Research laboratories and offices of the New Mexico Bureau of Mines and Mineral Resources are housed in the Research Building on New Mexico Institute of Mining and Technology campus.
NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

E. J. Workman, President

STATE BUREAU OF MINES AND MINERAL RESOURCES

Alvin J. Thompson, Director

Biennial Report

For the fiscal years ending

30 June 1961

and

30 June 1962

Prepared by
the Director

Socorro 1962
THE REGENTS

New Mexico Institute of Mining and Technology

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To the Board of Regents:

I have the honor of transmitting to you the Biennial Report of the State Bureau of Mines and Mineral Resources for the years ending June 30, 1961 and June 30, 1962, as required by Section 3, Chapter 115, of the session laws of the Eighth State Legislature, approved March 4, 1927.

Respectfully submitted,

E. J. WORKMAN

President
Senior student in mining engineering operating a diamond drill at the Banner Mining Company's mine near Lordsburg, in connection with a study of rock pressure in underground mines.
FOREWORD

Mineral production in New Mexico during the biennium rose to an all-time high, leading all other states in the production of uranium, potash, perlite, and carbon dioxide. New Mexico is third in the nation in production of helium and pumice, fourth in natural gas and vanadium, fifth in copper and molybdenum, and sixth in petroleum production.

The extraction of minerals, and the allied beneficiation and processing, continued to furnish a major share of the state's tax money, as well as providing employment for many of its people. New Mexico's continued progress in this field, therefore, requires more than a passing interest in mineral resources; it means putting forth further efforts to acquire more knowledge about these resources and their development.

The Bureau of Mines and Mineral Resources has moved into the 1960's with a field and laboratory program of significance to the mineral industry of the state during the biennium. Its field investigations and mineral reports provided vital data on the status of the industry. Its advisory services, which are becoming increasingly a part of its over-all work program, were constantly called upon by mining and petroleum companies, government departments of New Mexico and other states, industries and the general public.

Details of the Bureau's activities from June 30, 1960 to June 30, 1962 are summarized in this report.
GENERAL STATEMENT AND SUMMARY

The objectives and duties of the Bureau of Mines and Mineral Resources were set forth by the Eighth State Legislature when that body established the Bureau in 1927 as a division of the New Mexico School of Mines, now the New Mexico Institute of Mining and Technology.

The Bureau is the only state organization charged with investigating, studying, and reporting on the geology of the entire state. It is responsible for conducting research on all types of ore deposits for the purpose of increasing the production and use of the state's mineral resources, with due regard to proper conservation practices. Immediate and future needs, industry trends, and the probable by-product aspects of mineral production are factors guiding the Bureau's research.

In addition to its independent activities, the Bureau gives what assistance it can to other State, Federal, or private agencies which are working in the New Mexico minerals industry field. It helps in the accumulation and publication of data in studies made by professors and students in the geology and engineering departments of the New Mexico Institute of Mining and Technology. Cooperative projects have been completed, and others are in progress, between the Bureau and the U.S. Geological Survey in ground-water surveys and geologic mapping. An active part is taken by Bureau staff members in projects sponsored by engineering and geological professional societies, which it is believed will add to the knowledge of the State's mineral resources and improve its mineral economy.

The Bureau often aids, in a manner and to an extent consistent with general State policy, in projects initiated by private agencies. Geologists and mineral engineers serving with industry or working as consultants have made important contributions to the understanding of New Mexico's geologic features and mineral resources. Consistent with the policies of the private agencies involved, the Bureau endeavors to accumulate and make available to others the information so obtained.

A series of county mineral deposit reports and geological studies were made during the past two years. The results of these have appeared in various bulletins, circulars, and maps.

A study of stresses in mine rock is now in progress. Personnel of the Bureau have been active in the investigation of mine safety factors in New Mexico, working with special committees appointed for this purpose.

A series of paleontological studies by Bureau personnel have made important contributions to this science.
The Bureau has continued its efforts in the area of groundwater resources, giving advice on location and capacity of projected wells and making studies of ground-water conditions and problems.

The petroleum industry, which has made outstanding strides during the biennium, continues to use the Bureau's constantly expanding library of well samplings. One of the cooperative projects of the Bureau and the U.S. Geological Survey was the production of a map of New Mexico's oil and gas fields.

Of special significance in the Bureau operation during the biennium has been the greatly increased activity in the metallurgical section. A number of additions to the staff in this section were made, allowing the Bureau to increase the depth and breadth of studies in beneficiation of the state's low-grade and refractory ores. Construction of a large metallurgical laboratory of modern design was completed during the biennium, which will further aid the Bureau's metallurgical work in the coming biennium. Geological studies and mineral surveys, in progress and contemplated, will be correlated with the metallurgical program to provide a better understanding of the state's mineral potential and augment its future development.
GROUP VALUES BY YEAR
(thousands of dollars)

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Metals: 102,730 95,741 100,748 198,831 178,123 185,032
Nonmetals: 82,943 89,935 85,453 91,804 95,951 112,966
Fuels: 326,722 386,095 406,273 415,640 448,011 457,596
Totals: 519,895 571,771 592,474 646,275 717,085 755,594
MINING

A large part of the Bureau's work in mining during the past two years has been in the preparation of county reports of mineral deposits. One report was published, Bulletin 72: Mineral Deposits of Luna County. Two other reports dealing with Hidalgo and western Grant counties are in the manuscript stage, and field work is being done for a third report covering deposits in Bernalillo, Sandoval, and Santa Fe counties. Two out-of-print bulletins, Ore Deposits of Socorro County (Bulletin 8) and Geology and Ore Deposits of Sierra County (Bulletin 10), were reprinted.

The Bureau's mining engineer has been engaged in a rock-mechanics research program. The basic aim of this project is to study stresses in mine rock. This is a fundamental research project which, if successful, will promote the design of safer and more efficient underground openings.

Personnel of the Bureau participated as committee members in the work of a special committee appointed by former Governor Burroughs to investigate mine safety conditions in the uranium mines of the Grants area. A report covering the findings of this committee was submitted to the Governor's office.

In accordance with the provisions of the New Mexico statutes, the Director of the Bureau serves as chairman of the Mine Safety Board established by the State Legislature in 1961.

The entire staff served as consultants to numerous prospectors and exploration personnel of mining companies who visited Bureau offices for information concerning economic mineral deposits.
METALLURGY

In view of the growing significance of extractive metallurgy in the mineral industries, the metallurgical department of the Bureau was organized in March 1959, under the supervision of Dr. Roshan B. Bhappu.

This department conducts research in various aspects of extractive metallurgy and provides technical assistance to operators and mining companies requesting it.

In order to provide the best possible service to the mineral industry of the State, the department was expanded during the biennium by the addition to the staff of Dr. Maurice C. Fuerstenau as associate metallurgist in December 1961 and of Dr. Dexter H. Reynolds as research chemist in April 1962. All Bureau staff members are available for duty as instructors.

During the biennium the department carried out its operations, under the considerable handicap of limited space and equipment, in temporary laboratories established in the building occupied by the Bureau. Some experimental testing was also done in the metallurgical laboratory of the College Division when classes were not in session.

The building program in the fall of 1961 called for a new addition which was completed at the end of the biennium and the metallurgical department made plans to move into its expanded quarters.

The new facilities provide 4000 square feet of working area for the metallurgical section and house the sample preparation, mineral beneficiation, hydrometallurgical, and pyrometallurgical laboratories. Also provided is sufficient space for conducting pilot-plant studies, if required. The vacated laboratory space in the older part of the building now may be used for chemical, analytical, and additional metallurgical laboratories for dry-mineral beneficiation processes, studies on ion-exchange and solvent extraction, and basic research on various phases of extractive metallurgy.

About $20,000 worth of metallurgical equipment and supplies were purchased by the Bureau in the two years and put to good use on various projects. This equipment is also available to the College Division, and is being installed permanently in the new metallurgical laboratories.

Since the establishment of the Bureau's metallurgical program in March 1959, investigations have been carried out for the recovery of valuable metals and minerals from 120 different ores. These included refractory and low-grade metallic, nonmetallic, and rare-metal ores, all from New Mexico. The results of these investigations enabled the staff to offer advice and technical assist-
Metallurgical Department staff member and student assistant run froth flotation experiments in search of better methods of extracting valuable minerals. The long-range program is designed to aid the mineral industry and better the economy of the State.
ance to prospectors and mining companies operating in the State. In some instances, further exploration and development of the ore deposits were undertaken on the basis of the preliminary tests. In other instances, improvement and modification in the existing flowsheets and plant practices were made, resulting in increased efficiency and profits for the operators.

The metallurgical department continued to investigate the following long-range projects of possible economic importance to the State:

1. Systematic froth flotation studies on various silicate and oxide minerals.
2. Studies pertaining to the recovery of beryl, spodumene, lepidolite, microlite, and other valuable minerals from pegmatites.
3. Determination of the nature of chrysocolla and other copper-silicate minerals and the recovery of the copper.
4. Theoretical and practical studies on the leaching of low-grade molybdenum ores.
5. Development of shorter and more accurate methods of chemical analysis for various rare metals.

The results of the investigation of some of these projects have already been published and have been received favorably by the industry. Results of other investigations will be published as soon as the projects are completed. In a few instances patent applications on new ideas and processes have followed the investigations. The main reason for procuring patents is to protect the public interest rather than to exploit it.

It is hoped that the metallurgical studies undertaken by the department will stimulate the development of the mineral industry in New Mexico. With the recent expansion through additional staff members and the availability of modern research facilities, the Bureau will be able to provide increased service to the metallurgical industry.

PALEONTOLOGY AND STRATIGRAPHY

Work has continued on the general problem of adding to the knowledge of fossils and their use for correlation and dating of strata of New Mexico. In most eastern states the preliminary work
was done before 1900, but since then the number of described forms, with which new ones must be compared, has increased. Taxonomy has become more exacting in terms of structures which must be known for proper classification. Each systematic group has become a field of specialization in itself.

General work has continued, with concentration on the older formations but with excursions into the problems of younger beds and younger forms where the need has arisen. Work on the known forms of Bliss Sandstone is near completion and advances are being made on the El Paso and Montoya forms.

A study of the colonial corals of the Montoya group was completed. This is the first extensive study of fauna of this sort in North America since 1929. Some four hundred thin sections were prepared and comparisons made. Three weeks were required for comparison with the collections of the United States National Museum at Washington. The work is the first on western Ordovician coral faunas based upon specimens of precisely known origin and will serve as a basis of comparison for similar future studies in other regions. Tiny foreign organisms of 18 different kinds, not before noted, were found and described in an accompanying paper. Though the study could not be extended to include the material, related forms previously ignored were found in comparative study of U. S. National Museum specimens on corals from Norway, Anticosti Island, and Utah.

Other projects are as follows:

The Phragmocone of Ecdy cercas. This describes one of the oldest of the straight cephalopods, so strange in its occurrence and form it is given an order to itself.

Buttsoceras and Notes on the Michelinoceratida. The odd cephalopod Buttsoceras, formerly known from Alabama, is now known from New Mexico and Utah material. This is better preserved material than that previously found and shows that the supposed free tube in the siphuncle is only the leached-out inner silicified surface of a thick lining. Only in Sweden has a type with this structure been known previously. Incorporated are notes on the order to which this cephalopod belongs and contributions on some other crucial and strange types.

Works in the advanced stage are as follows:

Monograph of the Ellesmeroceratida. This is the primitive order of cephalopods. All known forms are listed and some new ones described, with special attention to structure and evolution of the group.

Monograph of the Tarphyceratida. This is a revision of previous forms, accompanied by descriptions of many new forms, largely from the El Paso limestone of New Mexico.
Piloceroids of the El Paso Limestone. These fossils are the largest and most conspicuous of the El Paso fossils and have been used for some years as horizon markers. The El Paso contains different associations of these fossils in several horizons and has the greatest concentration of them known in the world. The study includes critical examination of structures which previously were poorly understood. It has involved comparison with previously known forms from eastern North America and Scotland. Scotland was the source of the original specimens of these forms. Only Part I, dealing with the forms of the lower beds, will be completed immediately.

In the process, a new technique of etching was required which involves progressive masking of exposed surfaces to prevent leaching of unsilicified interiors.

An extension of these combined studies is another dealing with cephalopods of the Ordovician of Utah and Nevada Ordovician, involving correlation between these regions and New Mexico.

Also in progress is Illustrated Guidefossils for the Older Paleozoic of New Mexico. This will combine the more crucial and common forms.

Field work has continued with the investigations of the Older Paleozoic of southern New Mexico but has been at a minimum due to the work of preparation, illustration, and description.

Material from the Bureau’s collections has contributed to several major studies recently completed or now in progress. Montoya materials were included in the monograph on Ordovician Stromatoporoidea of North America by the late Dr. J. J. Galloway and Dr. St. Jean. Dr. G. A. Cooper and associates are continuing a study of the Devonian and early Mississippian brachiopods of New Mexico. Work is in progress here on a companion project describing the molluscs of the New Mexico Devonian.

Cephalopod specimens from outside sources have been submitted for identification, study, and where needed, description and illustration. They include items from England, Argentina, California, Oklahoma, Michigan, Quebec, Newfoundland, James Bay, and Alaska.

For studies at the Bureau, material has been borrowed from Oslo, Norway; Cambridge University, England; Tokyo, Japan; Stockholm, Sweden; Ottawa, Canada; Washington; New York; Cincinnati; Reno, Nevada, and various institutions in Utah.

An important part of the work is the gradual accumulation of collections and data on sections. The bringing together of collections is particularly worthy in that it makes specimens and data more readily available in groups to workers. Some groups can be studied competently today only by specialists. These specialists will look to such collections in state institutions for study as well as for an indication of the nature of the specimens the region is likely to yield. Material of this nature is constantly contributing to studies.
Angular unconformity separates Triassic rocks, below, from Jurassic rocks, above, on Battleship Mountain, Dry Cimmaron Canyon in Union County. Illustration is from the cover of Tour-guide No. 7, a Bureau of Mines and Mineral Resources publication.
The chief tool in the exploration for mineral resources is geology. Detailed geologic maps, reconnaissance geologic maps, structure contour maps, stratigraphic studies, direct investigations of ore deposits, and regional geologic reports by the Bureau help in the finding and eventual extraction of New Mexico's minerals. For rapid use of geologic information, many geologists, mining engineers, hydrologists, and prospectors visit with the staff and confer informally on geologic facts and problems.

The Bureau of Mines is primarily a service organization, but does both pure and applied geologic research. Prior to 1946, the study of perlite and pumice was chiefly pure research; today it is vital to the nation's booming construction industry. Geologic mapping of parts of southwestern New Mexico is largely pure research today, but it may be economically important tomorrow. Outcrop and subsurface stratigraphic studies of the 24 counties in which petroleum production has not been found may seem to be pure research now but may lead to the production of oil and gas in those areas.

The petroleum industry is the major sponsor of mineral exploration in New Mexico. Petroleum exploration activities have resulted in oil and gas production valued at $400 million in 1961. This industry in 1961 paid $54 million to the State in taxes and other charges, had about 10,000 employees, and produced two-thirds of the total value of all minerals from New Mexico (non-metallic minerals and metals each constituted about one-sixth of the total). Early hunters of oil long since have drilled in the most obvious locations. Oil sought today usually lies deeper in the earth and more closely hidden. To find it, and to reduce the odds against failure, exploration men apply a score of specialized geological and geophysical skills and sciences. Many of the geologic maps and geologic reports published by the Bureau are aimed at helping this exploration for the State's most valuable mineral resource.

Technical geologic reports to aid in the exploration for oil and gas have ranged from reconnaissance maps in the Geologic Map Series to detailed studies given in the bulletins, memoirs, and circulars. During the biennium reports were written on Mississippian rocks in southwestern New Mexico; the Precambrian rocks of New Mexico; clay minerals in Cretaceous strata; Pennsylvanian beds in southwestern New Mexico; stratigraphy and structure of the Sacramento Mountains; Paleozoic and Mesozoic strata of southwestern New Mexico; pre-Tertiary beds of the Tres Hermanas Mountains; geology of the southeast Chama Basin; glauconite in the Bliss Sandstone; high-calcium limestones in New Mexico; Pennsyl-
vanian and Early Permian rocks of the Zuni Mountains area; and the geology of the Delaware Basin. In addition, geologic maps were compiled covering the Alum Mountain, Las Cruces, Pelona NE, and Pelona NW quadrangles; as well as the Tres Hermanas Mountains and southern Animas Mountains areas. A bibliography of New Mexico geology and mineral technology covering the years 1956-1960 was prepared also. Paleontological studies, as discussed and described in the section on Paleontology and Stratigraphy, are useful in this search for oil because they aid in dating as well as in identifying the oil-bearing beds.

Many New Mexicans and many of the tourists that visit the State are not directly concerned with the technical investigations but do have a lively interest in the spectacular landscape. They seek explanations of how the mountains and canyons and other physical features were formed. The Bureau's guidebooks entitled, "Scenic Trips to the Geologic Past" are designed to give some insight into the geologic character of local areas. The regions near Santa Fe, Taos—Red River—Eagle Nest, Roswell—Capitan—Ruidoso—Bottomless Lakes, Zuni Mountains, Silver City—Santa Rita—Hurley, and the Upper Pecos Valley were featured in earlier guidebooks. A report on the grassy plains and volcanoes of northeastern New Mexico in the Raton—Capulin Mountain—Clayton area was published during the current biennium. Scenic guidebooks are planned for several of the National Monuments in the State and for Albuquerque's popular resort, the rugged and towering Sandia Mountains.

Geologic studies helpful in the exploration for metallic minerals and for industrial rocks and minerals range from studies of kyanite deposits in the Petaca district and reconnaissance of high-calcium limestones in New Mexico to tabulation of the mineral deposits of individual counties. Projects under consideration during the biennium that were of particular use for mineral exploration include the following: mineral deposits of Luna, Hidalgo, and Grant counties, Iron Mountain tungsten, Black Range tin, Petaca district kyanite, niobium in the Sanostee Formation, characteristics of alkali feldspars, biotite and silica variations in igneous and metamorphic rocks, crystallization of barite-fluorite-calcite, studies of zeolites, location of high-calcium limestones, and geology of the San Pedro Mountains and of the Truchas Peaks region. Most of the maps of the Geologic Map Series also aid exploration for minerals by showing the location of favorable rock types. The areal reports also provide basic information for ground-water studies.

Areal geologic mapping, a fundamental work for geologic and related studies, was done in only a few areas from 1960 to 1962, and that chiefly on a reconnaissance basis. Geologic maps published during the past two years cover about 1420 square miles
Graduate student, right, assists staff geologist in measuring intensity and spacing of X-ray reflections from feldspar crystals. In the X-ray analysis laboratory, mineral identification and structural analyses are made.
mapped in detail and more than 2050 square miles of reconnaissance mapping. The Bureau's share of the field mapping for the State Geologic Map was completed. A preliminary map in color of the southwest quarter was issued by the compilation agency, the U. S. Geological Survey, joining the previously published northwest and southeast quarter maps. The northeast quarter map was completed shortly after the end of the biennium. Revision of these preliminary quarter maps is under way, and they will be combined into a 1:500,000-scale State Geologic Map. The preliminary maps of the state are on a scale of 1:380,160 (about six miles to an inch) and can show only the generalized geology and structure.

Members of the Bureau staff have aided in preparing geologic field conference guidebooks, published by the New Mexico, Roswell, Four Corners, and West Texas Geological Societies, by writing articles on regional geology and preparing some of the road logs. For wider dissemination of information, selected reports are published in national scientific and professional journals, and talks are given at national and regional technical meetings.

Reports on the Precambrian rocks and structure of the State and on the Pennsylvanian strata of southwestern New Mexico were prepared at the request of committees of the American Association of Petroleum Geologists; the former will be published as part of a map of the Precambrian of North America, and the latter has been published as a chapter in the volume entitled, "Pennsylvanian System in the United States."

One member of the Bureau staff was appointed as an A. A. P. G. commissioner to the American Commission on Stratigraphic Nomenclature; others were appointed to the Basement Rock Project Committee of the A. A. P. G.
Cliffs of Jurassic Sandstone on the north flanks of the Zuni Mountains form an attractive setting for El Paso Natural Gas Products Company's Ciniza plant near Gallup.
PETROLEUM

Besides indirect aid to the petroleum industry through a program of field mapping and research activities, the Bureau performs certain direct services to this industry.

Accurate records of 28,000 test wells drilled in New Mexico are on file in the Bureau offices. Records of new wells are added to the file at the rate of about 1800 wells each year. These records are made available to the public through publications, as well as directly to those who visit, write, or call the Bureau office. Information from the test well records is compiled annually for publications on oil and gas tests and petroleum developments. County maps are also prepared showing the locations of wells drilled for oil and gas.

The well-sample library maintained by the Bureau is probably one of its most important services. This library contains representative samples of the various rocks penetrated during the drilling of test wells. More than 5800 test wells are represented by the 20,000 boxes of samples in the library. Sample cuttings are an extremely valuable source of subsurface geologic information. From the microscopic study of these samples, the depth and character of buried rock formations can be determined. Use is made of such information in the search not only for oil and gas but for other mineral deposits and water supplies as well. As new techniques of analysis and interpretation are developed, the sample library will be of even more value in the future.

A report dealing with petroleum exploration in the Chama basin was prepared for the 1960 Field Conference of the New Mexico Geological Society.

Bulletin 77, "Petroleum Developments in New Mexico During 1959" was published during the biennium.

A map entitled "Preliminary Geologic and Relief Map of the Precambrian Rocks of New Mexico" was issued as Circular 57. This map was an outgrowth of the Bureau's participation in the Basement Rocks Project of the American Association of Petroleum Geologists and is of great interest to the petroleum industry. The Bureau's files of information and the sample library were used extensively for this project.

Map No. OM-207, "Map of New Mexico Showing Oil and Gas Fields, Unsuccessful Test Wells, Precambrian Rocks, and Pipelines," was published by the U. S. Geological Survey. This was a cooperative project between the Bureau and the Survey.

Circular 61, "Index to Samples from Oil and Gas Well Tests in Library at Socorro, New Mexico," was issued. It lists the additions made to the library during the period from January 1, 1958 to July 1, 1961.
A report was given before the Tulsa Geological Society dealing with the activities of the Bureau relating to the petroleum industry. The Bureau strives to be of assistance to all who are interested in New Mexico's oil and gas resources, including representatives of oil companies, consulting geologists, independent operators, members of the federal government and state agencies, businessmen, drillers, lease brokers, and landowners. In serving these varied groups, the Bureau assists and encourages the petroleum industry, which is vital to the economy of New Mexico.

Bureau of Mines and Mineral Resources hydrologist checks the flow of a high-capacity well with a contractor in the Rio Grande valley.
The importance of ground water to New Mexico's economy and general welfare has increased as the state's population and industrial activities have continued to expand. The sustained efforts of many people and agencies are essential to solving the immediate problems that arise. The New Mexico Bureau of Mines and Mineral Resources, as a state agency authorized to study the underground resources of the state, has maintained its interest in the ground-water resources field and has endeavored to contribute to the solution of ground-water problems.

A major area of Bureau activity relates to the location of water wells. Requests for information have been received from well owners and well drillers, as well as from consultants, municipalities, industries, and other government agencies. Answers to these requests contain all pertinent data and aid the inquirer in deciding the proper location of a well or whether an adequate supply of water can be obtained.

Two cooperative agreements with the U. S. Geological Survey are in effect and are renewed periodically. Under the agreement with the Ground Water Branch, the Survey continues field investigations and preparation of reports on area-wide studies which have often encompassed entire counties. During the biennium, Ground-Water Report 6, Geology and Ground-Water Conditions in Southern Lea County, New Mexico, was issued in this program. Geology and Ground-Water Conditions of Eastern Valencia County, New Mexico; Geology and Ground-Water Conditions in Quay County, New Mexico; and Ground-Water in the Structural Basins West of Tucumcari, New Mexico are in the final stages of publication.

Under an agreement with the Quality of Water Branch, the Survey analyzes water samples delivered to the Albuquerque laboratory by the Bureau. Results of about 35 analyses annually are reported to well owners.

Both of the U. S. Geological Survey cooperative programs are adding materially to the wealth of basic data already available pertaining to the ground-water resources of the State.

As a special study the Bureau hydrologist is collecting water samples to determine the correlation of change in the amount and composition of dissolved solids with pumping. This study will require another season or two of data collection, since the primary correlation appears to be one of change versus quantity pumped. Water samples have been obtained from the selected wells at the end of each pumping season and estimates of pumping times were made and discharges measured.

The collection of data on the development of wells by chemical and mechanical means has continued. Chemical development in-
volves the use of acids, detergents, and dispersing agents on the aquifer to improve the flow pattern near the well. The accumulation of data on this project requires the cooperation of owners and drillers. With such cooperation available, the project must await not only completion of a well conveniently located but also notification that a test is to be performed. Some consideration has been given to the construction of test wells in which various factors could be controlled or changed as desired, thus expediting the collection of data.

Preparation of the Union County inventory-type report was temporarily suspended during the biennium, and while some work was done on the maps and text, the report has not yet been sent to the printer.

Notations on water-bearing rocks, wells, and springs made by Bureau geologists during field investigations will be valuable in later ground-water investigations.

The Bureau resource economist has continued his study of the administration of the supply of water in New Mexico. Collateral duties of the ground-water hydrologist have included the design of a proposed well, the improvement of the water distribution system of New Mexico Institute of Mining and Technology, and work with the resource economist on the Institute's water rights declaration.

Staff members of the Research and Development Division and the College Division of the Institute frequently consult Bureau personnel about ground-water problems and projects.

The Bureau's ground-water hydrologist continued to serve on the New Mexico Water Conference Advisory Committee and presented a paper entitled Analyzing Pumping Test Data at the Sixth Annual Conference. Notes on History of the Socorro Water Supply was presented to the Socorro Rotary Club. The 1962 spring meeting of the Professional Section of the Rio Grande Chapter of the Soil Conservation Society of America was addressed on the subject of Testing Aquifers.
MINERALOGY

The Bureau's mineralogist devotes his time to service work and research.

Identification of minerals, rocks, ores, and clays is offered to New Mexico residents free of charge. To aid in this identification, the mineralogical laboratory is well equipped with modern instruments, such as binocular and petrographic microscopes, X-ray diffraction apparatus, an X-ray fluorescent unit, radiometric apparatus, and a flame spectrophotometer. Other instruments of the Institute, such as the differential thermal analysis apparatus, the Perkin-Elmer 421 grating infrared spectrophotometer, and other high-temperature and high-pressure equipment also are available for use by the mineralogist.

The results of mineralogical studies may initiate research and development work in other fields, such as extractive metallurgy. For example, the publication of a detailed mineralogical study of the titanium-bearing Cretaceous Gallup Sandstone near Gallup was a prelude to the research project by the Bureau metallurgist on the recovery of titanium and other rare metals from the Gallup Sandstone. The discovery of native selenium and the study of the geochemistry of the Jurassic Poison Canyon Sandstone of the Grants mining district initiated work on the recovery of selenium from low-grade sandstone ores.

In this biennium, the results of two research projects were published: a study of the oriented growth of cryptomelane in sylvite from Carlsbad, and an investigation on the nature of chrysocolla.

Dr. Ming-Shan Sun, Bureau staff mineralogist, accepted a "resident research appointment" at the Jet Propulsion Laboratory of the California Institute of Technology, at Pasadena, California, for one year beginning July 1, 1962. His research work will be in the field of space sciences. Dr. Sun was granted a year's leave of absence by the Regents.
PUBLICATIONS

Published (or in press) during biennium, July 1960 through July 1962:

Bulletins:

35  Geology of the Sacramento Mountains Escarpment, Otero County, New Mexico, by Lloyd C. Pray, 1961
47  Kyanite Occurrences in the Petaca District, Rio Arriba County, New Mexico, by Fred Barker, 1960
66  Summary of Pennsylvanian Sections in Southwestern New Mexico and Southeastern Arizona, by Frank E. Kottlowski, 1960
72  Mineral Resources of Luna County, New Mexico, by George B. Griswold, 1961
73  Petroleum Developments in New Mexico During 1959, by Roy W. Foster, Robert A. Bieberman, Richard R. Chavez, and Glenda K. Niccum, 1961
75  Geology of the Southeastern Part of the Chama Basin, by Clay T. Smith, A. J. Budding, and C. W. Pitrat, 1961
77  Geology of the San Pedro Mountains, Santa Fe County, New Mexico, by William W. Atkinson, Jr., 1962
78  Geology of the Pelona NE and Pelona NW quadrangles, by Charles E. Stearns, 1962

Memoirs:

7  Montoya and Related Colonial Corals, Part I; Organisms attached to Ordovician Colonial Corals, Part II, by Rousseau H. Flower, 1961
8  Stratigraphy and Paleontology of the Mississippian System in Southwestern New Mexico and Adjacent Southeastern Arizona, by Augustus K. Armstrong, 1962
9  The Phragmocone of the Ecdyceras, by Rousseau H. Flower, 1961
Ground-Water Reports

6 Geology and Ground-Water Conditions in Southern Lea County, New Mexico, by Alexander Nicholson, Jr., and Alfred Clebsch, Jr., 1961

Circulars:

53 Froth Flotation of Ion-Exchange Resins and its Applications, by Roshan B. Bhappu, 1961
57 Preliminary Geologic and Relief Map of the Precambrian Rocks of New Mexico, by Roy W. Foster and Thomas F. Stripp, 1961
58 Economic Recovery of Selenium from Sandstone Ores of New Mexico, by Roshan B. Bhappu, 1961
59 Glaucinite in the Cambrian-Ordovician Bliss Formation near Silver City, New Mexico, by Douglas W. Lewis, 1962
60 Reconnaissance of Commercial High-Calcium Limestones in New Mexico, by Frank E. Kottlowski, 1962
61 Index to samples from Oil and Gas Well Tests in Library at Socorro, New Mexico, January 1, 1958 to July 1, 1961, by Linda Blynn and Sharon L. Ballenger, 1962
62 Alkali Feldspars of Southwestern United States, by Frederick J. Kuellmer, 1961

Scenic Trips to the Geologic Past:

7 High Plains—Northeastern New Mexico (Raton—Capulin Mountain—Clayton), by William R. Muehlberger, Brewster Baldwin, and Roy W. Foster

Geologic Map Series:

13 Reconnaissance Geologic Map of Alum Mountain Thirty-Minute Quadrangle, by Max E. Willard, Robert H. Weber, and Frederick J. Kuellmer, 1961
14 Reconnaissance Geologic Map of Las Cruces Thirty-Minute Quadrangle, by Frank E. Kottlowski, 1960
16 Geologic Map of Tres Hermanas Mountains, by Robert Balk, 1961
17 Reconnaissance Geologic Map of Southern Animas Mountains, by Robert A. Zeller, Jr., 1962
Outside Publications, July 1960 to June 1962:


ACTIVE PROJECTS

In addition to the projects that have been completed by the publication of a final report, as listed under Publications, the Bureau of Mines has a large number of active projects in various stages of completion, as follows:

Projects Near Completion:

Truchas Peaks Region of the Southern Sangre de Cristo Mountains, Santa Fe, San Miguel, Taos, and Mora counties, by Arthur Montgomery, John P. Miller, and Patrick K. Sutherland.
Petrographic Zoning of the Cretaceous of the San Juan Basin, San Juan and McKinley counties, by Max E. Willard.
Properties of Alkali Feldspars from Tertiary Porphyries, by Frederick J. Kuellmer.
Ground-water Resources of Union County, by F. X. Bushman.
Geology and Ground-water Resources of Quay County, by Charles F. Berksrester, Jr.
Ground Water in the Structural Basin West of Tucumcari, by F. X. Bushman and Frederick D. Trauger.
Mineral Deposits of Hidalgo County, by Wolfgang Elston (Bulletin 76).
Revision of Buttsoceras, Part I; Notes on the Michelinoceratida, Part II, by Rousseau H. Flower (Memoir 10).
Investigation and Interpretation of the Niobium-bearing Sanostee Heavy-mineral Deposit, San Juan County, by Edward C. Bingler.
Geologic Notes on the Delaware Basin, Eddy and Lea counties, by Leon B. Haigler (Circular 63).
Geologic Map of the Sandia Mountains, Bernalillo and Sandoval counties, by Vincent C. Kelley.
Crystallization of Barite-Fluorite-Calcite in the presence of water at 7350 p.s.i., by Frederick J. Kuellmer.
Pre-Tertiary Strata of the Tres Hermanas Mountains, Luna County, by Frank E. Kottlowski and Roy W. Foster.
Monograph of the Ellesmeroceratida, by Rousseau Flower. The primitive order of cephalopods. All known forms are included as well as a few new ones, with attention to structure and evolution of the group. 28 plates.
Monograph of the Tarphyceratida, by Rousseau Flower. Revision of previous forms accompanied by descriptions of many new ones, largely from the El Paso Limestone of New Mexico.
Cephalopods of the Garden City and Pogonip groups, by Rousseau Flower. A study of the extension of the El Paso cephalopod zones into Utah and Nevada.

Projects Fifty or More Percent Complete:

Carizozo Quadrangle, Lincoln County, by Robert H. Weber.
Big Hatchet Peak Quadrangle, Hidalgo County, by Robert A. Zeller, Jr.
Las Cruces 15-minute Quadrangle, Dona Ana County, by Frank E. Kottlowski.
Geology and Ground-water Resources of Eastern Valencia County, by Frank B. Titus, Jr.
Petroleum Developments in New Mexico During 1960, by Robert A. Bieberman and Sharon L. Ballenger,
San Diego Mountain Quadrangle, Dona Ana County, by Frank E. Kottlowski.
Rock Mechanics Study of In-Situ Stress in Mine Rocks, by George B. Griswold,
Mimbres Quadrangle, Grant and Sierra counties, by Frederick J. Kuellmer.
Mineral Deposits of Grant County, by Elliot Gillerman.
Mineral Deposits of Santa Fe County, by Wolfgang E. Elston,
Biotite Variations in Tertiary Porphyries and Metamorphic Rocks, by Frederick J. Kuellmer.
Pennsylvanian and Early Permian Rocks in the Zuni Mountains Area, Valencia and McKinley Counties, by Roy W. Foster.
Tin Deposits of the Black Range Area, Grant and Sierra counties, by Richard H. Jahns.

Projects Initiated:

Silica Variations in Igneous and Metamorphic Rocks of New Mexico, by Frederick J. Kuellmer.
Oil Tests and Stratigraphy of Southwestern New Mexico, by Roy W. Foster.
La Madera Quadrangle, Rio Arriba County, by Edward C. Binger.
Stratigraphy of the Pennsylvanian Strata in Southeastern New Mexico, by Richard F. Meyer.
Zeolites in New Mexico, by Robert H. Weber.
Quartz Deformation in Metamorphic Rocks of New Mexico, by Frederick J. Kuellmer.
Illustrated Guide fossils for the Older Paleozoic of New Mexico, by Rousseau H. Flower.

Inactive Projects:

The following projects upon which some work was performed during previous periods were essentially inactive during this biennium.

Florida Mountains, Luna County, by Christina L. Balk.
Petrology of the Igneous Rocks in the Socorro Quadrangle, Socorro County, by Ming-Shan Sun.
Pennsylvanian Stratigraphy in the Northern Sacramento Mountains, Otero County, by Lewis M. Cline.
Bueyeros Area, Harding County, by Charles J. Mankin.
Capitan Quadrangle, Lincoln County, by John E. Allen.
Winston and Sugarloaf Quadrangles, Sierra and Socorro counties, by Richard H. Jahns.
Iron Mountain Tungsten, Sierra County, by Richard H. Jahns.
Walnut Wells Quadrangle, Hidalgo County, by Allen Alper and Robert A. Zeller, Jr.
Cebolla and Brazos Peak Quadrangles, Rio Arriba County, by William R. Muehlberger.
PERSONNEL, BUREAU OF MINES AND MINERAL RESOURCES

Front Row: Miss Josie M. Baca, Miss Jane Allen, Mr. Robert L. Price, Mrs. Sharon Ballenger, Mrs. Myrtie M. Edgar, Mrs. Shirlee Stahmann. 2nd Row: Dr. Frederick J. Kuellmer, Mr. William E. Arnold, Dr. Roshan B. Bhappu, Mr. Dennis R. Flynn, Miss Teri Ray, Mr. Alvin J. Thompson, Dr. Frank E. Kottlowski, Mr. Richard Chavez. 3rd Row: Mr. David Rice, Dr. Dexter H. Reynolds, Mr. Lawrence Herber, Mr. Bill Bonnichsen, Mr. Dwight G. Moore, Jr., Mr. Adrian P. Visocky, Mr. Viet Howard, Mr. Lucien A. File. Top Row: Mr. Robert A. Bieberman, Mr. Francix X. Bushman, Dr. Robert H. Weber, Dr. Maurice C. Fuerstenau, Mr. Max E. Willard, Mr. Hugh Woody, Mr. George B. Griswold, Dr. Rousseau H. Flower, Mr. Roy W. Foster.
Professional Staff

DIRECTOR
* Alvin J. Thompson

ECONOMIC GEOLOGISTS
* Kottlowski, Frank E.
* Kuellmer, Frederick J.
* Weber, Robert H.
* Willard, Max E.

HYDROLOGIST
* Bushman, Franklin 3

METALLURGISTS
* Bhappu, Roshan B.
* Fuerstenau-Maurice C. (associate)

MINERALOGIST
* Sun, Ming-Shan

MINING ENGINEER
* Griswold, George B. (associate)

MINING & GEOLOGICAL ENGINEER
* Austin, Carl F. (associate)

PETROLEUM GEOLOGISTS
* Bieberman, Robert A. (associate)
* Foster, Roy W. (assistant)

POSTDOCTORATE RESEARCH FELLOW
* Rodgers, Peter L.

RESEARCH CHEMIST
* Reynolds, Dexter H.

RESOURCE ECONOMIST
* Bertholf, William E.

STRATIGRAPHIC GEOLOGIST
* Flower, Rousseau H.

Nonprofessional Staff

BUREAU BUSINESS OFFICE MANAGER
* File, Lucien A.

DRAFTSMEN
* Arnold, William E. (Chief)
* Molina, Raymond
* Price, Robert L.

LABORATORY ASSISTANTS
* Chavez, Richard R.
  Erickson, Edward
  Hunter, Charles H.

*Employed at end of biennium
PUBLICATION EDITORS
Kase, Edmund H., Jr.
McKee, John D.
*Ray, Teri

SECRETARIES AND TYPISTS
*Baca, Josie M.
*Ballenger, Sharon
*Devlin, Lois
*Edgar, Myrtle M.
Helton, Sandra
Johnson, Patricia

GEOLOGISTS & ENGINEERS ON SPECIAL PROJECTS
*Elston, W. E.
Gillerman, Elliot
*Jahns, Richard H.
Muchlberger, William R.
Smith, Clay T.

GRADUATE STUDENT EMPLOYEES
Ascencios, Alejandro
*Bingler, Edward
*Bonnichsen, Bill
Chen, Tse-Pu
Geddes, Richard
*Herber, Lawrence
*Howard, E. Viet
Kopicki, Robert

PART-TIME STUDENT EMPLOYEES
Abbiss, Yvonne
*Allen, Jane
Baldwin, James
Beckhart, Roller
Blynn, Linda
Brooke, James
Casteel, Gary B.
*Crouch, Peggy
Dilatash, Andrew
Eddy, Russell
*Flynn, Dennis R.
*Gustafson, Laura
Hall, William K.
Hartmann, Dan John
*Hartzog, Laurence
Hasan, Syed Mir
Hicks, Robert Gale

Miller, Madaline T.
Niccum, Glenda K.
Richards, Nadine
*Roche, Jeri
*Stahmann, Shirlee
Vigil, Bessie S.

University of New Mexico
University of Kansas
Pennsylvania State University
University of Texas
New Mexico Institute of Mining
and Technology

Mathur, Virendra Pratap
*Moore, Dwight G. Jr.
Pecht, Herbert A. Jr.
Ratcliff, Marvin W.
Sheffer, Herman W.
*Visocky, Adrian
Wedekind, Frank
Wilshusen, Peter

Jones, Robert
Lacey, Dorothy
Littleton, Mary Edith
*Marino, Miguel
Miller, William E.
Monett, Judy
*Rice, David
Roman, Ronald
Running, John
Schultz, Jane
Sharpton, Sarah
Stahmann, William
*Stephenson, Donald
Stillwell, Robert G.
*White, Nedra
*Woody, Hugh

*Employed at end of biennium
Mineral production in New Mexico continued to climb during the biennium, attaining a total of $717 million in the calendar year 1960 and $755.6 million in 1961. As in prior years, mineral fuels contributed the major portion of the totals. Crude petroleum output increased to 107 million barrels in 1960 and 112 million barrels in 1961, valued at $306 million and $321 million. Natural gas and natural gasoline cycle products together for each of the two years totaled $134 million.

The state's 1960 production of uranium concentrates was valued at more than $125 million, with a slight drop to $123 million in 1961. New Mexico now provides 40 percent of the uranium and holds 60 percent of the reserves in the country. There are about 75 operations in McKinley and Valencia counties, the main area of activity.

Six companies, producing potash from eight large mines in the Carlsbad area in Eddy County furnish approximately 95 percent of the nation's total. New Mexico production rose steadily, with an $82.6 million evaluation in 1960 and $96.3 million in 1961.

Copper is fourth in dollar value of mineral products in the state. Production, valued at $43.1 million in 1960, increased to $47.7 million for 1961, in spite of a price decline to 29.92 cents a pound. Ninety-five percent of the state's copper is mined at Santa Rita's open pit; the remainder comes from underground mines in Hidalgo County.

Sand and gravel production was valued at $7.5 million in 1960 and increased to $10 million in 1961. Road construction is an important factor in this industry.

After a 10-year period of extreme ups and downs, zinc production is on the rise again. The 1960 output was valued at $3.5 million and rose to $5.3 million in 1961. Average prices during the biennium were 12.94 cents a pound in 1960 and 11.54 cents in 1961.

Industrial demand for coal has revived New Mexico's coal mining. Extensive prospecting operations are being conducted in the northwestern part of the state, and two new mines were developed in the biennium. The value of production increased from $1.7 million in 1960 to $2.5 million in 1961.

New Mexico continues to rank first in the nation in perlite. Figures for 1960 and 1961 were $2.12 million and $2.16 million. Most of the perlite was mined in Taos County.

The production of stone increased to an all-time high during the biennium. The total for all varieties was $1.7 million for 1960 and $2.2 million for 1961.
Lead continued to suffer from declining prices, with a new low of 9.5 cents a pound reached during the first half of 1962. The value of production in 1960 was $467,000 and in 1961 was $480,000; this compares with $2.26 million in 1952.

Many other mineral products were recovered during the biennium, of lesser value but together amounting to $18 million. These are barite, beryl, carbon black, carbon dioxide gas, cement, clays, gem stones and mineral specimens, gold and silver, gypsum, helium, lime, magnesium compounds, magnetite and manganese iron ore, mica, molybdenum, pumice, salt, scoria, sulfur, vanadium, vermiculite, and volcanic cinders.

Of these, New Mexico ranks first in the nation in the production of carbon dioxide gas, third in the production of helium and pumice, fourth in vanadium. Production figures are withheld as confidential for carbon dioxide and vanadium but are included in the totals.

Staff members prepare drawings, maps, and illustrations for publications of the Bureau in the Drafting Room.
## MINERAL PRODUCTION

(all values in thousands of dollars)

<table>
<thead>
<tr>
<th>Year</th>
<th>Barite s. tons</th>
<th>value</th>
<th>Beryllium concentrate s. t.</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>492</td>
<td>10</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>1961</td>
<td>600</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Columbium-tantalum concen.

<table>
<thead>
<tr>
<th>Year</th>
<th>1000 lb. gross wt.</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copper s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>67,288</td>
</tr>
<tr>
<td>1961</td>
<td>79,606</td>
</tr>
</tbody>
</table>

Gold Troy oz.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>55,000</td>
</tr>
<tr>
<td>1961</td>
<td>105,000</td>
</tr>
</tbody>
</table>

Gypsum s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>193</td>
</tr>
<tr>
<td>1961</td>
<td>386</td>
</tr>
</tbody>
</table>

Lime 1000 s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>496</td>
</tr>
<tr>
<td>1961</td>
<td>350</td>
</tr>
</tbody>
</table>

Manganese ore & concentrate gross wt.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td></td>
</tr>
</tbody>
</table>

Natural gas million cu. ft.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>798,928</td>
</tr>
<tr>
<td>1961</td>
<td>825,000</td>
</tr>
</tbody>
</table>

Nat. gasoline cycle prod. 1000 gals.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>966,783</td>
</tr>
<tr>
<td>1961</td>
<td>958,155</td>
</tr>
</tbody>
</table>

Pumice & pumicite 1000 s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>365</td>
</tr>
<tr>
<td>1961</td>
<td>339</td>
</tr>
</tbody>
</table>

Salt 1000 s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>39</td>
</tr>
<tr>
<td>1961</td>
<td>33</td>
</tr>
</tbody>
</table>

Tungsten concentrate s. t.

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td></td>
</tr>
</tbody>
</table>

Uranium concentrate

<table>
<thead>
<tr>
<th>Year</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>7,760</td>
</tr>
<tr>
<td>1961</td>
<td>7,750</td>
</tr>
</tbody>
</table>

\[ a \] Adjusted New Mexico totals include the value of uranium after processing by the mills of this state. The value of uranium concentrate is approximately twice that of the ore tonnage.

\[ b \] Figures withheld, confidential.

\[ c \] Value included in value of items that cannot be disclosed.

\[ d \] Final figure.

\[ e \] Weight not recorded.

\[ f \] Revised figure.

\[ g \] Preliminary figure.

\[ h \] Total adjusted.

\[ i \] Less than $1,000.

Except for uranium, all production data is from U.S. Bureau of Mines and Minerals yearbooks.

38
<table>
<thead>
<tr>
<th>Natural CO₂</th>
<th>Clays</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 cu. ft.</td>
<td>s. t.</td>
<td>value</td>
</tr>
<tr>
<td>230,115</td>
<td>c</td>
<td>56,000</td>
</tr>
<tr>
<td>242,903</td>
<td>c</td>
<td>67,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diatomite</th>
<th>Fluorspar</th>
<th>Gem stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>s. t.</td>
<td>value</td>
<td>s. t.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Helium</th>
<th>Iron ore</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 cu. ft.</td>
<td>M. t. gross</td>
<td>s. t.</td>
</tr>
<tr>
<td>43,494</td>
<td>684</td>
<td>I</td>
</tr>
<tr>
<td>42,224</td>
<td>762</td>
<td>b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manganiferous ore</th>
<th>Scrap mica</th>
<th>Sheet mica</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp; concentrate</td>
<td>s. t.</td>
<td>value</td>
</tr>
<tr>
<td>gross wt.</td>
<td></td>
<td>235</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,800</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perlite</th>
<th>Petroleum</th>
<th>Potassium salts,</th>
</tr>
</thead>
<tbody>
<tr>
<td>s. t.</td>
<td>(crude)</td>
<td>K₂O equiv.</td>
</tr>
<tr>
<td></td>
<td>M₄₂-gal. bbls.</td>
<td>value</td>
</tr>
<tr>
<td>240,593</td>
<td>2,119</td>
<td>107,380</td>
</tr>
<tr>
<td>245,654</td>
<td>2,159</td>
<td>112,083</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sand &amp; gravel</th>
<th>Silver</th>
<th>Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 s. t.</td>
<td>Troy oz.</td>
<td>1000 s. t.</td>
</tr>
<tr>
<td>7,419</td>
<td>7,459</td>
<td>304,000</td>
</tr>
<tr>
<td>12,523</td>
<td>10,049</td>
<td>283,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zinc</th>
<th>Items</th>
<th>New Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>s. t.</td>
<td>undisclosed*</td>
<td>Totals</td>
</tr>
<tr>
<td>13,770</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22,900</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

j. Less than one ton.
k. Excludes uranium, data not released by A.E.C.
l. Hand-cobbled equivalent.
m. Value of uranium concentrate taken from U.S. Atomic Energy Commission reports, except 1957 and 1958 which are estimated.
n. Excludes fireclay included in items that cannot be disclosed.
* Items that cannot be disclosed:
FINANCIAL STATEMENT

The Business Manager of the New Mexico Institute of Mining and Technology, who supervises the finances of the Bureau, has submitted the following statements:

STATE BUREAU OF MINES
GENERAL

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning balance July 1</td>
<td>$33,990</td>
<td>$27,252</td>
</tr>
<tr>
<td>State appropriation</td>
<td>235,400</td>
<td>328,210</td>
</tr>
<tr>
<td>Receipts from sales of bulletins, etc.</td>
<td>7,167</td>
<td>6,784</td>
</tr>
<tr>
<td>Less prior year adjustments</td>
<td>7,468</td>
<td></td>
</tr>
<tr>
<td>TOTAL revenue</td>
<td>$319,089</td>
<td>$362,246</td>
</tr>
</tbody>
</table>

Disbursements and Commitments

Personal services:

| Regular salaries                          | 150,200   | 167,724   |
| Part-time salaries                         | 40,935    | 44,022    |
| **Total**                                  | 191,135   | 211,746   |

Travel and automotive:

| Travel and per diem                        | 3,561     | 3,903     |
| Gas, repairs, and insurance                | 5,160     | 2,867     |
| **Repairs and maintenance**                | 8,741     | 6,770     |

Supplies and materials:

| Postage and resale supplies                | 2,825     | 1,887     |
| Office supplies                            | 2,517     | 2,720     |
| Laboratory and scientific supplies         | 4,790     | 7,242     |
| **Total**                                  | 10,132    | 11,849    |

Printing and reproduction

| Printing and reproduction                  | 29,867    | 29,369    |

Other operating expenses:

| Telephone and telegraph                    | 1,814     | 2,078     |
| Professional services                      | 7,581     | 8,543     |
| Retirement                                | 7,886     | 9,350     |
| Social Security                            | 3,676     | 3,847     |
| Overhead                                   | 11,600    | 11,600    |
| Freight, express, insurance, audit, repairs, subscriptions, etc. | 9,548 | 10,834 |
| **Total**                                  | 42,105    | 46,252    |

Capital outlay

| Capital outlay                             | 9,161     | 18,844    |

TOTAL expenditures

| TOTAL expenditures                         | $291,837  | $325,284  |

Year-end balance

| Year-end balance                           | $27,252   | $36,962   |
## FINANCIAL STATEMENT

### BASIC GEOLOGY

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Beginning balance July 1</td>
<td>$17</td>
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<tr>
<td>State appropriation</td>
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<td>TOTAL revenue</td>
<td>$9,017</td>
<td>$10,000</td>
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Disbursements and Commitments

<table>
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<tr>
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<td>Travel</td>
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<td>TOTAL expenditures</td>
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Year-end balance --- ---

### GROUND-WATER SURVEYS

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Disbursements and Commitments

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</thead>
<tbody>
<tr>
<td>Salaries</td>
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<td>8,000</td>
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<tr>
<td>Print and publication</td>
<td>470</td>
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<tr>
<td>Overhead</td>
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<td>1,000</td>
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<tr>
<td>TOTAL expenditures</td>
<td>$9,470</td>
<td>$10,000</td>
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</table>

Year-end balance --- ---