NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

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CIRCULAR 25

RAW MATERIALS FOR CHEMICAL INDUSTRY IN NEW MEXICO

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(Raw Materials)

NEW MEXICO

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THE first recorded interest in the availability of raw materials L from New Mexico dates from the time of Francisco Vasquez de Coronado. During 1540 this bold explorer searched in vain for the famed "Seven Cities of Cibola," supposed to be filled with gold, silver, and precious jewels. Coronado failed in his attempt to find the fabulous cities, but those who followed him found a "land of enchantment," rich in valuable raw materials, possessing an ideal climate, and endowed with an abundance of energy in the forms of petroleum, natural gas, coal, and sunshine.

No single region possesses all the factors desirable for the establishment of industry and, in common with most of the West, distances in New Mexico from natural resource to plant and consumer are usually large. However, a large number of extractive industries have been developed in the state, production for the fiscal year ending June 30, 1952, amounting to $264,617,001. This was divided as follows: petroleum and natural gas $169,826,420, metallics $55,368,655, and nonmetallics $39,421,926 (14). Good highways have now opened up many hitherto isolated areas rich in resources. The state is developing rapidly and has practically doubled its population since 1920, the 1950 census giving a figure of 677,152. With the entire expanding West as a potential market, further utilization of abundant raw materials offers a real challenge and opportunity to those of pioneering spirit who are willing to carry out adequate exploratory work and possess the required ingenuity and engineering know how.

Figure 1 shows the principal cities and railroad lines. It is given to assist in visualizing the locations of the resources discussed.

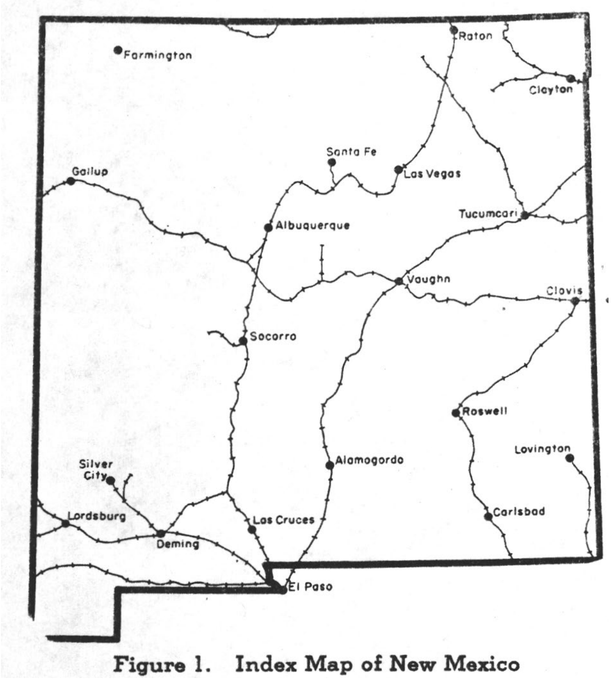

Figure 1. Index Map of New Mexico

AGRICULTURAL PRODUCTS

While agriculture in New Mexico is confined to dry farming and to areas where irrigation is available, it is one of the major industries of the state. Farm products produced in 1950 sold for $74,327,143 (23). The 1951 production figures listed in Table I *(12)* include agricultural crops and products processed from them which are available as chemical raw materials.

Table I. Production in 1951

Corn, bushels	1,116,000
Cotton (lint), bales	291,000
Cottonseed, tons	115,000
Cottonseed oil, tons	37,000
Peanuts, tons	4,000
Peanut oil, tone	1,200
Sweet potatoes, bushels	200,000
Wheat, bushels	1,094,000

The availability of desert plants is of real interest. Growth of plants in arid regions is, of course, slow; hence all desert plant projects must be planned carefully in order to ensure a sustained yield (7). However, utilization of plants which yield special substances of values, for which demand is limited, merits special consideration. For example, the creosote bush, which grows in great profusion in the southern half of the Rio Grande valley in New Mexico, is a commercial source of nordihydroguaiaretic acid, a valuable antioxidant for fats and oils (3). This bush has an acid content of 9 to 12%, and there is no important loss of acid after harvesting. The bush is also a potential source of varnish resins and stock feed.

FOREST PRODUCTS

The total forested area of New Mexico amounts to 20,001,000 acres, of which 6,101,000 acres are considered saw timber (22). The forests are generally found at elevations of 7000 to 11,500 feet, where the average annual rainfall is approximately 19 inches. The saw timber area contains about 130 species of trees: 82% Ponderosa pine, 10% Douglas fir, 3% white fir, and 3% Engelman spruce. Other pines and firs make up the remaining 2%.

Of the saw timber area 3,465,000 acres are classified *as* commercial and contain an estimated reserve of nearly 8.5 billion board feet. The remaining area is inaccessible or the timber is too scattered for profitable logging. In 1948 some 124,608,000board feet were cut out by 120 mills. At present most of the sawdust and other waste materials are used as fuel or burned as trash. Nearly all the mills are small, making waste utilization difficult. However, some utilization of forest waste as chemical raw materials should develop as the steady population increase of the West opens up the necessary consuming markets. Possibilities include the production of kraft pulp, wood molasses, and naval stores.

MINERAL FUELS

Petroleum and Natural Gas. Petroleum, natural gas, and natural gas liquids are among the most important raw materials available to the chemical industry in New Mexico. The oil and gas industries are also among the most important factors in the economy of the state. New Mexico ranks sixth in crude oil production and seventh in natural gas production in the United States. The average production of crude oil for the first half of 1952 was 160,400 barrels daily (8). Production has doubled during the past 10 years. Estimated proved reserves have increased fivefold in the past 10 years and are nearly equal to the cumulative production from 1924 to 1951. The value of the crude oil, dry gas, and natural gas liquids produced in 1951 amounted to approximately $169,830,000.

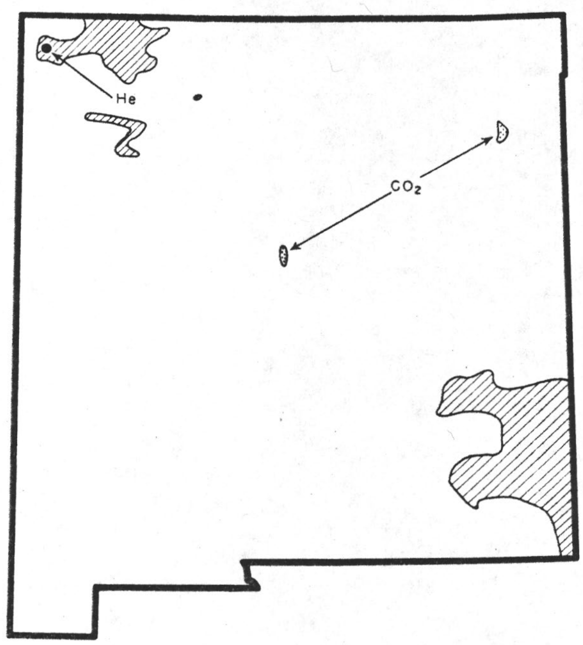

Figure 2. Petroleum- and Natural Gas-Producing Areas

The chief producing regions, shown in Figure 2 *(1, 24),* are the New Mexico portion of the Permian basin in the southeastern part of the state and the San Juan basin in the northwestern part. The San Juan basin is a rapidly developing region which has become an important producer only during the past few years. At present this field contributes approximately 7% of the oil and 30% of the gas produced in the state. Table II *(13)* summarizes the recent and cumulative production, together with estimated proved reserves.

There are eight refineries and thirteen extraction plants in the state, located as shown in Figure 3 *(15, 16).* Three refineries are topping plants and five are both topping and cracking. The refineries have a crude oil operating capacity of 20,050 barrels per day. The five cracking plants have a total capacity of 6000 barrels of cracked gasoline per day. The products of the plants are gasoline, kerosine, gas oil, fuel oil, and asphalt. The thirteen

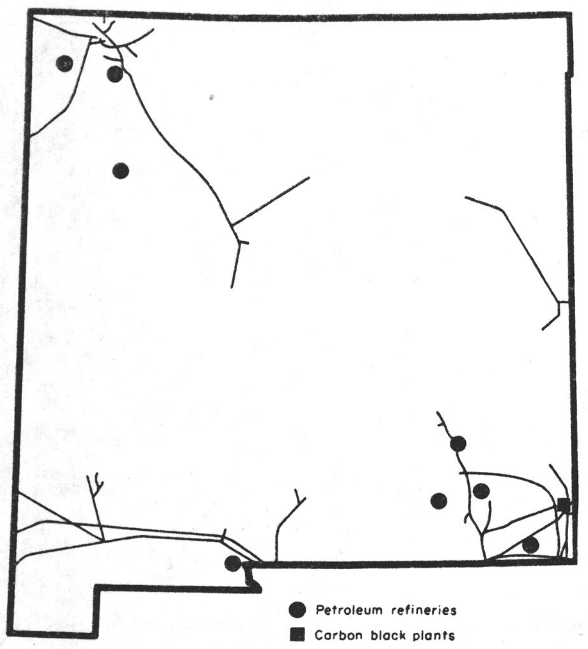

Figure 3. Natural Gas Pipelines, Petroleum Refineries, and Carbon Black Plants

extraction plants produced 3,881,178 barrels of gasoline, 1,410,840 of butane, and 758,273 of propane in 1951 (8).

As these figures show, most of the crude oil produced is not refined in the state. A large percentage is exported by pipelines to refineries in Texas and some of the refined products are returned to New Mexico for sale. Most of the natural gas is likewise exported, chiefly to California. The recently completed line from the Sari Juan basin now supplements the line from the Permian basin. The location of the gas pipelines within the state, shown in Figure 3, indicates the availability of natural gas. An extension of the gas network could easily provide all populated areas of the state with ample natural gas.

The five carbon black plants operating in New Mexico are all located in the Hobbs-Eunice area in the southeastern part of the state as shown in Figure 3. During 1951 *(8)* 56,266,801,000 cubic feet of gas were used to produce 112,036,862 pounds of carbon black. About half of the product is exported, chiefly to Great Britain, and most of the remainder goes to the domestic rubber industry.

Natural gas from the Rattlesnake field, north of Shiprock (Figure 2), contains 6 to 7% of helium. Reserves are estimated at 12 billion cubic feet of gas, from which 788,000,000 cubic feet of helium can be extracted. Cumulative production from 1942 has amounted to 2,243,414 cubic feet (13). Production is, of course, controlled by the Federal Government. An extraction plant, built by the Government at Shiprock during World War II, was

Table II. Production and Proved Reserves

	Production, 1951	Cumulative
Oil, bbl.	52,729,000	734,679,000 (1924-51)
Gas, dry		
Gross, thousand cu. feet	329,100,000	2,832,640,000 (1935-51)
Marketed, thousand cu. feet	300,169,000	1,950,584,000 (1935-51)
Natural ***gas*** liquids, bbl.	5,725,000	41,691,905 (1926-51)
	Reserves (Estimated Proved as of 1-1-52)	
Oil, bbl.	625,000,000	
Gas (dry), billion cu. ft.	7,500	
Natural **gas** liquids, bbl.	95,000,000	

shut down at the close of the war, but is now being reactivated. At present there is increasing demand for helium to provide inert atmospheres for welding.

The Bueyeros field in Harding County, southwest of Clayton in the northeastern part of the state (Figure 2), is the center of a small but expanding carbon dioxide industry. In 1951 66,470,000 cubic feet of carbon dioxide gas were extracted and cumulative production amounted to 589,556,000 cubic feet from 1946 to 1951 (13). Pro-

duction is somewhat seasonal, inasmuch as nearly all the gas is sold as dry ice for use in refrigeration, and is more than doubled from June through October. The production of carbon dioxide could be expanded if additional markets were available. Some carbon dioxide is also found near Estancia, Torrance County (Figure 2).

The continued steady growth of the petroleum industry in New Mexico, together with a rapidly growing population, should provide a stimulus for the establishment of a number of petrochemical industries in the near future. Interesting possibilities are the production of elemental sulfur from the sour gas of both the Permian and San Juan basins, production of hydrogen for ammonia synthesis, and the chlorination of hydrocarbons. [Since the preparation of this manuscript, two sulfur plants have been placed in operation; one in the San Juan basin is producing 30 tons of sulfur daily, and one in the Permian basin 12.5 tons. A third plant, under construction in the Permian basin, is scheduled to produce 100 tons a day.]

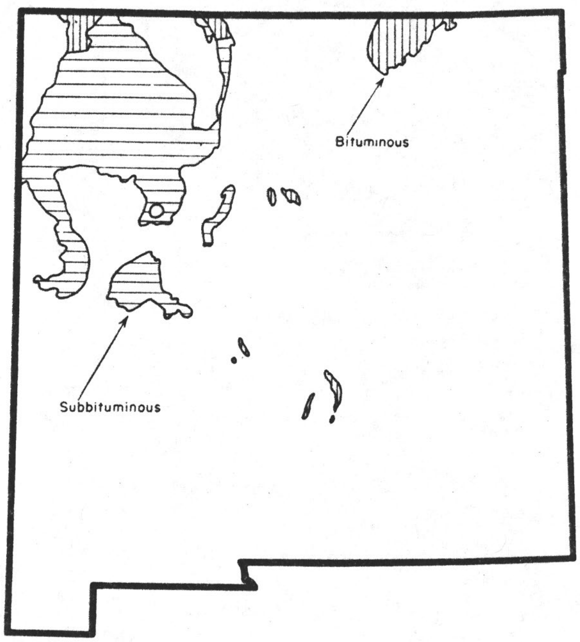

Figure 4. Distribution of Minable Reserves of Bituminous and Subbituminous Coal

Coal. Although constituting "the largest assured source of energy in New Mexico" (17), the coal deposits of the state have been exploited to a decreasing extent in the past two decades. Production for the fiscal year ending June 30, 1952, was 844,095 tons of coal of all grades (14). Total estimated reserves remaining in January 1948 were 61,515,761,538 tons (17), of which approximately 50% may be considered recoverable under present standards of mining. This total includes coals of subbituminous, bituminous, and anthracite ranks to depths of 3000 feet. Figure 4

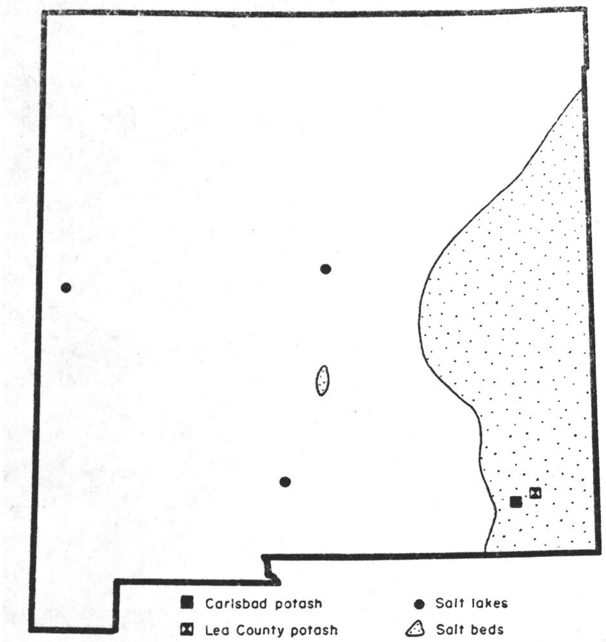

Figure 5. Deposits of Natural Saline Compounds

(17) shows the distribution of coal-bearing areas by rank, with the exception of anthracite, which occurs only in minor quantities in the Cerillos field. Bituminous coals in several fields are of excellent coking quality, the most extensive known deposits of which occur in the Raton field in the northeastern portion of the state.

NONMETALLIC MINERALS AND ROCKS

Nonmetallic minerals and rocks include the minerals and rock-forming mineral aggregates valuable chiefly for their contained nonmetallic elements or compounds, as well as construction materials, which, although not primarily of interest as chemical raw materials, may be important in the construction of the plant, or serve as physical media in some processes used by the chemical industry.

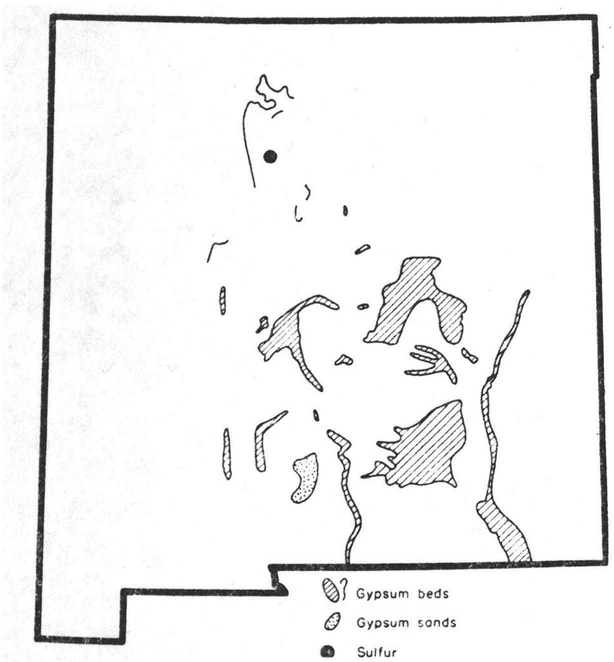

Figure 6. Deposits of Gypsum and Sulfur

Saline Compounds. Natural salts of potassium, sodium, and magnesium occur in commercial quantities in several areas, as shown in Figure 5. The potash-bearing beds of the Carlsbad basin are of particular interest (19), inasmuch as they supply 90 to 95% of the annual domestic potash production. Production from the four plants in operation in the fiscal year ending June 30, 1952, totaled 7,017,814 tons (14), averaging about 21% K20. Production from the five plants now operating *is* expected to approximate 1,660,000 tons K_20 equivalent for the calendar year 1953 (5). At current rates of mining, a productive life of at least 65 years is predicted for the known published recoverable reserves of nearly 100,000,000 tons of K_20 (5). Active exploration, in this and outlying portions of the Carlsbad segment of the Permian salt basin, is rapidly expanding the known reserves. Recent press releases forecast the establishment of two more mines and refineries in a newly developed area in Lea County.

The principal potash salts, sylvite (KCI) and langbeinite (K2SO4 2MgSO4), are associated with halite (NaCI) in beds that lie 800 to 1500 feet below the surface in the producing area. Mining is by highly mechanized conventional underground methods that permit high productive capacities. The crude and refined products, designed largely for agricultural usage, include potassium chloride ranging from 50 to 63% K_20 (80 to 99.95% CI), manure salts of about 2.5% K_20 grade, potassium sulfate averaging 90 to 95% K_2SO_4, and a langbeinite concentrate with a minimum analysis of 96% K_2SO_4. $2MgS_{O4}$ *(5, 6).*

Waste brines containing magnesium chloride from one refinery will be processed for the production of hydrochloric acid and magnesia in a plant now under construction.

Owing to limited local market demands, a relatively small production of common salt (NaCI) originates in New Mexico, despite the availability of tremendous reserves of rock salt in the Permian salt basin (Figure 5). During the fiscal year 1952, 7551 tons of salt were marketed (14), the bulk of which was obtained as salvage from wastes of the potash refineries in the Carlsbad district. Salt crusts formed by solar evaporation of shallow lake brines in northwestern Catron County, and near Willard in Torrance County, have been sources of sporadic minor production since prehistoric times. Most of the salt produced in the state is used as a livestock food supplement.

Sodium and magnesium sulfates in the brines and natural pre-

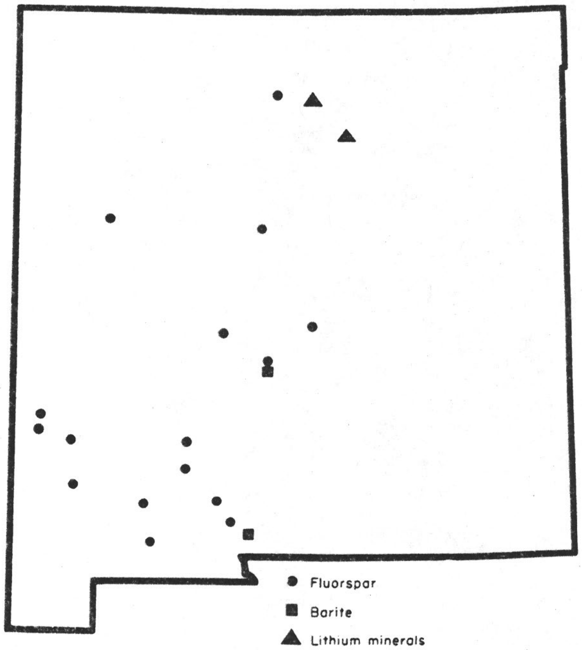

Figure 7. Deposits of Fluorspar, Barite, and Lithium Minerals

cipitates of salt lakes in Torrance and Doña Ana counties have not been commercially utilized, although some consideration has been giver. to their potential value (20).

Gypsum and Sulfur. Gypsum is widely distributed in the central and southern portions of the state (Figure 6, *20).* The material occurs in thick beds of rock gypsum of high purity at a number of places. Other occurrences include the noted White Sands area west of Alamogordo, in which gypsum is concentrated as dune sands, and several local deposits of gypsite. With increasing depth away from the outcrop, many of the gypsum beds grade into anhydrite, anhydrous calcium sulfate. Transportation costs to the larger consuming centers outside the state have restricted *the* production of gypsum and gypsum products. Current operations are limited to a single producer of ground agricultural gypsum near Los Lunas, Valencia County.

Recent shortages of elemental sulfur have stimulated research into economical methods for extra cting the element from gypsum and anhydrite. Anhydrite is preferred for its higher sulfur content. The perfection of such a process would place new importance on the extensive reserves of these minerals that exist in this area.

Occurrences of elemental sulfur are of limited extent. Low-grade deposits of native sulfur near Jemez Springs, Sandoval County, are reported to have yielded about 100 tons of refined sulfur (20). Sulfur has also been found in well cuttings near Artesia (20). The possibility of extracting sulfur from the sour gases of the San Juan and Permian basin areas has been mentioned above.

Fluorspar, Barite, Lithium Minerals. Some of the more important actual and potential producing districts are shown in Figure 7. Fluorspar *(18)* aggregated 19,426 tons of combined metallurgical and acid grade concentrates in the fiscal year 1952 (14), all of which was shipped to consumers outside the state. The 2400 tons (14) of ground barite concentrates produced during the same period represent only a fraction of the potential annual yield of the known deposits in this area. Production of the lithium-hearing silicates, lepidolite and spodumene, which amounted to 3025 and 1727 tons, respectively, in the fiscal year 1951, was sharply reduced to 1055 tons of spodumene in the fiscal year 1952 (14).

Limestone and Dolomite. Extensive unassessed reserves of these rocks crop out in narrow tracts in the mountain belts of thecentral and southwestern portion of the state, and over broad areas in the high plains to the east. Detailed chemical studies of these rocks have not been made, but they are known to range from pure nonmagnesian limestones, through dolomite, to argillaceous limestones suitable for cement rock.

ROCKY MOUNTAIN

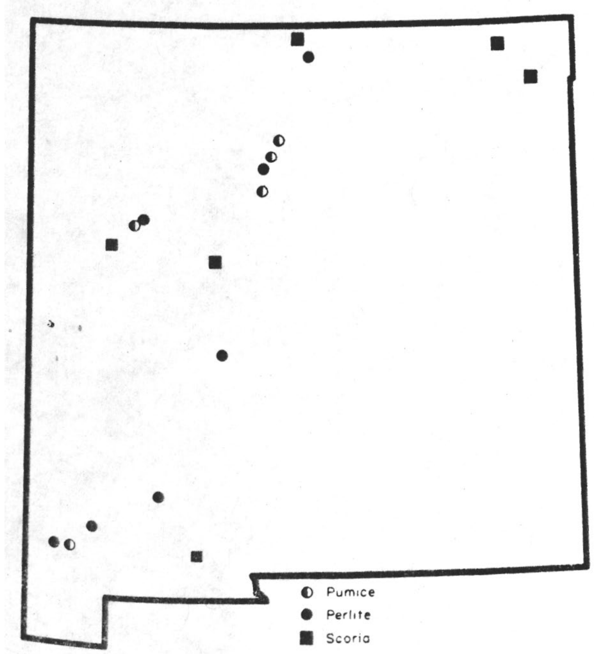

Figure 8. **Principal Deposits of Pumice, Perlite, and Scoria**

Clay. Among the variety of clays and clay shales known to occur in this region, only those suitable for brick and tile manufacture, and those of refractory type (fire clays), have seen sus-

tained commercial exploitation. Bentonite, found at a number of localities in the western half of the state, has been used in drilling muds and as an adsorbent. High-alumina low-silica clays, including those of kaolin type, appear to have a limited occurrence.

Pumice, Perlite, Scoria. New Mexico ranks first in the production of both perlite and pumice in the 'United States. Several of the more important sources of these materials, together with scoria, are indicated on Figure 8 (4). Although primarily of interest as lightweight aggregates in concrete and plaster, many new uses are being developed that will extend the scope of their utility. The 274,121 tons of pumice produced in fiscal year 1952 *(14)* was about half that produced in the previous year. Most of this total was used in the manufacture of lightweight concrete building blocks; a smaller fraction consisted of abrasive grade material. Crude perlite production has shown continued expansion to the fiscal year 1952 total of 69,345 tons (14). Most of the perlite is shipped as a crushed and sized aggregate to expanding plants located near the consuming centers, although an increasing amount is being expanded in the state. Expanded perlite offers several advantages as an inert carrier, extender, or filler in a number of industrial products. Scoria production in fiscal year 1952 was 217,300 tons (14). Principal uses are as railroad ballast and lightweight concrete aggregate.

METALLIC ORES

Copper, Zinc, Lead. Ores of these elements are prominent in many of the metalliferous districts, a few of which are shown in Figure 9. The bulk of the current production comes, however, from a concentrated cluster of deposits in the Silver City area. During the fiscal year 1952 (14), 73,954 tons of copper, 50,629 tons of zinc, and 13,205 tons of lead were produced. Most of the ores contain the metals as sulfide compounds which are mechanically concentrated before smelting to the elemental metals. A smelter at Hurley produces fire-refined copper, whereas all zinc and lead ores and concentrates are smelted and refined outside the state.

Iron, Manganese, Molybdenum, Tungsten. Figure 10 illustrates the more important districts containing deposits of iron and the ferroalloy metals. Iron occurs as the oxides hematite and magnetite in a number of deposits (11), but production is usually small and irregular, totaling but 1472 tons in the fiscal year 1952 (14). The production of manganiferous iron ores during the same period was 48,000 tons. Manganese production during the fiscal year 1952 was 3352 tons—a twofold increase over the previous year. Reactivation of still other operations should further increase the production of manganese ores and concentrates within the next few years. Molybdenum sulfide concentrates containing 701 tons of molybdenum were produced during the fiscal year 1952 (14). Although there was no recorded production of tungsten ores during this period, active exploration was under way at several properties, and some sorted ore was stockpiled.

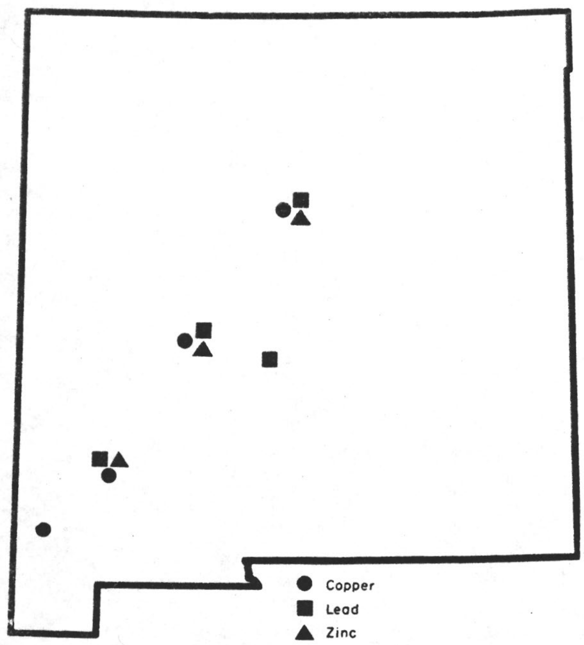

Figure 9. Principal Copper, Zinc, and Lead Districts

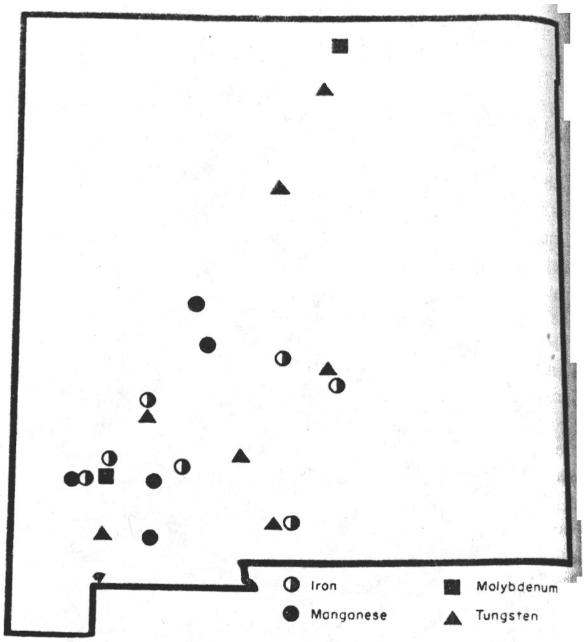

Figure 10. Iron, Manganese, Molybdenum, and Tungsten Deposits

Uranium, Vanadium, Tantalum, Beryllium, Rare Earths. Figure 11 illustrates some of the principal occurrences of these rare elements. Uranium-vanadium deposits in the recently discovered Grants district *(21)* are being rapidly developed for production. The production reported for the fiscal year 1952 consisted of 2202 tons of vanadium *(14)* from deposits in San Juan County. Although no tantalum was produced during this period, microlite and tantalite-columbite concentrates from the Harding mine, Taos County, supplied the bulk of the domestic tantalum production during World War II (9). Beryllium production from the same mine totaled 140 tons of beryl in the fiscal year 1952 (14). Deposits of the beryllium minerals helvite and danalite, in northwestern Sierra County, have not been commercially exploited. Monazite, tantalite-columbite, and beryl have been ob

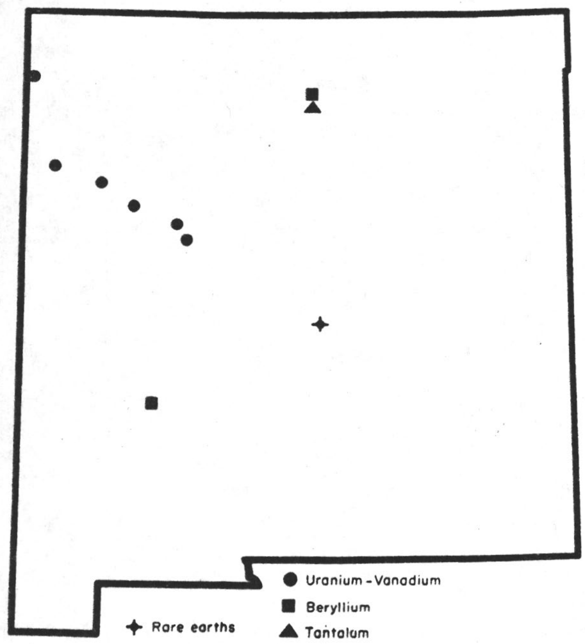

Figure 11. Uranium-Vanadium, Tantalum, Beryllium, and Rare Earth Deposits

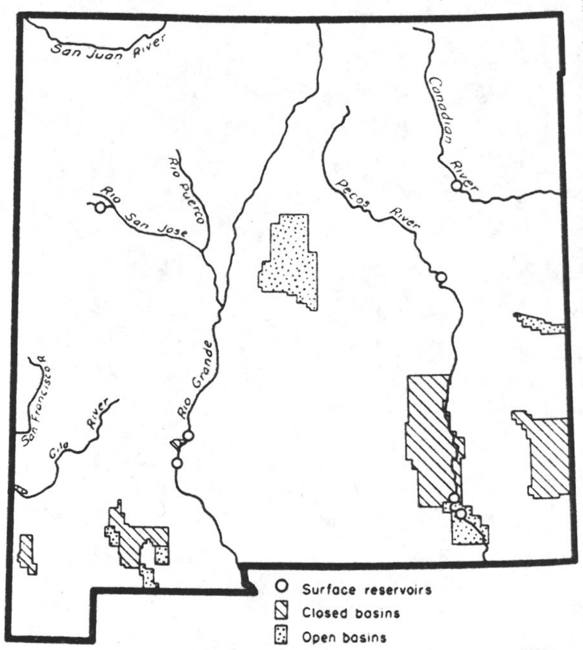

Figure 12. Surface Water and Declared Ground Water Basins

tained in small lots as by-products from mica operations in pegmatite districts of the northern portion of the state (10). Small shipments of ores containing the rare earth mineral bast- naesite have been made from the Red Cloud mine in Lino County.

WATER SUPPLY

The local availability of an adequate water supply will be of the principal factors influencing the location of chemical plan in New Mexico. Figure 12 *(2)* shows the principal streams and reservoirs, and the declared ground water basins. Stream flow largely intermittent in character, peak runoff occurring during the spring thaw of snow packs in the higher elevations, and f short periods following the heavier summer rain storms in *July,* August, and September. The existing reservoirs were developed for irrigation and municipal supply purposes, with essentially no provision for industrial usage. The surface waters of the state at large are allotted on the basis of prior appropriation, hence are available to industry only through purchase of the existing rights. Ground Water supplies are influenced by a wide range of geologic and hydrologic variables that lead to opposite extremes of availability in closely adjacent areas. The more extensive tracts of high capacity wells are those in which Permian limestones or Tertiary to Quaternary valley fill serve as aquifers. Exploitation of ground waters within the declared basins is subject to controls imposed by the State Engineer *(2) to* provide the maximum continued economic yield from the more highly developed ground water reservoirs. Certain of the declared basins are open to the **filing** of applications to appropriate the ground waters therein, whereas others are closed (2).

ACKNOWLEDGMENT

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