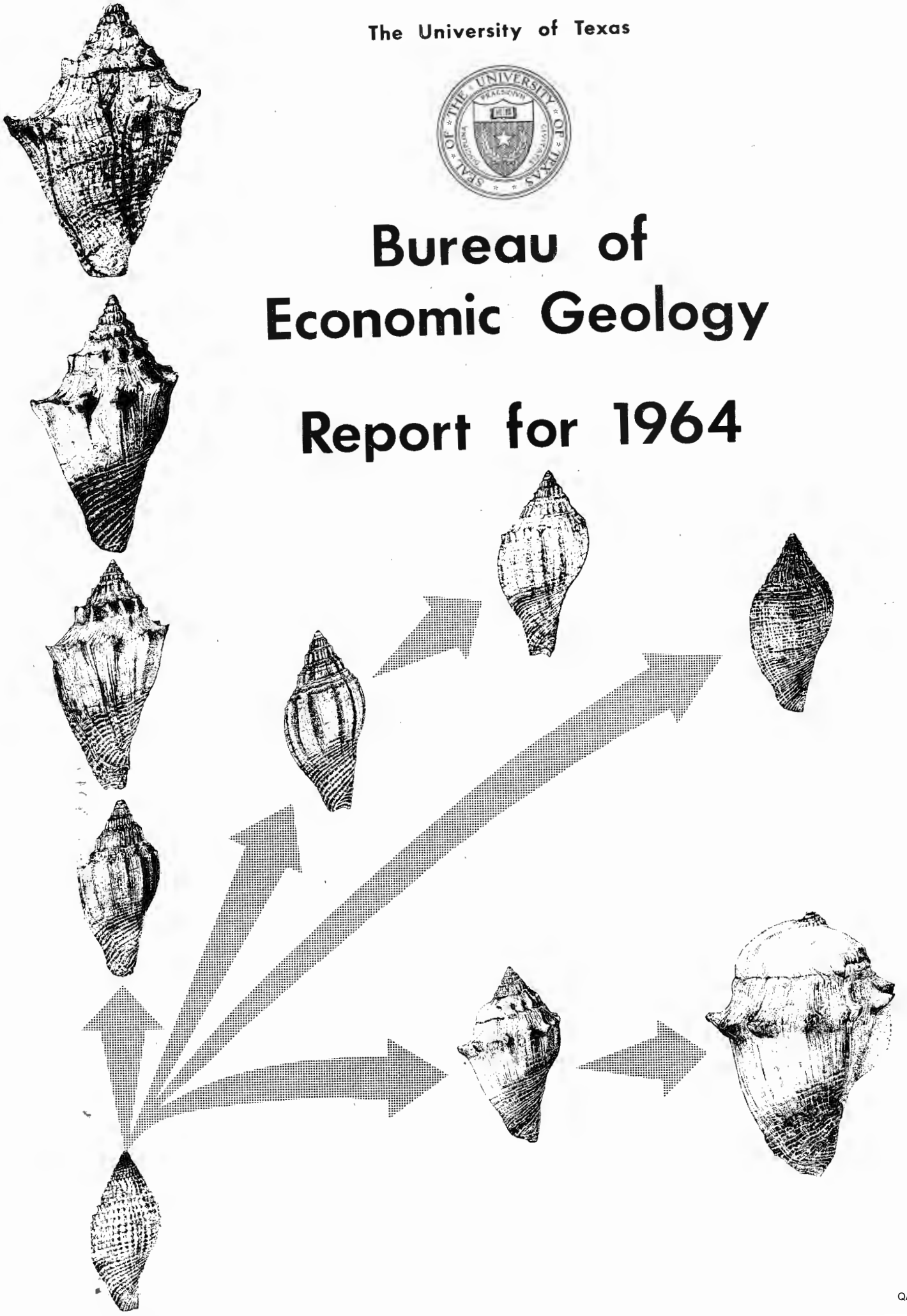
The University of Texas

Bureau of Economic Geology

Report for 1964



THE BUREAU OF ECONOMIC GEOLOGY is one of the organized research bureaus of The University of Texas. Established in 1909, it has for 55 years carried out the function of a State Geological Survey; its Director fills the position of State Geologist. The Bureau is engaged in a four-point program of research and public service in earth science and Texas mineral resources as follows: (1) basic geological research, (2) geology applied to resource and engineering problems, (3) systematic geologic mapping, and (4) public-service mineral information, identification and testing, and compilation of mineral statistics. The Bureau participates in other University research efforts in the fields of resources and earth sciences, such as the Center for Research in Water Resources. As a part of its effort, the Bureau publishes major reports in The University of Texas Publication series; it also has its own series of Reports of Investigations, Geologic Quadrangle Maps, Guidebooks, and Mineral Resource Circulars. The Guidebooks include non-technical publications of general interest.

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

As a result of growing interest in outdoor recreation, nature study, and tourism, the Bureau has over the past five years attempted to tell the geologic story of Texas through a series of popular guidebooks. Two general guides—*Texas Fossils* and *Texas Rocks and Minerals*, published in 1960 and 1964, are "best sellers" and are used as source material by elementary and secondary school teachers. The *Geologic Story of Longhorn Cavern* was told in a guidebook published in 1963. Other such guidebooks are being prepared.

The Bureau has offices on the Little Campus as well as a Mineral Studies Laboratory and Well Sample and Core Library at the Balcones Research Center.

Publications in 1964

During 1964, the Bureau issued University of Texas Publication 6413, Report of Investigations Nos. 51, 52, and 53, Guidebook No. 6, and Mineral Resource Circular No. 46. One report and one map were placed on open file. A complete list of publications issued by the Bureau of Economic Geology will be mailed on request.

Publication 6413. EVOLUTION OF *ATHLETA PETROSA* STOCK (EOCENE, GASTROPODA) OF TEXAS, by W. L. Fisher, Peter U. Rodda, and John W. Dietrich. 117 pp., 33 figs., 11 pls., 4 tables, July 1, 1964 ..... $4.00

This report describes the changes that occurred in evolutionary development in a group of fossil gastropods (Volutidae) that lived between 40 and 60 million years ago in marine waters that covered the Gulf Coastal Plain. The *Athleta petrosa* stock as developed in Texas includes one main-line species, divided into three successional subspecies, and three cladogenetic species. Morphologic features, including height, width, height of spire, longitudinal ornaments, columellar folds, length of protoconch and teleoconch, parietal callus, and labral denticulation, of about 1,700 specimens collected from 85 localities in Texas and other Gulf Coast States were studied and analysed quantitatively. Certain morphologic features of evolutionary significance were analysed through use of The University's CDC digital computer. Growth patterns were determined through study of individual whorls.

One of the main changes that occurred among these gastropods during the 20 million years they lived was a gradual increase in size, with younger forms progressively larger in size than older forms. Several morphologic changes took place to accommodate increase in size, though some changes are independent of size. Changes that occurred while these animals were in an embryonic and larval stage are basic to part of their evolutionary development.

Detailed systematic description and an extensive synonymy are given for each taxon in the stock. Appendices include sections on data processing, a summary of quantitative data, whorl analyses, and a locality register. A distribution map, pictorial evolutionary chart, summary histograms, Fortran programs, and contoured scatter diagrams are included as separate plates; five photographic plates and numerous line drawings illustrate morphologic variety in the stock.

Report of Investigations No. 51. RELATION OF OGALLALA FORMATION TO THE SOUTHERN HIGH PLAINS IN TEXAS, by John C. Frye and A. Byron Leonard. 25 pp., 3 figs., 1 pl., March 1964 ..... $0.75

The High Plains surface is the dominant physiographic feature of central-western and northwestern Texas. Studies along the southern and southeastern borders of the Plains have demonstrated the presence of outliers of fossiliferous Ogallala Formation, an important aquifer, in Borden and Scurry counties and have documented the occurrence of Pliocene deposition as far southeast as Sterling County. An ancient lake which existed 70,000 to 12,000 years ago in the Big Spring area is described in this report; it is named Lake Lomax from the community of Lomax on the lake plain in southwestern Howard County.

The illustrations include a map, generalized schematic physiographic profiles, cross profiles in the Big Spring region, and a photographic plate of field views.

Report of Investigations No. 52. STRATIGRAPHY OF THE FREDERICKSBURG DIVISION, SOUTH-CENTRAL TEXAS, by Clyde H. Moore, Jr. 48 pp., 12 figs., 19 pls., July 1964 ..... $2.00

This report describes the stratigraphy of Fredericksburg Cretaceous rocks in south-central Texas. The rocks studied are transitional between the Edwards Plateau or Hill Country rocks and subsurface rocks of the same age to the south. Understanding of the complex relationships of the rock units, including limestone reefs, marl, clay, and sands, is important in exploration for oil and gas in the region.

The illustrations include index and geologic maps, stratigraphic cross sections, detailed measured sections, outcrop photographs, and thin-section photomicrographs. Location maps are also included for the sections.

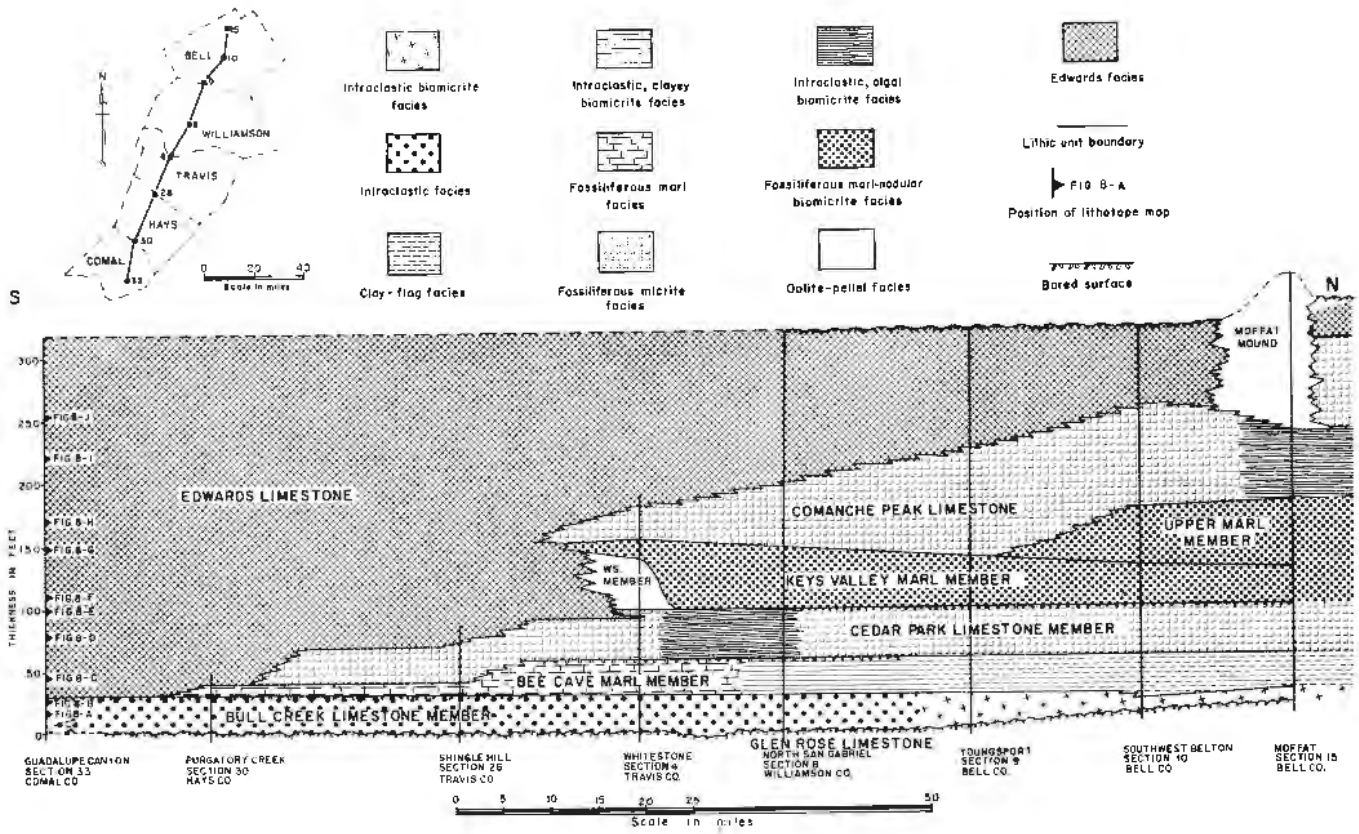
Report of Investigations No. 53. POTENTIAL LOW-GRADE IRON ORE AND HYDRAULIC-FRACTURING SAND IN CAMBRIAN SANDSTONES, NORTHWESTERN LLANO REGION, TEXAS, by V. E. Barnes and D. A. Schofield. 58 pp., 4 figs., 6 pls., August 1964 ..... $2.00

As a result of systematic geologic field studies over a period of many years, the Bureau of Economic Geology estimates that iron-bearing sandstones in Llano and Mason counties contain as much as 1.6 billion long tons of elemental iron in 23 billion long tons of rock. Although too low in grade to be considered ore under present economic conditions, the iron-bearing rock constitutes a potential resource for the future.

These sandstones now are exploited as sources of industrial sands for hydraulic fracturing and production of pulverized silica. The report includes detailed stratigraphic sections and petrographic data, two colored geologic maps, and tables containing data on sieve analysis, insoluble residues, and chemical composition of numerous samples.

Guidebook No. 6. TEXAS ROCKS AND MINERALS, AN AMATEUR'S GUIDE, by Roselle M. Girard. Sketches by Bill M. Harris. 109 pp., 76 illustrations, February 1964 ..... $1.25

This booklet is designed to serve as a guide for students and



Stratigraphic cross section; vertical facies distribution, Fredericksburg Divison. (Bureau Econ. Geol. Rep. Invest). No. 52, fig. 6.)

teachers, amateur collectors, and others who are interested in the rocks and minerals of Texas. The author has avoided highly technical vocabulary, and the informal yet scientifically accurate descriptive style makes for enjoyable reading and quick comprehension.

Bill M. Harris, of the Bureau's cartographic division, drew the sketches. The cover was designed by Cyril Satorsky. The booklet is further illustrated by photographs of numerous crystals and rocks. Included also are a geologic time scale, a physiographic map of Texas, and a generalized geologic map, in color, of the State.

An important section of the booklet is the detailed mineral and rock identification charts. In the mineral identificatiou charts, the miuerals arc grouped on the basis of luster, color, and hardness. In the rock ideutification charts, Texas rocks arc grouped according to their texture. The greater part of the text is a detailed description of many Texas rocks and minerals including composition, hardness, and specific gravity. Some generalized locality iuformation is included in the discussion.

The booklet contains a list of references on rocks and minerals including non-technical ones for beginners, textbooks, and other selected references. A glossary of the more technical terms used in the text and a compreheusive index to the publication complete the guide.

This booklet is a companion hook to Guidebook No. 2, *Texas Fossils.*

High school teachers and college instructors may wish to call this new booklet to the attention of their students and to public libraries. Various hobby groups will also find it of interest and help in collecting and identifying mineral specimens.

Mineral Resource Circular No. 46. THE MINERAL INDUSTRY OF TEXAS IN 1963, by F. F. Netzeband and Roselle M. Girard, December 1964 ..... Free on request

Reports and Maps Placed on Open-File in 1964

The Anadarko Basin (of Parts of Oklahoma, Texas, Kansas, and Colorado), by M. E. MacLachlan, U. S. Geological Survey.

This report, prepared on behalf of the U. S. Atomic Energy Commission, is a synthesis of published and unpublished data on the rocks of the Anadarko basin.

Geologic Map of Upper James River Area, Mason County, Texas, by V. E. Barnes.

This detailed (8 in. = 1 mi.) areal geologic map of about 8 square miles is a preliminary edition of a map to be included in a volume on Cambrian rocks of Texas.

Publications in Press

Geology of the Hye Quadrangle, Blanco and Gillespie Counties, Texas, by Virgil E. Barnes. Geologic Quadrangle Map No. 27.

This is another in a series of areal geologic maps of Blanco and Gillespie counties which are compiled on new 7½-minute topographic base maps.

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

This report is a comprehensive study of the areal geology, stratigraphy, petrology, structure, and paleontology of Big Bend National Park. It includes a large, colored geologic map, cross sections, stratigraphic columnar sections, and numerous photographs.

Rock and Mineral Resources of East Texas, by W. L. Fisher, with contributions by L. E. Garner, C. R. Chelf, C. A. Shelby, D. A. Schofield. Report of Investigations No. 54.

This report is the product of a 30-month study of rock and mineral resources of 42 East Texas counties, supported in part by a $40,000 contract with the Area Redevelopment Administration, U. S. Department of Commerce. Commodities considered include ceramic and nonceramic clays, industrial sands, constructional sand and gravel, cement and pozzolanic materials, building stone, lime and fluxstone, crushed stone, lignite, peat, natural abrasives, salt, greensand, phosphorite, heavy minerals, asphaltic sand, and mineral fillers and pigments. Each commodity is treated in terms of distribution, occurrence, quality, reserves, mining methods, production methods and costs, beneficiation, current and potential utilization, marketing, and past and current production. The report coutains 51 tables, 71 figures, 6 plates, and approximately 450 pages. Physical and chemical tests and analyses are included for approximately 2,000 samples.

Heavy Minerals in the Wellborn Formation, Lee and Burleson counties, Texas, by Cader A. Shelby. Report of Investigations No. 55.

This is a field and laboratory study of heavy minerals in the Wellborn Formation in Lee and Burleson counties. Five radiation anomalies in the area of outcrop of the Wellborn mark concentrations of heavy minerals, including zircon and ilmenite. The report includes a geologic map of the deposits as well as detailed mineralogic and stratigraphic information.

Limestone Resources of Lower Cretaceous Rocks of Texas, by Peter U. Rodda, W. L. Fisher, D. A. Schofield, and W. R. Payne. Report of Investigations No. 56.

The distribution, character, and chemical quality of Lower Cretaceous limestones in Texas were determined for more than 1,200 samples from about 360 localities. The main area of interest was from Red River south to Del Rio and from the Balcones Escarpment west to San Angelo. The report includes discussions of mining and production methods, costs, current and potential utilization, marketing, and current and past production.

Bloating Characteristics of East Texas Clays, by W. L. Fisher and L. E. Garner. Geologic Circular 65–1.

This short report summarizes correlation of bloating incidence and character with physical and chemical properties of approximately 600 samples of East Texas Cretaceous and Tertiary clays. Included are bloating field diagrams, based on clay mineral and clay pH, that permit prediction of bloating incidence and rapid evaluation of clays as potential sources of lightweight aggregate.

Texas Mineral Resources: Problems and Predictions, by P. T. Flawn. Geologic Circular 65–2.

This is the text of an address presented by the author to the Governor's Conference on Natural Resource Management and Development in Dallas in October 1964. The author reviews lessons to be learned from the history of mineral production in Texas, analyses the current mineral industry, stresses the need to broaden the industry's base, discusses future problems imposed by the needs of conservation and resource management, and makes a number of predictions.

Texas Mineral Producers, by Roselle M. Girard.

This is a new edition of the list of mineral producers in Texas exclusive of oil and gas.

Publications by Bureau of Economic Geology Staff in Scientific Journals

Barnes, V. E., with G. E. Wilford (1964) Brunei tektites (abst.): Trans. Amer. Geophys. Union, vol. 45, no. 1, p. 82.

Barnes, V. E. (1964) Petrography of tektites from near Muong Nong, Laos (abst.): Trans. Amer. Geophys. Union, vol. 45, no. 1, p. 82.

Barnes, V. E. (1964) Variation of petrographic and chemical characteristics of indochinite tektites within their strewn-field: Geochim. et Cosmochim. Acta, vol. 28, pp. 893–913.

Barnes, V. E. (1964) Terrestrial implication of layering, bubble shape and minerals along faults in tektite origin: Geochim. et Cosmochim. Acta, vol. 28, pp. 1267–1271.

Barnes, V. E. (1964) Rayed bubbles in tektites: Geochim. et Cosmochim. Acta, vol. 28, pp. 1373–1375.

Fisher, W. L. (1964) Lithologic and faunal zonation of massive limestones, Kaibab Formation, northwestern Arizona: Plateau, Museum Northern Arizona, vol. 36, no. 4, pp. 110–114.

Flawn, P. T. (1964) Basement rocks of the Texas Gulf Coastal Plain: Trans. Gulf Coast Assoc. Geol. Soc., vol. 14, pp. 271–275.

Flawn, P. T. (1964) The regional setting of the Marathon salient: Soc. Econ. Paleontologists and Mineralogists, Permian Basin Section, Pub. 64–9, 1964 Field Trip Symposium and Guidebook, pp. 9–11.

Girard, R. M., with F. F. Netzeband (1964) The mineral industry of Texas in 1963: U. S. Bureau of Mines, Minerals Yearbook, 1963, Vol. III, pp. 1015–1077.

Rodda, P. U., with M. A. Murphy and G. L. Peterson (1964) Revision of Cretaceous lithostratigraphic nomenclature, northwest Sacramento Valley, California: Bull. Amer. Assoc. Petrol. Geol., vol. 48, pp. 496–502.

Rodda, P. U., with W. L. Fisher (1964) Evolutionary features of *Athleta* (Eocene, Gastropoda) from the Gulf Coastal Plain: Evolution, vol. 18, pp. 235–244.

Projects

Texas Geologic Atlas

The year 1964 was the third year of the Texas Geologic Atlas Project. After three years of collecting and evaluating data and compilation, a series of sheets is nearing completion. The Tyler sheet is *in press* and is scheduled for publication early in 1965. Preliminary copy was reviewed by the Geologic Atlas Committee of the East Texas Geological Society during June 1964. Color separation and proofing were completed during August.

Contributions of geologic mapping continued to be received during the year from private companies, geological societies, and governmental organizations. A major contribution of maps of Pleistocene and Recent deposits along the Texas Gulf Coast was received from Humble Oil & Refining Company. Revision of Army Map Service 1:250,000 sheets continues, and revised base material is obtained by the Bureau when available for sheets on which geologic mapping is nearing completion. Such revised base material has been secured for the Tyler and Texarkana sheets.

Since the last annual report, the Emory Peak (Boquillas) 1:250,000-scale topographic sheet has been issued by the U. S. Geological Survey and the Presidio sheet is to be issued soon. The proposed date of issue of the remaining three sheets in Texas (Marfa, Del Rio, and Eagle Pass) is unknown.

Mrs. Charles (Mary Kathryn) Pieper, photogeologist, joined the Atlas Project October 15, 1963. During the year she completed photogeologic work on the Tyler sheet and continued work on the Texarkana sheet. Mr. Cader A. Shelby was transferred to the Atlas Project part-time from other Bureau work January 1964. During the year he field checked parts of the Tyler and Texarkana sheets and began work on the Palestine-Alexandria sheet.

In April, Mrs. Pieper, Mr. Shelby, and Dr. Barnes, Director of the Atlas Project, joined Dr. H. V. Ander-

sen, Professor of Geology, Louisiana State University, for a field trip in northwestern Louisiana to discuss correlation of Texas and Louisiana units.

Work on the Texas portion of the Texarkana sheet was stepped up following completion of the Tyler sheet. The Arkansas part of the sheet was completed and submitted June 1964 by Dr. Thomas J. Freeman of the Arkansas Geological Commission. When geologic mapping of the western part of Choctaw County, Oklahoma, is received from the Oklahoma Geological Survey, and field checking is completed, the Texarkana sheet will be ready for color separation, proofing, and review.

Mr. Joseph H. McGowen, a graduate student in geology, was employed for the summer to map the Paleozoic rocks in the western part of the Sherman sheet and to field check the rest of the Texas portion of the sheet. Love County, Oklahoma, has been remapped by the Oklahoma Geological Survey, and all that remains to be mapped on the Oklahoma portion of the Sherman sheet is a small area in Bryan County. When the remaining Bryan County area mapping is received, this sheet will also be ready for color separation, proofing, and review.

Mr. John W. Dietrich was transferred to the Atlas Project part-time from other Bureau work July 6, 1964. His first assignment was completion of the Van Horn—El Paso sheet. During the remainder of the year he mapped Quaternary deposits in the Hueco Bolson, Salt Basin, and parts of the Franklin, Hueco, and Delaware Mountains.

Dr. John C. Frye, Chief, Illinois State Geological Survey, and Dr. A. Byron Leonard, Department of Zoology, University of Kansas, were retained for two weeks during August to map Pliocene to Recent deposits in three areas on and adjacent to the High Plains. These areas were selected as test areas to check photogeologic mapping over much broader areas. One of the three areas (Big Spring sheet) includes Howard County and the western part of Martin County. Another area (Lubbock sheet) includes about one-third of Kent County. And the third area (Plainview sheet) includes all of Swisher County and the High Plains portion of Briscoe County.

Dr. G. K. Eifler, Jr., joined the Atlas Project full-time September 1, 1964. Dr. Eifler has broad experience in Texas geology and is well known to geologists in the State. He is a former member of The University faculty, consultant to the School Land Board, and consultant to private companies. Dr. Eifler is mapping and field checking for the Lubbock, Plainview, and Big Spring sheets.

James W. Macon, the Bureau's cartographer, supervised the scribing, color separation, and preparation of the Tyler sheet for the press.

Geology of Austin and Vicinity

The Bureau of Economic Geology has initiated a project on the geology of Austin and vicinity. The report and accompanying maps will describe bedrock and surficial deposits, engineering properties of the geologic units, and resources. The report will focus on engineering and environmental geology and will be designed as a basic reference for engineers and planners. The area of study will include the Austin East, Austin West, Oak Hill, and Montopolis 7½-minute quadrangles, as well as areas of probable urban expansion outside of the main area, such as along Lake Austin to Mansfield Dam. Proposed scale of mapping is 1,200 feet equal 1 inch.

In addition to a conventional geologic map, a map and profiles of the surficial deposits will be included. Water and construction material resources, including aggregates and material for subgrades and fills, will be described. Geologic aspects of park sites and other recreational and educational areas will be discussed. (For example, springs, natural pools, small dam sites, nature study areas, archeological sites.) Engineering properties of the rocks and surficial materials will be described in terms of classification, liquid limit, plasticity index, shear strength, shrink-swell potential, permeability, pH, resistivity, and corrosion index. These data will be discussed in relation to problems of the Austin area involving (1) foundation problems (expansive clays, bearing strengths, excavation problems, and permeability); (2) problems of the transportation network (slope stability of rock units, excavation problems, character as sub-base); (3) sewage disposal (septic tanks, sewer line routes, tunnels and deep cuts, effluent ponds); (4) corrosion of pipelines and other buried facilities; (5) agricultural potential as green belts; (6) man-made shelters and natural caves.

Preliminary conversations have been held between City engineering and planning departments, Texas Highway Department, and Soil Conservation Service.

The project is under the general direction of Keith P. Young, of The University's Department of Geology, and Peter U. Rodda, of the Bureau staff. L. E. Garner is assisting in the compilation of field and laboratory data.

Areal Geologic Studies

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

A long-term stratigraphic and paleontologic study of Cambrian and immediately overlying Ordovician rocks of central Texas. Project is complete except for sections on systematic paleontology and paleoecology.

Geology of the Rocky Creek and Stonewall quadrangles, Gillespie and Blanco counties, Texas. V. E. Barnes.

Two more of the areal geologic maps prepared by Dr. Barnes which are now being compiled on new 7½-minute topographic base maps.

Geology of the Presidio area, Presidio County, Texas. John W. Dietrich.

An areal geologic study of the Ocotillo, Ochoa, and Presidio quadrangles, with emphasis on the distribution, age and correlation, and petrography of the volcanic rocks.

Upper Cretaceous stratigraphy of Caldwell County and adjacent areas. P. S. Morey.

Definition of stratigraphic relationships of Upper Cretaceous rocks in Caldwell County based on subsurface lithologic, paleontologic, and electric-log studies.

Stratigraphy of Tyler Basin threshold. W. L. Fisher.

Facies analyses of Cretaceous and Cenozoic rocks across the structural-depositional threshold of the Tyler Basin, East Texas. Based on surface and subsurface investigations.

Mineral Resource Studies and Mineral Statistics

Industrial sands of the Trinity Group (Lower Cretaceous) of north and west Texas. W. L. Fisher and P. U. Rodda (publication scheduled for 1965).

Study includes mapping (scale 1:500,000) of various sand units in the Trinity Group (Lower Cretaceous) in 30 counties of north and west Texas. Area under study includes Coryell and Mills counties north to Red River and west to Howard, Glasscock, and Irion counties. Sands are being considered in terms of distribution and occurrence, quality, reserves, mining and production methods and costs, beneficiation, current and potential utilization, marketing, and production. Chemical and physical tests and analyses of approximately 200 samples from 130 localities have been completed.

Industrial sand resources and industry in Texas. W. L. Fisher, P. U. Rodda, and L. E. Garner.

Summary commodity survey of industrial and special sand resources in Texas, based on recent Bureau investigations of industrial sands in the Llano area, East Texas, South Texas, and North Texas, supplemented by investigation of stream and coastal sand deposits.

Regional variation in clay minerals. W. L. Fisher and L. E. Garner.

Regional and stratigraphic variation in clay mineral composition of Gulfian and Tertiary rocks of East Texas, based on clay mineral determinations of approximately 1,200 samples.

Texas mineral resources. R. M. Girard and P. T. Flawn.

A non-technical treatment of mineral resources in Texas, their significance in the economy, and conservation problems.

The annual compilation of Texas mineral production statistics, by Roselle M. Girard, in cooperation with the U. S. Bureau of Mines, is in progress as a continuing project.

Geology and Recreation

The Geologic Guide to the State Parks of Texas. Ross A. Maxwell.

A general guide designed to tell the story written in the rocks to park visitors so that their outings will be more meaningful.

The Geology of Palo Duro State Park. William H. Matthews III, Professor of Geology, Lamar State College of Technology, Beaumont.

A geologic guide designed for visitors to the park.

Bibliographies and Catalogs

Bibliography and Index of Texas Geology, 1951–1960.

Supervised by R. M. Girard, currently assisted by Margaret D. Brown.

Bibliographic listing of publications pertaining to Texas geology, as a continuation of previous Texas bibliographies and indices (Univ. Texas Bull. 3232, part 4, and Pub. 5910).

Catalog of type specimens of invertebrate fossils in the collections of the Bureau of Economic Geology. Peter U. Rodda.

An annotated catalog of about 5,000 separate specimens that have been described, figured, or listed in scientific publications.

Well Sample and Core Library

During 1964, the Library acquired a large volume of samples and cores from Gulf Oil Corporation, Humble Oil & Refining Company, and Pure Oil Company. Gulf presented samples from approximately 2,437 wells from 95 Texas counties; Pure gave samples from 841 wells from 63 counties of the State, Humble contributed important cores from Humble Oil & Refining Company No. 1 Pruitt in Atascosa County and Shell Oil Company No. 1 Walter O. Roehl well in DeWitt County. Cataloging and storage of cores and cuttings are supervised by P. S. Morey, geologist in charge of the Library.

The Library is now filled to capacity and plans to expand the facility are being studied.

Curating and cataloging Bureau collections is a never-ending job.

Mineral Studies Laboratory

The official opening of the new quarters of the Mineral Studies Laboratory at Balcones Research Center was held on October 5, 1964 and was attended by some 50 visitors.

Half of the 3,000-square-foot facility is occupied by the chemistry laboratory with its four accessory rooms (fusion room, apparatus closet, reagent closet, and balance room), by the spectroscopy laboratory and its darkroom, and by the office. The other half contains the physical testing and sample preparation laboratory with its accessory room, which houses the crushers, grinders, and pulverizers.

The Mineral Studies Laboratory has received $2,500 for the renovation of the 1.5-meter ARL spectrograph and densitometer.

New equipment added to the Mineral Studies Laboratory in 1964 includes a 49-inch fume hood with base and blower and a Pitchford Pica Pulverizer with tungsten carbide and high-alumina grinding units.

The work performed in the Mineral Studies Laboratory during the year involved physical testing and chemical analysis in support of regular Bureau of Economic Geology projects as well as testing of samples submitted by individuals and companies from over the State. One project involved determination of optimum calcination conditions for the separation of brucite and calcite occurring in brucitic limestones. Laboratory operations are supervised by D. A. Schofield, assisted by J. T. Etheredge.

Staff Activities

Scientific Meetings

The Bureau of Economic Geology was represented at numerous scientific and professional meetings held in the State and in other points in North America. Principal meetings attended by staff members during 1964 include:

American Association of Petroleum Geologists (annual meeting), Toronto, Canada: V. E. Barnes, P. T. Flawn

American Geophysical Union (annual meeting), Washington, D. C.: V. E. Barnes

Association of American State Geologists (annual meeting), Norman, Oklahoma: V. E. Barnes, P. T. Flawn

Baylor University, Symposium on Geoscience and Urban Development, Waco: P. T. Flawn

Geological Society of America (annual meeting), Miami Beach, Florida: P. T. Flawn

Geological Society of America (annual meeting, Southeastern Section), Baton Rouge, Louisiana: V. E. Barnes, P. T. Flawn, M. K. Pieper, C. A. Shelby

Governor's Conference on Natural Resource Management and Development, Dallas: W. L. Fisher, P. T. Flawn

Gulf Coast Association of Geological Societies (annual meeting), Corpus Christi: G. K. Eifler, W. L. Fisher, P. T. Flawn, L. E. Garner, J. W. Macon, P. U. Rodda

Society of Economic Paleontologists and Mineralogists (Permian Basin Section), Marathon: P. T. Flawn

Southwestern Federation of Geological Societies (annual meeting), Midland: W. L. Fisher, P. T. Flawn, J. W. Macou, P. U. Rodda

Tektite meeting, Corning Glass Works, Corning, N. Y.: V. E. Barnes

Texas Academy of Science (annual meeting), Waco: W. L. Fisher, P. U. Rodda

The University of Texas, Invitational seminar on Water Resource topics, Austin: W. L. Fisher

Lectures and Public Addresses, 1964

P. T. Flawn--

Basement: not the bottom, but the heginning: Keynote, American Association of Petroleum Geologists, Toronto, Canada

Geology and urban development: Symposium on Geoscience and Urban Development, Baylor University, Waco

Whither the Ouachita?: North Texas Geological Society, Wichita Falls; Tulsa Geological Society, Tulsa, Oklahoma

Economic concepts of the basement: Sinclair Oil and Gas Company, Research Laboratory, Tulsa, Oklahoma

The regional setting of the Marathon Salient: Society of Economic Paleontologists and Mineralogists (Permian Basin Section), Marathon

Texas mineral resources, problems and predictions: Governor's Conference on Natural Resource Management and Development, Dallas

Basement rocks of the Texas Gulf Coastal Plain: Gulf Coast Association of Geological Societies, Corpus Christi

V. E. Barnes—

Tektites: Sierra Leone Science Association, Fourah Bay College, University College of Sierra Leone, Freetown, Sierra Leone

Petrography of tektites from near Muong Nong, Laos: American Geophysical Union, Washington, D. C.

(with G. E. Wilford) Brunei tektites: American Geophysical Union, Washington, D. C.

W. L. Fisher—

Mineral resources in community industrial development: General Telephone Company Economic Development Conference, San Angelo

Conservation and mineral resources: Summer Conservation Workshop, Sul Ross State College, Alpine

The making of a gastropod: evolution of *Athleta*: Navy and Army Reserve Research Groups, The University of Texas, Austin

The search for nonfuel minerals: Corpus Christi Geological Society, Corpus Christi

P. U. Rodda—

How to identify fossils: Austin Gem and Mineral Society, Austin

Academic Assignments, Committee Service, and Other Professional Responsibilities

P. T. Flawn continued Chairmanship of the Basement Rock Project Committee of the American Association of Petroleum Geologists and served on the Research Committee and Committee on Preservation of Samples and Cores of that Association. He chaired The University of Texas Faculty Committee on Publications and served on the Nominations Committee of The Geological Society of America. He continued to serve on the Texas Mapping Advisory Committee and the Texas Committee on Conservation Education. During the summer, Dr. Flawn was Visiting Professor and Research Geologist at the Instituto de Geologia of the National University of Mexico.

V. E. Barnes was named by three organizations as their official delegate to the International Geological Congress in New Delhi, India; he will represent the Bureau of Economic Geology, the Department of Geology, and the Association of American State Geologists.

G. K. Eifler was elected as Austin District Representative for the American Association of Petroleum Geologists.

Three Bureau geologists gave courses in The University's Department of Geology during 1964: P. T. Flawn and W. L. Fisher taught Economic Geology and P. U. Rodda taught Paleontology. R. A. Maxwell continued to lecture to high-school groups as a visiting scientist of the Texas Academy of Science. W. L. Fisher took part in Industrial Planning Seminars of the Texas Industrial Commission. J. W. Macon lectured to graduate students on photogrammetry.

Tektite Research

In addition to his duties as Associate Director of the Bureau and as Director of the Geologic Atlas Project, V. E. Barnes continued as Director of Tektite Research. He attended a meeting on tektites at Corning Glass Works and on October 10 left for four months of field work on tektites and impact craters in Africa and Asia. He lectured on tektites before the Sierra Leone Science Association at Freetown and presented papers at the spring meeting of the American Geophysical Union in Washington, D.C. A National Science Foundation grant to Dr. Barnes and Dr. F. E. Ingerson of the Department of Geology was extended until October 1966.

Ground Breaking Near for New Geology Building

Bids on the $2,250,000 Geology Building which will house the Department of Geology and Bureau of Economic Geology were opened on December 3, and contracts were awarded on Decemher 12. B. L. McGee Construction Company of Austin was the low bidder on the general construction contract.

Bureau Publication Inventories Huge Potential Low-Grade Iron Reserves in the Northwestern Llano Region[1]

The red upper unit of the Hickory Sandstone is a hematitic and goethitic sandstone containing a large reserve of potential low-grade iron ore. It is estimated that about 7 million long tons of elemental iron is locked up in each square mile of the upper 30 feet of this deposit in sandstone averaging about 12.4 percent elemental iron. At least 175 square miles of the deposit is under less than 800 feet of cover, and reserves in the upper 30 feet in this area total about 650 million long tons if 75 percent of the potential iron ore is minahle and two-thirds of the iron in the mined ore is recoverable. Beneath this level another 50 or 60 feet of poorly exposed iron-bearing sandstone is probably equally as iron-rich, and if this is true, total potential reserves may be as much as 1.6 billion long tons of elemental iron in 23 hillion long tons of rock or about 6 billion tons of concentrates. No part of the deposit can be regarded as direct shipping ore. Iron oxide from the red unit of the Hickory Sandstone, except for high carbonate mineral content, is of paint pigment quality.

Hydraulic-fracturing sand production from the lower unit of the Hickory Sandstone is well established in the Voca area, McCulloch County, and within the area of this report the amount of such sand is very large.

The middle unit of the Hickory Sandstone, the Lion Mountain Sandstone, the Welge Sandstone, and the sandstone zones in the San Saba Member appear to be devoid of deposits of value.

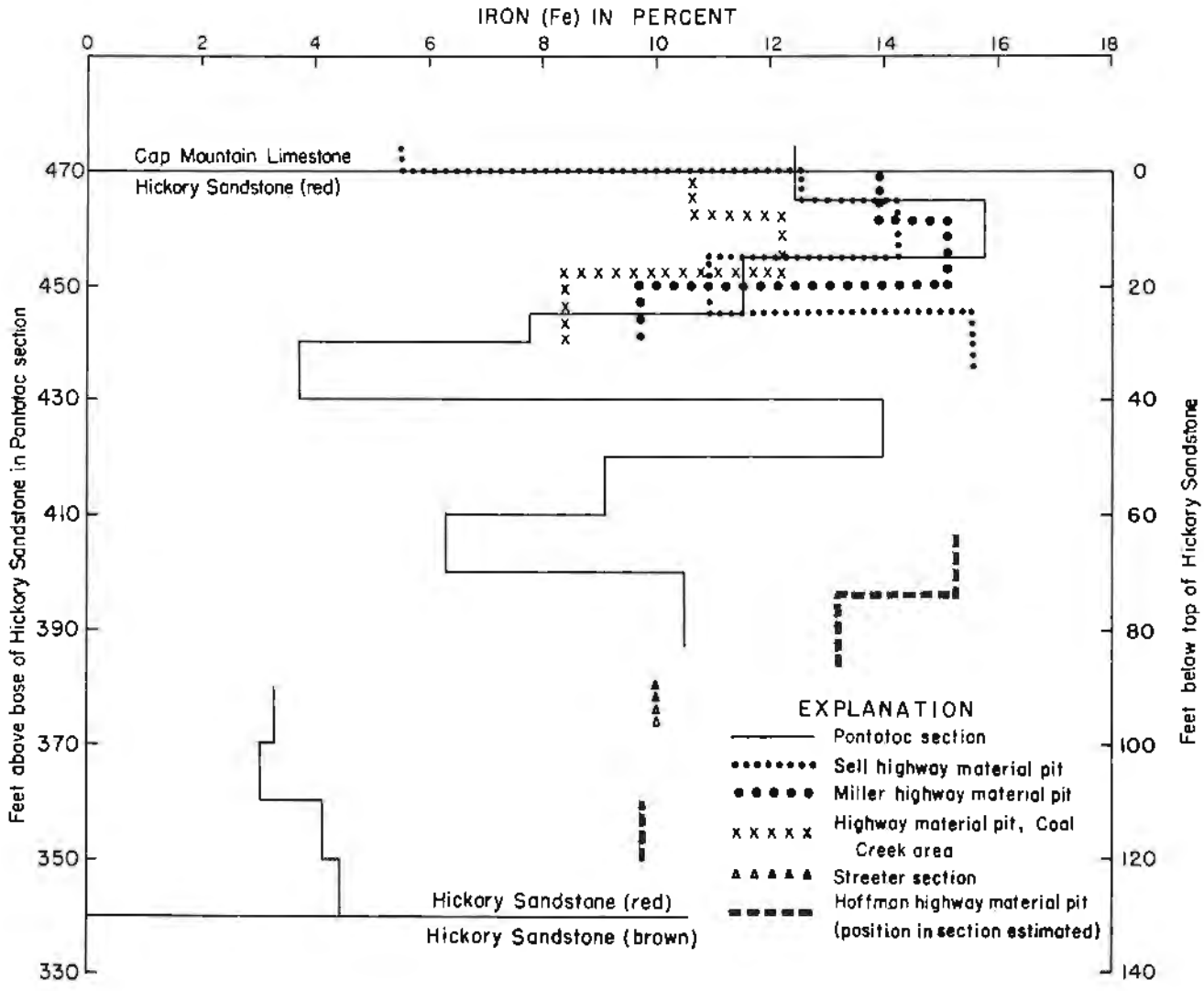
[1] Potential low-grade ore and hydraulic-fracturing sand in Cambrian sandstones, northwestern Llano region, Texas, by V. E. Barnes and D. A. Schofield: Univ. Texas, Bureau Econ. Geol. Rept. Invest. No. 53, p. 1.

Selected Remarks on Texas Resources Made to Governor's Conference

On October 16, Dr. Peter T. Flawn, Director of the Bureau, addressed the Governor's Conference on Natural Resource Management and Development in Dallas, Texas, on "Texas Mineral Resources: Prohlems and Predictions." Following are selected remarks from that address.

When a reference is made to the mineral wealth of Texas, most people think of oil and gas, and some few also of sulfur. And, of course, it is truc that of the whopping $4.4 billion dollars worth of minerals produced in Texas in 1962, 92% was oil, gas, and natural gas liquids. In 1963, for the 29th year, Texas led the Nation as a producer of minerals. Value of mineral products was twice the value of agricultural products, equal to the value of manufactured products, and equal to about one-half the value of all retail trade. It is clear that the State has a mineral-oriented economy; it is true also that the mineral industry is distributed broadly throughout the State and not concentrated in several giant oil fields or very large mines—241 of 254 counties reported mineral production in 1963.

But in addition to oil and gas, Texas produced 22 other minerals last year valned at $361.7 million dollars. There are indeed many States which would



Graph showing iron content of red unit of Hickory Sandstone, northwestern Llano region. The Hickory Sandstone—Cap Mountain Limestone boundary is used as plane of reference, and the footages shown are for the Pontotoc section. (Bureau Econ. Geol. Rept. Invest. No. 53, fig. 3.)

happily settle for this 8 percent of Texas' mineral production. Significantly, this is the segment of Texas' mineral industry growing most rapidly (fig. 1) and it is the segment that will continue to grow. . . .

* * * *

One way to get a quick but comprehensive look at the past is to compare Texas' mineral production in 1882 with prodnction in 1900, and again with production for the most recent year for which final figures are available, 1962. The rise and fall of industries are recorded in these statistics, particularly if they are examined on a year-to-year basis. For example, mineral water was a big industry prior to the State-wide development of approved public water supplies. The boom and bust of metal mines in the west are reflected in these statistics, as is the fall of coal and lignite industries before oil and natural gas. But although individual commodities have had their day and passed from the scene, or have fluctuated widely, the overall mineral industry has grown in a great soaring curve like the Texas population curve (fig. 1).

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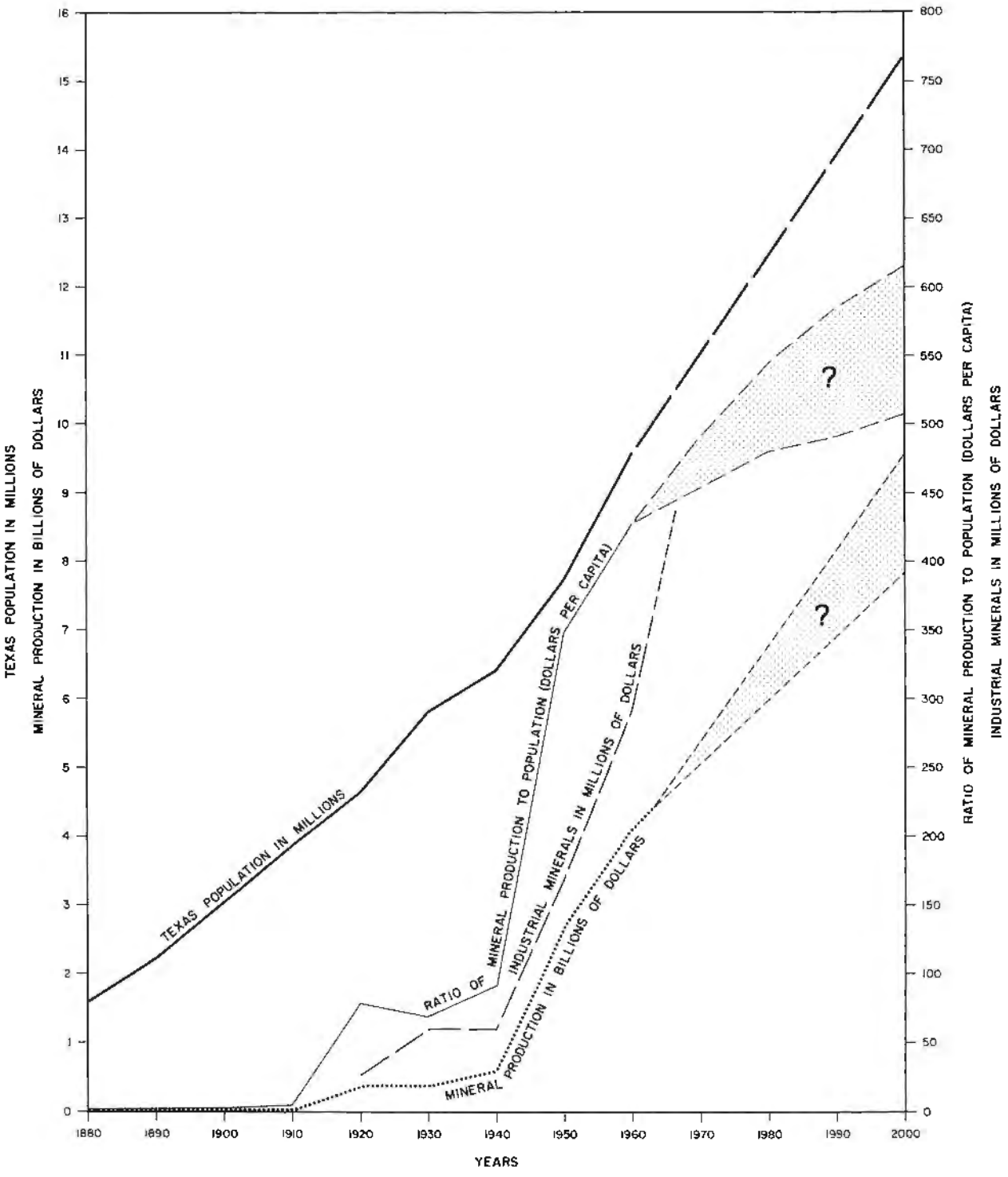
The lesson we can learn from yesterday is that changing demand and changing cost structures due to technological and social changes affect individual commodities but that overall demand for minerals rises with



TEXAS MINERAL INDUSTRY AND TEXAS POPULATION

FIGURE 1

population and with the march of our industrial society. The impact of the change is, of course, less on regions or political units with broad-based mineral economies than it is on those with only one mineral crop. Texas already knows this. When the petroleum industry (which accounts for 92% of the value of mineral products produced in the State) slumps, the State's mineral economy slumps and the State's tax revenue, geared in part to the petroleum industry, declines. Fortunately, the effect of the recent slump in petroleum production was in part offset by continued growth in natural gas and continued growth in other segments of the State's mineral industry. But the slogan for the future should be—broaden the base!

* * * *

Another requirement for a healthy mineral industry in the decades to come, and indeed a moral obligation to coming generations, is extension of the conservation concepts now well accepted in Texas in the oil and gas industry to other mineral commodities. Almost everyone agrees that conservation practices are necessary to protect our oil and gas industry, eliminate waste, and guarantee maximum recovery. However, the idea of extending conservation concepts to a commodity such as sand and gravel is commonly met with raised eyebrows. This is due to a failure to grasp the concept of "place value" applied to the mineral commodities that have a low unit value—the dollar-a-ton material—but which are used in large volumes.

* * * *

Commonly, there are conflicts between conservation and resource management groups because each group wants to conserve the area of its interest—which, of course, seems of paramount importance. It would seem that conflicts might be resolved by determining the highest use. In dealing with specifics, however, it turns out that ordinary bookkeeping is complicated by the need to assign dollar values to intangibles. For example, what is the value of a pretty landscape used for picnics and other recreation as opposed to a crushed stone quarry? How is the value determined? If a premium is put on aesthetics and recreation, as is the trend, many taxpayers will absorb hidden costs as a result of increased general construction costs because the crushed rock must be hauled a long distance from another source. Thus, more is involved than the direct loss of jobs and tax revenue from the quarry industry. The only answer is that the various interests must come together fully informed to plan over the long term.

I am closing with some predictions. Under sound conservation practices and disallowing extraordinary demand occasioned by National crises, oil and gas production in Texas will continue at about present levels until at least the year 2000. However, during this period the value of oil and gas will increase and an ever larger percentage of the total production will be used as chemical raw materials. Lignite and coal production will grow slowly for both power and chemical raw materials, with facilities constructed at the resource site to eliminate or minimize transportation costs. Limestone will move to the industrial Texas coast in ever larger volumes both for use as cement raw material, chemical raw material, aggregate, and base material—the effect of conservation measures applied to the oyster shell industry on the acceleration of the movement will be a matter of only a few years either way it goes. In parts of the State where aggregate shortages already exist, plants will be constructed to manufacture aggregates from local materials. The State's ceramic industries will expand. High-alumina clays in East Texas will he used as aluminum ores. Exploration for uranium in the Texas Coastal Plain will turn up additional deposits, and the high-cost deposit in Duval County will he mined. Exploration for copper, mercury, molybdenum, silver, and other metals in Trans-Pecos Texas will meet with some success and promote local mining industries. In the distant future, the tremendous low-grade iron reserves of the State will be developed. In central Texas, the low-grade near-surface hematitic ores will be concentrated and pelletized to make blast-furnace feed, and in East Texas the so-called greensands (glauconite) will yield to new metallurgical approaches. If I am only 50 percent correct in my optimism, the mining industry of the State will remain strong. However, unless conservationists understand the role of mineral industries in our society and disahuse themselves of the idea that a woodlot is good but a quarry is bad—by definition—all bets are off.

The full text of Dr. Flawn's address is published in the Proceedings of the Governor's Conference.

Bureau of Economic Geology exhibit at the October meeting of the Gulf Coast Association of Geological Societies in Corpus Christi. This compact, portable display, designed by J. W. Macon, was also exhibited at the January meeting of the Southwestern Federation of Geological Societies and at The University of Texas annual Roundup Showcase.

Dr. Eifler Joins Bureau Staff

Dr. G. K. Eifler, Jr., joined the Bureau staff on September 1 to work on the Texas Geologic Atlas. Dr. Eifler holds Bachelor's and Master's degrees from The University of Texas and a Doctorate from Yale University. He taught geology at The University of Texas from 1929 to 1950. He has been a consultant to the School Land Board and an independent consulting geologist in Austin. Dr. Eifler has worked in the United States, Canada, Mexico, and Australia. His broad experience in the geology of Texas makes his association with the Texas Geologic Atlas Project a most appropriate and happy one.

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