5910, and a Bureau of Economic Geology special publication, "Bibliography and Index of Texas Geology, 1951-1960").

**History of the Bureau of Economic Geology (1909-1960).**—W. K. Ferguson.

The history of the Bureau of Economic Geology, from its inception in 1909 through the directorships of W. B. Phillips, J. A. Udden, E. H. Sellards, and J. T. Lonsdale, has been assembled through analysis of official correspondence and publications of the Bureau, and through interviews with numerous individuals aware of the workings of the Bureau during its earlier years. The history is a study of the whole concept of public geologic research and the goals of that research, as well as the story of the Bureau of Economic Geology and the role of its contributions to the knowledge of the geology and resources of Texas. The 1909 to 1960 history is a sequel to Ferguson's earlier history entitled *Geology and Politics in Frontier Texas, 1845-1909*, published by The University of Texas Press. At yearend 1973, the manuscript was nearing completion.

## CONTRACTS AND GRANT SUPPORT

The Bureau of Economic Geology maintains formal and informal cooperative arrangements with several state and federal agencies. A part of the Bureau research program is supported by contracts and grants with state agencies, local units of government, and federal agencies. Contracts and grants in effect during 1973 include:

**Environmental Mapping, Inventory and Analysis of South Texas, Including the Edwards and**

**Carrizo-Wilcox Areas.**—Texas Water Development Board.

**Matagorda Bay and Environs Pilot Study.**—Texas General Land Office.

**Criteria for Coastal Zone Management.**—National Science Foundation (RANN) and Office of the Governor, Division of Planning Coordination, through The University of Texas at Austin, Division of Natural Resources and Environment.



## Land Resources Inventory Program

**Environmental Geologic Atlas of the Texas Coastal Zone.**—L. F. Brown, Jr. (project coordinator), W. L. Fisher, J. H. McGowen, C. G. Groat, C. V. Proctor, Jr., J. L. Brewton, and research assistants.

In 1973, the Beaumont-Port Arthur Atlas of the Environmental Geologic Atlas of the Texas Coastal Zone was published and the Kingsville Atlas was in final preparation. When completed, this Atlas series will comprise seven publications covering seven areas of the Coastal Zone: Galveston-Houston (published 1972), Beaumont-Port Arthur (published 1973), Kingsville (in final preparation), Bay City-Freeport, Port Lavaca, Corpus Christi, and Brownsville-Harlingen. Each Atlas of the series consists of a descriptive text, a basic environmental geologic map (scale, 1:125,000), and eight special-use maps (scale, 1:250,000). All the maps are multicolored, on a specially constructed base.

The Environmental Geologic Atlas of the Coastal Zone is the product of an extensive study conducted by the Bureau of Economic Geology during the past four years. The Atlas set covers 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 by the use of detailed photographic mosaics, topographic maps, and 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 diverse existing data. The Environmental Geologic Atlas of the Texas Coastal Zone is 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.

**Environmental Analysis and Mapping of the Nueces, San Antonio, Guadalupe, and Lavaca River Basins.**—E. G. Wermund (project director), P. J. Cannon, D. E. Deal, E. J. Dickerson, L. E. Garner, T. C. Gustavson, R. A. Morton, and C. M. Woodruff, Jr., assisted in 1973 by John Boone, Garry Dent, Lindsay Tade, Judy Russell, Nancy Smith, Rebecca Summer, Claudia True Waddell, and David Walz.

This long-term project, initiated in June 1972 under contract with the Texas Water Development Board, is a comprehensive environmental geologic analysis of approximately 33,000 square miles of the Nueces, San Antonio, Guadalupe, and Lavaca

River Basins of South Texas. Objectives of the project call for preparation of the following maps as a part of the environmental inventory: basic environmental geology map (scale 1:125,000), slope map (scale 1:125,000), physical properties map (scale 1:250,000), active process map (scale 1:250,000), biologic assemblages map (scale 1:250,000), current land-use map (scale 1:250,000), man-made features map (scale 1:250,000), and mineral and energy resources map (scale 1:250,000).

The first phase of the project is concerned with an area that includes the southern Edwards Plateau and Cretaceous coastal plain to south of U. S. Highway 90 and east of U. S. Highway 81. The region is of prime environmental significance as it includes the infiltration and productive areas for the subsurface Edwards Limestone aquifer, which supplies water to nearly one million people in metropolitan San Antonio, San Marcos, New Braunfels, Hondo, and Uvalde. The aquifer also supplies irrigation water for about 3,700 square miles of croplands.

During 1973, maps showing environmental geology, biologic assemblages, slope, and mineral and energy resources (except sand and gravel resources) were completed for the area. The map data were compiled on topographic sheets (scale 1:24,000) and controlled aerial photographic prints of the same scale, augmented by stereoscopic pairs of black-and-white photographs (scale 1:40,000). Interpretations were checked both on the ground and by means of low-level flights.

Additional work in the southern Edwards Plateau and Cretaceous coastal plain included the mapping of surface fractures (lineations) in 200 quadrangles (7.5-minute) in the area. In a selected test block composed of 36 of the quadrangles, more than 12,000 lineations were marked, and the end points of each lineation were mechanically located and recorded on punched cards at Texas Highway Department facilities. Joseph Cepeda and Ann Bell, assisting Dr. Wermund, have prepared computer programs to take the data of the test block area and mechanically plot: (1) rose diagrams of fractures in each quadrangle, (2) weighted arithmetic means of fractures in the northwest and southeast quadrants, (3) standard deviations of weighted means, (4) number of fractures per unit area, (5) total length of fractures per unit area, and (6) number of fracture intersections per unit area.

Computer programs 2, 3, 4, 5, and 6 (listed above) produce maps of the entire 36-quadrangle test block at any selected scale. Results of programs 4, 5, and 6 are displayed as machine-contoured maps.

In field reconnaissance, measurements of joints were made at 320 field stations in the test block area. Rose diagrams of the joints and of the photo lineations (fracture zones) show general agreement with the lineation mapping.

As surface fractures or lineations provide passageways for rainwater and other surface water to enter and recharge the underground aquifer, those areas containing greatest concentrations of fractures are the areas of highest infiltration. The fracture data are of importance in locating infiltration zones, and they supplement the environmental geologic mapping. The quantitative fracture data will be an essential part of the Texas Water Development Board computer model of the Edwards Limestone aquifer.

Project plans for 1974 include: (1) scribing of completed mapping, (2) derivation of physical processes and material maps, (3) environmental geologic mapping of the Tertiary coastal plain, and (4) preparation of land-use and man-made features maps of the total project area. Completion of the entire project is scheduled for 1975.

#### **Historical Monitoring of the Texas Gulf Coast Shoreline.—R. A. Morton and L. W. Epps.**

The purpose of this two-year project, initiated in September 1973 under separate appropriation by the 63rd Legislature, is to document changes in position of the Texas Gulf shoreline through time. Segments of the coast that have undergone accretion and erosion or have remained in equilibrium are described, and long-term rates of change are determined and presented in graphic and tabular form. Maps of sequential shorelines from the Rio Grande to the Sabine River are being prepared, with data compiled from (1) topographic and hydrographic charts dating from 1850 to the early 1920's, (2) aerial photographs dating from 1930 to 1970, and (3) miscellaneous reports and surveys. Supplementary data on seasonal changes and the effects of storms will be provided by monitoring beach profiles at selected locations.

Factors affecting changes in shoreline position are being investigated and related to natural and man-induced processes. Preliminary reports covering different segments of the coast will be prepared; reports covering the most critical parts of the coast will be published in 1974. A final report,

with cartographically-scribed, precise maps, will be published in 1975.

#### **Land Resources of Texas: Mapping and Classification.—R. S. Kier, L. F. Brown, Jr., L. E. Garner, and J. L. Brewton; assisted by Mary E. Bowers, Ann St. Clair, Beverley Vann, Sally Scanlon, Mary Poorman, Eileen Theilig, and Alan Funk.**

The project, initiated in April 1972 with partial support from the Texas Water Development Board and the Division of Planning Coordination, Office of the Governor, is designed to provide a statewide classification of Texas lands and a wall map (scale 1:500,000) showing distribution of the various land types and their natural capacity to sustain diverse kinds of land use. This statewide analysis complements detailed environmental mapping programs of the Bureau of Economic Geology and provides the needed technical base for proper land and natural resource conservation and development.

The classification includes approximately 78 land capability units broadly classed as (1) hydrogeologic units; (2) geologic (substrate) and soils units; (3) physical properties units; (4) geomorphic-structural units; (5) active process units; (6) biologic units; (7) subaqueous coastal units; and (8) man-made units. Each of the 78 capability units is indicated by a unique color and symbol on a U. S. Geological Survey topographic, physical, and cultural base map (scale 1:500,000). A legend—including color inset maps depicting such features as regional physiography, generalized soils distribution, climate, and major drainage basins—and a descriptive text will accompany the map.

A hand-colored copy of the map was near completion at yearend, and it is expected to be ready for color separation by early to mid-1974. Additional funds are being sought to help defray color separation and printing costs that otherwise will have to be recovered by an increase in the sale price of the map.

The text, for which data were compiled during the year, is expected to be ready for editorial review during 1974. The text will include descriptions of the capability units, related geologic formations and soils units, physical and engineering properties, associated faunal and floral types, topography and slope, regional distribution, current land use, limitations on land use, and resource attributes.

#### **Statewide Current Land-Use Map.—P. J. Cannon.**

The objective of this project, begun in December 1973, is to compile an up-to-date statewide land-

use map, using ERTS-A (Earth Resources Technology Satellite-A) imagery. Map units will follow the national land-use classification system developed by the U. S. Geological Survey (1967), but will be modified to reflect more precise current land use in Texas. The map will be prepared at a scale of 1:500,000, complementary to the Land Resources of Texas map, now nearing completion. These two basic maps are designed to provide the State with an assessment of land resources and current use.

**The Gulf Shoreline and Barriers of Texas: Processes, Characteristics, and Factors in Use.—J. H. McGowen.**

Dynamic changes of the shoreline through natural processes significantly impact activities along the coast. Through mapping (with data obtained from a series of vintage photographs and coastal charts) of the Texas shoreline and through construction of a large number of profiles (showing the outline of the topographic surface) across the barrier islands and the beaches, three kinds of shorelines have been defined. Some segments of the shoreline are eroding rapidly, up to a maximum of forty feet per year. Other segments are in equilibrium, being neither erosional nor depositional; equilibrium can result from natural or artificial stabilization or where sediment supply and beach processes are equal. Certain reaches of the shoreline are depositional—that is, showing seaward accretion over a short period of time.

The project dealt with the underlying causes of erosion, equilibrium or accretion. Volume of sand stored in the barriers was considered. The present erosional rates of headlands, erosion of the inner continental shelf, and volume of sediment delivered to the Gulf by the Brazos and Colorado Rivers and the Rio Grande were studied to determine the role each plays in barrier development and maintenance.

The resulting report, which considers the processes along the coast and the relation of these processes to use and development of the coast in largely a qualitative sense, is now in press. This work has led to a program in historical shoreline monitoring (described elsewhere in this Annual Report), which will develop quantitative information on shoreline changes.

**Criteria for Coastal Zone Management.**

During 1971, an interdisciplinary team of scientists, engineers, and economists was formed at The University of Texas at Austin under the

auspices of the Division of Natural Resources and Environment. The research team, charged with establishing and outlining criteria for land and water management of the Texas Coastal Zone, began initial work under funding from the Coastal Resources Management Program of the Division of Planning Coordination, Office of the Governor, in early 1972. Beginning in June of 1972, the research team continued work under a two-year grant from the RANN (Research Applied to National Needs) Program of the National Science Foundation, augmented by funds from the Office of the Governor. The grant is administered through the Division of Natural Resources and Environment.

Participating in the interdisciplinary research team are: W. L. Fisher, Robert S. Kier, and William A. White (Bureau of Economic Geology); E. Gus Fruh (Project Director), J. F. Malina, Jr., and Frank D. Masch (Department of Civil Engineering and Environmental Health Engineering Laboratories); Carl H. Oppenheimer (Marine Science Institute); and Jared E. Hazleton and Kingsley E. Haynes (LBJ School of Public Affairs).

During 1973, the team continued to focus its efforts on the Corpus Christi Bay area. The Bureau's principal input consists of (1) delineating the land-resource capability units in terms of their natural ability to withstand various uses, and constructing maps depicting the areal distribution of these units; (2) accumulating data that will allow quantification of the physical parameters of the capability units and permit determination of ground-water levels, seasonal fluctuations, and direction and rate of movement; and (3) documenting the kinds and rates of natural and man-induced changes in the dynamic units along the coastline.

During the year, efforts of Bureau of Economic Geology research scientists resulted in the completion of a full-color map showing land and water resources of a four-county area around Corpus Christi, comprising Aransas, Nueces, Refugio, and San Patricio Counties. The Bureau team also completed (1) a report containing descriptions of the capability units and of the engineering properties, activity limitations, compatible activities, and problematical activities of the units; (2) maps of piezometric surfaces of ground water under water-table conditions and under artesian conditions; and (3) an assessment of detailed changes in the Coastal Zone environments, accomplished by mapping sequential aerial photos.

Also during 1973, the Bureau team began (1) a more extensive investigation of shoreline changes in the Corpus Christi area (in cooperation with Dr. R. A. Morton, whose project is described elsewhere in this Annual Report); (2) a detailed analysis of the distribution and quality of ground water in the Coastal Bend Council of Governments area (data in part derived from Master of Science thesis work by Dennis Bell and Jim Woodman at The University of Texas at Austin); and (3) integration of work completed by the individual interdisciplinary research teams in analyzing the environmental and economic results of maintaining, through 1980 and 1990, the governmental policies that were in effect in 1970.

Assisting in the Bureau's work on the project are research assistants Albert Erxleben, Michael Dildine, Dennis Bell, James Woodman, and Peter C. Patton.

#### **Matagorda Bay and Environs—A Pilot Study.**

A cooperative program was initiated in 1971 between the Bureau of Economic Geology and the General Land Office; it is coordinated by J. H. McGowen of the Bureau of Economic Geology and Wayne D. Oliver of the General Land Office. During 1973, Bureau assistants on this project included B. H. Wilkinson, J. R. Byrne, W. R. Leeper, and C. R. Lewis; General Land Office participants included Doran Williams and Robert Clark. Field work for this comprehensive program and also laboratory studies, including sediment analyses, molluscan composition, content of organic carbon, and distribution and amount of heavy metals, have been completed. Determinations of heavy metals were made by Charles Holmes of the U. S. Geological Survey office in Corpus Christi.

Initial phase of the study involved the use of a series of vintage photographs to prepare detailed maps of geologic boundaries that are coextensive with legal boundaries between State and private lands. Historical change and rate of change of these dynamic boundaries were defined.

The first report of the project, emphasizing shoreline and wetland boundary change in the Matagorda Bay area, is now in press and will be published jointly by the Bureau of Economic Geology and the General Land Office. An additional report is in preparation.

In work related to the Matagorda Bay study, E. J. Dickerson and P. W. Dickerson, assisted by Jim Byrne, gathered seismic data in 1973 for use in mapping Pleistocene and Holocene depositional

systems in Lavaca Bay, which adjoins Matagorda Bay. Two seismic energy sources were tested, operated, evaluated, and modified for portability in two-person operations. A compact, low-cost distance marker designed for shallow marine position surveying was developed, and refinements were under way on an interval-timer refraction seismograph for use in fast, inexpensive shallow seismic surveys.

#### **Environmental Geologic Atlas of the Houston Area Test Site.—C. V. Proctor, Jr., assisted by Charan Achalabhuti and Douglas Hall.**

The objective of this study was to prepare an environmental geologic atlas of the 18-county area adjacent to Houston and Harris County, Texas. The project, which was completed in mid-1973, was launched under contract with the National Aeronautics and Space Administration in Houston. An extension of the Bureau's Environmental Geologic Atlas of the Texas Coastal Zone, the study involved the preparation of a series of maps showing (1) basic environmental geology, (2) active processes and biologic assemblages, (3) man-made features and surface water systems, and (4) mineral and energy resources. A special land capability classification was derived, which evaluates environmental carrying capacity of mapped lands and environmental units in terms of existing and potential land uses.

The area that was mapped includes Burleson, Brazos, Grimes, Walker, San Jacinto, Montgomery, Waller, Washington, Austin, Colorado, Wharton, Fort Bend, Harris, Liberty, Chambers, Galveston, Brazoria, and Matagorda Counties. Mapping for the Atlas utilized NASA black-and-white photomosaics at a scale of 1:125,000 and color and color-infrared aerial photographs at an approximate scale of 1:120,000. Photo interpretation was augmented by low-level aerial reconnaissance and on-site field checking. A final report, with completed maps, has been submitted to NASA.

#### **Environmental Geology and Geologic History of the Texas Inner Coastal Plain.—Cleo V. Proctor, Jr., Charan Achalabhuti, and Joseph L. Brewton.**

The project, initiated in 1971, is an inland extension of the Bureau's Environmental Geologic Atlas of the Texas Coastal Zone. It includes detailed mapping of sedimentary facies, environmental units, and land capability of a 55-mile-wide belt (located approximately 45 miles to 100 miles inland from the Texas Coast) that stretches from the Sabine River to the Rio Grande. Mapping was

completed in 1973 and cartographic scribing was in progress at yearend. Work maps are on open file and are available for examination.

**Active Faulting in Upper Gulf Coast of Texas.—C. W. Kreitler.**

The aim of this investigation is threefold. The first goal is to determine if active faulting in the Upper Gulf Coast is of greater frequency and intensity in the cone of subsidence that has developed as a result of ground-water withdrawal in Harris County. This is being accomplished by field checking the lineations (surface features) that Bureau geologists previously mapped both within and outside of Harris County. The other goals are to determine if the lineations are related to subsurface faults, and if the active faults are controlled by the sedimentary facies that are present.

The project, initiated in September 1973, is expected to be completed by mid-1974.

**Environmental Geology of the Austin Area, Texas—An Aid for Urban Planning.—L. E. Garner and K. P. Young.**

This study of the geology and physical properties of rock units of the Austin area is designed to provide data for planners, engineers, and other interested persons. Field mapping by L. E. Garner, P. U. Rodda, and K. P. Young is complete, color separation work is in progress on the maps, and a report on the project is in preparation. Maps to be included in the Atlas will indicate: (1) rock types, (2) land use, (3) slope, (4) drainage basins and flood-prone areas, (5) physical properties, and (6) soils.

Late in 1973, a videotape program on the Austin project was being prepared by P. W. Dickerson and L. E. Garner. The usefulness of Bureau environmental geologic maps and data to the nonscientist—the home buyer, the renter, the builder, the developer—is to be emphasized in this presentation for Austin Community Television. Capital Cable Company has made time available to agencies, such as the Bureau, that want to provide information about projects and issues affecting viewers in the region. The objective of the program is to help Austin area citizens make informed choices of home and work sites and avoid costly, possibly hazardous mistakes.

**Environmental Geologic Mapping of the CAPCO (Capital Area Planning Council) Area, Central Texas.—Charles M. Woodruff, Jr., assisted by Robert C. Lentz.**

The study, begun in February 1973, includes the preparation of two maps of an area comprising Bastrop, Blanco, Burnet, Caldwell, Fayette, Hays, Lee, Llano, Travis, and Williamson Counties. The maps, constructed at a scale of 1:250,000, show physical-engineering properties and environmental geologic land capability. Explanatory and interpretative texts will accompany the maps. Preliminary drafts of both maps have been completed, and a final report is in preparation.

**Land Use and Geology—Lake Travis Vicinity, Travis and Burnet Counties, Texas.—Charles M. Woodruff, Jr.**

In this project, problems related to residential development along Lake Travis have been evaluated in terms of the geology of the area. One of the major land-use problems is the disposal of domestic wastes by means of septic tanks. A study of the underlying earth materials has pointed to the threat of pollution from this method of waste disposal.

As a part of the investigation, a series of maps, presenting physical and cultural interactions, has been prepared. The maps show general geology, physical properties, environmental geology, fracture intensity, slope, soils, soil thickness, current land use, and land-use capability (septic tank use).

The project was initiated in March 1971, and research was completed June 1973 as a Ph.D. dissertation at The University of Texas at Austin. Results of the project will be presented as a Bureau of Economic Geology publication during 1974.

**Drainage Anomalies of the Upper Nueces River in South-Central Texas.—P. J. Cannon.**

The west (West Nueces River) and east (Nueces River) forks of the upper Nueces River in the Hill Country along the southern edge of the Edwards Plateau exhibit some marked differences in drainage and physiography, although the basins of both forks have been formed in similar rock types and under similar climatic conditions. Also the vegetation and the agricultural practices are the same on both watersheds. The two forks drain almost equal areas and have the same relief. The length of the main channel of the west fork, however, is 35 percent longer than the main channel of the east fork, and the basin of the west fork has a lower drainage density. The mean annual discharge of the east fork is more than four times that of the west fork. The valley walls of the east fork generally have the steeper slopes.

The drainage anomalies are best explained by differences in geologic history and relative differences in adjustment to changes in regimen. These differences are indicated by the local physiography, knickpoints along stream channels, abandoned channels, entrenched meanders, terrace distributions, and drainage orientation. Stream piracy, occurring between the two drainage basins and within each basin, also has influenced the alteration of the regimens of both streams. Factors indicate that the east fork possibly maintains its surface discharge at the expense of the west fork.

The project is a basic one aimed at a better understanding of area hydrology and its relation to

discharge and flooding. The study was started in 1972 and will continue through 1974.

#### **Applications of Radar Imagery to the Environmental Geologic Mapping of Texas.—P. J. Cannon.**

Limited application of airborne radar imagery to environmental mapping projects in the Central Texas Hill Country and in the Coastal Zone has shown that radar imagery can be a valuable tool for preliminary compilation of environmental geologic maps and for periodic updating of completed maps. This project was undertaken in spring 1973, and will continue into spring 1974.

### **Geologic Atlas and Quadrangle Mapping**

**Geologic Atlas of Texas.—V. E. Barnes, G. K. Eifler, J. B. Brown, M. K. Pieper, and others.**

A geologic map of the State is being prepared as a series of 37 separate 1° x 2° sheets at a scale of 1:250,000; fourteen sheets of the Atlas have been published.

Geologists of the Bureau have completed field checking the Emory Peak-Presidio and San Angelo Sheets and portions of the Fort Stockton, Big Spring, and Wichita Falls-Lawton Sheets. The San Antonio, Austin, and Seguin Sheets are in press and should be available in early 1974.

Geologists who worked on the Atlas during the year include V. E. Barnes, project director; G. K.

Eifler, Jr.; L. F. Brown, Jr.; R. S. Kier; M. K. Pieper; J. B. Brown; John Gries; and A. W. Cleaves. The Geologic Atlas of Texas project is in part supported through an interagency contract with the Texas Water Development Board.

#### **Geologic Quadrangle Mapping in Llano Region of Central Texas.—V. E. Barnes and R. V. McGehee.**

This project involves the preparation of geologic maps, with accompanying texts, of areas in Blanco, Burnet, and Llano Counties. Scribing is in various stages of completion for Cap Mountain, Click, and Dunman Mountain quadrangles; color separation for the Kingsland quadrangle is complete.

### **Other Research Projects**

**Relict Paleozoic Formations of Central Texas.—V. E. Barnes, with A. J. Boucot, P. E. Cloud, Jr., and others.**

Results of this investigation of the rocks and fossils of the geologic formations, constituting the sequence from the top of the Ellenburger Group to the base of the Marble Falls Limestone, have been published from time to time as a series of separate papers. Currently, A. J. Boucot is completing a manuscript on brachiopods collected from these formations. With the publication of his report, this long-term project will be completed.

**The Moore Hollow Group of Central Texas.—V. E. Barnes and W. C. Bell.**

The manuscript concerning these Cambrian and lowermost Ordovician rocks is being edited. The text will be published by The University of Texas; supporting data, such as measured sections, will be available from University Microfilms, Ann Arbor, Michigan.

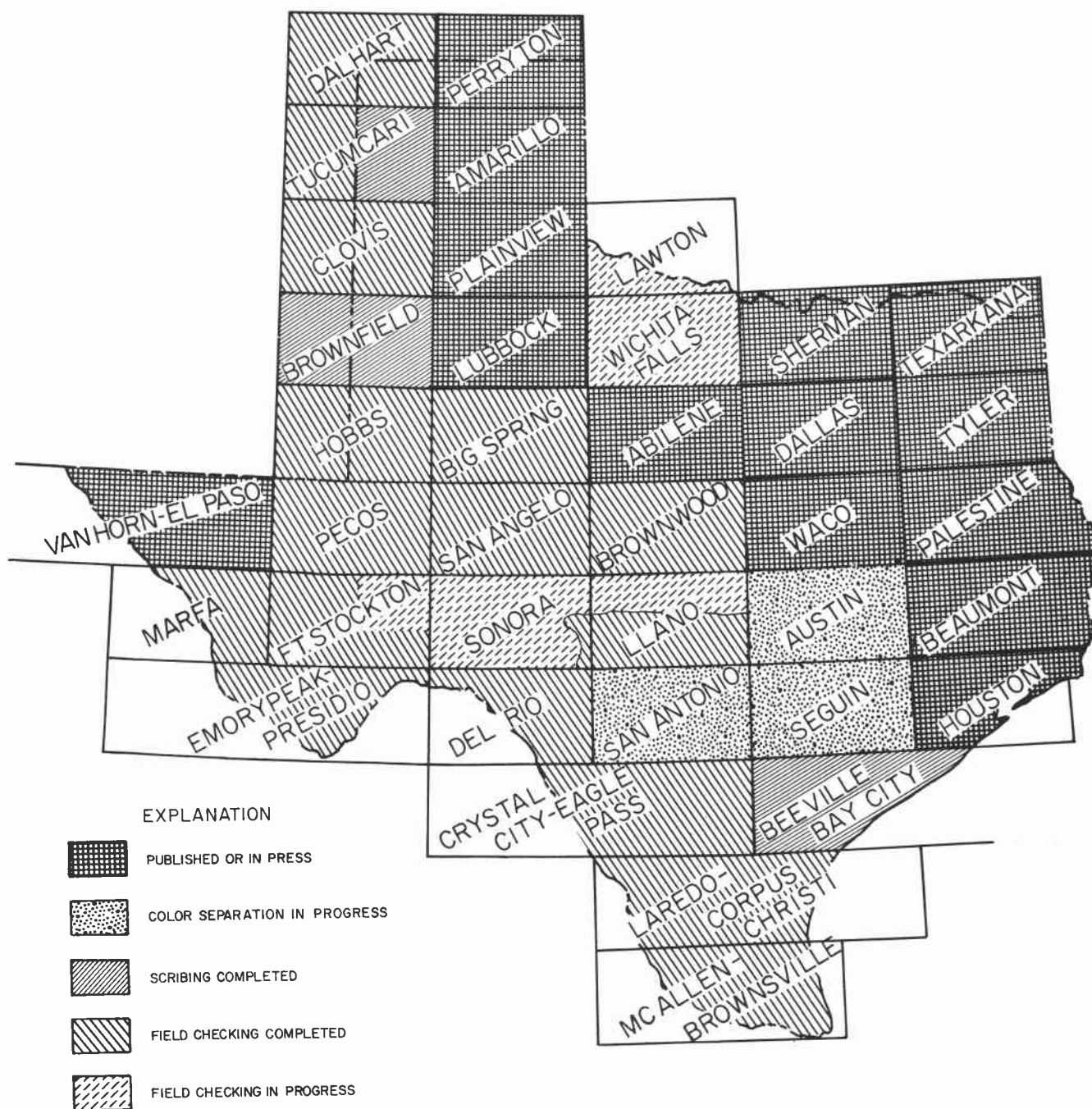
**Hydrologic Characteristics of Coastal Plain Streams.—R. A. Morton and A. C. Donaldson.**

This project is concerned with extending a previously established classification of streams to include rivers of the Texas Coastal Plain. Hydrologic data collected for the Guadalupe River, Coleta Creek (a tributary of the Guadalupe), San Antonio River, and Gum Hollow Channel have been utilized. Basic data include discharge, sinuosity, gradient, channel bottom profiles, and sediment analysis. Research has been completed, and a manuscript was in preparation during 1973.

**Paleoflow Characteristics of Ancient and Modern River Deposits.—R. A. Morton and A. C. Donaldson.**

In this project, derived paleoflow characteristics of the fluvial Grafton Sandstone (Pennsylvanian of northern West Virginia) have been compared with hydrologic characteristics of the Guadalupe River





**Current status of Texas Geologic Atlas**

of Texas. Results of the comparison indicate that the ancient Grafton fluvial system closely resembled some of the Texas coastal plain rivers. The depositional model, constructed from facies of the Guadalupe Delta and used for interpreting shallow-water deltaic sedimentation in the Appalachian Basin, now can be expanded to include the fluvial part of the depositional system. The project was initiated in 1971, and research was completed in late 1972. A manuscript describing results of the study was being written in 1973.

**Depositional Environments of the Marble Falls Formation, Central Texas.**—R. S. Kier and R. L. Zachry.

This study involves a delineation of the carbonate facies and depositional patterns present in the exposed part of the lower Marble Falls Formation. 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 will be gathered. A report on the results of this phase of a long-term study of the Lower Pennsylvanian of Central Texas was in progress during 1973.

**Depositional Models, Lower Pennsylvanian of Central Texas.**—R. S. Kier.

The purpose of this study is the development of a regional depositional model for Lower Pennsylvanian strata of Central Texas. Previous studies in eastern San Saba County and western Lampasas County will be augmented by data derived from additional field and subsurface studies of Lower Pennsylvanian strata in the area south of the Callahan Divide (West-Central Texas). The project, which is part of a long-term study, was initiated in 1968. A report on the project was in preparation during the year.

**Tektites.**—V. E. Barnes, Director of Tektite Research at The University of Texas at Austin, with Mrs. M. A. Barnes, and Kelley Kennedy.

In this project, research on tektites and natural glasses was continued under a 1973 National Science Foundation Grant.

The book *Tektites*, by V. E. Barnes and M. A. Barnes, was published in 1973 by Dowden, Hutchinson & Ross in their Benchmark series of reference books in geology.

**Bibliography and Index of Texas Geology, 1961-1972.**—Elizabeth T. Moore.

This project is a compilation, with detailed index, of publications pertaining to Texas geology. Initiated in 1973, this is a continuation of earlier bibliographies (University of Texas Bulletin 3232—Part 4, Publication 5910, and a Bureau of Economic Geology special publication, "Bibliography and Index of Texas Geology, 1951-1960").

**History of the Bureau of Economic Geology (1909-1960).**—W. K. Ferguson.

The history of the Bureau of Economic Geology, from its inception in 1909 through the directorships of W. B. Phillips, J. A. Udden, E. H. Sellards, and J. T. Lonsdale, has been assembled through analysis of official correspondence and publications of the Bureau, and through interviews with numerous individuals aware of the workings of the Bureau during its earlier years. The history is a study of the whole concept of public geologic research and the goals of that research, as well as the story of the Bureau of Economic Geology and the role of its contributions to the knowledge of the geology and resources of Texas. The 1909 to 1960 history is a sequel to Ferguson's earlier history entitled *Geology and Politics in Frontier Texas, 1845-1909*, published by The University of Texas Press. At yearend 1973, the manuscript was nearing completion.

## CONTRACTS AND GRANT SUPPORT

The Bureau of Economic Geology maintains formal and informal cooperative arrangements with several state and federal agencies. A part of the Bureau research program is supported by contracts and grants with state agencies, local units of government, and federal agencies. Contracts and grants in effect during 1973 include:

**Environmental Mapping, Inventory and Analysis of South Texas, Including the Edwards and**

**Carrizo-Wilcox Areas.**—Texas Water Development Board.

**Matagorda Bay and Environs Pilot Study.**—Texas General Land Office.

**Criteria for Coastal Zone Management.**—National Science Foundation (RANN) and Office of the Governor, Division of Planning Coordination, through The University of Texas at Austin, Division of Natural Resources and Environment.



**Environmental and Land Capability Mapping, 18-County Houston Area Test Site.**—National Aeronautics and Space Administration.

**Statewide Land Capability Mapping and Land Classification.**—Partial support from Texas Water Development Board and Division of Planning Coordination, Office of the Governor.

**Environmental and Land Capability Analysis, CAPCO.**—Partial support from Capital Area Planning Council.

**Geologic Atlas of Texas.**—Partial support from Texas Water Development Board.

## ENVIRONMENTAL GEOLOGIC MAPPING A Colloquium and Workshop

In the fall of 1973, Bureau researchers began preparations for a colloquium and workshop on environmental geologic mapping to be held on the campus of The University of Texas at Austin, May 13-14, 1974. Through mapping of environmental geology and land and water resources of the past ten years, the staff has a broad experience in varied climatic, physiographic, and geographic subdivisions of the State. The colloquium and workshop will emphasize philosophies, concepts, experiences, and procedures derived from coping with many different surroundings. Examples will include results and work in progress in: flat, rolling, and steep slopes; igneous-metamorphic, carbonate and sandstone-mudstone bedrocks; coastal, fluvial, eolian, and ground-water recharge processes; arid, semiarid, temperate-humid and subtropical climates; desert, prairie, forest and wetland floras; cities, seaports, recreational and rangeland land uses; and others.

The meetings will have workshop areas and presentation of sixteen papers on methods of mapping, interpreting, and displaying environmental geologic data on the following subjects. A Report of Investigations will include the tentative titles:

1. Environmental Geology at the Bureau of Economic Geology: Applications in Texas. W. L. Fisher
2. Environmental Inventory: Innovations in Geology and Geologic Presentation. L. F. Brown, Jr.
3. Environmental Studies in Coastal Areas: Case Study—Texas Coastal Zone. L. F. Brown, Jr.
4. Environmental Units in Carbonate Terranes as Developed from a Case Study of the Southern Edwards Plateau and Adjacent Interior Coastal Plain. E. G. Wermund
5. Environmental Geology—An Aid to Urban Planning: Austin Area, Texas. L. E. Garner
6. Environmental Studies about Metropolitan Seaports: Case Study—Houston Area. C. V. Proctor, Jr.
7. Preliminary Environmental Geologic Mapping on the Inner Coastal Plain, Southwest Texas. T. C. Gustavson and P. J. Cannon
8. Shoreline Changes in the Matagorda Bay Area: A Function of Natural Processes and Man's Activities. J. H. McGowen
9. Environmental Geology and Lakeshore Development. C. M. Woodruff, Jr.
10. Delineation and Environmental Application of Active Processes Mapped in Recharge Area of the Edwards Aquifer. R. A. Morton
11. The Application of Radar Imagery to Environmental Geologic Mapping. P. J. Cannon
12. Adapting Biologic Assemblage Data for Environmental Needs. E. G. Wermund and Claudia True Waddell
13. Quantification of Resource Capability Units: Corpus Christi Area. R. S. Kier
14. Statewide Mapping of Open-Pit Mining Operations: Case Study—A Texas Inventory. C. G. Groat
15. Environmental Geologic Mapping of Flood-Prone Areas: An Alternative to Engineering Methods. E. J. Dickerson
16. Texas Statewide Resource Capability Mapping and Inventory. R. S. Kier

## CONTINUING EDUCATION AND UNIVERSITY TEACHING

Data gathered in the course of Bureau research are disseminated not only through publications but also in short courses and in scheduled university teaching. During 1973, four Bureau staff members taught or participated in courses of the Department of Geological Sciences: L. F. Brown, Jr., W. L. Fisher, and J. H. McGowen participated in Terrigenous Depositional Systems (Geology 383); C. G. Groat taught Mineral Resources and Environmental Geology (Geology 362K); and J. H. McGowen participated in Coastal Geology (Geology 392C). In addition to teaching duties, L. F. Brown, Jr., is supervising graduate studies at the master's (two students) and doctoral (three students) levels; W. L. Fisher is supervising studies

of three students at the master's and two at the doctoral levels; and C. G. Groat is supervising five master's-level studies.

In the area of continuing education, L. F. Brown, Jr., W. L. Fisher, and A. J. Scott presented the short course, Delta Systems in the Exploration for Oil and Gas, to the Wyoming Geological Society in Casper and at the Permian Basin Graduate Center in Midland, Texas. W. L. Fisher participated in the Continuing Education Program of the American Association of Petroleum Geologists.

Bureau staff members also presented invited lectures during the year to professional societies, university groups, private groups, and state, federal, and local governmental bodies.

## PUBLIC SERVICE

The Bureau of Economic Geology provides numerous services to the public. One service is to disseminate information concerning mineral and land resources and other aspects of the geology of Texas to individuals, companies, and governmental agencies.

Much of the geologic data developed through Bureau research projects is available as published maps and reports. In addition, the Bureau serves as a public inquiries office. Each year, the Bureau responds to individual requests for information, received both by letter and telephone, and from visitors. During 1973, many members of the Bureau staff provided direct assistance—by conference and by correspondence—to geologists, engineers, students, tourists, realtors, industrialists, prospectors, rock and mineral collectors, and many other people. Staff members who spent a large part of their time in such public services are L. E. Garner, who examined rock and mineral specimens submitted to the Bureau for identification, and

Roselle Girard, who replied to hundreds of requests for information about Texas geology and mineral resources.

Other public services of the Bureau include preliminary testing and evaluation of selected industrial rocks and minerals at the Mineral Studies Laboratory—D. A. Schofield, Chemist-in-Charge. Also, the Bureau's Well Sample and Core Library continues to provide facilities for geologists and others to examine and study subsurface materials from Texas wells.

The Bureau provides a public Reading Room that contains publications pertaining to Texas geology and natural resources. Located on the fifth floor of the Geology Building on the Main Campus of The University of Texas at Austin, the Reading Room is open to the public Monday through Friday from 8:00 a.m. to 5:00 p.m. In addition, work maps, sections, and data developed in ongoing research projects are available for examination at the Bureau's main office.

## WELL SAMPLE AND CORE LIBRARY

The Well Sample and Core Library is a depository for rock cuttings and cores obtained from the drilling of oil and gas wells, dry holes, engineering test borings, and water wells. Rock materials from every county in Texas are included in the collections. The Library currently has on file cuttings from 61,000 wells and cores from 1,452 wells.

These materials were presented to The University of Texas at Austin by companies, government agencies, and individuals.

During 1973, additional cores were acquired by the Library. Belco Petroleum Company contributed cores from two wells—one in Kerr County and one in Maverick County; the Texas Water Develop-

ment Board provided cores from a well in Medina County; and Tesoro Petroleum Company donated a core from one well in Webb County.

Cores of Edwards Limestone from three wells in the Stuart City Trend also were acquired in 1973. Exxon Company, U. S. A. donated one of the cores, which came from a well in McMullen County, and Tenneco Oil Company provided cores from two wells in Live Oak County.

The cuttings and cores are sources of basic information about the composition and structure of the subsurface rocks of Texas. Geologists study

them in the exploration for oil, gas, uranium, and other economic mineral deposits. They also use them in environmental land-use studies, including the determination of potential waste-disposal and construction sites.

The Library, located in Building 18-B at Balcones Research Center, is open for public use Monday through Friday from 8:00 a.m. to 5:00 p.m. W. R. Stearns is Supervisory Geologist; Marce L. Morrow is Administrative Clerk-in-Charge; and Harry J. Madsen is Technical Staff Assistant at the Library.

## MINERAL STUDIES LABORATORY

The Bureau's Mineral Studies Laboratory is located in Balcones Research Center near the northwest edge of Austin. Its chief functions are the performance of chemical and spectrographic analysis and the physical testing of Texas rocks and minerals. Most of the activities are in support of research studies of the Bureau of Economic Geology, although work also is performed for various departments of The University of Texas at Austin, Texas state agencies, and Texas residents.

During 1973, a large portion of the Laboratory's activities focused on the Matagorda Bay and Environs project. Work for the project included the determination of percentage of organic carbon, by wet oxidation, in 800 samples of wet sediments. In addition, almost 200 of the samples required preparation of slides for observation of oriented X-ray diffraction patterns.

Another Bureau project, Dr. C. G. Groat's regional geologic and geochemical study of Trans-Pecos Texas, required complete chemical and spectrochemical analysis of six silicate rocks in order to determine major, minor, and trace elements. The project also required determination of organic carbon and qualitative spectrographic analysis of six samples of wet sediments in addition to semiquantitative spectrographic analysis of a cave deposit.

Other work performed by the Laboratory in support of Bureau of Economic Geology projects included chemical and spectrochemical analysis of Libyan desert sand and glass for Dr. Virgil E. Barnes' tektite studies, and the determination of the percentage of copper present in 26 samples of North Texas red beds for Dr. L. F. Brown, Jr.

Another function of the Laboratory is to process samples submitted to the Bureau of Economic Geology by Texas residents. Work on such samples involved evaluation of brick clays, qualitative and semiquantitative spectrographic analysis of a great variety of Texas rocks, and preparation of slides for the observation of oriented X-ray diffraction patterns.

In addition to work directly related to Bureau of Economic Geology activities, the Laboratory analyzed samples of archeological ceramic glazes, ceramic bodies, and kiln roofs from several Texas sites for the Archeological Laboratory of the Texas Historical Commission. Each sample was analyzed spectrographically for the presence or absence of 49 elements. The Laboratory then performed quantitative determination of a few minor and trace elements in order to correlate origin and composition. Also during the year, the Department of Geological Sciences of The University of Texas at Austin utilized the crushing, grinding, and pulverizing facilities of the Laboratory in the preparation of more than a hundred samples of rocks.

Daniel A. Schofield is Chemist-in-Charge of the Mineral Studies Laboratory, and Allen Wayne Nichols and Bill Ed Weldon are part-time laboratory assistants. J. Tom Etheredge held the position of Chemist at the Laboratory from September 1964, until he resigned in March 1973, to become a partner in a commercial firm, D & E General Contractors, Austin. Mr. Etheredge, a graduate of Southwest Texas State University, rendered almost ten years of excellent service at the Mineral Studies Laboratory.

## SHIPMAN ELECTED PRESIDENT OF TEXAS AIPG SECTION FOR 1974

Ross L. Shipman, Research Program Manager for the Division of Natural Resources and Environment and the Bureau of Economic Geology, has been elected President of the Texas Section of the American Institute of Professional Geologists.

The AIPG represents the business and professional aspects of the practice of geology. Members are certified after meeting stringent educational and ethical standards over a minimum practice of eight years in the profession.

## FISHER APPOINTED TO COASTAL ZONE MANAGEMENT ADVISORY COMMITTEE

Dr. William L. Fisher, Director of the Bureau of Economic Geology, was appointed to the Coastal Zone Management Advisory Committee, U. S. Department of Commerce. In making the announcement, Congressman J. J. Pickle said that Dr. Fisher and 14 other prominent scholars on coastal resources were selected by Secretary of

Commerce Frederick Dent from more than two hundred nominees.

The Committee, authorized by a new law providing federal assistance to state coastal management programs, will make broad recommendations on conservation, development, and protection of the Nation's coastal lands.

## STAFF ACTIVITIES

### Meetings Attended

Staff members represented the Bureau of Economic Geology at numerous scientific and professional meetings in 1973. Principal meetings attended during the year include:

American Association for the Advancement of Science, Annual Meeting, Mexico, D. F., Mexico—E. G. Wermund

American Association of Petroleum Geologists, Annual Meeting, Anaheim, California—D. G. Bebout, L. F. Brown, Jr.

American Association of Petroleum Geologists, Southwest Section, Annual Meeting, Fort Worth, Texas—R. S. Kier, R. L. Shipman

American Commission on Stratigraphic Nomenclature, Meeting, Dallas, Texas—V. E. Barnes

American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), Annual Meeting, Chicago, Illinois—C. G. Groat

American Institute of Professional Geologists, Annual Meeting, New Orleans, Louisiana—R. L. Shipman

American Institute of Professional Geologists, Texas Section, Annual Meeting, Houston, Texas—R. L. Shipman

American Society of Photogrammetry, Annual Meeting, Washington, D. C.—C. G. Groat, J. W. Macon

Association of American State Geologists, Annual Meeting, Atlanta, Georgia—L. F. Brown, Jr., W. L. Fisher; Meeting, Dallas, Texas—W. L. Fisher, C. G. Groat

Association of Earth Science Editors, Annual Meeting, Ottawa, Ontario, Canada—P. W. Dickerson

Capital Area Planning Council (CAPCO), General Assembly, Austin, Texas—C. M. Woodruff, Jr.

Coastal Dynamics, Technical Session, sponsored by Office of Naval Research, Virginia Beach, Virginia—T. C. Gustavson

Environmental Education Symposium, sponsored by Texas Education Agency and Institute for Advanced Environmental Studies, Austin, Texas—C. M. Woodruff, Jr.

**Environmental Problems in the Extractive Industries, Workshop**, Wright State University, Dayton, Ohio—C. G. Groat

**Geological Society of America, Annual Meeting**, Dallas, Texas—V. E. Barnes, L. F. Brown, Jr., P. J. Cannon, P. W. Dickerson, L. W. Epps, T. J. Evans, W. L. Fisher, C. G. Groat, T. C. Gustavson, W. R. Kaiser, R. S. Kier, C. W. Kreitler, J. W. Macon, J. H. McGowen, R. A. Morton, R. L. Shipman, E. G. Wermund, C. M. Woodruff, Jr.

**Geological Society of America, Northeastern Section, Annual Meeting**, Allentown, Pennsylvania—T. C. Gustavson

**Geological Society of America, Penrose Conference on Earth Sciences and Environmental Decision Making**, Vail, Colorado—W. L. Fisher

**Geological Society of America, Penrose Conference on Water and Carbonate Rocks**, Vail, Colorado—C. W. Kreitler

**Geological Society of America, South-Central Section, Annual Meeting**, Little Rock, Arkansas—P. J. Cannon, R. S. Kier

**Geological Society of America, Southeastern Section, Annual Meeting**, Knoxville, Tennessee—L. F. Brown, Jr.

**Governor's Intergovernmental Relations Conference**, Houston, Texas—W. L. Fisher, R. L. Shipman

**Governor's Remote-Sensing Task Force, Meeting**, Austin, Texas—P. J. Cannon, R. L. Shipman, E. G. Wermund

**Growth with Environmental Quality?**, National Forum, sponsored by U. S. Environmental Protection Agency and Tulsa Chamber of Commerce, Tulsa, Oklahoma—R. L. Shipman

**Gulf Coast Association of Geological Societies, Annual Meeting**, Houston, Texas—V. E. Barnes, D. G. Bebout, W. L. Fisher, J. W. Macon, R. L. Shipman

**Implications of Nuclear Power in Texas**, Conference, sponsored by College of Engineering of The University of Texas at Austin, in cooperation with the College of Business Administration, the

College of Natural Sciences, and the Lyndon B. Johnson School of Public Affairs—L. F. Brown, Jr., W. L. Fisher, R. L. Shipman

**International Symposium on Salt, Fourth**, sponsored by Northern Ohio Geological Society (Cleveland), Houston, Texas—D. G. Bebout

**Land-Use Planning, Meeting**, sponsored by Governor's Planning Division and the University of Mississippi, Jackson, Mississippi—L. F. Brown, Jr.

**National Land-Use Classification System, Workshop**, sponsored by U. S. Geological Survey, Denver, Colorado—E. G. Wermund

**National Speleological Society, Annual Meeting**, University of Indiana, Bloomington, Indiana—D. E. Deal

**Reclaiming Surface-Mined Land for Outdoor Recreation, Regional Conference**, sponsored by U. S. Bureau of Outdoor Recreation, University of New Mexico, Albuquerque, New Mexico—C. G. Groat

**Remote Sensing of Earth Resources, 2d Annual Conference**, University of Tennessee Space Institute, Tullahoma, Tennessee—P. J. Cannon, C. M. Woodruff, Jr.

**Rio Bravo Resource Conservation and Development Project, Conference**, Rio Grande City, Texas—L. E. Garner, R. L. Shipman

**Sigma Gamma Epsilon (National geology fraternity), Annual Meeting**, The University of Texas at Arlington, Arlington, Texas—L. F. Brown, Jr.

**Society of Exploration Geophysicists and Asociacion Mexicana de Geofisicos de Exploracion, Joint Annual Meeting**, Mexico, D. F., Mexico—E. J. Dickerson

**Society of Independent Professional Earth Scientists, Annual Meeting**, New Orleans, Louisiana—W. L. Fisher

**Soil Survey Technical Work-Planning Conference**, Texas A&M University, College Station, Texas—L. E. Garner

**Texas Academy of Science, Annual Meeting**, University of Houston, Houston, Texas—L. W. Epps, L. E. Garner, J. H. McGowen, R. A. Morton, C. V. Proctor, Jr.

**Texas Advisory Committee on Conservation Education, Meetings, Austin, Texas—W. L. Fisher; Brownsville, Texas—W. L. Fisher, C. M. Woodruff, Jr.**

**Texas Antiquities Committee Artifact Recovery Project, Conference, Port Mansfield, Texas—R. L. Shipman**

**Texas Council on Marine Related Affairs, Meeting, Padre Island, Texas—R. L. Shipman**

**Underground Waste Management and Artificial Recharge, Symposium, sponsored by American Association of Petroleum Geologists, United States Geological Survey, and International Association of Hydrologic Scientists, New Orleans, Louisiana—W. R. Kaiser**

#### **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. These are given both within the State and throughout North America, and nearly all are presented by invitation. Lectures are given to a wide audience, including professional societies, universities, and federal, state, and local units of government.

Although the prime means of disseminating the results of Bureau research is through publication, formal and informal lectures as well as sponsored research colloquia are an important means of presenting the results of Bureau research prior to final publication.

Following are lectures given by Bureau staff members during 1973:

##### **V. E. Barnes**

—**Tektites:** presented before Geology Club, West Texas State University, Canyon, Texas.

—**Impact structures:** presented before Class in Petrology, West Texas State University, Canyon, Texas.

##### **D. G. Bebout**

—**Anhydrite facies and environments—their role in reconstructing the geologic history of the Middle Devonian Elk Point Basin, Alberta:** presented at American Association of Petroleum Geologists, Annual Meeting, Anaheim, California.

—**Golden Lane, Mexico, and Stuart City Trend, South Texas—a comparison:** presented at Austin Geological Society, Luncheon Meeting, Austin,

Texas; and Houston Geological Society, Luncheon Meeting, Houston, Texas.

—**Golden Lane and Poza Rica Trend, Mexico—an alternate interpretation:** presented at South Texas Geological Society, Luncheon Meeting, San Antonio, Texas.

—**Stuart City Trend, South Texas—environments and diagenesis:** presented at South Texas Geological Society, Luncheon Meeting, San Antonio, Texas.

##### **J. L. Brewton**

—**Texas mineral resources, exclusive of oil and gas:** presented at Environmental Education Workshop, sponsored by Texas Education Agency and Texas A&I University, Kingsville, Texas.

##### **L. F. Brown, Jr.**

—**An evaluation of geologic analysis for environmental planning in Texas:** presented at Symposium on Resource Development and Environmental Conservation, Alaska Geological Society, Anchorage, Alaska.

—**Delta systems in the exploration for oil and gas:** Bureau of Economic Geology Research Colloquium presented at Permian Basin Graduate Center, Midland, Texas; and before Wyoming Geological Association, Casper, Wyoming.

—**Depositional systems in cratonic basins:** presented as a Distinguished Lecture of the American Association of Petroleum Geologists at Panhandle Geological Society, Meeting, Amarillo, Texas.

—**Depositional systems in the West Texas Basin:** presented at Department of Geological Sciences, The University of Texas at El Paso, El Paso, Texas.

—**Developing an environmental program in Mississippi:** presented at meeting sponsored by the Governor's Planning Division and the University of Mississippi, Jackson, Mississippi.

—**Environmental geology:** presented at Sigma Gamma Epsilon (National geological fraternity), Annual Meeting, Banquet, Arlington, Texas; and, as a Distinguished Lecture of the American Association of Petroleum Geologists, at Department of Geosciences, Texas Tech University, Lubbock, Texas.

—**Environmental geology and land management:** keynote address presented at Geological Society of America, Southeastern Section, Annual Meeting, Knoxville, Tennessee.

##### **P. J. Cannon**

—**Environmental geologic mapping of parts of Texas:** presented before Graduate Class in Envi-

ronmental Geology, the University of Oklahoma, Norman, Oklahoma.

—**Quantitative expressions of stream adjustment:** presented at Geological Society of America, Annual Meeting, Dallas, Texas.

—**Space-age geology:** presented before Alumni and Graduating Seniors, Tecumseh High School, Tecumseh, Oklahoma.

—**The analysis of radar and infrared imagery:** presented at Remote Sensing Task Force of the Interagency Council on Natural Resources and the Environment, Workshop, Austin, Texas.

—**The application of radar and infrared imagery to quantitative geomorphic investigations:** presented at Remote Sensing of Earth Resources 2d Annual Conference, University of Tennessee Space Institute, Tullahoma, Tennessee; and at Technical Session, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

—**The generation of explicit parameters for quantitative geomorphic investigations:** presented at Geological Society of America, South-Central Section, Annual Meeting, Little Rock, Arkansas.

—**The mineral industry of Texas, exclusive of oil and gas:** presented at Environmental Education Workshop, sponsored by Texas Education Agency and Abilene Christian College, Abilene, Texas.

#### **D. E. Deal**

—**Engineering geology in glaciated areas:** presented before Class in Ocean Engineering Short Course, College of Engineering, The University of Texas at Austin, Austin, Texas.

#### **E. J. Dickerson**

—**Mineral resources of Texas, exclusive of oil and gas:** presented at Environmental Education Workshop, sponsored by Texas Education Agency and The University of Texas at El Paso, El Paso, Texas.

#### **L. W. Epps**

—**Some implications of the Brazos River history:** presented at Texas Academy of Science, Annual Meeting, University of Houston, Houston, Texas.

—**Origin of plutonic rocks:** presented at Twin Mountain Gem and Mineral Society, Meeting, San Angelo, Texas.

#### **W. L. Fisher**

—**Analysis of land and water carrying capacity:** presented to the Water Resources Committee, Gulf Coast Council, Corpus Christi, Texas.

—**An inventory for land-use planning:** presented to League of Women Voters of Houston, Houston, Texas.

—**Clastic depositional systems—a genetic approach to facies analysis:** presented to Permian Basin Graduate Center Symposium, Midland, Texas; and Rocky Mountain Association of Geologists, Denver, Colorado [as a lecture of the American Association of Petroleum Geologists Continuing Education Lecture Series]; and to the Wyoming Geological Association, Casper, Wyoming.

—**Deltaic and related depositional systems of the Texas Gulf Coast Basin:** presented to Tulsa Geological Society, Bartlesville, Oklahoma.

—**Depositional systems—a genetic approach to facies analysis in mineral exploration:** presented as a lecture of the Southern Illinois University Visiting Lecture Series, at Southern Illinois University, Carbondale, Illinois.

—**Environmental carrying capacity—a geologic basis for management in the Texas Coastal Zone:** presented to symposium on Geology and Management in the Coastal Zone, Geological Society of America, Annual Meeting, Dallas, Texas.

—**Environmental geology of the Texas Coastal Zone:** presented as a lecture of the Southern Illinois University Visiting Lecture Series, at Southern Illinois University, Carbondale, Illinois.

—**Geologic projection in the management of lands and environmental resources:** presented as a lecture of the Southern Illinois University Visiting Lecture Series, at Southern Illinois University, Carbondale, Illinois.

—**Geology in environmental decision making:** presented to Geological Society of America, Penrose Conference on Earth Sciences and Environmental Decision Making, Vail, Colorado.

—**Land inventory and management in Texas:** presented to The Eighth Annual Governor's Conference on Intergovernmental Relations and Regional Planning, Houston, Texas.

—**Land resources inventory in Texas:** presented to the Land Resource Management Advisory Committee, Interagency Council on Natural Resources and the Environment, Austin, Texas.

—**Land-surface subsidence in the Texas Coastal Zone:** presented to Committee on Natural Resources, Texas House of Representatives, Austin, Texas; and to Council on Marine Related Affairs, Austin, Texas.

—**Land-use problems and status of land inventory program in Texas:** presented to the Local Government and Urban Affairs Subcommittees of

Intergovernmental Affairs Committee, Texas House of Representatives, Austin, Texas.

—**Lignite resource and utilization:** presented to City of Austin, Energy Study Committee, Austin, Texas.

—**Models of deposition—principal clastic systems:** presented as a lecture of the Southern Illinois University Visiting Lecture Series, at Southern Illinois University, Carbondale, Illinois.

—**Public geological research in Texas:** presented to Department of Geology, The University of Texas at Arlington, Arlington, Texas.

—**Resource use and environmental quality—toward a rational policy:** presented to the Environmental Education Workshop, Education Service Center, Region XIII, Austin, Texas.

—**Role of earth scientists in environmental protection:** presented to Society of Independent Professional Earth Scientists, Annual Meeting, New Orleans, Louisiana.

—**Scientific training in marine resources:** presented to Student Conference on Marine Affairs, Texas A&M University, Galveston, Texas.

—**The coast of Texas:** presented to Management of Natural Resources, Texas Federation of Women's Clubs, Austin, Texas.

—**The relation of land and water resources in the Texas Gulf Coast area:** presented to the Water Resources Committee, Gulf Coast Council, Houston, Texas.

—**The role of public geological research in Texas:** presented to the West Texas Geological Society, Midland, Texas.

—**The structure of research in the university and state government:** presented to The National Council of University Research Administrators, Region V, Austin, Texas.

—**The Texas barrier island dunes—their characteristics and role in coastal protection:** presented to Committee on Natural Resources, Texas Senate, Austin, Texas.

#### L. E. Garner

—**Mineral resources of Texas:** presented at Environmental Education Workshop, sponsored by Texas Education Agency and Midwestern University, Wichita Falls, Texas.

—**Processes and sediments of the lower Colorado River:** presented at Texas Academy of Science, Annual Meeting, University of Houston, Houston, Texas.

—**Projects and progress of the Bureau of Economic Geology:** presented at Soil Survey Technical Work-Planning Conference, Texas A&M University, College Station, Texas.

#### C. G. Groat

—**Environmental mapping in the Texas Coastal Zone:** presented at American Society of Photogrammetry, Annual Meeting, Washington, D. C.

—**Holocene faulting and subsidence in the Texas Coastal Zone:** presented at Geological Society of America, Annual Meeting, Dallas, Texas.

—**Surface mining in Texas: inventory and environmental effects:** presented at American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), Corpus Christi Mineral Subsection, Meeting, Corpus Christi, Texas.

#### T. C. Gustavson

—**Fluvial and lacustrine sedimentation in the glacial environment:** presented at Indiana State University, Terre Haute, Indiana; and Brooklyn College of The City University of New York, New York, N. Y.

#### W. R. Kaiser

—**Mineral resources of Texas, exclusive of oil and gas:** presented at Environmental Education Workshop, sponsored by Texas Education Agency and West Texas State University, Canyon, Texas.

#### R. S. Kier

—**Carbonate deposition of the lower part of the Marble Falls Formation, Central Texas:** presented before Geological Society of America, South-Central Section, Annual Meeting, Little Rock, Arkansas.

—**Description of Bureau of Economic Geology environmental geology program:** presented before visiting Russian scientists on tour with staff of U. S. Environmental Protection Agency, Houston, Texas.

—**Results of Bureau of Economic Geology investigations in the Corpus Christi area:** presented at Southwestern Center for Urban Research, Houston, Texas; and at the Executive Office of the Coastal Bend Council of Governments, Corpus Christi, Texas.

#### C. W. Kreitler

—**Nitrogen isotope ratios: a new technique for determining the source of nitrate in ground water:** presented at Geological Society of America, Annual Meeting, Dallas, Texas; and at Technical Session, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

#### R. A. Morton

—**Hydrologic characteristics of the lower reaches of the Guadalupe River:** presented at Texas



Academy of Science, Annual Meeting, University of Houston, Houston, Texas.

—The Guadalupe Delta—a model for shallow-water delatation: presented at Corpus Christi Geological Society, Meeting, Corpus Christi, Texas.

C. V. Proctor, Jr.

—Depositional systems of Pleistocene deposits, northeastern Gulf Coast, Texas: presented at Texas Academy of Science, Annual Meeting, Houston, Texas.

R. L. Shipman

—Politics and the geoscientist in the environmental decade: presented at American Association of Petroleum Geologists, Southwest Section, Annual Meeting, Fort Worth, Texas.

—The legislature and environmental problems: presented before Graduate Class in Environmental Geology, The University of Texas at Austin, Austin, Texas.

E. G. Wermund

—Additions to the Texas Water Development Board Edwards aquifer model from Bureau of Economic Geology environmental mapping: presented at Texas Water Development Board, Staff Meeting, Austin, Texas.

—Conduits in the Edwards Limestone recharge and aquifer beds: presented at Geological Society of America, Annual Meeting, Dallas, Texas.

—Interpreting remote sensing imagery: presented at Remote Sensing Task Force of the Interagency Council on Natural Resources and the Environment, Workshop, Austin, Texas.

—Lineation or fracture system mapping from aerial photography of the Edwards Plateau: presented before geologists of the Texas Water Development Board, Austin, Texas.

—Resource capability units in carbonate terranes: presented before Graduate Seminar on Environment, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

—The Edwards Limestone aquifer system: presented to the Texas Water Development Board, Austin, Texas.

C. M. Woodruff, Jr.

—Geologic factors related to land use in a predominantly crystalline-rock terrane: presented at Geological Society of America, Annual Meeting, Dallas, Texas.

—Mineral resources of Texas: presented at Environmental Education Workshop, sponsored by

Texas Education Agency and East Texas State University, Commerce, Texas.

—Planning for the future—environmental mapping: presented before Capital Area Planning Council, General Assembly, Austin, Texas.

—Septic tanks in the Lake Travis vicinity: a case study in land-use capability: presented at Technical Session, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

### Legislative Committee Hearings

Council on Marine Related Affairs, Senator A. R. Schwartz, Chairman: Austin—W. L. Fisher (testimony given).

Texas Senate, Administration Committee, Senator Jack Hightower, Chairman: Austin—C. G. Groat (testimony given on establishment of Joint Interim Surface-Mining Committee).

Texas Senate and Office of Lieutenant Governor, Gulf Coast Subcommittee of Water Resources Committee, Senator William N. Patman, Chairman: Corpus Christi and Houston—W. L. Fisher (testimony given).

Texas Senate, Natural Resources Committee, Senator Max Sherman, Chairman: Austin—W. L. Fisher (testimony given); R. L. Shipman (Water Resources Hearing).

Texas Senate, State Affairs Committee, Senator William T. Moore, Chairman: Austin—C. G. Groat (testimony given on coal strip-mining bill).

Texas House of Representatives, Committee on Natural Resources, Representative Gibson D. Lewis, Chairman: Austin—W. L. Fisher (testimony given).

Texas House of Representatives, Subcommittee of Committee on Natural Resources, Representative Dan Kubiak, Chairman: Austin—C. G. Groat (testimony given on establishment of Joint Interim Surface-Mining Committee).

Texas House of Representatives, Local Government and Urban Affairs Subcommittees of Intergovernmental Affairs Committee, Representatives Ray Hutchinson and Lyndon Olson, Jr., Chairmen: Austin—W. L. Fisher (testimony given).

## Committee Service and Offices

**V. E. Barnes**

—American Commission on Stratigraphic Nomenclature: Member representing Association of American State Geologists.

**L. F. Brown, Jr.**

—American Association of Petroleum Geologists: National Committee on Environment; and Program Committee for 1974 Annual Meeting.

—Interagency Council on Natural Resources and the Environment: Land Resource Management Advisory Committee.

**P. J. Cannon**

—Austin Geological Society: Entertainment Committee, 1973-1974.

**D. E. Deal**

—American Association for the Advancement of Science: Section Committee on Geology and Geography, member representing the National Speleological Society.

—National Speleological Society: Board of Directors.

**P. W. Dickerson**

—Association of Earth Science Editors: Board of Directors; and Secretary-Treasurer.

—Houston Geological Society: Academic Liaison Committee.

—The University of Texas at Austin: Department of Geological Sciences—Bureau of Economic Geology Library Committee, member representing Bureau of Economic Geology.

**W. L. Fisher**

—American Association of Petroleum Geologists: House of Delegates, alternate representative of the Austin Geological Society; and Technical Editor, 1974 Annual Meeting.

—American Institute of Professional Geologists: Environmental Geology Committee, Chairman.

—Association of American State Geologists: Environmental Geology Committee, Chairman; and Governmental Liaison Committee; and Offshore Drilling Committee.

—Austin Chamber of Commerce: Energy Information Committee.

—Austin Geological Society: President, 1973-1974; and Program Committee, Chairman, 1972-1973.

—Council for Agricultural Science and Technology: Task Force on Zero Concepts, 1973-1974.

—Geological Society of America: Committee on Environment and Public Policy.

—Interagency Council on Natural Resources and the Environment.

—Texas A&M University: Sea Grant Advisory Council.

—Texas Advisory Committee on Conservation Education: Chairman.

—Texas Mapping Advisory Committee.

—The University of Kansas: Geology Associates, Advisory Board.

—The University of Texas at Austin: Center for Research in Water Resources, Advisory Committee; and Energy Research Group; and Faculty Committee on Publications, Chairman; and Geology Foundation, Executive Committee; and Marine Science Institute, Search Committee.

—U. S. Department of Commerce: Coastal Zone Management Advisory Committee.

**R. M. Girard**

—Austin Geological Society: Publications Committee, 1972-1973, 1973-1974.

**C. G. Groat**

—Austin Geological Society: Nominating Committee, 1973-1974.

—Interagency Council on Natural Resources and the Environment: Problems and Issues Subcommittee of the Land Resource Management Advisory Committee.

—The University of Texas at Austin: Department of Geological Sciences Awards Committee; and Energy Research Group; and Energy Data Base Subcommittee of Energy Research Group.

**R. S. Kier**

—Interagency Council on Natural Resources and the Environment: Subcommittee on Flood Control and Floodplain Management.

**L. J. McVey**

—Association of Earth Science Editors: Committee on Reference Citations.

—Austin Geological Society: Treasurer, (Fall) 1973.

**R. L. Shipman**

—American Association of Petroleum Geologists: House of Delegates, representing the Austin Geological Society.

—American Institute of Professional Geologists: National Advisory Board, 1973; and Texas Section, President-elect, 1973; and State Executive Committee, 1973; and State Legislative and Governmental Committee, 1973.

—Austin Geological Society: Secretary, 1972-1973.

—Geological Society of America: Head Teller and Inspector of Election, 1973.

—Interagency Council on Natural Resources and the Environment: Alternate Representative of The University of Texas at Austin.

—Remote Sensing Task Force of the Interagency Council on Natural Resources and the Environment: Alternate Representative of The University of Texas at Austin.

—The University of Texas at Austin: Joint Council on University and State Relations.

#### A. E. St. Clair

—Austin Geological Society: Treasurer, (December) 1973-1974.

#### E. G. Wermund

—Interagency Council on Natural Resources and the Environment: Task Force on Remote Sensing; and Subcommittee [of Task Force on Remote Sensing] to Write the Texas Remote Sensing Plan, Chairman; and Task Force on Texas Natural Resources Information System.

—The University of Texas at Austin and Austin Area Council of Governments (AACOG) Recharge Zone Proposal: Interdisciplinary Committee.

### Other Professional Responsibilities

#### V. E. Barnes

—Consultation with Texas Ecological Panel concerning erosional implications of U. S. Navy's proposed Project Sanguine.

#### L. F. Brown, Jr.

—American Association of Petroleum Geologists Distinguished Lecturer, Spring 1973.

—Chairman of Field Trip Committee (Coal Division) of Geological Society of America, 1973 Annual Meeting.

—Co-chairman of symposium, "Geology and Management in the Coastal Zone: Area Perspectives," Geological Society of America, Annual Meeting, Dallas, Texas.

—Leader (with A. W. Cleaves and A. W. Erxleben) of Geological Society of America Field Trip (Coal Division), "Pennsylvanian Depositional

Systems in North-Central Texas—A Guide for Interpreting Terrigenous Clastic Facies in a Cratonic Basin," 1973 Annual Meeting.

—Organizer of "Symposium on Delta Systems: Significance of Stratigraphy and Facies in Exploration," for American Association of Petroleum Geologists, 1974 Annual Meeting to be held in San Antonio, Texas.

#### P. J. Cannon

—Represented Bureau of Economic Geology on Council for Advanced Transportation Studies, Division of Research, The University of Texas at Austin.

#### P. W. Dickerson

—Assisted Field Trip Committee of Geological Society of America, 1973 Annual Meeting.

—Compiled bibliography of North American geological society publications (to be issued as Geological Information Library of Dallas Publication No. 1).

—Technical editing of abstracts for American Association of Petroleum Geologists, 1974 Annual Meeting.

#### L. W. Epps

—Co-chairman of "Texas River Symposium," Texas Academy of Science, Annual Meeting, Houston, Texas.

#### W. L. Fisher

—Co-chairman of Field Trip Committee for Geological Society of America, 1973 Annual Meeting.

—Co-chairman of session, "Economic Geology," Geological Society of America, Annual Meeting, Dallas, Texas.

—Co-chairman of symposium, "Geology and Management in the Coastal Zone: Institutional Perspectives," Geological Society of America, Annual Meeting, Dallas, Texas.

—Interview on television program, "Capitol Gallery"—topic, "Land Management Issues in Texas"—Station KLRN-TV, Southwest Texas Educational Television Council, Austin, Texas.

—Lecturer, American Association of Petroleum Geologists Continuing Education Program, Denver, Colorado.

—Member, Task Force on the Concept of Zero Tolerance, Council for Agricultural Science and Technology.

—Organizer of symposium, "Geology and Management in the Coastal Zone: Area Perspectives

and Institutional Perspectives," Geological Society of America, Annual Meeting, Dallas, Texas.

—Panel Member at Bituminous Manpower Study of the Institute for Research on Human Resources, Pennsylvania State University, University Park, Pennsylvania.

—Statement to Bureau of Land Management at Public Hearing, 1973 OCS, East Texas General Oil and Gas Lease Sale, Houston, Texas.

#### **L. E. Garner**

—Prepared report, "Geology and Mineral Resources of the Rio Bravo Resource Conservation and Development Project Area: Jim Hogg, Starr, Webb, and Zapata Counties, Texas," for Rio Bravo Resource Conservation and Development Project.

#### **C. G. Groat**

—Co-chairman and organizer, "Symposium on Industrial Minerals: Exploitation and Land Use," for American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), 1974 Annual Meeting to be held in Dallas, Texas.

—Co-leader of Geological Society of America Field Trip, "Lignite Strip Mining and Reclamation at Big Brown Electric Power Plant, Fairfield, Texas," 1973 Annual Meeting.

—Interview on television program, "Capitol Gallery"—topic, "Air Pollution and the Energy Situation in Texas"—Station KLRN-TV, Southwest Texas Educational Television Council, Austin, Texas.

—Organizer of symposium, "Regional Mapping Programs—Data for Land-Use and Resource Planning," for American Association of Petroleum Geologists, 1974 Annual Meeting to be held in San Antonio, Texas.

—Co-chairman of Field Trip Committee for Geological Society of America, 1973 Annual Meeting.

#### **W. R. Kaiser**

—Co-leader of Geological Society of America Field Trip, "Lignite Strip Mining and Reclamation at Big Brown Electric Power Plant, Fairfield, Texas," 1973 Annual Meeting.

#### **C. V. Proctor, Jr.**

—Co-chairman, "Texas River Symposium," Texas Academy of Science, Annual Meeting, Houston, Texas.

#### **R. L. Shipman**

—Panelist at presentation of final report of Class in Renewable Resources, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin.

#### **E. G. Wermund**

—Official representative for Governor of Texas at Workshop on a National Land-Use Classification System, sponsored by U. S. Geological Survey, Denver, Colorado.

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