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New Mexico Bureau of Mines & Mineral Resources
A DIVISION OF
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
To: Board of Regents and President of
New Mexico Institute of Mining & Technology
Governor of New Mexico

I have the honor of transmitting to you the Annual Report of the New Mexico Bureau of Mines & Mineral Resources for the fiscal year July 1, 1974 to June 30, 1975, as required by Section 3, Chapter 115, of the Eighth New Mexico Legislature sessions laws, approved March 4, 1927.

During the fiscal year 21 new technical reports were published by the Bureau, 12 talks were presented at scientific meetings, and 35 papers by Bureau staff and consultants were published in scientific and mineral resources journals. Information concerning exploration, development, and conservation of New Mexico's mineral resources was provided in 6895 letters, in 4560 telephone calls, and in 3520 visitor conferences in Bureau offices. Sales of publications, priced at about cost of printing, totaled $32,550. More than 8,300 publications were distributed to state officials, libraries, and scientific agencies.

Resignations and deaths had reduced professional staff by 35 percent during the previous fiscal year; addition of 7 new members during 1974-75, however, restored professional staff to full strength. The Board of Educational Finance and the New Mexico Legislature closely followed the Regents' recommendations for a 6-percent increase in the Bureau's budget for the 1975-76 fiscal year, and allowed salary adjustments to keep competitive with State agencies.

During May 1975, most of the Bureau staff moved into the newly constructed southwest wing of Workman Research Center. Total space in the new facility is more than 10,000 square feet, a net gain of 3,500 square feet as the Bureau gave up 6,500 square feet of its previous floor space.

Respectfully submitted,

Frank E. Kottlowski
Director

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER
ANNUAL REPORT
for the Fiscal Year
July 1, 1974 to June 30, 1975

by
Frank E. Kottlowski
and Staff

1975
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
Kenneth W. Ford, President

NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES
Frank E. Kotilowski, Director

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Judy Peralta, Secretary

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Allan R. Sanford, Geophysicist
Thomas E. Zimmerman, Chief Security Officer

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Joseph Daichy
Jeffrey A. Fischer
Henry L. Fleischhauer

David L. Hawley
Stephen C. Hook
Joseph Iovinetti
Glenn R. Osburn

Charles Shearer
Paul Shulski
Terry Siemens
William Wilkinson

Plus more than 35 undergraduate assistants

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Introduction

Where can New Mexico turn for reliable knowledge of the mineral resources critically needed by the nation?

By law, the New Mexico Bureau of Mines & Mineral Resources is the official State organization charged with investigating and reporting on the geology and mineral resources of New Mexico, including the energy resources. The Bureau is required to give technical and scientific assistance in the exploration, development, production, and conservation of New Mexico's mineral wealth. That is the basis of our program. In 1974 the value of minerals extracted in New Mexico totaled more than $2.0 billion—about 2000 times the Bureau's appropriation for that year.

New Mexico's mineral industry contributes mightily to the State's economy. In addition to the $2.0 billion value of the raw products taken from the earth are the many jobs for mineral industry employees in the cities shown in the mineral map on the outside of the back cover. Furthermore, the industry paid to the State and its subdivisions more than $155 million in taxes, rentals, royalties, and bonuses. No other industry even approaches this kind of direct fiscal support. These tax monies comprise a major part of the current surplus in the general fund.

The mineral industry needs answers to economic and technical problems. Scientific evaluation is increasingly important in assessing New Mexico's mineral potential. Geologic, mining, and metallurgical studies insure a stable mineral economy. New Mexico must make sure that when presently producing deposits are used up others, to be discovered, are ready to take their place.

Most of the talents and funds for finding and developing New Mexico's mineral resources comes from private industry. The Bureau contributes actively to these programs by taking the lead in applied research that insures industry's prudent growth. Serving as a clearinghouse of the best possible scientific and technical information, the Bureau shares impartially its files of basic data with all companies, individuals, agencies, and institutions. An outstanding example is the New Mexico Library of Subsurface Data established in the Bureau. Oil well samples and records, secured by companies and individuals at a cost of several billion dollars, are freely available; their value increases with the passing of time.

Relation of Geology to Resources

Geological knowledge is indispensable in the exploration and development of mineral resources. Field investigations of mineral deposits, regional geologic reports, structure contour maps, detailed and reconnaissance geologic maps, and stratigraphic studies aid in finding and, eventually, in extracting minerals. Many geologists, mining engineers, prospectors, and landowners visit the Bureau to confer on geologic data and interpretations.

Much of the Bureau's work is in technical services, but pure and applied geologic research are also important. Prior to 1960, Schilling's study of low-grade molybdenum deposits near Questa was in the realm of pure research; today, a mill extracts this ore. Prior to 1962, studies of late Paleozoic reefs in the San Andres, Sacramento, and Guadalupe Mountains were mostly stratigraphic research; today, similar Abo reefs in southeastern New Mexico yield oil and gas.
Outcrop and subsurface stratigraphic studies of the 24 counties not now producing oil and gas may be considered pure geologic research today, but, tomorrow could lead to the discovery of petroleum in these areas.

Geologic investigations that may help exploration for metals and industrial rocks range from tabulation of county-by-county mineral production to detailed work on the gold deposits at White Oaks. Evaluation of ground-water supplies is aided by hydrogeologic reports setting forth basic geologic and engineering data for counties or other areas. Areal geologic mapping, fundamental to all geologic and mineral resources investigations, has been completed for many quadrangle areas.

Many of the Bureau’s technical publications are designed to aid in the search for fuels and minerals. These publications range from reconnaissance maps in the Geologic Map series to detailed studies contained in the Bulletins, Memoirs, and Circulars. Is the scientific and technical information generated by the Bureau useful to the mineral exploration industry? Sales of Bureau publications totaled more than $32,550 this fiscal year; about 8,500 copies of the new publications were issued free to state officials, libraries, and scientific organizations. Nor do the sales figures or a particular publication necessarily reflect its ultimate worth to New Mexico; a single report or map may contain the clue that leads to the discovery of a huge orebody or a million-barrel oil pool.

Many New Mexicans, and most of the tourists visiting the state, are not concerned directly with technical geologic investigations but do have a true interest in our enchanting landscapes. They want to know how the canyons and mountains, arroyos and mesas, and volcanoes and desert playas were formed. The popular guides Scenic Trips to the Geologic Past explain the geology of local areas, and point out scenic and geologic wonders. These booklets also are designed to keep tourists in the state “that extra day”—so important to New Mexico’s economy. Tens of thousands of copies have been distributed already, and the demand continues.

Basic Services

Citizens of New Mexico (and elsewhere) including geologists, engineers, landowners, prospectors, legislators, students, industry personnel, and tourists asked for technical advice from Bureau staff. Our records show that 6,955 letters and 4,560 telephone inquiries were answered, and 3,520 office visitors counseled.

More than 15,000 adults and school children toured the Bureau’s mineral museum. Bureau laboratories prepared 2,227 analytic reports on 1,002 samples (mineral, ore, water, and metallurgical). Staff mineralogists identified hundreds of hand specimens brought or mailed to the Bureau.

Direct services to petroleum exploration included making available records of many of the more than 65,000 test wells drilled in New Mexico, including cuttings from selected wells and a variety of borehole logs such as electric, radioactive, and sonic. Up-to-date petroleum exploration maps for most counties are maintained and available.

The business office sold publications and maps for total sales of $32,550. In
addition, about $26,000 of New Mexico Geological Society guidebooks were
sold; the Bureau handles these special publications as a public service. The
business office also furnished secretarial and stenographic services, assisted in the
selection of vendors for specialized materials, and prepared requisitions and
purchase orders.

The Mineralmobile was exhibited in various parts of the state for 19 days, as
well as at the State Fair.

The Director of the New Mexico Bureau of Mines & Mineral Resources is ex
officio Director-Secretary of the New Mexico Coal Surfacing Commission.
Surfacing permits were issued to Navajo Mine of Utah International, Inc.
and Sundance Mine of Sundance Mining Co. Inspections were made of York
Canyon mine of Kaiser Steel Co., McKinley mine of Pittsburg & Midway Coal
Co., and the San Juan mine of Western Coal Co.

The Director of the New Mexico Bureau of Mines & Mineral Resources is also
ex officio member of the State Water Quality Control Commission which
conducts regular bimonthly meetings as well as additional special meetings and
public hearings.

A number of cooperative projects were continued with state and federal
agencies. Staff members served on various government committees and com-
misions, served as officers of professional organizations, presented papers at
scientific meetings, and served New Mexico Tech by teaching, directing graduate
studies, and participating in the work of various campus committees.

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Geologic and Resource Investigations

Emphasis in the Bureau's program is to provide statewide evaluations of resources and reserves, to study key areas in detail, and to recommend guides for exploration, development, production, and conservation of our mineral and fuel resources.

Energy Resources
1. Foster and Grant—Future of New Mexico's oil and gas resources (Resource Map 3)
2. Biehman—Oil and gas fields and exploration map of New Mexico
3. Thompson and Biehman—Oil and gas exploration wells in Doña Ana County, New Mexico (New Mexico Geological Society 26th guidebook, in press)
4. Foster—Petroleum geology of the Bone Springs Formation
5. Biehman—Up-date catalog of samples available in New Mexico Library of Subsurface Data
6. Foster—Oil and gas potential of central Delaware basin, New Mexico
7. Biehman—New Mexico part of “Oil and Gas Field Data Bank and Map of North America” by American Association of Petroleum Geologists
10. Thompson—Petroleum potential of southwest New Mexico
11. Foster—Estimate of oil and gas reserves in New Mexico
12. Greenwood, Thompson and Kottlowski—Petroleum potential of Pedregosa basin
14. Zeller and Thompson—Structural geology of the Big Hatchet Peak quadrangle (Circular 146, in press)
15. Milner—Glorietta-San Andres facies in east-central New Mexico
16. Chamberlin and Chapin—Geology and geothermal potential of Socorro Peak volcanic field
17. Tabet—Jornada del Muerto coal field
19. Yurewicz—Capitan Formation in Guadalupe Mountains
20. Wheeler—Goat Seep reef in Guadalupe Mountains
21. Kumar and Foster—Tertiary recovery of oil in Loco Hills field, Eddy County
22. Roman and Shomaker—Spatial distribution of rock strata in coal spoil banks (in cooperation with U.S. Forest Service)
23. Christiansen—History of oil and gas exploration and production in New Mexico
24. Renault and Hayes—Thermoluminescence of quartz as a guide to exploration for uranium in sandstone deposits

Geology and Mineral Resources
1. Renault—Geology of Chupadera Mountains
2. Weber—Geology of Plains of San Agustin
3. Seager, Clemons, and Hawley—Geology of Sierra Alta quadrangle (Bulletin 102)
4. Weber—Geology of Mockingbird Gap site
5. Cunningham—Geologic map of Silver City quadrangle (Geologic Map 30)
6. Woodward and Martinez—Geologic map of Holy Ghost Spring quadrangle (Geologic Map 33)
7. Cunningham—Circle Mesa quadrangle
8. Clemons—Geologic map of east half of Corralitos Ranch quadrangle (Geologic Map 36, in press)
9. Woodward, DuChene, and Reed—Geologic map of San Miguel Mountain quadrangle (Geologic Map 34)
10. Kelley and Northrop—Geology of Sandia Mountains and vicinity (Memoir 29)
11. Woodward—Geologic map of San Ysidro quadrangle (Geologic Map 37, in press)
12. Seager and Clemons—Geology of Cedar Hills-Selden Hills area, Doña Ana County (Circular 133, in press)
13. Kelley, V.—Structure of Albuquerque basin
14. Hunt—Surficial geology of New Mexico
15. Lovejoy—Geology of Cristo Rey (Memoir 31, being edited)
16. Hoffer—Geology of Potrillo basalt field, south-central New Mexico
17. Seager—Geologic map and sections of south half San Diego Mountain quadrangle (Geologic Map 35, in press)
18. Hunt—Physiographic map and description of New Mexico
19. Seager and Dulas—Geology and ore deposits of the Organ quadrangle
20. Seager and Kottlowski—Geology of Doña Ana Mountains (Circular 147, in press)
21. Woodward—Geologic map of Gilman quadrangle
22. Woodward—Geologic map of Gallina quadrangle
23. Seager, Kottlowski, and Hawley—Geology of Robledo Mountains
24. Clemons—Geologic map of west half of Corralitos Ranch quadrant
25. Chapin—Geology and mineral resources of Socorro County
26. Robertson—Annotated bibliography and index to mapping of Precambrian geology of New Mexico

Water Resources
1. Sione—Geology and ground-water resources of San Juan County (in cooperation with U.S. Geological Survey)
2. Sione—Question-and-answer pamphlet on ground-water resources
3. Trauger—Ground-water resources of Harding County (in cooperation with U.S. Geological Survey)
4. Titus—Ground-water resources and geology of Estancia Basin (Bulletin 103, being edited)
5. Shomaker—Deep aquifers in the San Juan basin (in cooperation with companies in area)
6. Summers—Catalog of thermal waters in New Mexico (Hydrologic Report 4, in press)
7. Titus—Ground-water resources of Sandia and Manzano Mountains (in cooperation with U.S. Geological Survey)
8. Brandvold, L.—Mercury content of natural waters in New Mexico
9. Brown—Hydrogeology of Aztec quadrangle
10. Stein—New Mexico water resources information
11. Brandvold, L. and Dauchy—Analysis of heavy metals in Rio Grande basin

Industrial Minerals
1. Austin—Shale and clay resources in New Mexico
2. Austin—Potash deposits in New Mexico
3. Austin and Weber—Perlite deposits in New Mexico
4. McNulty—Fluorspar deposits in New Mexico
5. Weber—Zeolites in New Mexico
6. Taggart—Mineralogy of Hansonburg mining district

Metallic Ores
1. Chapin, Clemons, Seager, Weber, and Kottlowski—Age dating of igneous rocks and metallic mineralization in central and southwestern New Mexico
2. MacMillan—Structure, petrology, and ore deposits of southern part of Sierra Cuchillo
3. Robertson—Precambrian geology and ore deposits of southern Sangre de Cristo Mountains
4. Lufkin—Tin mineralization within rhyolite flow-domes, Black Range (Open-file report 57)
5. Iovenitti—Origin of silification in Kelly mining district
6. Proctor—Trace base metals in Cooke’s Peak stock
7. Condie and Budding—Precambrian rocks in San Andres Mountains
8. Condie—Precambrian rocks of the Ladron Mountains, Socorro County (Geologic Map 38, in press)

Mining Districts
1. Jahns and Willard—Manganese deposits of Luis Lopez district
2. Jahns and Willard—Gold deposits of White Oaks mining district
3. Chapin—Geology and mineral resources of the Magdalena area
4. Wilkinson—Cat Mountain mining district
5. Christiansen—History of mining in New Mexico (Scenic Trips 12)

Stratigraphy and Paleontology
1. Hawley, Bachman, and Manley—Quaternary stratigraphy of the Basin and Range and Great Plains Provinces, New Mexico and western Texas
2. Hawley—Quaternary geology of Las Cruces region
3. Flower—Mollusca of the Devonian of New Mexico
4. Frye, Leonard, and Glass—Ogallala Formation of northeast New Mexico
5. Sarg—Carbonate-evaporite transition facies of Seven Rivers Formation
6. Kotlowski—Mississippian strata of San Andres Mountains
7. Leonard and Frye—Pliocene and Pleistocene deposits and molluscan fauna, east-central New Mexico (Memoir 30)
8. Flower—Ordovician actinoceroids and endoceroids (Memoir 28, in press)
10. Frye, Glass, Leonard, and Coleman—Calcicale and clay mineral zonation of Ogallala Formation, central-eastern New Mexico (Circular 144)
11. Siemers, T.—Stratigraphy and petrology of Mississippian, Pennsylvanian, and Permian rocks in the Magdalena area, Socorro County (Open-file report 54)
12. Hook and Flower—Cephalopod faunas of latest Canadian age from southwestern United States
13. Flower—Ordovician correlation chart (Circular 138, in press)
14. Siemers, T.—Pennsylvanian stratigraphy of Socorro County
15. Flower and LeMone—Faunal and petrologic studies of Bliss Sandstone, El Paso Group, and Montoya Group
16. Sheely—Petrology of sandstones in Dakota Formation on southeast fringe of San Juan basin
17. Pfefferkorn—Pennsylvanian compression floras in northern New Mexico
18. Balk—Stratigraphic nomenclature for New Mexico
19. Grant and Owen—Dakota Formation of southern Chama basin
20. Kues—Fauna of Red Tanks Member of Madera Limestone in Lucero Mesa area
21. LeMone—Permian carbonate petrology for Doña Ana and Robledo Mountains
22. Simpson—Abo-Huco megaфаunas from Doña Ana and Robledo Mountains
23. Owen and Siemers, C.—Dakota units in southeast San Juan basin between Laguna and La Ventana
24. Gage—Mesa Rica sandstone in Tucumcari area
25. LeMone, Simpson, and Klement—Paleoecology of transition beds of Abo and upper members of Huco
26. King, Krause, and Dixon—Fusulinids of Huco Formation in Las Cruces area
27. Macurda—Mississippian crinoids in Lake Valley Formation
28. Van Wagoner and Wilson—Gobbler Formation facies in the Sacramento Mountains, Otero County
29. Smith, R.—Petrogenesis of clastic plugs in Union County
30. Gilbert—Sedimentology of braided alluvial interval of Dakota Sandstone in northeastern New Mexico
31. Benne—Lower Gobbler Formation in Sacramento Mountains, Otero County
32. Hook—Statistical analysis of plant spiral coiling in cephalopods, gastropods, and fusulinids
33. Flower—Cephalopod studies: 1) Orders Endoceratida and Tarphyceratida, 2) Piloceratida of Newfoundland, 3) cephalopods of Durness Limestone of Scotland, Plateville Limestone of upper Mississippi valley, Tyrone Limestone of Kentucky, and Smithville Formation of Arkansas and Missouri, and 4) Ordovician of Spitzbergen
34. Foster and Riese—Stratigraphy of the Castle Formation
35. Chapin—Cenozoic stratigraphy of Socorro-Magdalena area

Environment, Remote Sensing, and Geologic Hazards
1. Tabet, Feldman, and Inglis—“Landsat” (formerly Earth Resources Technology Satellite) evaluation of mineral resources, geological structures, land use and landforms in New Mexico
2. Tabet, Inglis, Feldman, and Page—Land use and remote sensing resources evaluation (in cooperation with Federation of Rocky Mountain States, Technology Application Center (University of New Mexico) and State Planning Office)
3. Feldman, Inglis, Vonder Linden, Chapin, Rhodes, and Kotlowski—Geologic analysis of ERTS-1 (Earth Resources Technology Satellite 1) imagery for New Mexico (Open-file report 53)

Geophysical Surveys
1. Reiter, Mansure, Edwards, and Shearer—Deep temperature logging and crustal radioactivity measurements in New Mexico and adjacent areas (funded by National Science Foundation
and the Energy Research and Development program of State of New Mexico in cooperation with New Mexico Institute of Mining & Technology.


3. Ritter, Edwards, and Shearer—Shallow temperature logging (4000 feet or less) in New Mexico and adjacent areas (funded by National Science Foundation in cooperation with New Mexico Institute of Mining & Technology).

4. Sanford—Survey of earthquakes in New Mexico (continued).

5. Sanford—Gravity survey in central New Mexico.


Special Projects


4. Weber-Petrographic and chemical characteristics of 4 new meteorites from New Mexico.

5. Renault-Petrology and geochemistry of basalts in the Isleta area, Socorro and Valencia Counties.

6. Chapin-New Mexico in the Cenozoic tectono-magmatic framework.


8. U.S. Geological Survey-Topographic map (1:50,000 scale) of Bernalillo County (in cooperation with Bernalillo County, City of Albuquerque, Four Corners Regional Commission, and New Mexico Bureau of Mines & Mineral Resources).


11. Sutherland—Revision of Scenic Trips No. 6, Trail Guide to the Upper Pecos.

12. James and Schilling, J.—Revision of Scenic Trips No. 10, Southwestern New Mexico (by incorporating Scenic Trips No. 5, Silver City-Santa Rita-Hurley into Scenic Trips No. 10).

13. Bikerman-Age-dating of volcanic rocks in Glenwood area.


Metallurgy

The primary functions of the Bureau's program in metallurgy are: 1) to provide assistance to any individual or group seeking help in developing a technical process for a mineral deposit in the state, 2) to improve the processes for testing ores and the procedures for operating mineral-processing plants, and 3) to assist in the technical education of individuals interested in the mineral industry in this state.

Formal courses were taught, guest lectures given, and graduate theses directed for the College Division; papers were presented at technical meetings, and current research results published.

Current metallurgical projects:

Briey—1) Biogenic extraction of copper and molybdenum at high temperatures, 2) effect of an oxidant on leach dump bacteria, 3) biogenic uranium extraction from Anaconda ores, and 4) properties of thermophilic bacteria.

Plow—1) Environmental equilibrium study with water and substrata samples from the Red River, upstream and downstream from Questa, 2) a feasible chloridization system for removing aluminum from clay, 3) a small-scale pilot plant for the solvent extraction of metals from leached ores, 4) small-scale characterization of leachability of copper oxide ores.

Roman—1) Heap leaching evaluation of Cerrillos copper ore, 2) heap leaching evaluation of Miami copper ore, 3) coal mine reclamation, 4) open-pit mining sequence, and 5) in-situ hydrogenation of coal.
Analytical and X-Ray Laboratories

The Bureau's laboratories are equipped to perform extensive chemical, mineralogical, and petrologic investigations. Chemical analyses, both qualitative and quantitative, are performed by classic wet-chemical and optical-spectrographic procedures, as well as by atomic absorption, X-ray, and electron-microprobe spectrometry.

The laboratories serve the public and all divisions of New Mexico Tech. Capabilities include analyzing water, ores, concentrates, geological samples, and leach liquids for the common elements or parameters.

During the year analytic assays were made of mineral samples, ore samples, water samples, metallurgical solutions, heads, concentrates, and tails on a total of 750 samples (1,670 assays). A data system has been established to reproduce the many water analyses run in our laboratory during the past 10 years; the file contains 400 entries and is about 65 percent complete.

X-ray analyses were performed on a large variety of rock materials. Machine time for X-ray diffraction totaled 920 hours; for X-ray fluorescence, 2,070 hours. The electron-microprobe facility was used mainly for microanalysis of spinel inclusions in olivine phenocrysts of basalts; more than 1,000 analyses were obtained.

The thin-section laboratory produced more than 500 thin sections for various Bureau projects; facilities were also used extensively by the Geoscience Department. Over 2,500 thin sections have now been cataloged for the Henry Birdseye Laboratory, including rocks from all areas of New Mexico.

New Mexico Library of Subsurface Data

During the year 210 sets of drilling samples were added, bringing the total number of sets on hand to more than 9,200. Also acquired were electric and other types of mechanical logs from 1,392 wells, in addition to 1,375 well records from drilling operations.

Publications

The Bureau issued 20 new publications in the form of memoirs, bulletins, circulars, scenic trips, journal of geochronology, geologic maps, resource map, publication catalogs, brochures, geologic postcard, and annual report. Another 3 publications were re-issued, while 10 manuscripts were released as open-file reports. Six publication announcement cards were prepared and released. Seven large-scale full-color geologic map sheets were published (3 sheets in 3 Geologic Maps, 2 sheets in Memoir, and 2 in Bulletin). The brochures were in conjunction with the mining symposium convened in Silver City in May, and the State Fair.

Editing and Publishing

A total of 621 pages were edited and printed in new publications (scientific, 412; popular, 113; publication catalogs, 64; annual report, 32). A total of 349 pages were printed in re-issued publications (all scientific).
Funds allocated to printing totaled $51,835, or about 6 percent of the total budget for operating the Bureau.

At the close of the fiscal year, 53 manuscripts were either in review or planning (up 15 percent); another 21 were being edited or were in press (up 16 percent).

Man-years devoted to publishing activities were estimated as follows: editing, 0.7 internal plus 0.1 external; pasteup and copyreading, 1.0; proofreading (student), 0.3; secretarial, 0.13. The cutback in editing staff amounted to a decrease of 0.82 man-years.

About 21 percent of the camera-ready copy for new publications was prepared in Bureau; about 18 percent of printing was done at Tech.

Drafting and Illustrating

Three full-time employees do most of the Bureau's cartographic and illustrating work. As time permits, occasional small jobs are done for the other divisions of Tech.

Running duplicate copies of U.S. Geological Survey aeromagnetic maps and other open-file maps continues at high volume.

Skills developed with the color-proofing equipment acquired previously, along with use of a new color selection chart, have contributed importantly to the increased quality of our multicolor maps.

Twelve large geologic maps were in production or awaiting preparation at the close of the fiscal year.

New Publications


Comprehensive coverage of rocks and formations, structure, paleontology, stratigraphy, geologic history, and mineral resources. Discusses caves and artifacts, historical geologic surveys and early mining operations; also includes such environmental problems as landslides and earthquakes. Contains a topographic map, structure map, structure sections, and color geologic map.

Memoir 30—PLOICEINE AND PLEISTOCENE DEPOSITS AND MOLLUSCAN FAUNA, EAST-CENTRAL NEW MEXICO, 1975, by A. B. Leonard and J. C. Frye, 44 p., 3 tables, 6 figures, 3 plates, $5.00.

Molluscan faunal assemblages (dated 18,000 to 5,000 B.P.) from 45 localities produce a composite fauna of 47 species. Describes paleoclimates and geology of the Cenozoic.

Bulletin 102—GEOLOGY OF SIERRA ALTA QUADRANGLE, DONA ANA COUNTY, NEW MEXICO, 1975, by W. R. Seager, R. E. Clemons, and J. W. Hawley, 56 p., 2 tables, 13 figures, 1 map, 2 appendices, $4.50.

Describes stratigraphy of Permian to Holocene rocks. Structure includes a volcano-tectonic depression which appears to be a precursor to Rio Grande rift in this area. Miocene to Pliocene faults superimpose across the depression. Also characterizes Quaternary evolution of landscape.

Bulletin 105—ANNOTATED BIBLIOGRAPHY OF GRANTS URANIUM REGION, NEW MEXICO, 1975, by F. A. Schilling, Jr., 69 p. $4.00.

Circular 142—ATOMIC ABSORPTION METHODS FOR ANALYSIS OF SOME ELEMENTS IN ORES AND CONCENTRATES, 1974, by L. A. Brandvold, 22 p., 1 table. $1.00.

Laboratory manual of procedures for application of atomic absorption and dissolution methods to rocks and minerals.


Clay mineral zones, lithology of rocks and physiographic setting determine climatic influences and correct age of zones. Top 4 to 6 ft of the capping calcite was developed by events of the Pleistocene and Holocene.

Scenic Trip 12—THE STORY OF MINING IN NEW MEXICO, 1974, by P. W. Christiansen, 112 p., 29 photographs, 3 maps, 7 drawings, $2.50.
History of mining from the Indians and Spanish, through the gold and silver rushes of the 1800's to the turn of the century. Includes a chapter on mining potpourri and an annotated bibliography. Unique collection of rare photographs and attractive illustrations.


A serial journal of isotopic geochronology.

Geologic Map 30—GEOLOGIC MAP OF SILVER CITY QUADRANGLE, NEW MEXICO, 1974, by J. E. Cunningham. $1.50.

Text on map.

Geologic Map 33—GEOLOGIC MAP OF HOLY GHOST SPRING QUADRANGLE, NEW MEXICO, 1974, by L. A. Woodward and R. Martinez. $1.50.

Text on map.


Text on map.

Resource Map 3—THE FUTURE OF NEW MEXICO'S OIL AND GAS RESOURCES, 1974, by R. W. Foster and P. R. Grant, Jr., text and 2 figures. $1.00.

Map classifies exploration potential of nonproducing areas. Recommends reevaluation of New Mexico's present regulations governing exploration and development of resources.


Comprehensive listing of geologic and mineral reports and maps, with subject and author index and colored index map.

Geologic Postcard—SKETCH OF NEW MEXICO FROM SATELLITE PHOTOGRAPHS, 1974, 4½” x 6” postcard. $0.10.


Brochure—BASE METAL AND PRECIOUS METAL DISTRICTS OF NEW MEXICO AND ARIZONA.

Abstracts of papers presented at symposium in Silver City, New Mexico, May 1975.

Re-issued Publications


ISOCHRONE/WEST—Nos. 6 and 10 (available to subscribers)

Open-file Reports


Outside Papers Sponsored in Part by Bureau


Reiter, M. A., Edwards, C. L., Shearer, C. R., and Weidman, C., 1974, Terrestrial heat flow studies


Shomaker, J. W., 1975, New Mexico coal resources: Governor's Energy Task Force, 44 p.


Taggart, J. E., and Brookit, D. G., 1975, Rb-Sr whole rock age determinations for Sandia Granite and Cibola Gneiss, New Mexico: Isochron/West, no. 12, p. 5-8.


Vail, P. R., Mitchum, R. M., Jr., and Thompson, S. III, Eustatic cycles based on sequences with coastal onlap (abs.): Geol. Soc. America, Abstracts with Programs, v. 6, no. 7, p. 993.

Articles in Bureau Publications


Kelley, R. W., 1975, Foreword to Memoir 29, Geology of Sandia Mountains and vicinity, p. 5.

Additional Professional Activities

Participation in Scientific and Professional Conferences

American Association of Petroleum Geologists: Annual Meeting, April; Circumpacific Energy and Minerals Conference, August; Rocky Mountain Section, June

American Chemical Society: Pacific Conference on Chemistry and Spectroscopy, October (society for Applied Spectroscopy, cosponsor); Regional Meeting, July

American Institute of Chemical Engineers: August

American Institute of Mining Engineers: September

American Institute of Mining, Metallurgical and Petroleum Engineers: Intermountain Section Conference, August

American Mining Congress: October

Association of American State Geologists: May; Coal Conference, February (U.S. Geological Survey, cosponsor)

Association of Earth Science Editors: October

Clay Minerals Society: October

Energy Research and Development Institute, New Mexico State University: Coal Symposium, April

Federal Energy Administration: Symposium on Subsurface Geoscience Records and Materials, April

Geological Society of America: Annual Meeting, November; Penrose Conference, August; Rocky Mountain Section, May; South Central Section, March

Institute of Electrical and Electronics Engineers, Inc.: April

Institute on Lake Superior Geology: Twenty-First Annual Meeting, April
Participation in Committees and Commissions

GOVERNMENTAL
Brandvold—New Mexico Water Resources Research Institute, New Mexico State University (Water Conference Advisory Committee); New Mexico Water Quality Control Commission (Bureau representative).
Foster—Interstate Oil Compact Commission (Tar Sands Committee); Governor’s Committee on Technical Excellence (Subcommittee on Radioactive Waste).
Kottlowski—New Mexico Coal Surface Mining Commission (Director-Secretary); New Mexico Mining Safety Advisory Board (chairman); Interstate Oil Compact Commission (member).
Reiter—National Academy of Science (Continental Drilling Committee); Governor’s Energy Task Force, State of New Mexico (Committee for Geothermal Energy Position Paper, chairman).

PROFESSIONAL
Bieberman—American Association of Petroleum Geologists (House of Delegates; Committee on Preservation of Samples and Cores; Membership Committee); New Mexico Geological Society (Publications Committee).
Chapin—New Mexico Geological Society (Publications Committee, chairman; Annual Meeting Committee, chairman; Executive Committee).
Flower—International Commission on the Cambrian-Ordovician Boundary (corresponding member).
Foster—American Association of Petroleum Geologists (Stratigraphic Correlations Committee).
Kelley—Association of Earth Sciences Editors (Board of Directors); New Mexico Geological Society (Publications Committee).
Kottlowski—American Association of Petroleum Geologists (Executive Committee; Publications Committee; Stratigraphic Correlations Committee; Academic Advisory Committee; Editorial Board, chairman; Committee on Preservation of Samples and Cores); American Commission on Stratigraphic Nomenclature (representative from Association of American State Geologists).
Weber—New Mexico Mapping Advisory Committee (Bureau representative); Archeological Society of New Mexico (Board of Trustees).

NEW MEXICO TECH
Arnold—Affirmative Action Task Force.
Chapin—Presidential Search Committee.
Kelley—Group Insurance Committee.
Kottlowski—Executive Committee.
Renault—Library Committee; Graduate Council.
Roman—Graduate Council; Council of Chairmen.
Off-Campus Talks by Bureau Staff

Brierley, C., “Biological methods for copper and molybdenum extraction” at Intermountain Minerals Conference, Vail, CO, August.

   Field trip speaker, New Mexico Geological Society, 25th Field Conference, Ghost Ranch, NM, October.

Foster, R., “Oil and gas potential of central Delaware basin” at Roswell Geological Society, Roswell, NM, March.
   “Oil and gas potential of waste disposal site” at Sandia Laboratories, Albuquerque, NM, April.

Hawley, J., “Geomorphology of the Rio Grande valley in southern New Mexico” at Penrose Conference on Rio Grande Rift, Geological Society of America, Santa Fe, NM, August.
   “Geologic relationships in New Mexico” at Albuquerque Geological Society, Albuquerque, NM, January.

Kottkowski, F., “Stratigraphy of the Santa Fe Group south of Albuquerque” at Penrose Conference on Rio Grande Rift, Geological Society of America, Santa Fe, NM, August.

Reiter, M., “Heat flow along the Rio Grande rift” at Penrose Conference on Rio Grande Rift, Geological Society of America, Santa Fe, NM, August.
   “Heat flow studies in New Mexico by New Mexico Tech” at Institute of Electrical and Electronics Engineers, Inc., Albuquerque, NM, April.

Renault, J., “Basalt volcanism and rift tectonics” at Penrose Conference on Rio Grande Rift, Geological Society of America, Santa Fe, NM, August.

Roman, R., “Heap design with the aid of computer simulation” at Annual Meeting AIChE, Salt Lake City, UT, August.
Bureau Personnel

STAFF CHANGES

New employees joining the Bureau were: George S. Austin, Industrial Minerals Geologist, September 1, 1974; Ruben A. Crespin, Technician, February 24, 1975; John W. Hawley (one year assignment), Geologist, September 1, 1974; Emily Mathieu, Clerk-Typist, February 6, 1975; Norma J. Meeks, Clerk-Typist, April 21, 1975; Candace H. Merillat, Editorial Secretary, May 9, 1975; Leslie S. Mott, Clerk-Typist, September 23, 1974; Marshall A. Reiter, Geophysicist, April 1, 1975; James M. Robertson, Mining Geologist, November 4, 1974; William J. Stone, Hydrogeologist, September 1, 1974; David E. Tabet, Assistant Field Geologist, March 10, 1975; Joseph E. Taggart, Jr., Assistant Mineralogist, August 1, 1974; Samuel Thompson II, Petroleum Geologist, November 4, 1974.

Resignations during the fiscal year were: Diane Allmendinger, September 1974; Jill Collis, January 1975; Emily Mathieu, May 1975; and Thomas M. Plouf, January 1975.

STAFF PORTRAITS

Frank E. Kottlowski
Director.
Senior Geologist 7/2/51

Diane Allmendinger
Clerk-Typist 8/10/72

William E. Arnold
Scientific Illustrator 1/4/54

George S. Austin
Industrial Minerals Geologist 9/1/74
Leslie S. Mott  
Clerk-Typist 9/23/74

Neila M. Pearson  
Draftswoman 8/15/73

Judy Peralta  
Secretary 2/23/74

Thomas M. Plouf  
Research Extractive Metallurgist 8/14/72

Marshall A. Reiter  
Geophysicist 4/1/75

Jacques R. Renault  
Geologist 9/1/64

James M. Robertson  
Mining Geologist 11/4/74

Ronald J. Roman  
Chief Research Metallurgist 5/5/69

Jackie H. Smith  
Laboratory Assistant 12/16/63

William J. Stone  
Hydrogeologist 9/1/74

David E. Tabet  
Assistant Field Geologist 3/10/75

Joseph E. Taggart, Jr.  
Assistant Mineralogist 8/17

Samuel Thompson III  
Petroleum Geologist 11/4/74

Robert H. Weber  
Senior Geologist 5/15/50

Shirley Whyte  
Stenographer 4/26/72

Michael W. Wooldridge  
Scientific Illustrator 1/25/71
Appendix
follows
Production and Reserves—Production of crude oil declined from almost 101 million barrels in 1973 to 98.7 million barrels in 1974 (calendar years). As in the preceding year, most of the decrease was in Lea County. Declines in production also occurred in Chaves, Roosevelt, McKinley, and Rio Arriba Counties. Partially offsetting these declines were the marked increases in production in Eddy and San Juan Counties. Production at Empire-Abo accounted for the gain in production in Eddy County. Almost 14 percent of the total oil produced in the state came from this field. The gain in production in San Juan County resulted from almost a million-barrel increase at the Toctic Dome-Pennsylvanian field. Reserves of crude oil estimated by the American Petroleum Institute show a decline of some 18 million barrels by the end of 1974. The northwest area of the state recorded a slight gain in crude produced; the southeastern area, a sharp decline. Estimated proved reserves for the state total 625 million barrels.

Production of natural gas increased about 30 billion cubic ft over 1973. Most of this increase occurred in Eddy and Lea Counties where development of Pennsylvanian-age pay zones continued. Increases in production also were recorded in McKinley, San Juan, and Sandoval Counties. The largest decline was in Rio Arriba County, but active in-fill drilling in 1974 should improve this trend. The American Gas Association's estimated reserves declined 543 billion cubic ft. As of the first of the year reserves totaled 12 trillion cubic ft.

Natural gas liquid production amounted to almost 36 million barrels, an increase of about 110 thousand barrels over 1973. Reserves declined slightly to 397 million barrels.

Drilling Summary—The number of wells drilled for oil and gas increased from 981 in 1973 to 1141 in 1974. The number of completions in the northwest area of the state declined slightly. This was more than offset by drilling activity in the southeast area of the state. Exploratory drilling was about the same with 228 completions in 1974, compared with 226 in 1973. Exploratory completions numbered 12 oil wells, 40 gas wells, 1 dual gas well, 146 dry holes and 29 temporarily abandoned wells. Twenty-seven percent of the wells were completed successfully. Eddy County again led in the number of wildcat tests with 100 completions. The total exploratory footage drilled in the state amounted to 1.5 million ft, an increase of 100,000 ft over 1973. The average depth of wildcat wells increased from 6,050 ft in 1973 to 6,416 in 1974. Independent operators accounted for 81 percent of the exploratory wells drilled.

Development drilling increased to 913 wells in 1974, compared with 755 wells in 1973. Development footage increased by over one million ft; the average depth, from 5,516 ft in 1973 to 5,737 ft in 1974. Almost one million ft more were drilled in Eddy County, offsetting a drilling decline in San Juan County. Independent operators drilled 530 development wells, compared with 382 completions for the major oil companies.

Twenty-eight oil and gas tests were completed in the nonproducing counties. Four of these wells, two in De Baca County, one in Mora County and one in Otero County were either listed as shut-in gas wells or had significant shows of gas. Exploratory wells were drilled in Colfax, Curry, De Baca, Guadalupe, Harding, Lincoln, Mora, Otero, Quay, San Miguel, Santa Fe, Sierra, and Valenica Counties.

The total footage drilled in 1974 was 6,700,408 ft. Not included are data from 18 wells drilled for carbon dioxide, 36 previously completed wells that were drilled deeper, 18 wells that were junked, and 19 wells drilled for water injection. This data would bring total operations to 1,232 wells and footage drilled to 6,850,148 ft.
## Oil and Gas Production, 1974

*Annual Report of New Mexico Oil and Gas Engineering Committee*

<table>
<thead>
<tr>
<th>County and area</th>
<th>Crude Oil (barrels)</th>
<th>Natural Gas (thousands cu ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Gain (+) or decline (-) from 1973</td>
</tr>
<tr>
<td>Chaves</td>
<td>1,787,622</td>
<td>-133,491</td>
</tr>
<tr>
<td>Eddy</td>
<td>21,504,533</td>
<td>+3,464,235</td>
</tr>
<tr>
<td>Lea</td>
<td>66,028,464</td>
<td>-5,806,427</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>1,372,927</td>
<td>-246,907</td>
</tr>
<tr>
<td><strong>Southeast area</strong></td>
<td>90,693,546 (92%)</td>
<td>-2,722,590</td>
</tr>
<tr>
<td>McKinley</td>
<td>1,263,069</td>
<td>-410,382</td>
</tr>
<tr>
<td>Rio Arriba</td>
<td>1,475,669</td>
<td>-140,066</td>
</tr>
<tr>
<td>Sandoval</td>
<td>264,131</td>
<td>+63,723</td>
</tr>
<tr>
<td>San Juan</td>
<td>4,998,550</td>
<td>+918,594</td>
</tr>
<tr>
<td><strong>Northwest area</strong></td>
<td>8,001,419 (8%)</td>
<td>+431,869</td>
</tr>
<tr>
<td><strong>State totals</strong></td>
<td>98,694,965</td>
<td>-2,290,721</td>
</tr>
</tbody>
</table>

## Oil and Gas Reserves, 1974

*American Petroleum Institute and Annual Report of American Gas Association*

<table>
<thead>
<tr>
<th>Area</th>
<th>Crude Oil (barrels)</th>
<th>Natural Gas (thousands cu ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reserves</td>
<td>Gain (+) or decline (-) from 1973</td>
</tr>
<tr>
<td><strong>Southeast area</strong></td>
<td>597,761,000 (96%)</td>
<td>-21,373,000</td>
</tr>
<tr>
<td><strong>Northwest area</strong></td>
<td>27,207,000 (4%)</td>
<td>+3,347,000</td>
</tr>
<tr>
<td><strong>State totals</strong></td>
<td>624,968,000</td>
<td>-18,026,000</td>
</tr>
</tbody>
</table>

## Drilling Statistics, 1974

<table>
<thead>
<tr>
<th>County and area</th>
<th>Wildcat</th>
<th>Development</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of wells</td>
<td>Total footage</td>
<td>Average depth (ft)</td>
</tr>
<tr>
<td>Chaves</td>
<td>24</td>
<td>108,279</td>
<td>4,512</td>
</tr>
<tr>
<td>Eddy</td>
<td>100</td>
<td>705,601</td>
<td>7,056</td>
</tr>
<tr>
<td>Lea</td>
<td>31</td>
<td>313,636</td>
<td>10,117</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>3</td>
<td>24,937</td>
<td>8,312</td>
</tr>
<tr>
<td><strong>Southeast area</strong></td>
<td>158</td>
<td>1,152,455</td>
<td>7,294</td>
</tr>
<tr>
<td>McKinley</td>
<td>6</td>
<td>12,028</td>
<td>2,005</td>
</tr>
<tr>
<td>Rio Arriba</td>
<td>6</td>
<td>24,904</td>
<td>4,151</td>
</tr>
<tr>
<td>Sandoval</td>
<td>16</td>
<td>41,941</td>
<td>2,621</td>
</tr>
<tr>
<td>San Juan</td>
<td>14</td>
<td>54,634</td>
<td>3,902</td>
</tr>
<tr>
<td><strong>Northwest area</strong></td>
<td>42</td>
<td>133,507</td>
<td>3,179</td>
</tr>
<tr>
<td>All other counties</td>
<td>28</td>
<td>176,923</td>
<td>6,319</td>
</tr>
<tr>
<td><strong>State totals</strong></td>
<td>228</td>
<td>1,467,893</td>
<td>6,416</td>
</tr>
</tbody>
</table>
### MINERAL PRODUCTION IN NEW MEXICO

Released by U.S. Bureau of Mines, December 30, 1974

<table>
<thead>
<tr>
<th>Mineral</th>
<th>1973 Quantity (thousands $)</th>
<th>1974 p/ Quantity (thousands $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clays²</td>
<td>88</td>
<td>W</td>
</tr>
<tr>
<td>Coal (bituminous) do</td>
<td>9,069</td>
<td>31,862</td>
</tr>
<tr>
<td>Copper (recoverable content of ores, etc.) short tons</td>
<td>204,742</td>
<td>243,643</td>
</tr>
<tr>
<td>Gem stones</td>
<td>NA</td>
<td>70</td>
</tr>
<tr>
<td>Gold (recoverable content of ores, etc.) troy ounces</td>
<td>13,864</td>
<td>1,356</td>
</tr>
<tr>
<td>Gypsum thousand short tons</td>
<td>255</td>
<td>1,220</td>
</tr>
<tr>
<td>Iron ore (usable) thousand long tons, gross weight</td>
<td>5</td>
<td>114</td>
</tr>
<tr>
<td>Lead (recoverable content of ores, etc.) short tons</td>
<td>2,556</td>
<td>833</td>
</tr>
<tr>
<td>Lime thousand short tons</td>
<td>44</td>
<td>793</td>
</tr>
<tr>
<td>Manganese ore (5 to 35 percent Mn) short tons</td>
<td>32,084</td>
<td>W</td>
</tr>
<tr>
<td>Mica, scrap thousand short tons</td>
<td>10</td>
<td>82</td>
</tr>
<tr>
<td>Natural gas million cubic feet</td>
<td>1,218,749</td>
<td>287,889</td>
</tr>
<tr>
<td>Natural gas liquids: Natural gasoline and cycle products thousand 42-gallon barrels</td>
<td>9,848</td>
<td>32,449</td>
</tr>
<tr>
<td>LP gases do</td>
<td>29,652</td>
<td>74,427</td>
</tr>
<tr>
<td>Peat thousand short tons</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Perlite do</td>
<td>478</td>
<td>5,024</td>
</tr>
<tr>
<td>Petroleum (crude)—thousand 42-gallon barrels</td>
<td>100,986</td>
<td>414,041</td>
</tr>
<tr>
<td>Potassium salts thousand short tons</td>
<td>2,168</td>
<td>91,996</td>
</tr>
<tr>
<td>Pumice do</td>
<td>339</td>
<td>1,001</td>
</tr>
<tr>
<td>Sand and gravel do</td>
<td>10,641</td>
<td>15,753</td>
</tr>
<tr>
<td>Silver (recoverable content of ores, etc.) thousand troy ounces</td>
<td>1,111</td>
<td>2,843</td>
</tr>
<tr>
<td>Stone thousand short tons</td>
<td>2,830</td>
<td>5,894</td>
</tr>
<tr>
<td>Uranium (recoverable content U₃O₈) thousand pounds</td>
<td>9,268</td>
<td>60,356</td>
</tr>
<tr>
<td>Zinc (recoverable content of ores, etc.) short tons</td>
<td>12,327</td>
<td>5,094</td>
</tr>
<tr>
<td>Value of items that cannot be disclosed: Cement, clay, iron, sulfur, fluor spar (1974), molybdenum, salt, tin, vanadium and values indicated by symbol W</td>
<td>XX</td>
<td>29,631</td>
</tr>
</tbody>
</table>

**Total** | XX | 1,306,590 | XX | 2,011,824

**p/ Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.**

²Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

²Excludes fire clay; included with "Value of items that cannot be disclosed."
Deposits of turquoise are widely distributed in New Mexico in a triangular-shaped region extending from Santa Fe County at the northern apex to Otero, Doña Ana, and Grant Counties in the south. The principal deposits that have been sources of significant production are distributed in 4 districts: The Cerrillos district near Los Cerrillos in Santa Fe County; the Burro Mountains district in the vicinity of Tyrone, Grant County; the Eureka (Hachita) district near Hachita, Grant County; and the Orogrande (Jarilla) district near Orogrande, Otero County.

Minor occurrences have been recognized in the White Signal and Santa Rita districts in Grant County, the Organ district in Doña Ana County, and the Nogal district in Lincoln County. Other reported occurrences remain unverified; probably the mineral is more widely distributed in minor amounts than has been recognized.

Inasmuch as all known deposits are on patented or unpatented mining claims, and leaseholds on State lands, the express permission of the claim owner or lessee must be obtained prior to entering the property for purposes of collecting or prospecting for turquoise.

The significance of turquoise to prehistoric inhabitants of the region is widely manifested by the ancient workings (with associated primitive mining tools) that led to the rediscovery of major deposits in the late 1800's. Although the beginnings of this industry are obscure, archeological evidence extends to circa 200 B.C. During the interval of approximately 900 to 1650 A.D., turquoise was intensively exploited and became a commodity of widespread trade throughout the Southwest and Mexico, having been fabricated into beads, pendants, inlay, and mosaic work. The recovery of more than 65,000 pieces during excavations at Pueblo Bonito in Chaco Canyon indicates the magnitude of trade with regions lacking local sources.
Cerrillos District. Deposits in the Cerrillos district are particularly well known from both archeological and historical records spanning a period from 1150 A.D. through the Spanish Colonial and American occupations of the region. In terms of its historic significance and production, the Cerrillos turquoise is pre-eminent among the deposits of the United States, as testified by numerous technical reports dating from 1858.

The major deposits are localized in two separate clusters 3 miles apart, on Mount Chalchihuitl and Turquoise Hill, a few miles north of Los Cerrillos. Extensive prehistoric workings are noteworthy at both localities. Turquoise occurs as narrow veinlets and nodules ranging in color from pale to bright blue through bluish green to dark green set in a matrix of altered monzonite and latite. Brown limonite staining of the matrix is common; occasional inclusions of pyrite in the turquoise have been noted.

Modern production by non-Indian miners began in the 1880's, reached a peak during the 1890's, and declined rapidly during the early years of the present century, although intermittent production in the district continued at the Blue Bell mine until 1925. Estimates of the value of production range widely, reportedly exceeding $2 million from operations of the American Turquoise Co. The major part of this production was from the Tiffany (Casilian) mine at Turquoise Hill, reputed to have yielded a higher proportion of high-grade gem material than any other mine in the United States. Some estimates place the total production of the district at as much as $9 million. Renewed interest in the Cerrillos district in the last few years has stimulated exploration for copper and turquoise, but data on any turquoise production are lacking. Turquoise mining operations in the Cerrillos district currently registered with the State Inspector of Mines consist of the Laura mine of the Laura Mining Co. with F. Rod Blankley of Albuquerque in charge.

Burro Mountains District. In the Burro Mountains district, turquoise has been recovered from a number of mines and prospects in an area about 6 miles southwest of the new townsite of Tyrone. Turquoise is widely distributed as veinlets and nodules in fractured zones in granite and quartz monzonite porphyry highly altered to kaolinite and sericite accompanied by secondary silica. The turquoise exhibits a wide range of color in various shades of blue and green and includes some of the finest gem-quality material obtained anywhere in the world. Pure nuggets to 1500 carats were recovered.

The "original" discovery was made in 1875 by John E. Coleman at the site of prehistoric mine workings. Major mining activity occurred during the period from 1890 to 1910 at several properties, among which were the Azure, Parker, and Porterfield (Maroney) mines. The Azure mine was particularly noteworthy for both the quantity and quality of the turquoise produced. Mine development extended across a fractured zone 40 to 60 ft wide on four adit levels, with a large open pit later excavated from the second level to the surface. The best turquoise was recovered within 100 ft of the surface, with a remarkable concentration in the "Elizabeth pocket" extending 150 ft along the vein, across a width of up to 40 ft, and over a vertical distance of 40 to 60 ft. Production estimates for this period range from $2 million to $4 million for the Azure mine alone, and up to $5 million for the entire district. The former turquoise-producing properties now are controlled by Phelps Dodge Corporation, whose Tyrone open-pit copper mine has in recent years exposed significant turquoise concentrations in the walls of the pit. Currently this deposit is being mined and marketed under contract with Phelps Dodge by James Hamilton of Silver City, doing business as Tyrone Turquoise. The turquoise mining operation is registered as the Tiffany mine.
(subject to confusion with the old Tiffany mine in the Cerrillos district). Both raw and cut turquoise in considerable quantity are being marketed by Tyrone Turquoise.

Eureka District. Turquoise deposits of the Eureka district, on the eastern side of the Little Hatchet Mountains about 6 miles west of Hachita, were rediscovered in 1885 by Sterling Burwell and Con Ryan while exploring ancient diggings for the gold they believed had been mined there by Aztecs or early Spaniards. Mining for turquoise continued intermittently in the district for the ensuing 25 years. Mines developed during this period included the Azure, Cameo, Galilee, Aztec, and the American Turquoise Company. The turquoise occurred in irregular seams up to half an inch thick in altered, fractured, and limonite-stained monzonite; also to a lesser extent in andesitic to basaltic volcanic rocks, sandstone, and diorite. Clay minerals and jarosite commonly were associated with the turquoise. Fine gem-quality stones were recovered in colors that ranged from pale blue through dark sky blue to greenish blue, the paler varieties tending to be relatively soft. Many of the stones were finished in attractive yellow and brown iron-stained matrix pieces; cameos were cut from some of the seams in which a tightly bonded brown matrix served as the base for the carving. Registered mining operations include the Old American mine of the Cameo Turquoise Mining Co., Bowie, AZ, Joseph C. Cooke in charge; and U. V. Industries, Inc. of Salt Lake City, W. H. Ott in charge. No production data are available either for past or current operations in the area, but evidently the total yield has been small as compared with the Cerrillos and Burro Mountains districts.

Orogrande District. In common with the previously described districts, prehistoric workings in the Jarilla Mountains, a few miles north of Orogrande, provided guideposts to turquoise for early prospectors. Although poorly documented, historic mining of turquoise apparently began circa 1891 when 50 kilos of marketable stones were shipped. The turquoise occurred at shallow depths as thin seams along fractures and as reniform, semiglobular, and irregular nodules associated with kaolin, limonite, pyrite, gypsum, and jarosite. Colors ranged from blue to green, some deep-blue stones tending to fade markedly following removal from the mine. Specimens at hand, probably representative of poor quality material from waste dumps, consist of soft, chalky, pale-blue seams with brown webbing and pale-blue to deep-green, irregular nodules in highly bleached and altered rock of monzonitic aspect. Iron oxide staining is conspicuous; the altered wallrock locally is replaced by secondary silica. The Jarilla Mt. Turquoise Co. (James Koons, Jr., El Paso, TX) has developed the Laura Claim No. 1 for production in the district during the past year.

Miscellaneous Occurrences. Minor amounts of turquoise have been recognized in 4 other districts that apparently have yielded relatively little or no commercial production. At the Chapman turquoise mine in the White Signal district, high-grade turquoise was mined (between 1890 and 1900) from a shaft and glory hole in kaolinized and sericitized rhyolite. At the Red Hill prospect, also in the White Signal district, turquoise occurs in narrow veinlets in a wide shattered zone in altered granite. Although most of the turquoise was soft and green in color, a few nodules of hard, blue stones were recovered. In the Santa Rita district, turquoise has been encountered in the Chino open-pit copper mine of the Kennecott Copper Corporation at Santa Rita. Some may have reached the market via miners working in the pit. Two specimens seen by the writer consist of aggregates of small spheroids of turquoise, one of which is bright blue and contains lesser amounts of quartz, sericite, and sparse pyrite; the other exhibits a
fine-textured spiderweb pattern of smaller (1 to 3 mm) bluish-green to dark-green spheroids in a brown to reddish-brown matrix. Small amounts of turquoise were found in kaolinized monzonite in underground workings of the Torpedo mine in the Organ district, near the town of Organ. Possibly from the Organ district is a specimen (in the Bureau Mineralogical Museum) for which the locality is given only as Doña Ana County. This specimen consists of a polished 1- to 2-mm-thick seam of mottled medium-blue and bluish-green turquoise with limonitic matrix inclusions; this seam coats a fracture surface on a fine-grained silicified rock. Turquoise has been reported to occur in the oxidized capping of a breccia pipe at the Parsons mine in the Nogal district (a few miles southwest of Nogal) but does not extend into the underground workings.

SELECTED REFERENCES
———, 1975, Turquoise and Spanish mines in New Mexico: Univ. New Mexico Press (Reprint of sections from "Minerals of New Mexico," including that on turquoise, with extensive bibliography and added photographs).
The Bureau's Financial Statements

BOARD OF EDUCATIONAL FINANCE—LEGISLATIVE

Funds Available:
- Beginning balance: $27,565
- State appropriation: 750,000
- Publication sales: 32,550

Total: $810,115

Expenditures:

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Balance: $11,298

GRANTS AND CONTRACTS

Funds available:
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- State grants: 136,180
- Federal and company grants: 71,722

Total: 212,011

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Total: 174,089

Balance: $37,922

NEW MEXICO COAL SURFACE MINING COMMISSION

Funds available:
- Beginning balance: 12,563
- Fees collected: 12,031

Total: 24,594

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Total: 15,487

Balance: $9,107