New Mexico Bureau of Mines & Mineral Resources

A DIVISION OF
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

ANNUAL REPORT

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

by
Frank E. Kottlowski
and
Staff

SOCORRO
1973

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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,

Frank E. Kottlowski

Frank E. Kottlowski
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 Committments		
Salaries		
Full time	$377,345	
Part time (mostly students)	99,902	
Project contracts	21,783	499,030
Travel and automotive		
Travel and per diem	12,201	
Gas, repairs, and insurance	6,471	18,672
Repairs and maintenance		4,992
Supplies and materials		
Postage and resale	7,563	
Office	4,278	
Laboratory and scientific	14,958	26,799
Printing and publications		38,341
Other operating expenses		
Telephone and telegraph	16,613	
Professional services	12,939	
Employee benefits, group ins., unemployment ins., social security, retirement	14,594	
Overhead – New Mexico Tech	18,250	
Building use charge – New Mexico Tech	8,000	
Computer service	6,376	
All other	3,471	110,243
Capital outlay		13,904
Total expenditures		711,981
Balance		13,439
Less budgeted for 1973-74		(7,000)
Unappropriated surplus		6,439

FINANCIAL STATEMENT–GRANTS AND CONTRACTS

Receipts		
Beginning balance (carried forward July 1, 1972)		$(3,833)
Income		
State and federal	$ 43,379	
Other	28,466	71,845
Total funds available		68,012
Expenditures		
Salaries	25,222	
Employee benefits	2,169	
Travel	6,405	
Supplies and services	8,206	
Printing	7,488	
Auto use charge	3,958	
Overhead	6,606	60,054
Balance, June 30, 1973		$7,958

FINANCIAL STATEMENT–NEW MEXICO COAL SURFACEMINING COMMISSION
(Bureau Director is Secretary-Director of Commission)

Fees Collected		$ 13,844
Expenditures		
Salaries	750	
Travel	458	
Supplies	1,848	
Printing	1,175	
Employee benefits	129	
Other	209	4,569
Balance, June 30, 1973		$9,275

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.~~ microbiology.

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 *Circulars*.

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 (Summarized 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. *Kottlowski, 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 aquifiers 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 Agustin
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, Clemons, 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 Water
3. *Walker*–Trace-element distribution as an indicator of mineralization

IV. Industrial Rocks and Minerals

1. *Frye* and *Leonard*–Caliche 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 Agustin
2. *Renault*–Geology of the Chupadera Mountains
3. *Clemons*–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 Clemons*–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. *Clemons*–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) *Ceratopea ankyloza* zone, and 4) *Ceratopea hami-buttsi* fauna

Sutherland and Harlow–Pennsylvanian brachiopods of north-central New Mexico (Memoir 27)

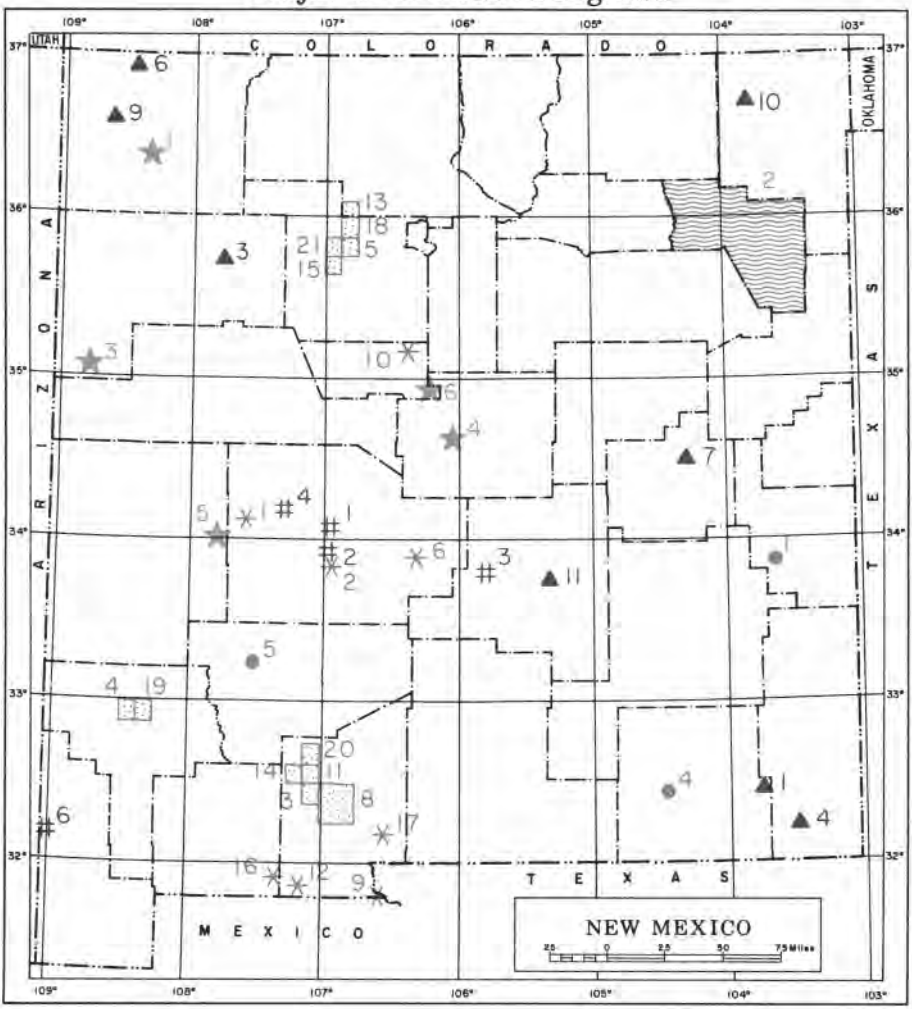
SPECIAL PROJECTS

Foster–Geoscience research projects for New Mexico in 1972 (Circular 136)

Renault–X-ray line broadening

Renault–Quantitative x-ray diffraction in mineral exploration

Projects in Atlas Program



▲ Energy Resources

● Industrial Rocks and Minerals

★ Water Resources

Mining Districts

✳ Geologic-Mineral Resources Maps

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 absorbtion, 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

Fiscal year —	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Funds allocated to printing[1]	30,000	29,000	29,000	30,000	30,000	26,000	30,000	24,000	38,000	32,000	36,000	35,000	38,000
Percent of total Bureau budget[2]	10	9	8	8	8	6	6	5	7	6	6	5	6
Pages published:[3]													
Scientific	800	800	365	365	784	951[4]	613	647	942	194	545	608[5]	1177
Popular	55	55	0	0	170	0	0	0	153	0	117	189	42
Total	855	855	365	365	954	951	613	647	1095	194	662	797	1219
Map publications	3	2	0	1	0	0	0	0	4	2	1	3	1

[1] To nearest thousand dollars
[2] To nearest whole number
[3] Excludes annual reports and publication catalogs
[4] Excludes 437 pages in a Congressional document (Bulletin 87)
[5] Excludes 670 pages in National Science Foundation report (Bibliography of Geothermal Phenomena)

NEW PUBLICATIONS

Bulletin 94–GEOLOGY AND ORE DEPOSITS OF EAGLE NEST AREA, NEW MEXICO, 1973, by Kenneth F. Clark and Charles B. Read, 149 p., 8 tables, 117 figures, 1 plate, 2 charts, 5 maps. $10.00.

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

Bulletin 98–GEOLOGY OF THE FORT SUMNER SHEET, NEW MEXICO, 1972, by Vincent C. Kelley, 55 p. $3.00.

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.

Bulletin 99–BIBLIOGRAPHY OF NEW MEXICO GEOLOGY AND MINERAL TECHNOLOGY, 1966 THROUGH 1970, 1973, by Marsha A. Koehn and Henry H. Koehn, 288 p. $5.00.

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

Circular 122–STRUCTURE OF GLORIETA SANDSTONE IN NORTHWEST CHAVES COUNTY, NEW MEXICO, 1972, by R. L. Borton, 25 p. $1.00.

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.

Circular 126–INSTRUMENTAL STUDY OF NEW MEXICO EARTHQUAKES JANUARY 1968 THROUGH JUNE 1971, 1972, by Tousson R. Toppozada and Allan R. Sanford, 6 p. $0.75.

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.

Circular 128–GEOSCIENCE RESEARCH PROJECTS FOR NEW MEXICO, 1972, 1972, by Roy W. Foster and Jean A. Meyer, 39 p. $1.50.

A list of currently active projects in the fields of geology and geophysics with a partial list of engineering and hydrologic projects.

Circular 129–MORRISON FORMATION OF SOUTHEASTERN SAN JUAN BASIN, NEW MEXICO, 1972, by L. A. Woodward and O. L. Schumacher, 7 p. $1.00.

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.

Circular 137–COMPUTER PROGRAM FOR MONTE CARLO ECONOMIC EVALUATION OF A MINERAL DEPOSIT, 1973, by Ronald J. Roman and George W. Becker, 23 p., 2 tables, 2 figures, 2 appendices. $1.00.

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.

Memoir 26–FUSULINIDS MILLERELLA AND EOSTAFFELLA FROM THE PENNSYLVANIAN OF NEW MEXICO AND TEXAS, 1973, by William E. King, 34 p., 4 plates, 6 figures, $4.00.

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.

Hydrologic Report 2–WATER RESOURCES AND GENERAL GEOLOGY OF GRANTS COUNTY, NEW MEXICO, 1972, by F. D. Trauger, 211 p., 15 tables, 50 figures. $9.50.

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.

Geologic Map 26–GEOLOGIC MAP AND SECTIONS OF SAN PABLO QUADRANGLE, NEW MEXICO, 1973, by Lee A. Woodward, John B. Anderson, William H. Kaufman, and Richard K. Reed. $1.50.

Text on map.

Target Exploration Report E-5–COMPUTER PROGRAM FOR MONTE CARLO ECONOMIC EVALUATION OF A MINERAL DEPOSIT, 1972, by Ronald J. Roman and George W. Becker, 23 p. $0.50.

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 OGALLALA 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.

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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.

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(Names of Bureau staff members are italicized)

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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

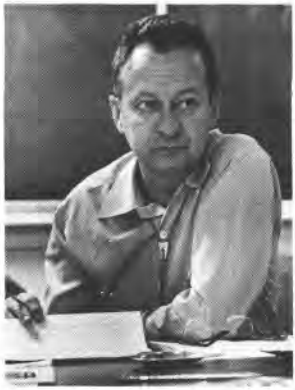
Mr. Don H. Baker, Jr., Bureau director, resigned in June, effective in July, to accept a position with the U.S. Bureau of Mines at Boulder City, Nevada.

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



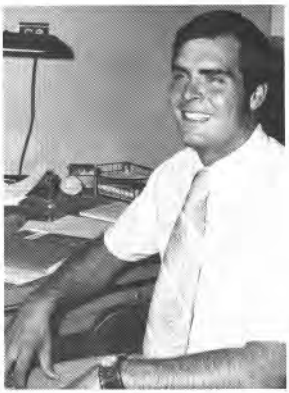
Frank E. Kottlowski, *Acting Director, Senior Geologist* July 2, 1951

Joyce M. Aguilar, *Stenographer*
Sept. 6, 1967

Diane Allmendinger, *Clerk-Typist*
August 10, 1972

William E. Arnold, *Scientific Illustrator*
Jan. 4, 1954

Robert A. Bieberman, *Petroleum Geologist*
June 1, 1950

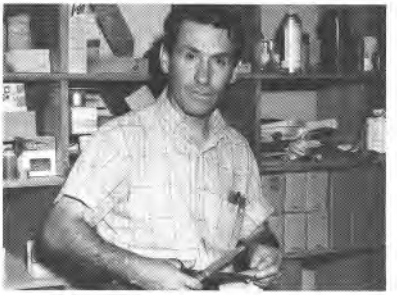


Blair R. Benner, *Junior Metallurgist*
March 1, 1971

Lynn A. Brandvold, *Chemist*
Nov. 10, 1965

Corale Brierley, *Chemical Microbiologist* Sept. 1, 1971

Charles E. Chapin, *Geologist*
June 1, 1970



Richard R. Chavez, *Technician*
Feb. 21, 1957

E. Jack Coats, *Bureau Information Coordinator*
Jan. 18, 1971

Jill Collis, *Secretary*
June 28, 1971

Lois M. Devlin, *Office Manager*
Jan. 24, 1962

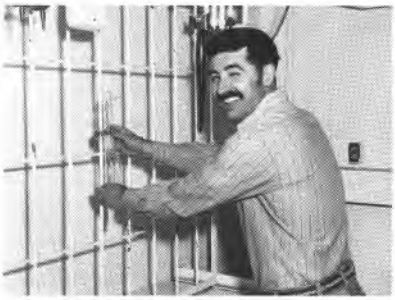
Jo Drake, *Administrative Assistant, Director's Secretary* Sept. 10, 1968

Rousseau H. Flower, *Senior Paleontologist*
Sept. 1, 1951

Roy W. Foster, *Petroleum Geologist*
Nov. 19, 1953

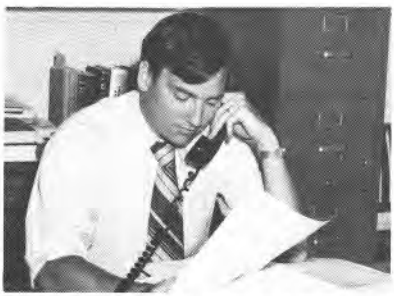
William L. Hawks, *Materials Engineer*
Jan. 19, 1970

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



Thomas M. Plouf
Research Extractive Metallurgist
August 14, 1972

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

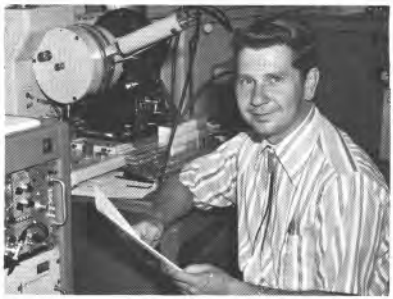


Ronald J. Roman, *Chief Research Metallurgist*
May 5, 1969

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

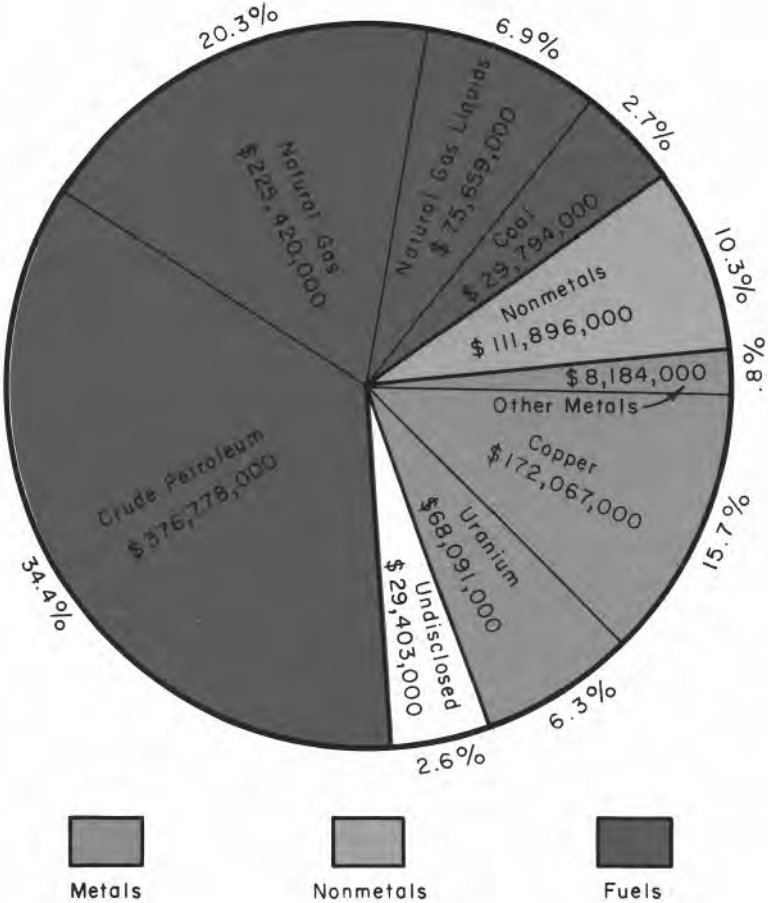
Juarine W. Wooldridge, *Editorial Clerk*
July 22, 1968

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.



Mineral Production for New Mexico, 1972

Value of mineral production in New Mexico 1972, by county (U.S. Bureau Mines)

County	Production (thousands $)	Minerals produced (in order of value)
Bernalillo	13,876	Cement, sand and gravel, stone, clay
Catron	--	
Chaves	10,742	Petroleum, natural gas, sand and gravel, stone
Colfax	10,667	Coal, stone, sand and gravel
Curry	176	Stone
De Baca	W	Sand and gravel
Doña Ana	380	Sand and gravel, stone, clay
Eddy	193,218 (2)	Potassium salts, petroleum, natural gas, natural gas liquids, stone, sand and gravel
Grant	173,521 (3)	Copper, zinc, silver, lead, molybdenum, gold, lime, manganiferous ore, stone, sand and gravel, fluorspar
Guadalupe	W	Sand and gravel
Harding	W	Natural carbon dioxide
Hidalgo	2,173	Copper, gold, silver, clay, sand and gravel, zinc
Lea	391,082 (1)	Petroleum, natural gas, natural gas liquids, stone, sand and gravel
Lincoln	W	Stone, iron ore
Luna	314	Sand and gravel, molybdenum, stone, clay
McKinley	72,777 (5)	Uranium, natural gas liquids, petroleum, coal, natural gas, stone, sand and gravel, clay
Mora	W	Sand and gravel
Otero	363	Sand and gravel, stone
Quay	324	Sand and gravel
Rio Arriba	43,666	Natural gas, petroleum, natural gas liquids, sand and gravel, stone, pumice
Roosevelt	11,786	Petroleum, natural gas, natural gas liquids, stone, sand and gravel
Sandoval	8,544	Copper, sand and gravel, petroleum, gypsum, natural gas, silver, peat, pumice, clay, zinc
San Juan	110,747 (4)	Natural gas, coal, petroleum, natural gas liquids, sand and gravel, stone, clay, pumice, uranium
San Miguel	W	Stone, sand and gravel
Santa Fe	1,876	Copper, sand and gravel, gypsum, mica, stone, pumice, gold
Sierra	W	Sand and gravel, copper, gold, lead, silver, zinc
Socorro	88	Copper, stone, sand and gravel, iron ore, silver
Taos	21,716	Molybdenum, perlite, sand and gravel, stone
Torrance	W	Sand and gravel, stone
Union	W	Stone, pumice, sand and gravel
Valencia	26,504	Uranium, perlite, sand and gravel, stone
Undistributed[1]	2,753	
Total[2]	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 35 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

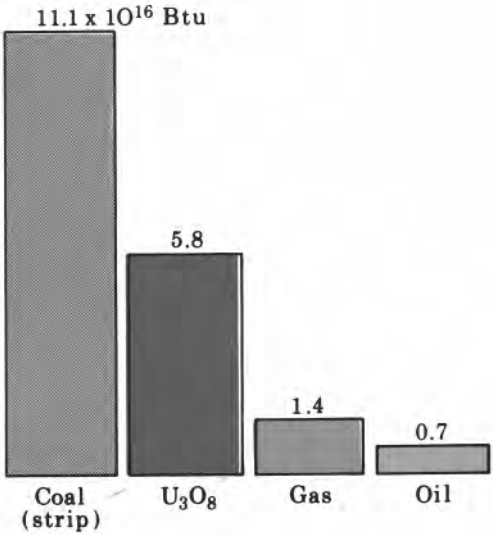
During 1972, a total of 1,030 wells were drilled in New Mexico. Oil tests were drilled in 14 of the 32 counties in the state. Lea County led in the number of tests with 326, followed by San Juan County with 211. Sixteen tests were drilled in 6 of the 24 nonproducing counties in the state. Colfax County 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 northwest 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)

County and area	Crude Oil and Distillate (bbl)	Dry Gas and Casinghead Gas (cu ft)
Chaves	2,304,271	12,860,023,000
Eddy	19,194,345	168,116,939,000
Lea	78,127,069	419,343,046,000
Roosevelt	2,294,527	11,115,262,000
Southeast area	101,920,212	611,435,270,000
McKinley	1,852,557	1,569,751,000
Rio Arriba	1,895,013	185,025,102,000
Sandoval	238,338	1,319,410,000
San Juan	4,619,104	398,420,125,000
Northwest area	8,605,012	586,334,388,000
State total	110,525,224	1,197,769,658,000



new mexico