STATE SCHOOL OF MINES
MINERAL RESOURCES SURVEY
OF
NEW MEXICO

FAYETTE A. JONES, DIRECTOR

BULLETIN 1

THE MINERAL RESOURCES OF NEW MEXICO

BY

FAYETTE A. JONES

1915

SOCORRO, NEW MEXICO

ALBRIGHT & ANDERSON, PRINTERS-BINDERS,
ALBUQUERQUE

Published by Authority of the Board of Regents of the New Mexico State School of Mines

LETTER OF TRANSMITTAL

To His Excellency:

WILLIAM C. MCDONALD, Governor,

Santa Fe, New Mexico.

DEAR SIR:

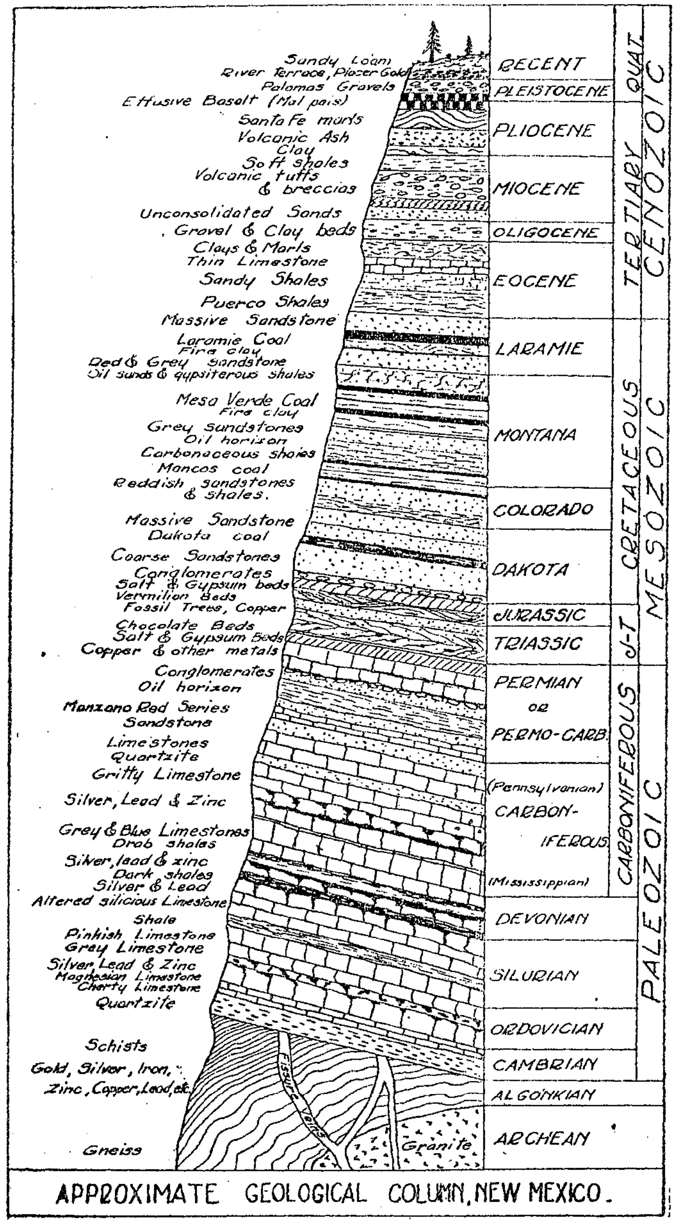
On behalf of the Board of Regents of the New Mexico State School of Mines, I have the honor in submitting to you and the people of the State Bulletin No. 1, of the Mineral Resources Survey, entitled "The Mineral Resources of New Mexico," which I trust may prove of some value to the public in acquiring a more extended knowledge of the varied mineral resources of the commonwealth.

With greatest esteem, I beg to remain,

Yours very truly,

FAYETTE A. JONES,
President, State School of Mines.

Socorro, New Mexico, March 27, 1915.



GEOLOGICAL COLUMN OF NEW MEXICO

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PREFACE

The appearance of this Bulletin is the first of the kind dealing with the mineral resources of New Mexico, published under the direction and authority of the State School of Mines. It is the intention to issue a series of similar Bulletins coming through the School of Mines Mineral Resources Survey. The demand for such literature is very great and rapidly increasing from year to year. In course of time these Bulletins will cover the field and laboratory investigations in every portion of the State. Probable artesian basins will also be examined and the feasibility of reclaiming the same by irrigation reported upon. New Mexico affords an almost unlimited field for reconnaissance and research work along the lines indicated.

It is just beginning to dawn upon the people that the mineral wealth of New Mexico is the State's greatest asset. The mineral production during the present year, 1915, will approximate $20,000,000. Mining is thus seen to be, by far, the largest single industry in the commonwealth. It rivals the combined industries of cattle, sheep, agriculture and horticulture. The mines of New Mexico employ more labor than that employed by any other single industry, excepting farming.

The present Bulletin is virtually a reprint or rather a revised edition of a former publication made in 1908, by the writer, under the authority of the New Mexico Bureau of Immigration. So great was the demand for the first booklet, the first two thousand copies were exhausted in less than six weeks. A second two thousand copies were ordered printed by the Bureau of Immigration before the type forms were thrown in, to meet the demand for literature about the mineral resources of the State.

THE AUTHOR.

Socorro, New Mexico, March 23, 1915.

HISTORICAL

In presenting this epitome of the Mineral Resources of New Mexico, it is to be hoped that what is herein offered may be conducive to a more intelligent understanding and appreciation of the dormant mineralogical resources of a commonwealth of which, comparatively speaking, but little is known. The value of the metallic output of the State in 1914, as estimated by the U. S. Geological Survey, was $12,070,000l; an increase over that of 1913 of $376,000. The non-metallic products were valued at $7,000,000 during 1914. The entire mineral production for the year 1914 aggregated an excess of $19,000,000, making the mining industry supreme in the State.

Historically, New Mexico is the oldest and most widely known of any section in the United States commercially; its importance is yet but meagerly comprehended.

Although New Mexico is the cradle of the mining industry in the Rocky Mountains and Pacific Slope regions, peculiar political conditions have materially retarded its development. The fact, however, should not be overlooked that the initial impulse received in the development of the Great West was due to the discovery of gold in Santa Fe County at the base of the Ortiz Mountains, in the year 1828. This discovery was made twenty years before the great gold excitement at Coloma in California and thirty years before the find on Cherry Creek in Colorado.

The discovery of placer gold in New Mexico marks the beginning of modern American methods that have so effectually revolutionized every phase in the art of mining and in the science of metallurgy.

The evolution of the old wooden bowl, known as the *"batea,"* used in these early diggings, is symbolized in the modern gold pan. Crude designs of the first "rockers" and sluice boxes for washing the auriferous gravels in trans-Mississippi fields, virtually had their inception in this primary gold camp, in Santa Fe County.

Among the first stamp mills constructed in the United States may be mentioned the one at Dolores for milling the ores from the celebrated Ortiz mine in Santa Fe County; one at the gold camp of Pinos Altos in Grant County; and one at the Aztec mine at the head of Ute Creek on Baldy Mountain, in Colfax County.

The first experiments in ore concentration in the west were conducted by J. Amberg, a German metallurgist at Pinos Altos, in the early sixties of the past century.

It should also be noted that the first gold lode or vein discovered and worked west of the Mississippi was made in the year 1833, on the famous *Sierra del Oro*, constituting what is now known as the Ortiz mine.

In the Los Cerrillos district, a few miles west of the Ortiz Mountains, exist what appear to be prehistoric workings on a metalliferous vein of lead and silver, known as *Mina del Tierra*. This antique working is of unusual interest with incline and nearly vertical shafts connecting and totalling, perhaps, over two hundred feet of work, including drifts and stopes. Since these ancient workings penetrate the water level and have been flooded ever since the mine was originally abandoned, the full extent of underground development is not known. As late as the year 1870 the remnants of an old canoe were still in evidence in the mine. This curious water craft was doubtless used in transporting ore and waste to the foot of the incline shaft, from whence these products were carried to the surface on the backs of Indian slaves in rawhide buckets; it is thus seen that the canoe served the purpose of a wheelbarrow or tram.

Not a great distance from the *Mina del Tierra* are the prehistoric turquoise workings at *Mount Chalchihuitl.* The mining of turquoise antedates all other kinds of mining in the Southwest. Prehistoric workings are found in all localities of New Mexico where turquoise is known to exist. The associated stone hammers, coiled and finger nail pottery found in the old dumps and working pits, fully corroborate the antiquity of turquoise mining in New Mexico.

Turquoise was used by the aboriginal tribes, not only for ornaments, but it afforded a medium of exchange; doubtless, the gem-stone was their money and basis of values.

In connection with what has already been said concerning early mining and metallurgical operations in the West, these preliminary remarks would not be complete without some mention of the copper mines at Santa Rita in Grant County. These celebrated copper mines were the first of their kind operated west of the Mississippi; they were opened in 1804. Lieutenant Pike in 1807, during his expedition to the Territory, in speaking of mining, says: "There are no mines known in the province, except one of copper, situated in a mountain on the west side of the *Rio del Norte,* in latitude 34 degrees. It is worked and produces 20,000 mule loads of copper annually. It contains gold, but not quite sufficient to pay for its extraction." The latitude of 34 degrees is a fraction greater than a degree too far north for the Santa

Rita deposits, but the error is not a serious one, since Lieutenant Pike must have estimated the latitude, as he never visited the mines. This copper was at that time carried on the backs of burros to the City of Mexico, a distance of 1,350 miles, and from there sent to Spain, where the major portion was coined at the Royal Mint. The remains of some of the old smelters may yet be seen standing by the railroad track at Fierro, still in a fairly good state of preservation.

From the foregoing it is obvious that New Mexico is the vanguard in the exploitation of the mineral resources of the West, as relating to manners and methods primarily practiced in both mining and metallurgy.

GENERAL GEOLOGY

PHYSIOGRAPHIO FEATURES

The whole of New Mexico may be regarded as a vast plateau region, averaging 5,000 feet in elevation, and dissected by numerous streams, forming narrow valleys and deep gorges. Geologically, the streams are yet in their youth.

The southwest portion of the State is characterized by stretches of Quaternary plains, embracing the desert ranges of mountains common to central Arizona and the Basin region of Nevada and southern California. The great plains of central and eastern New Mexico are, also, Quaternary. Most of the mountain ranges parallel each other in a north-south direction and the Continental Divide zig-zags across the western and southwestern part of the State. The drainage is to the south and west.

ROCK FORMATIONS

Practically the complete geological column is represented in New Mexico, extending from the pre-Cambrian complex to the most recent sedimentary deposits. Varying types of metamorphic, sedimentary and igneous rocks, comprising the three fundamental classifications, are abundantly represented.

METAMORPHIC OR PRE-CAMBRIAN ROCKS

The basal crystalline rocks found in all the principal mountain ranges in the north-central part of the State are unquestionably pre-Cambrian. Rocks of the pre-Cambrian complex constitute the core of the various ranges bordering on either side of the Rio Grande Albuquerque to El Paso; such rocks also comprise the core of the Sierra Blanca, Mogollon, Datil, Mimbres and Black Range. Passing to the desert ranges pre-Cambrian rocks, in the Floridas, Tres Hermanas, Granite Gap and Burro Mountains constitute the basal complex.

These types of rocks are readily recognizable and consist of gray and red gneisses, quartz-sericite-schists, pegmatite dikes, etc. The gneisses represent sheared granites and the schists result from extreme foliation of the gneisses and other rock aggregations.

SEDIMENTARY ROCKS

Sedimentation, as implied here, is due to the cumulative process of deposition through the action of water.

The thick beds of sediment laid down on the pre-Cambrian sea floor have been deposited by the slow cumulative process of untold ages, and built up as it were the geological column of the terrene.

Until recently it was thought that the Ordovician, Silurian and Devonian strata were lacking, but now these supposed gaps have been filled in by discoveries made in the central and southwestern part of the State.

In the northern part of New Mexico, it is found that the Carboniferous rocks rest unconformably on the pre-Cambrian complex.

IGNEOUS ROCKS

Aside from the primodial granite, it is observed that post-Paleozoic rocks of igneous character are abundant throughout the mountainous regions. Post-Paleozoic igneous rocks may with propriety be divided into two separate groups—intrusives and effusives. The intrusives embrace the porphyries, which are readily distinguished by their dark to light-gray and pinkish tint containing white phenocrysts of feldspar. Porphyries have a wide range of variation and necessitate an extensive nomenclature to specify them. They pass gradually from one to another, due to a variation in their composition, as from granite-porphyry through syenite-porphyry, quartz-monzonite-porphyry, monzonite-porphyry, to diorite-porphyry.

Certain porphyritic intrusives or dikes have an intimate relation with ore deposits; especially those of Tertiary age.

The effusive or flow-rocks are recognized by their extensive surface distribution, covering the older rocks frequently to profound depths. These flow-rocks found in various parts of New Mexico comprise rhyolites, andesites, dacites and basalts. The most recent of these lavas is basalt or what is locally termed *mal pais*; it belongs to the Tertiary and in many instances appear to have reached into the late Pleistocene. Many thousands of square miles of the surface of New Mexico are covered with this comparatively recent lava, especially in the north central portion.

ORE DEPOSITS

Concerning the mineral deposits of New Mexico and elsewhere, it is important to be able to recognize and differentiate the ore-bearing formations and rocks from those destitute of economic minerals.

The uneducated prospector has now begun to realize the important relation existing between certain kinds of minerals and their associated formations. Possessed of such knowledge, he is thus able to prosecute his work and apply his energy in fields especially favorable to success.

In prospecting for gold one should seek a region with abundance of porphyry and quartzy, iron-stained dikes; limestone formations, as a rule, should be avoided. Fissure veins appear the most promising.

Copper ores in many instances are found along limestone and porphyry contacts, and disseminated as sulphides through porphyritic masses of large extent. Certain strata of the Jura-Triassic and Permo-Carboniferous rocks in New Mexico carry impregnations of copper carbonate; on the whole these sandstones and thin bedded limestones will not average over two per cent copper. The "red beds" formation is also an important gypsum, salt and possible oil horizon.

The principal iron deposits of New Mexico are all intimately associated with monzonite-porphyry in juxtaposition with Carboniferous limestone. The denuded monzonite rock, with few exceptions, was primarily a laccolith.

Turquoise is found in localities similar to those in which iron abounds, with the additional presence of copper, but with or without the presence of limestone.

Certain strata of the Carboniferous rocks of the State are ore carriers, principally of lead, silver and zinc, as at Magdalena and Lake valley; such strata serve as important guide horizons to the intelligent prospector.

Silurian limestone at Chloride Flat, near Silver City, carries silver and lead, as also does the Ordovician or Devonian limestones at Granite Gap, Cooks Peak, Kingston and some other camps.

The Upper Cretaceous rocks are the chief fuel horizons in the West; the Laramie and Upper Montana coal measures are extremely important.

With the exception of the syngenetic deposits of gold placers and the Triassic copper as alluded to above, the greater portion of the ore bodies belong to the epigenetic class; that is, the metals were introduced subsequent to the formation of the encasing rock system.

AGE OF ORE DEPOSITS

It is observed by noted investigators that the greater portion, if not all, of the metalliferous deposits that are now being worked in New Mexico, are comparatively young in age and may be placed as post-Cretaceous. To support this supposition it appears that most of these deposits are closely allied and genetically related to igneous phenomena of Tertiary, and even later, times. In fact, there are some instances observed by the writer of southwestern ore deposits, indicating that the agencies of mineral segregation and deposition are operative at the present time.

Aside from the post-Cretaceous deposits there are others that would be classed as pre-Cambrian these ores on the whole are rather pockety and their average value quite low.

DISTRIBUTION OF MINERALS

GOLD

In this brief dissertation of the more important minerals of New Mexico, it would seem proper to begin with gold, since it has ever excited the attention and cupidity of mankind from the dawn of history to the present time.

The first discovery of gold west of the Mississippi River was made in Santa Fe County at the base of the Ortiz Mountains, in the year 1828. This discovery is known as the Old Placers; the New Placers were made eleven years later, in 1839, a few miles to the south of the Old Placers, in the San Pedro (Tuerto) Mountains. The first symptoms of "gold fever" in the Rocky Mountains and Pacific Slope regions were diagnosed in this primitive New Mexican camp.

The geographical distribution of gold seems to cover a wider range than any of the commercially valuable metals; it occurs in rocks of all ages and kinds, and is present in minute quantities in sea water and in the soil. Notwithstanding its universality, it is never found in any very great masses or bulky accumulations.

The primary source of gold is from the Plutonic rocks, segregating by dynamical, chemical and other complex agencies, in veins, dikes, and along zones of contact. Placers are secondary deposits, derived from the primary segregations through the effects of disintegration and erosion, re-deposited by the sorting power of wind and water in obedience to the law of gravitation.

It is practically proven in the research work of the U. S. Geological Survey, and the truth further substantiated by independent investigators, that the chief ore production of the Cordilleran regions of the western Continent is almost wholly post-Cretaceous in age. Whilst the pre-Cambrian rocks of New Mexico carry mineral, the grade, as a rule, is quite low. The chief minerals of these old metamorphic rocks are pyrite, chalcopyrite and sphalerite; also, gold and silver—averaging less than four dollars per ton in these two latter metals. Many of the rare metals are associated with these older rocks.

Mining in the pre-Cambrian rocks is carried on mainly in the central north-half of the State. The chief pre-Cambrian material bearing types of rock are amphibolitic or chloritic schist and, also, rock of a pegmatic and granitoid character.

The gold and copper prospects located in the great schist formation on the south side of Tijeras Canyon in the Sandia Mountains east of Albuquerque, are in pre-Cambrian rocks. The Hamilton mine, on the Pecos in northwestern San Miguel County; also, numerous prospects in the Santa Fe Range; the Frazer copper mine at Twining in Taos County; and mines in the Bromide and Hopewell districts in Rio Arriba County, belong to the pre-Cambrian rock-system. .

It is observed by those familiar with the ore production of New Mexico, that the chief producing mines lie in the southwest and south-central parts of the State, with but few exceptions; and that the ores are genetically related to an entirely different and very much younger vein-system. The ores from this younger vein-system are post-Cretaceous or Tertiary in age, and perhaps extend into the late Pleistocene.

GOLD LODE MINING DISTRICTS

The principal gold districts of New Mexico where gold lode milling is or has been carried on, are given in the following, by counties,

COUNTY.	DISTRICT.
Bernalillo	Coyote Canyon Hell Canyon
Colfax	Elizabethtown Red River
Doña Ana	Organ Mountains
Grant	Central Gold Hill Lordsburg Pinos Altos Sylvanite
Lincoln	Vera Cruz White Oaks Nogal Jicarilla
Otero	Jarilla Mountains
Rio Arriba	Hopewell
Sandoval	Cochiti
Santa Fe	New and Old Placers
Sierra	Hillsboro
Socorro	Cat Mountain Mogollon Mtns. Rosedale
Taos	Rio Hondo

PLACER MINING DISTRICTS

The chief placer mining districts, by counties, are given in the following

COUNTY.	DISTRICT.
Colfax	Elizabethtown Ute Creek Willow Creek
Grant	Sylvanite Malone Pinos Altos
Lincoln	Jicarilla Nogal White Oaks
Otero	Jarilla
Rio Arriba	Hopewell Rio Chama
Santa Fe	Galisteo Old Placers New Placers
Sierra	Hillsboro Pittsburg
Taos	Red River Rio Grande Rio Hondo

The value of all the gold produced in the United States from the year 1792 to January 1, 1915, according to estimates given by the U. S. Geological Survey, is approximately $3,643,000,000. The value of the world's output since the discovery of America to January 1, 1915, in round numbers, is placed at $15,186,000,000.

The production of gold in New Mexico for the year 1914 is estimated by the Mint and U. S. Geological Survey at $1,172,000. This is a gain in the gold production of the State over the preceding year of $290,000. The entire production of gold in the State since the modern discovery in 1828 in southern Santa Fe County will approximate $33,500,000.

The most usual occurrence of lode gold in New Mexico is in association with quartzy gangue material which frequently carries various metallic oxides and sulphides; these latter metallic compounds depend on the character and depth of the deposit and the encasing country rock.

The gold placers have uniformly resulted from the erosive effects of wind, weathering and water and the gold is found in the late Tertiary, Quaternary and more recent gravel beds in streams and gulches below the source.

Until recent years New Mexico was essentially a placer producing province; fully three-fourths of its entire production was attributable to that source. This latter condition is now reversed, due to the rapid growth in lode mining. During the past few years increased activity in prospecting and metal mining was noted in most every part of the State. The rich gold strike made during the summer of 1914 at Pinos Altos, on the Skillicorn lode, caused considerable excitement and gold mining in that celebrated old camp is once more on the ascendency. Some specimens of this late strike were recently placed on exhibition at the San Diego Exposition in the New Mexico building and are attracting considerable attention.

SILVER

The first authentic account of the modern discovery of silver in New Mexico, was through Pete Kinsinger in 1863, when he found rich silver float while a soldier under Gen. J. H. Carleton stationed at Pueblo Springs, near Magdalena in Socorro County. No important bodies of silver ore were ever uncovered at this point the discoveries were all confined to small veins and seams. The old Ace of Spades mine is where the discovery was made.

This early find of. the white metal had its influence, when three years later but a few miles away, rich carbonate ores of lead and silver were found in the Magdalena Mountains.

In 1867, a year after the discoveries at Magdalena, silver was found in Socorro Mountain.

The phenomenally rich silver discoveries made at Chloride Flat at Silver City, in 1871, followed by the great excitements at Georgetown, Cooks Peak, Lake Valley, Kingston and points further north in the Black Range, resulted in a tidal wave of mining activity which swept the then southwest territories.

Since silver, to a great measure, is genetically related with the occurrence of both gold and lead, much of that which has been said about gold and its geological relations to certain rock formations applies to silver; as, also, what may, along this line, be hereinafter said about lead. The silver ores seem to occupy an intermediate relationship to those of gold and lead.

Under the caption of gold it has been pointed out that the pre-Cambrian rocks, as a rule, are impoverished in values of the previous metals this phase of the subject will receive no further attention.

The principal silver ores of New Mexico seem to be more intimately associated with lead deposits than with those of gold. Since most of the great lead deposits of the State are found to be closely related to the phenomena of intrusive porphyry dikes into limestone, we now naturally look with favor on such conditions when prospecting for silver and lead ores.

It is also true that some very rich silver ore has been taken from more or less irregular types of fissure veins in the effusive andesite lavas, as at the Last Chance mine at Pyramid Peak south of Lordsburg, the Beck and Volcano Mines northwest of Steins Pass, Steeple Rock and elsewhere in Grant County; on the whole, the production of silver from this class of mines, though considerable, is quite insignificant, when compared to the output coming from deposits affiliated with intrusive porphyritic masses injected while hot into thick beds of limestone.

The limestone formations in which valuable deposits of silver-lead and lead-silver ores occur, seem to comprise the Carboniferous, Devonian, Silurian and Ordovician.

At Granite Gap, in southwestern Grant County, the lead-silver ores are contained in cavities in the Ordovician (?) limestone. This seems to be the case at Cooks Peak.

The silver-lead ores at Chloride Flat, Georgetown and Lone Mountain, lie in Silurian limestone, immediately below Devonian shale.

The silver deposits at Kingston and Hermosa likely occur in Devonian limestone, though this is not quite certain.

At Lake Valley the ore bodies occupy a position at the base of the Lower Carboniferous (Mississippian) limestone, immediately above the Devonian series. The Magdalena lead-silver-zinc deposits are, also, Carboniferous.

The above references are cited to some of the more important silver producers, showing the wide strati-graphical range of the ore horizons in the limestone of the State.

The principal producing silver districts, by c® ties, of New Mexico silver mines, are here given:

COUNTY.	DISTRICT.
Dona Ana	Hembrillo
	Organ Mtns.
Grant	Apache
	Camp Fleming
	Central
	Chloride Flat Eureka
	Georgetown
	Kimball
	Lone Mountain
	Pinos Altos Pyramid
	San Simon Steeple
	Rock Telegraph
Luna	Cooks Peak
	Florida
	Victorio
	Tres Hermanas
Rio Arriba	Bromide
Sandoval	Cochiti
Santa Fe	Cerrillos
Sierra	Bromide
	Hermosa
	Kingston
	Lake Valley
Socorro	Magdalena.
	Mogollon
	Socorro Mtn. (Encarnacion)

Aside from the principal silver camps as just enumerated, there are many other localities that may in time become important.

New Mexico has produced in silver values, as near as can be determined, $32,700,000 up to the present time. The silver production for 1914, amounts to 1,720,000 fine ounces, as estimated by the U. S. Geological Survey.

From general mining appearances the present output of silver will likely be gradually increased for a number of years to come.

COPPER

The geographical distribution of copper compounds in New Mexico covers a wider range of territory, excepting that of gold, than any one of the other commercially valuable base ores. Copper not only occurs in the pre-Cambrian schists and later Tertiary rocks, but it is found in the intermediate series, which comprise the Permo-Carboniferous and Jura-Trias formations.

As previously noted under the caption of Gold, the pre-Cambrian deposits do not appear so important from a commercial point of view as those formed at a subsequent period. It should not be construed that none of the pre-Cambrian copper deposits are devoid of merit; such, however, is not the case. The writer is acquainted with several cupriferous deposits in pre-Cambrian schists that have much in their favor, and will doubtless be profitably worked in the near future.

Besides the post-Cretaceous or later copper deposits, there is a class of bedded deposits occurring in the "red beds" formation which deserve mention, on account of their wide geographical distribution. These sedimentary cupriferous beds have been prospected in various localities where they exist, and many attempts at mining and milling the ores have been made meeting with doubtful success.

The most important of these deposits lie in the Nacimiento district, Sandoval County; near Abiquiu, Rio Arriba County; in the Black Mesa district, Union County; at Tecolote, near Las Vegas; and along the base of the San Andreas, Sierra Oscura, Manzano, and Sandia Ranges. Points where exploitation of these cupriferous beds have been carried on greater than elsewhere, are at Estey and Hansonburg in the Sierra Oscura; northeast of the Sandias, between the northern end of that range and South Mountain; at Tecolote, near Las Vegas; and at Señorita in Sandoval County. Reduction works were formerly erected at Señorita, at Tecolote and at Estey, but were not a commercial success.

It is the opinion of the writer, that it is only a question of time, coupled by metallurgical skill, until these deposits will be worked at a profit; their importance cannot be overlooked or underestimated in this day of rapid development.

The bulk of the ore in these interesting bedded deposits exists as a carbonate; although, some very high grade glance and other forms of copper ores are quite common. The copper has in many instances replaced organic substances, preserving in the minutest detail the texture of the plant. These freaks in metasomatism, most usually, have produced very high grade chalcocite. Opinion seems much divided as to the genesis of the deposits.

The post-Cretaceous ores of copper are those that contribute the greater portion of the output of the State.

'These deposits occur in veins and contact fissures in limestone cavities that have become filled with mineral matter due to the influence of igneous dikes; and in porphyritic masses where the metallic compound is disseminated through the rock constituent, principally as a sulphide.

In the smaller veins and fissures of copper ores, there are usually other kinds of mineral aggregations associated with the deposit; such as minerals of lead, silver, zinc, manganese and iron, with varying quantities of gold.

In the larger porphyritic deposits as at Santa Rita and Burro Mountains, the ores carry practically no values, other than copper. These latter ores, especially those of the Burro Mountains, are on the whole quite low grade not exceeding three per cent copper. At Santa Rita the grade of ore is somewhat better than that of the Burro Mountains. Much native copper is mined at Santa Rita.

The Lordsburg copper ores carry silver at the south end of the district; nearer town, values in both gold and silver are present.

Some exceedingly high grade chalcopyrite, bornite and chalcocite ores are encountered in the Cooney mine in the Mogollons; this character of ore carries good values in both gold and silver.

The region between Steins and Granite Gap in southwestern Grant County is extremely favorable for large copper deposits; it is practically undeveloped.

At Pinos Altos much of the copper ores contain both zinc and lead. There are valuable contact deposits of copper at the Organ camp, northeast of Las Cruces; these particular properties have been lying idle the greater part of the time for a number of years, caused by litigation and lack of capital.

In southern Santa Fe County at San Pedro, large quantities of low grade garnetiferous copper ores exist in the limestone. Operations at the smelter and mines have been intermittently conducted for the past fifteen years, due to the fluctuating price of copper. This smelting plant has been closed down for the past two years, but will resume again very shortly. The price of copper is beginning to advance quite rapidly through the demand made by the war in Europe.

In the Caballo Mountains, the Black Range, Red River, Baldy Mountain, in the Jarillas and in the Organ Mountains much prospecting and work have been done of late, having an especial bearing on the development of copper mining in the state.

At present most of the copper from New Mexico is mined in Grant County. The operations of the Chino Copper Company at Santa Rita are conducted on a stupendous scale and the production of copper in the State has materially increased since that company took over the mines of the *Santa Rita del Cobre* grant. The Chino Company mills nearly 6,000 tons of ore a day and the estimated production of copper for this one mine during 1914 being 54,822,000 pounds.

The history of copper mining in New Mexico is always extremely interesting, since the mines at Santa Rita are the oldest west of the Mississippi. These famous mines were discovered by an Apache Indian about the year 1798, and were first opened in 1804, and have been producing almost continuously to the present time. A brief sketch of the early history of the Santa Rita mines by the writer may be had in "New Mexico Mines and Minerals," 1904, Chapter VI.

The mines of the Burro Mountain Copper Company will be a close second to the operations of the Chino just as soon as the new ore treating plant, now in course of erection, is completed. Like the Santa Rita mines, the Burro Mountains' ore is a low grade porphyry copper proposition. Grant County is now producing most of the copper mined in. the State.

At the present writing the demand for copper is in-creasing at a very rapid rate, due to the effect of the war in Europe. The price is now quoted for electrolytic at from 15 cents to 15.25 cents a pound. The extraordinary conditions now confronting the European nations is certain to create an unprecedented demand for most all metals. The United States will be expected to supply the deficiency.

The principal districts of copper, by counties, are given in the following :

COUNTY.	DISTRICT.
Bernalillo	Hell Canyon
	Placitas
	Sandia
Colfax	Baldy Mtn.
	Cimarroncito
Dona Ana	Hembrillo
	Organ
Grant	Anderson
	Apache
	Burro Mts.
	Central
	Eureka (Hachita)
	Pinos Altos
	pyramid San
	Simon Steeple
	Rock
	Santa Rita
	Virginia
	White Signal

COUNTY.	DISTRICT.
Lincoln	Estey Sierra Blanca
Luna	Florida Tres Hermanas
Otero	Bent Jarilla Mts.
Rio Arriba	Bromide Headstone
Sandoval	Nacimiento
San Miguel	Hamilton Rociada Tecolote
Santa Fe	Cerrillos San Pedro
Sierra	Black Range Caballo Mts. Hillsboro
Socorro	Hansonburg Magdalena Mogollon Mts. Oscura San Andreas San Lorenzo Water Canyon
Valencia	Manzano Zuni Mountains
Taos	Copper Hill Red River Twining
Union	Black Mesa

Besides the above copper districts, the Guadalupe Mountains in southeastern New Mexico have a number of good copper showings.

LEAD

Briefly, what has been said concerning the genetical occurrence of the silver deposits of New Mexico and their relation to the surrounding rocks, will apply in a general sense to the lead and zinc ores of the State.

Aside from the mineralization found in the older metamorphic rocks, it is only the later Tertiary deposits of lead that seem to command much importance. It should be understood, however, that in some instances paying lead mines may eventually be developed in the pre-Cambrian rocks of the State.

New Mexico produced 1,340,000 pounds of lead in 1914, against 3,940,000 pounds the year previous, according to statistics gathered by the U. S. Geological Survey. The large decrease in the 1914 production was mainly due to the extremely low price of the metal. Most of the limestone lead deposits carry values in silver, with but little or no gold. Veins of lead in the porphyry rocks most always carry both gold and silver values. In deposits of this character, as at Pinos Altos, Lordsburg, Central and Cerrillos, the lead ores oftentimes carry appreciable quantities of copper and zinc sulphide.

A classification of the lead producing counties and principal districts of lead ores are given in the following:

COUNTY.	DISTRICT.
Bernalillo	Coyote
	Sandia
Doña Ana	Hembrillo
	Organ Mts.
Grant	Carpenter
	Central
	Chloride Flat
	Eureka Pinos
	Altos
	Pyramid
	San Simon
Lincoln	Sierra Blanca
Luna	Cooks Peak
	Florida
	Victorio
	Tres Hermanas
San Miguel	Hamilton
Santa Fe	Cerrillos
	New Placers
Sierra	Bromide
	Caballo (Pittsburg)
	Hermosa
	Kingston
	Lake Valley
	Macho
Socorro	Canyoncito
	Magdalena
	Mogollon Mts.
	Oscura
	San Andreas

Within the last few years considerable prospecting has been conducted in the Sandia Mountains east of Albuquerque and a number of rather promising lead prospects, carrying some copper and silver values, have been located. The ore horizon is in the Upper Carboniferous limestone, which rests unconformably on the pre-Cambrian complex.

ZINC

The zinc ores of the State seem wholly confined to the lead deposits. It is safe to say, that wherever zinc is found in New Mexico, lead is also present. One marked difference, however, is noted in extent of their geographical distribution—the lead being far more prevalent and not always accompanied by zinc.

In New Mexico, the geology of the zinc and lead deposits is practically identical; therefore, the remarks concerning lead ores may be considered applicable to zinc, without committing serious error.

The county and contained zinc producing districts in New Mexico may be cited in the following :

COUNTY.	DISTRICT.
Grant	Carpenter
	Central (Hanover)
	Eureka
	Pinos Altos
Luna	Cooks Peak
	Florida
	Tres Hermanas
Santa Fe	Cerrillos
	New Placers
Sierra	Hermosa
	Kingston
Socorro	Magdalena
	Oscura
	San Andreas

The zinc deposits of New Mexico did not receive any attention until 1902; the zinc ores of the Magdalena district were the first to be recognized as being commercially valuable. Two years later new deposits were found in the Tres Hermanas Mountains, and still later in the Floridas and Black Range.

The deposits at Magdalena, Hanover and Pinos Altos are the most important in New Mexico at the present writing.

The "mundic" or mixed sulphides of zinc, iron and lead at Cooks Peak, Pinos Altos, Hanover and Magdalena are receiving close attention commercially. Also, the sulphide ores at Central and the comparatively new district of Carpenter, are being closely investigated relative to their zinc contents.

The mining of zinc now overshadows that of lead and is fast becoming an important feature in the mineral output of the State. It is noted that the New Jersey Zinc Company and its subsidiaries have been acquiring many holdings of late in zinc properties of considerable magnitude in various parts of New Mexico. The recent rapid rise in the price of spelter, now quoted at 10.50 cents a pound in New York is reflected by the great shortage in Europe, and the price of the metal will likely reach a still higher level in the near future, unless there be a sudden cessation in hostilities. The outlook for the zinc industry is the best in years and the present high quotation is the greatest on record.

New Mexico produced 18,300,000 pounds of zinc (in terms of spelter and zinc oxide) during 1914. This is an increase over the preceding year of about 1,800,000 pounds. Every indication points to a still greater out-put during 1915.

IRON

Iron is the most useful of the metals. It is seldom found in the native state, excepting in meteorites; it enters into the composition of various types of minerals and mineral compounds.

The more important ores of iron are its oxides, carbonates and sulphides; the oxides are the chief ores of commerce.

The ores of iron are generally classified with respect to their metallic content as determined by chemical analysis.

The principal iron ores of New Mexico are classed as follows:

Name.	Composition.	Formula.	Iron %
Magnetite	Protosesquioxide of Iron	Fe_3O_4	72.4
Hematite	Sesquioxide of Iron	Fe_2O_3	70.0
Limonite	Hydrated Sesquioxide of Iron	$2Fe_2O \cdot 3H_2O$	59.8
Siderite	Carbonate of Iron	$Fe\ CO_3$	48.2
Pyrite	Sulphide of Iron	$Fe\ S_2$	46.4

All of the ores given in the table are useful in the manufacture of iron, excepting the last one, which is used in the manufacture of sulphur and sulphuric acid.

Phosphorus and sulphur are the two principal impurities found in iron ores which influence their value. Phosphorous renders iron "cold short," while sulphur makes it brittle at read heat or "hot short," and destroys its welding power.

It is observed that the principal economic iron ores of New Mexico are genetically related to monzonite porphyry in contact with limestone. The deposits lie along the plane of contact, and in some instances in the limestone itself, indicating metasomatic action.

The principal deposits of iron are in the Jones district at the north end of the Sierra Oscura; in the Jarilla Mountains; near San Pedro; about white Oaks; in the Capitan and Jicarilla Mountains; at Tecolote and in the Gallinas Mountains; the Blackington deposits west of the Gran Quivira; in the Cuchillo range; near Glorieta; at

Silver City; and at Fierro, Grant County. This latter deposit has been worked for more than a decade by the Colorado Fuel and Iron Company. The same company operates iron mines at Brice in the Jarilla Mountains and the Yellowjacket mine near White Oaks.

The following analyses of average samples of some of the New Mexico iron ores are here given:

Constituent.	Jones iron.	Blackington	Cuchillo.
Silica	2.00%	7.9 %	8.74%
Iron	66.40	64.1	62.48
Lime	.30	1.2	....
Magnesia	1.25	trace	....
Sulphur	.07	trace	none
Manganese	trace	trace	....
Alumina	.50	....	....
Phosphorus	.09	trace	.023
Titanium	.....		.080
Water	.20	.....	....
Ignition (gain)	.77	.....	....

The above analysis of the Jones iron was made by the Seamon Assay Company of El Paso; that of the Blackington iron by Elston E. Jones, a student of the University of New Mexico; and the Cuchillo iron was taken from a mining report on the property made by Martin Fishback.

MANGANESE

Little attention has, until recently, been manifested in the prospecting and development of manganese in New Mexico, but from a cursory view of the manganiferous localities it is thought that this mineral product may prove rather important.

It is seen from the Mineral Resources of the U. S. Geological Survey for 1913, that the manganese production for that year in this country was only 4,078 long tons, valued at $40,480. During the same year the imports of manganese ores were 345,090 long tons, valued at $2,029,680. Imports having been practically cut off covering the latter four months of 1914, there has been and now is quite a strong demand for manganese since that time. This demand has greatly stimulated the manganese industry in this country and the outlook for 1915 is exceedingly promising for a greatly increased production over that of recent years, provided the war in Europe be materially prolonged.

From the foregoing, it would be well for the prospector to pay some attention to manganese ores during the time of his search for the more alluring metals.

The three principal ores of manganese having commercial importance are Psilomelane, Pyrolusite and Manganite; these ores are more or less associated, including other types of manganiferous ores, in most all manganese deposits.

The uses of manganese may be divided into two distinct industrial branches - metallurgical and chemical. The former use is chiefly confined to the manufacture of iron and steel products and in the reduction of copper and silver ores; while in the latter instance it is made use of in the manufacture of potassium permanganate, chlorine, oxygen and as a coloring material.

The most important deposits of manganese, so far as now known, in the State, lie in the Florida Mountains, on the side opposite the town of Deming. These deposits from the meager development done, appear to be of considerable importance. The ore occurs in cavities in lime-*stone, having replaced the same through metasomatic action.

In the San Lorenzo mining district, about twenty-five miles northwest of the town of Socorro, are several outcroppings of high grade pyrolusite, occurring in porphyritic rocks; there has never been as much as a ten-foot hole sunk on these croppings.

In the Macho district near Lake Valley are numerous manganese indications. At Rincon some very high grade ore has been taken out and piled on the dumps. In various localities, as at Lake Valley, Kingston, near Georgetown and Silver City are manganiferous ores of silver and iron, that frequently contain large quantities of manganese, that should be commercially valuable as ores of this metal.

MOLYBDENUM

Minerals of molybdenum compounds exist in several parts of the State.

About eighteen miles northwest of Las Vegas in the El Porvenir mining district, at the Romero mine, is an occurrence of molybdenite which seems of considerable importance. The mine is fairly well developed and has a small reduction and concentrating plant for saving the ore values. The occurrence is in the pre-Cambrian rock-system of the Las Vegas range.

A similar occurrence exists in the older metamorphic rocks of the Santa Fe range, a few miles east of the city of Santa Fe. In this latter instance the mineral is disseminated through the associated rock. The property is undeveloped, though extremely promising.

Other occurrences in different parts of the State are known to exist, but have never been thoroughly examined.

In the Stephenson-Bennet lead mines in the Organ Mountains there are found many beautiful crystals of the mineral wulfenite—a lead-molybdenum compound. Wulfenite is quite frequently encountered at Lake Valley, in the Black range, at the Lucky Bill mine not far from Silver City, in the Caballos, Magdalena and some other localities. In fact, it occurs sparingly in most all the lead districts throughout the southwest.

Molybdenum, in the form of ammonium molybdate, is used chemically to determine phosphorus in iron. It is also used in fire-proofing, and as a germicide in disinfecting cloth in railway passenger coaches.

FLUORITE OR FLUOR-SPAR

Of late years some very fine deposits of fluor-spar have been uncovered in New Mexico.

The Colorado Fuel and Iron Company has been the chief purchaser. This same company exhausted a large deposit of very pure fluorite on the southwest side of Cooks Peak. Other large deposits are known to abound in the region between Cooks Peak and Deming which have also been extensively mined and shipped to the steel plant at Pueblo.

One of the best and largest deposits of this fluxing mineral of which the writer is acquainted, lies on the east side of the Gila River to the west of the Burro Mountains in Grant County. Lack of transportation prevents the marketing of the product at a profit for the present. The southwest part of the State possesses a number of other valuable deposits that will in time be exploited.

Deposits of fluor-spar exist in the north end of the Sierra Oscura. Some outcrops occur further to the south in the San Andreas range. In the Sandia Mountains this mineral is quite plentiful. In the Taos Range in northern New Mexico fluor-spar has been reported.

Most all of the fluorite deposits in New Mexico are exceptionally pure.

Hydrofluoric acid is manufactured from the purest 'ores of fluorite. Metallurgically, fluorite is used in the basic open-hearth process in the manufacture of steel; phosphorus and sulphur being removed by its introduction into the charge.

The following analysis made by the Seamon Assay Company of El Paso of a sample of fluorite from the deposit between Deming and Cooks Peak, in Luna County, is here given:

Silica	0.4%
Calcium	50.7
Fluorine	48.0
Total	99.1%

This sample was of the greenish-blue variety.

ALUM (ALUNOGEN)

There are four localities in New Mexico where alum has been reported: one of these is in the Sangre de Christo Mountains west of Red River postoffice, in Taos County; one in the northwest part of Sandoval County; one on the ranch of H. C. Abbott easterly from wagon Mound in Mora County; and a fourth deposit on the upper Gila River in Grant County.

Concerning the two first deposits reports have not been verified; the two last deposits are existing facts.

The alum in the latter deposit seems to incrust an alum rock; the rock itself carrying Alumina.

The writer, in May, 1902, made the following analysis of a sample of the alum of the Mora County deposit:

Silica	21.04%
Alumina	7.23
Calcium oxide	0.36
Magnesium oxide	0.18
Sulphur	11.92
Water and volatile matter	59.27
Total	100.00%

The following analyses were made by John Enequist of New York City, on the Gila River alum rock, in August, 1907:

	Incrustation.	Inside Rock.
Water	20.93% (plus organic)	6.26%
Alumina	16.75	16.87
Ferrous oxide	1.70	1.50
Ferric oxide	2.88	4.25
Lime	0.15	0.33
Magnesia	0.23	0.16
Silicic acid	31.31	56.11
Sulphuric acid (anhydrous)	26.36	14.08
Total	100.31%	99.56%

The Gila River alum rock is quite a peculiar mineral aggregation; the original rock has been greatly altered, resulting in the present form. The rock is not nor never was a true bauxite.

Owing to the vast quantity of this alum product it doubtless possesses much commercial value; its utilization is strictly a problem for the chemical engineer to solve. The chief value of the deposits seem to lie in the contained soluble sulphates; these surface incrustations of the soluble sulphates, constitute the mineral known alunogen.

It is thought that the alum deposits of New Mexico are quite suitable for the manufacture of a crude Sulphate of Alumina, which is used in vast quantities in sanitation of cities for the precipitation of sewage, in the sanitation of domestic water, and in the manufacture of "fuming". Sulphuric acid, the so-called Nordhausen oil of vitriol. That these deposits possess great commercial value there can be but little doubt.

SALT

New Mexico is quite well supplied with this indispensable product.

The saliferous horizon of the State is the same as that of gypsum and is confined to the "red beds." The association of salt with gypsum deposits is well known and this intimate relation is strikingly illustrated in the salt lagoons in Otero, Torrance and Eddy Counties. Such saline and alkali solutions collecting in impervious basins, after extreme desiccation is reached, will deposit their contained solid matter proportionate to solubility, when the point of saturation is reached. Since salt is more soluble than calcium sulphate, the gypsum is precipitated first later on the contained chloride of sodium is deposited. The saline lakes in New Mexico, occupying the central area of gypsiferous deposits, vividly portray the extreme point of desiccation now reached by these dying lagoons.

The saline lagoons and marshes in Otero, Eddy, Torrance and western Socorro Counties are susceptible of quite a production in salt; they having supplied this necessary article for ranchers and their herds, without any visible decrease in quantity, since the days of the *Conquistadores*, A. D. 1540.

Perhaps the most interesting and remarkable saline lake in the world is that of Crater Lake in western Socorro County. A careful study of this wonderful lake basin proves it to be nothing more than a sunken grave that marks the spot of a once active and magnificent volcano. In all probability this volcano originally towered at least 3,000 feet above the level of the plain. The past geological history of this lake basin is identically the same as that of Crater Lake, Oregon. This remarkable basin may be described as a circular depression, saucer-shaped, 200 feet deep, and at the center of the depression two black cinder volcanic cones, rising from the basin to a height of 150 feet. One of these cones is a solid, but the conduit of the other remains open to a depth of about eighteen feet below the level of the floor of the main basin. In the center of this hollow cone is a circular pool of brine almost to the point of complete saturation. The brine in the conduit rises and percolates through one side of the cone and spreads out in the large saucer-like basin. Owing to the desiccated condition of the atmosphere in this region of the United States, the excess of water is rapidly taken up by evaporation and salt is deposited over the lake floor. It is thus seen that the process of salt-making at Crater Lake is continuous and only during the wet season of the year when the water becomes somewhat freshened does a cessation in salt-making occur.

The cause of salinity of the water in the conduit cone may be satisfactorily explained on the supposition that the conduit of the crater extends downward into the underlying saliferous formation of the "red beds." It should be noted that the surface rocks about Crater Lake are Cretaceous, and it is thought that the depth of the underlying red series of rocks will not exceed one or two thousand feet. Waters circulating through the underlying saliferous horizon become highly saturated with salt, rise in the vent, as a spring, and finally flow through into the main outside basin where evaporation completes the salt-making process.

Besides the several layers of salt at the bottom of the lake, it is estimated that 500,000 tons of salt are contained in the brine.

The United States consumed, in round numbers, during the year 1913, thirty-four and one-half million barrels of salt, or over six hundred thousand barrels more than the home production.

GYPSUM

The principal gypsiferous horizon in the west appears to be chiefly confined or limited. to the "red beds;" this is especially true in New Mexico. Since the "red beds" formation is so widely distributed over the State, superficially comprising about one-fifth of the surface, the deposits of gypsum are correspondingly great. Here, every variety and form of gypsum may be found and the supply, for all practicable purposes, may be considered inexhaustible. The "plains of the white sands" in Otero County are said to compose the largest single deposit of almost pure gypsum in the world.

No attempt was made to utilize the gypsum of New Mexico until 1902, when the Rock Island Cement and Plaster Company built a 50-ton plant at Ancho in Lincoln County, for manufacturing cement plaster, plaster of paris, stucco, dental plaster, etc.; the capacity of the plant was shortly afterward doubled. Three other plants have since been erected: one at Acme in Chaves County ; one at Elida in Roosevelt County ; and one about six miles south of Lakewood at Oriental in Eddy County.

Two analyses of New Mexico gypsum, one from Ancho and the other from the "plains of the white sands," are here given:

Mineral constituents	Ancho gypsite	White sands product
Calcium sulphate (gypsum)	63.95%	97.00%
Calcium carbonate	20.04	2.06
Magnesium sulphate	.....	0.12
Magnesium carbonate	.....	0.06
Magnesium oxide	0.89	....
Potassium sulphate	.....	0.07
Sodium carbonate	.....	trace
Sodium chloride	0.09	trace
Silica	3.57	.....
Oxides, iron and aluminum	2.01	.....
Moisture	9.45	.....
Total	100.00%	99.31%

The analysis of the Ancho gypsite from which cement plaster is manufactured was made by M. Carleton Ellis of Boston, and the analysis of the "white sands" was furnished by the New Mexico College of Agriculture and Mechanic Arts.

The uses of gypsum are many and quite varied in character: such as cement plaster, filler in paper, stucco, dental plaster, cement paint, plaster of Paris, building blocks, scagiola inside finish, an imitation of onyx and marble, imitation meerschaum and ivory, etc. The low grade unburned material is used as a land plaster or fertilizer. The finer grades of alabaster are sought by sculptors for interior ornamentation.

SULPHUR

There are some deposits of sulphur in New Mexico that will in time prove of considerable commercial importance, when transportation facilities become so improved as to justify placing the product on the market.

Coronado as early as 1541, and other Spanish explorers first used sulphur in this State from the Jemez

Sulphur Springs and from the old Guadalupe sulphur mines, in the manufacture of gun powder. But little has ever been done toward utilizing the New Mexican product, for lack of transportation, as above noted, since the days of the *Conquistadores.*

Mariano S. Otero in 1901, erected a small plant of five tons capacity at the Jemez Sulphur deposits, but it was operated only a short time up to his death, which occurred less than three years later; the plant now lies idle. This is the only modern attempt ever inaugurated to work the New Mexican deposits.

Beside the two sulphur deposits just mentioned, there are northwest of White Oaks and also in the southeastern part of the State, near the Texas border, occurrences of native sulphur in gypsum. It is problematical whether deposits of this character will become important. The occurrences in the gypsiferous beds of southeastern New Mexico, are similar in every respect to those in western Texas and have doubtless been formed under the same conditions. Sulphur has also been reported in one of the extinct volcanic cones north of Tres Piedras.

MICA

The occurrence of Mica in New Mexico has been observed in different localities, and is found associated with pegmatite dikes. These pegmatic dikes are closely allied to granite in their composition, being chiefly composed of quartz and feldspar with other, less prominent, constituent minerals, not including mica.

There are a number of minerals belonging to the mica group, practically only two of which are commercially valuable, due to their physical properties these are designated as muscovite or potash mica, and phlogopite or magnesium mica.

The value of muscovite or white mica depends on its transparency and size of the sheets. The colors of phlogopite vary from brown to reddish brown and oftentimes possess a copper-like reflection. The chief value of phlogopite lies in its property of non-conductivity of electricity.

Biotite is another common type of mica though dark in color due to the presence of iron and other impurities; it is of the magnesium variety and closely allied to phlogopite.

All three of these micas vary largely in color, but only the two first are considered commercially valuable to any great extent.

The micas of New Mexico have been but little exploited, but those best known and developed are the deposits at Petaca in Rio Arriba County. Other deposits of mica occur in Taos County, not far north of Ojo Caliente. The product at this point would doubtless be classed as biotite and is perhaps inferior to that at Petaca. The Petaca mica is fairly transparent and would likely be classed as muscovite. No analyses of these micas have ever been made.

Mica is also found at Mocking-bird Springs in the north end of the San Andreas Mountains, Socorro County; the extent and value of the occurrence is unknown.

There are said to be deposits of mica at Nambé in Santa Fe County that are quite important; the writer has never visited this section. Mica is also reported to exist fit the little village of Talco, in Mora County.

Mica is used extensively in the arts and in electrical insulation; the latter use is of greater importance than in the former instance. The bespangled effect on wall paper is due to small particles of mica. The uses of sheet mica for stove windows, for incandescent gas lamps, miners' lamps, etc., are well known to all. Ground mica forms an ingredient in heavy lubricants and is used as an absorbent for explosives, and is a component in mica paints and bronzes; in fact the uses of mica increase each succeeding year.

The prices of scrap mica vary in price from $10 to $30 per ton, depending on quality and locality where needed; large sheets of clear mica command quite a price.

Most of the economic deposits of mica are common to the older series of metamorphic rocks, usually regarded pre-Cambrian in age. Such rocks are composed of coarse grained micaceous granites, gneisses, and schists. The mica deposits occur in what are termed pegmatite dikes, composed chiefly of white "bull" quartz and varieties of feldspar. The most common of these feldspars are those of orthoclase and microcline. The feldspathic component is very often made up of a variety of plagioclase, either that of albite or oligoclase. In the Petaca district, in Rio Arriba County, some extremely large crystals of feldspar were observed, attaining from three to five feet in length. The feldspar in the pegmatite at the Ojo Caliente deposits to the south of Petaca is of a beautiful flesh color and is more h the Petaca and Las Tablas feldspar.

ASBESTOS

Nearly the whole of the domestic asbestos comes from what is known as the Sall Mountain and Hollywood mines in Georgia; production in the other states is quite small. The entire output of the United States, according to the U. S. Geological Survey for 1913, was only 1,100 short tons. The greatest production was in 1911, when it reached 7,604 tons.

There are two varieties—the slip fiber or amphibole asbestos, and the cross fiber or serpentine (chrysotile); the latter is by far the more valuable.

Specimens of slip-fiber were observed south of Steins Pass and in Rio Arriba County. On the Gila River above Red Rock asbestos of the chrysotile variety is reported to exist, not far from the ricolite deposits.

New Mexico has never produced asbestos in commercial quantity.

MEERSCHAUM

During the year 1906, meerschaum in New Mexico was first brought to the attention of the public. The original find was made in Grant County, north of Silver City on the Sapello, a tributary of the Gila River. Meerschaum was also found about a year later on Bear Creek; this second discovery lies northwesterly from Silver City about twelve miles.

Since pure meerschaum is essentially a magnesium silicate containing water, the value of the New Mexico product will thus depend on how near it approaches the theoretical composition and the extent of the deposits.

For comparison with the theoretical composition of meerschaum, two analyses of the Grant County product are given below. No. 1 is from the Bear Mountain district and No. 3 is from the Sapello deposits; No. 2 is the theoretical mineral, given for comparison:

Constituents.	1.	2.	3.
SiO_2	57.10%	60.8%	60.97%
Al_2O_3	0.58	....	9.71
Fe_2O_3	trace	......	9.71
MgO	27.16	27.1	10.00
CaO	0.17	......	0.22
CO_2	0.32	......	......
H_2O	14.78	12.1	19.14
Total	100.11%	100.0%	100.04%

It will be noted that the Bear Mountain product compares very closely with the theoretical mineral.

The above analyses were taken from Bulletin 340, Part I, page 470, U. S. Geological Survey, 1907.

The deposits on the Sapello have been developed to a considerable extent by the Meerschaum Company of America.

Doubtless other deposits of meerschaum exist in the State, and it is not improbable that the mining of this rare mineral product may become a unique feature in New Mexican mining.

At the present time about the only country in the world that produces meerschaum is Asia Minor.

TURQUOISE

Turquoise mining in New Mexico antedates all other kinds of mining in the Southwest. There is not the slightest doubt that turquoise was actually mined by Aztec and Pueblo Indians, in their crude way, long before the discovery of the Western Continent by Columbus.

It is now conceded by all historians that Alvar Nuñez Cabeza de Vaca with his companions were the first Europeans to set foot on New Mexican soil; this was in the year A. D. 1534. At this early date Cabeza de Vaca speaks of turquoise that he saw at his farthest point north in the Rio Grande valley, presumably near the present site of Bernalillo. In all probability this turquoise came from Mount Chalchihuitl, in Santa Fe County, about forty miles to the northeast of, Bernalillo.

Extreme cruelty of the Spaniards inflicted on the Indian miners and the caving of the profound turquoise working at Mount Chalchihuitl, that killed a large number of slaves, caused a general uprising of the Pueblo Indians in 1680, which drove the Spaniards out of the country. The great antiquity of the old workings in a number of places around and near Mount Chalchihuitl, is proven by fragments of the most ancient make of pottery and the crude stone implements found in the old dumps and excavations.

In the Burro Mountains, Jarilla Mountains and at Hachita, prehistoric turquoise workings were observed by American trappers and prospectors when they first drifted into New Mexico. These old workings at that time were hoary with age and have changed but little, where they have not been disturbed, up to the present time.

New Mexican turquoise equals in beauty and quality the celebrated Oriental gemstone of Persia. For comparison of the two products analyses are here given:

New Mexico Turquoise

Aluminum and ferric oxides	39.53%
Phosphorus pentoxide	31.96
Copper monoxide	6.30
Lime	0.13
Silica	1.15
Water	19.80
Total	98.87%

Persian Turquoise	
Alumina	40.19%
Phosphorus pentoxide	32.86
Copper monoxide	5.27
Ferric and ferrous oxides	2.21
Manganous oxide	36
Water	19.34
Total	100 .23%

Doctor F. W. Clarke of the U. S. Geological Survey made the analysis of the New Mexican turquoise, and the analysis of the Persian product was taken from Dana's Mineralogy.

Chemically, it is seen that turquoise is a hydrous phosphate of aluminum colored by a copper compound. It is essentially a surface deposit, occurring in an oxidized zone.

Perhaps the most important turquoise mines in New Mexico exist in the Burro Mountains. It is claimed that the excavation on the Azure Turquoise Company's property there is the largest in the world, made in the mining of turquoise.

New Mexico stands prominent in being classed among the World's chief producers of turquoise.

GRAPHITE

Graphite is found in association with the old metamorphic types of rocks. There are two varieties of graphite—the crystalline and amorphous; the latter variety is by far the more abundant. The crystalline variety is more valuable commercially.

There are three known localities in New Mexico and possibly others, where deposits of graphite exist. These deposits are all bedded and will doubtless be found of considerable commercial value when more fully exploited.

One of these deposits is in the mountains near Raton, Colfax County; the second lies east of Albuquerque in the Sandia Mountains adjacent to Tijeras Canyon; and the third is in the Taos Range east of Taos.

Since the greater portion of graphite used in the United States is imported from the Island of Ceylon, necessarily this mineral possesses considerable industrial importance. Graphite prospects should not be too hastily condemned and passed over by the prospector as worthless, but should be carefully examined and samples selected and analyzed; more especially, if the deposit is close to transportation.

The deposit at Raton evidently was at one time a coal bed, but has been metamorphosed into graphite through the influence of igneous dikes.

The purpose for which graphite finds its greatest use is in the manufacture of crucibles, muffles, brazing boxes, stirrers, carbon sticks for arc lights and other equipment designed for high temperatures. It is used in the manufacture of lead pencils, and pure flake graphite is especially valuable as a lubricant.

COAL

First and most important of any one natural legacy to which the State of New Mexico points with the greatest assurance and pride, is in its vast coal deposits. The exact areas of all the fields have not, as yet, been fully defined and mapped but these areas have been expanded within the last few years and may eventually approximate 25,000 superficial square miles. There are yet other considerable areas of coal that will doubtless be discovered when a careful geological survey is made of the State.

Geologically, the chief coal bearing horizons belong to the upper Cretaceous rock system; there are three of these in number. There is, however, near the base of the Lower Cretaceous, in the Dakota sandstones, a lesser important coal horizon than any one of the three just mentioned. And far below the Dakota sandstones, in the red series of rocks or Permo-Carboniferous, is still another coal horizon. But little is known of this latter horizon and the only place that the writer has any definite knowledge of its coal bearing qualities is at Estey City, where a drill hole was put down for water and about two feet of an apparently good quality of coal was said to have been passed through at about 600 feet in depth.

The coals of the Dakota sandstones are bituminous in character, usually dirty, and are mined only in a limited way for use in the Government Indian School, at a point on the San Juan River a few miles below Ship Rock.

Good bituminous coal exists at White Oaks, Carthage, Abbey, Cerrillos, Raton, Van Houten, Dawson and some other localities. The greater portion of the New Mexico coals are sub-bituminous or non-coking in character. The later coals, especially of Laramie age, are all sub-bituminous. The Laramie coal beds attain a greater thickness than those of any of the other formations. One of these great coal veins in the Rio La Plata section of San Juan County, known as the Carbonero bed, reaches a maximum thickness of over thirty-six feet, the greater portion of which is solid coal.

The coal mining industry of Colfax County is important, inasmuch as that county continues to lead in the coal and coke output. The beds in this county range in thickness from three to eight feet, and the quality of coal is generally first class. The Colfax County coal field stands second in area to that of the great Gallup-Durango basin.

The Gallup coal fields in McKinley County stand second to the fields in the northern part of the State in point of production.

The most southern coal field lies in Sierra County westerly from Engle and very near the great Elephant Butte Dam project, now under construction by the U. S. Reclamation Service for impounding the waters of the Rio Grande. The next most southerly fields are those of Carthage, Capitan, White Oaks and Willow Springs, southeast of Carrizozo. These fields are rather circumscribed, yet they are important owing to their nearness to the City of El Paso, Mexico and the southwest mining centers.

The coals of these southern-most areas are generally of excellent quality and coke fairly well.

No anthracite is found in New Mexico, excepting at the coal mines at Madrid, near Cerrillos. The geology of this occurrence is extremely interesting, since the order of nature in this field seems to be reversed. Here the anthracite lies above the bituminous beds. This peculiar occurrence is due to the influence that igneous sills and surface lavas have exerted on the topmost coal bed, converting it into anthracite, while the heat was insufficient to metamorphose the veins of coal at greater depths, to any appreciable degree.

This anthracite area is rather circumscribed and the greater portion of the bed is thought by many to be nearing exhaustion. Analyses show about 89% fixed carbon for this coal.

The following proximate analyses of New Mexican coals from widely separated points are here given for comparison:

County.	Colfax.	Lincoln.	McKinley.	San Juan.	Santa Fe.	Socorro.
	%	%	%	%	%	%
Moisture	3.61	.75	9.13	3.20	2.00	.0
Volatile matter...	35.55	41.25	38.45	38.86	39.00	37.5
Fixed carbon	51.73	47.00	49.43	48.35	53.76	54.8
Sulphur	.63	.73	.09	.59	.30	.8
Ash	8.48	10.27	2.90	9.00	4.94	6.6
Total	100.00	100.00	100.00	100.00	100.00	100.0

The output of the coal mines in New Mexico during 1914 was the greatest in the history of the State. According to the report of the State Coal Mine Inspector for the fiscal year ending October 31, 1914, New Mexico produced 3,826,885 tons of coal, valued at $5,588,352. The production of coke during the same year amounted to 405,128 tons, valued at the ovens at $1,341,732. The value of the coal and coke combined was $6,930,084. No coke is produced, at present, outside of Colfax County.

Concerning the coal output in the western States, New Mexico was the only state that showed an increased production over the previous year. This was, perhaps, to a certain extent, due to the State not having had any labor troubles at any time in its history.

The U. S. Geological Survey has estimated that the great Gallup-Durango basin contains approximately 80,000,000,000 tons of coal. The northern end of this field lies in Colorado and the tonnage belonging to New Mexico of this particular basin ought not, conservatively speaking, fall below 65,000,000,000 tons.

Taking into consideration the great fields of Colfax County and the smaller ones scattered over the other coal sections of the State, a conservative estimate would place the total tonnage of New Mexico coals at not less than 100,000,000,000 tons!

For a more complete description of the coal fields of New Mexico, reference should be made to Contributions to Economic Geology, 1906, Part II, U. S. Geological Survey.

The value of the vast tonnage of New Mexican coal does not lie wholly in its quantity or quality, but in a very great measure to the position of vantage it occupies with reference to the great smelting centers of the Southwest and Republic of Mexico. Moreover, it being the closest coal of any importance to the Pacific Ocean at the extreme southwest seaport of the United States, it is not improbable that one of the chief markets will eventually be in supplying all ocean-going vessels with fuel through the harbor at San Diego, since the Panama Canal is now completed.

PETROLEUM AND NATURAL GAS

Petroleum and natural gas are so intimately related, it would be difficult to discuss one without the other. These products belong to the group of compounds, classed as hydrocarbons.

Commencing with natural gas, the hydrocarbon series passes gradually by loss of volatile matter and oxidation from one compound to another, through naptha, petroleum, mineral tar and finally to asphaltum.

By the processes of distillation and refining numerous products in medicine and the arts are manufactured.

From our present knowledge of New Mexico, there appears to be at least three geological horizons favorable for the existence of oil; one of these is in the upper Marine Cretaceous shales; one in the Lower Cretaceous; and one far below the two geological horizons just mentioned, in the Triassic or Upper Permian (red beds) formation.

Indications favorable to the existence of petroleum and illuminating gas extend over vast areas at widely separated points; such indications are evidenced in many places by seepages of both oil and gas. On the strength of this evidence, it is predicted with confidence, that producing wells of both these products will be brought in just as soon as conditions will warrant taking up their intelligent exploitation.

The Pecos Valley region in Eddy and Chaves Counties is a field of great promise in the development of both oil and gas in commercial quantities. It is the opinion of the writer, based on geological evidence, that one of the principal gas and oil bearing zones of the Pecos Valley region starts in the vicinity of Artesia and passes in a slightly curved line through Dayton, running a little to the west of Lakewood, thence southeasterly, crossing the Pecos through to Avalon and thence further south-easterly toward Alkali Flat and Salt Lake. Another similar zone heads in about Stillwells Ranch and Dexter passing southeasterly through Hagerman toward the Mescalero Ridge. The existence of certain minor folds in the strata between Dayton and Lake Arthur is also regarded as favorable for oil and gas.

The Brown oil well and the Belt gas and oil well both near Dayton indicate that the Pecos Valley may some day become an important petroleum field. The first named well has a capacity of thirty to forty barrels. The second well has a much lesser production in petroleum, but is a strong gasser. These wells are about 1,000 feet deep.

The oil-bearing sands of the Pecos region indicate that they belong to the "red beds" or Permo-Carboniferous - the lowest oil horizon in New Mexico.

At Farmington a joint stock company was formed about two years ago and a test well was sunk in the south edge of the village to a depth of 2,730 feet when the drill became stuck in a tenacious shale. The writer is in possession of a copy of the log of this hole and it is extremely interesting; however, it is not necessary for a detailed description in this booklet. Suffice it to say that two veins of coal, four gas zones, and one zone of maltha were passed through.

Near Gallup, Wingate, Antonio Sedillo land grant, various parts of the Navajo Reservation, western Socorro and Valencia Counties, Hagan coal field, the Plains of tornado del Muerto, parts of Guadalupe and Colfax Counties and a number of other localities seem to favor the probable existence of petroleum. It will take time to fully exploit these probable oil fields, and it is not unlikely that some of them, at least, will be productive. At Seven Lakes in McKinley County a well was sunk in 1910 to a depth of about 400 feet which pumped, it, is claimed, a few gallons of oil every twenty-four hours.

GUANO

There have been found in the State deposits of guano (bat excrement), the product being commercially valuable as a fertilizer, due to the contained soluble phosphates and ammonium.

Such deposits naturally belong to an arid climate; the desiccated atmospheric conditions act as a preservative on the more soluble matter, upon which the value of the product depends. The deposits in New Mexico are confined to dry caves and the protection of overhanging and shelving rocks.

Three guano deposits have been worked and the material of each was shipped to California, where it was used for fertilizing purposes; the product was reported to have been exceedingly rich in soluble phosphates. One of these deposits was in an old volcanic crater northeast of Engle on the plains of the Jornado del Muerto; one in the Guadalupe Mountains; and the other was in a cave in the Tres Hermanas Mountains. Doubtless other deposits will be discovered in the course of time.

BUILDING STONE

From a cursory knowledge of suitable stones for building purposes, it appears that New Mexico is generously endowed with such material. ,

The building stone of the State may, with propriety, be classified as follows:

IGNEOUS-	METAMORPHIC-	SEDIMENTARY-
Granite	Gneiss	Sandstone
Trachyte	Serpentine	Limestone
Basalt	Quartzite	Dolomite

The reason that but few quarries have yet been opened, is owing to the comparative newness of the American immigration. Most of the older towns and settlements, built by the natives are made from adobe dirt; this material until quite recently was almost wholly used in the building of houses. At the present time only the sandstones, limestones and basalts have been used to any extent in building.

The Sandia Mountains furnish a superior quality of limestone used extensively in. the City of Albuquerque for building purposes. Also, what seems to be an arkose sandstone, perhaps pre-Cambrian in age, is largely used for base rocks, door and window sills, etc., in many of the city's buildings. This latter stone is of a creamy-white color and is practically unaffected by frosts and general weathering.

At White Oaks and Gallup some very durable light gray and reddish sandstones of Cretaceous age are used in the more prominent structures.

The original main structure of the Capitol Building at Santa Fe is constructed from a beautiful cream colored Cretaceous sandstone, that was quarried from the top of a high hill at Lamy.

Beautiful sandstones of varying colors are used at Raton and also other types of building stones.

In the vicinity of Roswell good qualities of both sandstone and limestone can be had, and are much used in the Pecos Valley metropolis.

Las Vegas has, perhaps, the prettiest colored sandstone that is used for building purposes, to be found in the State. It is a red to brownish chocolate color and the Normal University is built of this stone. The paving stones at Las Vegas are also quite an asset to that town for a cheap, durable sidewalk; these are of a chocolate color, also.

At Silver City there are used quite extensively the dark curly marbles and limestones found in that vicinity; these stones are rather indurated, and very durable.

The main building of the School of Mines at Socorro is constructed of a gray trachyte, which makes an attractive and substantial building stone. This stone is one of the igneous flows of the Socorro Mountain volcano.

The granites, as yet, have received but little or no attention in their exploitation.

The northwest part of the State affords large areas of beautiful sandstones, varying in colors from a light gray, cream, light brown, reddish to chocolate. It is thought that many of these stones will be highly prized for building purposes after they become known and once opened to transportation.

In addition to what has been said on this subject, it might be remarked that in most every section of New Mexico to which the writer's knowledge extends, there appears to be an abundance of valuable building stones ready for use when the times demand it. The modern and almost universal use of cement, however, has had a blighting effect in the demand for building stone in the last decade.

MARBLE

In a general sense, marble may be defined as any limestone that will receive a polish and be suitable for ornamental purposes, regardless of whether its structure is granular, crystalline or compact. Lithologically defined, marble is a metamorphosed limestone.

Beds of crystalline limestones occur in quite a number of the mountain ranges of New Mexico, and are classed as marbles. Most of these marbles are rather coarse-grained, sometimes fossiliferous, ranging from light to bluish gray to a slightly brownish or pinkish color and all quite pretty.

Only within the last few years have the marbles of the State received attention; the industry is yet in the earliest stage of infancy.

At Las Vegas and Alamogordo marble quarries have been opened and the product from these two places seems to command a growing market. The stones run from light gray to delicate pinkish and brownish tints, and into darker shades.

A rather dark bluish variety of marble at White Oaks, susceptible of a high polish, is found in the adjacent mountains; the deposit lies dormant.

West of Las Cruces is a mottled marble of apparently good quality; the crystallization is both fine and coarse grained.

A coarse grained gray marble exists in the Tres Hermanas Mountains in Luna County, at the zinc mines and at the great bat cave, on the north and east sides of the range, respectively.

In the El Capitan Mountains in Lincoln County in the Manzanos in Valencia County; and in the Sandias east of Albuquerque are found attractive and durable types of light to dark gray marbles. Many beautiful monuments are being cut from the stone quarries of the Albuquerque Marble and Granite Works' property in the southwest section of the Sandia range of mountains.

CLAY

Very little is known about the clays of New Mexico; since but few analyses have been made, our knowledge of the extent and character of the beds is only fragmentary. Nevertheless, that valuable deposits of clay exist in various parts of the, State there is but little doubt.

Clay may be defined as a silicate of alumina and usually contains water in appreciable quantity. Its origin is due to the decomposition of feldspathic rocks from which the oxides of soda and potash have been removed by circulating waters. Kaolinite is the purest type of clay from which the finest grade of chinaware is manufactured; it is composed of only three compounds—silica, alumina and water. The more common forms of clay contain in addition to these three compounds, small quantities of various other substances, which sometimes exert a marked effect on the quality of the product.

Clays occur in most all the rock formations from the Lower Carboniferous to the latest alluvial deposits, but only the purer types possess especial commercial value.

The clay-bearing formations of New Mexico may be placed under four general groups, viz:

1. Carboniferous clays.
2. Jura-Trias and Cretaceous clays.
3. Tertiary clays.
4. Loess and Alluvial deposits.

Most of the river valley bricks and adobe mud belong to the fourth classification.

The best building brick and refractory products come from the Tertiary and Cretaceous marls and clays. The Cretaceous coal-bearing formations are especially rich in refractory clays. Some varieties of the Carboniferous shales are adapted to brick-making.

An apparently good brick of a beautiful cream color was a few years placed on the market, manufactured from the Middle Cretaceous shales on the Tonque, lying just north of the Tejon land grant in southeastern Sandoval County. Lack of adequate transportation resulted in the final closing of the plant.

Brick are made at most all the towns and villages in the State and vary considerably in their physical character pertaining to tensile and crushing strength and also in their power to resist the disintegrating effects of meterological agencies. From tests made in the physical laboratory at the College of Agriculture and Mechanic Arts at Las Cruces, N. M., it was demonstrated that the river valley bricks are softer and their adhesive qualities less than brick made from clays of a different source. Las Vegas makes one of the best grades of building brick in the State.

A splendid vitrified brick is turned out by convict labor at the State Penitentiary at Santa Fe. The clay comes from a deposit at the base of the Santa Fe range, near the City of Santa Fe. This brick is used in a number of the more important towns for sidewalk paving.

The industries of clay products in New Mexico have only fairly begun.

CEMENT

Analysis has disclosed the fact that some splendid grades of a bluish and also cream-white limestone exist in the mountains lying immediately northwest of White Oaks which are peculiarly adapted as an ingredient necessary in the manufacture of cement.

Overlying the White Oaks coal beds is a massive shale of such composition, that when combined with a proportionate part of this limestone a very high grade Portland cement can be made. Tests of these materials have been made by Mr. Wm. M. Strong, a former practical chemist of White Oaks, with highly satisfactory results.

Most of the principal mountain ranges of the State doubtless carry similar materials suitable for the manufacture of good grades of hydraulic cement.

The writer has observed extensive beds of Tertiary marls in a number of places and it is quite probable that some of these deposits could be used to advantage in making cement.

No hydraulic cement plants have yet been constructed in New Mexico. The nearest plant of this character is at El Paso, where apparently similar material is used to that so abundantly distributed throughout the commonwealth.

Owing to the abundance of raw material from which cement is made, coupled with the durability and cheapness of the finished product, the growth of the cement industry has been something phenomenal.

Cement blocks are now largely used in Albuquerque in various kinds of structures, and their use has become general throughout New Mexico.

The Hondo Stone Manufacturing Company of Roswell did pioneer work in the introduction of this modern building material throughout the Pecos Valley.

MINERAL PAINT

Deposits of ocher exist in the Sandia Mountains immediately east of Albuquerque, in the Caballo Mountains and in the vicinity of San Pedro in Santa Fe County. It is thought that these two latter beds are of considerable commercial importance when fully exploited.

Other deposits, perhaps, abound in the State, but no prospecting has ever been done along this line. The two occurrences already noted have never been looked into only in a very meager way the extent of the deposits is therefore unknown.

It is not improbable that some of the vermilion strata common to the "red beds" might be utilized for mineral paint.

GRAVELS FOR ROAD BUILDING

New Mexico is endowed with practically inexhaustible quantities of stream gravels particularly adapted for road building and ballast. These gravels are elipsoidal in shape and are composed of quartz, trap and other highly siliceous stones. Their resistance to wear is highly satisfactory.

The time has now arrived when the Commonwealth must secure proper legislation and inaugurate concerted action between the various counties for the improvement of the public highways. The intelligence of a people is measured by their standard of roads.

MISCELLANEOUS MINERALS

There are several other mineral products beside those discussed, some of which are now of commercial value and others will become so in course of time.

Good molding sand is had at Albuquerque which is used at the Foundry in that city.

Lithographic stone has been reported from several localities and some samples have been submitted to the writer which seem to be of good quality.

On the west side of the Gila River above Red Rock post-office is a large deposit of ricolite; this is a beautiful streaked stone and is valuable for ornamental purposes.

Other mineral species such as onyx, agate, ores of vanadium, uranium, tungsten, gems, etc., are found in various parts of the State. A. deposit of a beautiful variety of lime spar, generally called onyx, has recently been located at Columbus, in Luna County.

Radioactive minerals have been observed at Petaca in Rio Arriba County, where samarskite was recently discovered and in some uranium occurrences in the northeast side of the Limitar Mountains at the Jerome copper mine.

The newly discovered tungsten deposits at Copper Hill in Taos County appear to be rather important at this writing. Tungsten also occurs at White Oaks and in the Victorio Mountains, Luna County.

By referring to the Catalogue of New Mexican Minerals embodied in this bulletin, a complete list of all the known minerals found in the State up to the present time can be reviewed.

MINERAL SPRINGS

New Mexico is possessed of numerous mineral springs in various localities. Many of these springs may with propriety be classed as volcanic, since the temperatures range from 60 degrees to nearly 200 degrees Fah. These thermal springs are usually found in the mountainous regions where intense past volcanic action is in evidence and are, perhaps, the lingering effect of dynamical forces.

The waters of a number of these springs have long been noted for their efficacy in curing certain diseases and are patronized by large numbers of health-seekers annually. Many wonderful cures are reported, by those who seek their health giving power. The curative property of many of these springs has been thought due to emanations from radioactive substances contained in the earth through which the waters course. The school of Mines has already begun a series of investigations of the mineral springs of the State and will publish a bulletin on the results which is expected to be of great interest to the health seeker.

There are springs, the waters of which are especially adapted for the complete cure of acute and chronic rheumatism; springs for stomach and liver troubles springs for syphlitic and blood diseases; springs with lithia waters for stone in bladder and similar calcareous affections. In short, there are few ailments that are not either benefited or wholly cured, by proper bathing and use of the waters suited to the character of the disease.

At several of the prominent springs, bottling works have been established and the waters can be had for home use in the more important towns of the southwest.

A rather full discussion, with analyses, of the mineral waters of the State can be had by referring to the chapter on Mineral Waters, in the writer's volume, of "New Mexico Mines and Minerals," published in 1904.

ARTESIAN WATER

Of late years prospecting for Artesian water in New Mexico has been vigorously prosecuted, with quite satisfactory results.

The Pecos valley is developed more fully along this line than any other section in the State. The wells in this great Artesian belt are not excessive in depth, have strong flows and the water is fairly good, generally speaking, and adapted for boilers, domestic uses and irrigation.

What appears to be another Artesian belt of some promise is southwest of Suanee Station on the line of the A. T. & S. F. Railroad. The first well in this section was brought in early in the year 1908. The water horizon appears to be in the sands and conglomerates lying at the base of the Dakota sandstones the water though, is said to be excessively saline. This belt extends westerly about 100 miles to Gallup, where an Artesian flow is had for supplying that town with water, as well as a small flow at Chaves Station.

There are a few other flowing wells in various parts of the State, but none of these areas have been developed as in the case of the Pecos Valley.

The writer knows of several virgin localities where Artesian water seems probable, judging from the geology of the region, but space in this bulletin precludes giving detailed descriptions.

Knowing the nature of the source of Artesian water, as a word of caution, it would be well for all users to conserve the supply with scrupulous care, in order to prolong the flow through the greatest period of time. Water is quite similar to all other mineral substances and the quantity may become depleted or even exhausted just the same as working out a vein of ore. Observations made by the U. S. Geological Survey call attention to the fact that the elevation of the average water table of the United States is being lowered about three feet each decade.

CATALOGUE OF NEW MEXICO MINERALS

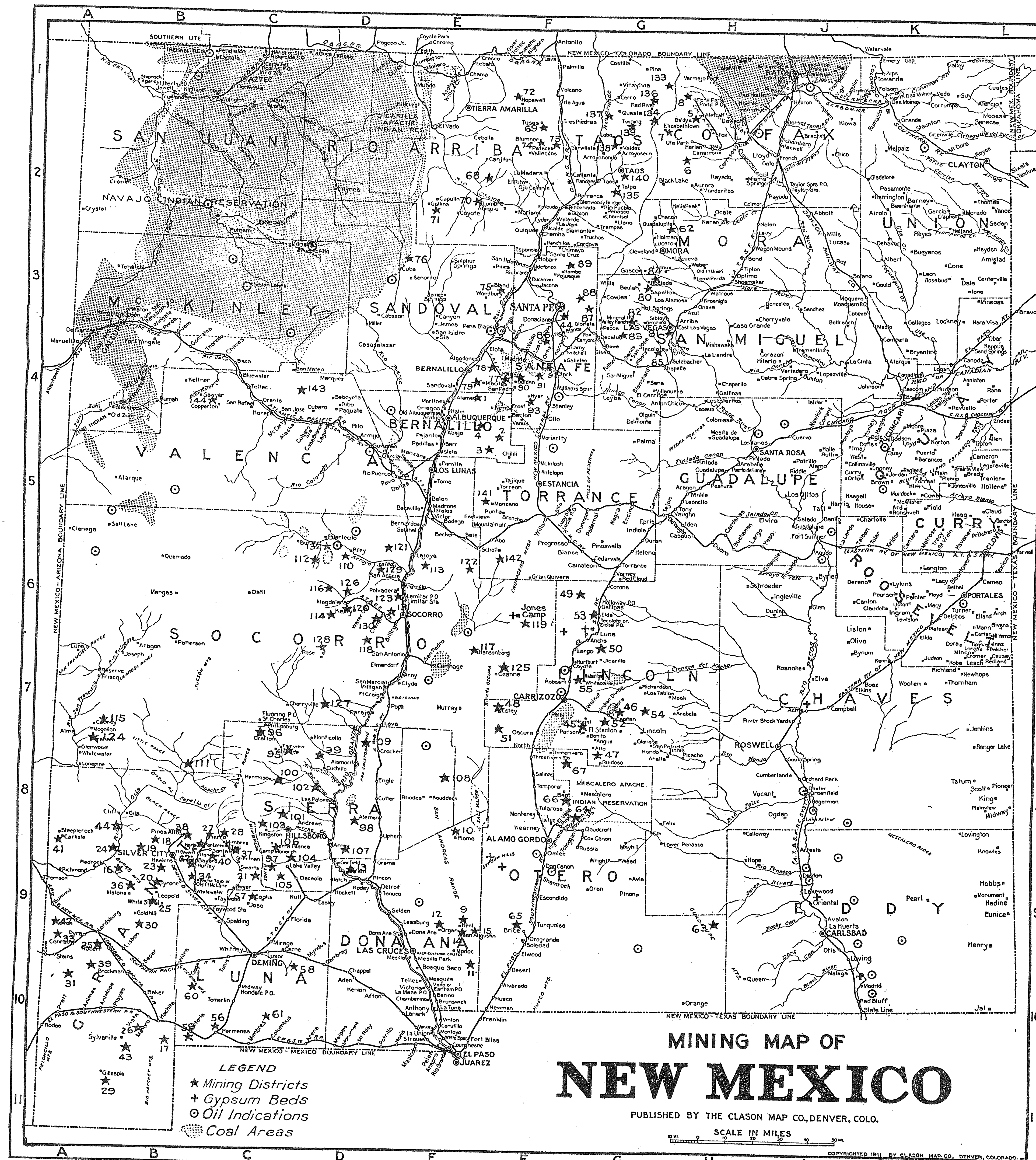
Actinolite	Jones iron mines, Sierra Oscura
Agate	Russels Canyon on Rio Tularosa
Alabandite	San Pedro copper mines
Alabaster	Jones mining district
Albite	Copper Hill, Taos County
Almandite	San Pedro copper mines
Allophane	Fierro and Hanover
Alounogen	Upper Gila and elsewhere
Amethyst	Black Range, Great Republic mine
Andesine	In various igneous rocks
Andradite	Organ and Cieneguilla districts
Anglesite	Victorio mining district
Anhydrite	Metamorphosed by lava flows
Ankerite	Lake Valley mines
Anorthite	Various mountain ranges
Anthracite	Madrid Mines, Cerrillos district
Anthraconite	Tejon and Quelites grants
Apatite	Lake Valley and Hillsboro regions
Aragonite	Kingston camp and Graphic mine
Argentite	Virginia mining district
Arsenopyrite	Ortiz and Virginia districts
Asbestos	Mimbres mining district
Asphaltum	Perea grant, Guadalupe county
Aurichalcite	Magdalena mining district
Automolite	Santa Fe mountains
Azurite	Santa Rita copper mines
Barite	Mimbres mining district
Baryto-calcite	Sierra Oscura
Baryto-celestite	Sierra Oscura
Beryl	Santa Fe gravel beds
Biotite	Ojo Caliente, Rio Arriba county
Bismuthinite	San Andreas range, Florida mountains
Bismuthite	San Andreas range
Bloedite	Estancia salt lake
Bornite	Blank range and Cooney districts
Bournonite	Los Cerrillos and Central districts
Brochantite	Torpedo mine, Organ district
Bromyrite	Bromide (Tierra Blanca) district
Brookite	Copper mountain district

Bucklandite	San Pedro copper mines
Calamine	Thunderbolt mine and Magdalena Mts.
Calaverite	LaBelle and Red River districts
Calcio-celestite	Sierra Oscura
Calcite	Kelly and Graphic mines
Caliche	Common to New Mexican plains
Carnelian	Found in various gravel beds
Carnotite	Peralta canyon, Cochiti district
Catlinite	Sangre de Cristo range (?)
Cassiterite	Las Tablas
Celestite	Sierra Oscura and San Andreas Mts.
Cerargyrite	Lake Valley and Kingston mines
Cerium	Las Tablas and gravels of Rio Chama (?)
Cerussite	Cooks Peak and Magdalena districts
Cervantite	Central district, Grant county
Chalcedony	Widely distributed over New Mexico
Chalcocite	Santa Rita and Cooney mines
Chalcophanite	Graphic mine Magdalena Mts.
Chalcopyrite	Cooney mine and elsewhere
Chalcotrichite	Santa Rita mine
Chert	Common in gravel beds
Chlorite	In decomposed igneous rocks
Chrysocolla	Torpedo mine, Organ district
Chrysolite (Olivine)	Zuni Indian reservation
Coal	Occurs in Cretaceous rock system
Copper	Santa Rita mines
Corundum (Sapphire)	Found in Santa Fe gravels
Covellite	Jarilla mountains
Cuprite	Santa Rita mines
Cyanite	Bromide district, Rio Arriba county
Cymatolite	Ojo Caliente, Rio Arriba county
Descloizite	Lake Valley
Diamond	Said to have been found (?)
Dioptase	Jarilla mountains
Dolomite	Various mountain ranges
Domeykite	Pinos Altos and Central districts
Embolite	Lake Valley mine
Emerald (Beryl)	Santa Fe gravel beds
Emeraudine	Jarilla mountains
Enargite	Pinos Altos and Central districts
Endlichite	Lake Valley and Hillsboro
Epidote	San Pedro copper mines
Epsomite	Estancia lakes
Erubescite	Black Range, Cooney mine
Euclase	Reported found (?)
Fiorite	Occurs in volcanic tufa
Flint	Various localities
Fluorite	Gila River and Sierra Oscura
Franklinite	Central mining district

Gahnite	Cerillos mining district
Galenite	Cooks Peak and Magdalena districts
Glauberite	Estancia lakes
Gold	Elizabethtown and Hillsboro placers
Goslarite	Graphic mine, Magdalena Mts.
Graphite	In Raton and Sandia mountains
Grossularite	San Pedro and Organ mountains
Guano	Extinct crater, near Engle
Gypsum	Ancho and plains of "white sands"
Halite	Estancia and crater salt lakes
Halotrichite	Gila River alum deposits
Hausmanite	San Lorenzo mining district
Hematite	Jones iron mines and elsewhere
Herrerite	Kelly mine, Magdalena Mts.
Hubnerite	Victorio mining district
Hyalite	Central and Cochiti districts
Hydro-zincite	Magdalena mining district
Ilmenite	Fierro and Hanover
Ilvaite	Fierro and Hanover
Idocrase	San Pedro and Organ Mts.
lodyrite	Lake Valley
Iridium	Hillsboro
Jadeite	Jicarilla mountains
Jasper	Canyoncito district
Jet	Vicinity of Santa Rosa
Kaolinite	Socorro mountains
Keyserite	Ladrones mountains
Labradorite	Various mountain localities
Lead	Lead
Lepidolite	Copper Hill, Cieneguilla mining district
Lerchenite	Tres Hermanas Mts.
Lieverite	Hanover and Fierro
Lignite	Gallup and elsewhere
Limonite	Many districts
Magnetite	Fierro
Malachite	Santa Rita and Las Vegas
Manganite	Lake Valley
Manganosite	San Lorenzo mining district
Marble	Near Alamogordo and elsewhere
Marcasite	Manzano mountains
Marionite	Graphic mine
Massicot	Chloride flat
Melaconite	Black range and Santa Rita
Melanotekite	Hillsboro, Las Animas district
Miargyrite	Kingston and Palomas camps
Mica	Petaca and Nambé
Microcline	Various mountain ranges
Millardite	Lake Valley mine
Mimetite	Socorro Mountain

Minium .... Hachita (Eureka mining district)
Mirabilite .... Estancia lakes
Molybdenite .... San Miguel county
Monazite .... In Chama river sands (?)
Monheimite .... Graphic mine, Magdalena Mts.
Moonstone .... San Mateo mountains
Muscovite .... Petaca, Nambé and Talco
Nickel .... Upper Pecos region
Novaculite .... Sangre de Cristo mountains
Obsidian .... Santa Fe mountains
Ocher .... Sandia mountains and San Pedro
Octahedrite .... Central mining district
Odontolite .... Nacimiento mountains
Oligoclase .... Various mountain regions
Olivine .... Common in basalts
Opal .... Cochiti and Central districts
Orthoclase .... Various mountain regions
Pectolite .... Cieneguilla district
Peridot (Peridotite) .... Zuni Indian reservation
Petalite .... Cieneguilla, Copper Mountain district
Petroleum .... Seven Lakes and Pecos Valley
Petzite .... Lookout mine and La Belle district
Phlogopite .... Nambé
Pistacite .... Red River
Platinum .... Tampa mine, Bromide No. 2 district
Plattnerite .... Cooks Peak and Central districts
Plumbojarosite .... Cooks Peak
Polybasite .... Telegraph mining district
Proustite .... Kingston and Bullard's Peak
Przibramite .... Carpenter mining district
Psilomelane .... Near Rincon, Caballo mountains
Pumice .... Near Grants P. O. and Socorro
Pyrargyrite .... Bullard's Peak and Kingston
Pyrite .... Various mining districts
Pyrolusite .... San Lorenzo mining district
Pyromorphite .... Macho district
Pyrostilpite .... Kingston and Bullard's Peak
Pyrrhotite .... Fierro and Hanover
Quartz .... In various mines
Radium .... Limitar mountains and Petaca
Rhodocrosite .... Graphic and Kelly mines
Rhodonite .... San Lorenzo mining district
Ricolite .... Gila river, near Red Rock
Ruby .... Reported found at Zuni (?)
Rutile .... Central district
Samarskite .... Las Tablas, Petaca district
Satin spar .... East of Strawberry Peak, Socorro
Scheelite .... Victorio mining district
Selenite .... Pittsburg district, Caballo mountains

Siderite	Granite Gap mine
Silver	Silver Bell mine
Smithsonite	Magdalena mining district
Specularite	In many contact deposits
Sphalerite	Cerillos and Carpenter districts
Spodume	Cieneguilla district
Staurolite	Cieneguilla and Copper mountains
Steatite	Various localities
Stephanite	Bromide mine, Rio Arriba county
Sternbergerite	Cooney mining district
Stibnite	Cerrillos mining district
Stilbite	Baldy mountain, Colfax county
Sulphur	Sulphur springs, Jemez mountains
Sylvanite	Trujillo Creek, Sierra county
Talc	Numerous localities
Tantalite	Mountains near Las Vegas
Tennantite	Pinos Altos and Central districts
Tenorite	Santa Rita mines
Tetradymite	Sylvanite district
Tetrahedrite	Pines Altos and Central districts
Thorium	Las Tablas
Titanite	Central mining district
Torbernite	Jerome mine, San Lorenzo district
Tourmaline	Bromide district No. 2
Travertine	Salt Lake crater, Socorro county
Tremolite	Various mountain ranges
Tripolite	Reported near San Antonio and Socorro (?)
Troostite	Magdalena mining district
Tufa	In eruptive regions
Turquoise	Cerrillos and Burro Mountain districts
Uranophane	Jerome copper mine, Socorro county
Vanadinite	Georgetown and Cerillos
Vesuvianite	San Pedro copper mine
Wad	Central mining district
Wheelerite	In Gallup-Durango coal beds
Willemite	Merritt mine, Socorro county
Witherite	Sierra Oscura and San Andreas
Wolframite	Copper Hill and Victorio mining district
Wollastonite	San Pedro and Organ mountains
Wulfenite	Stephenson-Bennett mine
Xanthoconite	Cerrillos mining district
Yttrium	Las Tablas, Rio Arriba county
Zaratite	San Miguel county
Zoisite	San Pedro and Organ mountains
Zincite	Magdalena mountains
Zinco-calcite	Kelly mine, Magdalena mountains
Zinkosite	Graphic mine, Magdalena mountains
Zirconite (Zircon)	Jarilla mountains



LIST OF MINING DISTRICTS

BERNALILLO COUNTY

No. — Key
1 Bernalillo, Cu Pb.......E-4
2 Coyote Springs, Pb......F 5
3 Hell Canon (Star), Au..E-5
4 Tijeras Canon, Pb.......E-4

COLFAX COUNTY

5 Baldy (Ute Cr.), Au Pl.H-2
6 Cimarroncito, Au H-2
7 Elizabethtown (Moreno Val.), Au Pl..........G-2
7 Moreno Valley (Elizabethtown), Au Pl......G-2
8 Ponil, Au H-1

DONA ANA COUNTY

9 Black Mt., Au Ag.......E-9
10 Hembrillo, Cu Pb.......E-9
11 Modoc, Pb Ag..........E-10
12 Organ Mts, Pb Ag Cu...E-9
13 Rincon, Cu Mg.........D-9
14 San Augustine, Au.....E-10
15 Texas Creek, Au Ag....F-9

GRANT COUNTY

16 Anderson, Cu Ag........A-9
17 Apache No. 2, Cu (Au Ag) B-11
18 Bear Mt., Ag............B-9
19 Black Hawk, Ag.........B-9
20 Burro Mt., Cu..........B-9
21 Carpenter, Zn Pb.......C-9
22 Central, Cu Pb Ag (Zn).B-9
23 Chloride Flat (Silver City), Ag Pb B-9
24 Clark's Peak, Ag.......A-9

No. — Key
25 Cow Sp. (White Signal), Au B-9
26 Eureka (Hachita), Ag Pb Cu Zn...........B-10
27 Fierro, Fe Cu..........B-9
28 Georgetown, Ag (Pb)....C-9
29 Gillespie, Pb Ag.......A-11
30 Gold Hill, Au...........B-9
31 Granite Gap (San Simon), Pb Ag A-10
32 Hanover, Cu Zn Fe......B-9
33 Kimball (Steins Pass), Ag Au Cu...........A-10
34 Lone Mt., Ag..........B-9
35 Lordsburg, Au Ag Cu..A-10
36 Malone, Au B-9
37 Mimbres, Ag Pb.........C-9
38 Pinos Altos, Cu Au Pb Ag Zn B-9
39 Pyramid, Ag Cu.......A-10
31 San Simon (Granite Gap), Pb Ag A-10
40 Santa Rita, Cu.........B-9
41 Steeple Rock (Carlisle), Au Ag Zn...........A-9
42 Steins Peak, Ag........A-9
43 Sylvanite, Au Cu.......B-11
44 Telegraph, Ag..........A-9
35 Virginia (Shakespeare), Ag Cu (Au Pb).....A-10

LINCOLN COUNTY

45 Bonito (Parsons), Au...G-8
46 Capitan, Au G-7
47 Cedar Cr. (Alto), Ag Cu Pb G-8
48 Estey, Cu F-7

No. — Key
49 Gallinas (Red Cloud), Au Ag Pb Fe.........G-6
50 Jicarilla, Au Pb........G-7
51 Little Burro Mts., Cu Ag Zn F-7
52 Nogal, Au Ag Cu.......G-7
53 Tecolote, Fe G-6
54 Vera Cruz, Au..........G-7
55 White Oaks, Au Ag (Pl) Fe G-7

LUNA COUNTY

56 Carrizalillo, Ag Cu Pb..B-10
57 Cook's Peak, Pb Ag Zn.C-9
58 Florida Mts., Ag Pb Cu.C-10
59 Fremont, Pb Ag Cu....B-11
60 Gage (Victorio), Pb Ag Zn B-10
61 Tres Hermanas, Au Ag Pb Zn C-10
60 Victorio, Pb Ag Zn....B-10

MORA COUNTY

62 Mora, Cu G-2

OTERO COUNTY

63 Guadalupe Mt., Cu Au..H-9
64 High Rolls, Cu.........G-8
65 Jarilla (Silver Hill), Au Ag Cu Fe............F-9
66 Rio Tularosa, Cu Au....F-8
67 White Mt., Au Cu......F-8

RIO ARRIBA COUNTY

68 Abiquiu, Cu F-2
69 Bromide No. 2, Cu Au Ag.F-1
70 Chama Placers, Pl F-2
71 Gallina, Cu E-2

No. — Key
72 Headstone (Hopewell), Au Pl Ag Cu.............F-1
73 Petaca (mica) F-2
74 Vallecitos, Au Ag Cu...F-2

SANDOVAL COUNTY

75 Cochiti (Bland), Au Ag.F-3
76 Nacimiento (Cuba), Cu..E-3
77 Nero Placers F-4
78 Placitas, Cu Au Pb.....E-4
79 Sandia, Ag Pb E-4

SAN MIGUEL COUNTY

80 Cooper (Pecos), Cu Au..G-3
81 Las Vegas Mines, Cu....G-3
82 Mineral Hill, Cu........G-3
83 Rio de la Vaca.........G-4
84 Rociada, Cu G-3
85 Tecolote, Cu G-4

SANTA FE COUNTY

86 Cerrillos (Galisteo), Pb Ag Zn F-4
87 Glorieta, Cu G-3
88 Mailleuchet, Au Cu.....F-3
89 Nambe, Au Ag..........F-3
90 New Placers, Au (Pl)...F-4
91 Old Placers (Ortiz Mine (Gt), Au (Pl).........F-4
92 Rio Galisteo, Pl........F-4
93 San Pedro, Cu Au Ag..F-4
94 Santa Fe, Cu Ag.......F-3

SIERRA COUNTY

95 Apache No. 1 (Chloride), Ag Cu Au...........C-8
96 Black Range, Ag Cu Au.C-8

No. — Key
97 Bromide No. 1 (Tierra Blanca), Ag Pb C-9
98 Caballos Mts., Cu Pb....D-8
99 Cuchillo Negro (Limestone), Fe Cu Zn Pb..........D-8
100 Hermosa (Palomas), Ag Pb C-8
101 Hillsboro (Las Animas), Au Ag C-8
102 Iron Reef, Ag Pb.......D-8
103 Kingston, Ag Pb Zn.....C-9
104 Lake Valley, Ag Pb......C-9
105 Macho, Ag Pb Cu.......C-9
106 Perche, Au Ag..........C-9
107 Pittsburg (Shandon), Au Pl D-9
108 San Andreas, Cu Pb...E-8
109 San Cristobal, Ag Cu...D-8

SOCORRO COUNTY

110 Abbey, Cu Pb..........D-6
111 Alumina, Alum B-8
112 Amy, Cu D-6
113 Canyoncito, Pb E-6
114 Cat Mt., Au Cu.......D.6
115 Cooney, Au Ag Cu.....A-8
116 Council Rock (Iron Mt), Ag D-6
131 Encarnacion (Socorro), Ag E-6
117 Hansonberg, Cu F-7
118 Hop Canon (Mill Can.), Au Ag Cu Au.......D-7
119 Jones Camp, Fe F-6
120 Kelly (Magdalena), Zn Pb Au Ag Cu........D-6
121 Ladrones, Au Cu........D-6

No. — Key
122 La Joya Mt. (Joya Mt), Cu Ag Pb............E-6
123 Limitar, Cu Pb.........D-6
120 Magdalena (Kelly), Zn Pb Au Ag Cu.........D-6
124 Mogollon, Au Ag Cu....A-8
125 Oscura Mt., Pb F-7
126 Pueblo, Ag Pb Cu Zn....D-6
127 Red Hill, Au..........D-7
128 Rosedale, Au Ag........D-7
129 San Lorenzo, Cu D-6
130 Silver Mt. (Water Can.), Au Ag Cu Pb.........D-6
131 Socorro (Encarnacion), Ag E-6
132 Spring Hill, Cu D-6

TAOS COUNTY

133 Anchor (LaBelle), Au Ag G-1
134 Black Copper, Au G-1
135 Picuris (Copper Hill), Cu Ag G-2
136 Red River, Au Ag Cu...G-1
137 Rio Colo. Placers, ...G-1
138 Rio Grande Placers, Pl..G-2
139 Rio Hondo (Twining), Cu Au Ag G-2
140 Taos G-2

TORRANCE COUNTY

141 Manzano, Cu E-5
142 Mud Springs, Fe Cu....F-6

VALENCIA COUNTY

143 Mount Taylor, Cu Pb...C-4
144 Zuni Mt. (Copperton), Cu B-4

Abbreviations for Metals

Gold ....Au
Silver ....Ag
Copper ....Cu
Lead ....Pb
Iron ....Fe
Zinc ....Zn
Placer Gold ....Pl