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1946

MINERAL RESOURCES OF COLFAX COUNTY, NEW MEXICO

By

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INTRODUCTION

GENERAL STATEMENT

The purpose of this report is to outline the history of mining in Colfax County, to give production figures to date, and to suggest future possibilities within the mining districts. It treats primarily of the metallic resources, as studies of the coal resources have been previously published by the U. S. Geological Survey (Lee, 1922, 1924). The report is intended as a guide for those who are interested in exploiting the mineral wealth of the county, and as a summary of geological investigations prior to 1946.

Available records of past operations have been consulted, many of the former and currently producing properties have been visited, and data ~~has~~ HAVE been obtained from old records made available to the writer. Information on the geology has been assembled primarily from reports and maps, both private and published, and from reconnaissance field work done in the summer of 1946. This report may be considered as a supplement to Bulletin 15 of the New Mexico Bureau of Mines and Mineral Resources, "The Geology and Ore Deposits of Northeastern New Mexico (Exclusive of Colfax County)" (Harley, 1940), in order to complete the picture in the northeastern part of the State.

ACKNOWLEDGMENTS

The writer received much courteous and valuable assistance from citizens of Colfax County, and from others who have been associated with the mineral industry there at various times. These include R. H. Faxon, former secretary of the Raton Chamber of Commerce; V. J. van Lint, manager of the Maxwell Land

Grant Company; G. O. Arnold, manager of the Stag Canon Branch, Phelps Dodge Corporation; James Barber, Sr., L. C. White, J. R. Kastler, and Joel Van Sant, of the St. Louis, Rocky Mountain & Pacific Company; H. E. Wilson, division engineer, Atchison, Topeka and Santa Fe Railway Company; O. J. Hammond, Elizabethtown; Wm. Lowery, Eagle Nest; Frank Gumm, Jr., Raton; C. T. Griswold, Albuquerque; Robert Lingle of the Maxwell Irrigation Company; Howard Ashbaugh, county treasurer, Colfax County; I. E. Pippert, Cimarron; Matt Gorman, Trinidad, Colorado; and Jesse Paddock, Tungsten, Nevada. Many owners of small mines were generous in furnishing information.

Personnel of the New Mexico Bureau of Mines and Mineral Resources edited the report, furnishing additional information and constructive criticism. Determination of minerals was made by the Department of Geology of the New Mexico School of Mines. Professor Georges Vorbe of this department also furnished information on geology from personal observations within the area.

GENERAL FEATURES

GEOGRAPHY

LOCATION

Colfax County is a roughly rectangular area, 3,798 square miles in extent, situated in northeastern New Mexico (Figure 1). It adjoins Colorado on the north, and is bounded on the east by Union County, on the south by Harding and Mora Counties, and on the west by Taos County. Until 1860 the area now occupied by Colfax County was included in Taos County, and from 1860 to 1869 was a part of Mora County. Union County was created from a part of Colfax County in 1893. Much of the early history and land titles are recorded in the records of these counties.

TOPOGRAPHY

The southeastern part of the county consists of rolling prairie. It is a part of the Great Plains (Figure 2), and lies at altitudes of 6,000 to 6,700 feet. The prairie is slightly dissected by arroyos that are tributary to the Canadian River, which roughly bisects the county from north to south. A few dikes, volcanic cones, and lava-covered hills stand out sharply from the plains in the eastern part, becoming more prominent and numerous to the north.

Bordering the plains on the north and northwest is an escarpment standing from 1,000 to 2,000 feet above the plains surface and merging on the southwest with the high foothills of the Cimarron Range. Northwest of this line of cliffs lies a high plateau, the Raton Mesa. This plateau, which ranges in altitude from 8,000 to 10,000 feet, is deeply and sharply dissected by streams that flow east and southeast into the Canadian River.

The western boundary of the county lies along the crest of the Sangre de Cristo Range, which is the southern extension of the Rocky Mountains. The mountains are termed locally, from north to south, the Culebra, Taos, and Mora Ranges. Altitudes range from 10,000 feet along the eastern foothills to 13,145 feet on Taos Peak, the highest point in Colfax County.

In the southwest part of the county the Cimarron-Baldy Range, of somewhat lower elevation, parallels the main range on the east. It merges at the south edge of the county with Ocate Mesa. Between the Taos and Cimarron Ranges is the narrow steep-sided Moreno Valley, occupied by the Moreno and Cieneguilla Rivers. At the junction of these two to form the Cimarron River is Eagle Nest Lake, a man-made and much smaller reproduction of a prehistoric lake which at one time occupied this region. The Cimarron River flows eastward from this lake and joins the Canadian River.

CLIMATE AND VEGETATION [1]

[1] Based on U. S. Department of Agriculture, Climatic Summary of the United States, Northeastern New Mexico Section, 1930.

Average annual precipitation varies from 17 inches on the plains east of the Canadian River to between 25 and 30 inches in the mountain region. West of the Canadian River annual precipitation averages 18 inches, while over most of the plateau it averages 20 inches.

Normal temperature variations are as follows. Plains area: minimum, ~~-30~~ 18° F., maximum, 100° to 108° F., mean, 57° F. Plateau area; minimum, -30° F., maximum, 100° to 105° F., mean, 50° F. Mountain area: minimum, -30° F., maximum, 90° to 95° F., mean 40° to 45° F. Altitude has a marked effect on temperature; protected or exposed points vary markedly from the figures given.

Usual periods during which damaging frosts are not expected are, for the plains area, April 20 to October 20, and for the plateau area, May 10 to October 10. In the mountain area, frosts may occur at any time. Relative humidity averages about 50 percent.

The plains area is well covered with grass and browse. Alfalfa and some grains are cultivated near streams. The plateau area is timber country. Several kinds of pine and spruce are cut for lumber. Canyons and wide openings or parks are grassy, and the parks are frequently cultivated. The lower Cimarron Valley contains some famous old orchards. Moreno Valley is covered with grass, and is excellent grazing country. The mountain area is timbered with the exception of a few bare peaks.

Permanent streams occupy the canyons of the plateau region. Permanent and semi-permanent lakes are found on lava-capped mesas and in undrained areas underlain by shale. Caves in lava on Johnson Mesa are known to contain ice the year around, and in one an underground glacier exists.

MAXWELL LAND GRANT

Roughly three-fifths of Colfax County is included in the Maxwell Land Grant. This is an estate originally granted to Carlos Beaubien and Guadalupe Miranda by the Mexican government, as represented by Manuel Armijo, the governor of New Mexico, on January 11, 1841. As finally confirmed by the United States in 1887, it contains 1,714,765 acres, of which 1,456,342 acres (85 percent) lie within Colfax County, the remainder being in Las Animas County, Colorado. It is the largest Mexican or Spanish land grant within the United States.

Many legal disputes arose before title was secured in the Maxwell Land Grant Company. The two original grantees were placed in possession by Don Cornelio Vigil, Justice of the Peace, on February 22, 1843, and the boundaries of the Grant, which were later in much dispute, were marked at that time. Complaints as to the advisability of making this grant were made, and the Grant was suspended on February 27, 1844, by Don Mariano Chavez, the interim governor. Armijo was reappointed governor on April 13, 1844, and the Grant was re-confirmed by council two days later. Beaubien and Miranda made only minor attempts at settlement, but Lucien B. Maxwell, son-in-law of Beaubien, established a ranch at the Rayado River in 1844.

The American Occupation wrested control of the government from Mexico in 1846, and by the treaty of Guadalupe Hidalgo the next year the American government became bound to respect all grant titles issued by the Mexican government. Beaubien and Miranda promptly put in their claim for recognition, and on September 25, 1857, Surveyor General Pelham declared it to be valid. On June 21, 1860, a congressional act confirmed the title, using for description the words of the original grant, which are to some degree ambiguous. Maxwell had, on April 7, 1858, become owner of Miranda's interest in the Grant, paying the sum of $2,745 for what was probably a one-half interest. Charles Bent, first governor of New Mexico after the American Occupation, acquired an interest in the Grant, which was held in a

suit by his heirs to have been a one-fourth part. After Beaubien's death in 1864, Maxwell was the owner of one-half, and bought out the interests of the other claimants, becoming sole owner before 1869.

On January 17, 1869, John B. Dawson received a deed from Maxwell to an indefinitely described tract of land on the Vermejo River which figures later in the history of the Grant. On May 6, 1869, Maxwell gave an option on the undeeded remainder of the Grant to Jerome B. Chaffee, with whom was associated Wilson Waddingham; and to George M. Chilcott and Charles F. Holly. The option price was $650,000, and on April 30, 1870, the option was transferred to the newly-formed Maxwell Land Grant and Railway Company, an English and Dutch concern, and taken up for $1,350,000 on June 12, 1870. The home ranch of 1,000 acres, excluded from the first sale, was bought on August 24, 1870, for $75,000. The boundaries of the Grant had yet to be officially surveyed, and most of the lands included within the present Grant were thrown open as public lands by the Department of the Interior in 1874. By 1875 the original company was bankrupt and the land was in tax trouble. A reorganization of the company took place, with its stock fluctuating wildly on the London market. On March 11, 1878, a committee of bondholders foreclosed, and the final reorganization was completed May 3, 1880, with the transfer of title to the Maxwell Land Grant Company, chartered by the King of Holland, shortly after the final boundaries were defined in the patent from the United States government dated May 19, 1878. This patent was unusual in that it was a quitclaim deed only.

The new company's policies toward settlers and miners were ruthless, and these men protested violently. Their most influential adherent, the Reverend O. P. McMains, was successful in persuading United States officials to institute suit against the company, charging fraud in enlarging the size of the granted area by the amount of 1,692,765 acres. The suit was carried to the United States

Supreme Court, which on April 18, 1887, finally established title by affirming that the Congress of the United States had adjudged the land grant to be perfect, and that its legality could not be questioned by the courts. This in spite of the facts that the original boundary descriptions may well have been intended to convey a much smaller tract, and that these descriptions were the subject of the proceedings. The arguments presented to the court by Frank Springer, attorney for the company, are said to be remarkable for their brilliance. Settlers and miners were soon forced to leave, or to acquire their title rights from the Maxwell Land Grant Company. However, John B. Dawson, one of the early settlers, held a deed from Maxwell, and although the company attempted to evict him, his deed was held valid by the courts. His holdings, at first thought to be relatively small, were adjudged to contain 20,000 acres. This suit was commenced in 1891, decision rendered in 1901, and the Dawson ranch, except for a small holding, was sold to C. B. Eddy and associates, as the Dawson Fuel Company, on October 3, 1901, for $400,000. Eddy constructed the El Paso and Northeastern Railroad to serve the new camp, and sold railroad and mines to the Phelps Dodge Company on July 1, 1905.2/

2/ From ~~Maxwell Land Grant, W. A. Keleher, 1942, and~~ Keleher, W. A., Maxwell Land Grant, 1942; The Fabulous Frontier, ~~W. A. Keleher,~~ 1945.

During the period of Maxwell's ownership gold was discovered on the Grant, a gold rush ensued, and Elizabethtown was founded. Claims were freely staked under miners' regulations and the laws of the United States pertaining to public domain. Maxwell attempted to assert title to these lands, but apparently did not realize a great deal from the placers. Probably to avoid violence, he entered into partnerships with discoverers of lodes, and staked some claims himself. During 1869 claims were staked acknowledging ownership by Maxwell, and at least one lode claim was deeded by Maxwell, who signed himself "Proprietor

The Moreno Mining District". Although the discovery of the district is not credited to Maxwell, he undoubtedly knew of the presence of placer gold on his property years before the find just referred to. He participated in financing the "Big Ditch", which furnished water to the placers, and joined with the original claimants in the now famous Aztec mine, on his own property.

The Maxwell Land Grant and Railway Company, immediately upon obtaining title, laid claim to a royalty from the gold production and stirred up a hornet's nest. The miners protested, held mass meetings, and refused to pay. Very few, if any, royalty payments were made to this company and the cream of the production had been skimmed before its successor company was in a position to enforce its demands. The contest over ownership also resulted in some secrecy, and the total value of metals produced in that time can only be estimated.

The Maxwell Land Grant Company early recognized that the mineral values present could only be developed by mining men, and commenced to encourage prospector to a limited extent. As early as September 16, 1881, the company, under the authority of an act of the Territorial Legislature dated February 15, 1878, published a copy of the "Rules Governing the Acquisition of Titles to Mines within the Maxwell Grant". These rules provided for a gift of a 99-year lease for an undivided one-half interest in any mining claim discovered and located by any person discovering a lode or vein in place, if the discoverer located the claim on the ground within 20 days, marked its boundaries, posted notice of discovery, and filed a copy of the notice in the company offices at Cimarron. Within 3 years he must have sunk a shaft or driven a tunnel a total of 30 feet on the vein, caused the claim to be surveyed, and deposited a copy of the survey with the company. The size of the claims were to be 1,500 feet by 300 feet, the end lines were required to be parallel, and the right of possession extended for the full depth of the lode, within the planes of the end lines extended downward.

Failure to comply fully with the regulations not only worked a forfeiture as to the discoverer, but also operated as a perpetual withdrawal of the posted claim from further entry. No placer claims were contemplated.

On April 6, 1894, following the recommendations of Van Diest and St. Auburn, geologists employed to estimate the value of the minerals within the Grant, the regulations were liberalized, veins of coal and iron were excluded, and the area upon Iron Mountain was reserved from location. Discoverers were allowed to stake claims not less than 300 nor more than 600 feet in width, and not more than 1,500 feet in length along the vein or lode; and one of the end lines was required to be no more than 50 feet from the point of discovery. Sixty days were allowed in which to mark the boundaries of the claim, sink a discovery shaft at least 10 feet, post a notice, and file a copy with the company. One year from location was allowed for the completion of at least 20 feet of shaft or tunnel work upon the vein, and the filing of an application for official company survey of the claim (with payment of $95.00 expenses for the survey). The Maxwell Land Grant Company then laid claim to an extension of the claim from the end line nearest the point of discovery, thus withdrawing it from entry. After completion of the survey and publication of the application for a deed, and in the absence of the filing of an adverse claim, and upon payment of $10.00 per acre, a title in fee passed to the claimant. Under this policy, the company designated much of its ground as mining land by surveying its extensions, and these have since been treated as mining claims, and sold and taxed under laws relating to mining claims, although many of them show no indication of valuable minerals.

Mill sites might be selected with the approval of the company, and surveyed and paid for in a manner similar to that provided for mining claims. Prospect tunnels might be run by special arrangement. Amendments to these regulations

were published July 11, 1895, restricting the widths of claims ~~under the foregoing~~ to 300 feet or less. References are found in the mining-claim records of the company to locations filed under Regulations published April 15, 1897, and April 12, 1899, but copies of these ~~were not~~ are no longer available. On December 5, 1901, further regulations appeared without material change except as follows. Methods of boundary marking were specified, all placer ground was positively reserved to the company, and the Maxwell extension claims were to revert to the status of unlocated land after one year from abandonment or forfeiture by the discovery claimant if survey had not been made, and after two years if survey had been made. Holders of undeeded claims were permitted to cut timber on the claims for use in development work. The last recorded claim under these regulations was located October 20, 1909, and recorded January 3, 1910. Since 1909 the company's policy has been to exclude their lands from all mineral locations, although recognized mining claims belonging to the company may be leased.

In 1879 the Santa Fe Railway reached the State at Raton, and 3 years later opened a coal mine at Blossburg (Dillon Canyon). In February 1881 the Raton Coal & Coke Company was formed by officials of the Maxwell Land Grant Company and the Santa Fe Railway (one-half interest each), and the new company took over the mines which had been operated by the Santa Fe. The Raton Coal & Coke Company was succeeded on June 8, 1905, by the St. Louis, Rocky Mountain & Pacific Company. This concern acquired the fee title to 212,000 acres of land on the Grant, 150,000 of which are estimated to contain coal and 20,000 to contain beds ~~be~~ of workable thickness. It also acquired coal rights on 350,000 additional acres, of which 7,000 are estimated to contain workable coal. The Maxwell Land Grant Company today owns less ground within the Grant than the St. Louis, Rocky Mountain & Pacific Company, owning as of August 1946 approximately 180,000 acres outright, and controlling

mineral rights in whole or in part on additional acreage as follows (to the nearest 1,000).

Type of lease	Acres
Coal	156,000
Minerals	166,000
Cement	126,000
Oil	184,000
Timber	56,000
Total	668,000

CULTURE

The population of Colfax County according to the 1940 census was 18,718. The largest town is Raton, the county seat, with a population of 7,607. Raton is a railroad division point and serves as a shipping and supply point for coal-mining and livestock-raising companies. Offices of the St. Louis, Rocky Mountain & Pacific Company are located there, and shops are maintained by the Atchison, Topeka and Santa Fe Railway. The Maxwell Land Grant Company also has offices in Raton. Other important towns in the county are Springer, Cimarron, Dawson, Brilliant, Koehler, Maxwell, and French.

The major industries are livestock raising, logging, railroading, farming, coal mining, and coke production. Livelihood is also derived from resort ranching and tourist trade.

Colfax County is crossed from north to south by U. S. Highway 85 and from east to west by U. S. Highway 64. The southeastern part of the county is served by paved State Routes 39 and 58, and the remainder of the county by unpaved roads.

Two major railroads have lines within the county. The main line of the Atchison, Topeka and Santa Fe Railway enters New Mexico from the north through Raton Pass, crosses Colfax County, and after paralleling the Canadian River as

French, leaves the county at Colmor near the middle of its southern border. A branch line of the Southern Pacific Railroad from Tucumcari enters the county from the south about 8 miles east of the Canadian River, crosses the river and the Santa Fe Railway at French, and continues up the Vermejo River Valley to the coal-mining center of Dawson.

Three former branches of the Atchison, Topeka and Santa Fe Railway, connecting with Des Moines, Yankee, and Ute Park, have been taken up, as has a line called the Santa Fe, Raton and Eastern, from Raton through Sugarite and as far east as Cunningham.

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GEOLOGY

GENERAL STATEMENT

The sedimentary rocks of Colfax County include at least 24 formations with an aggregate thickness of approximately 10,000 feet. They rest upon pre-Cambrian igneous and metamorphic rocks, and have been repeatedly intruded by andesitic and basaltic rocks. Volcanic lavas have overflowed the sediments at times.

The classification, thickness, and character of the rocks of Colfax County are shown in Table 1. Additional features are discussed in the following section. A generalized geologic map of the county (Plate 1) has been prepared from previously published reports.

DISTRIBUTION AND TOPOGRAPHIC EXPRESSION OF THE ROCKS

Pre-Cambrian rocks form the cores of the Taos and Cimarron ranges in the southwestern part of the county, where they form rounded ridges and deep valleys. They constitute the basement complex of the whole region.

The oldest of the sedimentary rocks is the Pennsylvanian system, which is widely exposed along the east slope of the Taos Range, in the Culebra Range from Costilla Peak northward, in the Moreno Valley, and less continuously in the Cimarron Range south of the Cimarron River. The Pennsylvanian rocks probably correspond in age to those designated in central New Mexico as the arkosic limestone member of the Madera formation. Some of the rocks now considered Pennsylvani may be classified in the future as of Permian age. Although Pennsylvanian rocks crop out only in the west, they are believed to underlie most of the Raton Basin, overlapping pre-Cambrian rocks against buried mountains. A negative area during Pennsylvanian time, with a resulting great thickness of Pennsylvanian rocks, occurred along a north-south axis slightly west of the present Moreno Valley (Ray and Smith, 1941).

Pettit

Permian rocks have not been separated from Pennsylvanian in surface mapping to date, but have been noted in cuttings from wells drilled in the Raton Basin in the south central portion of the county. The rocks mapped as Pennsylvanian about Rayado Peak (Plate 1) may be in part Permian.

Triassic rocks have been reported (Endlich, 1875) in the region north of Costilla Peak, and they may be present near Palo Flechado Pass and farther south in the Tetas and Cimarron Ranges. As they are found in well cuttings as far north as Township 27 North, and are exposed in the Canadian River Valley about 8 miles south of Colfax County, they doubtless underlie the entire Raton Basin.

Jurassic rocks are present near Costilla Peak and from the head of Cieneguilla Creek southward. The Morrison formation is brought to the surface in places along small folds on the west limb of the Sierra Grande Arch.

Pettit

On the basis of available information it is impossible to map separately the Purgatoire and Dakota formations of Cretaceous age. Most of the area shown on Plate 1 as underlain by Dakota probably contains both formations. The sandstones of these formations are highly resistant to erosion, and form prominent hogbacks in the foothills of the Cimarron Range. They are also present in the northern part of this range, in the Moreno Valley, in the canyon of the Cimarron

River near where it leaves the county, and over a large portion of the east side of the county. A noticeable increase in thickness of Dakota sandstone in the Moreno Valley was attributed by Ray and Smith (1941) to accumulation in a syncline somewhat east of the syncline of Pennsylvanian time; but it is possible that the apparent thickness is due to concealed faults. The formations between the Dakota sandstone and the Trinidad sandstone cover most of the plains area within the county, and the uppermost, the Pierre shale, crops out in many places throughout the Plateau region, on Baldy Peak, and in the Moreno Valley. These formations are soft and easily weathered; they form rolling country in the plains, and slopes and parks in the canyons of the Plateau country.

The Trinidad sandstone crops out as a prominent escarpment, or as the lowest of several cliff-making sandstones, along the edge of most of the plateau (~~Plate 2~~) and along the rim of Johnson Mesa. The coal-bearing Vermejo formation overlies the Trinidad sandstone at most places where the latter is exposed, but is locally absent owing to an erosional unconformity between Cretaceous and Eocene strata. In places some of the sandstone members of the Vermejo are cliff makers.

The Raton formation of Eocene age is the caprock of nearly all the Plateau region, is present as scattered remnants in the Moreno Valley, and underlies some of the lava-topped mesas along the north boundary of the county. It contains a basal conglomerate, usually cliff-making; two coal-bearing horizons, separated by several hundred feet of barren sandstones and shales that locally form cliffs or steep slopes; and an upper barren zone. On the plains to the southeast, and on the east limb of the Sierra Grande arch, is a loosely consolidated gravel assigned to the Ogallala formation (Pliocene) by Darton (1928).

Andesitic lavas cover Meloche Mesa, Hunter Mesa, Green Mountain, and a part of Johnson Mesa around Towndrow Peak. These have been considered Tertiary by some geologists, but were assigned to the Pleistocene by Mertie (1922), together

with basaltic lavas both older and younger. Under, between, and above the various lava flows are loose gravels, poorly consolidated conglomerates, and silts of Pleistocene age. Stream debris, rock slides, talus slopes, loess, and terrace gravels of Recent time are found in scattered localities.

STRUCTURAL FEATURES AND GEOLOGIC HISTORY

The major structural features of Colfax County (Figure 11) include the Sierra Grande arch, the Raton basin, and a part of the east limb of the southern Rocky Mountain anticline. The Sierra Grande arch is a wide low anticline, trending northeast, that crosses the southeast part of the county. It is believed to overlie a buried ridge of pre-Cambrian rocks. Its east limb is a gentle southeast-dipping monocline. Strata on the northwest side of the Sierra Grande arch dip into the Raton basin, a wide structural depression that underlies most of the county. The basin is markedly asymmetrical, with gentle dips on the southeast and steep dips on the west.

The Sangre de Cristo Range is a deeply dissected anticlinal feature with pre-Cambrian rocks at the center. In southwestern Colfax County the Cimarron-Baldy Range, an eastward-tilted fault block, is separated from the main Sangre de Cristos by the faulted syncline of the Moreno Valley.

Several minor anticlinal structures, some of which may reflect buried intrusions, lie on the northwest flank of the Sierra Grande arch (Figure 11). Their trend roughly parallels that of the major features. The Vermejo Park dome, on the west limb of the Raton basin, is an anticline that may have an igneous intrusion in its central part (Bates and others, 1942, p. 145).

No direct evidence of the history of this region from the Cambrian through the Mississippian periods can be found. From exposures to the north and south, however, Lee (1922) deduced that some rocks were deposited here during that

interval. These were removed by erosion prior to Pennsylvanian time. Pennsylvanian deposits indicating shoreline conditions alternate with limestones that indicate marine deposition. An uplift late in Pennsylvanian time brought the region above sea level, and conglomerates and redbeds of continental origin were laid down during late Pennsylvanian and Permian. Near the close of the Permian, seas encroached on the southern portion of the area, and the Glorieta sandstone and San Andres limestone were laid down.

Throughout Permian time highlands existed in the approximate position of the present Rocky Mountains. Sediments from these highlands filled the sea during Triassic time and drove it back, as indicated by the extensive Triassic redbeds of continental origin. The Jurassic period was chiefly one of erosion; by the end of this period a vast plain covered most of the county, with only a few mountain remnants present in the north. From this direction streams deposited extensive layers of reworked light-colored sand, interlayered with thin shales, which are now known as the Wingate and Morrison formations.

A subsidence and inflow of the sea introduced the Cretaceous period, of which the earliest representative is the Purgatoire formation. This unit and the overlying Dakota sandstone represent deposition along the shoreline of the advancing sea. Later Cretaceous rocks are alternating shales and limestones, whose great thickness suggests accumulation in a locally subsiding basin. The close of the Cretaceous indicates a filling of this basin and the deposition of another shoreline sandstone, the Trinidad, overlain by the coal-bearing Vermejo formation.

There followed a period of diastrophism, which was intense in other parts of the Rocky Mountains but was apparently not of large magnitude in the area of thi report. It was accompanied by widespread erosion that appreciably thinned the Vermejo in parts of Colfax County.

The basal Eocene Raton formation, like the underlying Vermejo, contains coal. The Raton formation reaches a maximum thickness of over 1,500 feet, owing to accumulation in a large syncline whose eastern and western margins roughly coincided with the present east and west boundaries of the county. At the end of the Eocene there was another uplift, probably of small magnitude, and the Raton formation was eroded by eastward-flowing streams. By Pliocene time a vast peneplain had been formed, which continued far to the east and of which remnants exist today (Plate 2). During the Pliocene or at its close the modern Rocky Mountains were uplifged as a broad anticline, the whole of the western continent was raised to about its present level, and erosion was revived. The Moreno Valley, a faulted syncline near the top of the southern Rocky Mountain anticline, was formed between the Taos and Cimarron Ranges, and several small structures on the limbs of the Sierra Grande arch were produced.

During the Pleistocene, ore-bearing monzonites and quartz monzonites of the Baldy Mountain (Cimarron) area were injected as sills and dikes. The dikes of this period — except near Baldy where they have a radiating pattern similar to those of the Spanish Peaks district, with which they are probably contemporary — have strikes ranging from due north to a few degrees west of north. Faulting accompanied or preceded the intrusion and probably localized the dikes. Other faults acted as channels for the formation of the ore deposits of the district.

Throughout the Pleistocene, erosion rapidly degraded the areas in which Cretaceous shales had been exposed or nearly exposed by Tertiary peneplanation. At intervals during Pleistocene degradation, basaltic and andesitic lavas were poured out over the plains, leaving lava-topped mesas at heights corresponding to the levels that erosion had reached at the time of extrusion. Pleistocene volcanic activity also produced dikes and sills, many of which intruded the coal-bearing formations and destroyed or replaced the coal seams or converted them to

coke or graphite. The dikes of this later period range in strike from nearly due west to N. 45° W., with the majority at about N. 70° W.

The present physiography has been influenced by the underlying geologic structure. The remnants of lava flows form mesa tops. The streams east of the Canadian River are mostly in dip or strike valleys on the harder formations within the shales. The Sierra Grande arch produces a low ridge, extending southwestward from the Sierra Grande in Union County near Des Moines toward the intersection of the Canadian River valley with the south boundary of Colfax County. Several folds along its west flank control the drainage for short distances. The dikes of the plains region form long ridges. One of the larger dikes is a prominent topographic feature from Black Mountain to Costilla Peak along the eastern slope of the Cimarron Range. The more resistant of the sedimentary rocks upturned along the flanks of the mountains have been eroded into hogbacks; the Dakota sandstone is especially prominent. Within the mountains, valleys lie along structural depressions, such as the Moreno Valley, along lines of structural weakness, such as the Cimarron Valley, and the deep valleys cut into the Raton formation along northwest-southeast faults. "Parks" have been formed in the plateau region in areas where erosion has exposed the soft Cretaceous shales. At least one of these, Vermejo Park, is formed over a dome.

HISTORY OF MINING IN COLFAX COUNTY

All the known mineralization in Colfax County occurs in the Cimarron-Baldy and Taos Ranges on the west. The first discovery that excited public interest took place in the early 1860's, when rich copper float was brought to Fort Union by a Ute Indian. Tracing the origin of this float resulted in the location of a copper property, probably the one known today as the Mystic claim, near the top of Baldy Peak (Plate 3.) In October 1866 the owners of this claim, William Kroenig, W. H. Moore, and associates, sent a party of men, including Larry Bronson, Richard P. Kelly, and Peter Kinsinger, from Fort Union to do the annual assessment

work. This party camped for the night on the west side of Baldy, some 4,000 feet below the peak, near the mouth of Willow Creek. Kelly went to the creek to wash out a few pans of gravel. Finding "colors" immediately, he told his companions, and they stayed there several days, washing gold and staking claims. Later they returned to Fort Union without having done the assessment work for which they had been hired. Although their intent was to keep their find a secret, the news leaked out. In the spring of 1867 a rush occurred, during which gold was discovered in most of the creek bottoms on the west side of Baldy. Among the earliest of those in the first rush was Mathew Lynch, who played the largest part in the early placer mining and discovered the first lode mine of the district. His hydraulics were the first in New Mexico, and he was the largest of the placer operators.

The water supply was small and uncertain, and large placering operations could not be based upon it. The early prospectors seem to have realized this immediately, for a survey of possible water sources was made, a construction company was formed, and work was begun on the "Big Ditch" on May 12, 1868. The survey, made by Captain N. S. Davis, an engineer of the United States Army, resulted in the construction of a ditch 41 1/8 miles long. This ditch diverted nearly 1,000 cubic feet per minute from the headwaters of the Red River, a tributary of the Rio Grande, at a point about 11 miles west of Elizabethtown. Three large lakes were constructed to serve as reservoirs along this ditch, and several smaller reservoirs were built on Baldy Mountain above the placers in order to accumulate enough water to operate the hydraulics. The work was practicall complete within six months. The rapidity of construction and the ingenuity shown is a monument to the ability of the men in charge, and to the engineering which made it possible. Although the ditch has not been used for over 50 years, it is still well marked; and some of the original flumes are still found in place on the sides of vertical cliffs, in locations that cause wonder at the final cost, including reservoir construction, of only $230,000. Seepage from the

ditch and leakage from the flumes, however, caused the loss of the major portion of the water, and the amount delivered was only about 75 cubic feet per minute.

The "Big Ditch" was owned and built by the Moreno Water and Mining Company, of which the original members were L. B. Maxwell, Capt. N. S. Davis, W. H. Moore, William Kroenig, John Dold, Col. V. S. Shelby, and M. Bloomfield. The first water was delivered to Humbug Gulch on July 9, 1869. Because of the tremendous losses of water the company was soon in financial difficulties, and the assets passed into the hands of Col. Shelby, who had loaned the company much of the money used in the construction. Maxwell was the next owner, but he was unable to make it pay and sold it to Mathew Lynch in 1875. Lynch was successful in making it pay, selling water for very high rates and using much of the water for his own large operations.

After the death of Mathew Lynch in 1880, Joseph Lowery succeeded him as the most prominent placer miner in the district, although the Lynch properties were operated by James and Patrick Lynch, brothers of Mathew. Lowery married Elizabeth Moore, and their son, William Lowery, still resides in the district, at Eagle Nest. He conducted the writer over many of the old properties, which are unmarked except in the memories of such oldtimers.

The first dredge began operations on September 19, 1901. The property of the El Oro Dredging Company worked the Moreno Creek bottom from one mile below Elizabethtown up to a point opposite Humbug Gulch, where the maintenance of the dredge became too expensive to permit further work.

The flush production was soon over, although the ground was placered continuously until 1904 and small operators have worked there intermittently ever since. Value of the placer production up to January 1, 1904 was estimated at $2,250,000 (Jones, 1904).

The miners organized soon after the first rush; some local regulations, more or less indefinite, were commonly observed as to size and location of claims,

assessment, etc.; but there is no record of these early regulations.

The Willow Creek district was organized on June 7, 1867, and reorganized August 25, 1867, with boundaries similar to those described in the discussion of the Willow Creek mining district. During the first year 355 claims were recorded in this district. Rules allowed each man four claims: (1) a ravine claim, 200 feet along the bottom and from bank to bank; (2) a hill claim, 200 feet along the stream by 300 feet toward the ridge; (3) a flat claim, 300 feet by 300 feet; and (4) a quartz or lode claim, 300 feet along the lode, with no width given. One extra claim of any type was allowed the discoverer on a new creek, hill, flat, or lode. Regulations required that each claim be worked one day in every 10, and at least once within 15 days after recording. Recording was not required as long as the claim was being steadily worked or prospected. All these claims were located under the public land laws, and attempts were made to locate land by this means as late as June 10, 1880.

On August 23, 1868, the Cimarron mining district was organized and a recorder appointed. The size of placer claims was limited to 300 by 300 feet. The records were turned over to the county clerk's office shortly after the formation of Colfax County, on August 29, 1869. During this period 92 claims were recorded, the larger part of the good ground having been staked long before. By the same year the Maxwell Land Grant Company had established title to the lands and had commenced suits to dispossess prospectors; most of them drifted away, or became lessees, acknowledging the title of the company.

The most prominent producing creek bottoms along the west slope of Baldy were the Willow, Humbug, Grouse, Big Nigger, and Pine, in approximately the order of their total production. From 1901 to 1903 a dredge operated in the Moreno Valley bottom, which for a time produced the major portion of the gold mined in the State. Very little gold was produced north of Pine Gulch, although colors were panned and claims worked in that area. A little gold came from the slopes

on the west side of Moreno Valley, but no source has been found there, and the production was very small. Placers were successfully operated in Ute Creek on the east side of Baldy, and in the South Ponil. Table 2 gives the estimated production of all the placer ground to date.

Prospecting by Mathew Lynch and Tim Foley in 1867 lead to the discovery of gold in flakes and nuggets on Ute Creek, which drains the southeast side of Baldy. Tracing this gold to its source, the next year they discovered and located the Aztec mine at the head of the creek on the ridge separating Ute Canyon from that of the South Ponil. This was, on the surface, a phenomenally rich find, and a fifteen-stamp mill was immediately erected. Mining commenced on October 29, 1868. The mine produced approximately $1,000,000 from veins in sandstone on this property within the next four years, after which the production declined and the property was sold. This rich find stimulated the search for others in the district, and the Montezuma mine was located the same year, followed by the French Henry in 1869, and others. None of these was as rich as the Aztec. Interest in prospecting continued as late as 1930, although the leading properties were all discovered before 1895.

Completed lode-mining locations made under Maxwell Land Grant Company regulations totaled 1,045, and at least 332 of these were deeded to the claimants. In addition to the locations made, some special tracts were sold under individual agreements, and nearly every claim had its counterpart, the Maxwell Extension. The Maxwell Land Grant Company acquired the more important claims during the period from 1910 to 1920, and, after operating all of them except the Aztec for a short time, closed the mines or turned them over to lessees. Production never reached the volume it attained in the early days, and gradually declined. The company operated the Aztec until 1940, when it was decided that the cost of producing further gold from the property was too great. In 1946 the district was practically idle, although two lessees had placer ground leased, and one of them

was active. A revival of the deep mines is certainly possible. Table 2 gives the production from the lode mines to date.

It is probably safe to assume that most of the properties would have operated longer had they been in charge of competent men. An additional difficulty which beset the early mine operators was highgrading. Stories are still in existence of thousands of dollars' worth of high-grade ore being stolen by shift bosses, assayers, mine foremen, and miners. Ores assaying over $100,000 per ton were found along the shoots, and it must have been nearly impossible to prevent such highgrading. In fact, among the miners it was not even considered dishonest, as the wages paid were not of the highest. The Maxwell Land Grant Company is known to have suffered heavily from highgrading, but made it a practice not to prosecute the persons responsible, although definite proof of theft was obtained in several cases. The total production from the lode mines of the district may have been nearly double the recorded production. Due to the more stringent laws regarding the possession and sale of gold that obtain today, such trouble as mentioned above would undoubtedly be less should there be a revival of mining in the district.

Elizabethtown was founded in 1867. By the next year it had a population of 7,000 and was the largest town in the State. It was the first incorporated town in New Mexico, and was the county seat of Colfax County from 1870 to 1872. The population rapidly declined in the middle 1870's, and in 1880 there were less than 400 people in the town. There are now only a few families there, and most of the early buildings have disappeared. The name of the town was a tribute to the daughter of John Moore, one of the men present at the founding.

The presence of coal in the area now known as the Raton coal basin was recognized at least as early as 1870, and probably for some time prior to that. Since the presence of coal has never had the stimulative effect of gold in causing "boom" influxes of population, this knowledge did not excite any immediate "coal rush". As early as 1880, the Atchison, Topeka, and Santa Fe Railway Company

operated a coal mine in Dillon Canyon. This company expanded its mining to include Blossburg by 1882. The Raton Coal & Coke Company succeeded to these coal rights upon its formation in 1891, having at that time, or shortly after, 10,000 acres of lands underlain by coal. By 1899, the mines were already the largest in the State, and they have held this position nearly continuously since that time. John B. Dawson operated a small mine on his ranch, and sold it to the Dawson Fuel Company (also known as the New Mexico Fuel Company) before 1888. The report of the territorial governor for 1889 lists several small mines near Raton and in the present Yankee and Sugarite districts.

The St. Louis, Rocky Mountain ~~and~~ Pacific Company opened its mines at Sugarite in 1912, and operated them for several years. Some time after 1922 they were closed because of labor difficulties and difficult mining conditions. The Sugarite seam contains some unmined coal on this company's lands and a larger amount on lands of the Cherokee and Pittsburgh Coal and Mining Company, which lands formerly belonged to the Yankee Fuel Company. This company was organized and began operations in 1906. In 1912 a dispute over water rights with the City of Raton arose, and a compromise was effected which caused the sale of the coal lands to the Atchison, Topeka and Santa Fe Railway Company, of which the Cherokee and Pittsburgh Coal and Mining Company is a subsidiary.

In 1899 the Standard Graphite Company of New York started a small mine in Cottonwood Canyon, where there is a seam of graphite 3 feet thick. ~~(Plate 5).~~ It is believed that this mine was closed because of difficulty in refining the natural graphite.

MINING DISTRICTS

BALDY MOUNTAIN (CIMARRON) AREA

This area, which includes Baldy Mountain and the Moreno Valley, was organized as the Cimarron or Baldy mining district. It was soon subdivided by the Maxwell Land Grant Company, and now includes four districts, the Ute Creek, Ponil,

Willoc Creek, and Moreno (Figure 2; Plate 3).

GEOLOGY

The Cimarron-Baldy Range is a tilted fault block (Figure 3). Its west face, which forms the east wall of the Moreno Valley, is marked by a series of normal faults that are downthrown to the west and have an aggregate vertical displacement of about 4,000 feet. These faults strike nearly due north. On the east side of the range is a group of similarly striking normal faults, with throws up to 600 feet, along which the rocks are downthrown on the east. Thus the central part of the range is a horst.

The forces that uplifted the range seem to have been dominantly vertical, and may have been produced, at least in part, by laccolithic intrusion. Monzonite and quartz monzonite porphyry are present as sills in the Pierre shales and as dikes cutting all the sedimentary rocks (Dakota sandstone, Pierre shale, Raton formation). The intrusives, which represent a fairly late stage of magmatic differentiation, are the source of the ore deposits. The normal faults bounding the mass are in general not intruded, but acted as channels for the late ore-bearing solutions.

Iron Mountain, an anticlinal feature on the west slope of Baldy Mountain between Mexican Gulch and Anniseta Gulch, is believed to have been domed by the intrusion of a large mass of porphyry that forms its core. The Moreno Valley is a faulted syncline situated between the Cimarron-Baldy Range on the east and the Sangre de Cristo Mountains on the west.

Ore-bearing solutions rose along many of the faults until they reached the Pierre-Raton contact. They spread laterally along the irregular contact zone, and also penetrated into fractures in the basal Raton sandstone. Pore spaces and fractures were filled with free gold and gold-bearing pyrite. On oxidation of the pyrite, large amounts of gold were left. This type of deposit was the source of the early rich production at the Aztec mine.

More commonly, deposits along the Pierre-Raton contact penetrate some distance into the underlying shale. Deposits of this type were worked at the French Henry, Yellow Dog, and Harry Lyons properties, as well as providing the later production from the Aztec mine.

Faulting along some of the dikes produced channels in which ore deposits accumulated, as at the Rebel Chief and Legal Tender mines. The ore-bearing solutio also utilized fractures within the dikes, such as those at the Bandanna, Moreno, Centennial, and other properties.

Deposits formed by contact metamorphism are found in the Moreno and Willow Creek districts. The intrusion at the core of Iron Mountain, and several neighboring smaller intrusions, baked and indurated the limy Cretaceous shales and partially replaced them with scapolite, magnetite, hematite, garnet, and gold-bearing pyrite. The Ajax mine is in a deposit of this type. Some of the limy strata have been replaced by hematite and magnetite that carry some gold, in beds 5 to 7 feet thick. They have not been mined.

Late movements along mineralized faults and along post-mineral faults has offset the ore bodies and complicated the finding of ore in the Baldy Mountain (Cimarron) area. The ore bodies, furthermore, are irregular in size and in distribution of values.

UTE CREEK DISTRICT

This district lies to the east of Baldy Mountain, in the valley of Ute Creek and on a high ridge to the south known as Black Horse Mountain. The district includes the Aztec, Rebel Chief, Montezume, and Bull of the Woods mines, the Black Horse group, and other less important claims (Plate 3).

AZTEC MINE

The Aztec mine, the original lode discovery and the largest producer in the district, is situated on the north side of the Ute Creek valley (see Frontispiece). It was discovered in 1868 by Mathew Lynch; for years the ownership was in dispute and litigation. It was acquired by the Aztec Gold Mining and Milling Company in 1895, and in 1910 became the property of the Maxwell Land Grant Company, the present owners. The latter company began operations in 1912 and worked the mine intermittently until 1940, when it was closed down.

In the first three years of operation the Aztec mine is estimated by Graton Lindgren, Graton, and Gordon, (1910) to have produced gold to the value of $1,000,000; the value of production from discovery to 1926 is estimated at $3,500,000. Figures are not available for more recent years.

The ore of the Aztec mine is thought to have been derived from a monzonite prophyry sill that lies 30 to 50 feet below the Pierre-Raton contact. Mineralizing solutions from this igneous body probably rose along the Aztec fault (Figure 6), which strikes about N. 40° W. and dips 20-45° NE., and along minor faults of similar strike and dip.

Early production was entirely from a quartzitic sandstone at the base of the Raton formation, where ore was found in quartz veins parallel to the bedding and in vertical fissures. Ore was then discovered along the contact between the sandstone and the underlying Pierre shale; this contact strikes N. 66° W. and dips 45-60° NE. (Figure 8). Ultimately large ore bodies were found in the shale. These were known as "shale ore" and occurred chiefly in the No. 4 workings. The minerals at the Aztec mine include quartz, calcite, pyrite, chalcopyrite, galena, and pyrrhotite.

Small amounts of coal are found in the basal Raton sandstone in the upper Aztec workings. When this coal is burned, the ash assays 8 cents per ton in gold. In close association with the ore in the older workings is a seam of graphite,

lying within the shale near the contact. It is evidently the result of metamorphic action on a thin bed of coal.

The first workings were the Aztec shaft and the Corcoran and Blacksmith tunnels, in sandstone. Openings made later by the Maxwell Land Grant Company include the Aztec Nos. 1, 2, 3, and 4 tunnels, all of which were begun at or near the Aztec fault. Tunnels No. 1 and 4 are in dark shale of the Pierre formation, and Nos. 2 and 3 in Raton sandstone. Sections of the Aztec mine are shown on Figures 5 and 6, and a plan on Figure 7.

Mining was by open-stope methods. Some stulls and props were used, and a few square sets were placed in the No. 4 workings. Raises and shafts were timbered. Little water was encountered.

The early stamp mills used amalgamation plates for catching the gold. Wilfley tables were added about 1911. In 1925 the stamps were replaced by a 50-ton mill, in which Wilfley tables, crushers, ball mills, jigs, and amalgamation tables were used. Capacity of the mill was enlarged to 100 tons in 1933 and to 140 tons the next year, when flotation cells were added. Water for mill operations was obtained from Ute Creek, and from the Thelma mine some distance below the Aztec on the opposite side of the creek. A tramway carried ore to the mill.

Mining costs between 1912 and 1920 ranged from $10 to $15 per ton; the cost of mine and mill operations, including haulage and taxes, in 1939-40 was $5 per ton. Costs today would be nearer the old than the new figures. In the later operations, about one ton of waste was mined for every six tons of ore.

After the mine was closed, in September 1940, the mill was torn down and sold during World War II. The property has remained idle, and most of the workings are caved.

The history of the Aztec mine was troubled by a succession of inept or incompetent managers, and by the necessity of doing a large amount of dead work in order to maintain a supply of ore for the mill. The total known ore supply was rarely more than enough for 90 days' operation, and was frequently at the edge of

exhaustion. Nearly all energies were directed toward extraction and few to development and prospecting.

There is reason to believe that additional ore supplies remain in the area of the Aztec mine. Much ore was left in the mine; when stopes became difficult to hold, they were abandoned. No evidence has been found to show a pinching-out of the ore with depth. Although the Aztec ore bodies pinch out to the south, they might be found to continue to the north beyond a fault which now limits the mine workings. The amount of ore that might be within the faults themselves has not been satisfactorily determined. Geological conditions similar to those at the Aztec mine exist over much of Baldy Mountain, and there remains the chance that like ore bodies have been overlooked.

REBEL CHIEF MINE

This mine is situated on a group of claims that lie about half way up the north slope of Black Horse Mountain, across the Ute Creek valley from the Aztec mine (see Frontispiece). The mine, which is owned by the Maxwell Land Grant Company, was closed in 1939.

The main quartz vein is 6 to 24 inches wide and occurs along the base of a monzonite sill that intrudes the Pierre shale. There are several smaller veins in the same zone (Figure 9). A nearly vertical vein cuts both shale and sill.

Twelve tunnels were driven to the ore bodies. Mining was by overhand stoping from the tunnels, with stull support. When the quartz veins were encountered, stoping upward began immediately. Stripping of waste, followed by removal of the vein, was the usual procedure. Little horizontal exploration was done. The ore was shipped directly or was milled with stamps. Sulfide ore was not mined, as it is not amenable to treatment.

It is reported that much high-grade ore remains in the mine. According to C. T. Griswold (personal communication), the main vein on a drift off the lowest tunnel was from 6 to 12 inches wide and assayed 5 ounces of gold per ton

for a distance of 45 feet. Average values from the Rebel Chief mine were about $50 per ton; some carloads returned as much as $74 per ton (figured at the old price of gold).

MONTEZUMA MINE

The Montezuma mine is situated on Black Horse Mountain approximately opposite the Aztec mine (see Frontispiece and Plate 3). The discovery, originally known as the Big Jacko lode, was made in 1868 by Thomas Martin and others. About $300,000 was taken from the mine in its early days. From 1932 to 1939 it was operated by I. E. Pippert, and for a few months thereafter by the Maxwell Land Grant Company, the present owners. The mine is now idle.

Gold at the Montezuma mine occurs in pyrite that is finely disseminated in a quartz vein. The vein, which is vertical and 3 to 6 feet wide, cuts small sills and dark siliceous shale. The ore was mined by overhand open stopes that closely followed the shoots. There are twelve tunnels, of which only four have been worked recently. Early values averaged about $40 per ton; more recent values, about half this amount.

BULL OF THE WOODS MINE

The lode of this mine lies just west of the Montezuma property and is an extension of the Montezuma lode. Only the eastern part has been worked, for a production valued at approximately $150,000. The mine is owned by the Maxwell Land Grant Company.

BLACK HORSE GROUP

The Black Horse group consists of three claims that extend in a northwest direction along the top of Black Horse Mountain. Each claim is 1,500 feet long. The two end claims are 600 feet wide and the middle claim is 900 feet wide. The Paragon claim adjoins the group on the northwest.

Two quartz veins, about 90 feet apart and 2 to 4 feet wide, are found in a monzonite dike that extends the length of the claims. Values have been as high as $100 per ton, but have averaged about $10. It is estimated by Graton Lindgren, Graton, and Gordon, (1910) that the Black Horse group has produced about $27,000 in gold, and the Paragon claim about the same amount.

PONIL DISTRICT

This district lies north and northeast of Baldy Mountain (Plate 3). It includes the valleys of South Ponil and Placer Creeks, and intervening ridges and spurs known as French Henry Mountain and North Baldy Ridge.

FRENCH HENRY MINE

The French Henry mine is located on the north side of South Ponil Creek, on French Henry Mountain. The discovery was made in 1869 by Henry Berdeaux. The mine has changed hands a number of times; from 1935 to 1938 it was worked first by C. H. Anderson and later by the French Henry Mining Company, and was finally bought for taxes by the present owner, Henry Ashbaugh.

Numerous faults cut the Pierre and Raton formations and associated dikes. Ore occurs in the Yellow Dog, French Henry, and Black Joe fault zones and along the Pierre-Raton contact. Values were especially high in a ferruginous fault gouge.

Mining was first done from shafts and later from drifts. Stoping followed the ore directly up from the drifts. Many of the old workings show considerable areas stoped out but are dry and still stand open without support. The Jack tunnel, near the bottom of the slope, is wet and has caved a short distance from its mouth.

In 1936 a 50-ton stamp and amalgamation mill was built. It started operations on $80 ore, but the supply was small and the ore value soon dropped to $7.50 per ton.

Two years later a larger mill was erected, but again insufficient good ore forced the operators to use material assaying only $0.35 to $1.50 per ton. This mill was shut down after less than two months' operation; some ore was found that assayed $7 to $10 per ton, but in insufficient amounts. Small pockets in fault gouge had in the past yielded as much as $455 per ton (at the new price of gold), and numerous small deposits had assayed $35 to $175.

SMUGGLER MINE

At this mine, which is located near the French Henry mine, ore was found in a nearly horizontal fault plane that in part lies along the Pierre-Raton contact (Figure 10). Small step faults offset the main fault; they are probably pre-mineral in age and may have acted as channels for the ore-bearing solutions. The ore zone was 4 to 8 inches wide, and the ore contained much pyrite and some chalcopyrite. It was mined by stoping, in a manner similar to long-wall coal mining. Values ran about $180 per ton.

YELLOW DOG GROUP

This group of claims is adjacent to the Smuggler mine. It contains flat-lying veins similar to that of the Smuggler, and a steeply dipping vein like the main French Henry vein. The Black Joe claim, just south of the French Henry mine, contains a vein of pyritiferous iron oxide 2 to 4 feet wide that assayed $50 to $100 per ton. Attempted amalgamation of this ore was unsuccessful.

NORTH BALDY RIDGE GROUP

The Harry Bluff, Mary L., and parallel claims are situated on North Baldy Ridge. Small ore bodies have formed where the Pierre shale has been intruded by monzonite dikes and sills. Selected hematite ore has yielded $292 per ton. The Harry Bluff and Mary L. claims are owned by the estate of Wallace Lyons.

HARRY LYONS GROUP

This group of claims lies on the next ridge east of North Baldy Ridge, across the deep canyon of Placer Creek. Veins 4 feet or more in width lie at angles of 60 to 70 degrees against a small dike. Although assays ran from $50 to $200 per ton, and one claim showed some values in copper, zinc, and silver, all the ores are non-free-milling and the property has long been idle. There are about 1,500 feet of workings, but they are now caved and inaccessible. Ownership is by the Maxwell Land Grant Company.

LOIS CLAIM

The Lois claim is situated about one mile northwest of the Harry Lyons group, and is the farthest north of the properties in the Baldy Mountain area. It was opened in the early 1930's and is thus the most recent discovery in the district. It was operated under lease from the Maxwell Land Grant Company. Workings are now caved, but the ore bodies appear to have been parallel to a sill in shale. A few small rich pockets were reportedly found. Pieces of pyrite and iron-stained shale from the sump and adit assayed less than $4 in gold (at present price) and $2 in silver per ton.

PONIL MINE

The Ponil mine, now a part of the Aztec workings, was started from the South Ponil Creek side of Aztec Ridge and for a time was operated as a separate mine. According to Matt Gorman, mine superintendent from 1932 to 1938, ore bodies were found along the Pierre-Raton contact, and also in vertical fissures that cut shale and intruded sills of porphyry. In these fissures the ore was associated with quartz. Ore was trucked to the Aztec mill, a distance of about $1\frac{1}{2}$ miles, at a cost of 9 cents per ton.

About 400 feet north of the Ponil opening, the Maxwell Land Grant Company drove a 3,300-foot tunnel toward the northwest. This was called the H tunnel and

and was driven in the hope of intersecting the Aztec and Lyons faults and finding lode copper ore of the type that had produced the rich float in Copper Park near the headwaters of South Ponil Creek. V. J. van Lint, present manager of the Maxwell Land Grant Company, believes that the Lyons fault had been cut through and the Aztec fault nearly reached when work was discontinued. The source of the copper ore was not found. At 1,200 feet from the mouth of the tunnel the Pierre-Raton contact was reached and a small stringer of ore assaying $18 per ton was found. Insufficient work was done to show the extent and quality of this ore body.

COPPER PARK PROSPECTS

On the southwest side of Copper Park, along upper South Ponil Creek, are several small copper prospects. Fault planes in a highly altered monzonite were found to be impregnated with cuprite, malachite, chalcopyrite, azurite, and limonite. Samples assayed 11.73 percent Cu, 0.445 percent Pb, and 1.28 percent Zn; no values in gold or silver were found.

WILLOW CREEK DISTRICT

This district lies southeast of Baldy Mountain, in the drainage area of Willow Creek (Plate 3). It is bounded on the east and north by high ridges extending outward from Baldy Mountain, and on the west by the divide that separates Willow Creek drainage from Anniseta Gulch and other westward-flowing tributaries of the Moreno River.

The district has never been a rich producer of lode gold, but contains creek bottoms that have yielded large placer production. Cretaceous shales crop out in the district; they are cut by dikes that radiate from Baldy Mountain and have metamorphosed and mineralized the shales.

LEGAL TENDER MINE

The Legal Tender mine, reportedly the first to be developed in the district, lies on the east side of Willow Creek (Plate 3). The ore body is 1 to 3 feet in width, lies at a contact between monzonite and baked shale, and assays $20 or more per ton. It dips 80 degrees to the east. Silver and lead minerals were noted in the vein material. Another quartz vein, in porphyry, strikes N. 10° E. and dips 60-90° W. Production from the Legal Tender mine has amounted to at least $25,000. The claim is owned by Emma Lou Matkin.

AJAX MINE

The Ajax claim lies southeast of the Legal Tender claim, on the opposite side of Willow Creek (Plate 3). It was located in the 1890's and was worked fairly constantly until just before World War II.

The ore is a dark heavy finely granular rock that is a highly contact-metamorphosed shale adjacent to a body of porphyry. The principal ore zone trends north. The minerals present are typical of contact-metamorphic deposits and include pyrite, garnet, epidote, scheelite, hornblende, magnetite, hematite, and scapolite. Gold in recently extracted ore averaged one ounce per ton; it is not visible in the ore, but is thought to be disseminated in the magnetite and possibly in the pyrite. Frequent assays have guided the mining. Considerable high-grade ore has been found in small pockets.

A washing and jigging plant below the mine is equipped to handle a large tonnage of ore per day. The plant has also been used to wash placer material from the creek bottom.

MYSTIC MINE

The Mystic claim is situated at the top of Baldy Mountain and extends into the Ponil and Ute Creek districts (Plate 3). The mine workings are in the part of the claim lying in the Willow Creek district. The Mystic is the only mine in the Baldy Mountain area that was worked solely for copper. It has been worked

intermittently for years, the most recent operations being in 1937 and 1938. The copper occurs chiefly as oxides, in veins with iron oxide and along fractures in the shale. Cuprite, malachite, chrysocolla, and molybdenite have been reported. So far as known, no sulfides are present.

The Mystic mine was an extremely difficult property to work, owing to difficulty of access, low temperatures, and large amounts of water in the workings. Heavy snows make the mine inaccessible for 5 to 7 months of the year. Mine waters frequently remain frozen throughout the summer.

The veins were followed into the mountain along drifts, from which some stoping was done. There are three tunnels on the property, the lowest of which is about 400 feet below the summit of Baldy Mountain. The tunnels are nearly completely caved. Freezing of the water made the raises hard to maintain; they tended to cave or to become choked with ice.

Ore was hand-picked and was packed down on burros to the rail terminus, now dismantled, at Ute Park. From there it was shipped to Pueblo, Colorado. A total of 1,000 tons, ranging from 20 to 25 percent copper, was probably shipped in this manner. One carload is reported to have run 42 percent. Values of samples gathered from the Mystic dumps ranged as follows: Au, 0.04-0.18 oz.; Ag, 0.09-0.14 oz.; and Cu, 20.54-25.67 percent.

The amount of ore remaining in the Mystic mine is unknown. Although the ore bodies are reported to have ended toward the center of the peak, they have never been adequately explored. Should additional deposits be found, a road could be constructed up Willow Creek. The property is owned by F. E. Wilkerson.

MONARCH NO. 2 CLAIM

Just south of the Mystic claim is the Monarch No. 2 claim, on which an open cut has exposed a 2-foot vein of iron ore. This vein is thought to be an extension of the Iron Mountain veins. Samples cut by the writer assayed 0.04 oz. Au, 0.14 oz. Ag, 39.16 percent Fe, and 33.00 percent SiO_2. The claim is owned by the Maxwell Land Grant Company.

MORENO DISTRICT

The Moreno is the largest district in the Baldy Mountain area. It lies on the west slope of the mountain, in and between Anniseta, Grouse, Humbug, Little Nigger, Big Nigger, and Pine Gulches (Plate 3). These are west-flowing tributaries of the Moreno River.

RED BANDANNA GROUP

Claims included in this group are the Red Bandanna, Empire, Moreno, Centennial, Galena, and American Flag claims (Plate 3). The group lies in Grouse Gulch. The claims have been worked intermittently from discovery in the 1880's until just before World War II.

Ore on the Red Bandanna claim is found as stringers in a large prophyry dike. There is a 130-foot shaft on the property, and a long tunnel that was driven nearly parallel with the vein for most of its length. A large stoped area above the tunnel is now caved. Assays ran as high as $140 per ton, but the average value of mined ore was only about $7. The Moreno and Centennial claims are located on a similar vein in the same or a parallel dike, about 900 feet south of the Red Bandanna claim. On the Moreno claim a shaft was sunk to a depth of 130 feet, on a shale-porphyry contact. Gold values up to $135 per ton were found in hematite, and several thousand dollars' worth was produced.

The Galena and American Flag claims extend across the bottom of Grouse Gulch. On the Galena, a nearly vertical vein 4 to 6 inches wide is enclosed in a porphyry dike. A shaft was sunk to a depth of 65 feet, and a 50-foot drift from the bottom of the shaft had been completed when a flood in Grouse Gulch filled the workings with debris. An attempt to reach the vein from a higher level was unsuccessful, and no further work was done. Assays averaged $300 to $400 per ton, with highs of $2,000. The Galena and American Flag claims contain a small

stringer of galena, one of the few reported occurrences of unoxidized lead ore in the Baldy Mountain area.

The Red Bandanna mill is a complete cyaniding plant with a daily capacity of 25 to 50 tons. With additional crushing and grinding equipment it could attain a capacity of 100 tons daily. The mill ran for a time on Red Bandanna ore, and, when this proved too low in grade, on ore trucked in from Iron Mountain. The mill was shut down about 1941.

The Red Bandanna, Empire, Moreno, and Centennial claims, and the Red Bandanna mill, are owned by Merco, Incorporated, and the Galena and American Flag claims by Emma Lou Matkin.

CHESTER CLAIM

The Chester Claim lies high on the ridge that separates the headwaters of Big Nigger Gulch from those of Pine Gulch (Plate 3). The claim contains several hundred feet of drifts and stopes, but these are now inaccessible. A stamp mill is still standing.

Ore, which occurred along the Pierre-Raton contact, is reported to have been of high grade; but it was apparently exhausted at an early date, as the mine has not been worked since 1881. The ore body may be cut off by a fault seen by the writer on the surface above the workings. Specimens from the dump assayed 0.09 oz. Au and 0.17 oz. Ag per ton.

GOLDEN ERA GROUP

The Golden Era group lies north of the Chester claim, at the head of Pine Gulch (Plate 3). It includes the War Eagle, Golden Era, Fairfax, Twinn, and City View claims. A small quantity of very high-grade ore was produced; it was packed over Baldy Mountain to the Black Horse arrastra. The workings are now caved, and samples could not be cut because of the condition of the openings.

Pieces from the Twinn dump contained traces of gold and silver; pieces from the War Eagle dump showed no values. Tungsten-bearing material from the Twinn claim probably included the minerals wolframite and ferberite. The Golden Era group is owned by the heirs of Joseph Lowery, who was associated with early development of the property.

IRON MOUNTAIN PROSPECT

Iron Mountain is situated in the south part of the Moreno district, at the head of Mexican and Anniseta Gulches. Limy Cretaceous beds, 5 to 7 feet thick, have been replaced by a mixture of magnetite and specular hematite (Figure 4). Some exploration for iron ore has been done, but production is limited to gold that occurs in small quantities with the iron oxide. The ore mined for gold was of two types —— soft ore, presumably limonite, and hard ore, probably magnetite and hematite. The soft ore averaged $27 per ton in gold and occasionally assayed as high as $140. The hard ore yielded only $5 or less per ton. Value of the ore produced at Iron Mountain for the Red Bandanna mill averaged $7 per ton. About 500 tons of soft and hard ore was produced.

OTHER CLAIMS

Many other claims in the Moreno district have been developed to varying extents. Numerous high-grade pockets of ore were found, but they proved of small extent. The Tomboy and Mountain Queen claims carried such pockets, and on the Mattie Bell claim some stringers reportedly assayed $400 per ton.

DEEP TUNNEL

This prospect tunnel was driven completely through Baldy Mountain, from Big Nigger Gulch in the Moreno district to the upper end of Copper Park in the Ponil district. The work was done by the Deep Tunnel Gold and Copper Mining

Company, which received from the Maxwell Land Grant Company a concession to the mineral rights on 277 acres providing the tunnel was holed through. After numerous difficulties and reorganizations the tunnel was completed and title to the mineral interests received. The owning company is now Merco, Incorporated. The tunnel failed to find any ore, although some molybdenite was discovered near the west portal and some copper near the east portal. A mill built to handle the expected ore supply has been dismantled.

PLACER MINING

Extensive placer claims were located during the first rush to the Baldy Mountain area. The richest were on the west side of the mountain. Over 350 claims were staked on Willow Creek alone during the first two years, from its source nearly to Eagle Nest Lake. The main channel of Willow Creek, a side canyon called Last Chance Gulch, and Last Chance Flats at the head of this gulch, were all found to be very rich. Excellent placer ground was also found from Willow Creek northward to Big Nigger Gulch, and all the intervening canyons were placered as high as water could be brought. Canyons north of Big Nigger Gulch were found to carry considerably lower gold values and in general were not profitable to work.

Ute Creek, on the east side of Baldy Mountain, was found to be rich in placer gold, much of it coarser than that on the west side, and was placered to within a mile of the Aztec mill. In 1941 a large washing plant operated in Ute Creek for a short time, but was forced to suspend work. The Ponil River and its branches were not productive of placer gold, although some claims were staked.

The valley of the Moreno River has been extensively placered, notably at Spanish Bar where Grouse Gulch empties into the river and on a property just below Elizabethtown. Plate 4 shows early placer operations in the Moreno Valley.

Although many pick-and-shovel operators made their claims pay, the most extensive operations were of the hydraulic type. Water was obtained from Red River via the Big Ditch, from the Moreno and Ponil Rivers, from Willow and Ute Creeks, and from the small streams in the gulches on the west side of Baldy Mountain.

The single placer now in operation is that of G. J. Smith and Ray A. Bennet in Big Nigger Gulch. It is a hydraulic operation that uses water from the gulch. The operators have leased 1,060 acres from the Maxwell Land Grant Company and other landowners.

FUTURE POSSIBILITIES

The lodes and placers of the Baldy Mountain area have produced gold with an estimated value of $10,000,000 to $12,000,000; yet the area is neither completely prospected nor worked out.

Unfavorable factors for lode mining include the occurrence of the most valuable ore to date in leached or oxidized zones and the resulting possibility that values might be less at depth; the spottiness and unpredictability of the high values; the poor accessibility of mines in the area; and the failure of diamond drilling to outline good ore deposits. The most favorable factors are the extreme richness of certain ore pockets and the virtual certainty that many such pockets still remain. The construction of a custom mill in the area and the building of good roads would strongly favor successful operation. Open-cut mining has been suggested, but the good deposits are probably too scattered to make this pay.

The remaining placer ground is considered to be suitably only for relatively small operations.

DISTRICTS WEST OF THE BALDY MOUNTAIN AREA

HEMATITE DISTRICT

The hematite district is situated on a ridge between the South Moreno River and a small tributary from the south called Hematite Creek, near State Route 38 about 5 miles northwest of Elizabethtown (Figure 2). Gold occurs in limonite along the contacts between porphyry dikes and pre-Cambrian country rock. The dikes trend north. They may be of the same age as those on Baldy Mountain, but are more granitic and carry large amounts of mica. The district has not been a producer, and prospecting ceased about 1903. East of this prospect and north of the river a claim was located from which small amounts of disseminated cassiterite were reported as occurring in a wide zone in quartzite. No development has been done. (Due north of the Hematite district the writer discovered a vein of almost pure schistose mica carrying a high percentage of lepidolite.) pink mica

WEST MORENO DISTRICT

The few claims that constitute the West Moreno district lie in the Comanche Creek area directly across the Moreno Valley from the Moreno district. No production is reported. The district was not visited.

DISTRICTS SOUTH OF THE BALDY MOUNTAIN AREA

CIMARRONCITO DISTRICT

This district is situated about 15 miles southeast of Baldy Mountain, at the head of the middle fork of Cimarroncito Creek. It lies within the Philmont Ranch, owned by the Boy Scouts of America.

Dikes of quartz monzonite porphyry, similar to those at Baldy Mountain and probably contemporaneous with them, have intruded pre-Cambrian granite and Pennsylvanian sedimentary rocks. The ore deposits are of the contact-metamorphic type. Minerals include gold, quartz, garnet, epidote, calcite, chalcopyrite,

magnetite, specularite, galena, and pyrite. Deposits are small and discontinuous, but a few very rich pockets have been found.

Considerable exploratory work has been done since discovery in the 1890's, but little gold has been produced. In 1930-39 several carloads were shipped from the Thunder mine; the average returns were less than $40 per ton. Small amounts of gold, silver, and copper have been found in other mines, including the Contention, Anaconda, and Carst. Prospects for future developments in the Cimarroncito district are fair.

PERRYVILLE DISTRICT

Twelve claims were located at Perryville, a former settlement in the canyon of the Cimarron River 4 miles west of Ute Park. Oxidized copper ore and low-grade gold ore occur in a broad zone in pre-Cambrian gneiss. Most of the workings are caved, but a tunnel on the Horseshow claim is still open and was examined by the writer. Thin limonite streaks, mostly vertical, appear to have governed the direction of mining. The streaks are so thin that assay samples could not be taken. No production has been reported from this district. Ownership is by the Maxwell Land Grant Company.

OTHER DISTRICTS

The Urraca-Bonito district, an extension of the Cimarroncito district, lies on the eastern slope of Clear Creek Mountain and the southern slope of Black Mountain. A small sample from the Craig prospect in this district assayed over $4,000 per ton. However, no production has been reported.

Several claims were located near Idlewild camp, 6 miles west of Eagle Nest. Work was done on these until 1941, but no ore was shipped. About 2,500 feet of drifts and tunnels have been driven in veins in Pennsylvanian rocks. Reported maximum assays of gold per ton were $44; of silver, $16; and of copper, 30 percent.

Signs of mineralization have been prospected along the system of intrusions on the high ridges leading to Costilla Peak.

RATON COAL BASIN

The coal-bearing rocks of Colfax County include the Vermejo and Raton formations, which underlie the plateau area in the north central part of the county (Figure 2). The Vermejo, of uppermost Cretaceous age, reaches a maximum thickness of 425 feet and contains at least 10 coal seams; the basal Eocene Raton formation ranges up to 1,600 feet in thickness and contains two coal-bearing zones separated by a barren interval. There is an erosional unconformity between the Vermejo and Raton formations; in many places the former has been partly or entirely removed by pre-Raton erosion. The outcrops of the coal seams, and the mined-out areas, are shown on Plate 5.

The commercially workable coal of the Vermejo formation is in a bed called the Raton seam (not to be confused with the Raton formation), which ranges up to 9 feet in thickness and averages slightly more than 4 feet in working mines. As the coal beds of the Vermejo are lenticular and tend to overlap, it is probable that the seams mined in different areas as the Raton seam are of slightly different ages. Partings of slate and bone are common and the coal seam is locally offset by small faults. Owing to the deep dissection of the Vermejo formation by pre-Tertiary erosion, in places the Raton coal seam is absent and in other places it is directly overlain by the sandstone or conglomerate at the base of the Raton formation. Mines developed in the Raton seam include the Swastika, Koehler, Gardiner, and Van Houten mines of the St. Louis, Rocky Mountain & Pacific Company, and the Dawson mine of the Phelps Dodge Corporation (Plate 6).

The lower of the two coal-bearing zones in the Raton formation is known as the Sugarite zone and contains the Sugarite seam.[1/] This seam, the highest in the

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1/ "Sugarite" is a corruption of Chicorica, the name of the creek that drains the Yankee and Sugarite districts.

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zone, ranges from 4 to 12 feet thick and averaged more than 5 feet thick in the Sugarite mine of the St. Louis, Rocky Mountain & Pacific Company; but in other parts of Raton Mesa the seam is much thinner and is generally not worked.

The upper coal-bearing zone of the Raton formation includes, in ascending order, the Yankee, Llewellyn, Metcalf, Tinpan (Brilliant), Potato Canyon, Reynolds, and Kellogg seams. These seams are of commercial thickness only locally, and are not all present at any one place except possibly as very thin partings. The Yankee seam was worked from 1906 to 1914 by the Yankee Fuel Company, and the Tinpan seam has been extensively worked at the Brilliant mine of the St. Louis, Rocky Mountain & Pacific Company. Small mines, each producing less than 1,500 tons per year for local consumption, are operating in seams of the upper Raton zone on the east fork of Chicorica Creek.

The coal of the Raton seam in the Vermejo formation is a coking coal, and much of it is coked for use in the smelters at Pueblo, Colorado (Plate 6, A). The coals in the upper zone of the Raton formation are also mostly coking coals.

Much of the coal in Raton Mesa has been destroyed by igneous intrusions, which occur as dikes and sills throughout the area. In places the coal beds have been replaced by sills; elsewhere they have been burned out or transformed into coke. For about 10 square miles in the vicinity of Windmill and Gardiner Canyons the coal has been changed by intrusive action to impure graphite.

Notwithstanding the effects of intrusion, however, tremendous coal reserves remain in the Raton Mesa region. In fact, it is doubtful if the total of commercial mining since its start in 1882 has greatly reduced the reserve supply. There are some 2,000,000,000 tons of coal left to be extracted in beds at least 3 feet thick. Total reserves of commercial thickness and quality that can be removed from present mine openings are estimated at 59,400,000 tons.

OIL AND GAS POSSIBILITIES

Several test wells have been drilled for oil and gas in Colfax County (Table 4). Although none has been successful, they do not by any means condemn the county for oil and gas. They are in widely scattered locations, and some of them have not been drilled deep enough to test the entire section of sedimentary rocks. The mountainous western part of the county, where pre-Cambrian rocks are exposed and igneous activity has been intense, is not considered to have oil and gas possibilities; but the remaining three-fourths of the county, of which the major structural features are the Raton Basin and the Sierra Grande arch (Figure 11), has a thick section of sedimentary rocks of the types that elsewhere have yielded commercial production.

Evidences that oil and gas are present in Colfax County include shows in several test wells; a gas seep between the forks of Willow Creek east of Van Houten; several small seepages of oil encountered in the coal mines at Dawson; and the presence of oil in pore spaces of a basaltic dike about $2\frac{1}{2}$ miles south of Black Mesa and in crushed and brecciated Fort Hays limestone near a similar dike.

Dark shales that might be a source of oil occur in the Pennsylvanian and Cretaceous systems; sandstones that might act as reservoir rocks include the Glorieta, Wingate, and Dakota. Arkosic beds in the Pennsylvanian might also accumulate oil. Thus it appears that source and reservoir rocks are present.

There are also numerous anticlines in the county. All of these except the Vermejo Park dome are situated on or near the Sierra Grande arch. It is a question whether these small structures are true folded anticlines; several have been drilled on their crests and found non-productive. More likely they are reflection of buried hills of pre-Cambrian rocks. If such is the case, the best possibilities for large accumulations of oil and gas would be on the flanks of these structures, where the older sedimentaries lap up against the crystalline rocks.

The Vermejo Park dome, a large isolated structure in the northwestern part of the county, appears to reflect a deeply buried intrusion, as evidenced by two tests that passed from Cretaceous shale into igneous rock below 3,200 feet (Table 4).

~~A correlation of subsurface formations in the eastern part of Colfax County is shown on Plate 7.~~

It is of interest that two test wells have yielded appreciable shows of carbon-dioxide gas. It is entirely possible that future drilling will discover commercial accumulations of this gas.

MISCELLANEOUS MINERAL RESOURCES

Sandstone from the Trinidad formation has been used for building stone, and Fort Hays limestone from the banks of the Cimarron River southwest of Springer was quarried in 1888-91 for use in making Portland cement. Gravel from various localities has been used as concrete aggregate and road metal. Certain of the clays in the Pierre shale have been utilized to make brick.

Scoria, now widely being used as a lightweight concrete aggregate, is being obtained from near Des Moines, just east of the Colfax-Union County line. Large quantitites are available nearby in Colfax County and farther west at Eagle Trail Mountain.

Deposits of aluminum sulfate have been reported from southern Colfax County, just north of the town of Abbott in Harding County (Jones, 1904).

October 16, 1943

COAL PRODUCTION

1905	255,383
1906	584,857
1907	922,267
1908	747,595
1909	1,063,879
1910	1,324,956
1911	1,089,923
1912	1,255,969
1913	1,397,008
1914	1,630,904
1915	1,631,588
1916	1,563,312
1917	1,754,025
1918	1,636,141
1919	1,305,421
1920	1,464,002
1921	996,193
1922	1,122,870
1923	836,343
1924	781,298
1925	709,207
1926	765,230
1927	874,715
1928	820,809
1929	741,095
1930	598,667
1931	480,915
1932	365,834
1933	400,857
1934	406,659
1935	434,412
1936	530,105
1937	540,065
1938	384,490
1939	398,102
1940	274,063
1941	244,011
1942	520,811
1943	790,889 — 34,374,039
1944	769,169
45	721,797
46	213,000 to May 27th -

write Mr White re reserves plan

acres coal rights. - 580,000 acres 150% fee
36 000 000 tons (Baxter) left at working places.

PETTIT REPORT - COLFAX COUNTY

FULL CAPTIONS FOR FIGURES

Figure 1. Index map of New Mexico, showing location of Colfax County.

Figure 2. Map of Colfax County showing physiographic subdivisions and location of mining districts. Coal lands lie northeast of line A-B.

To be typeset below cut of Fig. 2, above caption:

Mining Districts.

1. Ponil	5. Hematite
2. Moreno	6. West Moreno
3. Willow Creek	7. Perryville
4. Ute Creek	8. Cimarroncito

Figure 3. West-east section through Baldy Mountain at Elizabethtown. (Modified from Graton, U. S. Geol. Survey Prof. Paper 68, Fig. 4.)

Figure 4. Replacement of Cretaceous limestone beds at Iron Mountain by gold-bearing magnetite and hematite (cross-hatched), interbedded with unmineralized shales. (After Graton, U. S. Geol. Survey Prof. Paper 68, Fig. 6.)

Figure 5. Southeast-northwest vertical projection of the Aztec mine in 1918. (From files of Maxwell Land Grant Company.)

Figure 6. Northeast-southwest section of Aztec mine. (From Chase and Muir, Trans. Amer. Inst. Min. Met. Eng., vol. 68, p. 273.)

Figure 7. Plan of Aztec mine. (From Chase and Muir, Trans. Amer. Inst. Min. Met. Eng., vol. 68, p. 275.)

Figure 8. Section showing typical occurrence of ore lenses along Pierre-Raton unconformity. (After Lee, U. S. Geol. Survey Bull. 620, p. 330.)

Figure 9. Workings of the Rebel Chief mine, showing location of ore bodies with to monzonite porphyry sills. (Modified from Graton, U. S. Geol. Survey Prof. Paper 68, Fig. 5.)

Figure 10. Workings of the Smuggler mine. (From map in files of the Maxwell Lan Grant Company.)

Figure 11. Generalized structure map of Colfax County. Contours on Dakota sandstone, modified from Darton (U. S. Geol. Survey Bull. 794, Fig. 145). Anticlinal axes from state oil and gas map (N. Mex. Bur. Mines and Min. Res., 1942).

TABLE 2. VALUE OF LODE AND PLACER GOLD AND SILVER PRODUCED IN COLFAX COUNTY, NEW MEXICO, FROM 1868 TO 1945, INCLUSIVE [a]

	1868-1869	1870-1879	1880-1889	1890-1899	1900-1909	1910-1919	1920-1929	1930-1939	1940-1945	Total
Aztec mine	$150,000	$ 850,000	$ 150,000	$ 100,000	$ 5,000	$1,989,336	$340,341	$418,608	$31,761	$ 4,035,046
Other lode mines	25,000	395,000	310,000	280,000	48,260	51,750	23,999	72,940	2,001	1,208,950
Total gold from lode mines	175,000	1,245,000	460,000	380,000	53,260	2,041,086	364,340	491,548	33,762	5,243,996
Willow Creek placers	130,000	435,000	201,000	134,000	27,000	4,500	1,468	11,692	202	944,862
Moreno River placers	15,000	175,500	34,500	35,200	825,352	13,483	100		875	1,100,010
Grouse Gulch placers	45,000	481,000	282,000	216,000	17,000	5,400	2,758		27,916	1,077,074
Humbug Gulch placers	35,000	330,000	311,000	324,000	46,000	15,517	6,616	508	37	1,068,678
Ute Creek placers	91,000	260,000	104,000	6,600	3,500	2,300	3,730	9,641	7,750	488,521
Other placers	6,000	47,500	13,100	41,100	3,500	4,700	1,600	9,670		127,170
Total gold from placers	322,000	1,729,000	945,600	756,900	922,352	45,900	16,272	31,511	36,780	4,806,315
Total gold production	497,000	2,974,000	1,405,600	1,136,900	975,612	2,086,986	380,612	523,059	70,542	10,050,311

[a] Conservative estimates have been made where figures are not available.

TABLE 3, PRODUCTION OF COAL IN COLFAX COUNTY, NEW MEXICO, FROM 1868 TO 1945, INCLUSIVE (IN SHORT TONS) [a]

	1868-1869	1870-1879	1880-1889	1890-1899	1900-1909	1910-1919	1920-1929	1930-1939	1940-1945	Total
St. Louis, Rocky Mountain & Pacific Company (or predecessor)			1,081,595	2,101,736	4,291,012	14,589,247	9,111,762	4,540,106	3,320,740	39,036,198
Phelps Dodge Corporation (or predecessor)				175,000	4,898,666	12,933,092	9,135,623	2,637,761	1,985,615	31,765,757
Others	1,000	20,000	5,000	16,000	1,213,381	402,617	108,940	154,120	98,661	2,019,719
Total coal production	1,000	20,000	1,086,595	2,292,736	10,403,059	27,924,956	18,356,325	7,331,987	5,405,016	72,821,674

[a] Conservative estimates have been made where figures are not available.