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The University of Texas



Bureau of Economic Geology

Report for 1963

THE BUREAU OF ECONOMIC GEOLOGY is one of the organized research bureaus of The University of Texas. Established in 1909, it has for 54 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) investigations of mineral deposits, (3) systematic geologic mapping, and (4) public-service mineral information, identification and testing, and compilation of mineral statistics. 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.

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 1963

Publications bearing a 1963 issue date include a major report in The University of Texas Publication series (No. 6304); two Reports of Investigations (Nos. 49 and 50); two Guidebooks (Nos. 4 and 5); a comprehensive index to well samples (a revision, in mimeographed form, of The University of Texas Publication 5015); two Geologic Quadrangle Maps (Nos. 25 and 26); two geologic maps, one with text and one without; a preliminary edition of a correlation chart for a publication in progress; and one Mineral Resource Circular (No. 45).

Publication 6304. UPPER CRETACEOUS AMMONITES FROM THE GULF COAST OF THE UNITED STATES, by Keith Young. 373 pp., 34 figs., 82 pls. of fossils, 13 tables, February 1963 \$5.00

This monograph on Upper Cretaceous ammonites is a major contribution to Gulf Coast paleontology. It deals mainly with fauna of the Austin Chalk and discusses correlation throughout the Gulf Coast and with the Western Interior.

The Austin Chalk is one of the more prominent units of the inner Gulf Coastal Plain, and while many publications deal with this formation, the Ammonoidea of the Austin Chalk have not heretofore been studied. Some 82 species of ammonites are recognized and described, of which 42 species are given new names; they are distributed through 35 genera. A few important species from older and younger strata are described, including 13 from the Upper Campanian and one from the Upper Turonian. Nine species of pelecypods are also described. Of the 82 ammonoid species, 67 are from the limestone facies of the Austin Chalk of the Terlingua Formation. Fifty-seven species are from rocks ascribed to Austin Chalk by earlier authors.

Combined with a re-evaluation of important pelecypod species, the results of the ammonite studies indicate that the upper Austin Chalk of the type area and the Burditt Marl are roughly equivalent in age to the Brownstown-Gober and Brownstown-Ozan sequences of northeast Texas and adjacent Arkansas, which in turn are roughly equivalent to the Eutaw-Mooreville sequence in Mississippi, and are also approximately equivalent to the Telegraph Creek—Eagle sequence of the northern part of the Western Interior.

Ranges of collignoniceratid species, ranges of other ammonoids and some pelecypods, and diagrammatic correlations of formations are shown in figures; comparison of classification and zonation, together with distribution charts, ranges, and tentative correlation of Coniacian, Santonian, and Lower Campanian formations, are shown in tables.

Report of Investigations No. 49. PLEISTOCENE GEOLOGY OF RED RIVER BASIN IN TEXAS, by John C. Frye and A. Byron Leonard. 48 pp., 3 figs., 3 pls., January 1963.

This report summarizes results of studies of the late Cenozoic geology of the Red River basin in Texas. Late Tertiary terrace deposits have been identified as far east as Montague County and deposits of Nebraskan age have been recognized somewhat farther east. Terrace deposits of late Kansan and early Wisconsinan age have been traced throughout the basin in Texas. In north-central and northeastern Texas, the names Hardeman, Ambrose, and Cooke are proposed for the alluvial terraces that were formed during late Kansan and early and late Wisconsinan time. In northeastern Texas, pimple mounds existed on all terrace surfaces older than Wisconsinan. Varied and diagnostic faunas of fossil mollusks are reported from Kansan, early Wisconsinan, and late Wisconsinan deposits throughout most of the basin in northern Texas, and Pearlette volcanic ash occurs locally in the deposits of Kansan age. The Pleistocene history of the Red River has been a succession of alternating episodes of valley deepening, accompanied by progressive headward encroachment of nickpoints in northwestern Texas, and less extensive valley alluviation.

The locations are given of all fossil molluscan faunas, Pearlette volcanic ash localities, and measured sections, together with fossil molluscan faunas from selected localities in the Red River basin and profiles of the gradients of the Red River and its principal tributaries and of the major terrace surfaces. The topography and Pleistocene deposits of the basin are also illustrated.

Report of Investigations No. 50. LIGNITES OF THE TEXAS GULF COASTAL PLAIN, by W. L. Fisher. 164 pp., frontispiece, 67 figs., 5 tables, October 1963 \$2.00

Lignite, or low-rank coal, is one of the widespread industrial minerals of Texas. In this report, the occurrence, distribution and regional variation of lignite are discussed; reserves by county and principal deposits are indicated; and quality and utilization, both current and potential, are evaluated. The report also includes proximate and ultimate analyses of nearly 350 samples from 31 counties as well as several determinations of wax and trace-element content, ash composition, and carbonization and hydrogenation products. History of lignite mining and past production in the State are reviewed, and field description and graphic stratigraphic sections of lignite exposures in several areas are given.

Results of recent research indicate that future non-fuel as well as specialized fuel uses of lignite should be significant.

This paper, reproduced by offset in 8½ by 11-inch size, has as frontispiece a photograph of the operation of McKay Lignite Mining Company, Como, Texas, taken in August 1913.

INDEX TO WELL SAMPLES AND CORES (Revised Through 1962), by Philip S. Morey. 683 pp., October 1963\$3.00

The Well Sample and Core Library of the Bureau of Economic Geology, formally established in 1937, is located in a fire-proof brick building at the Balcones Research Center of The University of Texas. This Library contains about 5 million samples of bit cuttings from approximately 60,000 wells and about 68,000 feet of cores.

This Index is a revision of The University of Texas Publication 5015, issued in 1950. Wells are listed by serial number and arranged alphabetically by county, operator, and fee owner. Depth range of samples is given for each well.

The Index, 8½ by 11 inches in size, is mimeographed and bound in paper cover.

Guidebook No. 4. THE GEOLOGIC STORY OF LONGHORN CAVERN, by William H. Matthews III. 50 pp., 41 figs., February 1963\$1.00

Written in popular style and fully illustrated, this Guidebook details the story of one of Texas' best known caves. Longhorn Cavern State Park is located in Burnet County and was acquired by the State in 1931. The cavern is formed in the upper massive limestone of the Gorman Formation and contains many features of geologic interest. Cave formations present include stalactites, stalagmites, columns, draperies, calcite crystals, rimstone, and massive flowstone deposits. The cavern has yielded the remains of numerous prehistoric animals; it has been used as an Indian camp and as a hiding place for outlaws, including Sam Bass. During the Civil War, Confederate troops manufactured and stored gunpowder in the cave. The wrap-around cover of the publication features the impressive entrance. A detailed tour map is one of the many illustrations.

Guidebook No. 5. FIELD EXCURSION: GEOLOGY OF LLANO REGION AND AUSTIN AREA, by V. E. Barnes, W. C. Bell, S. E. Clabaugh, P. E. Cloud, Jr., R. V. McGehee, and Keith Young. 77 pp., 16 figs., 3 tables, April 1963 ...\$0.75

This Guidebook is a reprinting (with minor modifications) of *Field Trip No. 1* from "Geology of the Gulf Coast and Central Texas," E. H. Rainwater and R. P. Zingula, editors, published by the Houston Geological Society for the November 1962 Annual Meeting of The Geological Society of America and Associated Societies. The reprinting was in response to strong local interest in the geology of the Llano region and the Austin area and the needs of geology students and faculty engaged in study of this classic region.

The book includes an index map showing the excursion route and the eight stops and many geologic maps of the localities visited. Chapter headings and authors are as follows: "Introduction," by V. E. Barnes; "Geologic History of Central Texas"—"Precambrian Rocks of Llano Region," by S. E. Clabaugh and R. V. McGehee; "Cambrian History, Llano Region," by W. C. Bell and V. E. Barnes; "Ordovician to Earliest Mississippian Rocks, Llano Region," by V. E. Barnes and P. E. Cloud, Jr.; "Carboniferous History, Llano Region," by W. C. Bell; "Meso-

zoic History, Llano Region," by Keith Young. The detailed field trip road log includes 25 pages.

Geologic Quadrangle Map No. 25. GEOLOGY OF THE JOHNSON CITY QUADRANGLE, BLANCO COUNTY, TEXAS, by V. E. Barnes. Map with text. Scale: 1:24,000. November 1963\$1.50

The twenty-first in a series of 7½-minute quadrangles in Gillespie, Blanco, and some adjoining counties, this map of the Johnson City quadrangle is in color and is accompanied by a 12-page text printed in booklet form. This map is the first of a group of central Texas geologic quadrangle maps which will be compiled as new topographic bases become available.

Johnson City quadrangle is high on the southeastern side of the Llano uplift. Precambrian, Cambrian, and Ordovician rocks crop out in about two-thirds of the quadrangle; Cretaceous rocks and Quaternary surficial deposits occupy the remainder. Mineral resources of the area are discussed in the text, and sample descriptions are included for the Winans and Forbes No. 1 Buckner and the Stratoray Oil Corporation No. 1 Stribling wells.

Geologic Quadrangle Map No. 26. GEOLOGY OF THE EAGLE MOUNTAINS AND VICINITY, HUDSPETH COUNTY, TEXAS, by James R. Underwood, Jr. Map with text. Scale: 1:48,000. November 1963\$2.25

Eagle Mountains and vicinity include three physiographically distinct but stratigraphically and structurally related sub-units: Eagle Mountains, Devil Ridge, and Indio Mountains. Eagle Peak summit, the highest point in Hudspeth County, is 7,496 feet above sea level. The map area is in the Mexican Highlands section of the Basin-and-Range province. Rocks exposed in the Eagle Mountains and vicinity range in age from Precambrian to Recent, and the text includes a detailed discussion of the geology of the area. Lists of fossils identified in the course of the field work are given for various formations. The section on economic geology includes water, fluorspar, barite, lead, zinc, copper, silver, petroleum, and coal.

The detailed map is in color and is accompanied by several cross sections. The 32-page text is in booklet form.

INDEX TO AREAL GEOLOGIC MAPS IN TEXAS, 1891-1961, by Thomas E. Brown. Map with text. Scale: 1:1,200,000 (1 inch=about 19 miles). February 1963\$1.00

This index map shows published and unpublished areal geologic maps in Texas and brings up to date the "Geologic Map Index of Texas" published by the United States Geological Survey for the period up to 1951.

Maps with a scale of 1:250,000 or larger are outlined on the index map; maps on a smaller scale are also listed in the 20-page bibliography, which includes a total of 360 entries for published maps and 252 for unpublished maps (mostly maps in theses and dissertations).

The mapped areas are differentiated by color according to date of publication. Two enlarged insets are included for central Texas, where map density is high. The bibliography is

indexed by author, by county, by $1^{\circ} \times 2^{\circ}$ AMS quadrangle, and by region.

Open-File Map. GEOLOGIC MAP OF SOUTHEASTERN LLANO UPLIFT, LLANO, BURNET, BLANCO, AND GILLESPIE COUNTIES, TEXAS, by R. V. McGehee. Map without text (preliminary edition). Scale: 1 inch=3,000 feet. May 1963 \$1.25

This map shows the relations of a complex sequence of metamorphic and igneous rocks in the southeastern Llano uplift in Llano, Burnet, Blanco, and Gillespie counties, Texas. It is part of the author's Ph.D. dissertation, which may be consulted at The University of Texas Library.

Open-File Chart. CORRELATION OF CAMBRIAN ROCKS IN CENTRAL TEXAS, by V. E. Barnes. Chart without text (preliminary edition). About 40 by 27 inches in size. July 1963 \$2.50

This chart is one of the illustrations prepared by V. E. Barnes and W. C. Bell for a publication on Cambrian rocks of Texas

which will be a companion volume to The University of Texas Publication 4621, "The Ellenburger Group of Central Texas," by Barnes and P. E. Cloud, Jr. Manuscript for the Cambrian volume is not yet complete, but this chart and one other illustration—a geologic map of the Morgan Creek area, Burnet County—are available on open-file. Copies of the Morgan Creek area map, scale 8 inches equal 1 mile, are also available on request at a sale price of \$2.25.

Mineral Resource Circular No. 45. THE MINERAL INDUSTRY OF TEXAS IN 1962, by F. F. Netzeband, Thomas R. Early, and Roselle M. Girard. December 1963 Free on request

This annual publication, reprinted from the *Minerals Yearbook* of the United States Bureau of Mines, contains information on the quantity and value of mineral production in Texas during 1962.

Publications in Press in 1963

The following publications were in press at the close of 1963:

1. "Stratigraphy of the Fredericksburg Division, South-Central Texas," by Clyde H. Moore, Jr. This paper, in the Reports of Investigations series, is illustrated by 10 figures and 19 plates, including photomicrographs and measured sections together with location maps. It was in galley proof in December 1963 and should be available early in 1964.

2. "Relation of Ogallala Formation to the Southern High Plains in Texas," by John C. Frye and A. Byron Leonard. Three text figures and two plates illustrate this paper, which resulted in part from field work during the summer of 1962. Another in the series of Reports of Investigations, it should be available during January 1964.

3. "Evolution of *Athleta petrosa* Stock (Eocene, Gastropoda) of Texas," by W. L. Fisher, P. U. Rodda, and

J. W. Dietrich. This major work will be a numbered publication in The University of Texas Publication series. At the end of December 1963, it was in galley proof and should be completed during the first part of 1964.

4. "Texas Rocks and Minerals: An Amateur's Guide," by Roselle M. Girard. This booklet, designed to serve as a brief, simple guide that will be of help to school children and teachers, amateur collectors, and others who are interested in the rocks and minerals of Texas, is a companion volume to "Texas Fossils," which was published by the Bureau in 1960 as Guidebook No. 2. Written in non-technical language, the booklet includes information about the great variety of rocks and minerals in the State with general locality data, discussion of origin, and utilization. This Guidebook is scheduled for publication in January of 1964.

Publications by Bureau of Economic Geology Staff in Scientific Journals

Barnes, V. E. (1963) Terrestrial implications of layering, faulting, and crystalline minerals in tektites (abst.): Trans. Amer. Geophys. Union, vol. 44, p. 93.

Barnes, V. E. (1963) Variations in properties of indochinites within their strewn-field (abst.): Second International Symposium on Tektites, University of Pittsburgh, pp. 19-20.

Barnes, V. E. (1963) Crystalline minerals in Muong Nong-type indochinites from Nong Saping, Thailand (abst.): Second International Symposium on Tektites, University of Pittsburgh, p. 26.

Barnes, V. E. (1963) "Tektite strewn-fields." Chapter in *Tektites*, John A. O'Keefe (ed.), University of Chicago Press.

Barnes, V. E. (1963) Detrital mineral grains in tektites: Science, vol. 142, no. 3600, pp. 1651-1652.

Flawn, P. T. (1963) Status of detailed geologic map-

ping in the United States: The State Geologists Journal, Vol. XV, no. 1, pp. 57-58.

Kohls, D. W. (1963) Simsboro and adjacent formations between Brazos and Trinity Rivers, Texas, lithology and clay mineralogy: Gulf Coast Assoc. Geol. Socs., Trans., vol. 13, pp. 111-117.

Maxwell, R. A. (1963) Memorial to John Tipton Lonsdale (1895-1960): Bull. Geol. Soc. America, vol. 74, pp. P9-P12.

Owen, D. E. (1963) Gradational boundaries of the Dakota Sandstone in the southern San Juan Basin, New Mexico (abst.): Geol. Soc. America, Spec. Paper No. 73, p. 212.

Owen, D. E. (1963) Gulfian and Paleocene phosphorites of the Texas Coastal Plain (abst.): Texas Jour. Sci., vol. 15, no. 4.

Rodda, P. U., and W. L. Fisher (1963) Upper Paleozoic acrothoracic barnacles from Texas: Texas Jour. Sci., vol. 14, pp. 460-479.

Status of Current Projects

1. A report entitled "Potential low-grade iron ore and hydraulic-fracturing sands in Cambrian sandstone, northwestern Llano region, Texas," by Virgil E. Barnes and Daniel A. Schofield, is scheduled for publication in mid-1964. The report describes the deposits, discusses their stratigraphic control, and evaluates them as resources.

2. Geologic quadrangle mapping of Blanco County was mostly completed by Virgil E. Barnes a number of years ago. Compilation of this geology on new 7½-minute base maps issued by the U. S. Geological Survey is in progress. The Johnson City quadrangle was published in 1963; the Hye and Rocky Creek quadrangles are in progress. Eight other quadrangles are awaiting base maps.

3. The volume on Cambrian and immediately overlying rocks in central Texas, by Barnes and W. C. Bell, progressed slowly during 1963. Bell continued work on the sections dealing with systematic paleontology and paleoecology. Publication date cannot be estimated; however, a correlation chart prepared for this volume—"Correlation of Cambrian rocks in Central Texas"—was released on open-file in the summer of 1963.

4. Analytical work for the project under the direction of Peter U. Rodda on high-calcium limestone and silica sand along the outcrop of Comanchean rocks from the Red River to the Rio Grande was completed during 1963 and the manuscript is in preparation. This report is scheduled for completion in 1964.

5. A new study of the regional variation in clay minerals in Gulfian and Tertiary rocks of east Texas has grown out of the mineral resource investigation now under way in east Texas (described on page 11 of this report). Under the direction of W. L. Fisher and L. E. Garner, approximately 1,200 X-ray diffraction patterns of clay samples have been made.

6. The manuscript for "Geology of Big Bend National Park," by Ross A. Maxwell, John T. Lonsdale, Roy T. Hazzard, and John A. Wilson, has been reviewed by several editors and revisions are in progress.

7. Investigations by D. W. Kohls of the "sand-kaolin" belt of the Wilcox Group between the Brazos and Trin-



Dr. W. L. Fisher examines an exposure of Trinity Sandstone in southern Cooke County in connection with the Bureau's study of silica sand in north-central Texas.

ity Rivers continued through 1963. Mapping and petrologic studies are complete. Investigations of clay mineralogy and ceramic properties are in progress.

8. Field work on the Ocotillo, Ochoa, and Presidio quadrangles in Presidio County by J. W. Dietrich was completed in 1963. Map compilation and preparation of the manuscript are in progress. The project on mapping and correlation of volcanic rocks in this region outside of these three quadrangles was deferred pending completion of the quadrangle mapping.

9. Study by D. E. Owen of phosphatic nodules in Gulfian and Midway strata of the Gulf Coastal Plain is

still in progress. Dr. Owen made a preliminary report on his work at the December Texas Academy of Science meeting.

10. The annual compilation of Texas mineral statistics in cooperation with the United States Bureau of Mines continued under the direction of Roselle M. Girard.

11. Work on a new bibliography of Texas geology for the years 1951-1960 continued during 1963 under direction of Miss Girard.

12. Field and laboratory work for a study of heavy minerals in the Wellborn Formation in Lee and Burleson counties has been completed by Cader A. Shelby; manuscript is in the hands of readers. Five radiation anomalies in the area of outcrop of the Wellborn mark concentrations of heavy minerals, including zircon and ilmenite. The report will include a geologic map of the deposits as well as detailed mineralogic and stratigraphic information.

Staff Activities

Virgil E. Barnes, in addition to his duties as Associate Director of the Bureau, continued as director of the Geologic Atlas Project and of tektite research. He attended the spring meeting of the American Geophysical Union in Washington, D. C., where he presented a paper on the "Terrestrial Implication of Layering, Faulting, and Included Crystalline Minerals in Tektite Origin." He participated in the Second International Symposium on Tektites in Pittsburgh, Pennsylvania, where he was Chairman for the session on Chemical Composition and gave papers on the "Variations in Properties of Indochinites Within Their Strewn-field" and "Crystalline Minerals in Muong Nong-type Indochinites from Nong Sapong, Thailand." In connection with his tektite research he visited Brookhaven National Laboratory, Upton, Long Island, New York; the research laboratory of General Electric Corporation, Schenectady, New York; Muséum National d'Histoire Naturelle, Paris; and British Museum of Natural History, London. He lectured on tektites before Peace Corps geologists of Ghana while they were at the University of Oklahoma. He also attended the American Association of Petroleum Geologists meeting in Houston and the Association of American State Geologists meeting in Morgantown, West Virginia. During 1963 Dr. Barnes continued writing articles on tektites for publication in technical journals. *Tektites*, published during the year by the University of Chicago Press, contains his chapter titled "Tektite Strewn-fields."

John W. Dietrich worked on a manuscript on the geology of the Presidio area (Ocotillo, Presidio, and

Ochoa quadrangles) in southern Trans-Pecos Texas. A "mid-week warrior" in the Naval Reserve Officers' School at Austin for the past eight years, Lt. Dietrich in February received temporary orders as Instructor. He conducted a 20-week course in Oceanography during the spring semester; the course was repeated in the fall because of the current interest in the field. During the year he continued his public-service activities by working with elementary school science classes and with Girl Scouts on projects relating to geology.

William L. Fisher spent much of the year working on the Bureau's mineral resource study of 42 east Texas counties, a project that is scheduled for completion in July 1964. He finished work on two reports: one, on Texas Gulf Coast lignites, which was published in October by the Bureau, and another, with P. U. Rodda and J. W. Dietrich, based on a comprehensive study of the evolution of the Gulf Coast Eocene *Athleta petrosa* stock, which was in press at the close of 1963. He began preparing, with P. U. Rodda, a manuscript presenting results of the Bureau's study and inventory of high-purity limestones in Texas. During the year, Dr. Fisher gave geology lectures to Austin elementary school children at Casis School and to a class in Economic Geology at The University of Texas. He participated in talks with industrial development committees in east Texas and attended annual meetings of the American Association of Petroleum Geologists in Houston and the Gulf Coast Association of Geological Societies in Shreveport.

During 1963, *Peter T. Flawn* attended a Highway Geology Symposium at Texas A&M University, the

meeting of the American Association of Petroleum Geologists at Houston, the Gulf Coast Association of Geological Societies meeting in Shreveport, Louisiana, and the Water for Texas Conference at Texas A&M University. He made two trips to Mexico in connection with graduate student research in progress, one to Nuevo Leon and the other to Zacatecas. He accompanied a geologist with the Mexican Atomic Energy Commission on a trip to visit uranium mines and milling facilities in south Texas. Early in the year Dr. Flawn visited mines, quarries, and processing plants in Trans-Pecos Texas. In the summer he visited Bureau field parties mapping in Hudspeth County and in the Rio Grande Valley in Cameron, Willacy, and Kenedy counties. He addressed the Industrial Minerals Division of the American Institute of Mining, Metallurgical, and Petroleum Engineers at the national meeting in Dallas on "The State and Industrial Minerals: Too Much Oil in the Eyes of Texas?" He also addressed the Texas Coast Section of the Institute in Houston on the subject of "Texas Industrial Minerals," the Permian Basin section of the Society of Economic Paleontologists and Mineralogists in Midland on the "Ouachita System in West Texas and Mexico," and the Science and Mathematics Summer Institute at Texas Christian University in Fort Worth on the subjects "Geology Today and Tomorrow," "Geology of the Southwest and Its Relation to Southwestern Culture," and "Geological Research."

Roselle M. Girard completed work on a non-technical Guidebook, *Texas Rocks and Minerals*, which was scheduled to be published by the Bureau in January 1964. She also, in cooperation with the United States Bureau of Mines, helped prepare the Texas Chapter of the 1962 *Minerals Yearbook* and a new listing of Texas mineral producers that will be distributed by the Bureau of Economic Geology. During the year she provided mineral information in reply to more than 350 inquiries from all over the State and Nation. Work continued on a new bibliography and index of Texas geology—this compilation and indexing is a long-term project. She wrote the section on Bureau of Economic Geology activities that appeared in the Department of Geology *Newsletter*, July 1963, and continued her duties as librarian of the Bureau staff library. Miss Girard was initiated into the Texas Chapter of the Society of Sigma Xi in the spring of 1963.

Donald W. Kohls continued his investigation of the geology and mineralogy of the Simsboro (Tertiary,

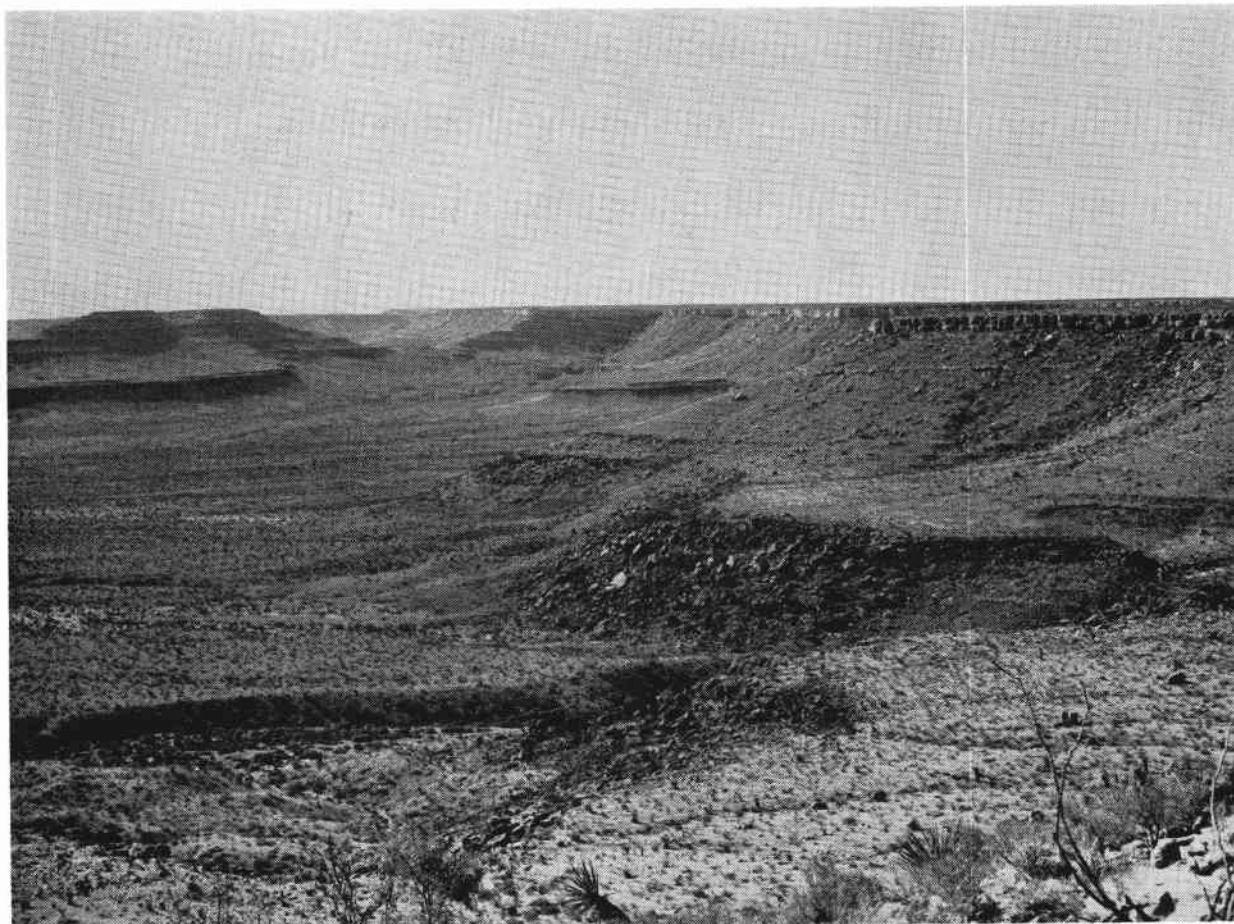
Wilcox) sand-kaolins in the area between the Brazos and Trinity Rivers in east-central Texas. He completed the petrologic studies and map for this project and brought to partial completion his studies of the mineralogy and ceramic properties of the clays. In November, Dr. Kohls attended the Gulf Coast Association of Geological Societies meeting in Shreveport, where he presented a paper on the lithology and clay mineralogy of the Simsboro and adjacent strata of east-central Texas.

James W. Macon lectured to graduate students at The University of Texas on photogrammetry, using the Bureau's Balplex plotter. He designed and built a Percent Reduction Pantograph for scribing. This new instrument makes it possible to scribe in more detail on geologic maps.

Ross A. Maxwell completed his manuscript on the geology of the Big Bend National Park and after it was critically reviewed, made further revisions. This detailed report is co-authored by John T. Lonsdale, Roy T. Hazzard, and John A. Wilson. Dr. Maxwell also began writing a non-technical report on the Big Bend National Park. In March, Dr. Maxwell attended the American Association of Petroleum Geologists meeting in Houston and in November, the conference for the Advancement of Science and Mathematics Teachers (CASMT), which met in Austin. He also participated for the Texas Academy of Science in Visiting Scientist Programs in Texas High Schools. He gave talks on geology to science classes in the Austin Public Schools and served as a counselor and committee member of the Boy Scouts of America Troop 11. He also served as a member of the Board of Directors for the Highland Lakes area of the Capitol Area Council of BSA and as a member of the Board of the Central Christian Church in Austin.

Philip S. Morey, geologist-in-charge of the Bureau's Well Sample and Core Library, spent much of the first nine months of the year preparing a new *Index to Well Samples and Cores*, which was published by the Bureau in October. He began work on a new project, an investigation of the "San Antonio Salient." As a part of this study he prepared detailed lithologic logs of several wells in Bexar County. During the year, Mr. Morey also supervised the processing of gifts of well samples from Gulf Oil Corporation, Wichita Falls; Shell Oil Company, Abilene; and Socony Mobil Oil Company, San Antonio.

Donald E. Owen, who received his Ph.D. degree from



The Rim Rock country of western Hudspeth County, Texas. The escarpment is formed by the Cox and Finlay Formations. Geologic mapping is in progress in this area for the Van Horn sheet of the Texas Geologic Atlas.

the University of Kansas in June, was occupied in 1963 with geologic mapping of the San Antonio Mountain, Tepee Butte, and Borrego quadrangles in Hudspeth County. He began mapping the Hueco Bolson in El Paso and Hudspeth counties for the Van Horn-El Paso sheet of the Texas Geologic Atlas. Dr. Owen continued his investigation of Gulfian and Paleocene phosphorites of the Texas Coastal Plain. Field studies and sampling of phosphorites in the northeast Texas portion of the Plain were completed. In March, Dr. Owen attended the annual meeting of the American Association of Petroleum Geologists in Houston and in November, the annual meeting of The Geological Society of America in New York. He presented a paper on "Gulfian and Paleocene Phosphorites of the Texas Coastal Plain" at the Texas Academy of Science meeting in Abilene in December.

The abstract of this paper appeared in the December issue of the Texas Journal of Science.

Mary Kathryn Pieper, who joined the Bureau's research staff in October, began work on the Texas Geologic Atlas project on the Texarkana sheet. Mrs. Pieper, whose husband is enrolled in the Graduate School of The University of Texas, previously was employed by Shell Oil Company in Houston, where she worked as a micropaleontologist and stratigrapher.

Peter U. Rodda completed his study, with W. L. Fisher and J. W. Dietrich, of the *Athleta petrosa* stock in the Eocene of Texas—the report of this investigation was in press at the close of 1963. During the year, Dr. Rodda also wrote, with W. L. Fisher, a paper on the evolutionary features of *Athleta*, which is scheduled for publication in *Evolution* in 1964. Also in collaboration

with Dr. Fisher, he began writing and brought to near completion a manuscript presenting results of the Bureau's high-calcium and high-magnesium limestone study. Dr. Rodda continued the cataloging of type specimens in Bureau paleontological collections and inspected, packed, and shipped to Austin the fossil collection presented to the Bureau by the late Mrs. Augusta Hasslock Kemp of Seymour, Texas. During the spring semester, Dr. Rodda taught a course in invertebrate paleontology at The University of Texas; in March, he attended the American Association of Petroleum Geologists meeting in Houston.

Daniel A. Schofield, chemist-in-charge of the Mineral Studies Laboratory of the Bureau, continued to work with engineers supervising the construction of the new quarters of the Laboratory, now nearing completion. Mr. Schofield supervised testing, analyzing, and evaluating over 1,100 samples of clays, sands, lignites, and

limestones for the Bureau's mineral resource survey of 42 east Texas counties.

Cader A. Shelby completed editorial revisions of the manuscript of his forthcoming report, *Heavy Minerals in the Wellborn Formation, Lee and Burleson Counties, Texas*, which is scheduled for publication by the Bureau in 1964. In addition to his public-service work in mineral identification, he wrote the first draft of a manuscript presenting results of his heavy mineral study for the Bureau's east Texas mineral resource survey. In January, Mr. Shelby accompanied Dr. Maxwell to the Big Bend National Park to photograph a large number of localities for the Big Bend project. In the late winter and spring he did photographic and field work for the east Texas project, and during the summer he completed photographic illustrations for the Bureau's Guidebook No. 6. In December, Mr. Shelby was initiated into the Texas Chapter of the Society of Sigma Xi.

Mineral Resources in East Texas Project

Area Redevelopment Administration Contract

A study of industrial mineral resources of east Texas, undertaken by the Bureau in July 1962, continued during 1963 with completion scheduled for July 1964. This mineral survey of 42 east Texas counties is supported by a \$40,000 contract with the Area Redevelopment Administration, United States Department of Commerce.

Commodities or resources being studied as a part of the survey include ceramic and non-ceramic clays, industrial and specialty sands, construction sand and gravel, cement and pozzolanic materials, building stone, lime and fluxstone, crushed stone, lignite and leonardite, peat, natural abrasives, salt, greensands, phosphorites, heavy minerals, asphaltic sands, and mineral fillers and pigments. In 1963, approximately 2,000 samples, collected from pits and outcrops, were tested

by the Bureau's Mineral Studies Laboratory and in the X-ray laboratory. Each of the commodities or resources surveyed is being considered in terms of distribution and occurrence, quality, reserves, mining and production methods and costs, beneficiation, current and potential utilization, marketing, and past and current production.

Industrial minerals are consumed in large quantities by industry. The purpose of this project is to provide a reasonably complete and up-to-date inventory of east Texas mineral resources. Emphasis is being placed on potential development and utilization of mineral resources commonly considered marginal in quality, new and additional uses of available mineral resources, and future utilization of currently undeveloped mineral deposits.



Open-pit, bench mining of bentonitic clay deposits, Bennett-Clark Company pit, southern Angelina County. Bentonitic clays mined in east Texas are used primarily as rotary drilling muds, filtering and decolorizing materials, and insecticide and fungicide fillers.

Texas Geologic Atlas Project

The first product of this project, published in February 1963, was "Index to Areal Geologic Maps in Texas, 1891-1961," by Thomas E. Brown. The index map (scale 1:1,200,000) shows the areas of published geologic maps and unpublished theses in Texas. The map is accompanied by a text including a short introduction, a bibliography of geologic maps in Texas, and indexes to the maps by counties, by Army Map Service sheets (which serve as a base for the Atlas), and by regions for maps at scale smaller than 1:250,000.

Mr. Walter Haenggi was retained for one month to field check the western half of the Tyler sheet and to map areas where no contributions of geologic mapping had been received. Most of the geologic mapping for the Tyler sheet has been scribed. This map should be ready for review shortly after the first of 1964.

Dr. Donald E. Owen mapped the San Antonio Mountain, Tepee Butte, and Borrego 15-minute quadrangles on the Van Horn sheet during the summer; the Van Horn part of the Van Horn-El Paso sheet, in process of being scribed, should also be ready for review shortly after the first of 1964.

Compilation of the Sherman and Texarkana sheets is advanced; parts of these sheets were field checked by Dr. Owen. The Oklahoma Geological Survey has remapped Love County (Sherman sheet); western Choctaw County (Texarkana sheet) is scheduled to be mapped soon. The Arkansas Geological Commission anticipates completion of their portion of the Texarkana sheet early in 1964. As soon as contributions of mapping are received from the Oklahoma Geological Survey and the Arkansas Geological Commission for

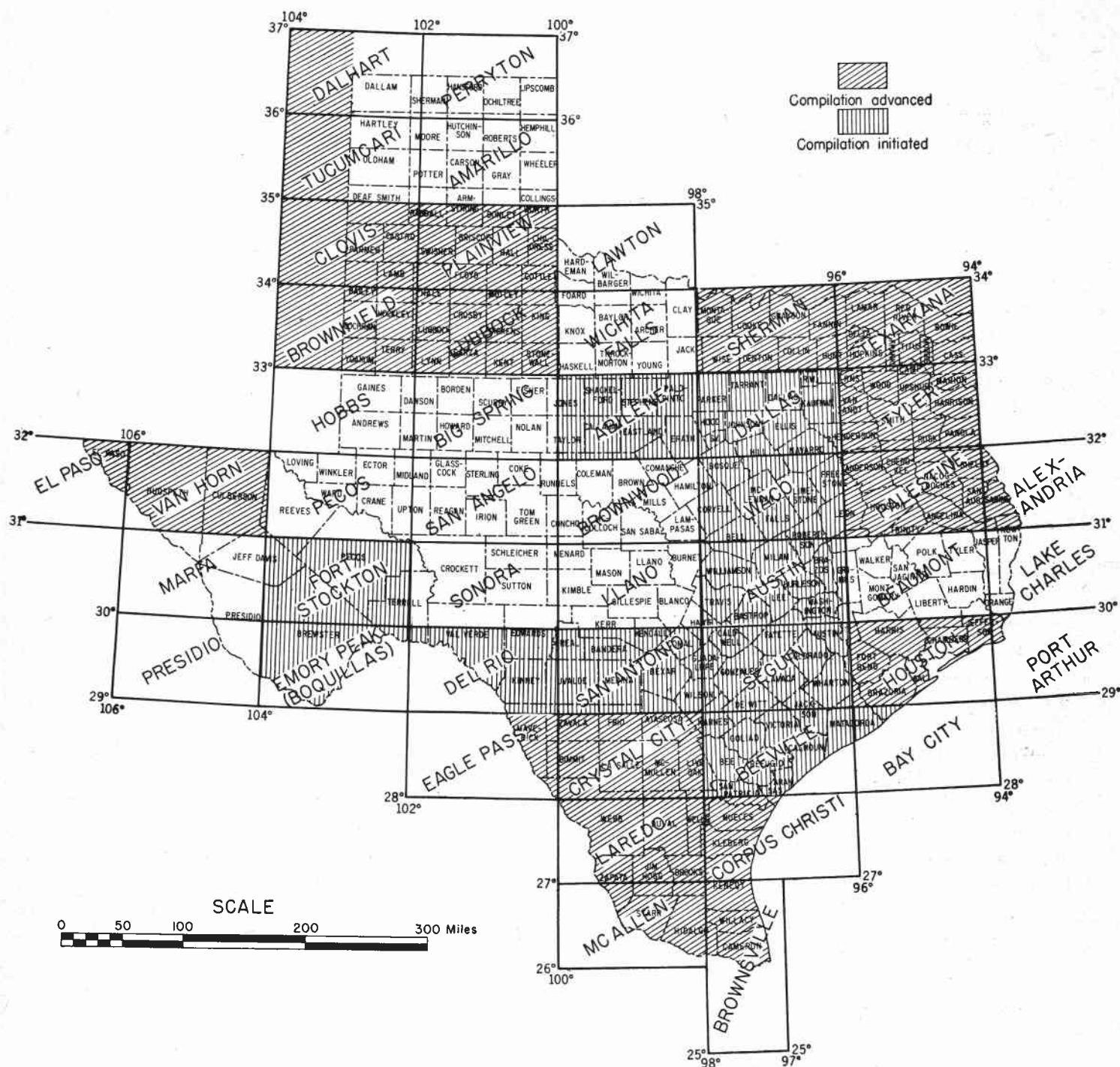
the portions of these sheets in Oklahoma and Arkansas, respectively, these sheets will be ready for completion of manuscript maps for review.

Dr. John P. Brand's assignment in Baghdad and Dr. David E. Dunn's transfer to the University of North Carolina brought work on the Plainview, Lubbock, and the Texas part of the Brownfield and Clovis sheets to a halt. The New Mexico Bureau of Mines and Mineral Resources reported that the pre-Tertiary rocks of the New Mexico portion of the Brownfield and Clovis sheets have been mapped; however, the Cenozoic rocks have been mapped only in a generalized manner. They also reported that the New Mexico portion of the Dalhart and Tucumcari sheets is essentially complete, except that the Cenozoic units are generalized on the Tucumcari sheet, and that reconnaissance geologic mapping of the Hobbs sheet has been completed except for a few miles along the north edge. However, detail is lacking in the Cenozoic rocks.

The Texas part of the McAllen-Corpus Christi sheet and the McAllen part of the McAllen-Brownsville sheet are ready for field checking. Field checking and publication of these sheets have been postponed until it can be ascertained whether or not geologic mapping of appropriate scale is available for the Mexican portion of these two sheets.

The accompanying "Index map of Texas showing 1° x 2° base maps for Texas Geologic Atlas Project" shows the progress in compilation of the Atlas.

Mrs. Charles A. Pieper, a photogeologist formerly with Shell Oil Company, joined the Atlas Project Staff in October 1963.



INDEX MAP OF TEXAS SHOWING 1°x2° BASE MAPS FOR
TEXAS GEOLOGIC ATLAS PROJECT

Well Sample and Core Library

The Well Sample and Core Library is one of the largest public collections of its kind in the United States. The collection weighs more than 400 tons, covers 17,000 feet of floor space, occupies 53,500 cubic feet of shelf space, and in length of geologic sections represented, measures about 25,000 miles. Nearly 5 million individual samples and 68,000 feet of core from 60,000 oil, gas, and water wells from every section of Texas are available for study.

During 1963 the task of processing the estimated 300,000 oil well samples from about 5,000 wells in 120

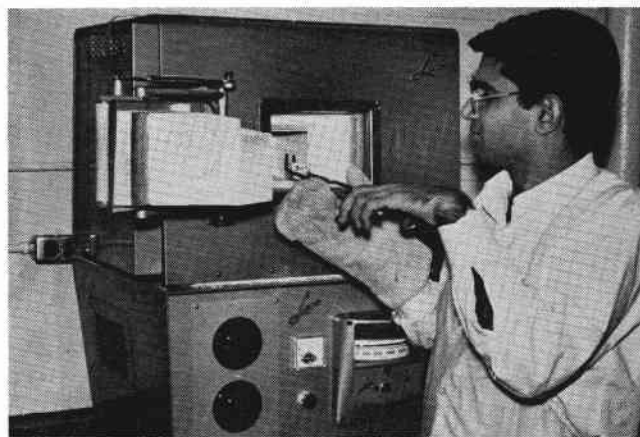
counties received in 1962 from the Shell Development Company was less than half completed when the Gulf Oil Corporation offered the entire contents of their sample warehouse in Wichita Falls to the Bureau of Economic Geology. Many of these valuable samples were salvaged and brought to the Well Sample Library. Approximately 350,000 samples from an estimated 3,000 wells in 97 counties in Texas and three adjacent counties in Oklahoma were added to the collections of the Library in 1963.

Mineral Studies Laboratory

The new quarters for the Mineral Studies Laboratory will be ready for occupancy early in 1964. The floor area of the present laboratory will be doubled, thus making it possible to bring under one roof the present facilities, the former spectrographic laboratory of the Balcones Research Center, and added facilities for sample preparation and mineral separation.

New equipment added to the Mineral Studies Laboratory in 1963 include a LECO Model 542 electric furnace, a Beckman ACDU 73600 power supply, a Mettler Type H-3 multi-purpose balance, and a BICO Model 242-72XX vertical grinder. The LECO furnace can be used to test refractory materials at temperatures as high as 3,000° F. The Beckman power supply facilitates and speeds the operation of the Beckman DU spectrophotometer for absorption and flame photometry. The Mettler multi-purpose balance saves considerable time in weighing for physical testing. The BICO vertical grinder is provided with high-alumina grinding plates which permit pulverizing rock samples without metal contamination. During 1963, the major effort of the laboratory was devoted to testing, analyzing, and evaluating about 1,100 samples of clays, sands, lignites, and limestones.

Mr. Jim Tom Etheredge joined the staff of the laboratory in September, filling the position of Research Scientist Associate I. Mr. Etheredge holds a B.S. degree with major in chemistry from Southwest Texas State College.



Clay sample undergoing firing tests in the Mineral Studies Laboratory's new LECO high temperature furnace. This furnace will develop temperatures up to 3,000° F and is being used for evaluating potential refractory materials.

National Science Foundation Grants in the Bureau of Economic Geology

The National Science Foundation grant to V. E. Barnes and F. E. Ingerson for research on the composition and origin of tektites has been extended. During 1963, chemical and petrographic investigations supported by solar furnace melts developed many new data which were included in scientific papers presented by Dr. Barnes at the sessions of the American Geophysical Union in Washington, D.C., and at the Second International Symposium on Tektites in Pittsburgh.

The term of the grant awarded to P. T. Flawn and E. F. McBride for study of igneous rocks in south Texas

and northeastern Mexico was extended for one year until October 1, 1964. Two master's theses supported by the project were completed in August 1963. W. L. Lindeman submitted a study of the Catahoula Formation in Duval County, Texas, and John F. McKnight reported on igneous rocks in the northern Sierra de Picachos, Nuevo Leon, Mexico. Field work in Texas was completed by Dr. McBride in 1963; field work by C. R. Sewell is continuing in western Nuevo Leon and eastern Coahuila, Mexico.

Geology Building Moves Ahead

The architectural firm of Page-Southerland & Page, working closely with S. E. Clabaugh, Chairman of the Department of Geology, and P. T. Flawn, Director of the Bureau of Economic Geology, is completing the engineering and working drawings of the approved plans. Bids will be let early in 1964 and construction will begin as soon as possible thereafter. The Bureau will occupy the top floor of the \$2,250,000 structure, which will be located southwest of the University Power Plant and east of the Chemical Engineering Building on the new East Mall. Lower floors will house the Department of Geology and some general classrooms. The

research facilities for the Bureau will feature a series of office-laboratory combinations, a large and fully equipped special projects laboratory, and a sample preparation room. The cartographic operations will utilize a large drafting room, photogrammetry laboratory, processing laboratory, and photographic laboratory and darkroom. Public-service facilities will include a public research room and library, mineral identification laboratory, publications and mailing room, reception area, and conference room. The Bureau's Mineral Studies Laboratory and Well Sample and Core Library will remain at Balcones Research Center.

Bureau Exhibit

During 1963, the Bureau exhibit was displayed at the meeting of the American Association of Petroleum Geologists in Houston and at The University of Texas Round-Up Showcase. The Houston meeting was attended by 4,600 geologists and geophysicists. The exhibit featured a central panel built around the Texas

Geologic Atlas Project and the Bureau's detailed quadrangle mapping program. One side panel displayed photographs of Bureau activities today and a half century ago, the opposing side panel was devoted to current publications and The University seal. A new exhibit is being designed for 1964.

Texas Mineral Industry News

According to preliminary figures prepared jointly by the United States Bureau of Mines and the Bureau of Economic Geology, the value of Texas' mineral production in 1963 was about 4.47 billion dollars, up nearly 143 million dollars, or 3.2%, over 1962. The 1963 total was second only to the record 1957 value of 4.48 billion dollars. Of the total value for 1962, 92% was petroleum, natural gas, and natural gas liquids. The nonmetallic industrial minerals, metals, and miscellaneous commodities were valued at 362 million dollars. Nearly all commodities showed gains. These included petroleum, natural gas, natural gas liquids, portland cement, clays, gypsum, helium, lime, salt, stone, barite, fuller's earth, lignite, graphite, iron ore, magnesium compounds, pumice, and uranium ore. The only commodities registering a decline were sand and gravel, sulfur, sodium compounds, asphalt, and bromine. The largest increases in units of production were registered by portland cement (12.2%), helium (9.5%), clays (9.4%), stone (5.8%), natural gas liquids (5.0%), talc and soapstone (4.6%), and petroleum (3.3%). Other commodities had increases of less than 2%. Sulfur production declined 5.0% and sand and gravel declined 2.5%. The decline in sand and gravel production in the face of increased production of other construction materials is attributed to depletion of some sand and gravel deposits and substitution of crushed stone in their market area. Among commodities whose production quantities and values are concealed because of the limited number of producers in the State, largest gains were recorded by barite, fuller's earth, uranium ore, magnesium compounds, and graphite while the largest decline in production was for pumice. In 1963, the Texas mineral industry was economically strong and healthy, although tight reins continued on petroleum production.

Over all, mineral fuels advanced 2.9% in value, of which 70.3% was petroleum, 18.5% was natural gas, and 10.9% was natural gas liquids. This shows a continuation of the industry trend of the last decade in which the crude oil segment of the industry has declined

or remained more or less static while the natural gas industry has expanded.

A number of developments in the Texas oil and gas industry in 1963 were reported in the *Oil and Gas Journal* and other sources. In east Texas, the giant Fairway field continued to grow as development projects proceeded. Exploration of the "dry" salt domes met with success as a discovery was made at the Grand Saline dome, and Texaco established the first production from the Bethel dome. Discoveries in the Smackover in Van Zandt County and in the Rodessa in Wood County encouraged exploratory drilling. In south Texas and the Gulf Coast, interest in the deep Wilcox was strong in 1963. The multi-pay Fort Trinidad field in Madison and Houston counties was further developed, and Texas' southernmost field—Southmost—was discovered near Linn in Cameron County. A new Frio discovery was made in Victoria County. In west Texas, development proceeded of a large gas-condensate field in Crockett County near Ozona. Shell Oil Company's No. 1 Baggett was the third producer in the field. Another successful Crockett County wildcat was completed as a dual producer from Fusselman and Pennsylvanian beds in the northwestern part of the county. Oil was discovered at west Texas' largest gas field (Azalea). Deep probing of the Val Verde basin and the frontal parts of the Ouachita structural belt continued. A remote wildcat in Terrell County was completed as a gas producer from Strawn beds. A Mississippian discovery was made in Yoakum County. Martin County had a new field confirmed in Fusselman. Upton County recorded a new Pennsylvanian producer northwest of Rankin. Pure Oil Company completed their No. 1 W. C. Tyrell in Pecos County as the world's deepest producing gas well. Two new Mississippian fields were brought in in north Texas' Hardeman County and yet another Mississippian find was made in Shackelford County. Coleman County recorded a new gas field. However, perhaps of most interest was a Gulf Oil Corporation wildcat which blew in late in the fall from just below 4,600 feet in dry Bandera County in the Kerr basin. The No. 1 Gallant

et al. remained a tight well at the close of 1963, while a lease play it generated continued over the area.

Water rivaled petroleum as the State's most important mineral commodity. U. S. Corps of Engineers projects planned or in progress in Texas total 2 billion dollars. In 1963, studies of water reserves and quality of water were accelerated by both State and Federal agencies.

In the summer of 1963, Susquehanna-Western, engaged in uranium mining and milling operations in Karnes County, discovered a new orebody about 2 miles south of the now largely exhausted deposits of the Deweesville area. The company classed the find as a major discovery. Stripping operations were scheduled for completion in January 1964. The new operation is named the Galen mine after geologist Galen Quigley.

During 1963, two new developments in the silica-sand industry were announced. Magnet Cove Barium Corporation of Houston began development of a sand-kaolin deposit near Kosse in Limestone County. Separation of the sand and clay is expected to yield about 150,000 tons per year of silica sand of glass quality and 60,000 tons per year of kaolin. H. B. Zachry Company of San Antonio formed an operating company, called Capitol Silica Products, to produce silica sand in northeastern Somervell County, 18 miles southwest of Cleburne. Heart of Texas Mining Company installed a grinding plant at its frac-sand operation at Brady to

produce "pulverized sand" for the construction industry. The new plant of Texas Clay Tile, Inc., at Malakoff was dedicated in March of 1963.

Southwestern Superior Products Corporation acquired the Superior Stone Products plant at Round Rock and expanded operations for production of metallurgical and chemical dolomite products. Facilities for production of dead-burned dolomite were completed in 1963. Because of large construction projects in central Texas and engineering projects along the Texas Gulf Coast, 1963 was a busy year for central Texas quarry operators. Texas Granite Corporation, Texas Crushed Stone Company, and Texas Quarries, Inc., reported increased activities early in 1963. Southwest Portland Cement Company constructed a 1.25 million-barrel-per-year cement manufacturing plant at Bushland, 10 miles west of Amarillo. The plant will utilize surficial sand-caliche deposits. Also accounting for the State's increase in cement production was the new McDonough plant at Houston and increased capacity for the Texas Industries, Inc., Midlothian plant. Other mining or metallurgical operations reporting expansions included Wah Chang Corporation's electrolytic ore-processing plant at Texas City, Cameron Iron Works' Houston operations, and Sheffield Division of Armco Steel Corporation, Houston. The Houston Division of Signal Oil and Gas Company announced plans to construct a 40-tpd sulfur recovery unit.

Bureau Receives Kemp Collection and Library

The late Mrs. Augusta Hasslock Kemp, of Seymour, Texas, donated to the Bureau an important paleontological collection consisting of about 5,000 fossil in-

vertebrates, including 50 type specimens, as well as a specialized library composed of about 1,600 items.

University Service Awards Go to Bureau Staff Members

On December 19 at the University's Annual Employee Recognition Program, James W. Macon, Bureau Cartographer, was recognized for 15 years service. Geologists Ross A. Maxwell, Philip S. Morey, Roselle M. Girard, and John W. Dietrich completed 10 years serv-

ice. Also recognized for 10 years service were Dan F. Scranton, Cartographic Technician, and Grant T. Millegan, Clerk. The successful operation of any organization is a reflection of the permanent staff whose years of service give a continuity of program.



Dr. J. R. Smiley, President of The University of Texas (left center), receives from Mr. Bernard S. Sines, President of Rio Bravo Oil Company and Vice-President of the Southern Pacific Railroad, the deed for the Rio Bravo Oil Company collection. Looking on are Dewitt C. Dunn (right), Manager of Rio Bravo, and Peter T. Flawn (left), Director of the Bureau of Economic Geology.

Rio Bravo Oil Company Collection Comes to Bureau

In March of 1963, the Bureau was given a collection of more than 40,000 fossil and rock specimens by the Rio Bravo Oil Company. Most of the specimens are from Texas and Mexico, but the collection also includes materials from California and other parts of the southern United States. On loan to the Bureau since 1931, the collection has been the basis for 16 scientific papers. In addition to its importance as a research and teaching

tool, the collection is of considerable historical interest to Texas geologists. It was begun in 1897 by E. T. Dumble when he organized the Southern Pacific Company's geological department—the first in the oil industry. The Rio Bravo Oil Company is a subsidiary of Southern Pacific. Many well-known geologists contributed to the collection, including C. L. Baker, W. F. Cummins, G. D. Harris, William Kennedy, and J. A. Taff.

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