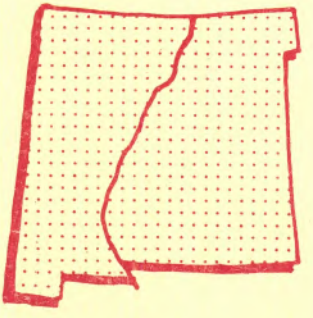
BIENNIAL REPORT

1954-5 and 1955-6



New Mexico Bureau of Mines
and Mineral Resources

Research Laboratory of New Mexico Institute of Mining and Technology. Laboratories and offices of State Bureau of Mines and Mineral Resources are in south wing (left).

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

E. J. Workman, President

STATE BUREAU OF MINES AND MINERAL RESOURCES

Eugene Callaghan, Director

BIENNIAL REPORT

FOR THE FISCAL YEARS ENDING

30 JUNE 1955-1956

Prepared by
the Director

SOCORRO 1956

THE REGENTS

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

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, 1955-1956, 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

DUTIES AND OBJECTIVES OF THE STATE BUREAU OF MINES AND MINERAL RESOURCES

The work and program of the State Bureau of Mines and Mineral Resources are designed to serve all citizens of New Mexico. The Bureau was established in 1927 by an Act of the Eighth State Legislature, as a division of the New Mexico School of Mines. This Act was so broad in its scope and so farsighted that no further enabling legislation has been necessary for the Bureau to meet the great changes in the population and economy of New Mexico and the unbelievable advances in technological development that have taken place. The Bureau of Mines and Mineral Resources is the only State organization charged with the duty of investigating, studying, and reporting on the geology of the entire State, as well as on all types of mineral resources, such as uranium, oil and gas, coal, metallic and nonmetallic minerals, and ground water. Having no regulatory or law-enforcement functions, the Bureau is free to cooperate impartially with all companies, individuals, agencies, and institutions in supplying the best possible information for their use and in turn receiving from them nonconfidential information which is shared by all, with the Bureau acting as a clearinghouse. A prime example of this is the oil-well-sample library and the records of drilling secured by companies and individuals at a cost of hundreds of millions of dollars, which are freely available in the Bureau. The value of these records increases with the passing of time.

An event of great importance during the biennium was the completion of a new wing at the south side of the Research Laboratory on the campus of the New Mexico Institute of Mining and Technology, designed functionally for use by the Bureau. This structure provides laboratories adequate for the present staff of the Bureau, although additional space is needed now for the oil-well-sample library which is growing rapidly with the greatly augmented drilling activity in the State.

With the completion of many of the field and research projects, the preparation of maps and reports for publication has become a major effort on the part of Director and staff. These publications are of the highest technical excellence in format as well as in content. They have won praise not only in New Mexico but in all parts of the world, where they serve to advertise the opportunities for mineral-resource development in the State and the quality of its scientific and engineering work. These reports must be satisfactory and informative for the investor and engineer as well as for scientists, educators, and prospectors. They must be as accurate as the state of knowledge permits.

In order to bring geologic and resource knowledge to students, tourists members of rockhound and mineral clubs, and other citizens, a series of guide books to interesting areas in the State has been initiated. These are designed to keep tourists in the State "that extra day" which the Tourist Bureau points out is so important to the State's economy. Several thousand of these books have been distributed already, and many more are demanded.

Notable scientific and resource studies by the Bureau were requested, and largely or wholly paid for, by outside agencies, so immediate and necessary was the demand for such information. Bulletins 36 and 44, "Mineral Resources of Fort Defiance and Tohatchi Quadrangles, Arizona and New Mexico," and "Mineral Resources of the Navajo Reservation in New Mexico," were prepared under contract with the Bureau of Indian Affairs under the Navajo-Hopi Rehabilitation Act. Memoir 1, "Stratigraphic Studies of the San Andres Mountains, New Mexico," is an unusually fine publication of particular interest to the oil industry, resulting from data acquired by Bureau staff under contract with three major oil companies. The awarding of these contracts was a fine compliment to the competence and reputation of the Bureau staff.

Another fine compliment to the Bureau was its selection as host for the 1955 meeting of the Association of American State Geologists, of which the Director is currently secretary-treasurer. All who attended this meeting, including the directing heads of the Federal Bureau of Mines and the Geological Survey, were warm in their praises of the Bureau of Mines and Mineral Resources.

Still another indication of confidence in the Bureau was the appointment of two members of the staff by the Governor of New Mexico to serve on the Western Governors Mining Advisory Council, along with Mr. Thomas M. Cramer, president of the Board of Regents of the New Mexico Institute of Mining and Technology, and Mr. James K. Richardson, of the Kennecott

Copper Corporation. These Council members were delegates to the Western Governors Mineral Policies Conference in November 1955 in Sacramento, California. The Director also served on the research committee of that conference.

A further expression of confidence in the Bureau was the grant of a substantial sum by the National Science Foundation to a member of the Bureau staff for a research project designed to assist in the search for metallic mineral deposits.

The Bureau contributes to public education in many ways. Some staff members give courses in geology in the New Mexico Institute of Mining and Technology as well as occasional lectures in that and other institutions. The field-assistance fellowship program provides the means for many geologists to secure advanced degrees at the Institute and at various universities. Student assistants are provided with both summer and part-time work and in-service training. Prepared educational collections of minerals and rocks are sent free to school children throughout the State and for mailing charges outside the State. The publications of the Bureau go to libraries throughout the State as well as to numerous institutions in the nation and in foreign countries. As such they serve as basic information for educational purposes. Much of the Bureau's correspondence is of an educational nature, as are the conferences with prospectors and others in the Bureau offices and laboratories.

Research facilities available to the staff have been improved. Through the efforts of all three divisions of the Institute, the library has been improved

greatly, so that complete or nearly complete sets of many foreign periodicals in geology and related sciences are available, and current subscriptions are maintained. The exchange arrangements the Bureau has made with all State and Federal surveys, many institutional libraries, and numerous foreign countries enrich the library and make it a useful tool. This, together with subscriptions to mineral-industry publications, serves to keep the staff fully informed on all reported advances in the field. Attendance at scientific or mineral-industry meetings also enables the staff to learn of new techniques that may be applied to problems in New Mexico. The X-ray laboratory, a most useful tool to speed up the determination of minerals and increase the accuracy of the work, has been improved through efforts of both the Bureau and the Research and Development Division of the Institute. Additional instruments to extend the scope and usefulness of this laboratory are needed.

County maps showing all known oil and gas tests are being prepared to aid in exploration. Geologic and structural maps, as well as paleontologic and stratigraphic studies, and a new State geologic map, in the compilation of which the Bureau is assisting the U. S. Geological Survey, are of vital use to the petroleum industry. In this connection a large part of southwestern New Mexico is being mapped by the Bureau for the first time.

The marked growth in professional experience and knowledge of New Mexico by the staff has made the Bureau vastly more useful to the mineral industry, to prospectors, and to all citizens seeking mineral-resource and earth-science information. Numerous determinations are made of mineral

and rock samples. Correspondents receive much information by mail, and a constant stream of visitors confer with staff members on their mineral-industry or geological problems. Cooperation with all State and Federal organizations is freely given. The State Highway Department, the State Economic Development Commission, and many others have sought assistance from the Bureau. Private organizations, such as the New Mexico Land Resources Committee, Chambers of Commerce, and others have looked to the Bureau for cooperation on their own projects and for specific information. Bureau members serve on committees, such as the New Mexico Water Resources Project and the Middle Rio Grande Study Group, and aided the International Arid Lands Conference.

Staff personnel serve as members and officers of national and State organizations and participate in meetings. Some of these are listed below:

National

American Association for the Advancement of Science
American Association of Petroleum Geologists
American Association of University Professors
American Geological Institute
American Geophysical Union
American Institute of Mining and Metallurgical Engineers
American Water Works Association
Association of American State Geologists
Geological Society of America
Mineralogical Society of America
National Research Council
National Society of Professional Engineers
Nebraska Academy of Sciences

State and Local

Colorado Mining Association
Four Corners Geological Society
New Mexico Geological Society
New Mexico Mining Association
New Mexico Society of Professional Engineers
Roswell Geological Society
Sigma Xi Club of New Mexico
State Mapping Advisory Board

Scientific lectures and papers presented before various groups are listed below:

Allen, J. E. (August 1954) Stratigraphy of Mesaverde formation, Flagstaff Field Conference.

(November 1954) Economic minerals of Fort Defiance area, Navajo Tribal Council, Window Rock; also Albuquerque Gem and Mineral Club.

(December 1954) Economic minerals of Fort Defiance area, Socorro Lions Club.

(April 1955) The making of a mine, Deming Chamber of Commerce.

(May 1955) The art of geology, NMIMT Colloquium.

(September 1955) Bentonite deposits in the Navajo Reservation, New Mexico and Tohatchi shale of Mesaverde formation, San Juan Basin, El Paso International Mining Days, El Paso, Texas.

(February 1956) The ultimate resource, Deming Chamber of Commerce; also Socorro Rotary Club.

(May 1956) Geology of Capitan quadrangle, Lincoln County, New Mexico, American Association for the Advancement of Science, State College, New Mexico.

(May 1956) Titaniferous Cretaceous beach sand deposit in McKinley County, New Mexico, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

Anderson, E. C. (June 1956) Mining resources of northeastern New Mexico, conference on "What Is Wrong With the Economy of Northeastern New Mexico," Las Vegas, New Mexico.

Baldwin, Brewster (May 1955) Facets of a ground-water study, New Mexico Geological Society, Gallup, New Mexico.

(May 1956) Geology and ground-water resources of Union County, New Mexico, American Association for the Advancement of Science, State College, New Mexico.

Bieberman, Robert A. (June 1956) Petroleum possibilities of northeastern New Mexico, conference on "What Is Wrong With the Economy of Northeastern New Mexico," Las Vegas, New Mexico.

Boyd, Donald W. (November 1955) San Andres formation in the Brokeoff Mountains, southeastern New Mexico, The Geological Society of America, New Orleans, Louisiana.

Callaghan, Eugene (May 1955) Correlation of igneous rocks of New Mexico by fusion, American Geophysical Union, Washington, D. C. (with Ming-Shan Sun* as coauthor).

(December 1955) Tectonic history of New Mexico, University of Texas.

(March 1956) Some geologic and related features of Cuba, NMIMT Colloquium.

(June 1956) Mineral resources of northeastern New Mexico, conference on "What Is Wrong With the Economy of Northeastern New Mexico," Las Vegas, New Mexico.

Elston, Wolfgang E. (November 1955) Volcanic succession and possible mineralization in Dwyer Quadrangle, southwestern New Mexico, The Geological Society of America, New Orleans, Louisiana.

Flower, Rousseau H. (November 1955) Bliss and El Paso successions in New Mexico, The Geological Society of America, New Orleans, Louisiana.

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* Indicates speaker.

Flower, Rousseau H. (May 1956) Montoya-Bighorn-Richmond correlations, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

(May 1956) The order Discosorida, NMIMT Colloquium.

Jicha, Henry L., Jr. (October 1954) Correlation of basalt flows in central New Mexico by fusion technique, The Geological Society of America, Los Angeles, California.

Kottlowski, Frank E. (November 1955) Rock units and structure seen at the mouth of Rhodes Canyon, New Mexico Geological Society, sixth field conference.

(November 1955) Lower Paleozoic sequence in Rhodes Canyon, New Mexico Geological Society, sixth field conference.

(November 1955) Lower Pennsylvanian strata in Rhodes Canyon, New Mexico Geological Society, sixth field conference.

(November 1955) Upper Pennsylvanian and Lower Permian stratigraphy of northern San Andres Mountains, New Mexico Geological Society, sixth field conference.

(April 1956) Cretaceous-Tertiary outcrops in Jornada del Muerto, NMIMT Colloquium.

(May 1956) Rock sequence exposed near Las Cruces, New Mexico, Southwestern and Rocky Mountain Division of American Association for the Advancement of Science, State College, New Mexico.

(May 1956) Late Cretaceous and early Tertiary outcrops of Jornada del Muerto, New Mexico, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

(June 1956) Rock units and their outcrops near Las Cruces and El Paso, Dona Ana Rockhound Club and El Paso Mineral and Gem Society, Anthony, New Mexico.

Kuellmer, Frederick J. (May 1955) Geology of a disseminated copper deposit near Hillsboro, New Mexico, New Mexico Geological Society, Gallup, New Mexico.

(November 1955) Potash-feldspar exsolution in a Tertiary porphyry, The Geological Society of America, New Orleans, Louisiana.

Kuellmer, Frederick J. (May 1956) Geology of the southern Black Range area, Grant, Luna, and Sierra Counties, New Mexico, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

Muehlberger, William R. (November 1955) Relative age of Folsom man and Capulin Mountain eruption, Colfax and Union Counties, New Mexicc The Geological Society of America, New Orleans, Louisiana.

Otte, Carl, Jr. (November 1954) Wolfcampian reefs of the northern Sacramento Mountains, Otero County, New Mexico, The Geological Society of America, Los Angeles, California.

*Pray, Lloyd C. (November 1954) Desmoinesian facies of the Sacramento Mountains, New Mexico, The Geological Society of America, California (with Roy W. Graves, Jr. as coauthor).

Smith, Clay T. (May 1955) General stratigraphy of the Gallup-Grants area, New Mexico Geological Society, Gallup, New Mexico.

Spiegel, Zane (May 1956) Relation of ground water to stream flow in New Mexico in late Cenozoic time, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

Sun, Ming-Shan (November 1954) Titanclinohumite in kimberlitic tuff, Buel Park, Arizona, The Geological Society of America, Los Angeles, California.

(November 1954) Geochemical aspect of the volcanic rocks of Cienega, New Mexico, The Geological Society of America, Los Angeles, California (with Brewster Baldwin* as coauthor).

(November 1954) Ardennite (This has been determined as a new mineral, Santafeite) from the Grants uranium district, New Mexico, The Geological Society of America, Los Angeles, California (with Robert H. Weber* as coauthor).

Willard, Max E. (February 1955) Seismic tests as an aid to classification of roadway excavations, annual highway conference, New Mexico A&M College, Las Cruces, New Mexico.

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* Indicates speaker.

Willard, Max E. (May 1956) Clay minerals in the Cretaceous rocks of Tohatchi quadrang. New Mexico, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico.

Zeller, Robert A., Jr. (May 1955) Recent lake system in southwestern New Mexico, New Mexico Geological Society, Gallup, New Mexico.

(May 1956) Occurrence of Tempskya Minor in strata of Albian age in southwestern New Mexico, Rocky Mountain Section of The Geological Society of America, Albuquerque, New Mexico (with Charles B. Read as coauthor).

Statistics of Services

	7-1-54 to 6-30-55	7-1-55 to 6-30-56
Sales:		
Bulletins	2,886	1,651
Maps	609	479
Well logs	1,275	2,282
Circulars, annual reports, and guidebooks distributed free	6,712	6,393
Publications and maps issued free to school libraries, institutions, etc., on exchange basis	270	287
Qualitative determinations	606	395
Small and special mineral collections to schools, etc.	820	254
Names on Bureau's notification list (as of June 30)		332
Letters written (to 48 States and 40 foreign countries)	5,824	3,659
Oil and gas:		
Oil and gas well samples available (approx.)	3,744 wells	4,000 wells
Number of boxes occupied by well samples	8,314	9,878
Drillers' logs on file	6,950	7,114
Correspondence handled	154	146

FIELD AND RESEARCH ACTIVITIES

Field and laboratory studies, as well as compilation and filing of pertinent data, cover parts of every county in the State except Los Alamos, which is essentially a Federal area. The work accomplished so far, impressive as a beginning, serves to point out the enormous amount of work yet to be done. Although the value of mineral production has doubled in the past five years, most of this has been derived, with the exception of uranium, from more intensive activity in well-known areas. The need is obvious for rapid expansion of regional geologic mapping, so that favorable areas for mineral exploration can be delineated, and for intensive mapping of these favorable areas to identify targets for drilling and other exploratory efforts. Also, data on underground water resources are needed now to guide intelligent development of the State; yet at the present rate years will pass before the most general type of information can be supplied for the whole State.

As in the past, the regular staff must share available time between service functions and field and laboratory research activities. The temporary staff devotes its time while in the employ of the Bureau to field work and does laboratory work and report writing largely on its own time. The same applies to the Field Assistance Fellows, who are mainly candidates for the Ph. D. degree at major universities.

The brief statements given below on each formalized project list the title of the project, the name of the principal investigator, the institution or agency with which he was associated at the time the field work was done,

the nature of the project, its status, and the date and title of publications resulting from the study. Comparison with previous reports shows noteworthy progress in the publication of results. Some reports and maps have been released on open file in the Bureau after appropriate notices were published in the press.

1. Costilla and Latir Peak quadrangles (in cooperation with Fuels Branch, U. S. Geological Survey), by Philip F. McKinlay (formerly with Bureau, now in private employment). Western part of Sangre de Cristo Mountains and San Luis Valley published April 1956 as Bulletin 42, "Geology of Costilla and Latir Peak Quadrangles, Taos County, New Mexico."

2. Questa and Eagle Nest quadrangles (in cooperation with Fuels and Mineral Deposits branches, U. S. Geological Survey), by Philip F. McKinlay. Materials of economic interest are molybdenum at Questa mine, gold, zinc, copper, various igneous rocks, and ground water. Publication of Eagle Nest quadrangle awaits completion of work by U. S. Geological Survey. Questa quadrangle being prepared for publication as Bulletin 53.

3. Big Rock kyanite deposits, by Allen F. Corey (University of Michigan). Mapping and laboratory study of kyanite (aluminum silicate) deposits. Manuscript being edited for publication as Bulletin 47.

4. El Rito quadrangle, by Harry B. Groom (Harvard University). The area contains pegmatite deposits in Precambrian rocks as well as Tertiary and Quaternary formations. Field work partly completed but inactive currently.

5. Water resources of the Santa Fe area (in cooperation with Ground Water Branch, U. S. Geological Survey, and Research and Development Division of New Mexico Institute of Mining and Technology), by Brewster Baldwin, Frank E. Kottlowski, and Wayne M. Bundy (Bureau), Zane Spiegel (U. S. Geological Survey), and Hartmut Winkler (Research and Development Division). An intensive study of local geology and of water resources available to the city of Santa Fe. Manuscript in hands of U. S. Geological Survey for editing and publication.

6. Cerrillos district, by Alan E. Disbrow (University of New Mexico). Detailed geology of complex intrusive and volcanic rocks and of base-metal mines. Area was once famous as a source of turquoise. Manuscript being edited for publication as Bulletin 48.

7. Thoreau quadrangle, by Clay T. Smith (New Mexico Institute o Mining and Technology). Geology of part of Grants uranium area. Published August 1954 as Bulletin 31, "Geology of the Thoreau Quadrangle, McKinley and Valencia Counties, New Mexico."

8. South Manzano Mountains, by John T. Stark (Northwestern University). A detailed study of Precambrian rocks and structure. Publish June 1956 as Bulletin 34, "Geology of the South Manzano Mountains, Ne Mexico."

9. Puertecito quadrangle, by William Tonking (Princeton Universi Stratigraphy and structure in Rio Salado basin. Manuscript being edited fc publication as Bulletin 41. Multicolored map published November 1955.

10. Stendel perlite deposit, by Robert H. Weber (Bureau). A detail field and laboratory study of a complex perlite deposit. Manuscript being edited for publication as Circular 44.

11. Socorro perlite deposit, by Eugene Callaghan and Robert H. Weber (Bureau). A detailed mapping and laboratory study of a major producing perlite mine. Field work completed.

12. Area east of Socorro (in cooperation with Fuels Branch, U. S. Geological Survey), by R. H. Wilpolt and A. A. Wanek (U. S. Geological Survey). Stratigraphy and structure of a large area in Socorro County are shown as well as the Carthage coal field. Published as Map OM 121, Oil and Gas Investigations, U. S. Geological Survey.

13. Carrizozo quadrangle, by Robert H. Weber (Bureau). Stratigra and structure of north end of Sierra Blanca. Resources of iron, precious metals, and ground water. Field work completed. Manuscript in preparati

14. Capitan quadrangle, by John E. Allen (Bureau), Stewart Jones (formerly on faculty of New Mexico Institute of Mining and Technology), and Wolfgang E. Elston (Texas Technological College). Materials of economic interest are iron, coal, and precious metals. Field work is nearly completed.

15. Sacramento Mountains area, by Lloyd C. Pray (California Institute of Technology). This report will provide detailed information on the stratigraphy and structure of this part of New Mexico. Manuscript being rewritten for publication as Bulletin 35.

16. Lookout Mountain quadrangle, by David Llewellyn (Stanford University). Precious metals, tin ores, and clay have been found in this area. Field work is completed. Inactive currently.

17. Winston and Sugarloaf Mountain quadrangles, by Richard H. Jahns (California Institute of Technology). Several noted precious-metal districts, as well as deposits of iron, beryllium, uranium, and tungsten occur in this area. Field work is being continued.

18. Geologic section of Black Range, by Frederick J. Kuellmer (University of Chicago). Detailed study of stratigraphy and structure which includes Kingston mining district. Published January 1955 as Bulletin 33, "Geologic Section of the Black Range at Kingston, New Mexico."

19. Dwyer quadrangle, by Wolfgang E. Elston (Columbia University). A careful study of the volcanic succession southeast of Santa Rita. Manuscript prepared for publication as Bulletin 38. Ground-water study by F. X. Bushman (Bureau). Published September 1955 as Circular 37, "Ground-Water Data for Dwyer Quadrangle, Grant and Luna Counties, New Mexico."

20. Lake Valley quadrangle, by Henry L. Jicha, Jr. (Columbia University). Structure and stratigraphy of sedimentary section and of volcanic succession. Contains Cooks Peak and Lake Valley mining districts. Published January 1955 as Bulletin 37, "Geology and Mineral Deposits of Lake Valley Quadrangle, Grant, Luna, and Sierra Counties, New Mexico."

21. Big Hatchet Peak quadrangle, by Robert A. Zeller, Jr. (University of California at Los Angeles). Stratigraphy and structure in thick section of Paleozoic and Lower Cretaceous rocks. Field work completed and manuscript in preparation for publication.

22. El Paso Gap quadrangle, by Donald Boyd (Columbia University). Detailed mapping and correlation of Permian rocks. Manuscript completed for publication as Bulletin 49.

23. Topical study of gossans, by William C. Kelly (Columbia University). A study of leached outcrops as guides to ore. Manuscript being edited for publication as Bulletin 46.

24. Columbus and Hermanas quadrangles, by Robert Balk (Bureau). Detailed mapping of intrusives and associated rocks with contact and other mineral deposits. Field work completed.

25. Picuris Range, by Arthur Montgomery (Harvard University). This report is a notable contribution to the knowledge of crystalline rocks and a variety of minerals of economic importance. Published June 1953 as Bulletin 30, "Pre-Cambrian Geology of the Picuris Range; North-Central New Mexico."

26. Las Cruces quadrangle, by Frank E. Kottlowski (Bureau). Detailed study of stratigraphy and structure in Lower Rio Grande Valley. Manuscript being prepared for publication.

27. Three Rivers area, by Robert F. Schmalz (Harvard University). Detailed study of structure and stratigraphy on east side of Tularosa basin. Mapping of Oscura and Three Rivers quadrangles completed and manuscript being edited for publication.

28. La Luz area, by Carl Otte (California Institute of Technology). A detailed study of lateral variations in Permian rocks. Manuscript being edited for publication as Bulletin 50.

29. Dog Springs quadrangle, by David B. Givens (University of California at Los Angeles). Study of stratigraphy and structure on north side of Datil volcanic area. Manuscript completed for publication.

30. Post Office Flat, Mt. Sedgwick, Valle Largo, and Paxton Springs 7½-minute quadrangles, by Clay T. Smith (New Mexico Institute of Mining and Technology) (in cooperation with E. N. Goddard, Mineral Deposits Branch, U. S. Geological Survey). Study of stratigraphy and structure of Zuni uplift and of fluorspar deposits. Field work nearly completed.

31. Tohatchi and Fort Defiance quadrangles, by John Eliot Allen and Robert Balk (Bureau). This mineral-resource study includes detailed geologic mapping and is financed wholly by Federal funds under contract with the U. S. Bureau of Indian Affairs. Published November 1954 as Bulletin 36, "Mineral Resources of Fort Defiance and Tohatchi Quadrangles, Arizona and New Mexico."

32. Pelona NE. and NW. quadrangles, by Charles Stearns (Tufts University). The purpose of this study is an understanding of the geology of the San Agustin Plains as a basis for evaluation of ground-water resources. Manuscript in preparation for publication. Ground-water study by F. X. Bushman and C. P. Valentine (Bureau) published April 1954 as Circular 26, "Water Well Records and Well Water Quality in Southwestern San Agustin Plains, Catron County, New Mexico."

33. Hansonburg mining district, by Frank E. Kottlowski (Bureau). The map shows parts of the Hansonburg district and details of stratigraphy and structure affecting barite mining operations. Published as Circular 23, "Geology and Ore Deposits of a Part of the Hansonburg Mining District, Socorro County, New Mexico."

34. Las Tablas quadrangle, by Fred Barker (California Institute of Technology). The purpose of this project is to show the regional geology of many of the pegmatite deposits as well as to provide basic information on the succession of volcanic and sedimentary rocks. Manuscript being edited for publication as Bulletin 45.

35. Foster Canyon quadrangle, by Clay T. Smith (New Mexico Institute of Mining and Technology). Distribution and structure of uranium-bearing formations will be shown. The manuscript is being prepared for publication.

36. Bland mining district, by Wayne M. Bundy (Indiana University). Detailed geology, both underground and at the surface, is shown for this precious-metal district. Manuscript being edited for publication.

37. Socorro manganese district, by Alfred T. Miesch (Indiana University). The sequence of volcanic rocks is shown as well as the geologic setting of manganese oxide deposits. Published February 1956 as Circular 38, "Geology of the Luis Lopez Manganese District, Socorro County, New Mexico."

38. Contact metamorphism in Sierra Rica and Apache Hills, by Oscar Strongin (Columbia University). Mineral deposits occur in Lower Cretaceous rocks in an area complicated by overthrusts. Manuscript being edited for publication.

39. Oil and Gas Map of New Mexico, by Robert A. Bieberman (Bureau) (in cooperation with Fuels Branch, U. S. Geological Survey). A new edition of this popular and important map; the last was issued in 1949. Published in 1954 by U. S. Geological Survey as OM 159, "Map of New Mexico showing test wells for oil and gas, oil and gas fields, and pipelines," accompanied by Circular 333, "Wells Drilled for Oil and Gas in New Mexico."

40. Geologic Map of New Mexico. The staff of the Bureau in cooperation with the Fuels Branch, U. S. Geological Survey, is undertaking the preparation of a new edition of the State geologic map. Field work and compilation nearly complete. The Bureau has undertaken major responsibility for the southwestern quarter of the State. Northwestern quarter compiled and ready for printing as preliminary map in blackline.

41. Characteristics of petroleum in New Mexico. Inactive.

42. Tertiary volcanic rocks of New Mexico. The staff of the Bureau is continuing field mapping and laboratory study of these rocks to which so many mineral deposits are closely related.

43. Tertiary intrusive rocks of New Mexico. The staff of the Bureau continues to assemble data on these rocks with which most of the base-metal deposits of the State are associated.

44. Stratigraphy of New Mexico, by R. H. Flower and staff of the Bureau. A fundamental knowledge of the sequence and relationships of all rocks will aid greatly in maintaining our future oil and gas production as well as assisting in exploration for mineral deposits and for ground water. A part of this study is to be published as Circular 43.

45. Stratigraphy and paleontology of the El Paso limestone, by R. H. Flower (Bureau). Field and laboratory work is continuing on this basic stratigraphic study of a prominent formation of southern New Mexico.

46. Coal in Capitan quadrangle, by Marc W. Bodine (Columbia University). The geology of a small area of coal beds is outlined in this study. Published January 1956 as Circular 35, "Geology of Capitan Coal Field, Lincoln County, New Mexico."

47. Ojo Caliente area, by Richard H. Jahns (California Institute of Technology) and Clay T. Smith (New Mexico Institute of Mining and Technology). A small area of Precambrian rocks and pegmatite deposits is covered in this study. Manuscript is being prepared for publication.

48. Iron Mountain tungsten deposits, by Richard H. Jahns (California Institute of Technology). A notable occurrence of tungsten will be described in the report. Manuscript is nearly completed.

49. Hermosa district, by Richard H. Jahns (California Institute of Technology). An intensive study of a famous old silver camp. Manuscript in preparation for publication. Manuscript on a laboratory investigation of the ores by Henry L. Jicha, Jr. (Bureau) was printed in Economic Geology and was reprinted as Circular 27, "Paragenesis of the Ores of the Palomas (Hermosa) District, Southwestern New Mexico." A brief study of possibilities for further ore discovery was published as Circular 33, "Possibilities for Discovery of Additional Lead-Silver Ore in the Palomas Camp Area of the Palomas (Hermosa) Mining District, Sierra County, New Mexico: A Preliminary Statement," by R. H. Jahns.

50. Mud Springs Mountains quadrangle, by John D. Hill (University of New Mexico). Paleozoic rocks are delineated for a small but well-exposed area. Manuscript available for publication.

51. Pennsylvanian stratigraphy, by L. M. Cline (University of Wisconsin). A bed-by-bed study of a characteristic sequence of Pennsylvanian rocks. Manuscript nearly completed.

52. Ore deposits of the High Rolls district, by S. E. Jerome, et al. A detailed study by staff of New Jersey Zinc Exploration Company of base metals in sedimentary rocks. Manuscript being edited for publication.

53. Mineral deposits of Questa mine area, by John H. Schilling (Harvard University). This is an intensive study of the Questa molybdenite mine and the surrounding area. Published July 1956 as Bulletin 51, "Geology of Questa Molybdenum Mine, Taos County, New Mexico.

54. Inscription Rock quadrangle, by Clay T. Smith (New Mexico Institute of Mining and Technology). Stratigraphy and structure in the Zuni uplift area are being delineated in this study. Manuscript in preparation for publication.

55. Hillsboro quadrangle, by Frederick J. Kuellmer (Bureau). This very complex area contains the Hillsboro and Kingston mining districts. Field work completed. A detailed study of a porphyry copper deposit, published August 1955 as Circular 34, "Geology of a Disseminated Copper Deposit near Hillsboro, Sierra County, New Mexico."

56. Pennsylvanian stratigraphy in Fresnal Canyon in Sacramento Mountains. Inactive.

57. Mineral survey of the Navajo Reservation in New Mexico, by John Eliot Allen (Bureau). This is the second project completed under contract with the U. S. Bureau of Indian Affairs. Published June 1955 as Bulletin 44, "Mineral Resources of the Navajo Reservation in New Mexico (exclusive of uranium, coal, oil, gas, and water)."

58. The metal resources of New Mexico and their economic features, by E. C. Anderson (Bureau). A compilation of data on metalliferous deposits by county for the entire State. To be published as Bulletin 39, "The Metal Resources of New Mexico and Their Economic Features Through 1954."

59. Bibliography of geology and mineral resources of New Mexico through 1950, by Marian R. Burks and John H. Schilling (Bureau). Published August 1955 as Bulletin 43, "Bibliography of New Mexico Geology and Mineral Technology Through 1950."

60. Pyramid Mountains in Lordsburg quadrangle, by Fred R. Flege (Washington University in St. Louis). Detailed study of groups of volcanic rocks, one of which contains notable deposits of perlite. Manuscript available for publication.

61. Mesa del Oro quadrangle, by Henry L. Jicha, Jr. (Bureau). Stratigraphy and structure in an area of sedimentary rocks and basalt-covered mesas are delineated. Manuscript nearly completed. Travertine resources published February 1956 as Circular 36, "A Deposit of High-Calcium Lime Rock in Valencia County, New Mexico."

62. Pennsylvanian stratigraphy and paleontology in Whiskey Canyon, Mud Springs Mountains, near Truth or Consequences, by John L. Gehrig (University of Wisconsin). Manuscript being edited for publication.

63. Guidebook of southwestern New Mexico, Fourth Field Conference, New Mexico Geological Society, October 1953. The Bureau staff, in cooperation with the Mineral Deposits Branch of the U. S. Geological Survey, prepared the annual guidebook for a route extending from El Paso, Texas, to Caballo Reservoir, to Silver City, and thence through Lordsburg to the vicinity of Wilcox, Arizona. Much original field work was necessary in order to prepare the route maps. Published October 1953.

64. Cambrian cephalopods, by R. H. Flower (Bureau). A study of the earliest forms in this group of important guide fossils for the Paleozoic of New Mexico. Published December 1954 as Bulletin 40, "Cambrian Cephalopods."

65. San Diego Mountain quadrangle, by Frank E. Kottlowski (Bureau). Detailed study of volcanic and intrusive rocks. Field work nearly completed.

66. Cienega area, by M. S. Sun and Brewster Baldwin (Bureau). Detailed study of volcanic and intrusive rocks. Manuscript being edited for publication as Bulletin 54.

67. Wallrock alteration in Bland District, by Wayne M. Bundy (Indiana University). A field and laboratory study of altered rock associated with mineral deposits. Manuscript in preparation for publication.

68. Walnut Wells quadrangle, by Allen Alper (Columbia University). Mapping of an area of volcanic rocks, and of sedimentary rocks containing mineral deposits. Field work nearly completed.

69. Steins area, by Elliot Gillerman (University of Texas). Detailed mapping of complex area of sedimentary and volcanic rocks containing mineral deposits. Manuscript in preparation.

70. Precambrian rocks of Gila River area, by Charles H. Hewitt (University of Michigan). A detailed study of basement rocks and associated mineral deposits. Manuscript in preparation.

71. Uranium associated with fluorspar at Monticello, by William A. Bassett (Columbia University). A field and laboratory study. Manuscript is available for publication.

72. Paleozoic stratigraphy in south-central New Mexico, by Frank E. Kottlowski, R. H. Flower, Roy W. Foster (Bureau), and M. L. Thompson (University of Kansas). Manuscript being edited for publication as Memoir 1.

73. North Magdalena area, by James T. Johnson (New Mexico Institute of Mining and Technology). Detailed mapping of north end of Magdalena mining district and adjacent area. Manuscript available for publication.

74. Engle NE. quadrangle, by Eugene Cserna (Columbia University). Stratigraphy and structure of Fra Cristobal Mountains. Manuscript available for publication.

75. Cebolla NW. quadrangle (includes part of Monero NE. quadrangle), by William R. Muehlberger (University of Texas). Stratigraphy, structure, and volcanic sequence in the projection of the San Juan Mountains into New Mexico. Field work in progress.

76. Cebolla SW. quadrangle, by Hugh H. Doney (University of Texas). Relation of Chama embayment of San Juan Basin to projection of San Juan Mountains. Field work in progress.

77. Bueyeros area, by Charles J. Mankin (University of Texas). Stratigraphy and sedimentary petrology of rocks surrounding Bueyeros CO_2 field. Field work in progress.

78. Sowell quadrangle, by Frank Kottlowski (Bureau). Stratigraphy (type section of San Andres formation) and structure on west side of San Andres Mountains. Field work nearly completed.

79. Black Top Mountain quadrangle, by Frank Kottlowski (Bureau). Stratigraphy (Precambrian upward) and structure of San Andres Mountains. Barite and fluorspar prospects. Field work nearly completed.

80. Mississippian stratigraphy, by Augustus K. Armstrong (University of Cincinnati). A study of stratigraphy and paleontology of Mississippian formations in central and northern New Mexico. Published December 1955 as Circular 39, "Preliminary Observations on the Mississippian System of Northern New Mexico."

81. Manganese deposits of Socorro area, by E. C. Anderson and H. L. Jicha, Jr. (Bureau). Detailed study of producing mines, prospects, and treatment plants. Field work in progress.

82. Hachita quadrangle, Robert A. Zeller, Jr. (Bureau). Structure, stratigraphy, and mineral deposits in Little Hatchet Mountains and adjoining areas. Field work in progress.

83. Truchas region, by Arthur Montgomery (Lafayette College), John R. Miller (Harvard University), and Patrick K. Sutherland (University of Houston). Detailed study of metamorphic rocks of Sangre de Cristo Mountains and adjoining formations. Program sponsored but not financed by Bureau of Mines. Field work in progress.

84. Clay minerals in Cretaceous rocks, by Max E. Willard (Bureau). A careful laboratory and field study of clay minerals in all varieties of sedimentary rocks as an aid in correlation. Laboratory work in progress. Results of first part of study published in Bulletin 36. Second part nearly ready for publication.

85. Pennsylvanian sections in New Mexico, by M. L. Thompson (University of Kansas). Field work completed. Manuscript in preparation.

86. Carrizo Peak NE. quadrangle, by Edgar J. McCullough, Jr. (University of Arizona). Field work initiated.

87. Playas quadrangle, by Robert A. Zeller, Jr. (Bureau). Field work in progress.

88. Arabella quadrangle (not assigned).

89. Socorro quadrangle (four 7½-minute sheets), by Eugene Callaghan and M. S. Sun (Bureau). Field work initiated.

90. Exsolution of feldspars (National Science Foundation Grant G2277), by Frederick J. Kuellmer (Bureau). Field and laboratory work in progress.

91. Bibliography of New Mexico geology and mineral technology, by Constance F. and John H. Schilling (Bureau). Published November 1956 as Bulletin 52, "Bibliography of New Mexico Geology and Mineral Technology, 1951-1955."

92. Magdalena quadrangle (not assigned).

93. Riley quadrangle, by Roy W. Foster (Bureau). Field work initiated.

94. Mimbres quadrangle, by Frederick J. Kuellmer (Bureau). Field work about one-half completed.

95. Rincon 3 quadrangle, by Frank E. Kottlowski (Bureau). Field work initiated.

96. Rincon 4 quadrangle, by Frank E. Kottlowski (Bureau). Field work about one-half completed.

97. Mississippian stratigraphy of southwestern New Mexico, by Augustus K. Armstrong (University of Cincinnati). Field work initiated.

98. Structure and volcanic sequence northeast of Lordsburg, by Father Donald L. Ballman (University of Illinois). Field work initiated.

99. Geologic map of Hillsboro 30-minute quadrangle, by Frederick J. Kuellmer (Bureau). Nearly ready for printing.

100. Geologic map of Paraje 30-minute quadrangle, by John H. Schilling (Bureau). Field work completed. Compilation nearly completed.

101. Geologic map of Reserve 30-minute quadrangle, by Robert H. Weber and Max E. Willard (Bureau). Field work nearly completed.

102. Stratigraphy and structure of the Florida Mountains, by Christina L. Balk (Bureau). Field work initiated.

103. Geologic maps of Ghost Ranch and Echo Amphitheatre 7½-minute quadrangles, by the New Mexico Institute of Mining and Technology Summer Camp, with Clay T. Smith and Charles W. Pitrat (New Mexico Institute of Mining and Technology). Field work initiated.

104. Geologic map of Pelona 30-minute quadrangle, by Max E. Willard (Bureau) and Charles E. Stearns (Tufts University). Field work completed.

105. Geologic map of Leura Spring 30-minute quadrangle, by Max E. Willard (Bureau). Field work completed.

106. Geologic map of Datil 30-minute quadrangle, by Max E. Willard (Bureau) and David B. Givens (University of California at Los Angeles). Field work completed.

107. Geologic map of Pinonville 30-minute quadrangle, by Max E. Willard (Bureau). Field work completed.

108. Geologic map of Canon Largo 30-minute quadrangle, by Max E. Willard and Robert H. Weber (Bureau). Field work completed.

STRATIGRAPHY AND PALEONTOLOGY

A primary function of a State Bureau or Geological Survey is the determination of the proper succession of rock units throughout the State, their regional variation from place to place, and their fossil content, the latter serving to fix the age and permit intelligent correlation of units whose continuity is interrupted by erosion or by cover of other formations. The practical value of this work is axiomatic. Certain formations are more favorable as locations for petroleum or natural gas accumulations, others for uranium, and still others for various metals and nonmetals. Exploration for mineral resources, almost all of which are hidden, must take into account the thickness and succession of rock units intervening between the unit sought and the surface, as well as the structural discontinuities that affect the situation.

Units of the entire geologic column in New Mexico, from the oldest to the youngest, are embraced in the various field and research projects listed previously. The oldest basement, or Precambrian, rocks are being studied throughout the State (Projects 1, 2, 3, 4, 5, 8, 12, 15, 17, 18, 19, 20, 21, 25, 30, 31, 34, 47, 53, 55, 70, 72, 74, 75, 79, 83, 92, 93, 99, and 102). Samples from the "granite" reached in oil tests also are recorded and studied.

The very difficult Lower Paleozoic section (Cambrian, Ordovician, Silurian, and Devonian) has been given special attention (Projects 15, 17, 18, 19, 20, 21, 44, 45, 49, 50, 55, 63, 64, 65, 69, 72, 74, 79, 99, and 102),

with the result that almost all the exposures have been studied, and fossil collections made. Already this work has gone far toward unraveling the complexities, and regional correlations can be made accurately. Several reports have been published in appropriate journals or in Bureau publications.

The Upper Paleozoic (Mississippian, Pennsylvanian, and Permian) has been the subject of intensive field studies (Projects 2, 5, 7, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 26, 27, 28, 30, 31, 33, 35, 38, 44, 48, 49, 50, 51, 52, 54, 55, 62, 63, 65, 69, 72, 74, 75, 78, 79, 80, 83, 85, 86, 92, 93, 97, 99, and 102) and some paleontologic work, particularly on the fusulines of the San Andres Mountains (Project 72). Many fossil collections from this section await paleontologic work.

Mesozoic rocks (Triassic, Jurassic, and Cretaceous) are included in many intensive field studies (Projects 6, 7, 9, 12, 13, 14, 17, 19, 20, 21, 24, 30, 31, 35, 38, 44, 46, 54, 55, 57, 60, 61, 63, 68, 69, 72, 74, 75, 76, 77, 78, 82, 84, 86, 87, 93, 98, 103, 106, 107, 108, and GW-H). Their fossil content, where present, remains to be studied thoroughly, some progress, however, having been made on Lower Cretaceous paleontology.

The Tertiary and Quaternary sections contain no known marine fossils, and only sparse collections of fossil plants, fresh-water invertebrates, and vertebrates have been made. Nevertheless, the Tertiary and Quaternary, particularly the volcanic succession and the relation of certain units to ore deposition (Projects 1, 2, 4, 5, 6, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 26, 27, 29, 31, 32, 34, 36, 37, 42, 43, 46, 47, 49, 53, 55, 60, 61, 63, 65, 66,

67, 68, 69, 73, 75, 76, 81, 87, 89, 90, 92, 94, 95, 96, 98, 99, 100, 101, 102, 104, 105, 106, 107, 108, and GW-H), have been studied in all parts of the State where these rocks occur. The succession of volcanic rocks is for the first time well known. Mapping of the volcanic areas in Catron County has brought to light windows of Paleozoic rocks. This may have a profound effect upon attitudes toward petroleum exploration in this area.

A lexicon of stratigraphic names is being prepared; one section has been published as Circular 40.

The new paleontology laboratory in the Research Building has permitted proper housing of collections for study and for comparative purposes. The laboratory is well equipped, so that all modern approaches to paleontologic study can be used.

A sedimentary petrology laboratory also has been established, enabling the undertaking of stratigraphic studies based on mineral content. This laboratory is operated in conjunction with the X-ray laboratory, and new approaches to the study of Mesozoic rocks have been devised by Bureau personnel.

As the publications list shows, many of the technical stratigraphic and paleontologic reports appear in journals and special volumes as well as in the Bureau publication series.

GROUND WATER

Without ground water few people could exist in New Mexico, and there would be little development of the State or hope for the future. Though many people "never miss the water till the well runs dry," numerous thoughtful citizens are acutely concerned about our water resources. In order to plan any future development, not to mention maintaining the present population and economy, we need to know how much water can be obtained from the subsurface. We are not, as yet, in possession of the basic facts, even though we should know them today. Federal and State organizations are attacking the problem, but it will take redoubled effort on the part of all agencies which have a competence in this field to produce accurate and quantitative results that can keep pace with our soaring population and economy.

The Bureau of Mines and Mineral Resources was authorized by the Eighteenth State Legislature to cooperate with the Ground Water Branch of the U. S. Geological Survey, and an appropriation of $20,000 was made available annually to the Bureau for cooperation in basic geology and ground-water studies. Half of this amount ($10,000, less anticipated publication costs and overhead) is allotted each year for ground-water study. The State Engineer makes a modest contribution to this fund, which is matched by the Federal Government. All work under this program, except publication, is performed by the staff of the Ground Water Branch of the U. S. Geological Survey. The appropriation has not been increased, so

that it does not meet rising costs. Whereas, at the time the legislation was enacted, it was possible to employ three staff members for a year under the contribution made by the State, the amount now covers less than half that number. The slowdown in work accomplished is obvious. Nevertheless, reports on eastern Colfax County, on San Miguel and Eddy Counties, and on northeastern Socorro County, have been published by the Bureau, and it is expected that the report on Torrance County will be issued early in 1957. A detailed report on ground-water resources of the area around Santa Fe has been prepared in cooperation with the Geological Survey and the Research and Development Division of New Mexico Institute of Mining and Technology, and awaits publication by the Geological Survey. Reports on Quay County and southern Lea County are being prepared, and field work is in progress on eastern Valencia County, involving a special study of water in the Rio Grande trough. With the rise in publication costs, it has been necessary for the Bureau to contribute increasing amounts out of its regular appropriation to cover the cost of printing the reports.

As ground-water resource evaluation involves a thorough knowledge of both geology and hydrologic engineering, and as the Bureau has a thoroughly competent geologic staff engaged in regional mapping, which is basic to ground-water study, it is in line with efficient operation that hydrologic engineers be added to the Bureau staff to speed up the ground-water resource work. Funds thus far have permitted the employment of only one engineer. It is hoped that the 23rd session of the State Legislature will see

fit to provide funds for at least two more engineers. This could triple the rate of assemblage of data, as the geologists are already doing the mapping, and locating the springs and wells.

In spite of the small staff devoted to this work, data have been assembled on wells in many geologically mapped areas, and the quality of water has been determined under a cooperative agreement with the Quality of Water Branch of the U. S. Geological Survey. The Bureau has its own equipment for testing the hardness and conductance of water samples, many such tests being requested by ranchers and others in areas not included in formal projects. Conferences both in the office and in the field are held with individuals having water-supply problems. Reports have been issued on ground water in the San Agustin Plains, Catron County (Circular 26), and in Dwyer quadrangle, Grant County (Circular 37). In cooperation with the U. S. Geological Survey, the engineer collaborated on a report on the water supply of Tucumcari, which was transmitted to that city.

A comprehensive study of the ground-water resources of Union County, begun in 1953, is essentially complete, and the preparation of maps and reports covering this area of 3,817 square miles is well under way. As no topographic maps were available, the U. S. Coast and Geodetic Survey was induced to extend a level net throughout the county, and some 800 benchmarks were set. This is a permanent contribution to all types of engineering in the county and permits the drawing of structure contours on the base of the Ogalalla formation and the Dakota (?) formation, the

principal aquifers in the area. This information will be invaluable not only for ground-water drilling but for petroleum exploration as well. Data on more than 2,500 water wells have been compiled, and 210 chemical analyses have been made. The hydrologic and geologic information will be presented in such a way that evaluation can be made of water possibilities in any part of the county. The new geologic maps will be useful not only for ground water but for exploration for mineral resources, including scoria (light-weight aggregate), clay, sand and gravel, carbon dioxide, and possible petroleum and natural gas. A detailed study of the volcanic rocks in the vicinity of the Capulin National Monument will be of interest to all who visit that natural wonder or the nearby Folsom man locality, which is known to anthropologists all over the world. As the work has progressed, the people in Union County have been kept informed, and maps have been posted locally. Data on proposed sites for an Air Force base were provided. The geologic map of Union County is also a major contribution to the new geologic map of New Mexico.

Under the Field Assistance Fellowship program, the Bureau has supported a study of the area between the Rio Grande and Magdalena, in Socorro County. A report is available for publication.

In view of the major importance of the Philmont Boy Scout ranch to the economy and advertising of New Mexico, special help has been extended on the acute water problems of that ranch. Help has been extended also to Las Vegas and other communities in this area of the State.

Any ground-water study the Bureau undertakes is discussed freely with the Research and Development Division of New Mexico Institute of Mining and Technology, the Geological Survey, and the State Engineer, so that duplication of effort or expenditure is carefully avoided. Assembled data are available at all times to these other agencies.

The status of formalized ground-water projects is given below. Not included is Ground-Water Report 1, "Geology and Ground-Water Resources of the Eastern Part of Colfax County, New Mexico."

A. San Miguel County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by R. L. Griggs and G. E. Hendrickson (U. S. Geological Survey). Published as Ground-Water Report 2, "Geology and Ground-Water Resources of San Miguel County, New Mexico."

B. Torrance County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by Zane Spiegel (U. S. Geological Survey). Manuscript is being edited for publication as Ground-Water Report 5.

C. North Socorro County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by Zane Spiegel (U. S. Geological Survey). Published as Ground-Water Report 4, "Geology and Ground-Water Resources of Northeastern Socorro County, New Mexico."

D. Socorro-Magdalena area, by John H. Waldron (Stanford University). Manuscript available for publication as Ground-Water Report 6.

E. Eddy County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by G. E. Hendrickson (U. S. Geological Survey). Published as Ground-Water Report 3, "Geology and Ground-Water Resources of Eddy County, New Mexico."

F. Tucumcari (in cooperation with Ground Water Branch, U. S. Geological Survey, and city of Tucumcari), by F. X. Bushman (Bureau) and Fred Trauger (U. S. Geological Survey). Manuscript nearly completed for publication.

G. South Lea County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by Alexander Nicholson (U. S. Geological Survey). Manuscript being edited for publication.

H. Union County, by F. X. Bushman and Brewster Baldwin (Bureau), and William Muehlberger (University of Texas). Field work is completed. Field work and study of volcanic succession in Capulin Mountain region in Des Moines quadrangle completed by Muehlberger.

J. Quay County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by Charles F. Berkstresser (U. S. Geological Survey). Field work nearly completed.

K. Wells in western San Agustin Plains, by F. X. Bushman and C. P. Valentine (Bureau). Published as Circular 26, "Water Well Records and Well Water Quality in Southwestern San Agustin Plains, Catron County, New Mexico."

L. East Valencia County (in cooperation with Ground Water Branch, U. S. Geological Survey, and State Engineer), by Frank B. Titus, Jr. (U. S. Geological Survey). Field work in progress.

PETROLEUM AND NATURAL GAS

A considerable part of the program of the Bureau of Mines and Mineral Resources is devoted to assisting in exploration for petroleum and natural gas. Perhaps the major contribution is the maintenance of the sample library and the records of drilling. Samples from more than 4,000 wells are on file and occupy about 10,000 boxes. The boxes now accumulate at the rate of 1,500 or more per year. These records and samples are examined by many persons, some of whom spend a week or so on such research. Numerous inquiries by telephone and letter are answered. These inquiries and visits come from representatives of oil companies, consulting geologists, independent operators, Federal and State agencies, businessmen, drillers, lease brokers, and landowners. They seek geological and drilling information on wells that are in process of drilling or have been drilled, assistance on the identification of well cuttings, estimates as to depths to certain formations, evaluation of areas as to petroleum possibilities, and even specific recommendations as to the location of test wells, the leasing of land, or investments.

The Bureau staff made a large contribution to the data shown on the new oil and gas map, OM 159, "Map of New Mexico Showing Test Wells for Oil and Gas, Oil and Gas Fields, and Pipelines," and the accompanying Circular 333, "Records of Wells Drilled for Oil and Gas in New Mexico," published by the U. S. Geological Survey.

Petroleum exploration maps have been prepared for 14 countries and will be available eventually for all areas except those for which the U. S.

Geological Survey issues similar maps. The master copies of these maps are kept up to date, so that ozalid prints with the latest information can be supplied to correspondents.

Subsurface completion data for all wells drilled are published annually as circulars. Copies of drillers logs of more than 7,000 wells are supplied on request.

The field and research program of the entire organization is of value to petroleum exploration, particularly the stratigraphic and paleontologic studies and the regional geologic maps. The comprehensive stratigraphic study of the San Andres Mountains made at the request of, and with financial assistance from, major oil companies, under special arrangements with the United States Department of Defense, and published (subsequently to June 30, 1956) as Memoir 1, "Stratigraphic Studies of the San Andres Mountains, New Mexico," is one of the most complete investigations of this type ever issued by any agency.

The mapping program in southwestern New Mexico, especially in the undrilled area covered by a blanket of volcanic rocks in Catron, Socorro, and Grant Counties, is under way and is revealing information which may be very significant for petroleum exploration.

The principal immediate need is a modest but adequate storage building for the sample library and for special cores that occasionally are available, but for which no facility for preservation now exists. Staff should be added to carry on subsurface studies and the preparation of sample logs. The

regional mapping program should be expedited; likewise significant stratigraphic studies.

The accumulation of engineering data essential to a sound program of secondary recovery that would prolong the life of the petroleum industry in New Mexico is a proper function of the Bureau, but funds thus far have not been available to secure a qualified engineer for this work.

In spite of the limitations noted above, the accumulated experience and knowledge of the present staff is an asset of untold value.

MINING AND METALLURGY

The services of the Bureau's mining engineer were directed principally to the many prospectors who were interested in finding uranium. More than 500 persons called at the office seeking information on prospecting procedure, claim-location requirements, and the status of ownership of lands in all sections of the State. As radioactive materials have been found to be widespread in formations in which no other metals have been found, scarcely any limits can be placed on areas for prospecting. Prospects and mines were examined in many parts of the State, and requested advice was given on the ground. Hundreds of inquiries by letter concerning uranium and thorium were answered. Close cooperation and exchange of information were maintained with Federal and State agencies concerned with uranium prospecting and mining activity, notably the Atomic Energy Commission, Geological Survey, Bureau of Mines, Bureau of Land Management, Forest Service, State Land Office, State Inspector of Mines, and State Economic Development Commission.

Other materials were not neglected, and many conferences were held both in the office and in the field with persons interested in copper, manganese, beryl, mica, barite, clays, lithium minerals, rare earths, and other deposits. Many conferences were held both in the office and in the field concerning resources for cement plants, ore processing plants, and manufacturing establishments concerned with natural resources.

The manuscript of Bulletin 39, "The Metal Resources of New Mexico and Their Economic Features Through 1954" was brought up to date and was

in press late in 1956. Circular 29, "Occurrences of Uranium Ores in New Mexico," was reprinted to meet continuing demand. The manuscript for Circular 45, "Carbon Dioxide and the Dry Ice Industry," was prepared for printing. Unpublished mine-examination reports were added to the files. Some time was devoted to the Arkansas-White-Red River Basins Inter-Agency Committee. The 23-volume report of this committee has been published and transmitted to the Congress of the United States.

Perhaps the most significant omission in the services which citizens of the State can request of the Bureau of Mines and Mineral Resources is that concerned with tests of ores and mineral materials, studies of processing problems, and the preparation of mineral raw materials for market. Though qualitative tests of samples are made by the mineralogist, and reports made promptly to the individuals concerned, no assaying is done, and no chemical or other analyses are made to determine the quantities of useful materials. No research metallurgist is on the staff, and very little equipment is available to provide information on how useful metals can be extracted from their ores, or how nonmetallic materials can be beneficiated and prepared for market. Industry personnel have commented adversely on the fact that all uranium ores in New Mexico have had to be sent outside the State for processing tests. Although the Bureau has a modern chemical laboratory, funds have not yet been available for a skilled analytical chemist and appropriate assistance and materials. Assay equipment is available. Should the 23rd State Legislature see fit to provide funds to staff these functions and secure equipment, probably

much of the cost of maintenance could be met through reasonable charges for quantitative tests and services. Probably arrangements could be made for joint use of equipment employed for instructional purposes in the College Division of New Mexico Institute of Mining and Technology, if qualified staff were available.

METALS

In addition to the compilation of data on metal resources now being published (Bulletin 39, "The Metal Resources of New Mexico and Their Economic Features Through 1954") and the regional mapping projects which serve to point out areas favorable for exploration, the Bureau has conducted intensive studies of known mining areas to point out the possibilities for additional ore bodies. These include: Project 6, Cerrillos, an area in which base metal ores are now being produced; Project 36, Bland mining district in Sandoval County, a former producer of precious metals; Project 37, Socorro manganese area in Socorro County, published as Circular 38, "Geology of the Luis Lopez Manganese District, Socorro County, New Mexico"; Project 81, detailed mapping of individual manganese deposits in the same area; Project 48, Iron Mountain tungsten deposits in Sierra County; Project 49, silver and base metal deposits in Hermosa district, Sierra County, published in part as Circular 27, "Paragenesis of the Ores of the Palomas (Hermosa) District, Southwestern New Mexico," and Circular 33, "Possibilities for Discovery of Additional Lead-Silver Ore in the Palomas Camp Area of the Palomas (Hermosa) Mining District, Sierra County, New Mexico"; Project 52, base metals in High Rolls district, Otero County; Project 53, molybdenum resources of Questa mine area in Taos County, published as Bulletin 51, "Geology of the Questa Molybdenum (Moly) Mine Area, Taos County, New Mexico"; and Project 55, a detailed study of a porphyry copper deposit in Sierra County, published as Circular 34, "Geology of a Disseminated Copper Deposit Near

Hillsboro, Sierra County, New Mexico." This last study led to initiation of copper production in this area and stirred interest in deep exploration. Project 23 is a study of surface indications as guides to exploration for ores. The need for multiplying these intensive studies is obvious.

In view of the tremendous investigative efforts of the Federal agencies, particularly the Atomic Energy Commission and the Geological Survey, and the possibilities of duplication of effort and money, the Bureau has not carried on intensive studies of uranium deposits. Data on uranium deposits was published as Circular 29, "Occurrences of Uranium Ores in New Mexico." Data on these and other materials are contained in Bureau files.

Project 90, supported by a grant from the National Science Foundation, is a study of feldspars in intrusive igneous rocks, mainly of Tertiary age, designed to show the relation to the occurrence of metallic ores and to serve as a possible guide to exploration.

NONMETALS OR INDUSTRIAL MINERALS AND ROCKS

Bulletin 12, "The Non-Metallic Mineral Resources of New Mexico and Their Economic Features," issued in 1936, is now out of print. The need for a new volume based on current data is obvious. In addition to the regional mapping studies which show the locations of various nonmetallic materials, several intensive studies are in progress or have been completed. These include: Project 3, Big Rock kyanite deposits in Rio Arriba County; Project 10, Stendel perlite deposits in Socorro County, being printed as Circular 44, "Geology and Petrography of the Stendel Perlite Deposit, Socorro County, New Mexico"; Project 11, Socorro perlite deposit in Socorro County; Project 33, Hansonburg barite district in Socorro County, published as Circular 23, "Geology and Ore Deposits of a Part of the Hansonburg Mining District, Socorro County, New Mexico"; and Project 57, mineral resources of the Navajo Reservation, published as Bulletin 44, "Mineral Resources of the Navajo Reservation in New Mexico." Many field examinations have been made of nonmetallic materials and are on file. A report on perlite was published as Circular 32, "Processing Perlite--The Technologic Problems." The comprehensive publications on mica and fluorspar, Bulletin 25, "Mica Deposits of the Petaca District, Rio Arriba County, New Mexico, With Brief Descriptions of the Ojo Caliente District, Rio Arriba County, and the Elk Mountain District, San Miguel County," and Bulletin 21, "Fluorspar Resources of New Mexico," are still available. Studies of high-quality dolomite resources are in progress. A study of high-calcium lime rock was published as

Circular 36, "A Deposit of High-Calcium Lime Rock in Valencia County, New Mexico."

Inasmuch as the U. S. Geological Survey has been carrying on a detailed study of the great potash resources of southeastern New Mexico, no attempt has been made to duplicate this work.

Materials available for the chemical industry in New Mexico are reviewed in Circular 25, "Raw Materials for Chemical Industry in New Mexico."

In view of the greatly expanded highway construction program, studies of various aggregate materials should be undertaken immediately.

STATE GEOLOGIC MAP

As a major part of its program of cooperation with the U. S. Geological Survey in studies of basic geology, as provided by law, the Bureau is mapping large areas for the new State geologic map which will be published by the Survey. Four maps, each representing a quarter of the State will be published in preliminary form in black line with symbols for the units represented. The northwest quarter has been compiled, and it is expected that it will be published early in 1957. The southeast quarter is largely compiled. Field work is nearly completed on the other two quarters, and compilation is under way.

PUBLICATIONS

The following publications were issued during the 2-year period 1954/5 and 1955/6:

Bulletin 33, "Geologic Section of the Black Range at Kingston, New Mexico," by Frederick J. Kuellmer. Structure and stratigraphy of the Black Range, detailed petrology of igneous rocks, and general guides to ore exploration. One hundred pages, 13 tables, 28 figures, 3 plates. Extra copies of colored geologic map were printed and may be purchased separately.

Bulletin 34, "Geology of the South Manzano Mountains, New Mexico," by J. T. Stark. Text of 48 pages, 1 figure (sketch map of New Mexico showing location of the South Manzano Mountains), and 8 plates. Extra copies of map were printed and may be purchased separately.

Bulletin 36, "Mineral Resources of Fort Defiance and Tohatchi Quadrangles, Arizona and New Mexico," by John Eliot Allen and Robert Balk. Prepared under contract for the Bureau of Indian Affairs under the Navajo-Hopi Rehabilitation Act of 1950. Contains colored geologic map and sections, 192 pages, 19 tables, 21 figures, 16 plates.

Bulletin 37, "Geology and Mineral Deposits of Lake Valley Quadrangle, Grant, Luna, and Sierra Counties, New Mexico," by Henry L. Jicha, Jr. Stratigraphy and structure of sedimentary and volcanic rocks and descriptions of mining districts. Contains colored geologic map and sections, 93 pages, 8 tables, 13 figures, 5 plates. Extra copies of map were printed and may be purchased separately.

Bulletin 40, "Cambrian Cephalopods," by Rousseau H. Flower. Fifty-one pages, 7 figures, 3 plates.

Bulletin 42, "Geology of Costilla and Latir Peak Quadrangles, Taos County, New Mexico," by Philip F. McKinlay, in cooperation with U. S. Geological Survey. Geology and ore deposits of the north half of the Taos Range of the Sangre de Cristo Mountains and the Costilla Plain to the west. Contains colored geologic map and sections, 32 pages, 1 figure, 1 plate. Extra copies of map were printed and may be purchased separately.

Bulletin 43, "Bibliography of New Mexico Geology and Mineral Technology Through 1950," by Marian R. Burks and John H. Schilling. Listed bulletins, articles, papers, and reports on the geology and mineral technology of New Mexico that have appeared from the earliest years through 1950. Text of 198 pages. Supersedes Bulletin 22.

Bulletin 44, "Mineral Resources of the Navajo Reservation in New Mexico," by John Eliot Allen. Prepared under contract for the U. S. Department of the Interior, Bureau of Indian Affairs. A map with text on the margin.

Ground-Water Report 4, "Geology and Ground-Water Resources of Northeastern Socorro County, New Mexico," by Zane Spiegel. Prepared cooperatively by the United States Geological Survey, New Mexico Bureau of Mines and Mineral Resources, and the State Engineer. Contains 99 pages, 6 tables, 8 figures, a geologic map of northeastern Socorro County, and a plate showing the availability of water.

Circular 27, "Paragenesis of the Ores of the Palomas (Hermosa) District, Southwestern New Mexico," by Henry L. Jicha, Jr. Reprint from Economic Geology.

Circular 29, "Occurrences of Uranium Ores in New Mexico," by E. C. Anderson.

Circular 30, "Index to Samples from Oil and Gas Well Tests in Library at Socorro, New Mexico," by Robert A. Bieberman and Florence B. Crespin.

Circular 31, "Subsurface Completion Data of Wells Drilled for Oil and Gas During 1954," by Roy W. Foster and Florence B. Crespin.

Circular 32, "Processing Perlite - The Technologic Problems," by Robert H. Weber. Reprinted from Mining Engineering.

Circular 33, "Possibilities for Discovery of Additional Lead-Silver Ore in the Palomas Camp Area of the Palomas (Hermosa) Mining District, Sierra County, New Mexico; a Preliminary Statement," by Richard H. Jahns.

Circular 34, "Geology of a Disseminated Copper Deposit near Hillsboro, Sierra County, New Mexico," by Frederick J. Kuellmer.

Circular 35, "Geology of Capitan Coal Field, Lincoln County, New Mexico," by Marc W. Bodine, Jr.

Circular 36, "A Deposit of High-Calcium Lime Rock in Valencia County, New Mexico," by Henry L. Jicha, Jr.

Circular 37, "Ground-Water Data for Dwyer Quadrangle, Grant and Luna Counties, New Mexico," by F. X. Bushman.

Circular 38, "Geology of the Luis Lopez Manganese District, Socorro County, New Mexico," by Alfred T. Miesch.

Circular 39, "Preliminary Observations on the Mississippian System of Northern New Mexico," by Augustus K. Armstrong.

Circular 333, "Records of Wells Drilled for Oil and Gas in New Mexico," by Robert A. Bieberman, et al. (in cooperation with the U. S. Geological Survey).

"Biennial Report for the Fiscal Years Ending June 30, 1953-1954," by Eugene Callaghan, director.

Petroleum exploration maps of Colfax, Curry, DeBaca, Guadalupe, Harding, Lincoln, Mora, Quay, Roosevelt, San Miguel, Socorro, Torrance, and Union Counties, New Mexico, by Robert A. Bieberman and Roy W. Foster.

Geologic map and sections, South Manzano Mountains, New Mexico. This map will be included in Bulletin 34, "Geology of the South Manzano Mountains," by John T. Stark.

Geologic map and sections, Questa Molybdenum mine area, Taos County, New Mexico. This map will be included in Bulletin 51, "Geology of Questa Molybdenum Mine, Taos County, New Mexico," by John H. Schilling.

Multicolored geologic map and sections of Puertecito quadrangle, New Mexico. This map will be included in Bulletin 41, "Geology of Puertecito Quadrangle, Socorro County, New Mexico," by William H. Tonking.

Map of New Mexico showing test wells for oil and gas, oil and gas fields, and pipelines; scale 1:500,000. Map OM 159, Oil and Gas Investigations, by Robert A. Bieberman, et al. (in cooperation with the U. S. Geological Survey).

Guidebook 1, "Scenic Trips to the Geologic Past - Santa Fe Area," by Brewster Baldwin and Frank E. Kottlowski.

Manuscripts in Press

Bulletin 39, "The Metal Resources of New Mexico and Their Economic Features Through 1954," by E. C. Anderson. A revision of Bulletin 7.

Bulletin 51, "Geology of the Questa Molybdenum Mine, Taos County, New Mexico," by John H. Schilling. Contains colored geologic map and sections.

Bulletin 52, "Bibliography of New Mexico Geology and Mineral Resources, 1951-1955," by Constance F. and John H. Schilling.

Circular 40, "Lexicon of New Mexico Geologic Names: Part 1, Precambrian and Lower Paleozoic," by Henry L. Jicha, Jr.

Circular 42, "Subsurface Completion Data of Wells Drilled for Oil and Gas During 1955," by Roy W. Foster and Constance F. Schilling.

Guidebook 2, "Scenic Trips to the Geologic Past - Taos-Red River-Eagle Nest, New Mexico, Circle Drive," by John H. Schilling.

Petroleum exploration map of McKinley County, New Mexico, by Robert A. Bieberman.

Manuscripts Prepared and in Process of Revision or Being Edited for Publication, June 30, 1956

Bulletin 35, "Stratigraphy of the Escarpment of the Sacramento Mountains, Otero County, New Mexico," by Lloyd C. Pray.

Bulletin 38, "Geology and Mineral Resources of Dwyer Quadrangle, Grant, Luna, and Sierra Counties, New Mexico," by Wolfgang E. Elston.

Bulletin 41, "Geology of Puertecito Quadrangle, Socorro County, New Mexico," by William H. Tonking. With multicolored geologic map and sections.

Bulletin 45, "Precambrian and Tertiary Geology of Las Tablas Quadrangle, New Mexico," by Fred Barker.

Bulletin 46, "Selected Aspects of the Leached Outcrop Problem," by William C. Kelly.

Bulletin 47, "Kyanite Deposits of the Petaca District, Rio Arriba County, New Mexico," by Allen F. Corey.

Bulletin 48, "Geology of Cerrillos Area, Santa Fe County, New Mexico," by Alan E. Disbrow and Walter C. Stoll.

Bulletin 49, "Geology of El Paso Gap Quadrangle, Otero and Eddy Counties, New Mexico," by Donald Boyd.

Bulletin 50, "Late Pennsylvanian and Early Permian Stratigrapny of the Northern Sacramento Mountains, Otero County, New Mexico," by Carl Otte, Jr.

Bulletin 53, "Geology of Questa Quadrangle, Taos County, New Mexico," by Philip F. McKinlay.

Bulletin 54, "Volcanic Rocks of the Cienega Area, Santa Fe County, New Mexico," by Brewster Baldwin and Ming-Shan Sun.

Memoir 1, "Stratigraphic Studies in the San Andres Mountains, New Mexico," by Frank E. Kottlowski, Rousseau H. Flower, M. L. Thompson, and Roy W. Foster.

Ground-Water Report 5, "Geology and Ground-Water Resources of Torrance County, New Mexico," by R. E. Smith.

Ground-Water Report 6, "Ground-Water Resources of the Socorro-Magdalena Area, Socorro County, New Mexico," by John H. Waldron.

Ground-Water Report 7, "Underground Water Supplies for the City of Tucumcari, Quay County, New Mexico," by F. X. Bushman and Fred Trauger.

Ground-Water Report 9, "Geology and Water Resources of the Santa Fe Area, New Mexico," by Brewster Baldwin, Zane Spiegel, et al. In cooperation with the U. S. Geological Survey.

Circular 41, "Making of a Mine," by John Eliot Allen.

Circular 44, "Geology and Petrography of the Stendel Perlite Deposit, Socorro County, New Mexico," by Robert H. Weber.

Petroleum exploration maps of Valencia, Sandoval, Dona Ana, and Otero Counties, New Mexico, by Robert A. Bieberman and Roy W. Foster.

A map and text entitled "Geology and Ore Deposits of the Apache Hills and Northern Sierra Rica, Hidalgo County, New Mexico," by Oscar Strongin.

A map and text entitled "Paleozoic Stratigraphy of the Mud Springs Mountains, Sierra County, New Mexico," by John D. Hill.

A map and text entitled "Geology of Lordsburg Quadrangle, Hidalgo County, New Mexico," by R. Fred Flege.

A map and text entitled "Mineralogical and Geological Investigation of the Terry Uranium Prospect Near Monticello, New Mexico," by William A. Bassett.

A map and text entitled "Structural Geology and Stratigraphy of Fra Cristobal Quadrangle, Sierra County, New Mexico," by Eugene Cserna.

Maps and text entitled "Geology and Ore Deposits of the Sacramento (High Rolls) Mining District, Otero County, New Mexico," by S. E. Jerome, et al.

Geologic map of Hillsboro 30-minute quadrangle, Grant, Luna, and Sierra Counties, New Mexico, by Frederick J. Kuellmer.

Geologic map of the State of New Mexico, preliminary map of NW$\frac{1}{4}$, compiled and being drafted for printing by the U. S. Geological Survey, by the Bureau staff (in cooperation with U. S. Geological Survey).

A map and text entitled "Geology of Mesa del Oro Quadrangle, Socorro and Valencia Counties, New Mexico," by H. L. Jicha, Jr.

OUTSIDE PUBLICATIONS

Members of the Bureau staff also published the following reports and papers in scientific journals or special publications issued by agencies other than the Bureau.

Allen, John Eliot (1954) Tohatchi formation of Mesaverde group, western San Juan Basin, New Mexico, American Association of Petroleum Geologists Bull., v 37, n 11.

(1956) The art of geology, Journal of Geological Education, v 4, n 1.

(1956) Estimation of percentages in thin-sections - Considerations of visual psychology, Journal of Sedimentary Petrology, v 26.

(1956) (abs) Titaniferous Cretaceous beach placer in McKinley County, New Mexico, The Geological Society of America Bull., v 67.

(1956) Geologic thinking in the discovery and extension of mineral deposits, Mining Engineering, v 8.

Anderson, Eugene Carter (1955) Mineral deposits and mines in south-central New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, sixth field conference.

Balk, Christina Lochman (1955) Cambrian stratigraphy of the south and west margins of Green River Basin, Wyoming Geological Association Guidebook, tenth annual field conference.

(1956) The evolution of some Upper Cambrian and Lower Ordovician trilobite families, Journal of Paleontology, v 30.

(1956) Cambrian stratigraphy of eastern Utah, Intermontane Association of Petroleum Geologists, seventh annual field conference.

Bieberman, Robert A. (1955) Mineral fuels, prime resource of San Juan Basin, play important role in area's overall economy, Ira Rinehart's Four Corners Reference Book.

Boyd, Donald W. (1955) (abs) San Andres formation in the Brokeoff Mountains, southeastern New Mexico, The Geological Society of America Bull., v 66, n 12, pt 2.

Callaghan, Eugene (1954) Field and research projects of the New Mexico Bureau of Mines and Mineral Resources for 1954, New Mexico Miner, v 16, n 7, July 1954.

(1955) Field and research projects of the New Mexico Bureau of Mines and Mineral Resources for 1955, New Mexico Miner, v 17, n 7, July 1955.

(1956) Geologic map of the Gabbs magnesite and brucite deposits, Nye County, Nevada, Mineral Investigations Field Studies Map MF 35, published by U. S. Geological Survey (with Charles J. Vitaliano as coauthor).

(1955) (abs) Correlation of igneous rocks of New Mexico by fusion method, Transactions American Geophysical Union, v 36, n 3 (with Ming-Shan Sun as coauthor).

Elston, Wolfgang E. (1955) (abs) Volcanic succession and possible mineralization in the Dwyer quadrangle, southwestern New Mexico, The Geological Society of America Bull., v 66, n 12, pt 2.

Flower, Rousseau H. (1955) Cameral deposits in orthoconic nautiloids, Geological Magazine, v 92.

(1955) Status of endoceroid classification, Journal of Paleontology, v 29, n 3.

(1955) New Chazyan orthocones, Journal of Paleontology, v 29, n 5.

(1955) Trails and tentacular impressions of orthoconic cephalopods, Journal of Paleontology, v 29, n 5.

(1955) Pre-Pennsylvanian stratigraphy of southern New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference.

(1955) (abs) Bliss and El Paso successions in New Mexico, The Geological Society of America Bull., v 66, n 12, pt 2.

(1956) Cephalopods from the Canadian of Maryland, Journal of Paleontology, v 30.

(1956) Some endoceroids from the El Paso limestone, Journal of Paleontology, v 30.

Jahns, Richard H. (1955) Road log in Sierra Cuchillo and neighboring areas, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference.

(1955) Geology of the Sierra Cuchillo, New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference.

(1955) Volcanic rocks of south-central New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference (with Frank E. Kottlowski and Frederick J. Kuellmer as coauthors).

Jicha, Henry L., Jr. (1954) (abs) Correlation of basalt flows in central New Mexico by fusion technique, The Geological Society of America Bull., v 65, n 12, pt 2.

(1954) Paragenesis of the ores of the Palomas (Hermosa) district, southwestern New Mexico, Economic Geology, v 49, n 7.

(1954) The White Sands, New Mexico Geological Society Guidebook of Southeastern New Mexico, Fifth Field Conference.

Kottlowski, Frank E. (1954) Geology and coal deposits of the Dugger quadrangle, Sullivan County, Indiana, Coal Investigations Map C 11, with text, published by U. S. Geological Survey.

(1955) Geologic structures in the Coal City and Switz City area of Indiana, Indiana Academy of Science Proceedings, v 64.

(1955) Correlation chart, Paleozoic and Mesozoic sedimentary rocks in south-central New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference.

(1955) Cenozoic sedimentary rocks in south-central New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference.

(1955) Road log in Rhodes Canyon area, San Andres Mountains, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference (with Roy W. Foster as coauthor).

Kuellmer, Frederick J. (1955) Review of Geology and mineral deposits of Precambrian rocks of the Van Horn area, Texas, by Phillip B. King and Peter T. Flawn, Journal of Geology, v 63.

Kuellmer, Frederick J. (1955) (abs) Potash-feldspar exsolution in a Tertiary porphyry, The Geological Society of America Bull., v 66, n 12, pt 2.

Muehlberger, William R. (1955) (abs) Relative age of Folsom man and Capulin Mountain eruption, Colfax and Union Counties, New Mexico, The Geological Society of America Bull., v 66, n 12, pt 2.

Otte, Carl, Jr. (1954) (abs) Wolfcampian reefs of the northern Sacramento Mountains, Otero County, New Mexico, The Geological Society of America Bull., v 65, n 12, pt 2.

Pray, Lloyd C. (1954) (abs) Desmoinesian facies of the Sacramento Mountains, New Mexico, The Geological Society of America Bull., v 65, n 12, pt 2 (with Roy W. Graves, Jr. as coauthor).

(1954) (abs) Correlation of the Abo formation of south-central New Mexico, The Geological Society of America Bull., v 65, n 12, pt 2 (with Carl Otte, Jr. as coauthor).

Sun, Ming-Shan (1954) Heavy minerals of the Jacksonian sediments of Mississippi and adjacent areas, Journal of Sedimentary Petrology, v 24.

(1954) (abs) Titanclinohumite in kimberlitic tuff, Buell Park, Arizona, The Geological Society of America Bull., v 65, n 12, pt 2.

(1954) (abs) Geochemical aspect of the volcanic rocks of Cienega, New Mexico, The Geological Society of America Bull., v 65, n 12, pt 2 (with Brewster Baldwin as coauthor).

(1956) Grain-size analysis of the Jacksonian sediments of Mississippi and adjacent areas, Journal of Sedimentary Petrology, v 26.

Thompson, M. L. (1955) Pennsylvanian and lower marine Permian stratigraphy of south-central New Mexico, New Mexico Geological Society Guidebook of South-Central New Mexico, Sixth Field Conference (with Frank E. Kottlowski as coauthor).

Weber, Robert H. (1956) Material on perlite in New Mexico in Perlite resources of the United States, U. S. Geological Survey Bull. 1027-I.

(1955) Processing perlite - The technologic problems, Mining Engineering, v 7, n 2.

(1955) Mining in Socorro County, brochure issued by Socorro Chamber of Commerce.

Willard, Max E. (1956) Bedrock geology of the Williamsburg quadrangle, Massachusetts, Geologic Map GQ 85, published by U. S. Geological Survey.

PERSONNEL

The only changes in the professional staff of the Bureau resulted from the tragic death of Dr. Robert Balk in the crash of a commercial airliner on Sandia Mountain, near Albuquerque, in February 1955.

Robert Balk, who was 56 years old at the time of his death, was one of America's most distinguished and highly respected geologists. Not only was he respected for his superior abilities and experiences as a geologist but for unique qualities of personality that established him among all who knew him as a truly great man. He was dedicated to the profession of geology and was so fully a lover of all nature that he was a naturalist in the best sense of the term. With such unusual comprehension of the natural world was combined a love of people that lives on in the hearts of associates who feel they have lost the best and most devoted friend they will ever have. Though his own struggles with adversity were Lincolnesque, he never shrank from personal sacrifices to help others.

When Dr. Balk joined the staff of the Bureau in January 1952, he so enhanced the stature of this organization that it received unusual respect and attention throughout the nation. With characteristic vigor he proceeded with his first assignment, the mapping of the Tres Hermanas, south of Deming, and the elucidation of the complex rocks and mineral deposits in this area. Before this could be completed, he was assigned to the study of the mineral resources of the Navajo Reservation, in company with John Eliot Allen, under a contract which the Bureau secured from the Bureau of Indian Affairs.

The resulting report, which bears his name, is the finest the Bureau has produced and is replete with suggestions for improvement of the lot of the Navajos in this unfruitful land. In the autumn of 1954 he responded to the request of his many good friends at the California Institute of Technology to teach structural geology for three months and returned to continue the preparation of his report on the Tres Hermanas.

On his way East on Bureau business, and as a member of a committee of the National Research Council to select National Science Foundation fellows, he lost his life. His associates take such solace as they can in the knowledge that in New Mexico "Balk was happy and enjoyed his work as never before. His productivity rose, and he had, after long search, finally found the ideal opportunity where he could reap some of the harvest of his labors."

Robert Balk's passing was noted in appropriate memorial resolutions of the State Legislature.

Dr. Christina Lochman Balk was appointed to the staff as stratigraphi geologist in March 1955. Dr. Balk is one of the nation's outstanding authorities on the stratigraphy and paleontology of the Cambrian and is noted for her broad knowledge of the field of paleontology. She received the A. B. and A. M. degrees from Smith College and the Ph. D. degree from Johns Hopkins University. She served on the faculty of Mt. Holyoke College for 12 years and has lectured in paleontology and stratigraphy at Johns Hopkins University, the University of Chicago, and the New Mexico Institute of

Mining and Technology. She has contributed many scientific papers to various publications and is currently engaged in detailed mapping and study for the Bureau of the complex Florida Mountains, near Deming, as well as in various stratigraphic and paleontologic problems.

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

Receipts	1954-1955		1955-1956	
Beginning balance, July 1	$ 3,214.64		$ 3,916.97	
State appropriation	200,000.00		224,091.00	
Receipts from sales of bulletins, etc.	8,389.67		4,734.13	
TOTAL revenue		$211,604.31		$232,742.10
Disbursements and Commitments				
Personal services:				
Regular salaries	112,196.32		129,751.45	
Part-time salaries	17,259.62	129,455.94	17,181.72	146,933.17
Travel and automotive:				
Travel and per diem	12,632.90		13,215.96	
Gas, repairs, and insurance	5,565.58	18,198.48	5,376.25	18,592.21
Supplies and materials:				
Postage and resale supplies	4,905.01		4,474.64	
Office supplies	1,299.65		891.58	
Laboratory and scientific supplies	5,979.53	12,184.19	4,993.78	10,360.00
Printing and reproduction		12,677.16		15,180.81
Other operating expense:				
Telephone and telegraph	1,804.81		1,724.37	
Professional services	1,796.85		1,827.44	
Retirement - State and Federal	3,100.36		3,312.81	
Overhead	13,000.00		13,000.00	
Freight, express, insurance, audit, repairs, subscriptions, etc.	2,951.47	22,653.49	6,298.52	26,163.14
Capital outlay		11,849.44		14,011.55
TOTAL expenditures		207,018.70		231,240.88
Year-end balance		3,916.97		1,501.22
Outstanding obligations		668.64		-
TOTAL		$211,604.31		$232,742.10

FINANCIAL STATEMENT

BASIC GEOLOGY

Receipts	1954-1955	1955-1956
Beginning balance, July 1	$ 250.26	$ 1,303.73
State appropriation	10,000.00	10,000.00
TOTAL revenue	10,250.26	11,303.73
Disbursements and Commitments		
Salaries	7,229.03	7,999.93
Travel	717.50	885.10
Overhead	1,000.00	1,000.00
TOTAL expenditures	8,946.53	9,885.03
Year-end balance	1,303.73	1,418.70
	$10,250.26	$11,303.73

GROUND-WATER SURVEYS

Receipts	1954-1955	1955-1956
Beginning balance, July 1	$ 73.13	$ 70.26
State appropriation	10,000.00	10,000.00
TOTAL revenue	10,073.13	10,070.26
Disbursements and Commitments		
Salaries	9,002.87	8,000.00
Printing and publications	-	600.00
Overhead	1,000.00	1,000.00
TOTAL expenditures	10,002.87	9,600.00
Year-end balance	70.26	470.26
	$10,073.13	$10,070.26

THE MINERAL INDUSTRY OF NEW MEXICO

The past biennium has seen enormous growth in the mineral industry of New Mexico. The value of production for the year ending June 30, 1956, amounted to $457,674,049, nearly twice that for the year 1951. The value of uranium already is third among the metals and nonmetals, being exceeded only by copper and potash. Owing to the price increase, copper production for 1956 is valued at an all-time high of $61,567,627. Potash continued its climb to an all-time high of $55,659,278. In spite of the decline in coal production the value of the mineral fuels increased to $302,670,697, or twice the value of the production in 1951. Lead and zinc production increased notably with the increase in price. Perlite production has enjoyed a steady increase, so that its value has exceeded a million dollars during the past 2 years. On the other hand, fluorspar, formerly a leading mineral product, is no longer produced, owing to low-cost foreign competition.

The mineral production for the past 2 years is given in the accompanying table, and the production history of several products is shown by the graphs which follow. Demand, price, and supply determine the course of each segment of the mineral industry. A major function of the State Bureau of Mines and Mineral Resources is to do the basic research work and geologic mapping which will aid in assuring supplies of mineral products that are being exhausted, and find new sources of materials which will be needed in the future to help support New Mexico's growing population. Vigorous expansion of this program is demonstrably warranted.

MINERAL PRODUCTION IN NEW MEXICO
1954/5 and 1955/6

	July 1, 1954–June 30, 1955		July 1, 1955–June 30, 1956	
	Quantity	Value	Quantity	Value
Fuels				
Crude oil[1]	77,893,375 bbl	$214,206,781	84,425,815 bbl	$232,170,991
Natural gas[2]	499,700,000 mcf	38,976,600	547,300,000 mcf	42,689,400
Natural gasoline and allied products[2]	11,960,952 bbl	24,759,170	12,966,000 bbl	26,839,620
Coal[3]	143,216 tons	835,520	153,416 tons	970,686
TOTAL value		$278,778,071		$302,670,697
Metals[3]				
Bastnaesite	42 tons	$ 9,420	0	$ 0
Beryl	136 tons	76,485	71 tons	37,000
Columbium	1,276 lb	6,410	90 lb	450
Copper	73,700 tons	43,714,109	70,533 tons	61,567,627
Gold	1,450 oz	48,695	1,617 oz	53,257
Iron	9,020 tons	56,250	8,563 tons	34,252
Iron-Manganese	28,000 tons	112,000	37,400 tons	149,600
Lead	1,821 tons	435,894	7,382 tons	1,905,370
Manganese	102,661 tons	2,955,936	97,485 tons	3,677,464
Molybdenum	830 tons	1,202,093	857 tons	1,040,421
Selenium	728 lb	728	10,983 lb	10,983
Silver	141,100 oz	123,525	257,718 oz	230,278
Tungsten	6 tons	335	0	0
Uranium	not available	4,680,906	not available	15,349,376
Vanadium	not available	71,824	190,985 lb	67,377
Zinc	5,239 tons	1,257,366	47,763 tons	11,454,905
TOTAL value		$ 54,751,976		$ 95,578,360
Nonmetals[3]				
Barite	4,653 tons	$ 74,448	4,748 tons	$ 74,814
Brick and tile	30,893 tons	31,417	0	0
Caliche	0	0	33,000 cu yd	33,000
Crushed rock ballast	546,798 cu yd	343,953	791,186 cu yd	646,477
Dolomite	100 tons	700	0	0
Drilling mud	6,046 tons	42,214	23,598 tons	65,430
Fire Clay	2,416 tons	7,427	51,277 tons	53,768

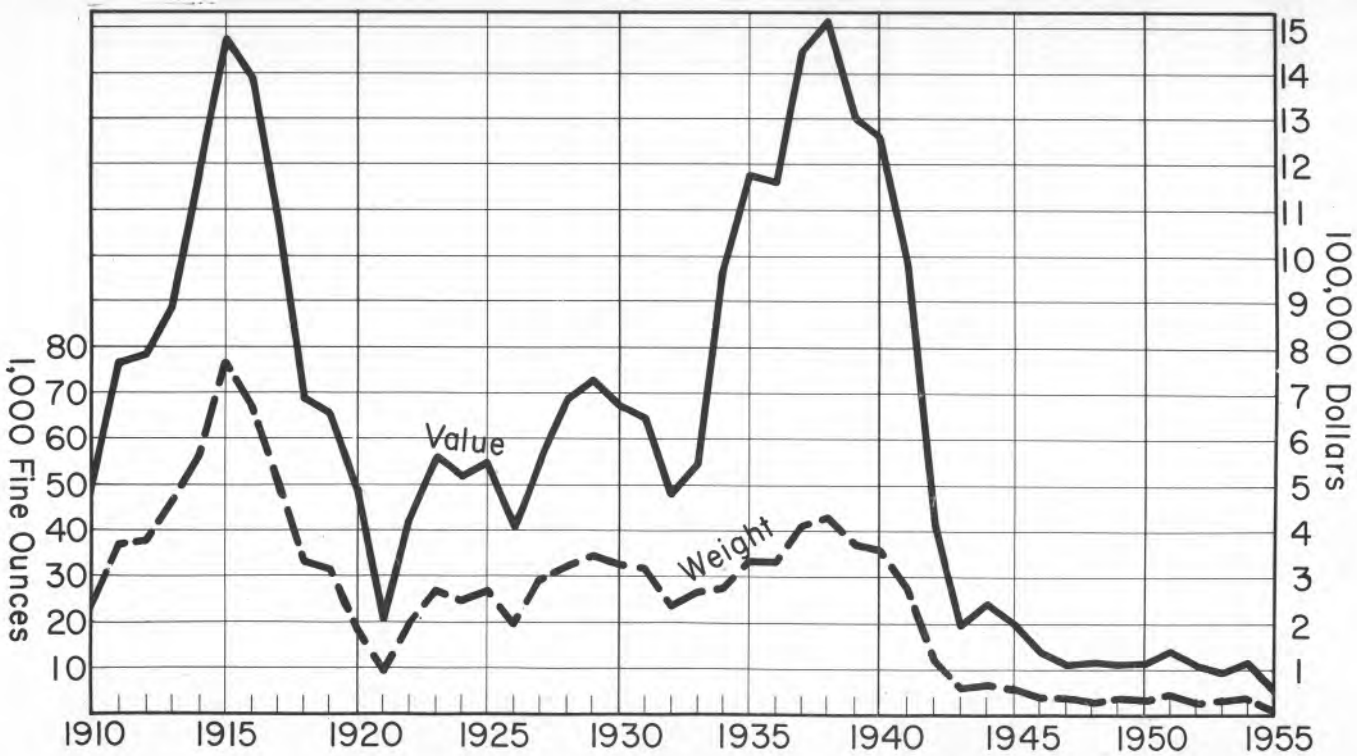
1. New Mexico Oil Conservation Commission.

2. U. S. Bureau of Mines.

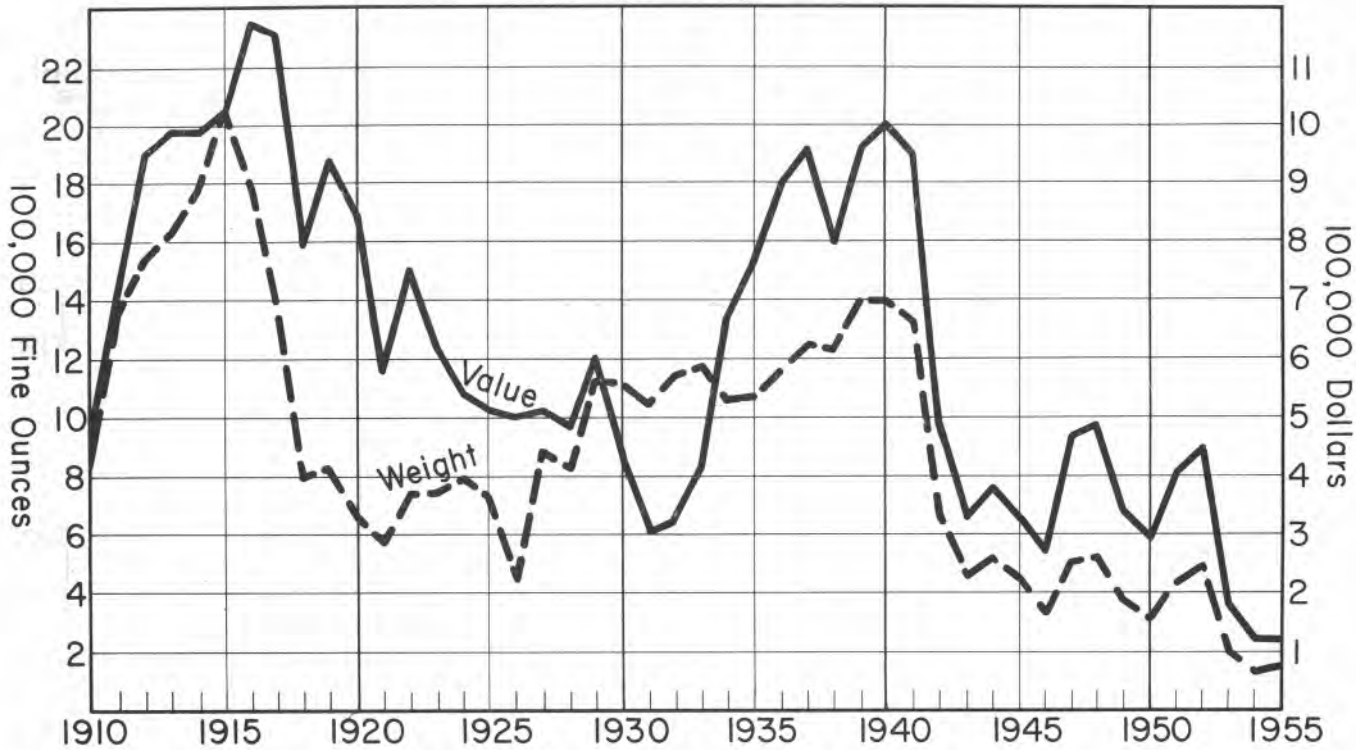
3. New Mexico State Inspector of Mines.

MINERAL PRODUCTION IN NEW MEXICO
1954/5 and 1955/6 (Continued)

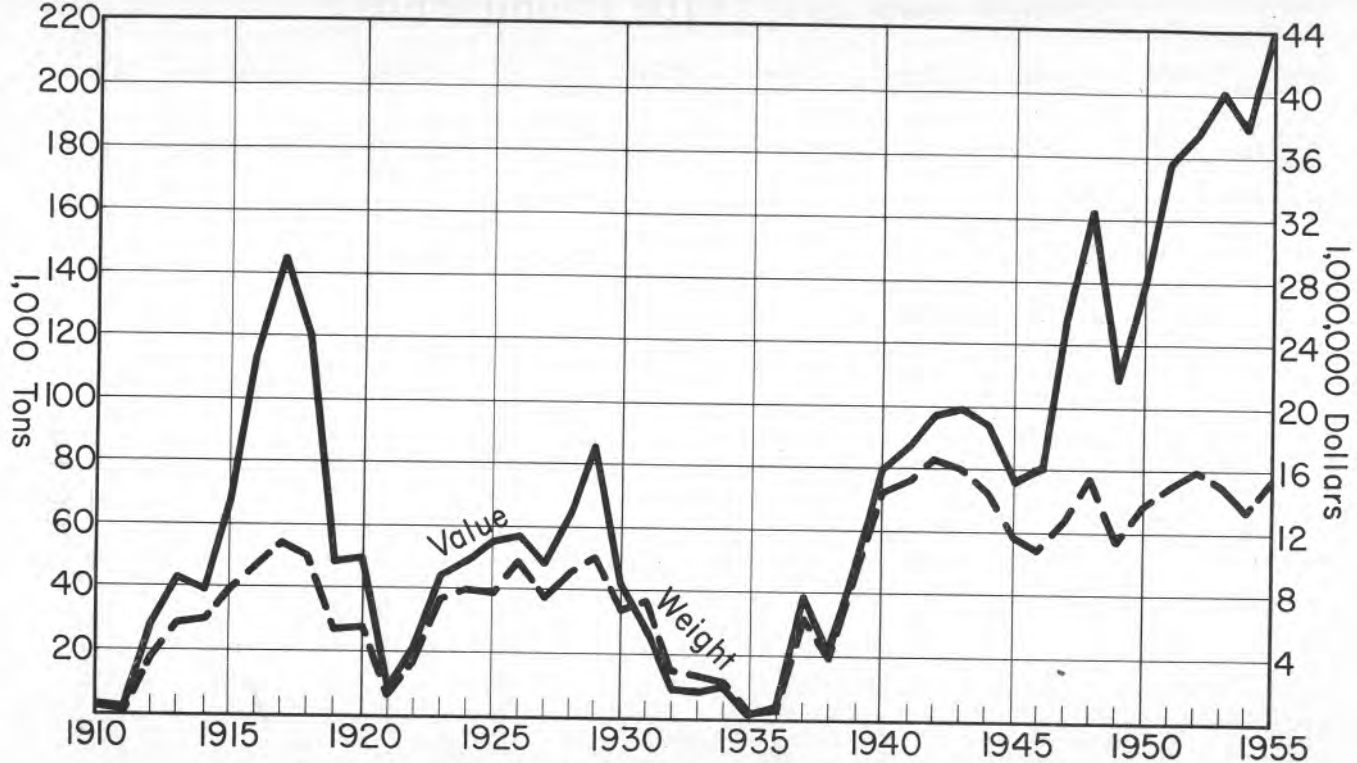
	July 1, 1954–June 30, 1955		July 1, 1955–June 30, 1956	
	Quantity	Value	Quantity	Value
Nonmetals (continued)				
Gravel (pit-run)	114,100 cu yd	$ 92,320	154,958 cu yd	$ 190,130
Gravel (screened)	336,944 cu yd	609,836	273,205 cu yd	283,823
Mica	2,103 tons	72,738	762 tons	106.536
Perlite	142,941 tons	1,052,869	163,331 tons	1,166,884
Potash	10,445,623 tons	51,322,262	11,482,108 tons	55,659,278
Pumice	444,032 cu yd	284,768	192,299 cu yd	266,878
Salt	1,694 tons	11,858	47,868 tons	70,358
Sand (pit-run)	22,078 cu yd	33,350	76,724 cu yd	78.147
Sand (screened)	305,473 cu yd	531,168	268,593 cu yd	391,317
Scoria	351,727 cu yd	376,150	270,067 cu yd	338,152
Shale (carbonaceous)	4,988 tons	24,940	0	0
TOTAL value		$ 54,912,418		$ 59,424,992
TOTAL value of mineral production		$388,442,465		$457,674,049



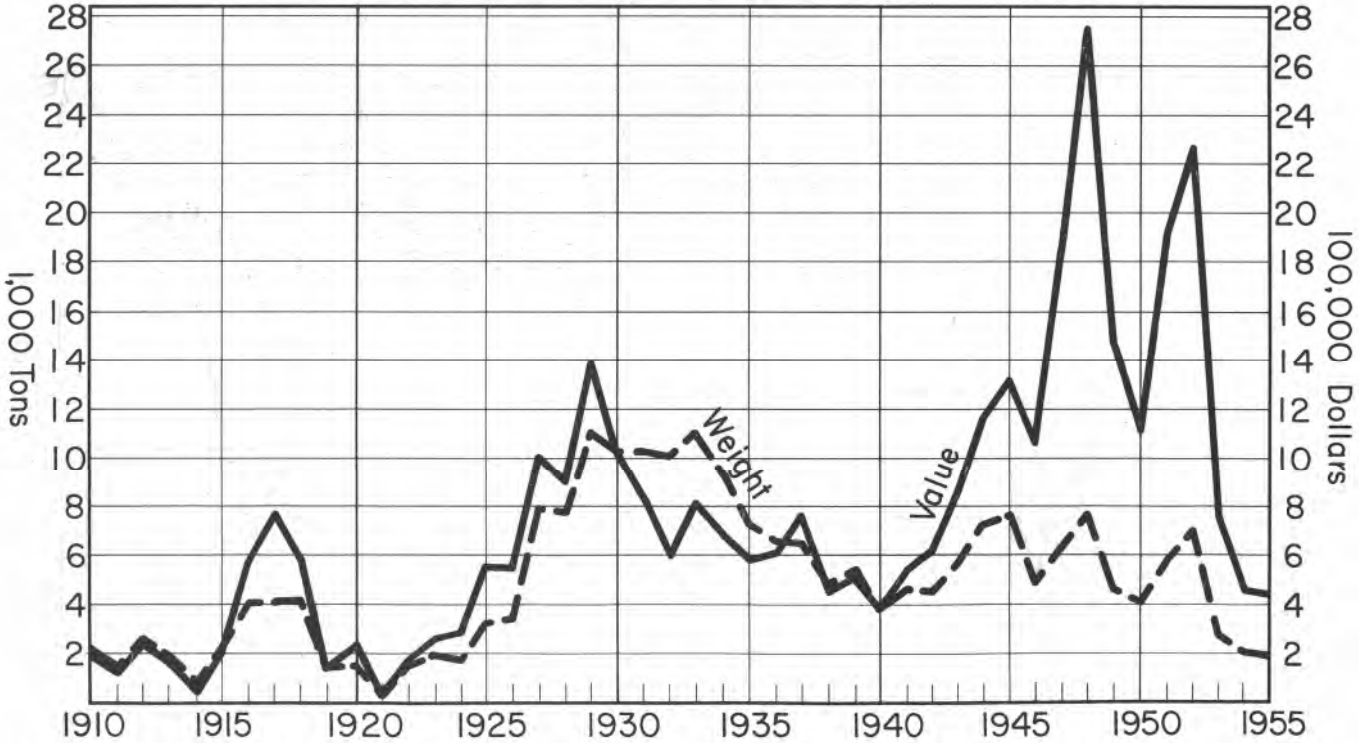
Production of GOLD in New Mexico



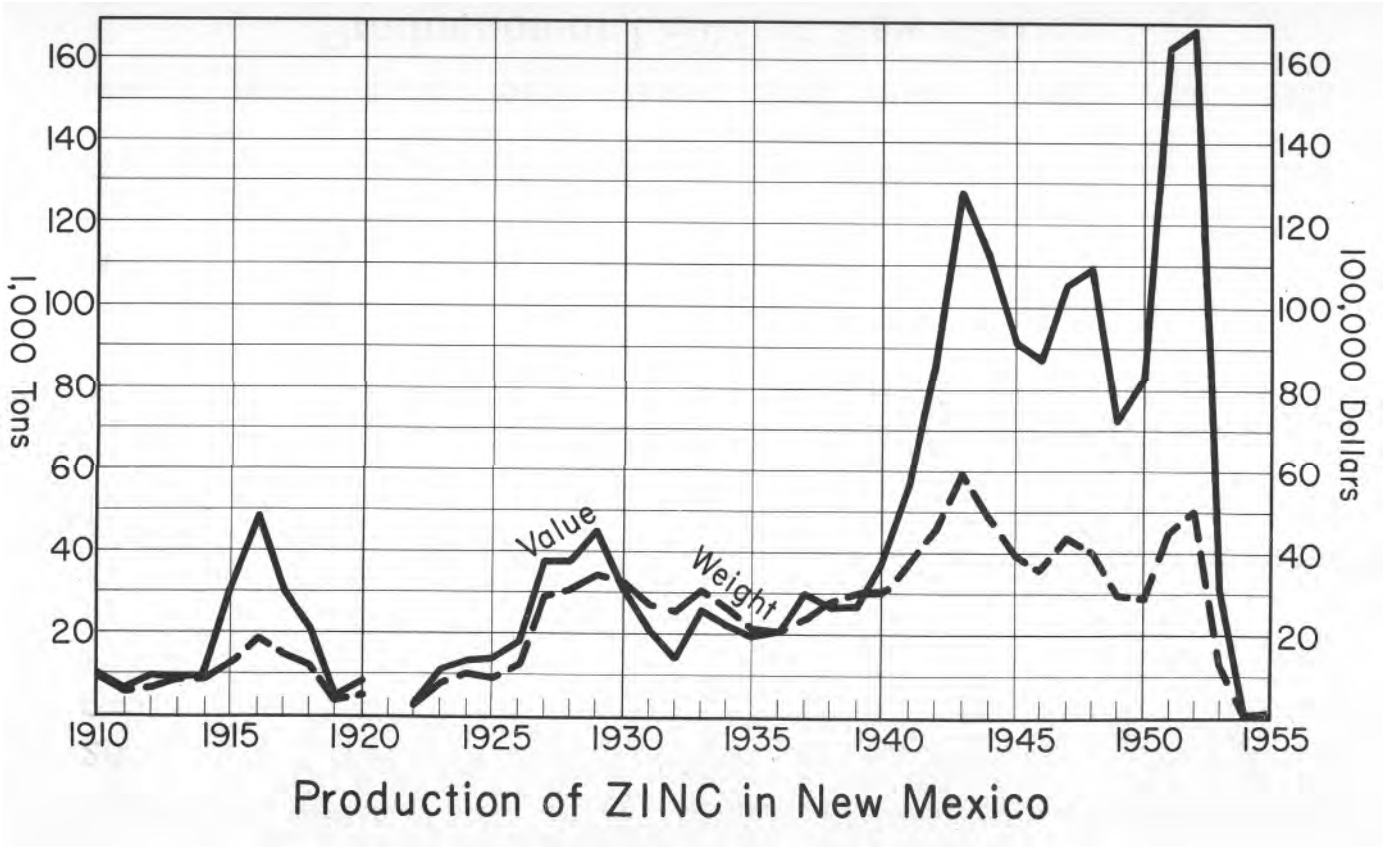
Production of SILVER in New Mexico

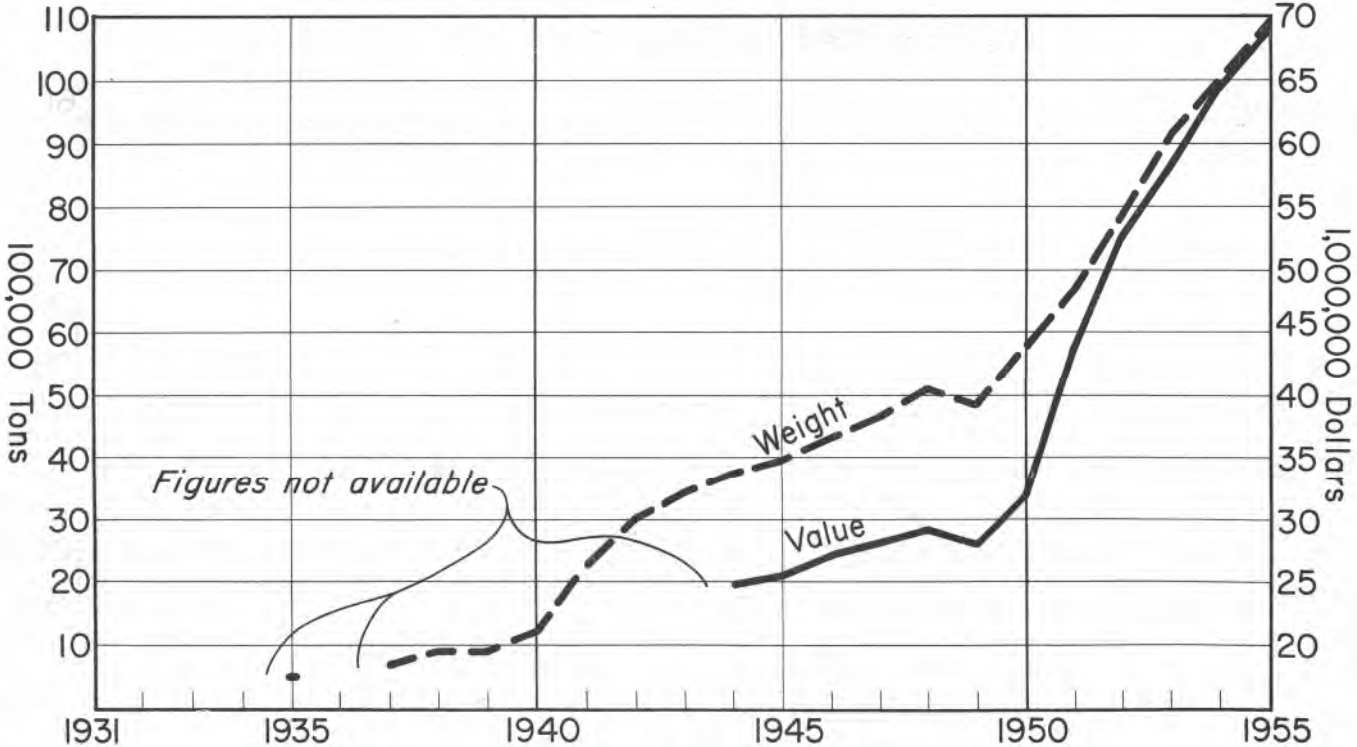


Production of COPPER in New Mexico

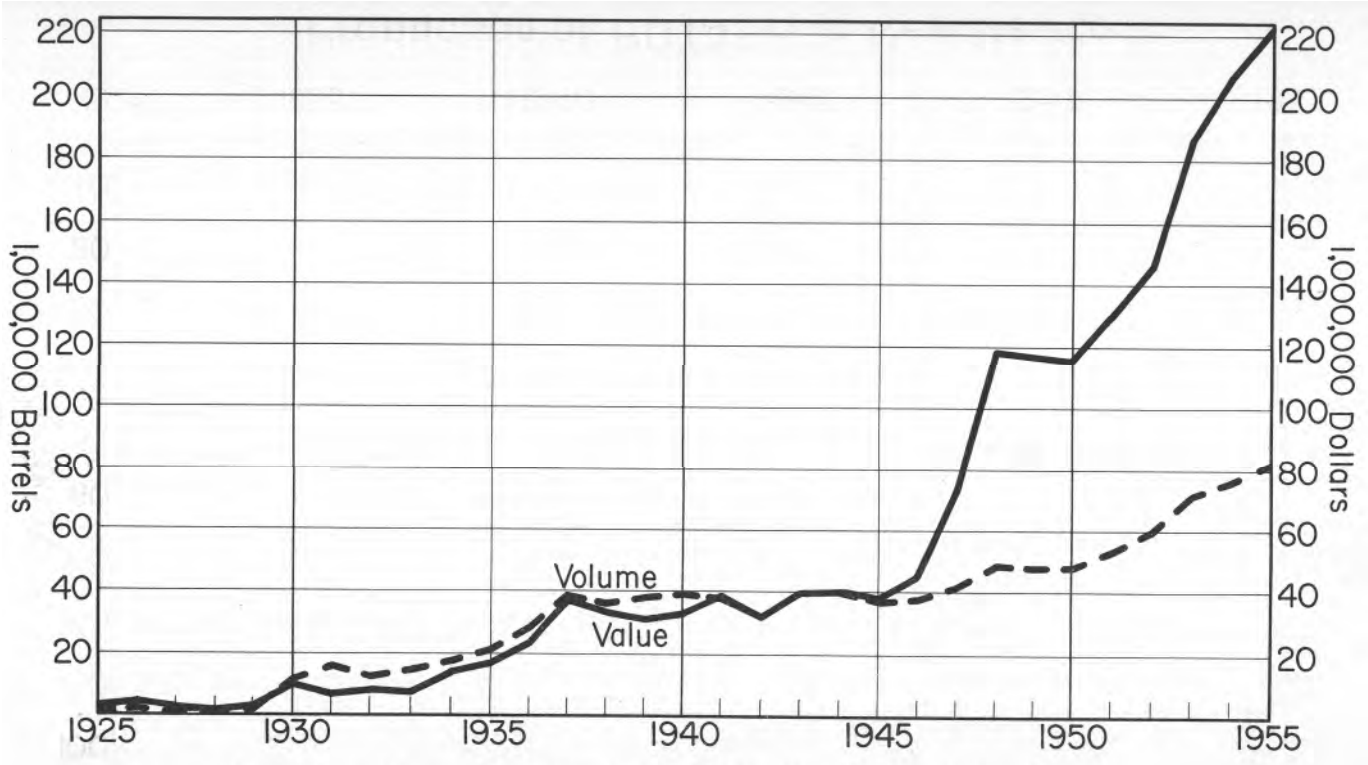


Production of LEAD in New Mexico

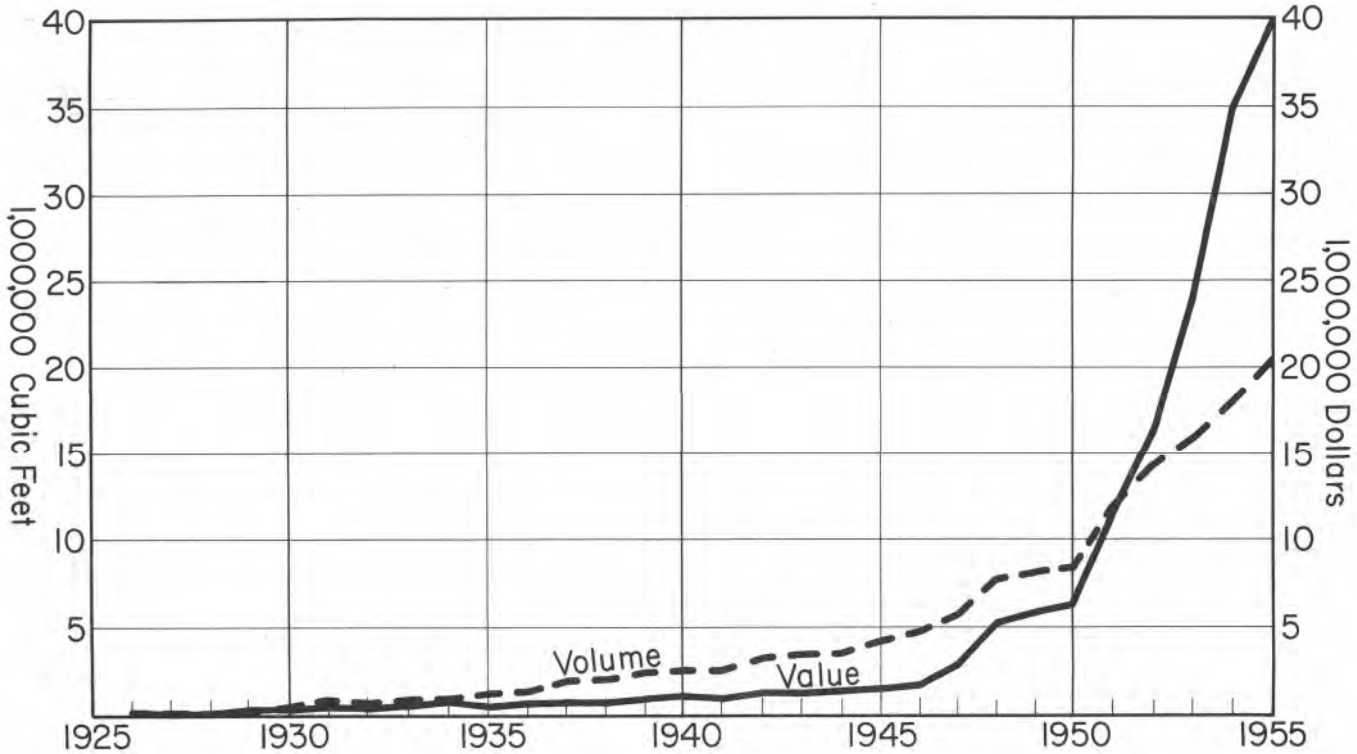

160
140
120
100
80
60
40
20
1,000 Tons
100,000 Dollars
Value
Weight
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
Production of ZINC in New Mexico



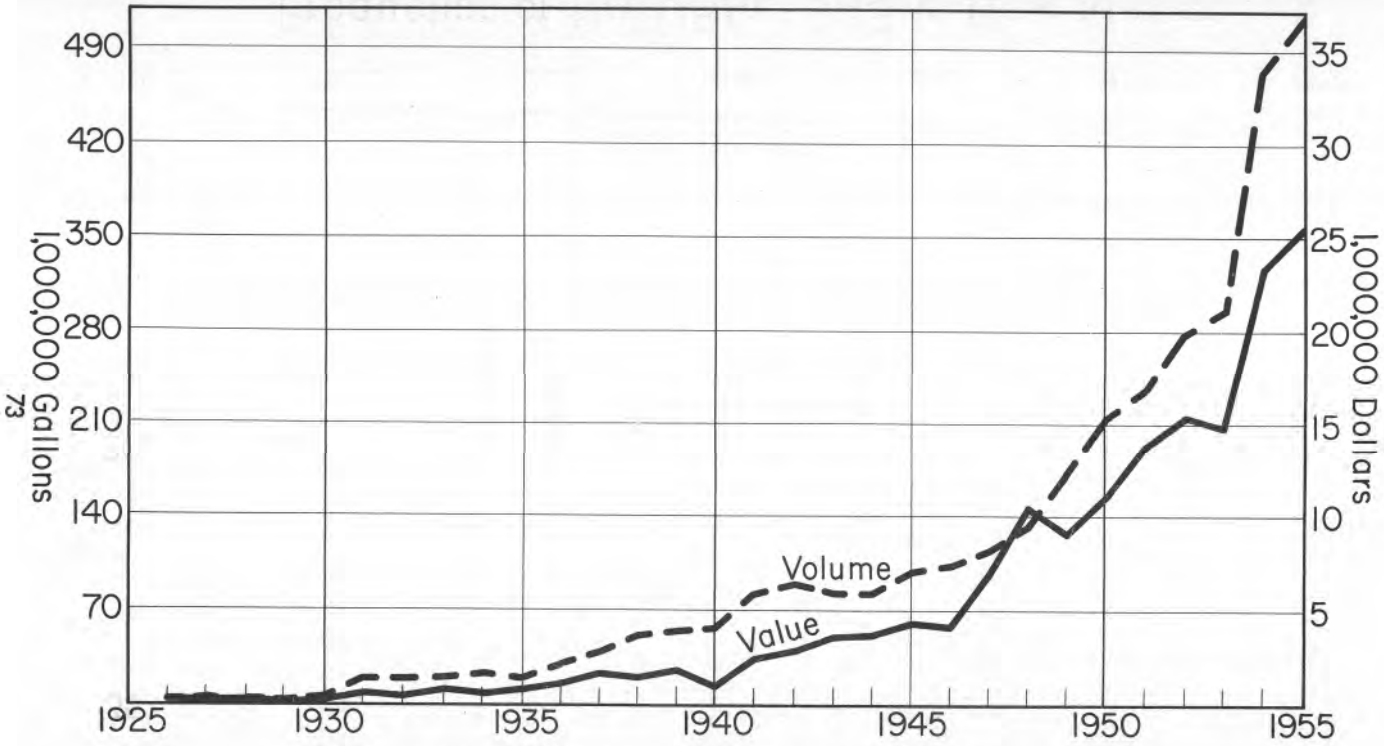
Production of POTASH in New Mexico



Production of CRUDE OIL in New Mexico



Production of NATURAL GAS in New Mexico



Production of NATURAL GASOLINE in New Mexico

BUREAU PERSONNEL

Eugene Callaghan . . . . . Director
E. C. Anderson . . . . . Mining Engineer
John E. Allen . . . . . Economic Geologist
Brewster Baldwin . . . . . Economic Geologist
Robert Balk (deceased 2-19-55) . . . . . Economic Geologist
Henry L. Jicha, Jr. . . . . Economic Geologist
Frank E. Kottlowski . . . . . Economic Geologist
Frederick J. Kuellmer . . . . . Economic Geologist
John H. Schilling . . . . . Assistant Geologist
Robert H. Weber . . . . . Economic Geologist
Max E. Willard . . . . . Economic Geologist
Robert A. Zeller, Jr. . . . . Associate Geologist
Robert A. Bieberman . . . . . Petroleum Geologist
Roy W. Foster . . . . . Junior Petroleum Geologist
Francis X. Bushman . . . . . Ground-Water Hydrologist
Christina L. Balk (employed 4-4-55) . . . . . Stratigraphic Geologist
Rousseau H. Flower . . . . . Stratigraphic Geologist
Ming-Shan Sun . . . . . Mineralogist Petrographer
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Mrs. L. Maureen Frische (employed 10-6-54) . . . . . Assistant Illustrator
Myrtie M. Morris . . . . . Secretary to the Director
Mrs. Marian R. Burks (resigned 3-31-55) . . . . . Office Manager
Mrs. Dora A. Coffman (employed 9-19-55) . . . . . Office Manager
Mrs. Barbara Detterick (resigned 1-19-56) . . . . . Stenographer
Mrs. Florence Crespin Foster (resigned 7-21-55) . . . . . Stenographer
Mrs. Janice Hardin (employed 1-9-56) . . . . . Stenographer
Mrs. Fidelia Baldonado Razaghnia . . . . . Stenographer
Mrs. Constance F. Schilling . . . . . Stenographer

TEMPORARY EMPLOYEES

Augustus K. Armstrong . . . . . Geologist
Irene E. Barber . . . . . Geologist
Wayne M. Bundy . . . . . Geologist

PART-TIME ASSISTANTS

Gordon E. Adams, University of Texas
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Richard N. Cowles, New Mexico Institute of Mining and Technology
Wilgus B. Creath, St. Louis, Missouri
Lawrence Hathaway, New Mexico Institute of Mining and Technology

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John D. Thomas, New Mexico Institute of Mining and Technology
Theodore G. Trujillo, New Mexico Institute of Mining and Technology
Harold K. Wainwright, New Mexico Institute of Mining and Technology

GEOLOGISTS ON SPECIAL PROJECTS

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Wolfgang E. Elston, Texas Technological College
Elliot Gillerman, University of Texas
Richard H. Jahns, California Institute of Technology
William R. Muehlberger, University of Texas
Clay T. Smith, New Mexico Institute of Mining and Technology
Charles E. Stearns, Tufts University
Patrick K. Sutherland, University of Houston
M. L. Thompson, University of Kansas

FIELD-ASSISTANCE FELLOWSHIPS

Allen Alper, Columbia University
William A. Bassett, Columbia University
Eugene Cserna, Columbia University
Hugh H. Doney, University of Texas
R. Fred Flege, Jr., Washington University
Charles H. Hewitt, University of Michigan
James T. Johnson, New Mexico Institute of Mining and Technology
Charles J. Mankin, University of Texas
Oscar Strongin, Columbia University

FIELD PROJECTS - 1956

The field projects listed below and located on the following map are described in this report.

Regional and Special Projects

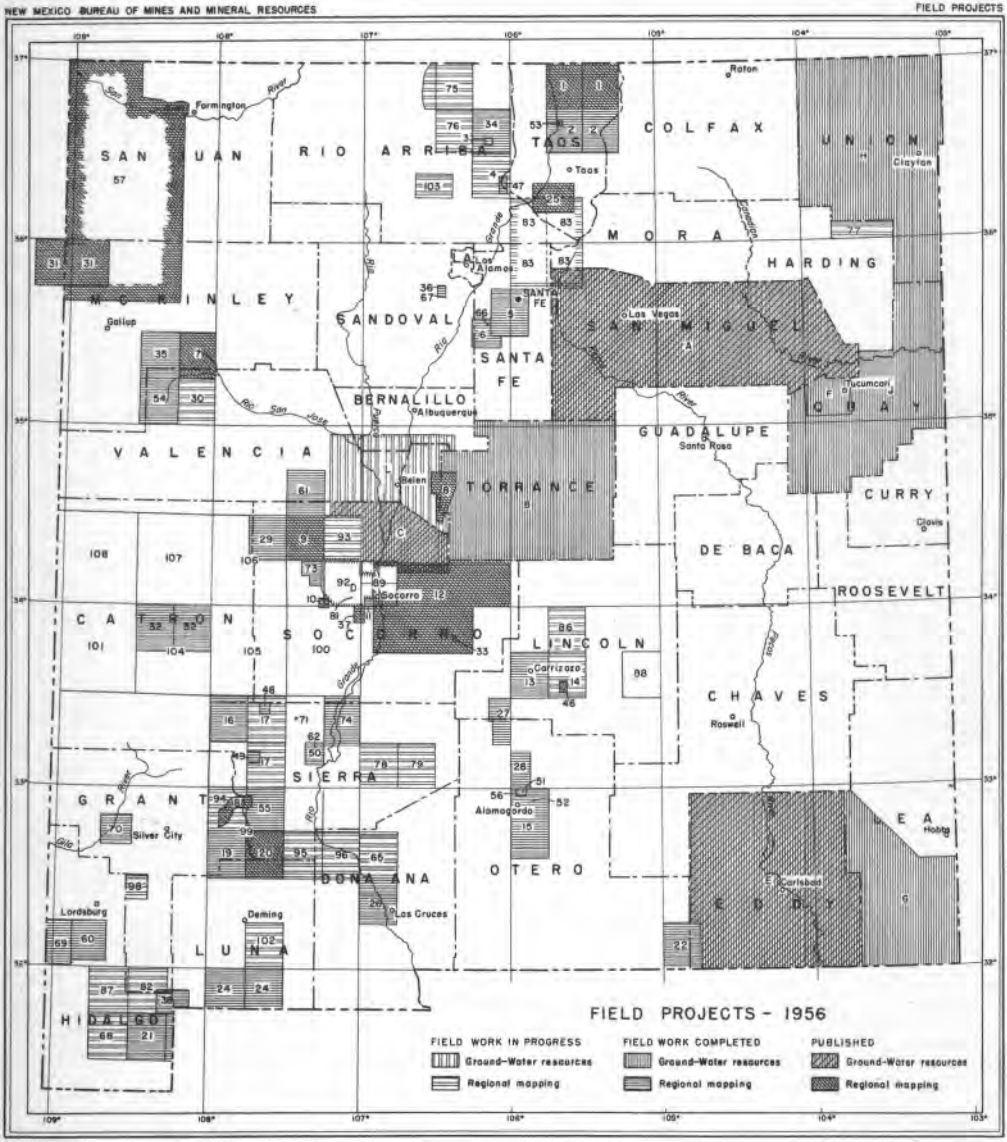
1. Costilla and Latir Peak quadrangles
2. Questa and Eagle Nest quadrangles
3. Big Rock and other kyanite deposits
4. El Rito quadrangle
5. Santa Fe area
6. Cerrillos Hills area
7. Thoreau quadrangle
8. South Manzano Mountains
9. Puertecito quadrangle
10. Magdalena perlite deposits
11. Socorro perlite deposits
12. Area east of Socorro
13. Carrizozo quadrangle
14. Capitan quadrangle
15. Sacramento Mountains area
16. Lookout Mountain quadrangle
17. Winston and Sugarloaf Mountain quadrangles
18. Geologic section of Black Range
19. Dwyer quadrangle
20. Lake Valley quadrangle
21. Big Hatchet Peak quadrangle
22. El Paso Gap quadrangle
23. Topical study of gossans
24. Columbus and Hermanas quadrangles
25. Picuris Range
26. Las Cruces quadrangle
27. Three Rivers area
28. La Luz area
29. Datil NE. quadrangle
30. Mt. Sedgwick quadrangle
31. Fort Defiance and Tohatchi quadrangles
32. Pelona NE. and NW. quadrangles
33. Hansonburg mining district
34. Las Tablas quadrangle
35. Foster Canyon quadrangle
36. Bland mining district
37. Socorro manganese district

38. Contact metamorphism in Sierra Rica and Apache Hills
39. Oil and gas map of New Mexico
40. Geologic map of New Mexico
41. Characteristics of petroleum in New Mexico (inactive)
42. Tertiary volcanic rocks of New Mexico
43. Tertiary intrusive rocks of New Mexico
44. Stratigraphy of New Mexico
45. Stratigraphy and paleontology of the El Paso limestone
46. Coal in Capitan quadrangle
47. Ojo Caliente area, Rio Arriba County (included in area of Project 4)
48. Iron Mountain tungsten, Sierra County (included in area of Project 17)
49. Hermosa district
50. Mud Springs Mountains quadrangle
51. Pennsylvanian stratigraphy
52. High Rolls district
53. Questa mine area
54. Inscription Rock quadrangle
55. Hillsboro quadrangle
56. Fresnal Canyon, Sacramento Mountains
57. Mineral survey of the Navájo Reservation in New Mexico
58. The metal resources of New Mexico and their economic features
59. Bibliography of New Mexico geology and mineral technology through 1950
60. Pyramid Mountains, Lordsburg quadrangle
61. Mesa del Oro quadrangle
62. Pennsylvanian stratigraphy and paleontology in Whiskey Canyon, Mud Springs Mountains
63. Guidebook of southwestern New Mexico
64. Cambrian cephalopods
65. San Diego Mountain quadrangle
66. Cienega area
67. Wallrock alteration in Bland district
68. Walnut Wells quadrangle
69. Steins area
70. Gila River area
71. Uranium associated with fluorspar at Monticello
72. Paleozoic stratigraphy in south-central New Mexico
73. North Magdalena area
74. Engle NE. quadrangle
75. Cebolla NW. quadrangle
76. Cebolla SW. quadrangle
77. Bueyeros area
78. Sowell quadrangle
79. Black Top Mountain quadrangle
80. A study of stratigraphy and paleontology of Mississippian formations in central and northern New Mexico

81. Manganese deposits of Socorro area
82. Hachita quadrangle
83. Truchas region
84. Clay minerals in Cretaceous rocks
85. Pennsylvanian sections in New Mexico
86. Carrizo Peak NE. quadrangle
87. Playas quadrangle
88. Arabella quadrangle
89. Socorro quadrangle
90. Exsolution of feldspars
91. Bibliography of New Mexico geology and mineral technology, 1951-1955
92. Magdalena quadrangle
93. Riley quadrangle
94. Mimbres quadrangle
95. Rincon 3 quadrangle
96. Rincon 4 quadrangle
97. Mississippian stratigraphy of southwestern New Mexico
98. Structure and volcanic sequence northeast of Lordsburg
99. Hillsboro 30-minute quadrangle
100. Nogal Canyon 30-minute quadrangle
101. Reserve 30-minute quadrangle
102. Stratigraphy and structure of the Florida Mountains
103. Ghost Ranch and Echo Amphitheatre 7½-minute quadrangles
104. Pelona 30-minute quadrangle
105. Leura Springs 30-minute quadrangle
106. Datil 30-minute quadrangle
107. Pinonville 30-minute quadrangle
108. Canon Largo 30-minute quadrangle

Ground-Water Studies

A. San Miguel County
B. Torrance County
C. North Socorro County
D. Socorro-Magdalena area
E. Eddy County
F. Tucumcari, Quay County
G. South Lea County
H. Union County
J. Quay County
K. Western San Agustin Plains
L. East Valencia County


SAN JUAN
RIO ARRIBA
TAOS
COLFAX
UNION
MORA
HARDING
MC KINLEY
SANDOVAL
SANTA FE
SAN MIGUEL
QUAY
BERNALILLO
VALENCIA
TORRANCE
GUADALUPE
CURRY
DE BACA
ROOSEVELT
CATRON
SOCORRO
LINCOLN
CHAVES
GRANT
SIERRA
OTERO
EDDY
DONA ANA
LUNA
HIDALGO
Farmington
Taos
Raton
Clayton
Los Alamos
Gallup
Las Vegas
Tucumcari
Santa Rosa
Belen
Albuquerque
Clovis
Socorro
Carrizozo
Roswell
Silver City
Alamogordo
Hobbs
Carlsbad
Lordsburg
Deming
Las Cruces
FIELD PROJECTS - 1956
FIELD WORK IN PROGRESS
Ground-Water resources
Regional mapping
FIELD WORK COMPLETED
Ground-Water resources
Regional mapping
PUBLISHED
Ground-Water resources
Regional mapping