ANNUAL REPORT
for the Fiscal Year
July 1, 1972 to June 30, 1973

by
Frank E. Kottlowski
and
Staff

SOCORRO
1973
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
Sterling A. Colgate, President

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

BOARD OF REGENTS
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By Order, Governor, State of New Mexico
Leonard Delage, Superintendent of Public Instruction

Appointed
William B. Ahlborn, Chairman, 1961-1970, Hobbs
George A. Cowan, 1972-1975, Las Cruces
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Stephen C. Hook
James Jensen
Terry Siebers
Roger Ward

Plus more than 33 undergraduate assistants

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November 16, 1973

To: Board of Regents
   Honorable Stirling A. Colgate, President
   Board of Educational Finance
   Members of the New Mexico Legislature

I have the honor of transmitting to you the Annual Report of the New Mexico Bureau of Mines and Mineral Resources for the fiscal year July 1, 1972, to June 30, 1973, as required by Section 3, Chapter 115, of the Eighth State Legislature sessions laws, approved March 4, 1927.

During the year, 31 technical reports were published, additional laboratory equipment was procured, 11 technical talks were presented at scientific meetings, and 28 technical papers by Bureau staff or researchers sponsored by the Bureau were published in outside scientific journals. Information concerning exploration and development of New Mexico's mineral resources was disseminated in 6,380 letters, in 3,670 telephone calls, and in 2,730 visits to the Bureau offices by technical personnel seeking answers to problems. Sales of our publications, priced at cost of printing, totaled $27,424.81. More than 8,200 publications were sent to state officials, libraries, and scientific agencies. In addition, more than 50,000 brochures describing the geology and resources of the various state parks were given out by our publications office and the New Mexico State Park and Recreation Commission.

Throughout most of the fiscal year, all positions authorized by the Board of Educational Finance were filled. During the latter part of the period and continuing into the first 2 months of fiscal year 1973-74, deaths and resignations reduced the professional staff by 35 percent. The Director, Mr. Don H. Baker, Jr., resigned in late June 1973, effective in July 1973, to become Supervising Metallurgist for the U.S. Bureau of Mines in Boulder City, Nevada. A six-member committee, headed by Dr. Robert H. Weber, is now processing applications for this vacancy.

The Board of Educational Finance recommended an increase of 4.65 percent in the Bureau's appropriation for fiscal year 1973-74. This contrasted with the national increase in costs of 7.4 percent. Annual salaries for Bureau professional staff were about $1,200 below comparative college salaries, and about $4,000 less than comparative federal salaries.

Overall support of the Bureau by the Board of Regents and the President of Tech, the Legislature, the taxpayers, and the mineral industry is appreciated. In turn, our technical service and research has helped develop the billion-dollar mineral industry of New Mexico.

Respectfully submitted,

[Signature]

Frank E. Kotlowski
Acting Director
## Financial Statement — Board of Educational Finance — Legislative

### Receipts
- Beginning balance: $9,995
- State appropriation: 688,000
- Publication sales: 27,425
- **Total receipts:** 725,420

### Disbursements and Commitments

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<th>Category</th>
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<td>Salaries</td>
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<td>Full time</td>
<td>$377,345</td>
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<td>Part time (mostly students)</td>
<td>99,902</td>
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<td>Travel and per diem</td>
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<td>Capital outlay</td>
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<tr>
<td><strong>Total expenditures:</strong></td>
<td>711,381</td>
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### Balance
- Less budgeted for 1973-74: (7,000)
- Unappropriated surplus: 6,439
- **Total:** 13,439

## Financial Statement — Grants and Contracts

### Receipts
- Beginning balance (carried forward July 1, 1972): $(3,833)
- Income
  - State and federal: 43,379
  - Other: 28,466
  - **Total funds available:** 71,845

### Expenditures
- Salaries: 25,222
- Employee benefits: 2,169
- Travel: 6,405
- Supplies and services: 2,226
- Printing: 7,486
- Auto use charge: 3,958
- Overhead: 5,666
- **Total:** 60,854
- **Balance, June 30, 1973:** $7,988

## Financial Statement — New Mexico Coal Surfaceminning Commission
(Bureau Director is Secretary-Director of Commission)

### Fees Collected
- **Total:** $13,844

### Expenditures

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<td>209</td>
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<td><strong>Total:</strong></td>
<td>4,569</td>
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- **Balance, June 30, 1973:** $9,775
Introduction

New Mexico's mineral industry contributes significantly to the State's economy. In 1972, minerals production totaled more than $1 billion, and the industry paid to the State and its subdivisions approximately $100 million in taxes, rentals, royalties, and bonuses. No other industry even approaches this direct fiscal support.

The demand for applied research, basic information, and answers to economic and technical problems throughout the mineral industry is considerable. Scientific evaluation is increasingly needed to assess New Mexico's mineral potential. Geologic, mining and metallurgical studies are needed to assure a stable mineral economy. New Mexicans must look ahead to the time when the presently producing deposits are depleted and others, as yet not discovered, must take their place.

Most of the talents and funds for the exploration and development of New Mexico's mineral resources must come from private industry. The State, however, must actively contribute to the exploration and development of its mineral resources, and must take the lead in applied research that aids in industry's prudent growth. Appropriations provided by the State Legislature for such purposes provide a return far out of proportion to the funds invested. Of the $6 appropriated per square mile in New Mexico, a return of $8,810 production per square mile is realized.

The New Mexico Bureau of Mines and Mineral Resources is the only official organization charged with the duty of investigating and reporting on the geology of the entire state, as well as on all types of mineral resources, including uranium, oil and gas, coal, metals, industrial minerals, and ground water. The Bureau also is charged with conducting applied research on all types of mineral deposits for the purpose of finding new deposits and increasing production on all deposits within the state.

The Bureau cooperates impartially with all companies, individuals, agencies, and institutions in providing the best possible scientific information. In turn the Bureau receives information which can be shared by all, serving as a clearinghouse of technical information. A prime example is the oil well sample and record library. These records, secured by companies and individuals at a cost of several billion dollars, are freely available at the Bureau. Their value increases with the passage of time.

The activities of the New Mexico Bureau of Mines and Mineral Resources cover applied research in four major scientific fields: geology and mineral resources, metallurgy, chemistry, and biochemistry.
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.

In recent years the emphasis has been on laboratory studies that aid in developing mineral resources. The Bureau has not lost sight, however, of the fact that mineral resources occur in the field—in the rocks—and that laboratory work should relate to field occurrences. Thus most geologic studies and mineral resources investigations performed by the Bureau are joint field-laboratory projects. The Bureau’s overall experience with New Mexico geologic resources exceeds that of any other group.

Although primarily a service organization, the New Mexico Bureau of Mines and Mineral Resources does engage both in pure and applied geologic research. Prior to 1960, Schilling’s study of low-grade molybdenum deposits near Questa was in the realm of pure research; today, a mill is extracting this ore. Studies of late Paleozoic reefs in the San Andres, Sacramento, and Guadalupe mountains prior to 1962 were chiefly stratigraphic; today, similar Abo reefs in southeastern New Mexico are yielding oil. Investigation of oil shales may be pure research today, but, sooner than we realize, these shales may be important in meeting the nation’s petroleum needs. Outcrop and subsurface stratigraphic studies of the 24 counties not now producing oil or gas may be considered pure geologic research today, but, tomorrow could lead to the discovery of petroleum in these areas.

Many New Mexicans and most of the tourists visiting the state are not concerned directly with technical geologic investigations but do have a lively 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 are written to explain the geology of local areas, and to point out their 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.

Many of the Bureau’s technical publications are designed to aid in the search for oil and gas. These publications range from reconnaissance maps of the Geologic Map series to detailed studies reported in the Bulletins, Memoirs, and Circulares.

Geologic investigations that may help exploration for metallic minerals and industrial rocks and minerals ranged from tabulation of county-by-county mineral production to detailed work on such areas as the Luis Lopez manganese deposit.

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.
Is the technical information generated by the Bureau useful to the mineral exploration industry? Sales of Bureau publications totalled more than $27,000 this year; about 8,200 copies of the new publications were issued free to state officials, libraries and other scientific organizations. However, the popularity of a particular publication may not reflect its ultimate worth to New Mexico, because a single copy may contain the clue that will lead to discovery of a huge ore body or a million-dollar oil pool.

Basic Services

Residents of New Mexico and other states required considerable assistance from the Bureau, evidenced by the records of service and activity. Statistics show that 6,380 letters were received, more than twice the number in the previous period; 3,670 telephone inquiries were answered; and 2,730 visitors were received.

An estimated 16,650 adults and children from public and parochial schools viewed the Bureau’s 9000-specimen mineral museum.

Staff members spent 1,592 days in the field, involving 387 man-days of per diem and 131,719 miles of travel.

Laboratory workers gave 4,119 analytical reports on 1,833 samples, and prepared 43 reports on sample groups submitted for identification. Technicians also completed 291 water analyses. In addition, staff mineralogists informally identified many hand specimens brought or mailed to the Bureau.

Direct services to the petroleum industry include making available the records on at least 63,000 test wells drilled in New Mexico, cuttings from selected wells, and electric, radioactive, sonic, and other types of logs. Up-to-date petroleum exploration maps also are available for most counties.

The business office sold 15,814 publications for a total sales figure of $27,424.81. This activity was in addition to furnishing secretarial and stenographic services, providing assistance in the selection of vendors for specialized material, and preparing 751 requisitions and purchase orders.

In addition to cooperative projects with other state and federal agencies, staff members also served on various committees and commissions and as officers of professional organizations, gave 11 talks at scientific meetings, and aided the other divisions of New Mexico Tech by teaching, directing theses studies, and serving on campus committees.

Atlas Program

The “Energy Crisis” will be most apparent this winter if there is a long, cold spell, resulting in shortages of natural gas, fuel oil and other energy materials. But the dwindling reserves of energy resources are merely the visible tip of the iceberg; the present shortage of oil and gas is the forerunner of scarcity of many mineral resources. Highly mechanized society cannot function without the many metals and industrial rocks and minerals, and energy materials. Inasmuch as the major statutory duty of the New Mexico Bureau of Mines and Mineral Resources is to aid in finding and wisely developing the state's
mineral resources, the Bureau should play a key role in solving anticipated mineral resource problems.

A unified approach suggested to the Legislature last year was the Atlas Program. The main thrust of this program is to provide statewide estimates of reserves of individual mineral resources—including strippable coal, fluorspar, and uranium. After examining major mineral commodities, key resource areas will be studied in detail. Most of the Bureau's ongoing projects already fit naturally within the scope of the Atlas Program. Speeding up the program with a special 7-year appropriation is deemed urgent. When completed, this program will provide New Mexico with inventory data for properly managing its minerals.

Components of the Atlas Program are:

I. Energy resources—oil and gas, coal, uranium, geothermal
II. Water resources
III. Metallic ores—gold-silver, copper-lead-zinc, manganese, molybdenum, iron and vanadium
IV. Industrial rocks and minerals—gypsum-salt, potash, stone, cement, sand-gravel, clay, pumice-perlite, fluorspar, mica, and gemstones
V. Geophysical mapping—airborne magnetometer, gravity, and seismic
VI. Mining districts mapping
VII. Geologic-mineral resources mapping of key areas
VIII. Environmental-geologic hazard mapping of urban areas.

Most of our present geologic-mineral resources projects, and those planned for fiscal year 1973-74, are designed to fit into the Atlas Program.

**SPECIFIC PROJECTS IN ATLAS PROGRAM**
(See index map, page 13)

I. Energy Resources
1. Foster—Evaluation of petroleum potential of Atomic Energy Commission high-level radioactive waste disposal site area
2. Bieberman—Updated map of oil and gas fields and exploration drilling in New Mexico
3. Shomaker—Deep coal deposits in the San Juan basin (in cooperation with U.S. Bureau Mines)
4. Foster—Stratigraphy and petroleum resources of the Delaware Mountain Group
5. Bieberman—Oil and gas exploration in New Mexico, for fiscal year 1972-73 (Summary in Appendix B)
6. Shomaker—Coal resources of the Ute Indian Reservations (Circular 134, in cooperation with Bureau of Indian Affairs)
7. Foster—Subsurface geology of east-central New Mexico (New Mexico Geological Society Special Publication 4)
8. Bieberman—Computerization of petroleum sample library data
9. Kotlowski, Shomaker and Beaumont—Sulfur in San Juan basin coals
10. Foster—Carbon dioxide in northeastern New Mexico (New Mexico Geological Society 23rd Guidebook)
11. Milner—Glorieta-San Andres facies in east-central New Mexico

II. Water Resources
1. Shomaker—Deep aquifers in the San Juan basin (in cooperation with New Mexico Water Resources Institute)
2. Trauger—Ground-water resources of Harding County (in cooperation with U.S. Geological Survey and State Engineer Office)
3. Summers—Water supply in the Zuni Indian Reservation (in cooperation with the Bureau of Indian Affairs)
4. Titus—Ground-water resources and geology of the Estancia Basin (Bulletin 103)
5. Blodgett—Ground water of the Plains of San Agustín
6. Titus—Ground-water resources of the Sandia and Manzano Mountains area (in cooperation with U.S. Geological Survey and State Engineer Office)

III. Metallic Ores
1. Weber, Clemens, Chapin, Seager, Willard and Kottlowski—Age dating of igneous rocks and metallic mineralization in south-central and southwest New Mexico
2. Brandvold—Mercury content of natural waters in New Mexico
3. Walker—Trace-element distribution as an indicator of mineralization

IV. Industrial Rocks and Minerals
1. Frye and Leonard—Calcite in the Ogallala Formation of southeast New Mexico
2. Hawks—Clay deposits of New Mexico
3. Renault—Spinel composition of Rio Grande basalts
4. Sarg—Carbonate-evaporite transition facies of the Seven Rivers Formation
5. McAnulty—Fluorspar deposits of New Mexico
6. Weber—Zeolites of New Mexico

V. Geophysical mapping
U.S. Geological Survey cooperative project; airborne magnetometer mapping of area from Silver City to Socorro

VI. Mining Districts
1. Vonder Linden—Chupadera copper mine area
2. Willard—Geology and ore deposits of the Luis Lopez mining district
3. Willard—White Oaks gold area
4. Chapin—Geology and mineral resources of the Magdalena-Tres Montosas area
5. Chapin—Mineral resources of Socorro County
6. Armstrong and Silberman—Carbonate petrology and mineralization controls in the central Peloncillo Mountains

VII. Geologic-Mineral Resources Mapping of Key Areas
1. Weber—Geology of the Plains of San Agustín
2. Renault—Geology of the Chupadera Mountains
3. Clemens—Geology and mineral resources of NE Corralitos Ranch quadrangle
4. Cunningham—Circle Mesa quadrangle
5. Woodward—San Miguel Mountain quadrangle
6. Weber—Geology of the Mockingbird Gap site
7. Chapin—Origin and evolution of the Rio Grande rift
8. Seager and Kottlowski—Geology and mineral resources of the Las Cruces quadrangle
9. Lovejoy—Geology and mineral resources of Cristo Rey
10. Kelley—Geology of Sandia Mountains (Memoir 29)
11. Seager and Clemens—Geology of the Sierra Alta quadrangle (Bulletin 102)
12. Hoffer—Geology of East Potrillo Mountains area
13. Woodward—Geology of Nacimiento Peak quadrangle (Geologic Map 32)
14. Clemens—Geology of the Souse Springs quadrangle (Bulletin 100)
15. Woodward—Geology of the Holy Ghost Spring quadrangle (Geologic Map 33)
16. Hoffer—Geology of West Potrillo Mountains
17. Seager—Geology and mineral resources of Bishop Cap area (Geologic Map 29)
18. Woodward—Geology of Ranchero del Chaparral quadrangle (Geologic Map 27)
19. Cunningham—Geology and mineral resources of Silver City quadrangle (Geologic Map 30)
20. Seager and Hawley—Geology of the Rincon quadrangle (Bulletin 101)
21. Woodward—Geology of the La Ventana quadrangle (Geologic Map 28)
VIII. Environmental-Geologic Hazard Mapping
   1. Vonder Linden—Environmental Geology of the Socorro area
   2. Vonder Linden, Kottlowski, Willard, Weber and Chapin—Geologic application of
      remote sensing to New Mexico as part of the ERTS (Earth Resources Technology
      Satellite) program

Although not a part of the Atlas Program, the following related projects are
underway:

**STRATIGRAPHIC PALEONTOLOGY**

*Flower—Faunas of 1) Montoya Group, 2) Bliss Sandstone, and 3) Florida Formation (with
LeMone)*
*Flower—Monograph of 1) Endoceratida, 2) Tarphyceratida, 3) Ceratocea ankyloza zone, and 4)
   Ceratocea hami-buttsi fauna*
*Sutherland and Harlow—Pennsylvanian brachiopods of north-central New Mexico (Memoir 27)*

**SPECIAL PROJECTS**

*Foster—Geoscience research projects for New Mexico in 1972 (Circular 136)*
*Renault—X-ray fine broadening*
*Renault—Quantitative x-ray diffraction in mineral exploration*
Metallurgy

The metallurgy section of the Bureau has three primary functions: 1) Provide assistance to any individual or group seeking help in developing a technical process for a mineral deposit in the state; 2) analyze processes for testing ores and procedures for operating mineral-processing plants to improve the process or procedure, or, to develop new processes or procedures, and 3) assist in the technical education of individuals interested in the mineral industry in the state.

Technical assistance has ranged from discussions of alternative processes available for treating a specific ore, to laboratory bench tests for the evaluation of flowsheets, and, in rare instances to providing on-site assistance in plant start-up.

Process and procedure analyses usually are internally generated research projects of both basic and applied nature. Examples are basic studies on ball mill grinding and bacterial leaching, exploratory tests on leaching, and developing a procedure for determining production schedules.

Educational activities include teaching formal courses and giving guest lectures in the college division, directing graduate theses, presentations at various technical meetings, and publication of the results of current research being conducted by the staff. The staff also supplies information to other governmental organizations, and answers inquiries from all sources about the mineral industry in New Mexico and elsewhere.

Current metallurgical projects:

Brierley—1) Use of high-temperature, molybdenite-leaching microorganisms, 2) effect of iron oxidant on bacteria, 3) extraction of copper from sulfide ores using thermophilic microorganisms, 4) theoretical study to support practical studies on microbial copper leaching

Plouf—1) Small-scale characterization of leachability of copper oxide ores, 2) small-scale characterization of leachability of copper sulfide ores, 3) sulfide leaching, 4) metal ion extraction, 5) environmental equilibrium study, 6) clay chlorination

Roman—1) Study of physical and chemical variables in heap leaching with emphasis on their economic significance and scale-up, 2) dissolution of copper concentrates, alternatives to conventional copper smelting, 3) open-pit mining sequence (Progress Report 8), 4) use of dynamic programming for determining mine-mill production schedules, 5) computer program for Monte Carlo economic evaluation of a mineral deposit (Circular 137), 6) computer simulation of fluid flow in a leach dump or heap, 7) optimization of dump and heap leaching

Benner—Hydrometallurgical application to New Mexico ores and concentrates.

Analytical Testing

Analytical laboratories at the Bureau are equipped to perform extensive chemical, mineralogical, and petrologic investigations. Chemical analyses, both qualitative and quantitative, are performed by the classical wet chemical
and optical spectrographic procedures, as well as by atomic absorption, x-ray, and electron microprobe spectrometry.

Primarily the laboratory serves the Bureau, College, and R & D divisions. Capabilities include analyzing water, ores, concentrates, geological samples, and leach liquids for the common elements or parameters. New methods of analysis and some basic research are conducted as time permits. Mineralogical and petrologic investigations are facilitated by x-ray diffraction facilities and the newly installed Henry Birdseye petrologic laboratory.

The x-ray fluorescence facility features a vacuum spectrograph and is utilized for non-destructive analysis of rock materials, primarily silicates. More than 12,000 analyses were provided in cooperation with New Mexico Tech, University of New Mexico, and University of Texas at El Paso.

Non-destructive microanalyses are provided by an electron microprobe. The Bureau's microprobe is capable of securing quantitative chemical analyses on solid materials over areas as small as a few microns in diameter. Compositional profiles also can be obtained for study of inhomogeneities with special resolution of a few microns.

During the year, the microprobe was used to study distribution of gold, compositional variation of basalt spinels, weathering of olivine in basalts, and distribution of uranium in metal subject to corrosion fracturing.

Publications

The Bureau issued 31 new publications in the form of bulletins, circulars, memoirs, state park brochures, geologic maps, target explorations, journal on geochronology, hydrologic reports, mineral folders, price lists, and an annual report. An open-file report and two Director's Newsletters were issued. In addition 28 papers published in outside journals were authored by Bureau staff members or by researchers sponsored by the Bureau.

EDITING

The editing section brings into print the reports and maps approved for publication by the Bureau. These public documents are a principal source of scientific and technical data on the mineral resources of New Mexico. The editorial staff counsels authors, advises on suitability of manuscripts for publication, determines printing specifications, and sets the standards for publication.

An unprecedented number of 32 manuscripts were in review at the close of the fiscal year (only 13 were on hand two years earlier). This backlog has accumulated despite an increased rate of publication production.

The increased number of manuscripts being submitted reflects the overwhelming amount of scientific literature being generated today. As this trend continues, many more manuscripts will be received than can be published. More manuscripts will become open-file reports. In this "publisher's market," the Bureau will be even more selective in allocating manuscripts to publication. Authors and publishers alike understand that competition intensifies the pursuit of excellence in publication.
All manuscripts submitted to the Bureau are reviewed by the editor, director, associate director, staff members, and frequently, by qualified scientists outside the organization.

**CARTOGRAPHY**

The drafting section completed 23 color maps. New color-proofing equipment was purchased to handle the increasing work loads. Scribing and peel coat techniques are being used on most of the major maps now in preparation. Thirteen projects were awaiting cartography at the close of the year.

### PUBLISHING DATA, 1960 TO PRESENT

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<td>954</td>
<td>951</td>
<td>613</td>
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*To nearest thousand dollars.

**To nearest whole number.

*Excludes annual reports and publication catalog.

**Excludes 437 pages in a Congressional document (Bulletin 87).

*Excludes 670 pages in National Science Foundation report (Bibliography of Geothermal Phenomena).
NEW PUBLICATIONS


A major field work covering stratigraphy, structure, geomorphology, geologic history and economic geology.


The work was done as part of a program by the New Mexico Bureau of Mines and Mineral Resources to make available basic geologic data bearing upon the mineral, land, and water resources of the state.


Includes references on geology, geophysics, geochemistry, hydrogeology and mineral technology.


Part of a study of the geology and ground-water resources of an area of approximately 2,300 square miles. The investigation was sponsored by the New Mexico State Engineer Office and the U.S. Geological Survey.

Circular 123—MINERAL DEPOSITS OF NOGAL AND BONITO MINING DISTRICTS, NEW MEXICO, 1973, by Tommy B. Thompson, 29 p., 22 figures, 1 map. $3.50.

Possible present potential for high-tonnage, low-grade copper-molybdenum "porphyry" is cited.

Circular 125—STRUCTURAL GEOLOGY OF NORTHERN PART OF ANIMAS MOUNTAINS, HIDALGO COUNTY, NEW MEXICO, 1973, by James M. Soule, 15 p., 8 figures. $2.00.

Physiography, climate, economy, rock units, structure and tectonic history.


A total of 19 earthquakes are listed, 11 located by the National Earthquake Information Center and 8 by the New Mexico Institute of Mining and Technology. Origin times, magnitudes and locations are given for all earthquakes having local magnitudes greater than, or equal to, 2.7.

Circular 127—DETERMINATIVE TABLES OF TWO-THETA COPPER AND TWO-THETA IRON FOR MINERALS OF SOUTHWESTERN UNITED STATES, 1972, by Charles W. Walker and Jacques R. Renault, 103 p. $3.00.

The conversion of Bragg angle or two-theta to interplanar spacing is a time-consuming step in the routine identification of minerals by X-ray diffraction methods. The tables appearing in this publication alleviate these inconveniences in the X-ray identification of inorganic materials.
A list of currently active projects in the fields of geology and geophysics with a partial list of engineering and hydrologic projects.

Since the discovery in the 1950's of the large reserves of uranium in the Morrison Formation near Grants, the stratigraphy has continued to receive much attention.

Describes how computer science can be used in analyzing a mineral property. The New Mexico Bureau of Mines provides computer time and assistance in adapting the program to individual needs.

Has great value for correlation of the Lower Pennsylvanian of the U.S. with the Carboniferous of Russia and Japan. One new species also is described.

Descriptive records of 1,724 wells, test holes and shafts, 45 springs or spring groups, drillers' logs of 60 wells, 224 chemical analyses, summary of streamflow records, water-level records and geologic and hydrologic maps.

Hydrologic Report 3—WATER RESOURCES OF GUADALUPE COUNTY, NEW MEXICO, 1973, by George A. Dinwiddie and Alfred Clebsch, Jr., 43 p., 7 tables, 9 figures. $4.00.
Includes detailed analyses of selected wells.

Text on map.

Probability of investment return on mining ventures will be more readily determined as a result of a new computer program developed by members of the New Mexico Bureau of Mines and Mineral Resources.

Target Exploration Report E-6—STRUCTURE OF OJALLALA FORMATION IN EAST-CENTRAL NEW MEXICO, 1972, by John C. Frye and A. Byron Leonard, 8 p. $0.50.
Brecciated soil caliche which mantled the surface of the alluvium is shown on accompanying structure map.

Target Exploration Report E-7—FLUORSPAR IN SILICIFIED ROCKS IN NEW MEXICO, 1972, by W. N. McAnulty, Sr., 3 p. $0.50.
Many large, low-grade, siliceous deposits in New Mexico can be developed and profitably exploited. Attention is directed to these deposits.
ISOCHRON/WEST No. 4, No. 5, and No. 6, edited by John H. Schilling, 31 p., 24 p., and 37 p. Available by subscription (5 issues for $3.00) or $1.00 each.

A serial journal of isotopic geochronology.

State Park Brochures—CHICOSA LAKE, CLAYTON LAKE, COYOTE CREEK, MORPHY LAKE, AND UTE LAKE. Free leaflets.

Prepared by Bureau staff and others in cooperation with the New Mexico State Park and Recreation Commission, describing the location, facilities, history, flora, fauna, and the geology of each park and its environs, with emphasis on geology.

Price Lists No. 3 and No. 4—PUBLICATIONS AVAILABLE FROM NEW MEXICO STATE BUREAU OF MINES AND MINERAL RESOURCES. Free.

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

Brochure—MINERAL SPECIMENS
Brochure—BUREAU MINERAL MUSEUM

RE-ISSUED PUBLICATIONS

Bulletin 10—GEOLOGY AND ORE DEPOSITS OF SIERRA COUNTY, NEW MEXICO (1934), $5.00.
Bulletin 87—MINERAL AND WATER RESOURCES OF NEW MEXICO (1965), $3.00.
Scenic Trip 2—TAOS—RED RIVER—EAGLE NEST, CIRCLE DRIVE (1956), $1.50.
Scenic Trip 6—TRAIL GUIDE TO THE UPPER PECOS (1967), $2.00.
State Park Brochures—CONCHAS AND ALAMOGORDO LAKES, ELEPHANT BUTTE LAKE, and VALLEY OF FIRES.

OUTSIDE PAPERS SPONSORED IN PART BY BUREAU
(Names of Bureau staff members are italicized)


19


NEW MEXICO LIBRARY OF SUBSURFACE DATA

This new, low-cost, steel, three-story structure built partly from educational bond funds, was occupied by Bureau personnel in September 1972.

It houses well logs, subsurface maps, and more than 2,900,000 individual well samples (cuttings) valued at more than $1 million, and representing 8,693 oil, gas, and water wells drilled in New Mexico during the past 30 years. Samples from tests to locate uranium and other minerals also are available.

This library brings together exact data needed more and more in solving the present energy crisis.
Bureau Personnel

STAFF CHANGES

Mr. Don H. Baker, Jr., Bureau director, resigned in June, effective in July, to accept a position with the U.S. Bureau of Mines at Boulder City, Nevada.

Other resignations were Mrs. Joyce M. Aguilar, stenographer; Blair R. Benner, junior metallurgist; E. Jack Coats, information coordinator; John W. Shomaker, geologist; and Robert Wood, draftsman. William L. Hawks, materials engineer, passed away in April 1973.

New employees joining the Bureau were Mrs. Diane Allmendinger, clerk-typist (Aug. 19, 1972); Thomas M. Plouf, research extractive metallurgist (Aug. 14, 1972); and Russell J. Wood, draftsman (March 19, 1973).

STAFF PORTRAITS

Don H. Baker, Jr., Director
(resigned July, 1973) July 1, 1969

Frank E. Kottlowski, Acting Director,
Senior Geologist July 2, 1951

Joyce M. Aguilar, Stenographer
Sept. 6, 1967

Diane Allmendinger, Clerk-Typist
August 10, 1972
Roy W. Foster, *Petroleum Geologist*
Nov. 19, 1953

William L. Hawks, *Materials Engineer*
Jan. 19, 1970

Robert W. Kelley, *Editor, Geologist*
May 15, 1971

Thomas M. Plouf
*Research Extractive Metallurgist*
August 14, 1972

Jacques R. Renault, *Geologist*
Sept. 1, 1964

Ronald J. Roman, *Chief Research Metallurgist*
May 5, 1969
John W. Shomaker, Geologist
Aug. 18, 1969

Jackie H. Smith, Laboratory Assistant
Dec. 16, 1963

Karl Vonder Linden, Mining Engineer,
Environmental Geologist
Oct. 12, 1970

Charles W. Walker, Mineralogist
Oct. 12, 1970

Robert H. Weber, Senior Geologist
May 15, 1950

Shirley Whyte, Clerk-Typist
April 26, 1972
Max E. Willard, Economic Geologist
Feb. 20, 1952

Robert Wood, Draftsman
March 1, 1972

Russell J. Wood, Draftsman
March 19, 1973

Juarine W. Wooldridge, Editorial Clerk
July 22, 1968

Michael W. Wooldridge, Scientific Illustrator
Jan. 25, 1971
Appendix A—
Mineral Production 1972 (calendar year)

New Mexico mineral production in calendar year 1972 totaled $1,097,292,000, a gain of 4.86 percent over the 1971 total of $1,046,400,000. The state ranked 7th in the U.S. in total mineral production, according to figures released by the U.S. Bureau of Mines, Department of the Interior.
<table>
<thead>
<tr>
<th>County</th>
<th>Production (thousands $)</th>
<th>Minerals produced (in order of value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernalillo</td>
<td>13,876</td>
<td>Cement, sand and gravel, stone, clay</td>
</tr>
<tr>
<td>Catron</td>
<td></td>
<td>Petroleum, natural gas, sand and gravel, stone</td>
</tr>
<tr>
<td>Chaves</td>
<td>10,742</td>
<td>Coal, stone, sand and gravel</td>
</tr>
<tr>
<td>Colfax</td>
<td>10,667</td>
<td>Stone</td>
</tr>
<tr>
<td>Curry</td>
<td>176</td>
<td>Sand and gravel</td>
</tr>
<tr>
<td>De Baca</td>
<td>W</td>
<td>Sand and gravel, stone, clay</td>
</tr>
<tr>
<td>Dona Ana</td>
<td>380</td>
<td>Potassium salts, petroleum, natural gas, natural gas liquids, stone, sand and gravel</td>
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<tr>
<td>Eddy</td>
<td>193,218</td>
<td>Copper, zinc, silver, lead, molybdenum, gold, lime, manganiferous ore, stone, sand and gravel, fluor spar</td>
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<tr>
<td>Grant</td>
<td>173,521</td>
<td>Sand and gravel</td>
</tr>
<tr>
<td>Guadalupe</td>
<td>W</td>
<td>Natural carbon dioxide</td>
</tr>
<tr>
<td>Harding</td>
<td>W</td>
<td>Copper, gold, silver, clay, sand and gravel, zinc</td>
</tr>
<tr>
<td>Hidalgo</td>
<td>2,173</td>
<td>Petroleum, natural gas, natural gas liquids, stone, sand and gravel</td>
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<tr>
<td>Lea</td>
<td>391,082</td>
<td>Stone, iron ore</td>
</tr>
<tr>
<td>Lincoln</td>
<td>W</td>
<td>Sand and gravel, molybdenum, stone, clay</td>
</tr>
<tr>
<td>Luna</td>
<td>314</td>
<td>Uranium, natural gas liquids, petroleum, coal, natural gas, stone, sand and gravel, clay</td>
</tr>
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<td>McKinley</td>
<td>72,777</td>
<td>Sand and gravel</td>
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<td>Mora</td>
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<td>Otero</td>
<td>363</td>
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<tr>
<td>Quay</td>
<td>324</td>
<td>Natural gas, petroleum, natural gas liquids, sand and gravel, stone, pum ice</td>
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<tr>
<td>Rio Arriba</td>
<td>43,666</td>
<td>Petroleum, natural gas, natural gas liquids, stone, sand and gravel</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>11,786</td>
<td>Copper, sand and gravel, petroleum, gypsum, natural gas, silver, peat, pum ice, clay, zinc</td>
</tr>
<tr>
<td>Sandoval</td>
<td>8,544</td>
<td>Natural gas, coal, petroleum, natural gas liquids, sand and gravel, stone, pum ice, uranium</td>
</tr>
<tr>
<td>San Juan</td>
<td>110,747</td>
<td>Stone, sand and gravel</td>
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<tr>
<td>San Miguel</td>
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<td>Copper, sand and gravel, gypsum, mica, stone, pum ice, gold</td>
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<tr>
<td>Santa Fe</td>
<td>1,876</td>
<td>Sand and gravel, copper, gold, lead, silver, zinc</td>
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<tr>
<td>Sierra</td>
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<td>Taos</td>
<td>21,716</td>
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<td>Torrance</td>
<td>W</td>
<td>Uranium, perlite, sand and gravel, stone</td>
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<tr>
<td>Union</td>
<td>W</td>
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<td>Valencia</td>
<td>26,504</td>
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Total: 1,097,292

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

1 Includes some sand and gravel and stone which cannot be assigned to specific counties; gem stones, vanadium, and values indicated by symbol W.

2 Data may not add to totals shown because of independent rounding.

Los Alamos County not listed because no production was reported.
Appendix B—

*Oil and Gas Production, 1972 (calendar year)*

by Robert A. Bieberman

Crude oil and distillate production in New Mexico during 1972 amounted to 110,525,224 barrels, a decrease of 7,884,746 barrels from 1971. New Mexico ranked sixth in the production of crude oil in the United States behind Texas, Louisiana, California, Oklahoma, and Wyoming. Three percent of the total amount of oil produced in the United States came from New Mexico.

Slight increases in production occurred in Eddy, McKinley, and Sandoval counties during 1972. All other producing counties recorded decreases. The production decline in Lea County amounted to 5,349,682 barrels and in Roosevelt County, 1,919,355 barrels.

Natural gas production in 1972 totaled 1,197,769,658,000 cubic feet, an increase of 50,339,117,000 cubic feet from the amount produced in 1971. New Mexico ranked fourth in the production of natural gas in the United States behind Louisiana, Texas, and Oklahoma. New Mexico provided 5 percent of the nation’s total gas production.

Lea County continued to lead in the production of dry and casinghead gas, accounting for 15 percent of the state total. However, the county showed a decline in production of 6,604,754,000 cubic feet from the total for 1971. Of the remaining producing counties, Chaves, Roosevelt, and Sandoval counties recorded decreases in production totaling 5,445,925,000 cubic feet. Gas production increased in Eddy, McKinley, Rio Arriba, and San Juan counties during 1972, the largest gain being in Eddy County which showed an increase of 33,980,081,000 cubic feet.

RESERVES

The American Petroleum Institute’s Committee on Petroleum Reserves estimated proved reserves of crude oil in New Mexico, recoverable under existing economic and operating conditions, to be 582,593,000 barrels on Dec. 31, 1972, a decrease of 74,292,000 barrels over the previous year’s estimate of 656,885,000 barrels. Production exceeded new reserves discovered during 1972 by 102,570,000 barrels. Extensions of existing reservoirs and revisions of previous estimates during 1972 added 28,278,000 barrels. The ratio of reserves to production for New Mexico crude oil declined during the year to 5.47 years from the 1971 ratio of 5.77 years.

The American Gas Association’s Committee on Natural Gas Reserves reported that estimated proved recoverable reserves of natural gas in New Mexico totaled 12,335,647 million cubic feet as of Dec. 31, 1972, decreasing by 732,307 million cubic feet during the year. Production exceeded new reserves discovered during 1972 by 1,127,276 million cubic feet. Extensions of existing reservoirs and revisions of previous estimates during 1972 added 394,969 million cubic feet. The ratio of natural gas reserves to production declined from the 1971 ratio of 11.63 years to 10.51 years during 1972.

The Committee reported that estimated proved recoverable reserves of natural gas liquids in New Mexico totaled 502,787,000 barrels as of Dec. 31, 1972. This represents a decrease of 47,239,000 barrels from the previous year’s
estimate of 550,026,000 barrels. Production exceeded new discoveries by 51,835,000 barrels and 4,596,000 barrels were added during 1972 by extensions of existing reservoirs and revisions of previous estimates. The ratio of natural gas liquids reserves to production in New Mexico declined from 10.8 years in 1971 to 9.6 years in 1972.

**DRILLING SUMMARY**

During 1972, a total of 1,030 wells were drilled in New Mexico. Oil tests were drilled in 14 of the 32 counties in the state. Lea County led in the number of tests with 326, followed by San Juan County with 211. Sixteen tests were drilled in 6 of the 24 nonproducing counties in the state. Colfax County led the nonproducing counties with 8 tests followed by Otero with 3, Harding with 2, and Bernalillo, Curry, and Hidalgo counties with one each. None of these tests were successful. The southeast producing area of New Mexico, consisting of Chaves, Eddy, Lea, and Roosevelt counties, led in the number of tests drilled with 618, compared to 396 tests in the northwestern area of San Juan, Rio Arriba, McKinley, and Sandoval counties.

Of the total wells drilled in the state, 215 were wildcat or exploratory tests and 815 were field development or extension wells. The 70 exploratory tests drilled in the northwestern producing counties resulted in 1 gas and 6 oil discoveries. Ten oil and 25 gas discoveries were made during the drilling of 129 exploratory tests in the southeast. The most active wildcat area in the northwest was in McKinley and southern San Juan counties where the search for Dakota stratigraphic traps continued at a fast pace. The Pennsylvanian Strawn and Morrow trend on the Northwest shelf in Eddy County drew considerable wildcat activity in the southeast.

The 326 development wells drilled in the northwestern resulted in 50 oil and 248 gas wells. In the southeast, the 489 development wells resulted in 379 oil wells and 47 gas wells. The total number of producing oil wells in New Mexico at the end of 1972 was 20,035 compared to 19,891 at the end of 1971. The number of producing gas wells increased from 9,394 at the end of 1971 to 9,690 at the end of 1972.

**Oil and Gas Production by County, Area, and State, 1972**
(from 1972 Annual Report of New Mexico Oil and Gas Engineering Committee)

<table>
<thead>
<tr>
<th>County and area</th>
<th>Crude Oil and Distillate (bbl)</th>
<th>Dry Gas and Casinghead Gas (cu ft)</th>
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</thead>
<tbody>
<tr>
<td>Chaves</td>
<td>2,304,271</td>
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<tr>
<td>Eddy</td>
<td>19,194,345</td>
<td>168,116,939,000</td>
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<tr>
<td>Lea</td>
<td>78,127,069</td>
<td>419,343,046,000</td>
</tr>
<tr>
<td>Roosevelt</td>
<td>2,294,527</td>
<td>11,115,262,000</td>
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<tr>
<td><strong>Southeast area</strong></td>
<td><strong>101,920,212</strong></td>
<td><strong>611,435,270,000</strong></td>
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<tr>
<td>McKinley</td>
<td>1,852,557</td>
<td>1,569,751,000</td>
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<tr>
<td>Rio Arriba</td>
<td>1,895,013</td>
<td>183,025,102,000</td>
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<tr>
<td>Sandoval</td>
<td>238,338</td>
<td>1,319,410,000</td>
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<tr>
<td>San Juan</td>
<td>4,619,104</td>
<td>398,420,125,000</td>
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<tr>
<td><strong>Northwest area</strong></td>
<td><strong>8,605,012</strong></td>
<td><strong>586,334,388,000</strong></td>
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<tr>
<td><strong>State total</strong></td>
<td><strong>110,525,224</strong></td>
<td><strong>1,197,769,658,000</strong></td>
</tr>
</tbody>
</table>
new mexico