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Mineral Deposits of Lincoln County, New Mexico

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Abstract

Lincoln County has yielded a variety of metals and minerals: gold, coal, iron, lead, copper, zinc, fluorite, bastnaesite, gypsum, and tungsten. In addition, deposits of molybdenum, thorium, uranium, and manganese are known, although no significant production has been recorded.

The White Oaks district produced almost $3 million in gold from the time of its discovery in 1879 until shortly after the turn of the century. This district was the leading producer for the entire county. The Nogal (gold, silver, lead) and Gallinas (copper, lead, silver) districts produced significant amounts of metals during the late 1800's and early 1900's. Lesser districts, such as the Oscuro, Jicarilla, and Schelerville, have produced gold, copper, and other metals intermittently in the past. Mining was revived during World War II and later years to produce iron, fluorspar, and bastnaesite in previously known districts, but mining is now practically at a standstill. The total recorded production for Lincoln County to date is estimated at approximately $5½ million.

Excluding coal, gypsum, and placers, the majority of the deposits are of hydrothermal origin, being intimately associated with the widespread igneous activity evident in Lincoln County. The temperature of deposition of the deposits extends from epithermal to pyrometasomatic. The composition of the various igneous intrusives appears to have controlled the type of mineralization found in each district.

The known deposits of the area studied do not appear to favor economic exploitation under present market conditions, but several of the iron and fluorite deposits may be exceptions. Future exploration by courageous prospectors may completely reverse this discouraging outlook.

Introduction

PURPOSE AND SCOPE

The mineral deposits of Lincoln County were studied as part of a continuing effort by the New Mexico Bureau of Mines and Mineral Resources to provide individual reports of the mineral-producing counties of the State. This bulletin does not attempt to appraise to any great degree the commercial potentialities of the various mines and prospects of the county; instead, the known mineral deposits are described briefly for the benefit of prospectors and others concerned with the types and modes of occurrence of ores previously mined, and the occurrence of other mineral commodities of possible value.

The study describes the entire county. The southwestern part of the area, including the Oscuro district, now lies, however, within the White Sands Missile Range of the Department of Defense. Inasmuch as the Range is necessarily closed to the general public, that portion of the county was not examined by the writer. The brief description of the Oscuro district contained herein was extracted from the works of earlier investigators.

METHOD OF INVESTIGATION

An effort was made to examine every significant occurrence of known economic mineralization within Lincoln County. Field work was started in the late summer of 1957 and continued through 1958. The length of time spent at individual mines or prospects varied, depending on the extent of the mine workings and outcrops, and other factors, but detailed examinations were not undertaken. Although an attempt was made to seek out each mine and prospect, it is likely that a few deposits were missed; this is unavoidable in a mining area, such as Lincoln County, which has been inactive for a long period.

PREVIOUS WORK

The ore deposits of Lincoln County were studied briefly by Jones (1904) at the turn of the century, but the first comprehensive study of the metalliferous deposits was made by Lindgren et al. (1910), who examined the area in 1905. The coal resources of the Sierra Blanca Basin were described by Campbell (1907) and Wegeman (1914), and a detailed description of the Capitan coal district was completed recently by Bodine (1956). Brief descriptions of the principal mining districts of Lincoln County are contained in the publications of Lasky and Wootton (1933), Talmage and Wootton (1937), and Anderson (1957).

During World War II, the U. S. Geological Survey and the U. S. Bureau of Mines did considerable exploration in Lincoln County for iron and fluorspar. The results of these investigations are discussed by Rothrock et al. (1946), Sheridan (1947), Soule (1947, 1949), and Kelley (1949). These studies were drawn upon freely for the descriptions of the various iron and fluorspar deposits contained herein.

ACKNOWLEDGMENTS

The field examination of the mineral deposits of Lincoln County was initiated under the leadership of Dr. John Eliot Allen, now of Portland State College. Dr. Allen participated in the examination of the Vera Cruz, Helen Rae, and Whettige deposits. Morris T. Worley ably assisted the writer during the 1958 field season. The various mine owners and prospectors of Lincoln County gave their wholehearted cooperation during the field examinations. Special credit is due to Miss Grace M. Jones and Messrs. C. E. Degner, Ralph Forsythe, Tom Bragg, F. G. McCrory, Owen A. Simpson, and John E. Wright.

Miss Shirley Farrar assisted in preparing the index.

Geography

LOCATION

Lincoln County occupies an irregular area of 4,859 square miles in south-central New Mexico. The population of the county was listed as 7,409 in the United States census of 1950. Carrizozo, located on the Southern Pacific Railroad, is the county seat and largest town. The principal mining districts within the county, and the geographical relationship of Lincoln County to the adjoining counties, are shown on Plate 1.

TOPOGRAPHY

Lincoln County is located at the junction of two physiographic provinces: the High Plains, represented by the eastern portion of the county, and the Basin and Range, from the Sierra Blanca westward. The highest point in the county is on the north flank of Sierra Blanca Peak, the crest of which reaches an altitude of 12,003 feet above sea level about 1 mile south of the county line. The lowest altitudes occur immediately to the west in the Tularosa Valley, 4,400 feet being about the minimum.

Major drainage systems are absent in the county. Minor creeks and arroyos drain into the Pecos River to the east or into the closed Tularosa Basin to the south. The divide between the two drainage systems is the Gallinas-Jicarilla-Patos-Tucson-Carrizo-Sierra Blanca mountain chain extending in a north-south direction through the central portion of the county.

Owing to the absence of perennial streams or shallow irrigation wells, the western part of the county does not support farming, but the land is used extensively for ranching. Several of the principal creeks in the eastern part of the county, notably the Bonito, Nogal, Ruidoso, and Hondo, support small farms and orchards.

CLIMATE AND VEGETATION

The abrupt changes in altitude characteristic of Lincoln County are reflected in a diversity of climate and vegetation. The Sierra Blanca, for example, is densely covered with coniferous growth, and the climate in this area is noted for its cool summers and cold winters. On the other hand, the far western and eastern parts of the county, being at much lower altitudes, are sparsely covered with cacti, and the weather is mild in the winter and hot in the summer. The intermediate altitudes, 6,000 to 7,500 feet, are characterized by scrubby growths of pilion and juniper.

Climatological data are summarized in the table below for three stations in the county.

It should be noted that the "high country" of the Sierra Blanca has much colder and wetter seasons than those of the three stations listed.

TABLE 1. CLIMATOLOGICAL DATA FOR LINCOLN COUNTY

Data from *Climate and Man, U* . S. Department of Agriculture, 1941, p. 1,013.

		TEMPERATURE (degrees Fahrenheit)				PRECIPITATION (inches)		
Station	Altitude (feet)	January average	July average	Maximum	Minimum	Wettest month	Dryest month	Annual average
Carrizozo	5,429	38.2	75.3	110	—9	2.46 (July)	0.58 (Nov.)	13.38
Corona	6,670	33.6	69.4	105	—14	2.62 (July)	0.54 (Nov.	14.67
Ft. Stanton	6,400	34.9	69.2	105	—21	3.07 (July)	0.46 (Jan.)	15.40

Geology

INTRODUCTION

In detail, the geology of Lincoln County is complex. A belt of intense faulting trending north-south, accompanied by many and varied types of intrusive and extrusive rocks, extends through the west-central part of the county (pl. 2). In addition, an east-west trending zone, represented by the Capitan Mountains, traverses the area. The latter zone appears to continue east into Chaves County and west into Socorro County, as evidenced by the presence of several east-west trending dikes of considerable lengths.

Apart from the ever-present Quaternary alluvial deposits, the exposed sedimentary rock sequence in Lincoln County ranges in age from Ordovician to Tertiary. With the exception of the Cambrian, Silurian, Devonian, Mississippian, and Jurassic periods, every major period of deposition is represented in the area.

STRATIGRAPHY

PRECAMBRIAN ROCKS

Erosion has revealed the Precambrian basement in only two localities in Lincoln County. These exposures are in the Gallinas Mountains, west of the town of Corona, and in the Oscura Mountains, in the southwest part of the county. At these localities, the Precambrian is represented by granites and gneisses typical of that age. The Standard Oil Company of Texas drilled a wildcat oil test (No. 1 Heard) in sec. 33, T. 6 E., R. 9 E., which entered Precambrian diorite at a depth of 8,739 feet. Another well (Morrow No. 1 Franks), drilled in sec. 23, T. 2 S., R. 15 E., was bottomed in Precambrian pink biotite granite; the depth to granite was 1,990 feet. (See appendix for brief descriptions of the well logs of these wildcats.)

SEDIMENTARY ROCKS

Ordovician

A thin sequence, slightly more than 100 feet, of Ordovician sediments is exposed in the Oscura Mountains (pl. 2). Although Ordovician sediments have wide areal distribution in some parts of New Mexico, the sediments are of limited extent in Lincoln County; viz., the extreme southwest corner. Darton (1928, p. 194) has described the Ordovician sequence as exposed in T. 9 S., R. 6 E., as follows:

> The Bliss sandstone, although thin, is characteristic and appears to grade into the El Paso limestone through a few feet of slabby rusty glauconitic limestone. The El Paso beds are highly characteristic with thin, slabby bedding

TABLE 2. GENERALIZED SECTION OF SEDIMENTARY ROCKS IN LINCOLN COUNTY

SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION	THICKNESS (feet)
Quaternary				Clay, silt, sand, gravel.	Variable
Tertiary			Cub Mountain	Poorly sorted arkosic sandstones, shales, clays, and conglomerates. The sandstones are generally white to buff, the shales and clays are pale to medium red.	±2000
Cretaceous		Mesaverde	Undifferentiated	White to gray, and buff to yellow, quartzose sandstone; gray shale; carbonaceous shale; and coal.	±500
	Upper		Mancos shale	Gray marine shale, sandy shale, and some light-gray thin-bedded limestone.	±400
			Dakota(?) sandstone	Red to buff quartzose sandstone, conglomerate, and dark shale.	135-175
Triassic	Upper	Dockum	Undifferentiated	Maroon, red, and gray irregularly bedded sandstone; bright- and dark-red shale and sandy shale; and purplish limestone pebble beds.	±500
Permian			Chalk Bluff	Gypsum, dolomitic limestone, and red sandstone and siltstone.	100-350
	Guadalupe Leonard		San Andres	Light- to dark-gray evenly bedded limestone; locally thick beds of gypsum, and sandstone beds near base. Includes the Glorieta sandstone in the central and southern parts of the county.	300-1000

TABLE 2. GENERALIZED SECTION OF SEDIMENTARY ROCKS IN LINCOLN COUNTY (continued)

SYSTEM	SERIES	GROUP	FORMATION	DESCRIPTION	THICKNESS (feet)
	Leonard		Glorieta sandstone	White to gray fine- to medium-grained clean sandstone. Distinguishable as a separate formation in the northern part of the county only; otherwise included with the San Andres formation.	0-340
			Yeso	Pinkish-gray or yellow fine-grained silty sandstone and gypsum, with some limestone and dolomitic limestone.	1000.2000
	Wolfcamp		Abo	Dark-red or reddish-brown mudstone, locally arkosic and conglomeratic.	0-800
			Bursum	Bedded gray limestone and gray shale. Present only in the southwestern part of the county.	0-300
Pennsylvanian		Magdalena	Madera limestone Sandia	Bedded and massive gray limestone with dark chert; gray, brown, and red shale, graywacke, arkose, and conglomerate. Present in the southwestern portion of the county only.	0-3000
Ordovician		Montoya El Paso	Bliss sandstone	Includes Bliss sandstone, El Paso group, and Montoya group. Present only in the Oscura Mountains, in the extreme southwestern part of the county.	0-100
Precambrian				Granite, gneiss, etc.	

and brown reticulations on the bedding planes and weathering to a dirty tint. They contain abundant *Ophileta*. The Montoya limestone includes the dark massive lower member, 35 feet thick, grading up into a 6-foot member with cherty layers, much thinner than the corresponding member in the San Andres Mountains, with which it was found to be continuous.

The Bliss sandstone is believed to be of Ordovician age in this locality, although the formation is assigned to the Cambrian period in many of the more southern exposures in the State.

Silurian and Devonian

Sediments of these ages are believed to be absent in Lincoln County, except for the possible presence of the Percha (Devonian) shale noted by Darton (1928) in the Oscura Mountains.

Pennsylvanian

Sedimentary rocks of Pennsylvanian age crop out only in the southwestern corner of the county. Rocks of this age are believed to be largely absent in the remainder of the county, owing to the existence of the Pedernal positive element during Pennsylvanian times. The rocks are predominantly limestone throughout the sequence, reaching a thickness of approximately 3,000 feet in the extreme southwestern portion of the county. The previously described Standard Oil Company of Texas well penetrated only 910 feet of Pennsylvanian limestone, and equivalent beds are completely absent in the Gallinas Mountains, at the north end of the county. This indicates that the Pennsylvanian sediments rapidly thinned to extinction northward against the Pedernal highlands.

Permian

The predominant sedimentary outcrops in Lincoln County are those of Permian age. There are five distinct divisions of sediments of this period shown on the geologic map (pl. 2); namely, from the oldest to the youngest, the Bursum formation, Abo formation, Yeso formation, Glorieta sandstone, San Andres formation, and Chalk Bluff formation.

Bursum formation. The areal distribution of sediments of Wolf-camp age is similar to that of the previously described Pennsylvanian rocks. In the Standard Oil Company of Texas well, the Bursum formation is represented by approximately 230 feet of marine limestone interbedded with dark-red mudstone and arkosic conglomerate. Both the upper and lower contacts are difficult to define because of the lack of distinct unconformities.

Abo formation. Excluding areas of igneous activity and postdepositional erosion, the Abo formation is present practically everywhere in the county, except possibly in the north-central part of the county, in the vicinity of Corona. The formation consists of interbedded dark reddish-brown shales, siltstones, mudstones, and arkosic sandstones and conglomerates. Deposition is considered to have been continental, and measured thicknesses of the formation vary widely, apparently because of the very uneven surface on which the sediments were deposited.

Yeso formation. The overlying Yeso formation also has wide areal distribution in Lincoln County. The formation consists of interbedded limestone, sandstone, shale, and gypsum. The limestones are generally buff and tend to be somewhat impure (i.e., silty). The sandstone beds are generally pinkish to yellow, and the shales are variegated. The gypsum beds are white to gray and generally contain thin partings of shale and silt. In general, the gypsum beds are not as thick or pure as those in the overlying San Andres formation. The thick sequence of salt penetrated in the Standard Oil Company of Texas No. 1 Heard well is an unusual feature of the Yeso formation in this area; it is probable that the salt is limited to that immediate vicinity.

Measured thicknesses of the Yeso formation in Lincoln County vary over a considerable range. In general, the formation thickens toward the southeast, being about 1,000 feet thick in the vicinity of Corona and almost 2,000 feet thick near Picacho. Listed below are measured thicknesses of the formation at several localities:

Gallinas Mountains — ± 1,000 feet (Kelley, 1946)
Morrow No. 1 Franks well (sec. 23, T. 2 S., R. 15 E.) — 1,380 feet (see p. 110)
Rhodes Canyon (Otero County) — 1,579 feet (Kottlowski et al., 1956)
Stanolind No. 1 Picacho well (sec. 10, T. 12 S., R. 18 E.) —1,830 feet (see p. 110)

The Standard Oil Company of Texas No. 1 Heard well penetrated 4,265 feet of Yeso formation (see appendix), but this unusual thickness is believed to be due to folding and faulting in that locality.

Glorieta sandstone. As shown in Plate 2, the Glorieta sandstone is differentiated as a separate unit only in the northern part of the county. This is due to the thinning of the formation to the south, where it is included simply as part of the San Andres formation. The formation consists of white to gray fine- to medium-grained clean sandstone which is resistant to erosion, and the outcrops generally form cliffs or steep slopes. The formation is approximtaely 250 feet thick in the Gallinas Mountains (Kelley, 1949, p. 171), and the thickness penetrated in the Morrow No. 1 Franks well was 340 feet.

San Andres formation. The San Andres formation overlies the Yeso formation except where the Glorieta sandstone is distinguished as an intermediate unit. In outcrop, the San Andres covers a wide area in Lincoln County (viz., the eastern half of the county). The formation is composed mainly of gray limestone with lenses of white to gray sandstone and gypsum. Allen (1951) reports the formation to be approximately 700 feet thick, including the Glorieta sandstone tongues, in the vicinity of Capitan, but the formation is believed to thicken farther south and east. In the northern portion of the county, where the

Glorieta sandstone is distinguished as a separate formation, the San Andres formation is probably 300 feet thick at the maximum.

Chalk Bluff formation. Overlying the San Andres formation is a sequence of reddish sandstones, thin limestone, and gypsum beds. Allen (1958) has mapped this sequence as the Chalk Bluff formation in Capitan quadrangle. The Chalk Bluff is the equivalent of the Whitehorse group of Bates (1942, p. 42); in the extreme western portion of the county, the same sequence can be correlated with the upper member of the San Andres formation mapped in eastern Socorro County by Wilpolt and Wanek (1951). Other workers, notably Bachman (1953), have called the same general sequence the Bernal formation in northern New Mexico.

The formation is believed to thicken from west to east, as shown by the following measurements: 5 to 36 feet in eastern Socorro County (Wilpolt and Wanek, 1951); 200 to 275 feet in the vicinity of Lone Mountain (Smith, personal communication); 350 feet in the vicinity of Capitan (Allen, 1958).

Triassic

The Triassic sediments are shown in Plate 1 as a single group of undifferentiated formations. The sequence is composed of maroon, red, and gray irregularly bedded sandstone and bright- and dark-red shale, with occasional thin pebble-conglomerate beds. Allen (1958) has divided the Triassic sediments into two units in the vicinity of Capitan, the Santa Rosa formation (300 feet) and the Chinle formation (180 feet). Therefore, the entire sequence, which is frequently called the Dockum group, is 480 feet thick in the vicinity of Capitan. The Santa Rosa formation is composed mainly of red to gray sandstone and conglomerate, and the overlying Chinle formation contains red siltstones and mudstones, with some interbedded limestone near the top.

Jurassic

Sediments of this age are absent in Lincoln County.

Cretaceous

Three divisions of Cretaceous sediments have been recognized in Lincoln County, in ascending order: Dakota(?) sandstone, Mancos shale, and the Mesaverde group.

Dakota(?) sandstone. The Dockum group (Triassic) is overlain by a medium-grained sandstone formation which has been called Dakota(?) by Allen (1951), Wegemann (1914), and others in the vicinity of the Sierra Blanca. The formation contains thick-bedded to massive red to buff sandstone at the base, grading into interbedded black shale and sandstone at the top. The lower part of the formation is very resistant to erosion and forms cliffs or steep slopes in areas where it crops out. Allen (1951) states that the formation is 135 feet thick in the vicinity of

Capitan, and Wegemann (1914) gives the thickness as 175 feet in the White Oaks area. Owing to the gradational contact between the Dakota(?) sandstone and the overlying Mancos shale, measurements of the thickness of the formation are apt to vary from place to place.

Mancos shale. The Mancos shale is an easily eroded formation; hence it forms many of the valleys in areas where it crops out. The overall outcrop area has a roughly elliptical pattern peripheral to the Sierra Blanca (pl. 2). The Mancos consists of gray to black fissile shale interbedded with thin strata of gray limestone. The thickness of the formation is given as 389 feet by Allen (1951) in the vicinity of Capitan, but the thickness probably varies over a moderate range.

Mesaverde group. The Mesaverde group is composed of white, gray, yellow, and buff sandstones and gray shale, with several coal-bearing horizons. A detailed study of the group in the vicinity of Capitan has been made by Bodine (1956), who divides the group into three sections: (1) lower sandstone unit (165 feet thick), composed of massive white sandstone near the base and interbedded sandstone and fissile shale at the top; (2) middle shale unit (275 feet), composed of 95 feet of dark-gray marine shale wtih intercalated beds of thin limestone at the base, overlain by 180 feet of carbonaceous shale, coal, and thin beds of silty sandstone; and (3) upper sandstone unit (30 to 60 feet) of thick-bedded buff to white sandstone. The total thickness of all three units is approximately 500 feet near Capitan, but the thickness is believed to vary, with a general tendency to thin toward the southeast.

Tertiary

Cub Mountain formation. This formation was first mentioned in the literature by Bodine (1956), but the unit was defined and the type section measured by Weber (personal communication) in the Carrizozo area. Future publications by the latter are expected to describe the formation in considerable detail. The Cub Mountain formation contains poorly sorted, interbedded, impure sandstones, shales, clays, and conglomerates. The sandstones are white to buff, whereas the shales and similar fine-grained sediments are characteristically red. According to Weber (personal communication), the reddish coloring of the shales and clays is the most distinctive aid in separating this formation from the underlying Mesaverde group. The formation is very similar to the Baca formation in western New Mexico, but direct correlation of the two has not been made. Weber measured a thickness of 2000+ feet at the type locality (Cub Mountain south of Carrizozo), but the thickness may be expected to vary over a wide range.

Quaternary

Sedimentary deposits of Quaternary age in Lincoln County consist of clay, sand, and gravel. These rocks constitute the surface formations of the principal valleys and plains in the area.

IGNEOUS ROCKS

Tertiary Volcanic Rocks

One of the most striking features of Lincoln County is the immense volcanic pile which forms the bulk of the Sierra Blanca. The thickness of the volcanic rocks in this area probably exceeds 4,000 feet. Their composition is predominantly andesitic, but Weber (personal communication) noted latitic varieties on Church Mountain at the northern end of the range. The Godfrey Hills, south of Carrizozo, contain some latite flows, but the exact age relationship between this rock type and the Sierra Blanca andesites is not clear.

As shown in Plate 2, the Tertiary extrusive rocks form a belt around the north end of the igneous complex which forms the "high country" of the Sierra Blanca. Actually, this is misleading in some respects, because the volcanics are more or less present throughout the entire range. The term igneous complex as used here means a very intricate network of intrusive stocks and dikes contained within the same volcanic sequence as that which surrounds the complex.

Tertiary Intrusive Rocks

A wide variety of intrusive igneous rocks have invaded the earlier sedimentary beds in Lincoln County. Weber's (personal communication) investigations in Carrizozo 15-minute quadrangle have shown that the intrusives of that area, ranging in composition from rhyolite and syenite to gabbro, are post-Cub Mountain formation in age. This relationship indicates a Tertiary age for the intrusive rocks. In other intrusive areas of the county, all that can be affirmed is that the intrusions are younger than the enclosing sediments and are probably of the same general age indicated above.

The Jicarilla and Gallinas Mountains, and the Sierra Blanca, contain numerous crystalline intrusive masses. Isolated intrusive bodies also form the Capitan, Carrizo, Patos, and Lone Mountains in the central portion of the county. The major compositions of these various intrusive bodies may be given as follows: Jicarilla Mountains, monzonite and monzonite porphyry; Gallinas Mountains, syenite; Sierra Blanca, largely volcanic rocks, with monzonite, diorite, syenite, and possibly granite stocks; Capitan Mountains, alaskite; Carrizo and Patos Mountains, syenite; and Lone Mountain, monzonite and syenite.

The intrusives of Lincoln County are, in general, notably low in quartz, as indicated by the abundance of syenite stocks. The prominence of silica-poor intrusives probably had considerable influence on the deposition of ore. Unfortunately, this influence was probably unfavorable for the deposition of large base-metal deposits. The only occurrences of quartz-rich intrusives observed by the writer were the Capitan Mountains alaskite and several of the stocks in the Sierra Blanca range, the most notable of which was the monzonite stock at the Rialto molybdenum prospect.

A wide range of dikes cut the intrusive stocks, as well as the surrounding sediments and volcanic rocks. A particularly dense northeast-striking dike swarm has been mapped by Allen (1951) in Capitan 15-minute quadrangle (pl. 2). The composition of this particular dike swarm is basic, but practically the entire range of composition from rhyolite to basalt is present in various parts of the county.

Quaternary Basalt

Another striking feature of Lincoln County is the large basaltic lava flow or "malpais" located west of Carrizozo. Including the extension into Otero County, the flow is approximately 44 miles long and up to 5 miles wide. Allen (1951) has made a rough calculation of the volume of the flow, estimating that approximately 1 cubic mile of material was spilled out on the desert floor. The flow is believed to be one of the most recent in the United States.

STRUCTURAL FEATURES

Probably the dominant structural element within Lincoln County is the structural basin on which the Sierra Blanca volcanic pile rests. As shown in Plate 2, the outline of the basin, except where modified by faulting and minor structures, is defined by the outcrop of the Cretaceous sediments, particularly the Dakota(?) sandstone. Though not shown on the geologic map, the Cretaceous sediments close around the south end of the Sierra Blanca in northern Otero County, except where they are faulted downward on the southeast. The basin, therefore, is approximately 40 miles long and 20 miles wide, with the axial trend in a north-northeasterly direction. Some investigators have attributed the origin of the basin to the extrusion of the Sierra Blanca volcanic rocks, which in effect removed the underlying foundation of the area, allowing the volcanic rocks to settle to form a basin structure. This reasoning, though plausible, is not proven.

The Capitan Mountains, formed by a laccolithic intrusion of alas-kite, is another prominent structural feature. The long axis of the range strikes almost due east, which is an odd orientation in comparison to the common north- and northwest-trending intrusive rocks of the region. This structural trend is reflected to the east and west of Lincoln County by the presence of large dikes with the same orientation. Mayo (1953, p. 1172) states that this east-west trend through the Capitan Mountains may be a branch of the Texas lineament.

A series of strong faults trend north-northeast through the central portion of the county. In addition, the intense dike swarm just west of Capitan has the same general alinement. It is also interesting to note that the long axes of the Sierra Blanca and Jicarilla Mountains, both of which were formed by igneous activity, are oriented in a north-northeast direction. This zone of faulting and intrusion lies along the eastern side of the Cordilleran Front lineament described by Mayo (1958, p. 1173) and others.

The junction of these two structural zones, one trending east-west and the other almost north-south, occurs in the vicinity of the Carrizo, Patos, Vera Cruz, and Lone Mountain intrusive masses. This intersection may have influenced the location of these intrusions to some extent. Much additional work relating to the analysis of the structure of the area would be required, however, before the foregoing statement would have more than a speculative basis. The attitude of the sediments surrounding the Carrizo, Patos, and Vera Cruz intrusive bodies suggests that they are laccoliths, and the Lone Mountain stock may be of the same form.

The intrusive syenite of the Gallinas Mountains possesses an odd shape; i.e., a more or less circular shape with a prong extending to the southeast. The latter feature may be attributed to a laccolithic or sill-like prong extending from the main intrusive body, which appears to be a laccolith itself. The intrusive rocks appear to have spread along the contact between the Precambrian basement and the overlying Permian sediments in this area (Kelley, 1949).

A discussion of the structure of Lincoln County would not be complete without at least a brief mention of the folds exposed in Rio Bonito Canyon, east of the town of Lincoln. At this locality, the Yeso formation is contorted into a series of sharp north-trending folds, but the overlying San Andres formation is undisturbed, lying almost horizontal. The folds have been explained by a variety of mechanisms, such as arching, sill intrusions, and sliding of the overlying competent San Andres formation across the weak underlying Yeso shale beds. Further field work will be necessary to determine the true explanation of the folding.

Mining in Lincoln County

HISTORY

The earliest mining in Lincoln County probably was done by the Spaniards; unfortunately, little information is available on these early operations. It appears that the first lode deposit worked on a significant scale by Americans was the gold vein at the Helen Rae and American mines, in 1868. Placer gold was worked in the gulches below the lode as early as 1865. It is said that the early prospectors in the area were harassed by Mescalero Indian raids.

In 1882, the Rockford mine was discovered south of the American and Helen Rae mines. The following year, a small mill was erected to treat ores from the Rockford; this was probably one of the first ore-concentrating plants built in the county. Soon afterward, mills were built at the American mine, and at the newly discovered Parsons mine in Tanbark Canyon.

By the early 1880's, the White Oaks district was the focus of attention in the area. Lode gold was first discovered in that district in 1879 by a party consisting of George Wilson, "Old Jack" Winters, and George Baxter. The location of their discovery became the North Homestake mine. Soon after this important discovery, a score of other mines sprang up in the area, most notable of which were the Old Abe, South Homestake, Lady Godiva, Little Mack, and Rita mines. Mills were soon erected to treat the ores from the various properties. Jones (1904, p. 175) states that five such plants were operating in the district at the turn of the century.

The Gallinas Mountains district, now considered a fluorspar, rare-earth, and iron district, was originally mined for lead, copper, and silver. The Red Cloud and Old Hickory mines are believed to have been worked for these metals as early as 1885. Sketchy reports indicate that ore from the district was shipped by wagons to a smelter located at Socorro, some 100 miles distant.

The period from 1885 until shortly after the turn of the century was marked by the discovery of such other deposits as the Vera Cruz (gold), Renowned (lead-silver), gold placers and lodes in the Jicarilla Mountains, Oscuro district mines (copper), and numerous others. This same period of mining operations was probably the most active in the county's history, but the activity rapidly decreased thereafter. By the time Graton (Lindgren et al., 1910, p. 179) visited the county in 1905, little active mining was being done in the White Oaks district, except by lessors. The Helen Rae and American mines continued to operate intermittently until the early 1930's, and the Parsons mine produced in a similar manner until about 1920.

Mining was revived for short periods after the turn of the century, notably the mining of iron and tungsten, the latter from the old dumps in the White Oaks district. The Red Cloud mine made several shipments of high-grade lead-copper-silver ore during the period 1920-23, but these were to be the last important shipments of such ore from the county.

Among the last deposits to be worked were the fluorspar and rare-earth occurrences in the Gallinas Mountains. The demand for fluorspar during World War II led the U. S. Bureau of Mines to carry out an extensive exploration program in the district. Although several promising discoveries were made as a result of this program, little in the way of actual fluorspar production ensued. Bastnaesite had long been recognized in the Gallinas district, but important shipments of the rare-earth mineral were not made except for a brief time during 1954-56.

Mining in Lincoln County is almost at a standstill at the present time (1958). Several individuals are investigating prospects in the area, but the immediate outlook is rather dim for an active revival of mining.

Although coal mining is not discussed in detail in this bulletin, it may be appropriate to give a brief outline here of this once prosperous industry of Lincoln County. Coal was mined in the vicinity of White Oaks, beginning around 1880, to supply fuel to the various mines in the same area. In 1885, the extensive coal deposits near Capitan, which had supplied small quantities of coal for some years, were first mined on a large scale. From this date until 1906, a considerable quantity of coal was produced, making Lincoln County the third-ranking producer in the State during that period. The coal beds of the Capitan district are interrupted by numerous faults and dikes, which caused a great deal of difficulty in mining. These and other factors caused the closing of most of the Capitan mines shortly after 1906. The White Oaks district continued to produce a small quantity of coal for local use, including the generation of electric power for the town of Carrizozo, until 1939. A small amount of coal also was produced from the Willow Hill area, south of Carrizozo, but the period of operation is not known.

PRODUCTION

The production of minerals (including coal) from Lincoln County, through 1958, amounted to $5,449,268[1] (table 3). Of this amount, $4,048,589 was produced prior to 1906, and only $1,400,679 thereafter. Ranked according to production values, the various minerals and metals are: gold, coal, iron ore, lead, copper, silver, tungsten, fluorspar, bastnaesite, and zinc. These 10 minerals are the only ones for which production has been recorded in Lincoln County; others may have been mined, but the quantity is certain to have been of minor proportions.

1. Although production values are given to an apparently high degree of accuracy, they should ***be*** considered as only approximate.

TABLE 3. PRODUCTION OF METALS AND MINERALS FROM LINCOLN COUNTY (continued)

Year	Principal metals*						Other metals and minerals†						Total (dollars)	Year
	Gold‡ (dollars)	Silver (oz)	Copper (lb)	Lead (lb)	Zinc (lb)	Total (dollars)	Iron ore (tons)	Fluorspar (tons)	Bastnaesite concentrate (lb)	Tungsten, WO_3 (lb)	Coal (tons)	Total (dollars)		
1902	50,607	11,520	—	—	—	56,613	—	—	—	—	56,808	113,616	170,229	1902
1903	46,449	301	—	—	—	46,610	—	—	—	—	98,096	196,192	242,802	1903
1904	28,596	2,576	—	2,261	—	30,183	—	—	—	—	92,495	277,485	307,668	1904
1905	7,475	757	14,404	7,511	—	10,532	—	—	—	—	43,140	129,420	139,952	1905
1906	16,463	1,946	—	—	—	17,767	—	—	—	—	2,545	7,635	25,402	1906
1907	41,417	721	—	—	—	41,893	—	—	—	—	1,956	5,866	47,759	1907
1908	29,712	5,472	1,195	—	—	32,770	—	—	—	—	2,522	7,566	40,336	1908
1909	23,863	388	700	7,977	—	24,499	—	—	—	—	§	§	24,499	1909
1910	55,276	559	189	5,614	—	55,849	—	—	—	—	2,315	6,945	62,794	1910
1911	31,934	184	555	6,620	—	32,399	—	—	—	—	1,658	4,974	37,373	1911
1912	22,416	1,005	9,988	103,911	—	29,358	—	—	—	—	2,550	7,650	37,008	1912
1913	42,496	1,100	7,068	94,010	—	48,392	3,700	—	—	—	2,780	26,840	75,232	1913
1914	63,407	961	15,068	10,641	—	66,360	9,050	—	—	—	§	45,250	111,610	1914
1915	45,376	493	5,091	13,277	—	47,141	5,889	—	—	54,000	4,000	95,445	142,586	1915
1916	7,744	953	28,045	—	—	15,270	3,504	—	—	7,651	§	25,171	40,441	1916
1917	8,242	324	13,172	—	—	12,105	5,245	—	—	1,200	§	27,425	39,530	1917
1918	14,106	177	1,850	—	—	14,740	3,640	—	—	4,935	§	23,135	37,875	1918
1919	11,146	792	—	—	—	12,033	2,544	—	—	—	§	12,720	24,753	1919
1920	4,110	1,411	11,386	175,250	—	21,763	1,952	—	—	—	§	9,760	31,523	1920
1921	6,000	1,200	49,240	155,222	—	20,537	248	—	—	—	§	1,240	21,777	1921

* Value computed by using the average annual price for each metal. † Value computed by using the following: iron ore at $5 per ton, fluorspar at $30 per ton, bastnaesite concentrate at $0.114 per pound, tungsten trioxide (WO_3) at $1 per pound, coal at $2 per ton prior to 1904 and $3 per ton thereafter. These prices are only estimates; the actual value realized from the sale of the metals and minerals may have diverged widely from the value indicated.
‡ The average price for gold prior to 1933 was $20 per ounce; since 1933, the price has been stabilized at $35 per ounce. § Data lacking.

TABLE 3. PRODUCTION OF METALS AND MINERALS FROM LINCOLN COUNTY (continued)

Year	Principal metals*						Other metals and minerals†						Total (dollars)	Year
	Gold‡ (dollars)	Silver (oz)	Copper (lb)	Lead (lb)	Zinc (lb)	Total (dollars)	Iron ore (tons)	Fluorspar (tons)	Bastnaesite concentrate (lb)	Tungsten, WO_3 (lb)	Coal (tons)	Total (dollars)		
1922	24,144	11,435	213,072	700,072	—	102,848	—	—	—	—	§	§	102,848	1922
1923	9,249	3,102	38,966	232,657	—	33,807	—	—	—	—	§	§	33,807	1923
1924	7,738	442	8,596	26,912	—	11,313	—	—	—	—	§	§	11,313	1924
1925	964	141	2,500	—	—	1,417	—	—	—	—	§	§	1,417	1925
1926	—	—	—	—	—	—	—	—	—	—	3,555	10,665	10,665	1926
1927	—	381	3,382	21,683	—	2,025	—	—	—	—	4,806	14,418	16,443	1927
1928	—	253	1,118	10,535	—	920	—	—	—	—	6,000	18,000	18,920	1928
1929	25	1,606	391	1,000	—	1,013	—	—	—	—	1,870	5,610	6,623	1929
1930	133	179	700	12,900	—	938	—	—	—	—	2,000	6,000	6,938	1930
1931	898	783	100	300	—	1,145	—	—	—	—	§	§	1,145	1931
1932	9,895	1,397	1,000	12,000	—	10,712	—	—	—	—	§	§	10,712	1932
1933	14,542	289	1,000	14,000	—	15,225	—	—	—	—	1,070	3,210	18,435	1933
1934	36,406	512	4,400	13,900	—	37,603	—	—	—	292	1,950	6,142	43,745	1934
1935	31,269	455	2,000	17,900	—	32,470	—	—	—	—	3,254	9,762	42,232	1935
1936	14,935	594	250	9,800	—	15,869	—	—	—	—	§	§	15,869	1936
1937	7,182	357	100	200	—	7,482	—	—	—	—	§	§	7,482	1937
1938	5,852	458	100	5,800	—	6,425	—	—	—	—	§	§	6,425	1938
1939	9,205	84	—	—	—	9,262	—	—	—	—	100	300	9,562	1939
1940	11,585	675	100	—	—	12,086	—	—	—	40	—	40	12,126	1940
1941	8,085	758	—	200	—	8,635	—	—	—	—	—	—	8,635	1941

* Value computed by using the average annual price for each metal. † Value computed by using the following: iron ore at $5 per ton, fluorspar at $30 per ton, bastnaesite concentrate at $0.114 per pound, tungsten trioxide (WO_3) at $1 per pound, coal at $2 per ton prior to 1904 and $3 per ton thereafter. These prices are only estimates; the actual value realized from the sale of the metals and minerals may have diverged widely from the value indicated.
‡ The average price for gold prior to 1933 was $20 per ounce; since 1933, the price has been stabilized at $35 per ounce. § Data lacking.

TABLE 3. PRODUCTION OF METALS AND MINERALS FROM LINCOLN COUNTY (continued)

Year	Principal metals*						Other metals and minerals†						Total (dollars)	Year
	Gold‡ (dollars)	Silver (oz)	Copper (lb)	Lead (lb)	Zinc (lb)	Total (dollars)	Iron ore (tons)	Fluorspar (tons)	Bastnaesite concentrate (lb)	Tungsten, WO_3 (lb)	Coal (tons)	Total (dollars)		
1942	1,260	4	—	—	—	1,263	12,285	—	—	—	—	61,425	62,688	1942
1943	—	—	—	—	—	—	4,397	—	—	—	—	21,985	21,985	1943
1944	—	—	—	—	—	—	—	—	—	—	—	—	—	1944
1945	—	—	—	—	—	—	—	—	—	—	—	—	—	1945
1946	35	5	—	1,000	—	148	—	—	—	—	—	—	148	1946
1947	—	—	—	—	—	—	—	—	—	—	—	—	—	1947
1948	35	854	10,000	74,000	16,000	18,352	—	—	—	—	—	—	18,352	1948
1949	1,400	21	—	2,000	—	1,735	—	—	—	—	—	—	1,735	1949
1950	1,680	43	—	—	—	1,719	—	—	—	—	—	—	1,719	1950
1951	630	32	—	4,000	—	1,351	—	80	—	—	—	2,400	3,751	1951
1952	—	—	—	—	—	—	1,472	—	—	12	—	7,372	7,372	1952
1953	175	189	4,000	14,000	—	3,328	2,644	674	—	—	—	33,440	36,768	1953
1954	—	45	—	6,000	—	863	350	854	40,000	—	—	31,930	32,793	1954
1955	35	212	—	8,000	—	1,419	—	—	84,000	—	—	9,576	10,995	1955
1956	—	—	—	—	—	—	—	—	22,000	—	—	2,508	2,508	1956
1957	—	—	—	—	—	—	2,805	—	—	—	—	14,025	14,025	1957
1958	—	—	—	—	—	—	—	—	—	—	—	—	—	1958
Total	3,311,700	153,332	628,088	1,771,480	16,000	3,624,671	59,725	1,608	146,000	68,130	606,197	1,824,597	5,449,268	Total

* Value computed by using the average annual price for each metal. † Value computed by using the following: iron ore at $5 per ton, fluorspar at $30 per ton, bastnaesite concentrate at $0.114 per pound, tungsten trioxide (WO_3) at $1 per pound, coal at $2 per ton prior to 1904 and $3 per ton thereafter. These prices are only estimates; the actual value realized from the sale of the metals and minerals may have diverged widely from the value indicated.
‡ The average price for gold prior to 1933 was $20 per ounce; since 1933, the price has been stabilized at $35 per ounce.

Mineral Deposits

GEOGRAPHIC DISTRIBUTION

Plate 1 shows the locations of the principal mining districts of Lincoln County. The known mineral deposits are limited, in general, to the mountainous areas, but there is no clearly defined geographic distribution. Zoning of minerals is present on a limited scale (i.e., within certain deposits) but not on a regional basis.

CLASSIFICATION

All the mineral deposits examined, with the exception of the placer, coal, gypsum, and clay, are probably of hydrothermal origin. The temperature extends from epithermal to pyrometasomatic conditions; however, true hypothermal conditions were not observed. The iron deposits in the county are dominantly pyrometasomatic replacement bodies in limestone adjacent to igneous contacts; the Rialto molybdenum deposit suggests mesothermal conditions of deposition; and the epithermal deposits are represented by the lead-zinc-silver-gold veins of the Nogal district. The White Oaks district (gold), the Vera Cruz and Parsons mines (gold), and the Gallinas district (fluorspar-lead-copper-rare earths) do not fit exactly into any specific temperature class; nevertheless, the dominant characteristics of these deposits are epithermal.

A classification of the deposits as to structural conditions is possible, but inasmuch as such conditions are practically unique at each deposit, a critical classification would have little meaning. However, the broad classifications are: (1) ore associated with breccia zones — the Gallinas district, Vera Cruz mine, Capitan iron deposit, and possibly the Parsons mine; (2) fissure veins — most of the lead-zinc-silver-gold veins of the Nogal and West Bonito districts; (3) mineralized fracture zones — the White Oaks and Jicarilla gold districts; (4) disseminated or "porphyry" deposits — the Rialto molybdenum prospect; (5) limestone replacement deposits — most of the iron deposits of the county.

Although the hydrothermal deposits are epigenetic (i.e., later than the enclosing rocks), their absolute age is not evident. Inasmuch, however, as such deposits are related to periods of igneous activity, their age is believed to be Tertiary, the only period of igneous intrusion (excluding the Precambrian) evident in Lincoln County. Economic mineralization has not been discovered in the few Precambrian outcrops present in the area.

MINERALOGY

A wide variety of economic minerals are found in Lincoln County, in addition to a vast assemblage of gangue minerals. The table below lists the economic minerals of importance.

TABLE 4. PRINCIPAL ECONOMIC MINERALS OF LINCOLN COUNTY

Gold	*Silver*	*Copper*	*Lead*	*Fluorine*
native *	argentiferous galena*	chalcopyrite*	galena*	fluorite
auriferous pyrite *	native	bornite	anglesite	
gold tellurides(?)	argentite	chalcocite*	cerussite	
	cerargyrite	malachite	wulfenite	
		azurite		

Zinc	*Rare earths*	*Iron*	*Molybdenum*	*Tungsten*	*Manganese*
sphalerite*	bastnaesite *	magnetite *	molybdenite	huebnerite*	psilomelane*
smithsonite	allanite	hematite	wulfenite	wolframite	pyrolusite
		pyrite		scheelite	
		arsenopyrite			
		marcasite			

* The most important mineral(s) within each group, as indicated by records of past production from the county.

Sedimentary deposits of economic importance include placer gold, gypsum, bituminous coal, and fire clay.

FUTURE POSSIBILITIES

With the possible exception of the White Oaks district, lack of sufficient development of the various mines and prospects in Lincoln County prevents an accurate appraisal of the potentialities for further ore discovery. However, a few general statements can be made which may be of some aid to future prospecting.

Many of the intrusive rocks of the area are classified as syenite or as rocks of similar composition; e.g., the Gallinas, Carrizo, and Patos "intrusives." This type of intrusive rock is subsilicic (i.e., low in quartz), and such rocks are not considered to be favorable for the formation of large base-metal deposits, excluding iron. On the other hand, syenites are considered favorable for the formation of iron, fluorspar, and rare-earth deposits. These statements are verified in the known mineralization associated with the syenite intrusions of Lincoln County.

Most of the monzonitic intrusive rocks of the county, such as the Jicarilla and Lone Mountain intrusions, are low in free silica; the resultant absence of quartz probably was unfavorable for the formation of significant base-metal deposits other than iron. Gold deposits are associated with such a wide variety of igneous rocks that the foregoing statement does not apply to that type of deposit.

Several of the exposed intrusive rocks in the Sierra Blanca igneous complex are quartz-rich, notably in the vicinity of the Rialto molybdenum prospect, and the area in and around such bodies may be considered as favorable for base-metal prospecting. This area, however, has never had a truly successful base-metal mining operation in spite of rather extensive prospecting. Further exploration of known veins in this area should be done with caution; such veins seldom improve radically with depth, especially where the zone of oxidation is as shallow as in the Nogal district.

Iron deposits and minor occurrences of thorium and manganese are associated with the alaskite laccolith of the Capitan Mountains, but the area appears to be void of other types of deposits. The exact reason why this intrusive rock apparently was not a favorable ore source is not clear. Perhaps the intrusion was emplaced at too shallow a depth for differentiation to take place, or the laccolithic shape prevented the formation of ore-forming fluids.

Gold mining was apparently very successful in the early days. This may be attributed to three principal factors: (1) The mining was done only to shallow depths; hence low mining costs; (2) the ore was free-milling; and (3) the price of gold was high in relationship to other costs. At the present time, all these favorable factors have been nullified by rising mining costs, a stable gold price, and the refractory nature of the sulfide ores eventually encountered with depth. As an example of rising mining costs, the author noted in an old (1900) but probably authentic report on the White Oaks district that a vertical shaft was sunk to a depth of 1,000 feet at a total cost of $15,000. The cost of a similar shaft today might well exceed $200,000. This represents a 13-fold increase in costs, whereas the price of gold has increased only from $20 to $35 per ounce during the same period of time. The cost of labor has also increased enormously. In 1900, the average wage for an experienced miner was about $3 for a 10-hour day; now, the miner earns $18 or more for an 8-hour day.

The iron-ore deposits of Lincoln County possibly have not received the attention they deserve. Every iron mining venture in the area collapsed after only brief periods of operation. These failures may have been due to the inability to mine a direct-shipping ore. Future operations should be accompanied by an upgrading plant, inasmuch as the tonnage of high-grade ore present in any of the known deposits is small. Careful plans should be laid before commencing such an operation, because the margin of profit, if present at all, is certain to be low.

The fluorspar deposits of the Gallinas district have economic possibilities, if three requirements are met: (1) Much further development must be undertaken to prove the ore bodies; (2) a successful method for concentrating the ore must be devised; and (3) the fluorspar market must improve.

The rare-earth mineral bastnaesite, found associated with fluorspar in the Gallinas district, may be of considerable economic importance, but the presently known occurrences appear to be of too low grade for profitable mining.

Descriptions of Deposits

WHITE OAKS DISTRICT

GENERAL

In terms of value, the White Oaks district has accounted for the major portion of the metal production from Lincoln County. The district has produced gold and tungsten, but the value of the latter is minor compared with that of the gold.

The district lies approximately 1 mile northwest of the village of White Oaks, which, in turn, is 12 miles northeast of Carrizozo (fig. 1). The town of White Oaks is a typical ghost mining camp. A number of tourists visit this historic spot each year.

The first lode gold deposit in the district was discovered in 1879 by George Wilson, "Old Jack" Winters, and Ralph Baxter. The site of their discovery later became the North Homestake mine, one of the better mines of the district. The story is told (Jones, 1904) that immediately after the discovery, Wilson sold his interest to Winters for $40, a pony, and one bottle of whiskey. Though subsequent events cast doubt on Wilson's wisdom in this transaction, it must be acknowledged that he is one of the select few who ever made a profit from mining!

Soon after the initial discovery, several other veins were discovered, leading to the development of such mines as the South Homestake, Old Abe, Lady Godiva, Rita, and Little Mack. By far the most active period for the district was before the turn of the century (table 5). According to Jones (1904), the gold production up to 1904 was valued at $2,860,000 (143,000 ounces at $20 per ounce). The total known production since that time amounts to only 9,373 ounces, plus a possible ± 10,000 ounces which are not accounted for (table 5, footnote I I).

The last steady operation in the district was during the 1930's, when the El Aviador Gold Mining Co. operated the Smuggler and Little Mack mines in the western part of the district. After World War II, the Q.B.Q. Company, Inc. operated the North Homestake and Old Abe mines for a brief period, but the district is now dormant.

Plate 3 is a claim map of the district. Although most of the claims have changed ownership many times since the original locations, the majority are now part of the A. H. Hudspeth Estate (Grace M. Jones and Oliver Seth, trustees).

GEOLOGY

Figure 2 is a geologic map of the southwestern portion of the Little Black Peak 15-minute quadrangle. The White Oaks district lies just northeast of Baxter Mountain, in the extreme southeast portion of the map. The mapping was done by students of the New Mexico Institute of Mining and Technology's summer field-geology class of 1958 under the supervision of Dr. C. T. Smith.

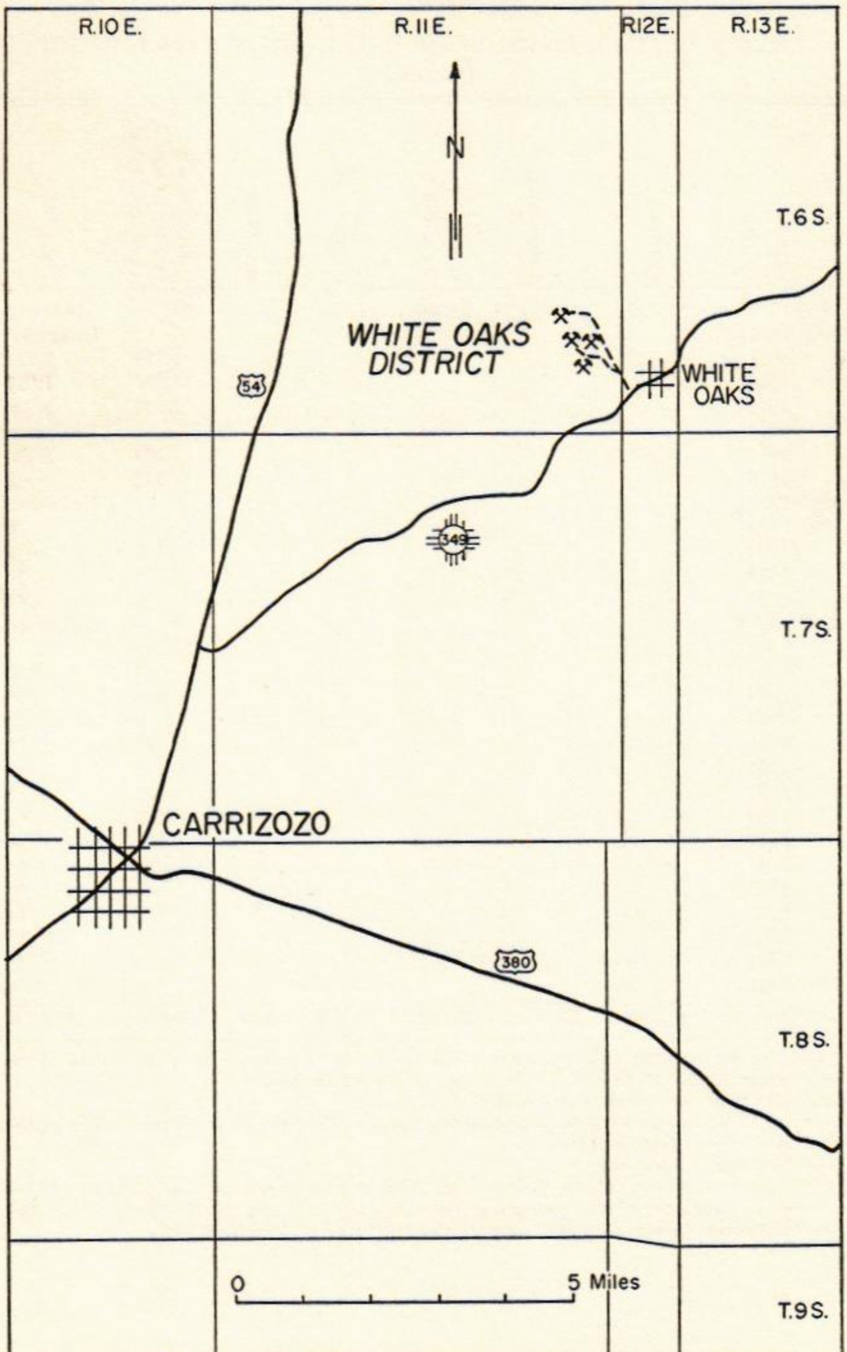


Figure 1
Location map of the White Oaks district

TABLE 5. GOLD PRODUCTION FROM THE WHITE OAKS DISTRICT
(In ounces)

YEAR*	OLD ABE†	SOUTH HOMESTAKE	NORTH HOMESTAKE	LITTLE MACK	SMUGGLER	UNDISTRIBUTED AND OTHER MINES, INCLUDING PLACERS	TOTAL
1879-1903‡	43,750	30,000	20,000	2,500	—	46,750	143,000‡
1904-1910§‖							Unknown
1911						1,545	1,545
1912						1,037	1,037
1913						2,056	2,056
1914							Unknown
1915	1,937					193	2,130
1916						342	342
1917-1920§							Unknown
1921-1922							0
1923						447	447
1924						374	374
1925						46	46
1926-1931§							Unknown
1932						9	9
1933						130	130
1934						518	518
1935				79	279	0	358
1936						13	13
1937						5	5
1938						2	2
1939						60	60
1940						151	151
1941						53	53
1942						0	0
1949	40					0	40
1950			39			0	39
1951	18					0	18
1952-1957						0	0
Totals	45,745	30,000	20,039	2,579	279	53,731	152,373

* Data for the years 1911-1931 from U. S. Geol. Survey, *Mineral Resources of the United States;* for the years 1932-1957, from U. S. Bur. Mines, *Minerals Yearbook.*
† Old Abe mine production from Finlay (1921-22, p. 80).
‡ Jones (1904); based on a gold price of $20 per ounce. The figures exceed those given by the U. S. Mint reports (shown in table 3).
§ Data lacking for these years.
‖ Gold production for Lincoln County from 1904 to 1910 is estimated at $202,802 (10,140 ounces). A large part of this production undoubtedly came from White Oaks. U. S. Geol. Survey, *Mineral Resources of the United States* (1912), pt. 1, Metals, p. 840.

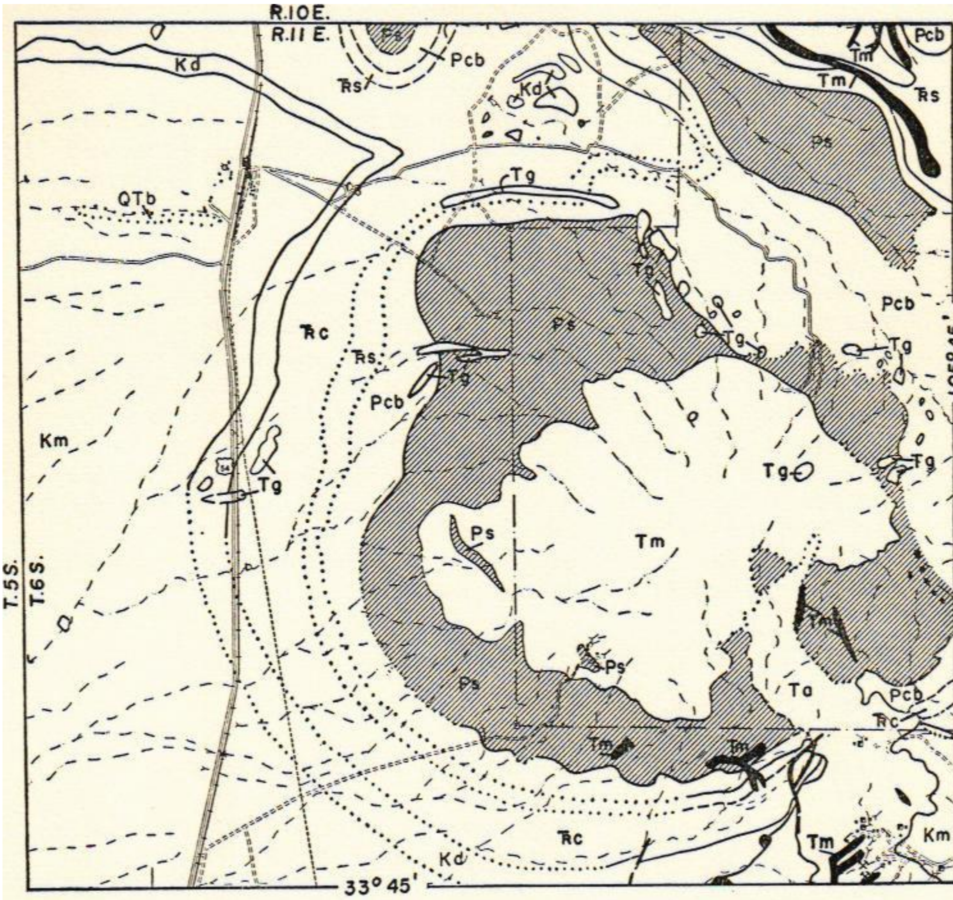


Figure 2

GEOLOGIC MAP OF A PORTION OF THE LONE MOUNTAIN AREA

Geology by C. T. Smith, et al., 1958. Qt, Quaternary gravel; QTb, Quaternary and late Tertiary basic dikes and flows; Ta, Tertiary agglomerate and tuff (includes some small stocks of monzonite); Tg, Tertiary quartz-rich monzonite; Tm, Tertiary monzonite and syenite; Km, Mancos shale; Kd, Dakota(?) sandstone; ℞c, Chinle formation; ℞s, Santa Rosa formation; Pcb, Chalk Bluff formation; Ps, San Andres formation; Pg, Glorieta sandstone.

The dominant feature of the White Oaks area is the Lone Mountain monzonite intrusive, which has domed the Paleozoic sediments into an almost circular pattern of outcrops. The Lone Mountain intrusive may be laccolithic in shape, but conclusive evidence of this form is lacking. Several iron deposits (described on p. 97-99) occur along the contact of the intrusive mass and the surrounding sediments.

A belt of complex extrusive and intrusive rocks and possibly Tertiary sediments extends southward from Lone Mountain through the western portion of the White Oaks district. These rocks, and the Cretaceous sediments immediately to the east, are the hosts for the ore deposits of the district.

In the immediate vicinity of the mines, most of the igneous rocks are intrusive. A swarm of dikes and irregular bodies of monzonite intrude the Mancos and Mesa Verde formations of Cretaceous age. Later(?) in age is a very basic set of dikes and irregular masses which have been identified as minette and kersantite by Graton (Lindgren et al., 1910). In certain areas, the predominant constituent is biotite, which makes the rock distinctive enough to be mapped as a separate unit (here called mica trap) in the underground workings. The latest intrusive rock observed in the district is a white rhyolite which invades both the monzonite and the basic dikes and masses.

The area has not been mapped in detail; therefore, generalizations as to the trends of the dikes are not possible.

DESCRIPTIONS OF MINES

Old Abe Mine

Location. Locality 1 in Figure 3.

History. The Old Abe shaft is located near the center of the north end of the White Oaks claim (M. S. 759). The vein was discovered in the winter of 1879-80, but paying ore was not exposed until 1890. According to Jones (1904), a 20-stamp amalgamation mill was erected on the property in April 1893, which was expanded to include cyanidation in 1898. The most productive era for the mine was apparently from the time of the discovery until 1904 (table 5). The workings on the property extended to a depth of 1,375 feet by 1904, at which time it was the deepest mine in the State. Subsequent operations reportedly deepened the mine to a total depth of 1,500 feet. As is characteristic of the district, the mine did not encounter significant amounts of water, even on the deepest level. Although this feature was advantageous to the mining operations, it necessitated transporting water long distances for the milling operations.

The foundations of the mill and the headframe at the shaft are all that now remain of this once prosperous mining operation.

Geology. The shaft timber is now collapsed a few feet below the collar, preventing examination of the underground workings. Figure 4 is

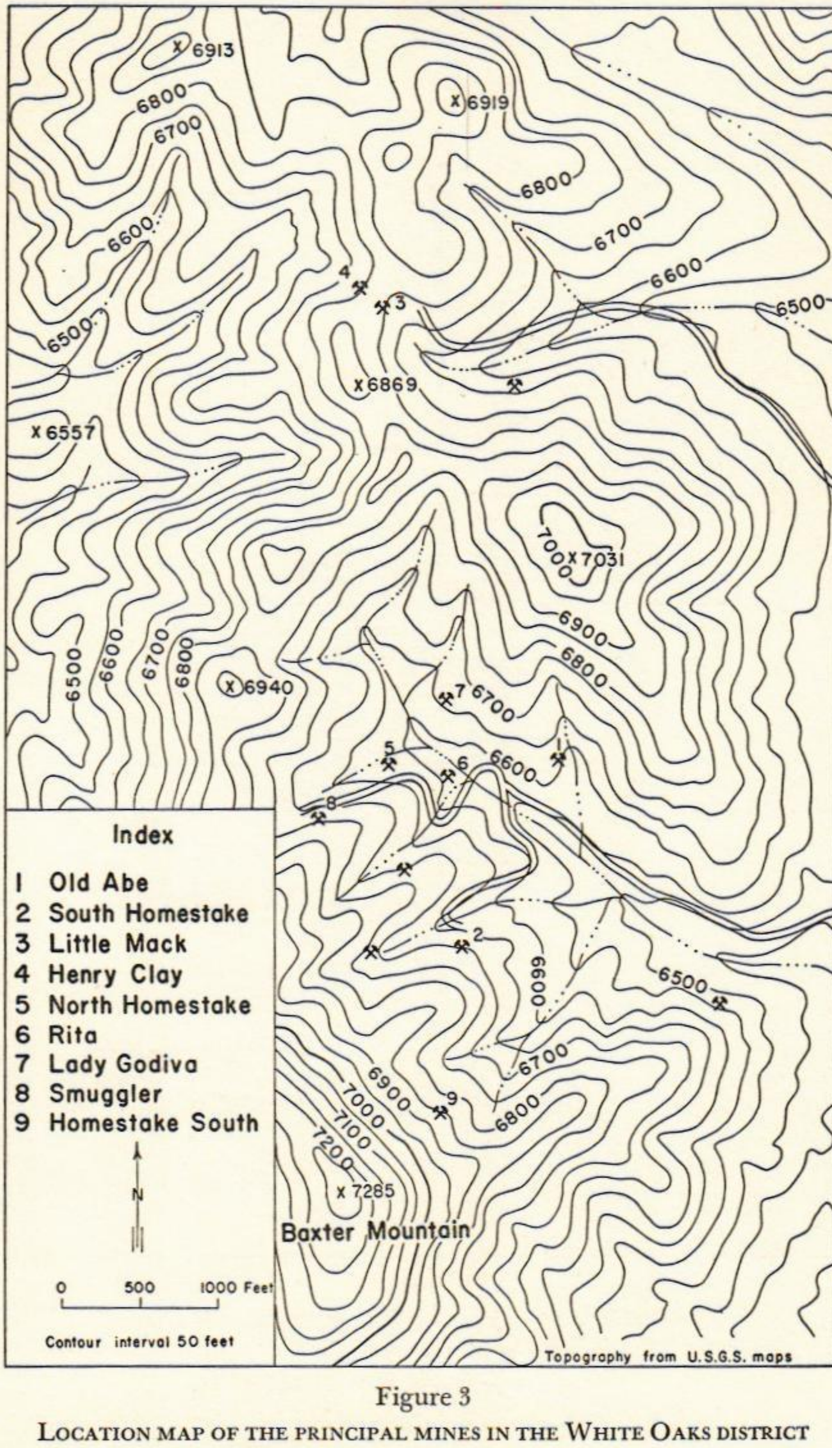


Figure 3

LOCATION MAP OF THE PRINCIPAL MINES IN THE WHITE OAKS DISTRICT

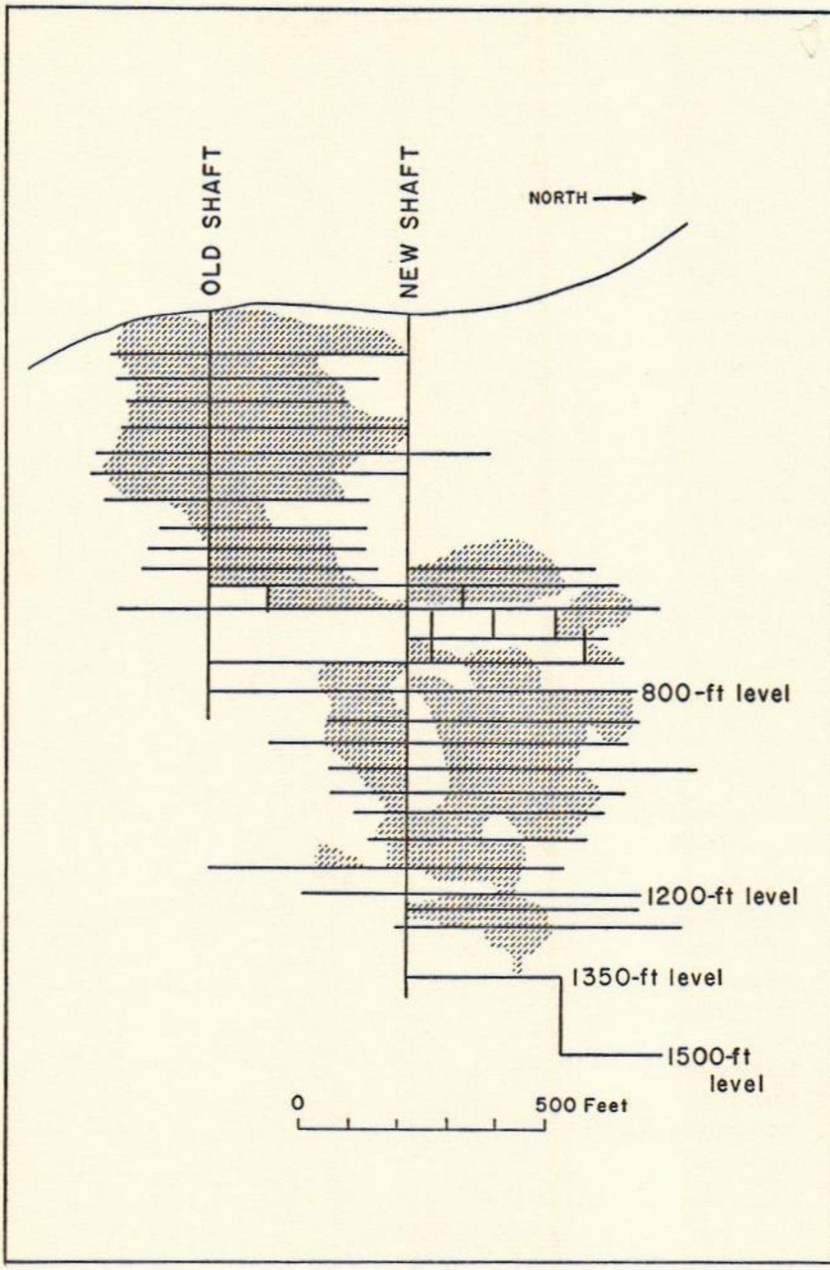


Figure 4

IDEALIZED VERTICAL LONGITUDINAL SECTION OF THE OLD ABE MINE, LOOKING WEST

From old maps. Stoped areas are stippled.

an idealized longitudinal section of the underground workings taken from an old map now in the possession of Miss Grace M. Jones. The vein has been stoped through to the surface just south of the shaft. In this exposure, the vein strikes north with an almost vertical dip. The vein appears to be a minor plane of movement, just a few inches wide, in a rather wide zone of intense brecciation. The breccia is located along a north-trending contact between a monzonite dike on the west and Cretaceous sediments on the east. The breccia contains fragments of both these rock types, plus small irregular masses and fragments of lamprophyre.

The vein is definitely postbreccia inasmuch as it occurs as a vertical plane cutting through the breccia. Visually, the vein contains only iron oxide and minor amounts of quartz. It is rather unusual that the mineralization appears to be limited to a minor fault plane, because the breccia host appears to be quite permeable.

Graton examined the mine in 1905 (Lindgren et al., 1910). As the only factual account of the underground workings, his statements are quoted in full:

> The Old Abe vein strikes N. 10° W. and dips very steeply toward the west. It cuts both monzonite and shale and such dikes as are present. One especially micaceous dike is encountered just west of the vein on several of the lower levels. The vertical shaft reached the 1,300-foot level in 1905, and was the deepest in the Territory. Below the 1,300-foot level a winze had been sunk 80 feet. Ore was said to be present in this winze, but was not rich enough to stand hoisting twice. The main shaft has since been deepened, therefore, and some ore extracted from the bottom levels. The mine was practically dry to the thirteenth level. In driving that level water was encountered; for some time it came in at the rate of about 20 gallons a minute, but later subsided. In November, 1905, though no unwatering had been done for a long time, there were only a few *feet* of water in the winze. The upper workings of the mine were reached through a shaft with levels at intervals of about 50 feet; this has been replaced by the new shaft, and the lower levels are mostly 100 feet apart. Only the lower half of the mine was visited. The ore was found in pockets and shoots in the lode. On the 700-foot or seventh level, for example, an ore shoot 50 feet long was struck about 250 feet north of the shaft. It was mostly in sheeted shale and the ore was much oxidized. As seen in the face of the drift 30 or 40 feet north of the stope the vein consists of a 4-inch seam of limonite and manganese oxide. Directly above, on the 650-foot level, the shoot was 80 feet long. Another good bunch of ore was found on the seventh level, where a flat seam crosses the main lode. This flat seam also shows that a little faulting has taken place along the main fracture, the west wall being thrown down 6 or 8 inches. On the eighth level the shoot extends from 50 or 60 feet south to 200 feet north of the shaft. It reaches from 45 feet above the eighth level to the 950-foot level. It was widest, attaining a width of 10 feet, just south of the shaft on the eighth level. The rich stopes known as the Fish Pond and the Duck Pond were also reached from the eighth level, or the fourteenth level of the old shaft. These stopes were close to but at one side of the main lode and consisted of brecciated masses of shale and monzonite, porous and somewhat silicified and stained with iron. The Fish Pond stope was 20 feet wide, 50 feet long, and 60 feet high; it is said to have yielded $80,000. On the tenth level a stope about 150 feet

long begins at 100 to 150 feet north of the shaft. In going northward the ore was found to follow a branch stringer on the east, but the ore gave out where this stringer again united with the main vein farther north. At this level a considerable amount of pyrite is seen in the seams and the adjoining wall rock. On the twelfth level the wall rock was especially impregnated with pyrite, with values, though gradually decreasing away from the central fracture, sufficient to permit stoping to a width of 31 feet. On the 1,300-foot level sulphide ore is also found, but most of the ore is oxidized. About 150 feet north of the crosscut west from the shaft is a stope 35 feet in diameter and 15 feet high. The ore here was said to be of good value. Shale is present with the monzonite and both are more or less brecciated, as above. This ore body is followed down by the 80-foot winze and a small stope made at the bottom, but extraction was not profitable under the conditions then existing. Massive shale, little oxidized, is present 50 feet north of the ore body on the thirteenth level. It is stated that on the whole the ore was of a little better grade in the shale than in the monzonite.

TABLE 6. GOLD PRODUCTION FROM THE OLD ABE MINE FROM APRIL TO AUGUST 1901

MONTH	TONS MINED	GOLD RECOVERED (in dollars) AMALGAMATION	CYANIDATION	TOTAL	OUNCES at $18/oz *	AVERAGE GRADE (oz/ton)
April	826	$ 4,598.99	$ 351.05	$ 4,950.04	275.10	0.33
May	776	5,578.96	584.30	6,163.26	343.41	0.44
June	1,000	7,088.95	748.35	7,837.30	436.41	0.44
July	912	4,381.40	609.96	4,991.36	277.30	0.31
August	1,300	3,100.38	446.05	3,546.43	197.02	0.15
Totals	4,814	$24,748.68	$2,739.71	$27,488.39	1,529.24	0.33

* A gold value of $18 per ounce is used here because the report from which the data were obtained stated this as the average price *received* from the mint at the time (1901).

From Graton's account, it may be deduced that the vein structure passes from the breccia into the Cretaceous sediments at depth. This being the case, the contact between the breccia and sediments must dip to the west at a flatter angle than the west-dipping vein.

Mining and milling methods. Little can be said on these topics owing to the inaccessibility of the mine workings and the removal of the old mill.

The only factual account of the grade of ore mined from the Old Abe is contained in an old report, dated September 1901, which is now in the possession of Miss Grace M. Jones. Table 6 has been compiled from data given in this report.

According to the same report, most of the ore extracted from April to August 1901 was from stopes on the 1200 and 1250 levels. As noted in the table, the gold recovered averaged 0.33 ounce per ton; the gross value of such ore today (gold at $35.00 per ounce) is $11.55 per ton.

South Homestake Mine

Location. Locality 2 in Figure 3.

History. The early history of this mine is not known in detail. The workings are located on the South Homestake claim (M. S. 146; pl. 3).

As shown by Table 5, the South Homestake was the second-ranking gold producer of the district. The property is now a part of the Hudspeth Estate.

Geology. Figure 5 is a planetable map of the surface of the mine area. Although most of the area is covered with soil and talus, the principal rock outcrops are monzonite. The existing outcrop pattern vaguely suggests a wide monzonite dike striking north-northwest contained within altered shale members of the Mesa Verde group.

There are two distinct zones of mineralization near the surface, the Capitan and Devil's Kitchen stopes (fig. 5). But these zones seem to be controlled by closely spaced vertical fractures which strike north. The fractures are filled mostly with limonite; the amount of quartz present is negligible. The Devil's Kitchen stope is reported to have been the most productive zone in the entire mine.

Figure 6 is a plan map of the 180-foot or adit level. The adit was portaled in a highly fractured and altered limy shale member of the Mesa Verde group. Two dike-shaped bodies of lamprophyre containing much biotite, designated as mica trap on the map, have been injected along the contact between the monzonite and Mesa Verde group. The north-trending set of vertical fractures, which localizes the mineralization in the overlying Devil's Kitchen and Capitan stopes, is exposed in the western part of the workings on the 180-foot level.

Plate 4 is a three-dimensional view of the underground workings of the South Homestake mine. The total depth of the main shaft is 660 feet, with a winze (unfortunately inaccessible) extending at least 50 feet below the 660-foot level. Although the veins are vertical, the ore zones appear to rake to the south at about 70 degrees.

The majority of the stopes below the 180-foot level are along north-trending vertical fractures; however, two additional fracture systems were noted. On the 430-foot level, ore was also stoped along fractures in a N. 40 E. direction at the intersection of that system and the main north-trending zone at a point approximately 40 feet north of the main shaft. A similar condition existed on the 540-foot level except that the ore occurred about 90 feet south of the main shaft along a zone trending N. 15 W. The stoping width along the vein below the 180-foot level ranges from 1 foot to as much as 15 feet, but the average is about 4 feet. These narrow widths are in contrast to the Devil's Kitchen stope near the surface, where the mineralized zone was 25 feet wide or more over a strike length of approximately 75 feet.

The veins are simply a group of closely spaced vertical fractures, seldom more than a quarter inch wide, containing limonite and locally a small amount of quartz. The monzonite host is not visibly altered adjacent to the fractures; however, Graton (Lindgren et al., 1910, p. 179) noted under the microscope a minor amount of sericitization and silicification of specimens of the rock. Pyrite was not observed, even on the bottom level, but Graton states that pyrite was observed in other mines

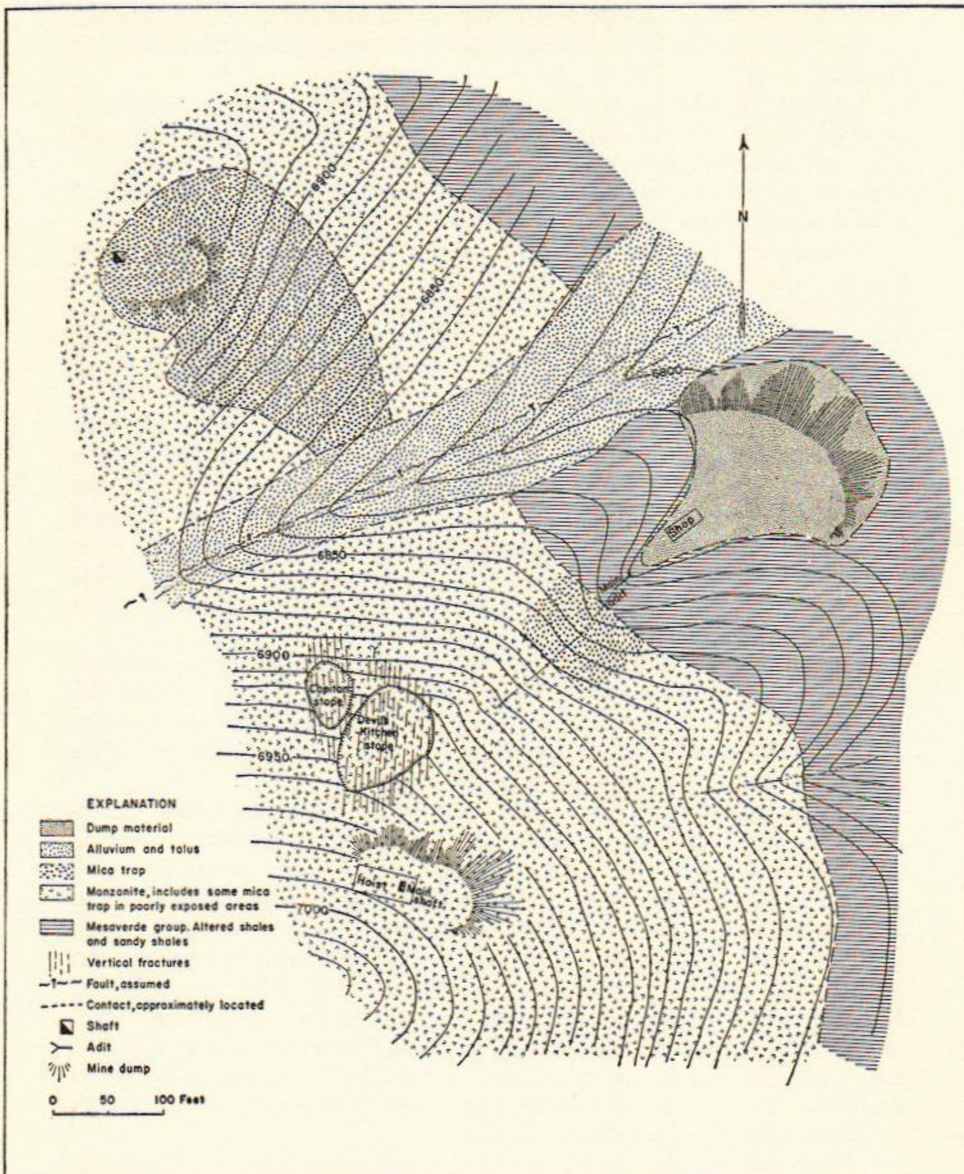


Figure 5

MAP OF THE SOUTH HOMESTAKE MINE

Geology and topography by G. B. Griswold, M. T. Worley, T. Pearse, 1958-59.

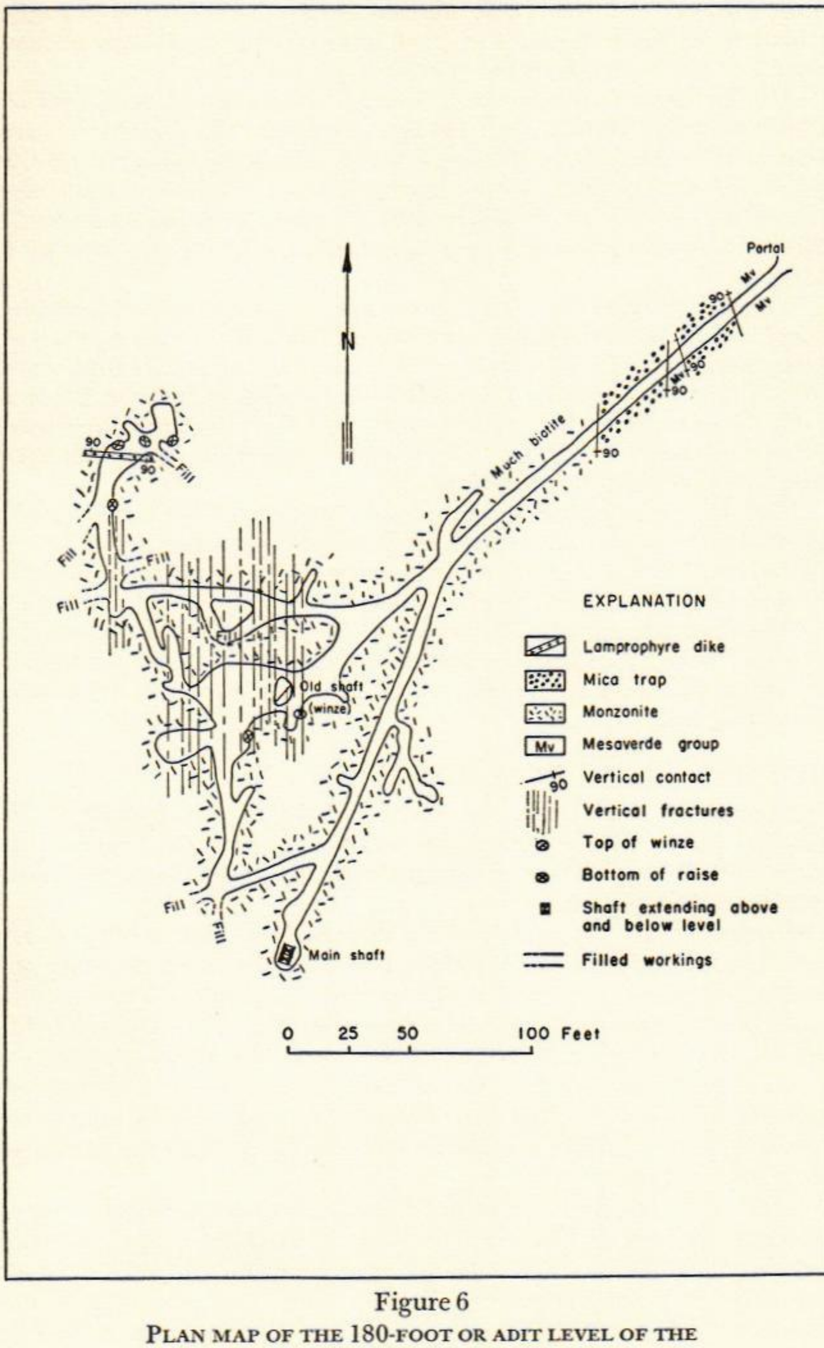


Figure 6
PLAN MAP OF THE 180-FOOT OR ADIT LEVEL OF THE SOUTH HOMESTAKE MINE
Geology by G. B. Griswold, 1958.

of the district. The limonite is believed to have been derived from the oxidation of this mineral. The gold probably occurred both uncombined and in the pyrite in the veins before oxidation.

Mining methods. As shown in Plate 4, the mine was developed by a 2-compartment vertical shaft 660 feet in depth. A total of 9 levels are connected to the shaft, with the possibility of additional levels off the old shaft (winze), which is now inaccessible. In addition, a level may exist below the 660-foot level served by the winze sunk from that level; unfortunately, this winze is not accessible, owing to the lack of a manway.

The Capitan and Devil's Kitchen stopes apparently were mined by glory-hole methods, the broken ore being extracted through a group of draw raises from the 180-foot or adit level. The ore bodies must have been fairly wide to justify this method of stoping. Below the 180-foot level, the ore occurred in narrow veins, and the mining method used was open stoping with stulls. In spite of the lack of fill, the stopes have been well preserved over the years.

The stoping is fairly extensive on all levels except the bottom level. As stated previously, the average stoping width is about 4 feet below the 180-foot level. Unfortunately, a map could not be prepared to show the position of the stopes because these openings are largely inaccessible.

The remnants of an old stamp mill are located just north of the adit-level portal, but information as to the type or size of the mill is lacking. Much of the ore is believed to have been treated at the North Homestake mill.

Little Mack and Henry Clay Mines

Location. The mine was worked originally as two separate units, the Little Mack and the Henry Clay (localities 3 and 4; fig. 3). Inasmuch as the mines are on the same vein structure, it is convenient to discuss them as one deposit.

History. The early history of the mines is not known, but it is reported that litigation over the titles to the claims hampered development of the mines for a number of years after the initial discovery. The Little Mack claims (M. S. 177 and 525) now belong to Mr. John Wright, and the Henry Clay claim (M. S. 619) belongs to Miss Grace M. Jones.

Geology. Plate 5 is a plan map of the principal levels on both properties. It will be noted that the workings are connected by an incline extending upward from the Henry Clay adit level into the workings of the Little Mack.

Most of the ore apparently was limited to fractures and breccia zones in the monzonite. It would appear from the existing stopes that the brecciated and fractured zone running slightly east of north through the main shaft was the most productive zone. Two lower levels, the 100- and 150-foot levels, were developed on the same structure. The zone dips steeply to the east and strikes approximately N. 70 E. on the lower levels.

Some stoping was done along the contact between the rhyolite dikes and the lampophyre, but the relatively minor extent of these workings indicates that most of the ore was contained in the monzonite. This phenomenon may be due to the better development of fractures in the monzonite, which served as channeiways for the ore-forming fluids.

Mining methods. The mine was developed by a 2-compartment vertical shaft approximately 150 feet deep. The Little Mack adit level connects with the shaft about 50 feet below the collar. In addition, 2 deeper levels, the 100- and 150-foot levels, are connected to this same shaft.

The incline connecting the Henry Clay adit with the Little Mack workings was driven on a 14-degree slope for approximately 100 feet; therefore, the Little Mack adit level is about 25 feet higher than that of the Henry Clay. Two winzes have been sunk from the Henry Clay adit, but the easternmost of the two was the only one examined. From the latter, a small amount of development was done in lamprophyre on the 80-foot level (pl. 5).

North Homestake Mine

Location. Locality 5 in Figure 3.

History. As stated previously, the North Homestake mine is the oldest lode mine in the district. The mine also ranks third in the district in gold production, most of which was obtained prior to 1904. The Homestake claim (M. S. 621) which covers the deposit is presently owned by the Hudspeth Estate.

Geology. The mine is said to have been developed by a vertical shaft 1,000 feet deep, and then by a 450-foot inclined winze to a total vertical depth of about 1,400 feet. The upper part of the shaft was destroyed by fire and caved about 1919, so that the workings cannot be examined in detail.

The vertical shaft and some of the stoping area can be reached from the bottom (425-foot) level of the Rita mine (the Rita shaft being located about 300 feet east of the North Homestake). Although the shaft is not caved below this level, the shaft was not entered because of the uncertainty of its condition and ventilation. The area adjacent to the shaft on the 425-foot level has been stoped over a width of about 15 feet. The stoped area is within a zone of fractured and brecciated lamprophyre which appears to be nearly vertical and strikes north. The ore is mineralogically similar to that of the Little Mack and South Homestake mines except that the host rock is lamprophyre.

Mining and milling methods. Inasmuch as the mine workings could not be examined in detail, no accurate statements can be made regarding the mining methods used at the property. The foundations of the old mill are still visible, but most of the machinery has been removed.

Other Mines

Rita mine. The Rita mine is located about 300 feet east of *the* North Homestake (fig. 3). The Rita shaft, which is 425 feet deep, was used to hoist ore from the North Homestake after its shaft burned. There was only a moderate amount of stoping done in the Rita mine proper; the principal stope was adjacent to the shaft and extended from the 125-foot level up to the surface.

Lady Godiva mine. The Lady Godiva (locality 7; fig. 3) was developed by an inclined shaft reported to be 700 feet deep. The incline is now inaccessible from the surface, but the mine workings are connected to the Rita on the 425-foot level. At this point, the timber in the Lady Godiva shaft is in fair condition, but the shaft contains considerable debris. The rock type on the 425-foot level in the vicinity of the inclined shaft is a light-gray monzonite(?), but there is little evidence of mineralization. A small stope is reported about 100 feet north of the shaft on this level, but the presence of the shaft across the access drift prevented an inspection of that area.

An adit extends into the hill just north of the shaft collar. A winze from the adit level extends into a stoping area, but the stopes were not examined.

Smuggler (Compromise) mine. The Smuggler is the most westerly mine in the district (locality 8; fig. 3). The mine was worked by the El Aviador Gold Mining Co. during the 1930's — the last substantial mining effort in the district. The mine was developed by a vertical shaft 200 feet deep, with levels cut at 50, 70, 110, and 200 feet.

There are numerous other small mines and prospects in the district, but for the most part the underground workings are inaccessible. In a district dormant for so many years, it is difficult to obtain factual information on such old operations.

TUNGSTEN

The White Oaks district has produced a small amount of tungsten in addition to gold. Unfortunately, complete records of the amount of tungsten produced are not available. Table 7 shows the total amount of tungsten shipped from the entire county, most of which probably came from the White Oaks area.

The shipment of 90,000 pounds of tungsten ore in 1915 is believed to have been mined by the Wild Cat Leasing Co. from the South Home-stake mine. The average grade of 56.81% WO_3 is not to be construed as the average grade of the ore; rather this is the grade of the concentrate produced by milling. Accurate data are not available as to the grade of the raw ore, but a reasonable guess would be less than 1 percent $W0_3$.

The tungsten mineral is huebnerite, which occurs intimately associated with the gold veins throughout most of the district. Huebnerite was not considered to be an ore mineral during the early life of the

TABLE 7. TUNGSTEN PRODUCTION FROM LINCOLN COUNTY
(Data from a preliminary report by the U. S. Bureau of Mines)

YEAR	POUNDS	PERCENT WO_3
1915	90,000	60.00
1916	17,842	42.88
1917	2,000	60.00
1918	7,960	62.00
1934	2,000	14.6
1940	111	36.1
1952	20	60.00
	Total 119,933	Average 56.81

district, and some of the old dumps may contain a moderate amount (certainly less than 1 percent $W0_3$) of tungsten. Portions of the Old Abe mine dumps were sampled in 1922 and are said to contain 0.38% $W0_3$.[2]

PLACER GOLD DEPOSITS

The small arroyos in the immediate vicinity of the mines have been worked for placer gold with varying results. The principal obstacle to these operations was the scarcity of large quantities of water.

NOGAL DISTRICT

GENERAL

The Nogal district proper consists of the area around the village of Nogal in the southern part of the County. However, for the purposes of this report, the district is considered to extend from U. S. Highway 380 southward to the boundary between Otero and Lincoln Counties, being bounded on the east by State Highway 37, and on the west by the mountain divide of the Sierra Blanca (fig. 7). The Vera Cruz mine, located just north of U. S. Highway 380, is also included in this district.

The district, as defined above, contains several subdistricts; namely, the Bonito, Parsons, White Mountain, Eagle Creek, and possibly others. The principal metals mined in the past were gold, lead, zinc, silver, and copper. One deposit of molybdenum is known, but no production of this metal has been recorded from the area. The district is presently inactive except for some exploratory work being done by a few prospectors.

The first mining of record in the district was in the 1860's for placer gold in Dry Gulch, but prospecting and some actual mining were probably done during the days of Spanish rule in New Mexico.

GEOLOGY

The Sierra Blanca, in which most of the mines are located, is best described as an igneous complex of both extrusive and intrusive rocks.

2. Private report on the White Oaks district in the possession of Miss Grace M. Jones.

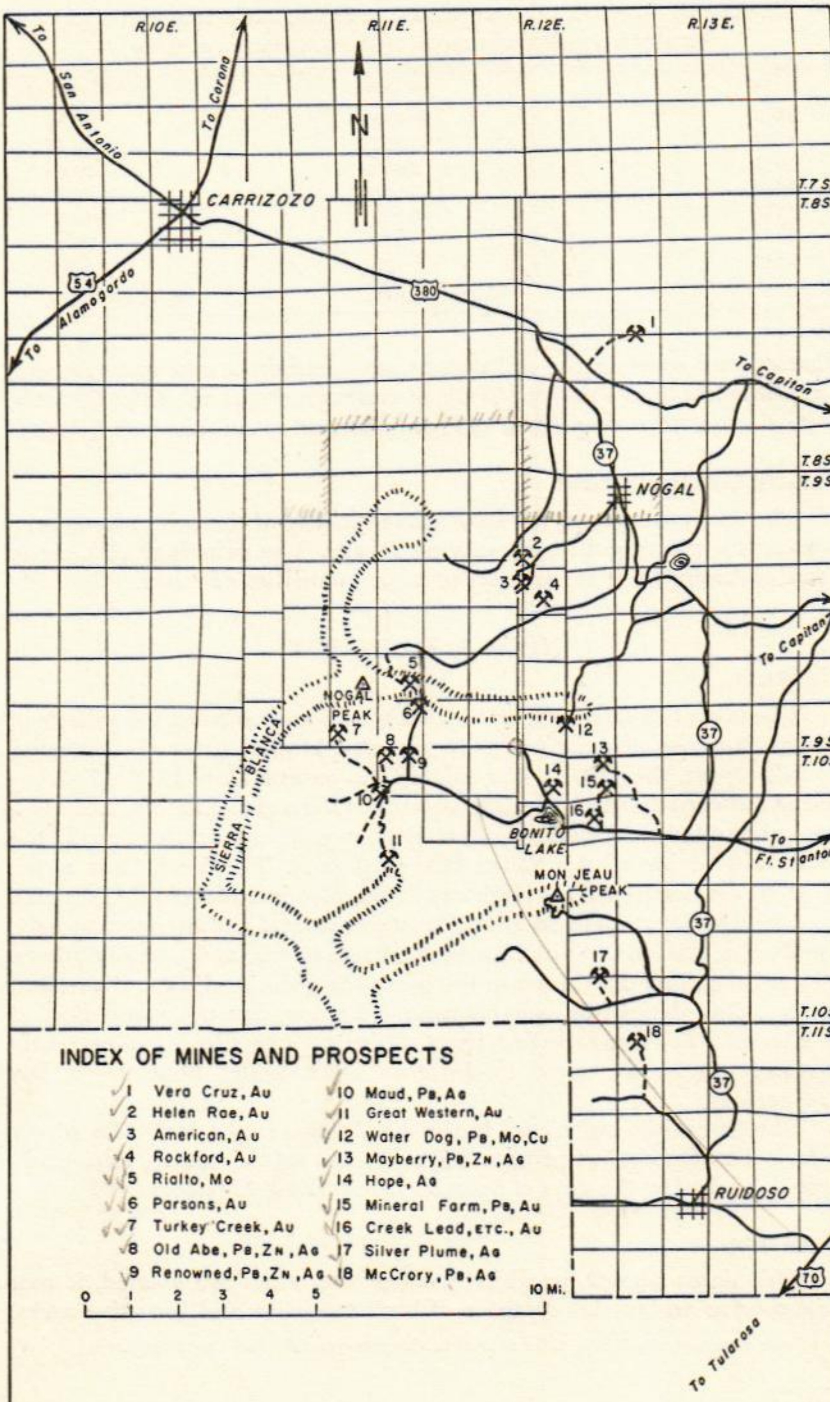


Figure 7

Index of mines and prospects in the Nogal district

Predominant is a thick sequence or pile of volcanic rocks, mostly andesitic in composition. Later intrusive rocks, ranging from syenite to diorite, have invaded the volcanic rocks in the form of small stocks and dikes. The volcanic rocks are post-Cub Mountain formation and are, therefore, believed to be of Tertiary age.

Most of the lead-zinc-silver deposits occur as simple fissure veins in the volcanic rocks. The predominant strike is east-west for these veins, but several strike north-south. The gold deposits are of two types, breccia zones and fissure veins, of which the Parsons and Helen Rae mines are examples of each type respectively. The Rialto molybdenum prospect evidences a disseminated type of sulfide mineralization in a stock of monzonite.

DESCRIPTIONS OF MINES AND PROSPECTS

Parsons Mine

Location and access. The Parsons mine, formerly known as the Hopeful, is located almost on the section line between secs. 34 and 35, T. 9 S., R. 11 E. The mine is reached by traveling 1 3/4 miles up Tanbark Canyon (northward) from the Bonito Creek road (fig. 7).

History. The mine is covered by the Hopeful claim (fig. 15). The early history of the property is not known in detail. According to Mr. Tom Bragg (personal communication), caretaker at the mine, the deposit was discovered by R. C. Parsons around 1880. The mine's most productive era is believed to have been from 1900 to 1918. The total tonnage of ore mined is not known, but from the size of the mine excavations, it is estimated that around 75,000 tons of rock has been removed. The average grade of the ore was low; during 1908, the ore is said to have averaged $3.50 per ton in gold, based on a gold price of $20.00 per ounce (Lindgren et al., 1910). The mine is now owned by J. H. Fulmer, of Carrizozo.

Geology. The gold ore is limited to a zone of intensely altered breccia (fig. 8). The extent of the breccia is not known, but it may be a breccia pipe. On the surface, the only exposed contact between the breccia and the enclosing rock is on the north end of the glory hole. Here, altered andesite forms the breccia boundary along a steeply dipping contact striking slightly north of east. On the adit level, this same contact was observed, but it was cut off by a minor northwest-striking fault about midway between the portal and the face. This fault in turn terminates against a second fault trending almost parallel to the original contact (fig. 8). A thick cover of soil prevented delimiting the south, east, and west extensions of the breccia zone.

The breccia fragments range up to 1 foot in diameter, but the majority are much smaller. The fragments have been kaolinized to such an extent that the original texture and composition of the rock are not detectable. Some limonite is present in the matrix between the frag-

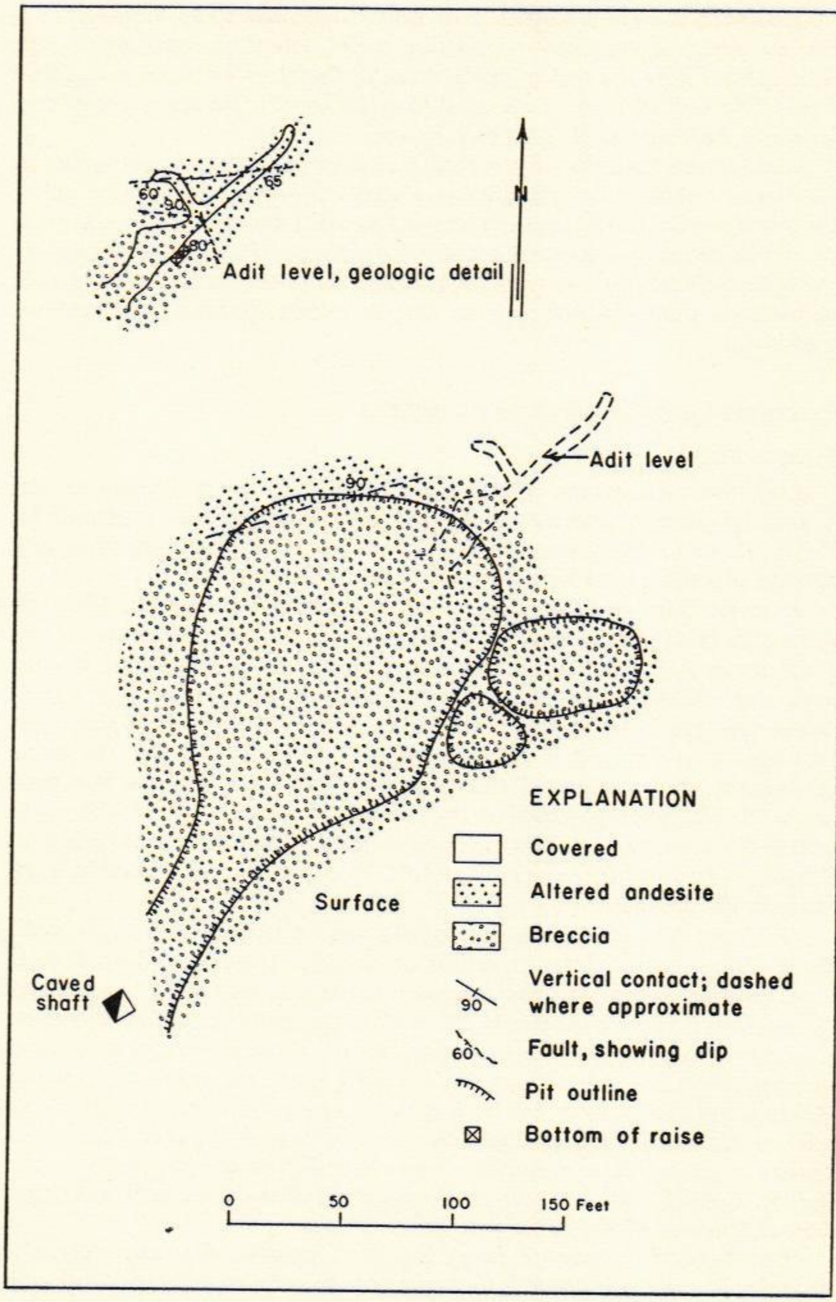


Figure 8
SKETCH MAP OF THE PARSONS GOLD MINE
Geology by G. B. Griswold, 1958.

ments, but the presence of sulfides was not observed. This contrasts with the surrounding andesite, which contains an abundance of pyrite grains disseminated through the rock. Apparently, oxidation has penetrated deeper in the breccia zone than in the surrounding rock.

The mode of occurrence of the gold is not known, but it is reasonable to assume that auriferous pyrite was deposited in the breccia. Later, oxidation converted the pyrite to limonite, freeing the gold. However, detailed microscopic examination of the ore would be required before the foregoing could be proved.

Mining methods. The deposit was worked by a glory-hole method of mining. First, an adit or haulage level was driven; then raises were driven to the surface. The ore then was blasted to the raises, starting at the surface and working downward. The two small pits east of the main glory hole are believed to be connected to the main excavation by drifts which are now caved. Ore was drawn into ore cars from the raises at the haulage level and then trammed to the mill. A shaft, located about 100 feet southwest of the mine, is now caved, and it is not known if ore was extracted from workings below the glory hole.

Milling methods. According to Bragg (personal communication), the first treating plant at the mine was a 240-tpd amalgamation mill located about one-half mile south of the mine. This plant was replaced by a cyanide concentrator in 1914. The ruins of this later operation are located just south of the glory hole.

Helen Rae and American Mines

Location and access. The mines are located in the NW¼ sec. 13, T. 9 S., R. 12 E., and may be reached by traveling on a dirt road approximately 31/2 miles southwest from Nogal.

History. According to Jones (1904), the original discovery was made in 1880 by R. D. George, Harry George, and Charles Epps. The ownership of the mines has been transferred many times since their discovery. The Helen Rae property is now under the control of Leonard Sharpe and Clinton Rice, of Haxton, Colorado, and Carrizozo, New Mexico, respectively. The American, discovered in 1868, is now owned by J. H. Fulmer, of Carrizozo. Plate 6 shows most of the patented claims in the area.

The production records of the mines have been lost; therefore, the tonnage and grade of ore mined are not known. The mines produced intermittently from the 1880's to the early 1930's, but the most productive periods are believed to have been at the turn of the century and in the early 1920's. At the time the property was examined, Mr. Sharpe was operating a small sluice on the old placer ground in Dry Gulch about 1 mile east of the Helen Rae.

Geology. The inaccessibility of the mine workings and the lack of outcrop exposures prevented a detailed study of the mine area. The principal country rocks are monzonite and andesite. Figure 9 is a sketch map showing the locations of the principal veins in the Helen Rae mine area. The main vein strikes almost due north and dips steeply to the west, and the structure can be traced roughly along its strike for approximately 2,000 feet.

The principal gold-bearing veins are simple fissure fillings of calcite, dolomite, and quartz. On the surface, there is no evidence of sulfides, but the veins are said to have carried minor amounts of galena, sphalerite, and pyrite below the water table. For the most part, the gold was probably contained in the sulfides and was freed by oxidation near the surface. The main vein ranges from 2 to 5 feet in width over most of its exposed strike. A minor amount of alteration is present in the wall rock immediately adjacent to the vein.

Two barite veins, both striking northwest, were observed east of the main vein. The age relationship between these veins and the gold veins is not known. The barite vein immediately east of the Evalena adit carries a small amount of galena, but no sulfides were detected in the other barite vein.

Apparently, the highest grade ore was found at intersections of the main vein and minor crosscutting veins. One such vein intersection, about 75 feet inside the Evalena adit, is said to have produced $80,000 in gold. This ore shoot lies directly in line with the projection of one of the barite veins, but examination of the walls of the stope did not show any evidence of this mineral.

The American shaft is located about 800 feet south of the No. 4 shaft on the Helen Rae property. Although the American mine is under different ownership from that of the Helen Rae, they are both on the same vein. Vein intersections are said to have controlled the best ore shoots in the same manner as at the Helen Rae.

Mining methods. The Helen Rae property has been developed on two levels (fig. 11). Figure 10 is a plan map of the underground workings which was obtained from the owners. Mining of the vein probably was done by a combination of shrinkage and open stoping with stulls. The mine is now flooded up to within 30 feet of the adit levels, and the adits themselves are caved short distances from the portals.

The American mine was developed by a vertical shaft some 400 feet deep (fig. 11). Three development levels were driven along the vein from the shaft, and a short adit was driven from the creek to the shaft for drainage purposes. Stoping operations were conducted from the 75- and 165-foot levels, but no important stoping was done from the 360-foot level. The mine is now flooded, and a plan map of the underground operations could not be obtained.

Milling methods. A mill building is located a few hundred feet east of the No. 4 shaft on the Helen Rae property. All the mill equipment has been removed, but the method of treatment was probably by amalgamation.

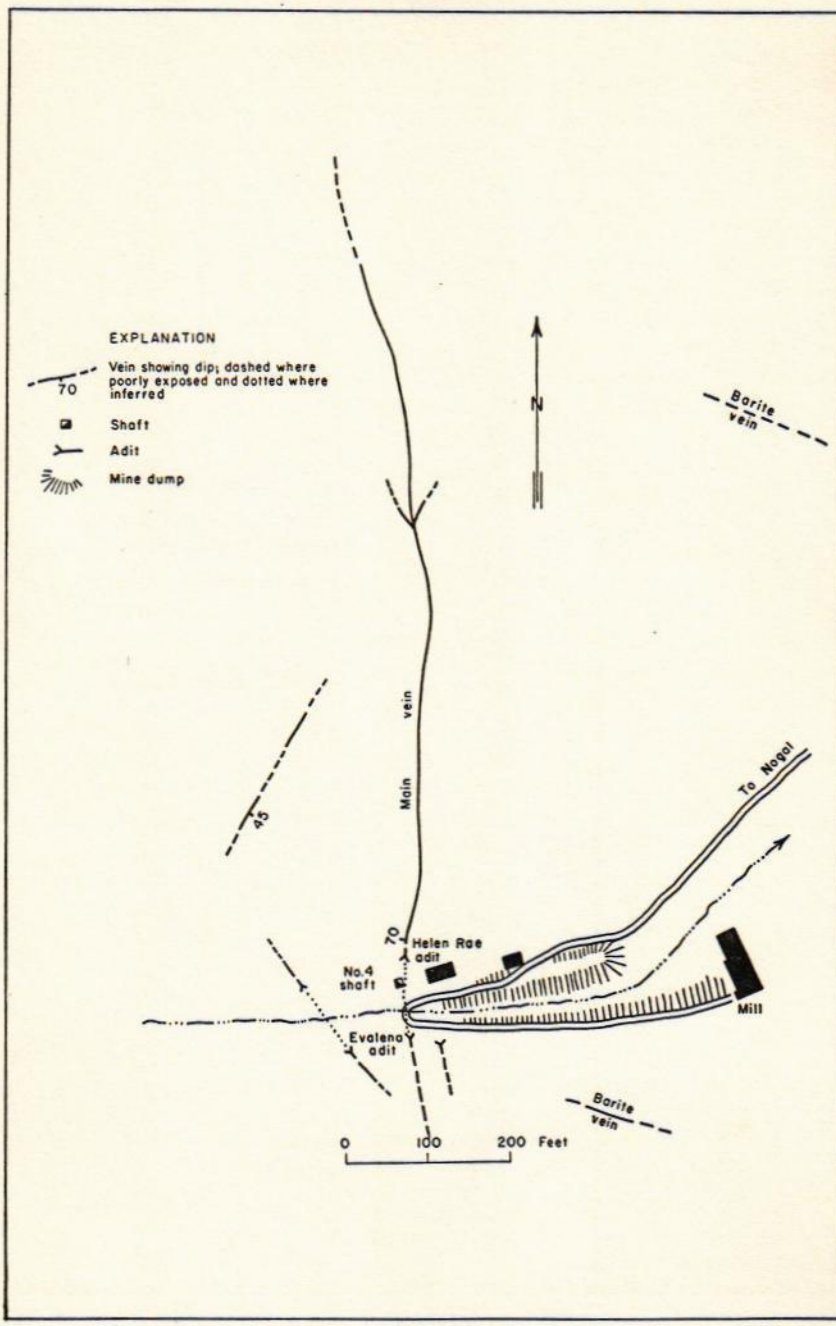


Figure 9

SKETCH MAP OF THE HELEN RAE MINE AREA

Geology by G. B. Griswold and J. E. Allen, 1957.

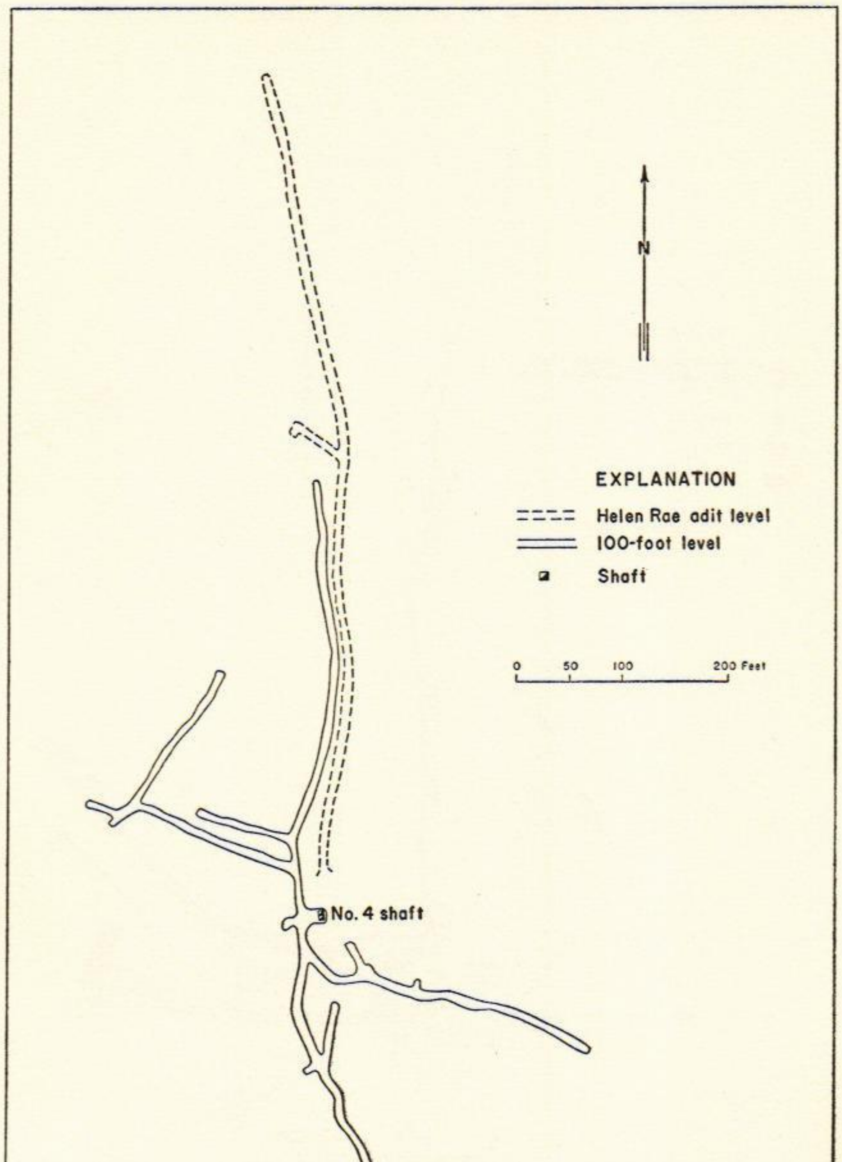


Figure 10
COMPOSITE PLAN MAP OF THE HELEN RAE MINE WORKINGS
From old maps.

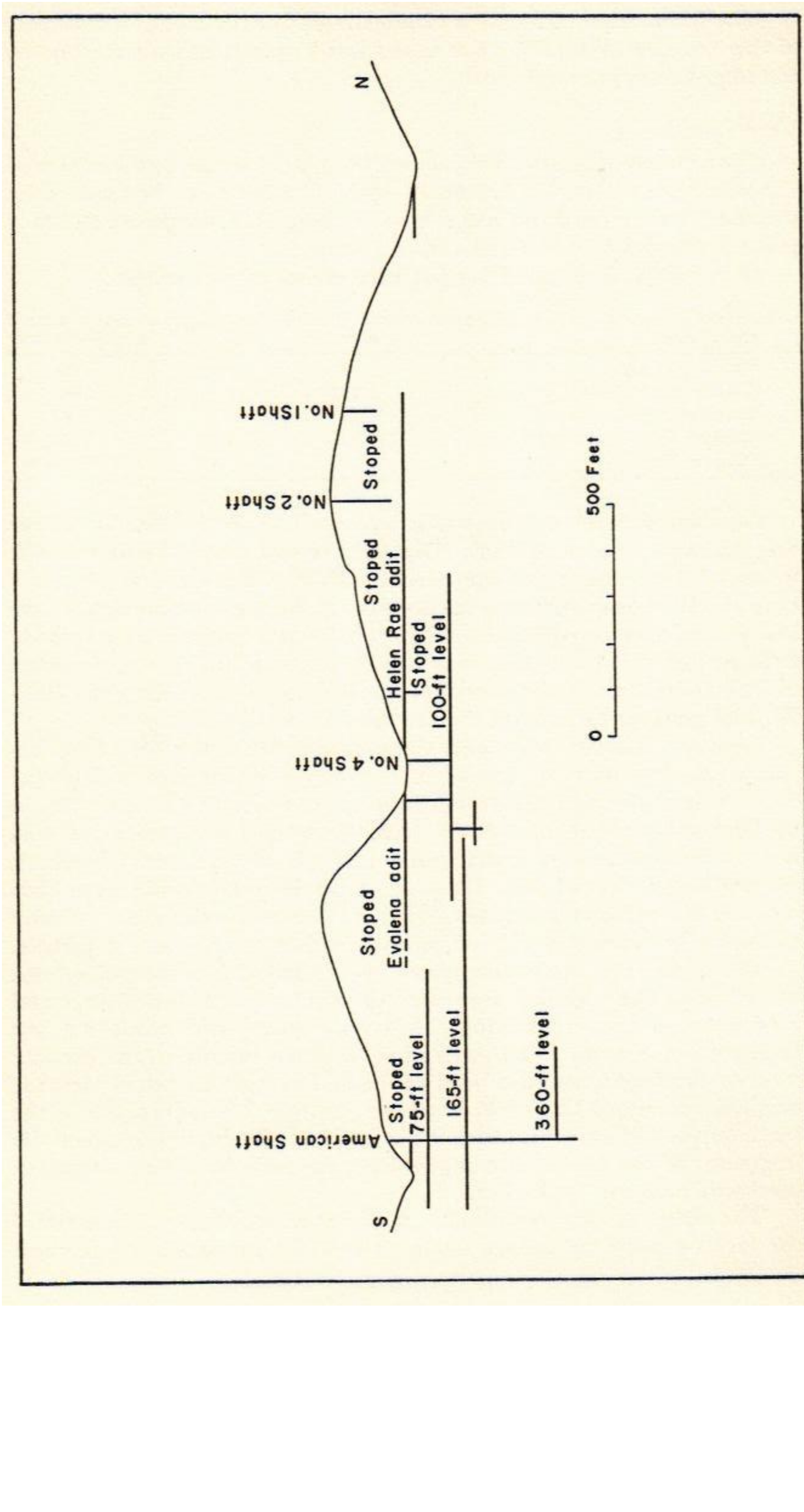


Figure 11

IDEALIZED VERTICAL LONGITUDINAL SECTION OF THE HELEN RAE AND AMERICAN MINES, LOOKING WEST

From old maps.

The foundation of a mill is visible about one quarter of a mile east of the American shaft. The size of the former plant and the method of treating the ore are not known.

Vera Cruz Mine

Location and access. The main workings are located in the center of the south line of sec. 17, T. 8 S., R. 13 E. The mine can be reached by traveling 1 mile north on a dirt road leaving U. S. Highway 380 at a point approximately 10 miles east of Carrizozo.

Ownership. A group of five patented claims cover the area:

CLAIM NAME	SURVEY NO.	DATE OF PATENT
Vera Cruz lode	141	1889
Golden Eagle lode	157	1889
Bustamente lode	271	1889
Washoe lode	272	1889
Diadem lode	567	Unknown

History. The dates of the patent surveys indicate that the Vera Cruz was discovered prior to 1889. The only record of production to the writer's knowledge is for the period 1907-09.[3] During this period, a cyanide mill was constructed to concentrate the ore after amalgamation had proved unsuccessful. The mill probably was used in later years to treat custom ores from other mines of the district, but the record seems to indicate that the mill treated its own ore only during the years 190709. The grade or tonnage of the ore mined is not known.

Geology. The mine lies near the south border of the Vera Cruz laccolith, an intrusion of fine-grained alaskite which has arched the Mesaverde shales and sandstones into an irregular domal structure. A well-defined postmineral fault system, trending a little north of east, has cut the area at about quarter-mile intervals; displacements, however, are not large. Most of these faults are downdropped on the west. Outcrops in the mine area are insufficient to determine the exact location of the faults. Numerous sills of rhyolite further complicate the picture.

Ore body. The ore zone appears to be limited to a zone of intense brecciation. The breccia is composed of angular fragments of shale and sandstones of the surrounding Mesaverde group and possibly a few fragments of igneous rocks. Alteration has been intense in the breccia; most of the fragments have been kaolinized to such an extent that the original texture of the rocks has been destroyed. Silicification of the fragments is also evident, but it is not intense. The matrix between the fragments of the breccia is composed almost entirely of clay alteration products, limonite, and silica.

The shape of the brecciated zone is not exactly known, because of the lack of sufficient surface outcrops and the inaccessibility of most

3. Mineral resources of the United States (1907-09), U. S. Geol. Survey.

of the original underground workings. The principal outcrop of breccia is in and around the glory hole (fig. 12). The contact between the breccia and the unfractured surrounding rocks appears to be arcuate on the east and south sides of the excavation. The contact is concealed on the west and north sides, but the ground north of the small arroyo is not brecciated, indicating that the contact is somewhere between the arroyo and the glory hole.

A small patch of breccia is exposed between the glory hole and the upper adit. The breccia contact is exposed on the south side in a stope which holed through to the surface, but the rest of the surface is void of outcrops in the immediate area. The writer could not find evidence on the surface that this breccia zone is continuous up to the glory hole, but Graton (Lindgren et al., 1910, p. 178), who probably had access to the underground working at the time of his visit, states that the brecciated zone is 900 feet long and 120 feet wide. If this is true, the brecciation is probably continuous from the glory hole to the small breccia outcrop just above the portal of the upper adit.

In the upper adit, the breccia is terminated to the west against a fault or breccia contact trending northeast, about 50 feet inside the portal. Owing to the apparently elliptical shape of the main breccia zone, the writer believes that the structure is a breccia pipe. The fragments give definite indication of rotation and displacement.

The shale members of the Mesaverde group have been altered to hornfels in the vicinity of the mine; this alteration was probably associated with the intrusion of the Vera Cruz laccolith. The shales are kaolinized and bleached in the immediate area of the breccia pipe, probably owing to hydrothermal solutions.

The presence of much limonite in the vugs of the breccia, and occasional indigenous limonite in the breccia fragments, seem to indicate the former presence of sulfides; the writer, however, did not find any residual sulfides on the mine dumps. It seems plausible to assume that the original breccia was subjected to hydrothermal solutions which deposited considerable pyrite in the vugs of the breccia, and that the pyrite was probably auriferous. Oxidation of the ore zone has converted the original pyrite to limonite, and the gold remained unchanged. If the foregoing is correct, sulfides should be encountered at depth, but the tenor of the gold should remain about the same.

To judge from the outcrops of the breccia, copper sulfides were probably not present, because of the lack of copper stains. Other base-metal sulfides, besides iron, could have been present, but direct evidence of their prior existence is lacking.

Mine workings. The operators apparently used a glory-hole system of mining whereby the ore was blasted into several raises leading to a main haulage level below (the upper adit level). This level is now caved at a point about one-third of the way to the glory hole. The upper adit level is more than 100 feet below the surface of the glory hole. From

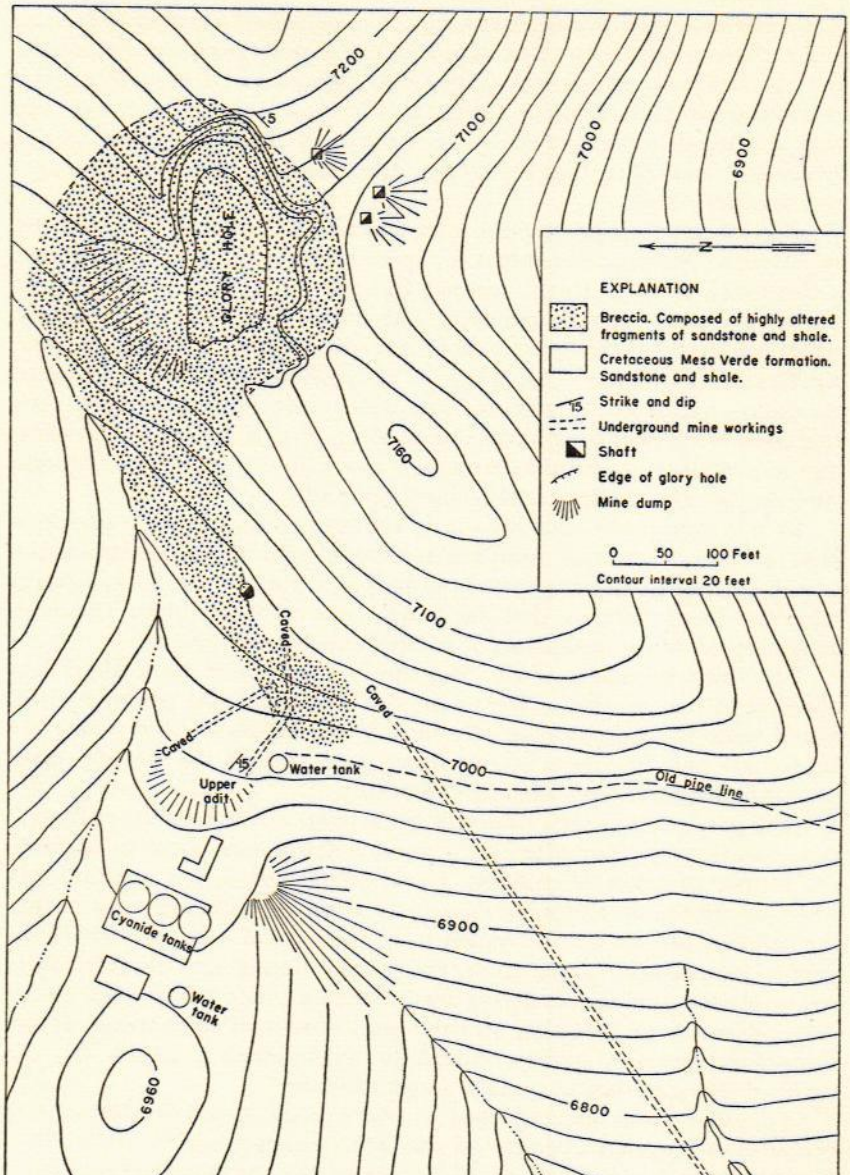


Figure 12

GEOLOGIC MAP OF THE VERA CRUZ MINE

Geology and topography by G. B. Griswold and J. E. Allen, 1957.

the present size of the glory hole, it appears that around 50,000 tons of rock has been mined from the excavation. The existing mine dumps do not indicate such a large tonnage, but it is evident that considerable material from the dumps has been washed down the arroyos by the flash floods common in this region.

A lower adit was driven into the hillside some 220 feet below the upper level. The adit is now caved approximately 600 feet from the portal, but mineralized rock was found on the dump, indicating that the adit reached the ore zone. No estimate is possible of the amount of ore, if any, that was mined from this lower level.

Accurate information as to the grade of ore mined is lacking, but it probably averaged less than $10 per ton in gold, with minor amounts of silver.

Milling methods. The foundations of the old cyanide concentrator are still intact. The size of the original plant can only be inferred, but its capacity could not have been larger than 200 tons per day. Apparently, water was pumped up to the mill through a pipeline from wells located about 1 mile to the south. This must have required a large pumping installation, because the total pumping head would be about 1,000 feet.

Renowned Mine

Location and access. The Renowned mine workings are just west of the road leading from Bonito Creek to the Parsons mine (fig. 7). The Renowned lode patented claim covers the deposit, lying in sec. 3, T. 10 S., R. 11 E.

History. The early history of the property is not known. The Renowned claim is now under the control of the New Mexico Copper Corp., of which C. E. Degner, of Carrizozo, is president. This company is reported to have shipped about 25 tons of lead-silver ore concentrate from this property in 1957. The ore was concentrated in the company's mill at Carrizozo.

Geology. Galena, sphalerite, pyrite, and minor amounts of chalcopyrite occur in a west-trending quartz vein in altered (pyritized) andesite. The galena carries good values in silver and is, therefore, the principal economic mineral.

The vein has been exposed intermittently in an adit approximately 400 feet long (pl. 7). In the stope area, near the winze, the vein averages about 1 foot wide and contains a fair amount of galena (an assay at the bottom of the winze averaged 11.3 percent lead over a width of 1.1 feet). A raise extends about 40 feet above the adit level, but examination of this opening was not possible owing to poor ventilation.

The vein was lost about 50 feet beyond the winze in the main adit, near the contact of the andesite and a gray porphyry. The shape of the gray porphyry mass is not known because of the lack of exposures. The remaining part of the adit follows the contact of the andesite with the gray porphyry, but there is no conclusive evidence of the vein. The andesite is pyritized throughout the workings, whereas the gray porphyry is not. If the gray porphyry is a dike (evidence for this is lacking, however), prospecting to the north from the end of the adit may reveal an extension of the vein.

Considerable postore movement parallel to the vein is evident just east of the winze. The vein is either weak or is not exposed from the north-trending diabase(?) dike to a point 50 feet inside the portal.

Mining methods. Other than development headings, the small stope in the winze area is the only evidence of ore removal. The stope apparently was mined by a square-set method. Several mine dumps are present a few hundred yards east of the adit. Although the underground workings are not accessible, they are believed to be on the same vein structure exposed in the adit.

Milling methods. The New Mexico Copper Corp. owns a selective flotation and gravity concentrator which has an operating capacity of about 100 tons per day. The mill is located about 2 miles west of Carrizozo, just south of U. S. Highway 380.

Figure 13 is a diagram of the flowsheet, arranged to show the production of two concentrates (e. g., lead and zinc). In addition to the flotation circuit, there is a gravity section consisting of three concentrating tables (not shown in fig. 13).

The concentrator was built to treat custom ores as well as ores mined from the various properties of the New Mexico Copper Corp. However, depressed metal prices have prevented continuous operation of the concentrator.

Mayberry Mine

Location and access. The Mayberry mine is located approximately 1.5 miles up Philadelphia Canyon from Bonito Creek. The approximate location is sec. 5, T. 10 S., R. 13 E. (fig. 7). The mine is served by a truck road leading up Philadelphia Canyon from the Bonito Creek road.

History. The early history of the property is not known, but it may have been worked during the early 1900's. The property is now owned by R. T. Lamay and Fred Richardson; the former lives near the mine.

Geology. The deposit is a fissure vein of galena and sphalerite trending approximately N. 30° E. with vertical dip. The vein appears to be along the contact between latite porphyry and andesite (fig. 14). The latite porphyry is bleached and pyritized adjacent to the vein.

The vein has been developed by an adit, approximately 130 feet in length, and a vertical shaft located at the portal of the adit. The shaft is now flooded to within a few feet of the collar, and the extent of the workings below the adit level is not known. A minor amount of stoping has been done at two places in the adit.

The vein is exposed in a small cut on the opposite side of the small canyon from the portal, but the lack of development prevents an ap-

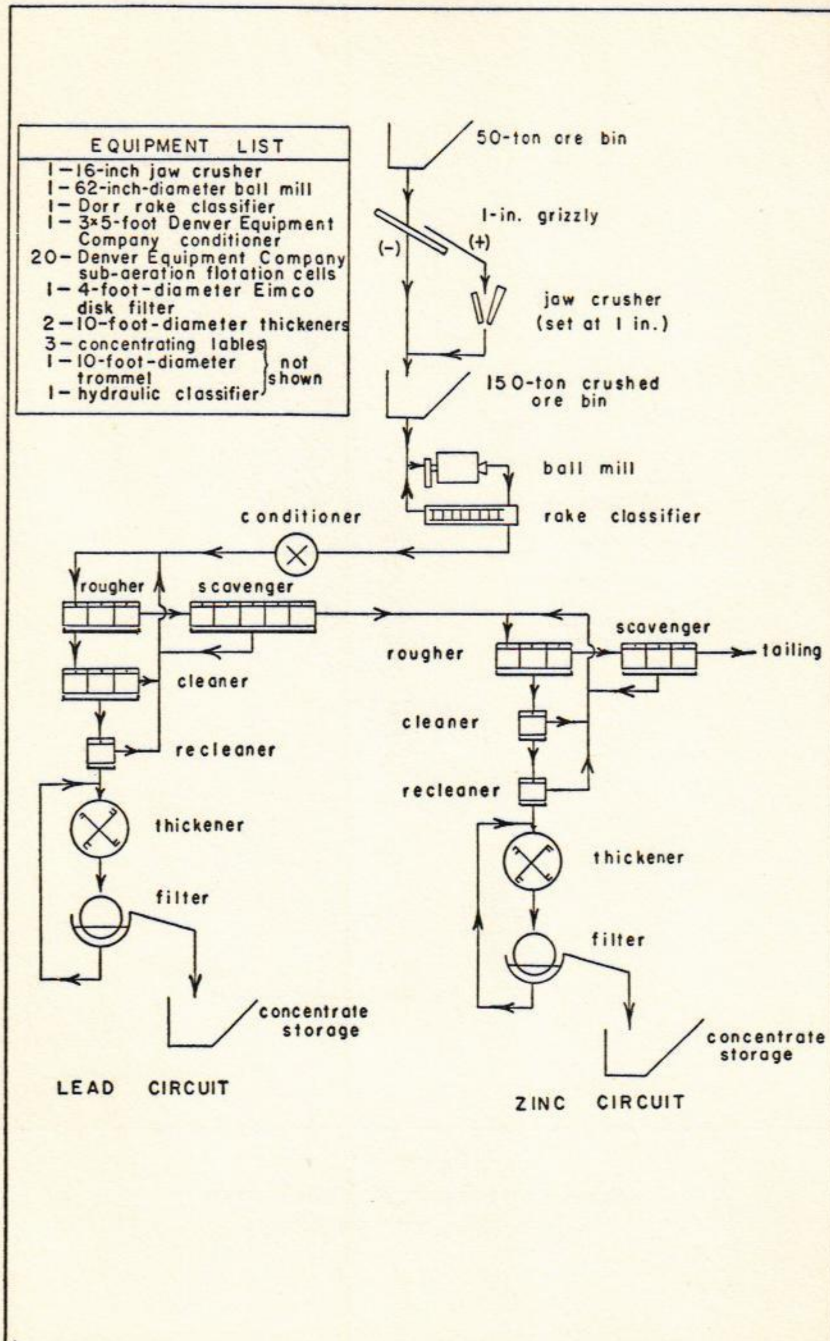


Figure 13

FLOWSHEET OF THE NEW MEXICO COPPER CORP. CONCENTRATOR

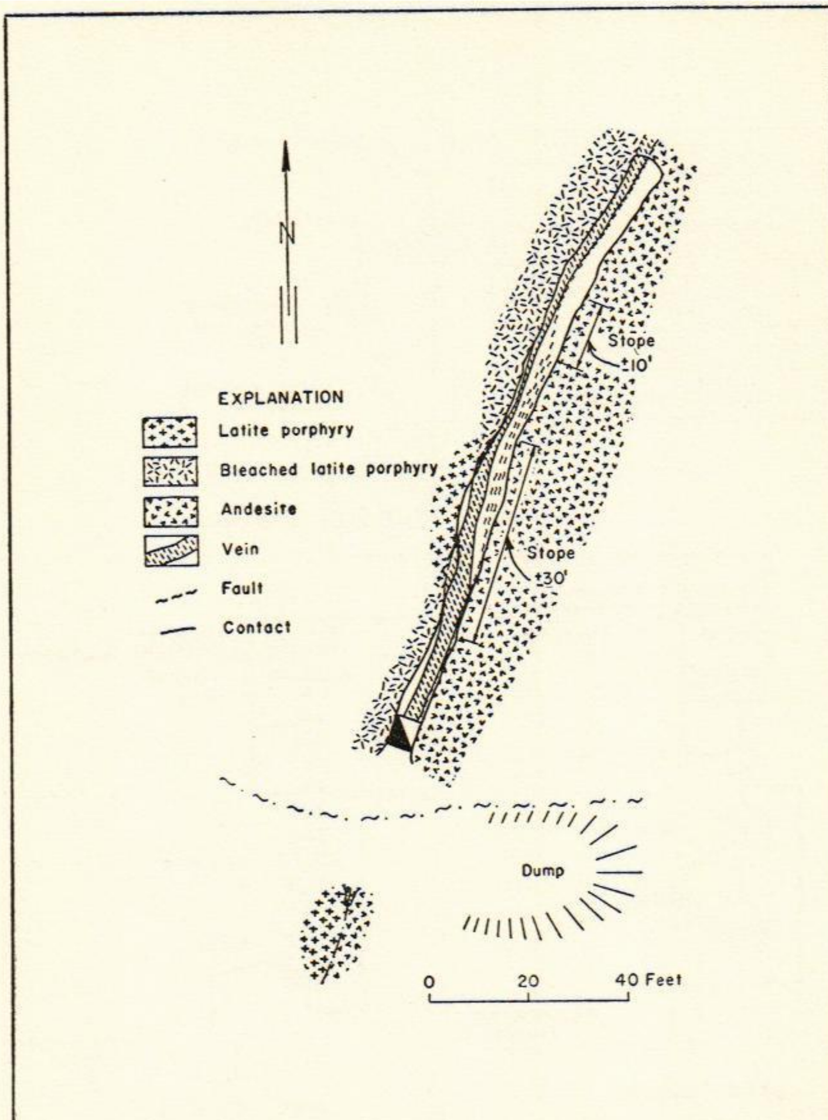


Figure 14

SKETCH MAP OF THE MAYBERRY MINE

Geology by G. B. Griswold, 1958.

praisal of this vein extension. In the main adit, the mineralized zone ranges from 6 inches to 3 feet in width.

Rialto Prospect

Location and access. The Rialto prospect is located about 1 mile east of Nogal Peak, in sec. 27, T. 9 S., R. 11 E. The area is reached from the village of Nogal by traveling approximately 8 miles south and west up the Nogal Creek road, thence 1 mile south on a bulldozed road leading to the prospect.

History. Figure 15 is a claim map of the unpatented claims covering the deposit. The claims belong to a group of seven persons; namely, Leonard Sharpe, Ralph Forsythe, Marlow Sharpe, Ernest Key, Clint Rice, Gordon Sipple, and Winton Friend. Forsythe, who oversees the property, resides in Nogal.

The early history of the deposit is not known in detail, but the first development was done with the hope of discovering gold. According to Gaylord (1901), the Rialto group was staked by him in 1894, and some random development work was done. The prospect lay dormant from this time until 1957, when the area was prospected for molybdenum by the Climax Molybdenum Co. (now American Metals Climax, Inc.). This company held an option on the entire group of claims shown in Figure 15 while the exploration work was in progress, but the property has now been returned to the owners.

Geology. The principal occurrence of molybdenum is within a 380-foot adit, locally known as the Fulmer tunnel, which was driven in a slightly south of east direction (fig. 16).

The chief rock type exposed in this adit is monzonite, which has been considerably altered, in the mineralized portions, by the formation of sericite and the addition of quartz. Molybdenite, chalcopyrite, and pyrite occur as small veinlets and disseminated grains from a point about 280 feet from the portal to the face, a distance of 100 feet. A weighted average of 11 assayed samples taken by Climax geologists in 1957 over this 100-foot interval in the adit averaged 0.181 percent MoS_2. No assays were made to determine the amount of copper present, but it appears to be fairly low.

The surface in the immediate area around the Fulmer tunnel is covered by a soil layer, from 2 to 10 feet thick, which prevents determination of the extent of the mineralization exposed by the underground workings. A few hundred feet west of the adit, there is a bold outcrop of igneous rock, somewhat similar to the monzonite, but the outcrop contains only a moderate amount of iron oxide. Weathering has caused this outcrop to appear porous, and the rock may have been brecciated.

A small pit located on the Moly 1E claim contains molybdenite in a breccia of monzonite in the hanging wall of a minor fault trending northeast and dipping to the northwest. The molybdenite, accompanied

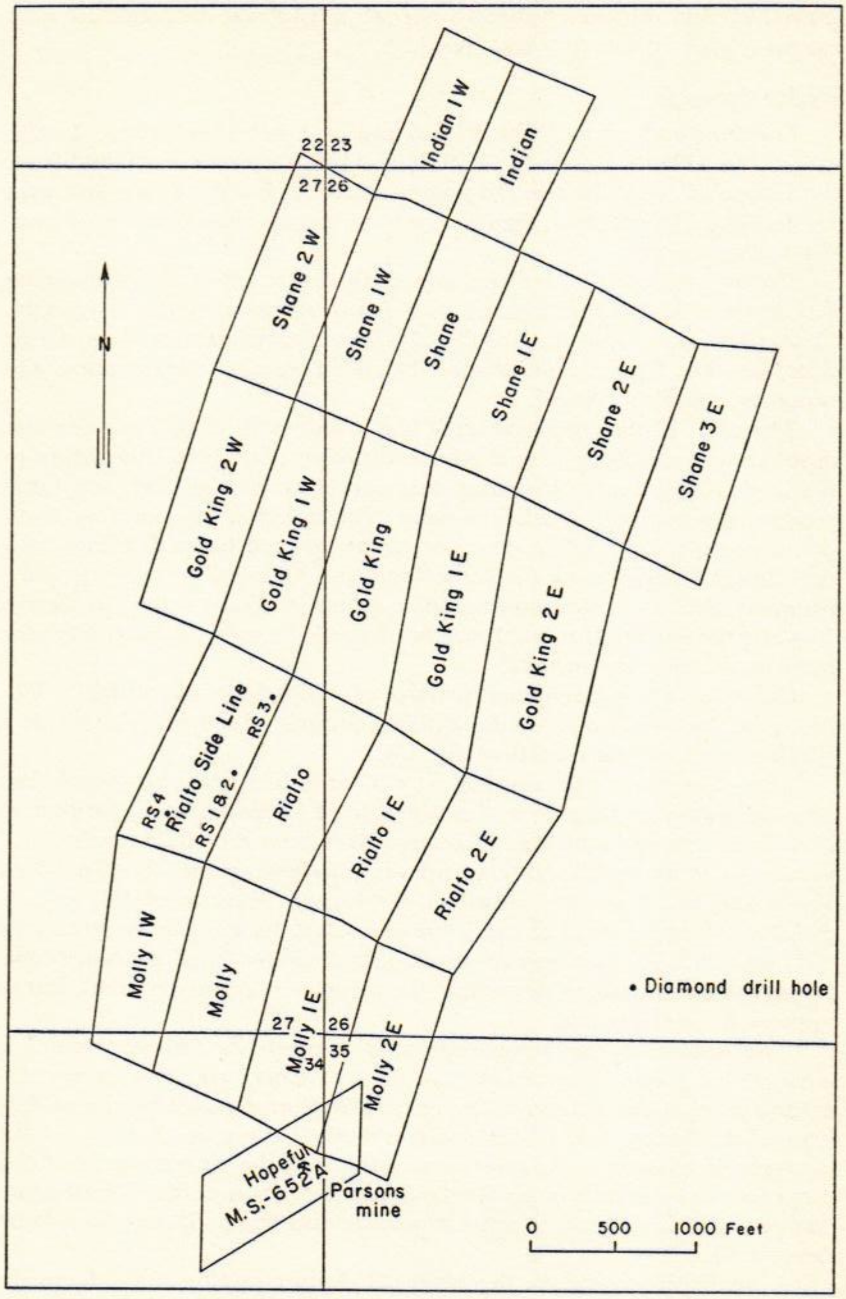
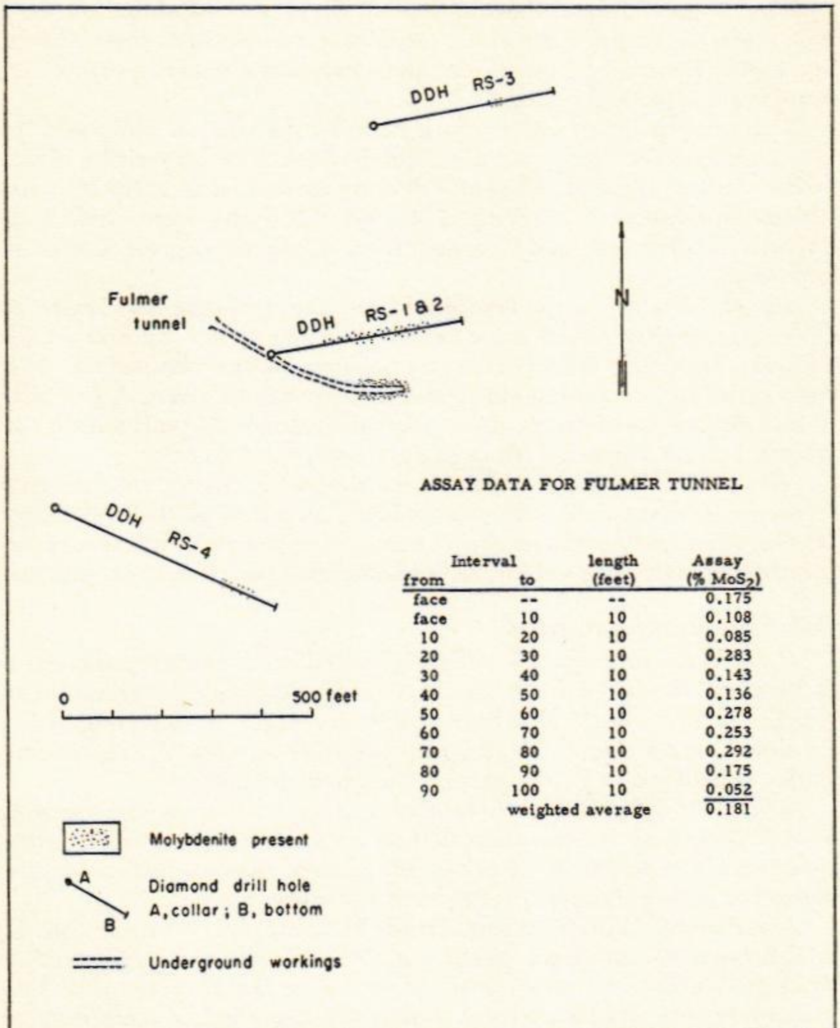


Figure 15

CLAIM MAP OF THE RIALTO MOLYBDENUM PROSPECT, T. 8 S., R. 11 E.



ASSAY DATA FOR FULMER TUNNEL

Interval from	Interval to	length (feet)	Assay (% MoS_2)
face	--	--	0.175
face	10	10	0.108
10	20	10	0.085
20	30	10	0.283
30	40	10	0.143
40	50	10	0.136
50	60	10	0.278
60	70	10	0.253
70	80	10	0.292
80	90	10	0.175
90	100	10	0.052
	weighted average		0.181

Figure 16

SKETCH MAP SHOWING THE LOCATIONS OF DIAMOND DRILL HOLES RELATIVE TO THE FULMER TUNNEL by pyrite and minor copper stain, is limited to a relatively small area in comparison to the Fulmer tunnel.

The dump of a small shaft located on the Shane 1W claim, one-half mile north of the Fulmer tunnel, contains a few specks of molybdenite in a highly pyritic monzonite. The shaft has caved; hence, molybdenite could not be observed in place.

The principal exploratory work done by the Climax Molybdenum Co. consisted of drilling four diamond-drill holes in the vicinity of the Fulmer tunnel (fig. 16). The total drilling amounted to 2,319 feet, the longest individual hole being 734 feet. All holes were drilled in an easterly direction and inclined from 30 to 60 degrees from the horizontal.

Figure 17 is a graphic compilation of the drill-core logs made by Climax geologists, which were supplied to the writer by Mr. Ralph Forsythe. Inasmuch as the writer has not personally examined the drill cores or sludge, he cannot verify the interpretations given. A compilation of the results of assays of cores in mineralized intervals within the various holes is also given (sludge samples were not taken).

The thick soil mantle, which covers almost the entire area, prevents an accurate appraisal of this property based on purely field observations. On the other hand, soil sampling to determine molybdenum-concentration anomalies may reveal targets for additional prospecting in the area.

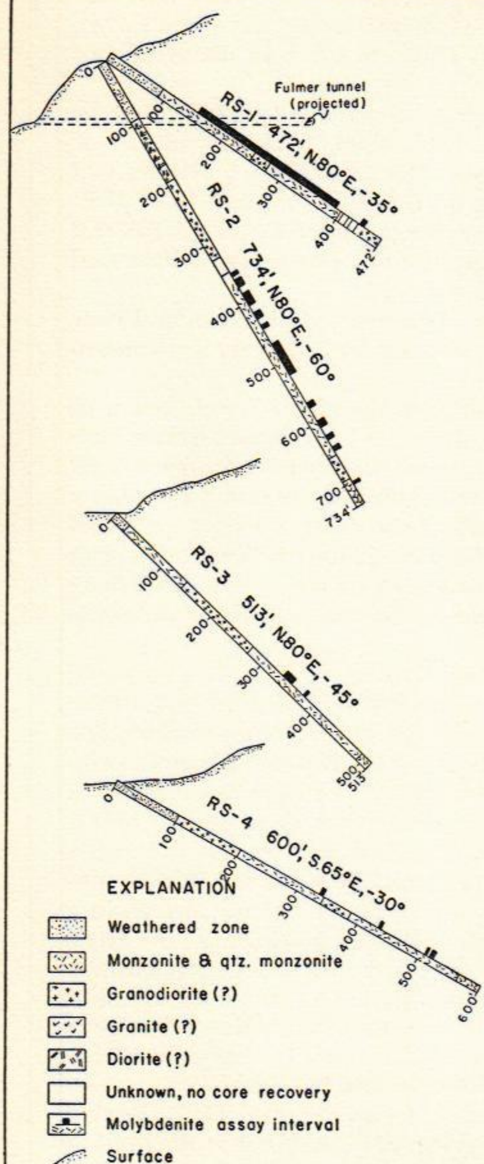
Other Mines and Prospects

Great Western mine. The mine is located in an unsurveyed portion of Lincoln National Forest; the location would roughly correspond to sec. 15, T. 10 S., R. 11 E. The property is reached by traveling about 2 miles along a steep road leading up Big Bear Canyon (fig. 7). LaMarr Bailey is believed to be the present owner of the mine.

Several adits have been driven in a much altered monzonite, and a small open pit has been excavated on a silicified outcrop of the same rock type. The tenor of the ore is not known. A small mill is located below the open pit, but signs of recent operation are lacking.

Maud mine. William White, Dorsey White, Frank White, and R. L. Glassbrook are joint owners of a patented claim covering a west-trending silver-gold-lead vein located near the mouth of Big Bear Canyon. The vein occurs in altered andesite and is accompanied by considerable pyrite. Some galena is visible, but its occurrence is rather irregular along the strike of the *vein.*

Old Abe claim. This patented claim lies northwest of the Renowned claim, in sec. 3, T. 10 S., R. 11 E. Title to the property is held by Floyd Skinner, of Nogal. A quartz vein that trends west, dipping steeply to the south, carries some galena. The andesite wall rock is moderately pyritized adjacent to the vein. The vein is similar to that on the Renowned property, but it is impossible to trace the vein eastward onto the latter claim because of soil cover.



ASSAY DATA OF CORES

Interval from	Interval to	Length (feet)	Assay (%MoS_2)	Core recovery (percent)
		RS-1		
155	165	10	0.026	65
165	175	10	0.066	10
175	185	10	0.043	40
185	195	10	0.021	65
195	205	10	0.068	65
205	215	10	0.002	40
215	225	10	0.023	35
225	235	10	0.222	10
235	243	8	0.036	36
243	253	10	0.005	70
253	263	10	0.152	90
263	273	10	0.012	50
273	284	11	0.002	60
284	295	11	0.005	75
295	305	10	0.026	75
305	315	10	0.084	20
315	325	10	0.092	30
325	335	10	0.028	30
335	345	10	0.003	45
345	355	10	0.008	80
355	365	10	0.009	20
365	375	10	0.043	70
375	385	10	0.005	40
385	391	10	0.003	16
434	435	1	0.049	30
435	441	6	0.024	91
		RS-2		
355	358	3	0.010	50
364	373	9	0.005	69
373	376	3	0.005	55
386.6	397	10.4	0.002	50
397	407	10	0.003	35
419	428	9	0.003	78
437	444	7	0.008	70
444	455	11	0.015	64
470	479	9	0.020	45
479	488	9	0.005	75
488	497	9	0.003	65
497	506	9	0.007	38
506	515	9	0.005	45
515	521	6	0.013	46
568	573	5	0.024	75
573	577	4	0.037	64
597	607	10	0.016	58
624	630	6	0.028	76
641	647	6	0.075	79
699	703	4	0.011	54
		RS-3		
334	341	7	0.006	92
341	351	10	0.049	100
375	378	3	0.024	89
		RS-4		
333.5	337	3.5	0.072	100
430	431.5	1.5	0.016	100
514	521	7	0.003	100
506	511	5	0.004	100

Figure 17

SCHEMATIC CROSS-SECTIONS OF DIAMOND DRILL HOLES AND CORE ASSAYS, RIALTO MOLYBDENUM PROSPECT

Core lithology and assays by Climax Molybdenum Co.

The principal workings on the deposit consist of 2 short adits and 1 shallow shaft, all connecting. The shaft and upper adit were driven on the vein, whereas the lower adit crosscuts the vein about 20 feet below the upper level.

Claims along Turkey Creek. A group of patented claims cover the central portion of sec. 33, T. 10 S., R. 11 E., along Turkey Creek. These claims originally belonged to the Iowa and New Mexico Mining and Milling Co., which did some mining on the claims around 1901. Most of the workings which are now visible, consisting of shallow shafts and short adits, do not reveal much mineralization. The properties are said to have produced only a small amount of gold.

Several other prospects are located between the old Iowa and New Mexico holdings and Bonito Creek, but the workings do not contain much visible mineralization.

Mineral Farm prospect. This prospect lies about 1 mile north of Bonito Creek and about 1 mile east of Bonito Lake (approximate location shown in fig. 7). A shallow shaft, now inaccessible, has been sunk on a small quartz vein in andesite. Inspection of the dump revealed a few specimens of galena, but the bulk of the dump is simply pyritized andesite. Present ownership of the claim or claims covering the deposit is not known; the original work, however, is believed to have been done around 1900 by a prospector named Bourne (Skinner, personal communication).

Creek Lead, Monjeau No. 1, and Oso claims. Floyd Skinner, of Nogal, owns three unpatented claims just north of Bonito Creek, in the N½ sec. 7, T. 10 S., R. 13 E. The principal underground working is a short adit driven along a north-trending zone of mineralization, principally pyrite, in andesite on the Oso claim. The Monjeau No. 1 and Creek Lead claims lie just to the west of the Oso; these claims cover a rather large area of highly fractured, bleached, and pyritized andesite.

Hope prospect. This prospect lies about 500 yards north of Bonito Lake dam (approximate location shown in fig. 7). An adit driven in a northeast direction is the only development work which is now accessible, and even this opening is partially filled with water, preventing a detailed examination. The only mineralization observed on the adit dump is pyrite, but Bragg (personal communication) believes that some silver ore was produced. The wall rock at the portal is a porphyry which has been altered by the formation of sericite and kaolin.

McCrory prospect. F. G. McCrory, of Capitan, and G. L. Booker and V. W. McBee, of Hobbs, own a group of nine claims at the head of Spring Creek, in sec. 5, T. 11 S., R. 13 E. At the time of examination (August 1958), McCrory was cleaning out an old shaft some 20 feet deep, and a vein about 6 inches wide of quartz, with some partially oxidized galena and pyrite, had been exposed. The vein is vertical and trends slightly west of north. Several other prospect pits in the same vicinity have showings of galena, but development is insufficient to appraise these occurrences.

Just below or south of McCrory's prospect are several old adits and shafts which are said to have been worked for silver during the 1920's. Some specimens of galena were observed on the old mine dumps, but there is little visible mineralization in the accessible underground workings.

Water Dog prospect. In the early part of 1959, F. G. McCrory and Tom Lamay were prospecting several claims, known as the Water Dog group, located at the head of Kraut Gulch, about 1½ miles north of Bonito Lake. The area may best be reached by traveling about 5 miles on a U. S. Forest Service road leading southwest from Nogal Lake through the Pfingston ranch.

The owners were prospecting the area by means of a truck-mounted rotary drilling machine. At least one shallow hole (100 feet) was put down adjacent to an old vertical shaft, now abandoned, some 100 feet deep. The dump of the shaft consists of altered latite porphyry and pyrite; occasional veinlets of galena were noted. The drill-hole cuttings contained considerable pyrite, but other sulfides were not detected.

About 1 mile south and west of the shaft described above, several prospect holes were drilled in the immediate vicinity of an old adit, now caved. The rock type exposed at the portal of the adit is a latite porphyry, which appears to have been brecciated. The cuttings of 4 drill holes, ranging from 50 to 150 feet deep, were examined. The drill-hole cuttings contain a much altered and silicified rock (probably latite); pyrite is abundant (1 to 5 percent) in all the holes. A minute amount of molybdenite was observed in two of the holes, but a selected sample assayed only 0.025 percent MoS2.

Gold prospects in Rockford Canyon. Several gold prospects are located in Rockford Canyon, about 1 mile south of the American mine (fig. 7). Numerous shallow shafts and short adits have been excavated in attempts to find a workable lode. The exposed veins are narrow quartz fissures accompanied by small amounts of pyrite. The veins vary in strike, but the general attitude is north, with near-vertical dips. The remnants of an old mill are visible at the mouth of the canyon, but it is doubtful that a large quantity of gold was ever produced.

Silver Plume mine. J. B. Hightower, of Ruidoso, owns a group of claims covering a silver deposit along Eagle Creek, in the NW¼ sec. 31, T. 10 S., R. 13 E. The deposit occurs as a fissure vein in andesite and shows evidence of postore fault movement. The general course of the vein is northeast, dipping 60 to 90 degrees west. In the accessible portions of mine workings, the vein is much oxidized; only occasional pyrite grains remain. The original composition of the vein prior to oxidation is not known. If the vein was worked for its silver content, it may be assumed that the ore mineral was silver chloride (cerargyrite).

The remnants of an old mill are located near the upper adit. A lower adit was driven along the vein, but the portal is now caved, preventing examination.

GALLINAS DISTRICT [4]

GENERAL

The Gallinas district lies in a small group of mountains of the same name located about 10 miles west of the town of Corona. The mines have produced a variety of minerals and metals; namely, fluorspar, bastnaesite, iron, copper, lead, zinc, and silver. Records (Mains, 1901) show that Jones Taliaferro had *been* working a lead-copper prospect for some 16 years prior to 1901; this would place the commencement of his work around the year 1885. Jones (1904) mentions several small operations in this district in 1904, and that lead-copper ore was being shipped to Socorro for smelting. The earliest exact record of ore shipment is for the period 1920-22, when 2,384 tons of lead-copper-silver ore was shipped from the Red Cloud mine to the American Smelting and Refining Co.'s smelter at El Paso, Texas.

The district appears to have been dormant from 1922 until the start of World War II. At this time, the district was activated for the exploitation of iron and fluorspar deposits, the U. S. Bureau of Mines and the U. S. Geological Survey doing considerable exploration work for these two types of ores in 1943 and 1944. The total amount of fluorspar shipped from the district was small, probably less than 2,000 tons, most of which was mined from the Conqueror and Conqueror No. 9 claims in 1953-54.

During the period 1954-55, approximately 60 tons of bastnaesite concentrate was produced from ore mined from the Conqueror No. 9 claim. The concentrate was produced in a small mill owned by the United States Rare Earths, Inc., located at Gallinas. The New Mexico Copper Corp. mined approximately 300 tons of copper-lead-fluorspar ore from the Conqueror claim, and about 11 tons of bastnaesite ore concentrate was produced from the Conqueror No. 10 claim in 1956. The entire district is now dormant except for annual assessment work on the various claims.

GEOLOGY

Kelley (1949) and Kelley et al. (1946) mapped the geology of the district as part of the exploration work done by the U. S. Geological Survey during World War II. The description of the geology, and the geologic map shown in Plate 8, are taken mainly from Kelley's work.

The only sedimentary rocks exposed in the district are the Abo, Yeso, and Glorieta formations of Permian age (pl. 8). The Abo red beds directly overlie Precambrian granite and gneiss in the Gallinas Moun-

4. Excluding iron deposits. The iron deposits of the Gallinas district are described on p. 102-104.

tains. Gypsum is almost entirely absent from the Yeso formation in the area, unlike most of the Yeso exposures in Lincoln County. The Glorieta sandstone caps several of the ridges and is exposed at various places along the flanks of the mountains.

Later intrusive rocks occur mostly as laccoliths, sills, and dikes which, by analogy with similar intrusives elsewhere in New Mexico, are believed to be of Tertiary age. They may be classified broadly into syenite porphyry and medium- to fine-grained monzonite porphyry. The syenite porphyry occurs principally in laccoliths southwest of Red Cloud Canyon, and the monzonite occurs mostly as sills and dikes in the area northeast of the canyon. Several monzonite breccia plugs or pipes occur in the northwest part of the district; these pipes consist of fragments of monzonite, andesite, syenite porphyry, and sedimentary rocks. Most of the concordant intrusive rocks are emplaced in the Yeso formation, and most of the ore deposits are limited to this formation.

The structure of the eastern portion of the Gallinas Mountains suggests that the entire mass is a complicated dome formed by the intrusion of laccoliths and sills into Permian rocks. Red Cloud Canyon partly follows a weak zone caused by sharply flexed and faulted rocks between the principal laccolithic mass to the southwest and the adjoining sedimentary rocks to the northeast. The canyon diagonally crosses the principal fault in the district, which runs north from South Canyon to the area west of Rough Mountain.

The ore deposits, excluding the iron deposits, are related to brecciated or highly fractured zones, and most of the deposits are restricted further to such zones within the Yeso formation. Mineralization appears to have been fairly complex. During the field investigations, the following ore minerals were identified: fluorite, barite, galena, chalcopyrite, sphalerite, chalcocite, wulfenite(?), malachite, azurite, and bastnaesite. Considerable amounts of calcite and some quartz accompanied the mineralization.

Certain parts of the monzonite intrusive rocks are very high in dark minerals, particularly hornblende, and notably low in quartz. Petrographic studies of the intrusive rocks in the area were not made by the writer, but they appear to be much more varied in composition than Kelley indicates on his map. The presence of rare-earth carbonates, barite, and fluorite suggests a possible carbonatite type of mineralization, in which case igneous rocks of the shonkinite variety may be expected to be present.

DESCRIPTIONS OF MINES AND PROSPECTS

The reports of Soule (1946) and Rothrock et al. (1946) describe the individual deposits in considerable detail, except for the Conqueror (Rio Tinto) mine. These works have been employed freely for the descriptions contained herein; the reader is referred to the original texts for more complete information.

Old Hickory Mine

Location and access. The mine is located in the NW¼, sec. 19, T. 1 S., R. 12 E. The area can be reached by traveling approximately 2 miles west on an unimproved road leaving the Gallinas Lookout road (pl. 8).

History. The mine is believed to be owned by Adele Lehman and Edna Lehman Davis, both of Alhambra, California. The property is covered by the Old Hickory (M. S. 1099) patented claim, which was staked in the early part of the century. The claim is believed to have been worked first for lead and copper, but the deposit may have yielded some fluorspar ore during World War II.

Geology. A lens of fluorspar occurs as a replacement body in a north-trending trachyte dike and adjacent brecciated quartzitic sandstone. The deposit has been developed by a 200-foot vertical shaft, with development levels at the 100- and 200-foot levels. At the surface, the lens is about 180 feet long and averages 13 feet wide, but it appears to diminish in length and width at depth. On the 200-foot level, the ore lens is only 65 feet long and 3 feet wide.

The vein material consists chiefly of a fine-grained dense intergrowth of fluorite, barite, calcite, quartz, and dolomite. An assay by the
U. S. Bureau of Mines of a composite sample of ore yielded the following results: CaF_2, 56.0 percent; $Si0_2$, 15.1 percent; $BaSO_4$, 15.4 percent; CaO, 2.3 percent.

Conqueror (Rio Tinto) Mine

Location and access. The mine is in the SE¼ sec. 25, T. 1 S., R. 11 E., which can be reached by traveling northward on a side road from the Red Cloud Canyon road (pl. 8).

History. The mine is now part of the New Mexico Copper Corp.'s holdings in the district. The early history of the mine is not known, but the first extensive development work on the deposit is believed to have been performed around 1940, when a vertical shaft was sunk 130 feet. In 1953-54, the shaft was deepened to 230 feet, and some drifting was done from the 130-foot level. In addition, some open-pit work was undertaken north of the shaft. In 1956, about 300 tons of fluoritecopper-lead ore from the mine was treated at the company's mill in Carrizozo.

Geology. The ore appears to be limited to a zone of intense brecciation in the Yeso formation. Figure 18 is a plan map of the mine workings on the 130-foot level. The entire workings are within the breccia zone, and the better ore seems to be controlled by the more intensely broken ground. Both of the drifts, as well as the bottom of the shaft, are in breccia; therefore, the lateral and vertical extent of the zone is not known. In addition, the surface is covered with soil mantle to such an extent as to preclude an accurate estimation of the size or shape of the breccia outcrop.

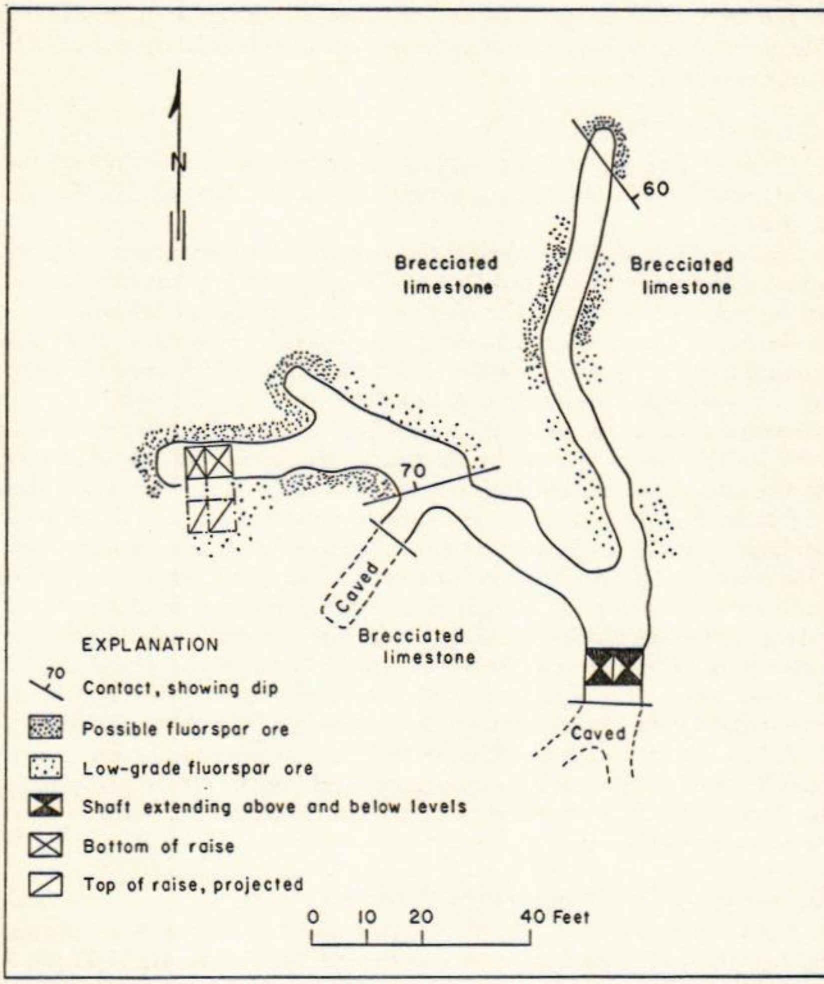


Figure 18

PLAN MAP OF THE 130-FOOT LEVEL, CONQUEROR (RIO TINTO) MINE

Geology by G. B. Griswold, 1958.

In the ore zones, fluorite has replaced the matrix between the breccia fragments, and the fragments themselves to some extent. The fluorite is fine grained and is accompanied by some barite, azurite, malachite, and wulfenite(?). In some parts of the ore zone, large blocks of unbroken limestone occur as horses of waste; some of these blocks are as much as 10 feet in diameter.

All American Mine

Location and access. The All American mine is located just off the Red Cloud Canyon road in the central part of the N½ sec. 23, T. 1 S., R. 11 E.

History. The claims covering the deposit (not shown on pl. 9) are believed to belong to Edward D. French. The owner of the mine could not be reached; therefore, the history of the mine is not known.

Geology. The deposit has been developed by a vertical shaft approximately 85 feet deep. Figure 19 is a plan of the 85-foot level, showing the workings. A contact is exposed between syenite porphyry and brecciated rock in the west and southwest headings. The exact composition of the fragments of the breccia is not known owing to rather intense alteration, but the majority are believed to have been limestone originally. Highly fractured limestone is exposed in the ends of both headings, but the two contacts do not project as though continuous. This could be due to incorrect interpretation of the exposures or by faulting between the drifts. It is also possible that the drifts terminate in large limestone blocks contained in the finer breccia; such blocks were noted in the Conqueror (Rio Tinto) mine. Fluorite, the principal ore mineral, occurs as a replacement of the matrix between the fragments and as small veinlets in some of the fragments. The mineralization is erratic in distribution, in addition to being limited to the brecciated zone. Barite, calcite, and minor amounts of copper oxide accompany the fluorite. Bastnaesite is said to be present (Kelley et al., 1946) but was not detected by the writer.

Red Cloud and Conqueror No. 9 Claims

Location and access. The Red Cloud and Conqueror No. 9 claims straddle the Red Cloud Canyon road in sec. 25, T. 1 S., R. 11 E. (pl. 8 and 9).

History. The Red Cloud patented claim belongs to C. S. Thomas, and the Conqueror No. 9 claim to William E. Heim. The Red Cloud was one of the earliest claims staked in the area and has produced the district's greatest quantity of lead-copper-silver ore. As mentioned earlier, the mine produced rather steadily from 1920 to 1922 (table 8).

The Conqueror No. 9 claim contains a fluorspar-bastnaesite deposit which was developed during World War II; ore shipments were not made, however, until the early 1950's. The exact amount of fluorspar ore shipped from the Conqueror No. 9 is not known, but a rough esti-

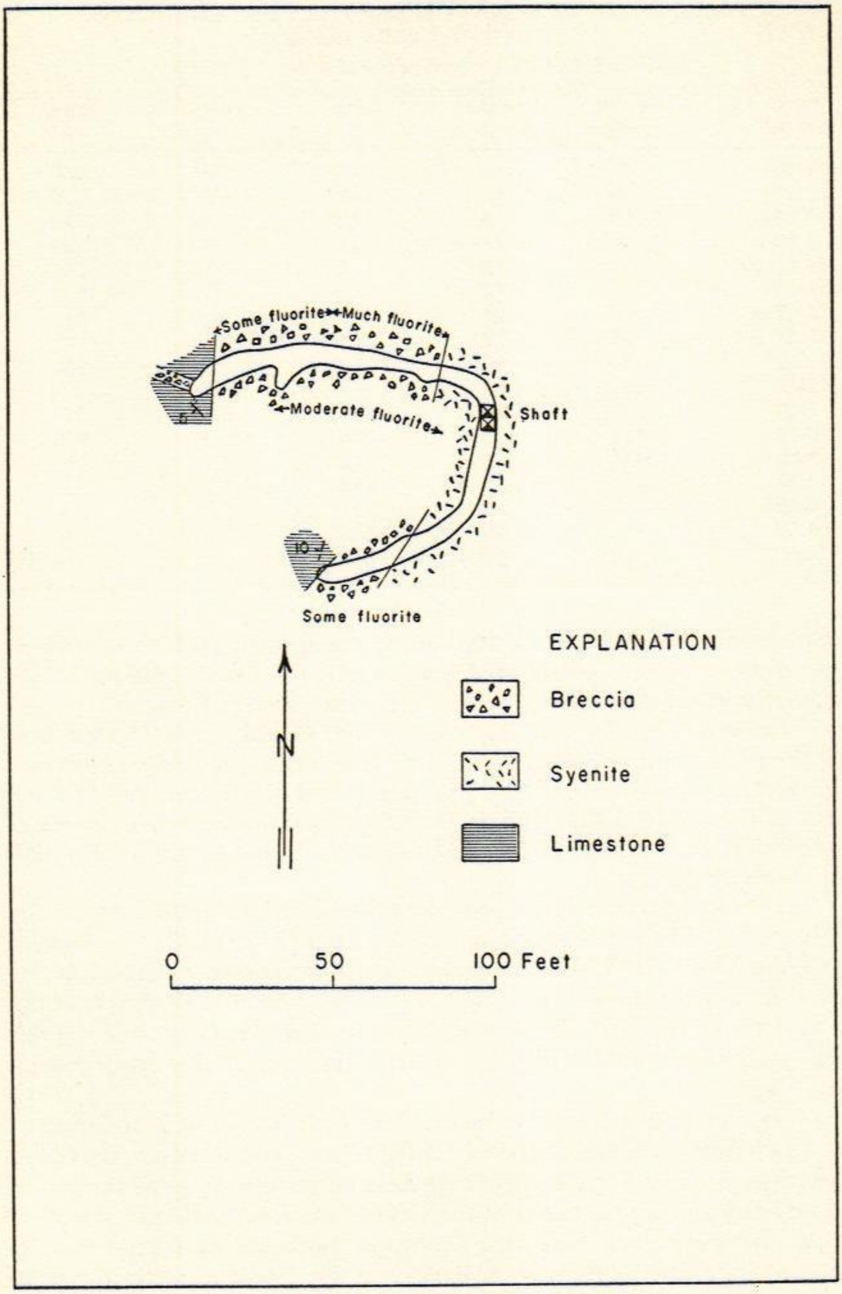


Figure 19
PLAN MAP OF THE 85-FOOT LEVEL, ALL AMERICAN MINE
Geology by G. B. Griswold, 1958.

TABLE 8. ORE SHIPMENTS FROM THE RED CLOUD MINE FOR THE YEARS 1920-22
(Data from C. E. Degner, personal communication)

DATE (mo-yr)	WEIGHT (tons)	SILVER (oz/ton)	LEAD (%)	COPPER (%)	ZINC (%)
6-20	48	2.5	24.8	1.97	0.10
7-20	93	4.1	30.2	2.60	1.70
8-20	65	4.9	32.2	3.10	0.80
9-20	70	3.5	26.2	1.60	1.30
10-20	57	3.0	22.2	1.72	2.80
11-20	30	3.7	22.9	2.40	2.60
7-21	24	5.3	34.6	3.67	1.5
10-21	37	5.8	31.0	5.93	1.2
11-21	82	6.5	23.3	9.49	0.20
12-21	235	7.1	21.3	10.34	1.40
1-22	369	7.0	20.6	9.98	2.0
2-22	481	6.9	22.4	6.53	2.00
3-22	299	5.3	21.3	6.44	2.10
4-22	194	5.3	18.5	7.74	2.70
5-22	167	5.2	22.2	6.02	2.60
6-22	133	5.8	20.0	7.00	2.50
Total	2,384	6.0 (ay.)	221 (ay.)	6.93 (ay.)	1.93 (ay.)

mate would be 1,000 tons. In 1954-55, approximately 60 tons of bastnaesite concentrate was produced from ore mined from the claim; the ore was concentrated in a small gravity-flotation plant at Gallinas.

Geology. The old workings on the Red Cloud claim, located west of the road, are now caved; hence little information is available on that ore zone. The main workings of the Conqueror No. 9 are about 300 feet east of the old Red Cloud shaft. The deposits are assumed to be somewhat similar, except that the Red Cloud contains an unusually high amount of sulfides.

The Conqueror No. 9 claim was developed originally by an inclined shaft 110 feet deep, with development drifts at the 35-foot and 100-foot levels. In addition, an adit level was driven eastward at approximately the same level as the shaft collar. Most of this development was done by the U. S. Bureau of Mines in 1943-44. Later, the deposit was mined by open-pit methods, destroying most of the underground openings.

The Conqueror No. 9 ore body is located in a zone of brecciation at the junction of the Red Cloud Canyon fault and a minor northeast fault (pl. 8). The breccia appears to be composed of fragments derived from sandstone and siltstone of the Yeso formation. Fluorspar, the principal ore mineral, occurs as a filling, or replacement of the matrix, between the breccia fragments. Barite, calcite, and quartz are the principal gangue minerals. The bastnaesite occurs as small grains in parts of the ore zone. The percentage of bastnaesite present is not accurately known, but the writer believes it to be 1 percent or less. In Table 9, an analysis of hand-picked grains of bastnaesite is compared to a similar analysis of bastnaesite from Mountain Pass, California.

TABLE 9. COMPARATIVE ANALYSES OF BASTNAESITE
(In percent)

	CONQUEROR NO. 9 (Soule, 1946)	MOUNTAIN PASS (Olson et al., 1954)
Total rare-earth oxides (R208)	74.39	69.17
Ce_2O_3	25.61	32.47
(La, Di),O,	48.78	36.70
CO_2	19.94	18.31
F	7.45	6.88

Other Deposits

Several other deposits, not described in this report, are noted in Plate 8. The reader is referred to the reports of Rothrock et al. (1946) and Soule (1946) for descriptions of these deposits.

Origin of Breccia Zones

As noted previously, the main ore control in the district is brecciation. Some of the breccia zones occur at fault junctions or splits; for example, the All American and Conqueror No. 9 ore-zone breccias. Others, notably the Conqueror (Rio Tinto), apparently are not associated with prominent faulting. Most of the breccia areas which are well exposed are circular or elliptical in plan. Few contacts between breccia and the surrounding rocks are well exposed, but those observed are abrupt, lacking fault gouge or slickensides. The circular to oval shape and abrupt contacts indicate, to the writer at least, that the origin of the breccia zones may not be due to faulting. Alternatively, the zones may be breccia pipes caused by intrusion, gaseous explosion, collapse, or some other phenomenon. Kelley et al. (1946) have mapped several breccia pipes in the northern part of the district (pl. 8). Although these pipes do not physically resemble the breccia zones containing fluorspar, they may be related.

Much more field evidence will be required before the statements made above can be substantiated. However, future exploration in the district should be keyed to finding zones of brecciation, and the writer hopes that his views concerning these zones may be of some aid to future prospecting.

SCHELERVILLE (WEST BONITO) DISTRICT

GENERAL

The Schelerville or West Bonito district lies a few miles south and east of Carrizozo (p1. 1). The district contains several copper and lead

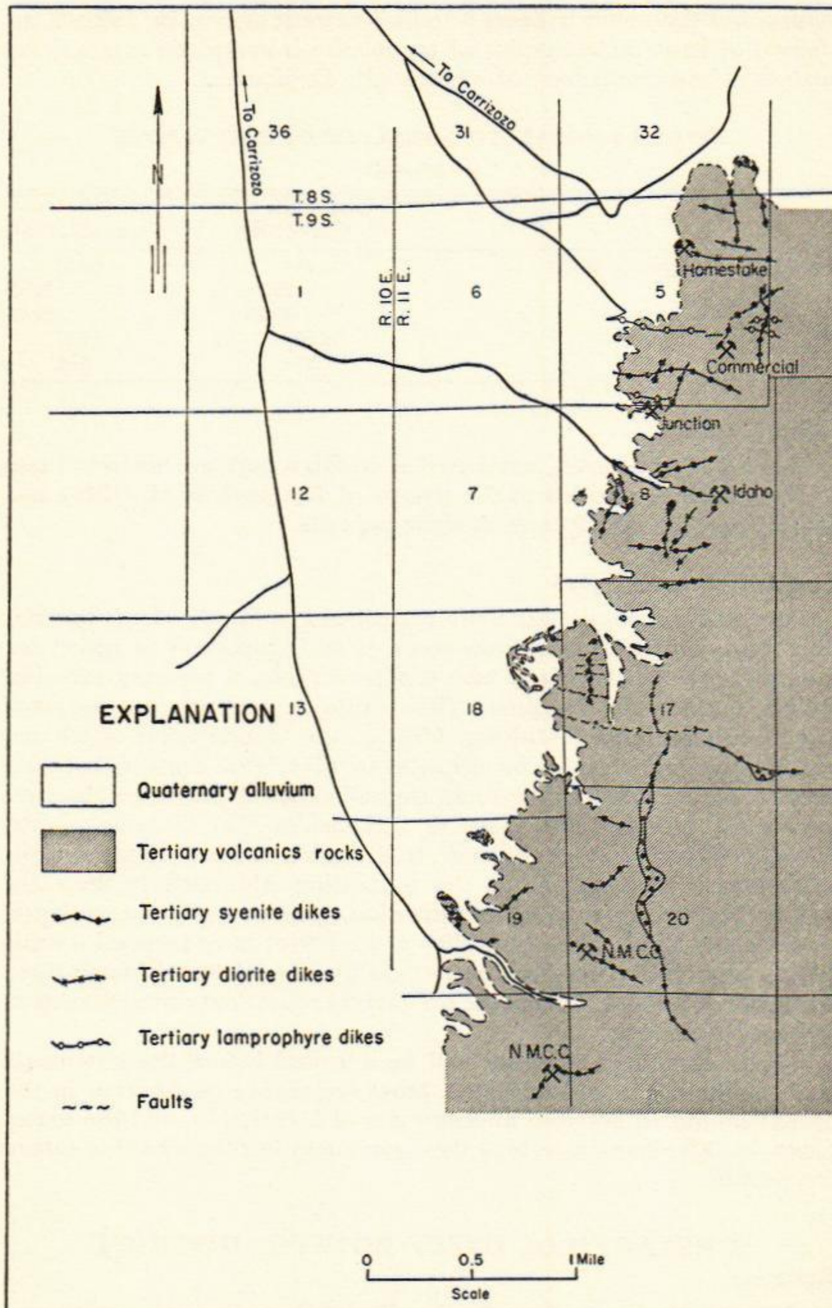


Figure 20

GEOLOGIC MAP OF THE SCHELERVILLE (WEST BONITO) DISTRICT

Geology by R. H. Weber, 1957.

prospects, but ore shipments have been rather insignificant. The oldest mine is believed to be the Homestake, in the *northern* part of the district; this mine was worked in 1901 by the Iowa and New Mexico Mining and Milling Co. (Anonymous, 1901, p. 37-38). The most recent activity in the district was in 1956, when the New Mexico Copper Corp. did some development work at its properties in Water Canyon; however, this work was discontinued when the price of copper fell in the latter part of the same year.

GEOLOGY

The geology of the Carrizozo 15-minute quadrangle has been mapped by Weber (personal communication). Figure 20 is a map, taken from Weber, showing the geology of the district. The mines lie on the western slopes of the Sierra Blanca volcanic pile. The predominant rock formations are andesite and basaltic andesite Rows and breccias; the age of these extrusive rocks is believed to be Tertiary. Later in age, but still of the Tertiary period, are numerous syenite, diorite, and lamprophyre dikes and small sills. Most of the dikes run east-west, but a few strike north.

The mineralization of the district appears to be associated closely with the east-trending dikes. The veins typically occur at the contact of these dikes with the enclosing andesite flows, particularly where post-dike movement is evident. The principal vein minerals are calcite, quartz, barite, and sulfides of iron, copper, and lead. The veins appear to be simple fissure fillings for the most part; comb structure of the calcite is evident in many of the veins.

DESCRIPTION OF MINES AND PROSPECTS

Homestake Mine

Location and access. The Homestake mine is located in the NE¼ sec. 5, T. 9 S., R. 11 E. (fig. 20). The mine can be reached by traveling approximately 4 miles south of Carrizozo on a dirt road leading to the C. J. Harrold ranch, and thence 3 miles to the southeast along a truck trail. The last one-quarter mile to the mine must be traveled on foot.

History. As stated previously, the Homestake mine is believed to be the oldest in the district, having been worked as early as 1901 by the Iowa and New Mexico Mining and Milling Co. This company probably did most of the development on the property and may have shipped some copper ore from the deposit. The deposit is covered by three patented daims (M. S. 1266; pl. 10), which now belong to Brice Dugger, of Carrizozo. There was no sign of recent activity or presence of mining equipment at the property at the time the examination was made (June 1958).

Geology. The ore mineralization appears to be limited to two east-trending diorite porphyry dikes. Post-dike-emplacement movement is evidenced by shearing and brecciation along the dike contacts. Quartz and calcite occur as small veinlets and between the breccia fragments in the broken areas at the dike contacts. The presence of iron oxides and moderate copper staining on the vein outcrops indicate the probable occurrence of sulfides at depth. An inspection of the dump of a shaft on the southernmost dike revealed a few specimens of chalcopyrite and pyrite. A short adit on the same dike, about 500 feet east of the shaft, contains two stringers of galena.

The northern diorite porphyry dike has been prospected by 2 shallow shafts and 2 short adits. Quartz, calcite, iron oxides, and minor copper staining are the only evidence of ore mineralization along this dike; sulfide minerals were not detected on the dumps of the workings.

Commercial Mine

Location and access. The Commercial mine is located in the SW1/4 sec. 5, T. 9 S., R. 11 E., about one-half mile south of the Homestake mine. The mine area is reached by traveling along the same road which leads to the Homestake.

History. John E. Wright, of Carrizozo, owns a group of nine claims covering the deposit. Mr. Wright (personal communication) staked the Betty and Stella claims in 1921, and the seven patented claims (M. S. 386 to 391) to the north were purchased by him in 1948. Most of the development work on the claims was done prior to Wright's acquisition of the property, and the early history of the mine is not known. There is no record of ore shipments.

Geology. Examination of the surface of the mine area revealed two principal veins (pl. 10). One vein follows the center lines of the patented claims numbered 389 to 391; the other follows the center lines of the nonpatented Betty and Stella claims. The two veins are, therefore, parallel and strike N. 75° W. with steep dips.

The south vein, located on the Betty and Stella claims, is probably the stronger of the two. The zone has been developed by several short adits and shallow shafts. The vein is best exposed in a 100-foot vertical shaft on the Stella claim. The poor condition of the ladders in this shaft prevented inspection of the vein lower than 20 feet below the collar, at which level the vein is approximately 2 feet wide. The vein is contained within a 4-foot fault-breccia zone in andesite. The strike of the fault zone is N. 80° W., with almost vertical dip. The vein minerals are calcite, quartz, and iron oxides. Sulfides were not detected on the shaft dump or down to the 20-foot level in the shaft, but the owner showed the writer several bornite-chalcopyrite-pyrite specimens which, he stated, came from the bottom of the shaft. The presence of iron oxides at the surface support this evidence of sulfide mineralization at depth.

The north vein is similar to the south one, except that the vein is not as pronounced. Several test pits have been sunk on the vein, but the depth attained was not sufficient to reach sulfide mineralization, if present.

Junction Mine

Location and access. The Junction mine is located in the NW¼ sec. 8, T. 9 S., R. 11 E. The mine area can be reached by traveling 6 miles south of Carrizozo on the dirt road leading to the C. J. Harrold ranch, thence 2 miles to the east (fig. 20).

History. The owner of the property could not be reached; therefore, the past history of the mine could not be learned in detail. The layout of the claims covering the deposit is not known; for this reason, Plate 17, the claim map of the district, does not show the Junction mine claims. It is known, however, that on March 8, 1953, Frank S. Hall relocated three claims, the Silver Pick, Golden Pick, and one other (name unknown). These three claims were originally staked in 1934 by L. G. (Dan) Connelly.[5] According to Mr. C. E. Degner (personal communication), of Carrizozo, Connelly spent about $15,000 on developing the property around 1934-35; it is not recalled, however, that Connelly shipped any ore.

Geology. Two inclined shafts, now inaccessible, have been sunk on a slightly silicified shear zone in andesite which strikes N. 70° W. and dips 60 degrees to the north. The shear or fault zone is about 4 feet wide, and several quartz and iron oxide stringers were observed in the vicinity of the shafts. At the lower or east shaft, some copper staining was noticed on the vein outcrop. Inspection of the mine dumps failed to reveal any ore specimens.

Idaho Mine

Location and access. The Idaho mine is located in the east-central part of sec. 8, T. 9 S., R. 11 E., about one-half mile southeast of the Junction mine. The mine is reached by traveling one-half mile farther east on the road which passes near the Junction mine (fig. 20).

History. C. E. Degner has been in possession of the mine since 1944. Three claims cover the deposit; namely, the Idaho, Idaho No. 1, and Idaho Millsite claims. Mr. Degner (personal communication) states that about 160 tons of copper ore was shipped from the property prior to his purchase.

Geology. The principal mineralization is limited to the contacts of an east-trending syenite dike which dips steeply to the north. The property has been developed by two shafts, about 500 feet apart, which were

5. A claim notice was found at one of the shafts, with Mr. Hall named as locator. A search of the County Recorder's Office in Carrizozo revealed that three claims were relocated, all having been first staked in 1934.

sunk on the syenite dike. The shafts were not examined because they were not timbered or laddered. The vein contains calcite, together with some barite(?) and iron oxides at the surface. Examination of the dumps of the mine workings did not yield sulfide ore specimens, but the owner exhibited several sulfide samples taken from the bottom of the easternmost shaft. Apparently, copper sulfides were encountered below the zone of oxidation in this shaft.

New Mexico Copper Corp. Claims

Location and access. The claims are located in secs. 19, 20, 29, and 30, T. 9 S., R. 11 E., and sec. 24, T. 9 S., R. 10 E. The claim area is within and around Water Canyon, which can be reached by traveling 10 miles south of Carrizozo on the dirt road passing through the Harrold Ranch.

History. The New Mexico Copper Corp. has control of a group of 57 claims, only 2 of which are patented, partially covering several sections. The claims comprise the Surprise, Park Gold, Little Hecla, and Copper Lode groups and patent claims 689 and 690. The company was formed for the purpose of operating these and other properties in Lincoln County. The majority of the claims were owned formerly by C. E. Degner. Mr. Degner, who is president of the company, deeded the properties to the company at the time of its formation. The veins in the mine area were worked intermittently up to 1956. At that time, the New Mexico Copper Corp. commenced to develop the claims with the expectation of sending copper ore to the company's mill in Carrizozo. According to Degner (personal communication), the development program was halted in the latter part of the same year, owing to reduced copper prices.

Geology. There are two principal veins on the property, both striking northwest, one on the north side of Water Canyon, the other on the south side. The northern vein, which appears to be the more prominent of the two structures, is associated with a syenite dike in the andesite. The vein was examined only on the Surprise claim, but the vein is said to be readily traceable onto the Surprise No. 1 to the east and the Surprise No. 2 to the west.

On the Surprise claim, the vein is composed of considerable barite accompanied by calcite and limonite, and the mineralized portion is about 2 feet wide. Some copper staining is present on the vein outcrops. The vein has not been developed in sufficient depth to prove the existence of primary sulfide mineralization.

The south vein, which strikes northeast, was examined on the Park Gold No. 4 claim where it crosses McCoy Canyon. In the area examined, the vein did not appear to be as pronounced as the north vein; however, it is similar to the latter, except that it does not carry barite.

JICARILLA DISTRICT

GENERAL

The Jicarilla district is located near the small village of the same name (pl. 1). Most of the mines lie within the east half of T. 5 S., R. 12 E. Mining in the district is now dormant, but the area was the scene of moderate exploration for gold at the turn of the century and during the early 1930's. Placer mining probably accounted for most of the gold produced, but there are numerous lode mines as well. The total value of gold production from the district is not known; a few hundred thousand dollars is a reasonable estimate.

GEOLOGY

Figure 21 is a generalized geologic map of the district. Most of the lode mines and the best placer ground are located within an area of monzonite and monzonite porphyry intrusive rocks. These rocks are surrounded by Permian sediments which, in general, dip gently away from the intrusive mass. The sediments appear to have been domed upward by the intrusion. The intrusive may be laccolithic in shape. Rocks of the San Andres and Yeso formations are the predominant sedimentary rocks near the intrusive contact. The exact age of the intrusive is not known, but its emplacement was probably during Tertiary time.

The intrusive has been moderately fractured, with the fracturing taking place in three principal directions, east-west, north-south, and northwest-southeast. The latter system of fracturing seems to predominate. Mineralization in the form of pyrite, quartz, and minor amounts of copper and gold occurs along the fractures and as disseminations in the monzonite and monzonite porphyry. Hydrothermal alteration was not intense; the rock is only slightly bleached in its mineralized portions.

In some areas, small amounts of skarn-type silicates have been formed in the limestone members of the San Andres formation immediately adjacent to the contact with the intrusive rocks. Several magnetite deposits occur along the contact, and several magnetite bodies are known within the intrusive itself. Most of the deposits of the latter type are believed to be the result of replacement of limestone inclusions within the intrusive mass.

Scheelite is said to have been noticed in many of the gold placers. This mineral was not observed in any of the lode mines examined; however, its presence is probable in the type of mineralization occurring in the Jicarilla district.

DESCRIPTIONS OF MINES AND PROSPECTS

Gold Placers

Practically every arroyo in the district has been worked, with varying results, for placer gold. The most productive were Ancho, Warner,

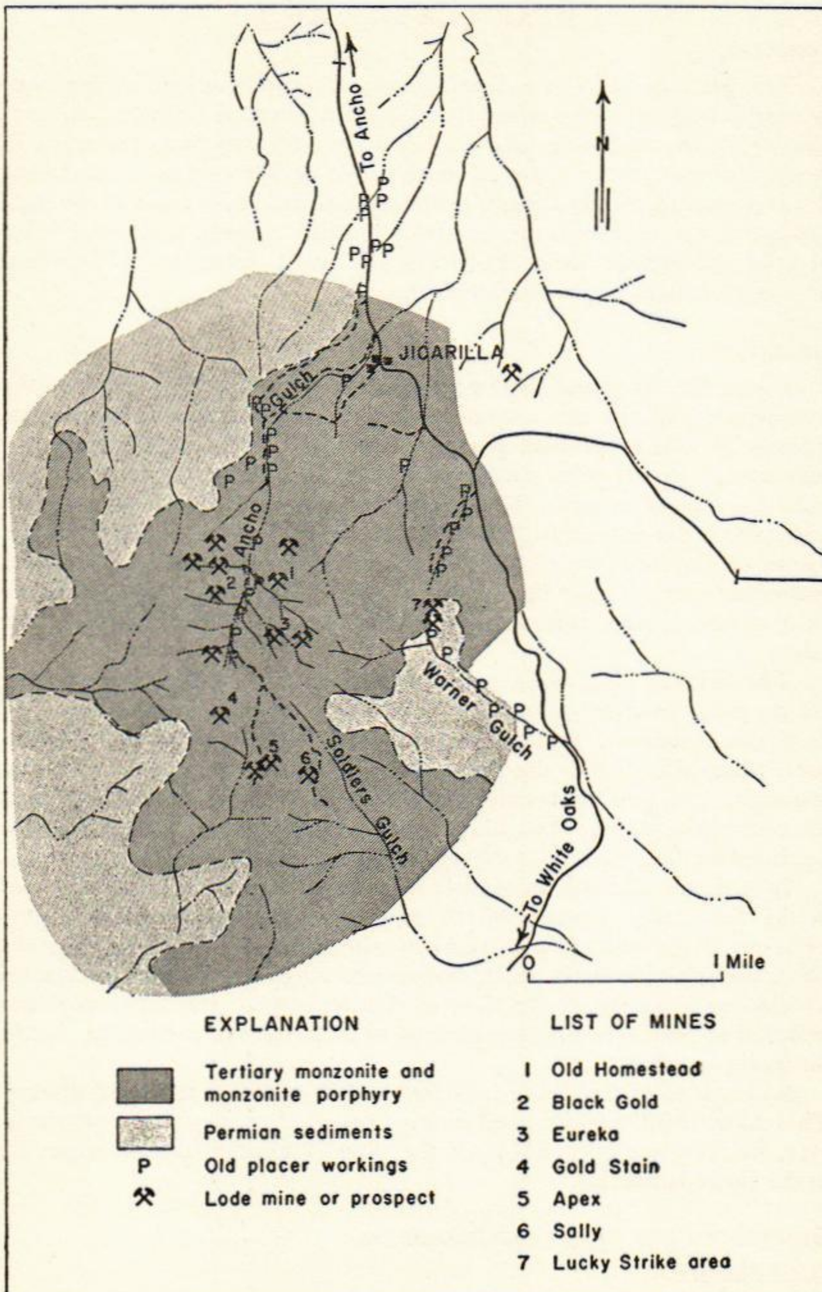


Figure 21
GENERALIZED GEOLOGIC MAP OF THE JICARILLA DISTRICT
Geology by G. B. Griswold, 1958.

Spring, and Rico Gulches. The lack of large quantities of water has been the principal obstacle to successful placer operations in the district.

The gold placers probably were derived by the erosion of small gold-pyrite veins contained in the Jicarilla intrusive monzonite. The oxidation of the pyrite liberated the gold, which was then concentrated in the existing streams and arroyos. No attempt was made to sample or determine the extent of the placers, but some of the principal placer areas are noted in Figure 21.

Hubbard Claims

Location and access. W. A. Hubbard, of Jicarilla, owns a group of 15 lode claims in sections 27, 34, 35, covering several gold lode deposits. The general area is reached by traveling about 2.5 miles southwest of Jicarilla along Ancho Gulch (fig. 21 and pl. 11).

History. Mr. Hubbard gained possession of most of the claims in 1934. Some of the claims originally were part of the holdings of the Wisconsin Mining and Milling Co., which operated the Sally, Apex, and Spring (Gold Stain) mines. This company had operated a small mill, located in the NW¼ sec. 27, for a brief period around 1905.

According to the company prospectus,[6] the mill used amalgamation to recover the free gold. The ruins of the foundation of the mill are all that remains. Mr. Hubbard operated a small cyanide plant to treat sulfide ores in the late 1930's and early 1940's. The mill was located about 700 feet east of the Sally mine (fig. 14).

In June 1958, Mr. Hubbard was beginning some development work from the bottom of the winze at the end of the main adit level in the Sally mine. The other mines are dormant except for the annual assessment work.

Sally Mine

Location and access. The Sally mine is located in the SE1/4 sec. 27, T. 5 S., R. 12 E. The mine can be reached by traveling 3 miles south of Jicarilla along an unimproved road which leads up Ancho Gulch and thence down into Soldier's Gulch (fig. 21).

Geology. The mine workings are within monzonite and monzonite porphyry. Numerous pyrite and arsenopyrite stringers transect the intrusive rock; the predominant strike of the sulfide stringers is northwest, with almost vertical dips. In the more mineralized portions of the mine, disseminated grains of pyrite also impregnate the rock between the veinlets. The gold is believed to be contained within the sulfides, because cyanide extraction was required for its recovery.

Mine development. Figure 22 is a topographic map of the mine area. The mine has been developed by three levels; namely, the main adit, the 70-foot-level adit, and an intermediate level midway between. Figure 23 is a schematic longitudinal section through the mine illustrating the

6. Loaned to the writer by Mr. W. A. Hubbard.

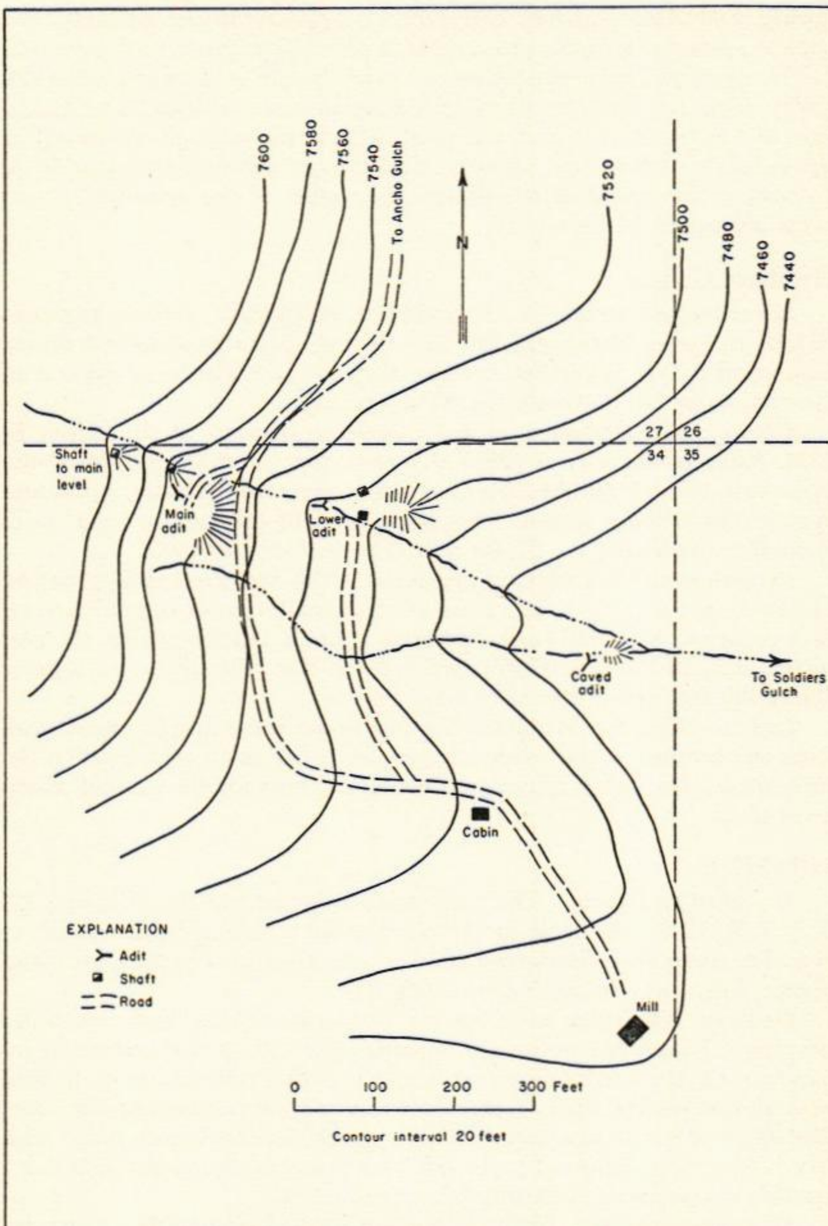


Figure 22

TOPOGRAPHIC MAP OF THE SALLY MINE AREA, T. 5 S., R. 12 E.

Topography by G. B. Griswold and M. T. Worley, 1958.

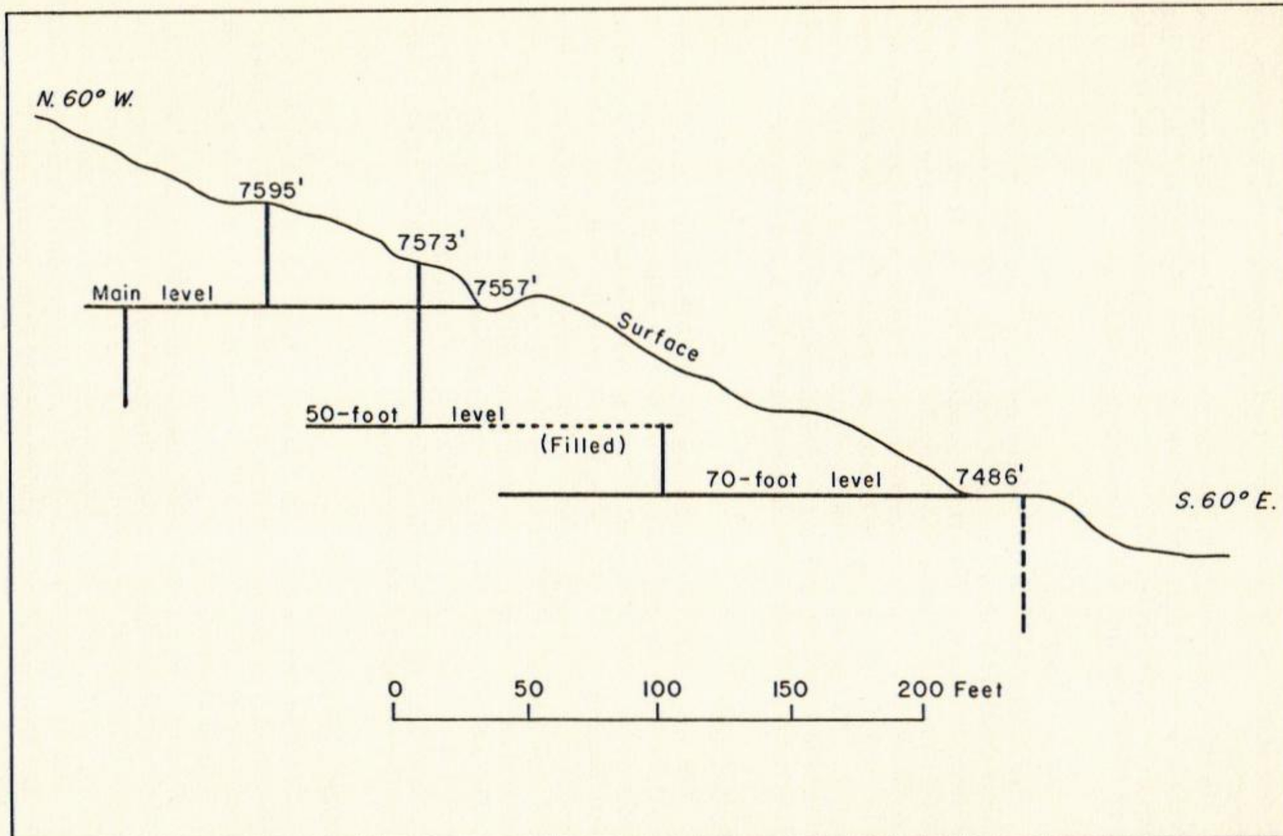


Figure 23

IDEALIZED VERTICAL LONGITUDINAL SECTION OF THE SALLY MINE WORKINGS interrelationship of the three levels. An adit lying approximately 300 feet southeast of the 70-foot-level portal was caved and, therefore, not examined.

In the summer of 1958, the owner was starting a drift from the bottom of the winze at the end of the main adit level (fig. 24). This heading was to be driven in a southerly direction along a narrow band of dark-gray monzonite in a host of monzonite porphyry.

Spring (Gold Stain) Mine

W. A. Hubbard is the present owner of the Spring claim, which covers the Gold Stain mine (fig. 21 and pl. 11). The mine was developed by several shafts, now inaccessible, and an adit, which is now caved about 30 feet inside the portal. The mine dumps are the largest in the district; therefore, considerable underground development must have been done. The material on the dump is fairly mineralized by pyrite and arsenopyrite. The host rock is mainly monzonite porphyry, and the rock is altered by bleaching and minor kaolinization. An assay of a grab sample from the mine dump failed to yield more than a trace of gold.

Apex Claim

The Apex claim is located northwest of the Sally claim. The principal workings on the claim are a 300-foot adit extending S. 75° E., located along the old wagon trail to the mine, two shallow shafts located near the crest of the ridge about 500 feet to the east, and a short adit extending in an easterly direction about midway between the lower adit and the shafts. All the dumps from the mine workings show some pyrite mineralization in monzonite and monzonite porphyry rock. The two shafts just below the crest of the ridge expose a steeply dipping breccia zone 1 foot wide. The breccia strikes to the east, and some chalcopyrite was noted, along with considerable pyrite, as either a filling or replacement between the breccia fragments.

Haley Claims

Location and access. C. W. Haley, of Capitan, owns a group of 12 lode claims, 7 of which are patented, immediately north of the Hubbard group (pl. 11). The general area is reached by the road leading from Jicarilla southward along Ancho Gulch.

History. The patented claims were located in the early 1900's. Ore from the Eureka claim is believed to have been treated in the old Wisconsin Milling and Smelting Co.'s mill, which was located in the NE1/4 sec. 27, T. 5 S., R. 12 E. Past ownership of the group of claims was not traced by the writer. According to Mr. Haley (personal communication), the Red Rose and Hawkeye claims are said to have once been the property of the Chicago Mining and Smelting Co., one of the stock companies which operated in the district in the early days.

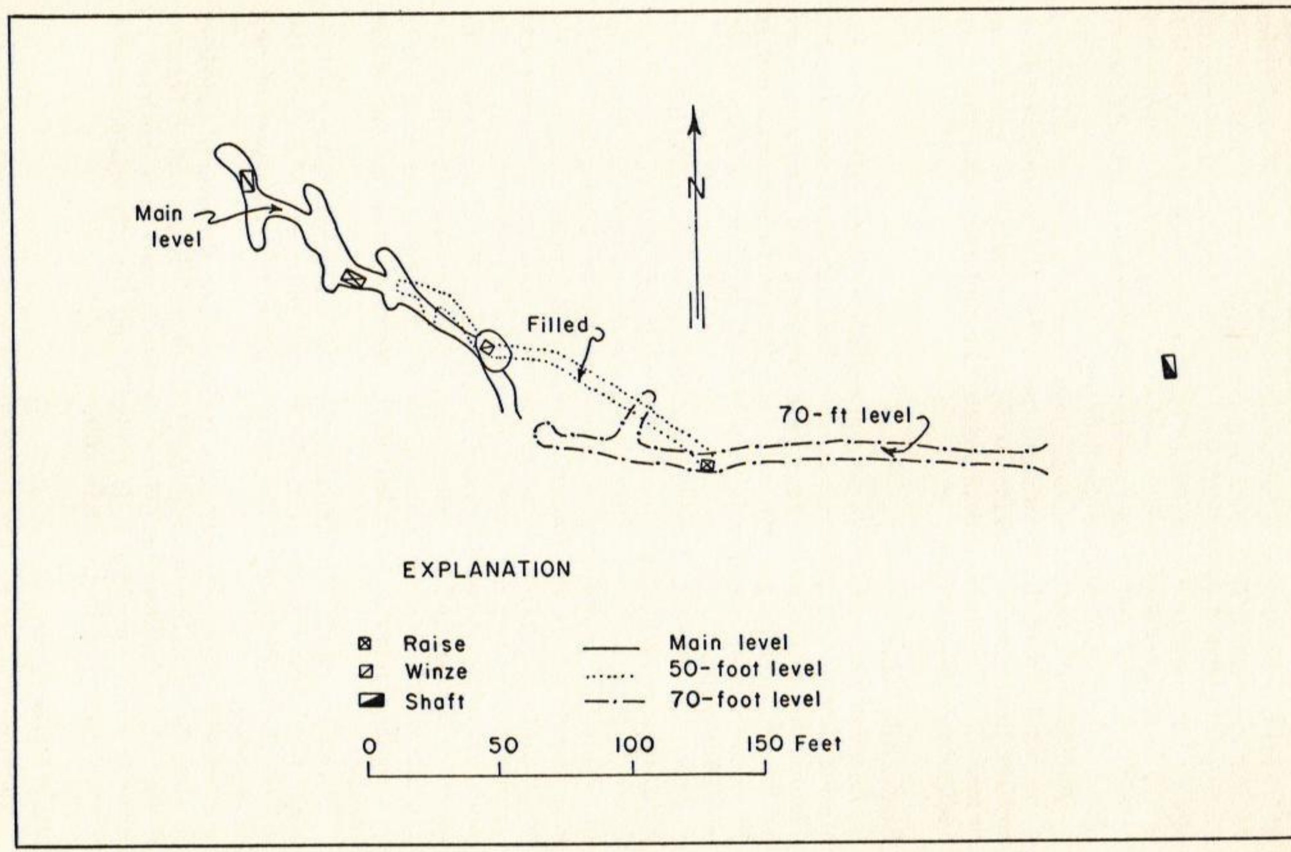


Figure 24

COMPOSITE PLAN MAP OF THE SALLY MINE WORKINGS

Old Homestead mine. The most extensive underground workings which are now accessible are located on the Old Homestead No. 1 claim. An adit approximately 420 feet long has been driven in a northeasterly direction (fig. 25). Several drifts have been driven from the main adit along what must have appeared to be promising gold leads. The drift driven to the northwest from the end of the adit exposed a narrow bed of highly altered sedimentary rocks, and a band of magnetite has replaced sediments parallel to the bedding.

Eureka claim. Several vertical shafts have been sunk on the Eureka claim, southeast of the Homestead mine. The shafts are inaccessible, and the underground workings could not be examined. The dumps surrounding the shafts contain monzonite and monzonite porphyry, with minor amounts of pyrite.

Black Gold Mine

Location and ownership. Several adits have been driven into the hillside about one-quarter mile west of the Homestead mine (pl. 18). The number of claims covering these workings, and their names, are not known. According to Mr. A. Lobner (personal communication), of Jicarilla, the mine was recently sold by L. T. Williams to Leslie Settle, of Albuquerque.

Mine development. The principal underground working is an adit which was driven northward for 150 feet (fig. 26). Most of the adit was driven through highly metamorphosed sediments, probably limestones and shales. The sediments strike a little west of north and dip from 35 to 45 degrees to the east. Monzonite porphyry is exposed along a vertical northwest-trending contact in the end of the adit, and monzonite and monzonite porphyry are exposed on the surface immediately to the south, east and west of the portal. Inasmuch as the altered sediments appear to be surrounded by monzonite, it is believed that the block is a large xenolith within the Jicarilla intrusive. Magnetite and some pyrite have replaced about a 1-foot bed in the sediments near the end of the workings.

Two adits, one 250 feet and the other 300 feet long, have been driven to the south just over the crest of the ridge and north of the adit described above. Neither of the adits exposed mineralization of any consequence.

A small outcrop of magnetite was observed on the crest of the ridge between the adits, but the attitude of the deposit is not known because of the lack of development. The magnetite appears to be enclosed in intrusive rock; therefore, it is probably not directly related to the magnetite exposed in the main adit.

Lucky Strike Area

Location and access. The Lucky Strike mine area is located at the head of Warner Gulch in the north-central part of sec. 26, T. 5 S., R. 12

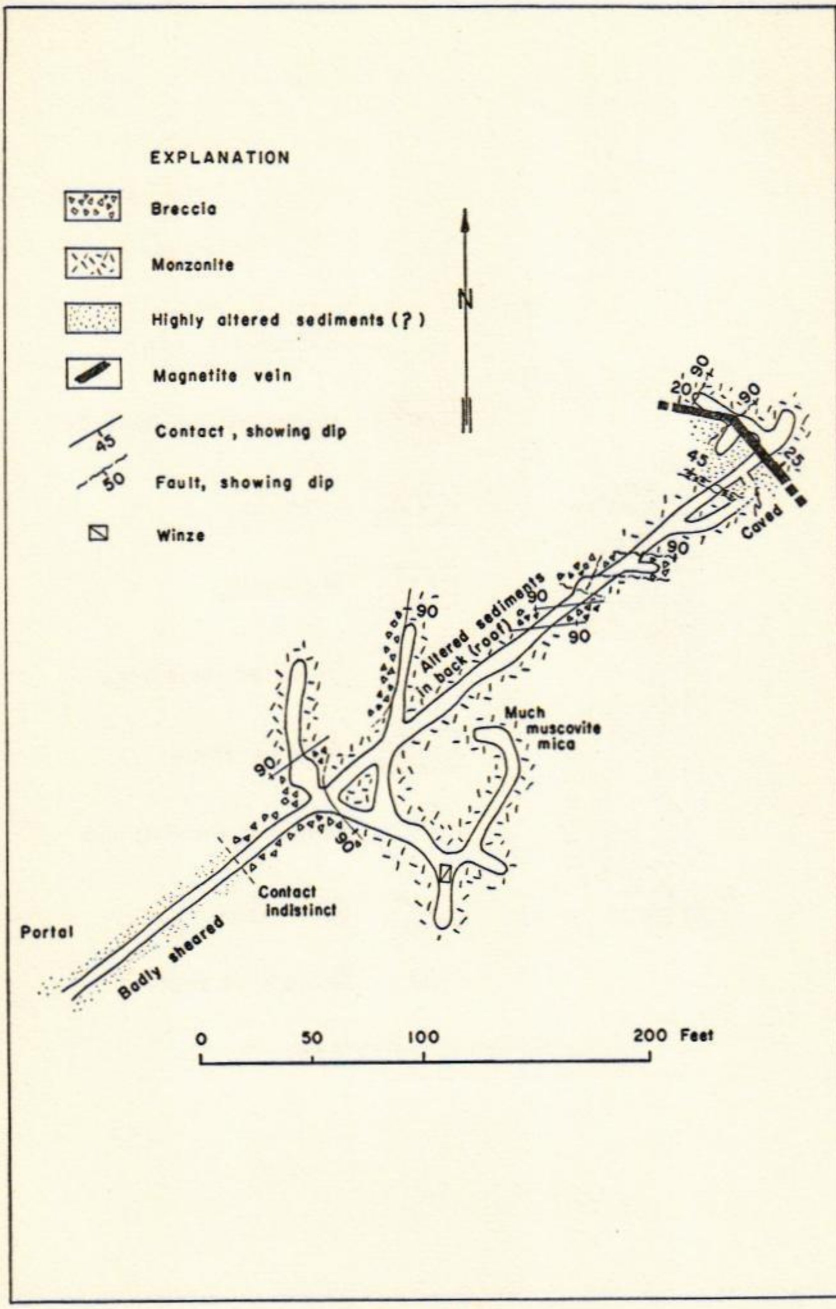


Figure 25
PLAN MAP OF THE OLD HOMESTEAD MINE
Geology by G. B. Griswold, 1957.

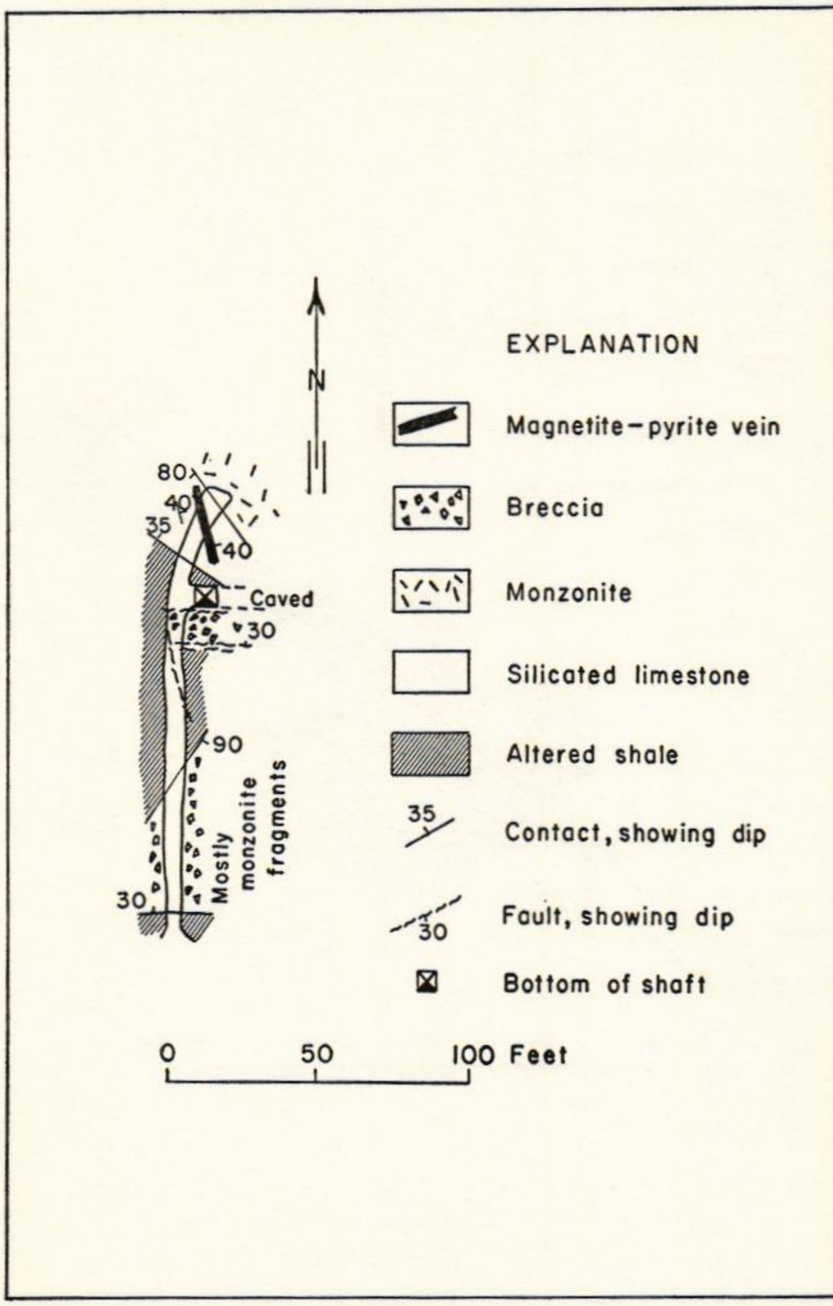


Figure 26
PLAN MAP OF THE BLACK GOLD MINE
Geology by G. B. Griswold, 1957.

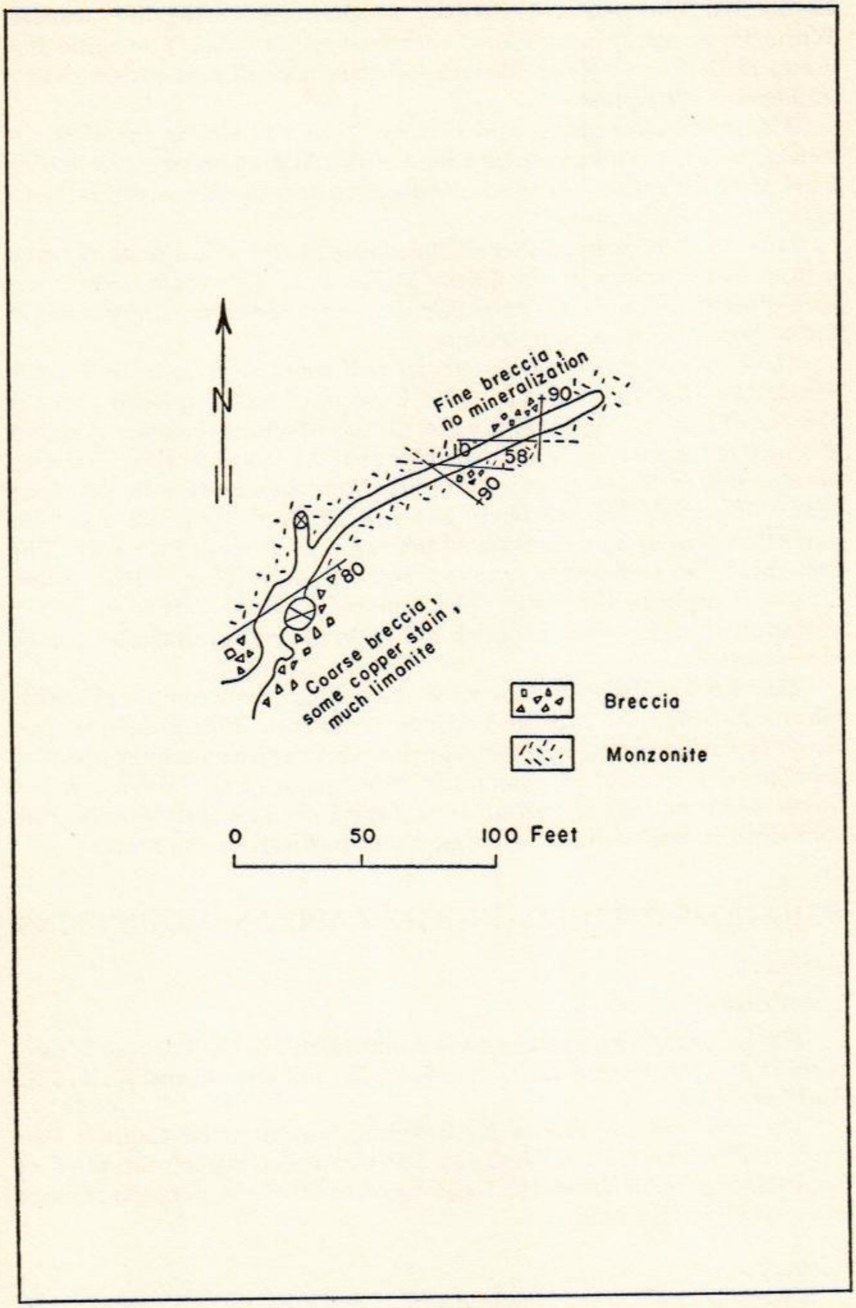


Figure 27

PLAN MAP OF AN ADIT IN THE LUCKY STRIKE AREA

Geology by G. B. Griswold, 1958.

E. (fig. 21). The area is reached by a short trail leaving the JicarillaWhite Oaks road about 1 mile southeast of Jicarilla. The mine is a group of shafts and short adits clustered in a small area rather than a single mine excavation.

The names, locations, and ownership of the claims covering the mining area are not known, and the writer was not successful in finding marked claim corners in the immediate vicinity during a rather hasty examination of the area.

History. Information was not available to the writer as to the past history of the mines in the Lucky Strike area. The shaft timbers are badly weathered, and it is probable that most of the work was done in the early part of the present century.

Mine development. Several shafts and short adits have been excavated. The shafts are not accessible because of rotted timbers and the absence of ladders. Figure 27 is a sketch map of one of the adits. A minor amount of copper staining, accompanied by considerable limonite, occurs between the fragments of slightly brecciated monzonite porphyry near the portal. The porphyry has been altered appreciably in this particular area by kaolinization of some of the feldspar of the rock. The mineralization terminates against a small fault striking northeast and dipping steeply to the south. The remainder of the adit is in barren monzonite porphyry even though it is altered and intensely brecciated in some areas.

The Lucky Strike area is near the contact between the Jicarilla monzonite intrusive and the Permian sediments. The sediments, particularly the limestone members, have been contact metamorphosed to a higher degree than is common in other parts of the district. A few pieces of garnetized limestone were found on the shaft dumps, and considerable magnetite float covers some portions of the area.

THORIUM DEPOSITS IN THE CAPITAN MOUNTAINS

GENERAL

Location and access

The principal deposits are on the south flank of the Capitan Mountains, in secs. 14, 15, and 22, T. 8 S., R. 15 E., and secs. 36 and 31, T. 7 S., Rs. 14 and 15 E.

The area can be reached by traveling north on the Capitan Pass road, which leaves U. S. Highway 380 two miles east of the town of Capitan. Figure 28 shows the location of most of the deposits relative to the Capitan Pass road.

History

The exact date of the initial thorium discovery is not known, but it is believed to have been in the early 1950's, when extensive prospecting

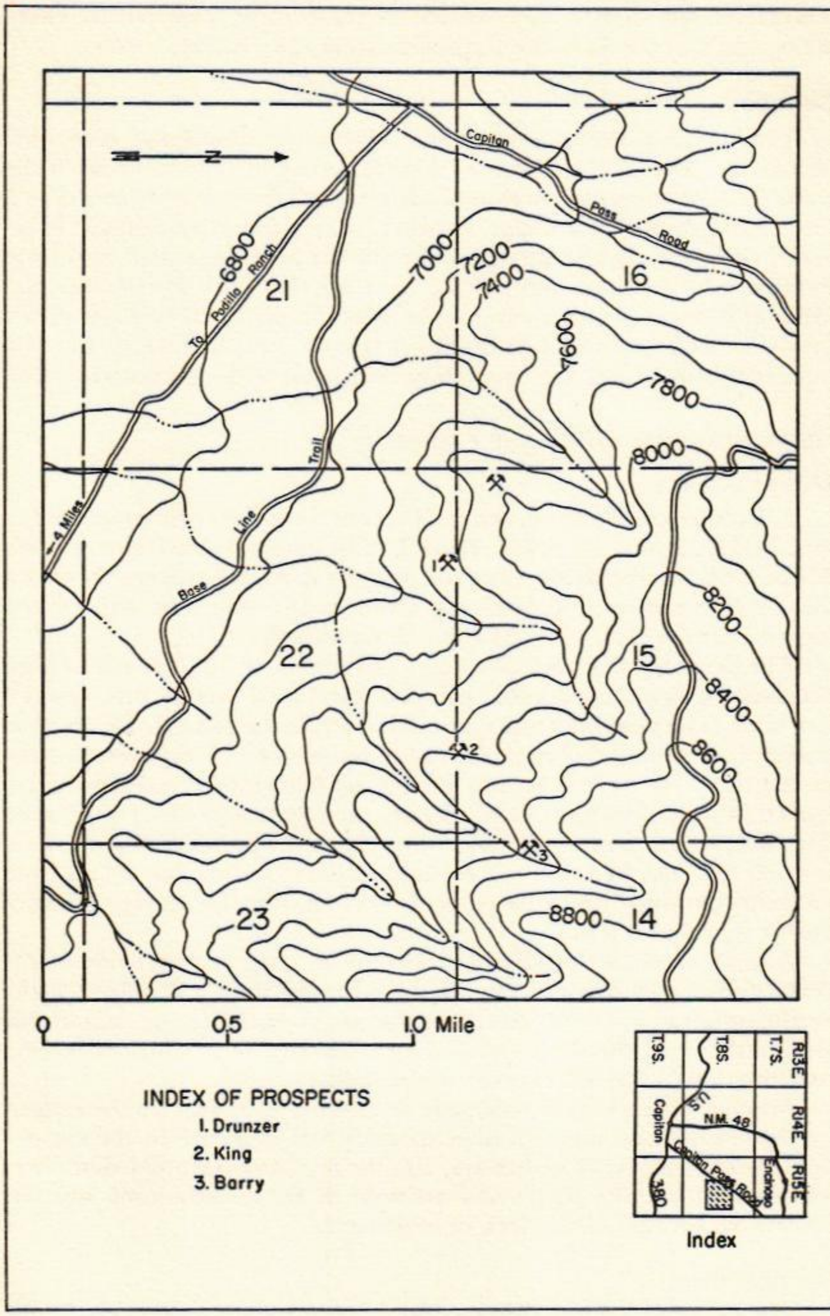


Figure 28

LOCATION MAP OF THORIUM PROSPECTS IN A PORTION OF THE CAPITAN DISTRICT, T. 8 S., R. 15 E.

was carried out all over New Mexico for radioactive ore deposits. There is no record of thorium ore shipments from the district to date.

GEOLOGY

The Capitan Mountains are an east-west trending range composed of alaskite. The known thorium deposits occur in breccia veins in the alaskite. The deposits generally show a radioactive high of from 3 to 5 times background on a Geiger counter. The radioactive mineral is believed to be mostly allanite; this mineral has been identified in several specimens by Dr. M.-S. Sun, of the New Mexico Bureau of Mines and Mineral Resources. Other thorium-bearing minerals may be present, but they were not recognized in the field. Quartz, purple fluorite, tourmaline, and iron oxides are commonly associated with the breccia veins.

DESCRIPTIONS OF MINES AND PROSPECTS

Barry Prospect

E. C. Barry, of Roswell, owns six claims near the common corner of secs. 14, 15, 22, and 23, T. 8 S., R. 15 E. The names of the claims are We Three Nos. 1-3 and Ruth Ann Nos. 1-3; the date of discovery shown on the location notices is January 14, 1955. In addition, Mr. Barry has a lease on the S½NW¼ sec. 23 from V. Grantham.

The property was visited during the summer of 1957, at which time Mr. Barry was sinking a small prospect shaft on a breccia vein about 1 foot wide. The vein is almost vertical and strikes northwest. The breccia is composed of angular fragments of alaskite as much as several inches in length which have been recemented by fine-grained red rhyolite(?). Quartz, tourmaline(?), and limonite are present in significant quantities. The breccia vein is fairly radioactive owing to the presence of a thorium-bearing mineral, believed to be allanite. Barry stated that assays from the vein contained up to 1.7 percent thorium, but the average tenor of the ore is probably less.

A small crossfault terminates the vein on the northwest side of the shaft, and the vein could not be traced more than a few feet to the southeast because of soil mantle and talus. A bulldozer cut about 200 feet southeast of the shaft exposed a radioactive zone which may be a continuation of the vein exposed in the shaft.

Another bulldozer cut was made several hundred feet up the canyon (to the north), and a radioactive anomaly was observed in the excavation. A few fragments of breccia, similar to that previously described, were noted, but the shape and attitude of the breccia zone was not observable because of the lack of exposures.

Drunzer Prospect

The prospect is located in sections 22 and 23, approximately 1 mile west of the Barry prospect. The deposit has been developed by several bulldozed cuts and a trench. The trench follows a bold outcrop of alaskite trending northeast; a weak vertical shear zone trends in the same direction. A breccia vein about 3 inches wide is exposed on the east side of the trench. The vein strikes N. 70° E. and dips 30 degrees to the north. It exhibits a radioactive anomaly of approximately three times that of the background count. The source mineral of the radioactivity was not detected in the field, but it may be due to allanite in view of the close similarity of the vein with other veins in the district known to carry allanite. The breccia appears to stop abruptly on the west side of the trench against a group of closely spaced fractures or shears. The vein can be traced to the east only a few feet before it passes under a mantle of soil.

A radioactive anomaly was detected in a bulldozer cut approximately 100 feet southwest of the aforementioned trench. The bottom of the open cut is covered with loose rock, so that the source of the radioactivity could not be located.

Another open cut has been made about one-quarter of a mile northwest of the main workings, but these workings were not examined.

Other Prospects

J. R. King, of Carrizozo, owns two claims southwest of the Barry prospect. Several bulldozer cuts have been made which expose alaskite. Several small radioactive anomalies were noted, but attempts to identify radioactive material in place were unsuccessful.

F. G. McCrory, of Capitan, owns a group of claims covering two thorium deposits in secs. 36 and 31, T. 7 S., Rs. 14 and 15 E., respectively. The more westerly deposit is located in the NW¼SE¼ sec. 36. A breccia vein similar to that on the Barry prospect has been exposed. The alaskite fragments have been kaolinized, and the interstices of the breccia are filled with vuggy quartz, tourmaline, and purple fluorite. The second deposit, just north of the center of sec. 31, was not visited.

Several thorium occurrences are reported on the northern slopes of the Capitan Mountains across the ridge from the Barry and Drunzer prospects. These claims were not visited.

IRON DEPOSITS

GENERAL

Introduction

There are numerous iron deposits scattered across the northwestern and central parts of the county. From several of the deposits ore has been shipped in the past, mainly during war periods, but all the mines are now dormant. New exploration on several claims was commenced in 1956-57 because of a new use[7] that had been developed for magnetite

7. For coating undersea oil pipelines in the Gulf Coast region. Magnetite is used because of its high density, which tends to stabilize the pipe on the sea floor.

iron ore. However, no large production has been recorded to date as a result of the new demand.

Previous Investigations

Figure 29 shows the location of most of the iron deposits within the county. All the deposits listed, except the Whettige and Ferro, have been well described by Kelley (1949), Soule (1947, 1949), and Sheridan (1947). The writer has drawn freely on these three works, particularly Kelley's, for the descriptions of the deposits given here.

History

The first recorded production of iron ore from Lincoln County occurred in 1913, when approximately 3,700 tons of ore was shipped from the Yellow Jacket mine to the Colorado Fuel and Iron Co., Pueblo, Colorado. During World War I and up to 1921, and then again during World War II and the Korean War, sporadic production was recorded from the county.

TABLE 10. OUTPUT OF LINCOLN COUNTY IRON ORES

YEAR*	TONS
1913	3700†
1914	9050†
1915	5889†
1916	3504
1917	5245
1918	3640†
1919	2544
1920	1952†
1921	248
1922-41	None reported
1942	12,285
1943	4,397
1944-51	None reported
1952	1,472
1953	2,644
1954	350
1955-56	None reported
1957	2,805
Total	59,725

*Data for the years 1913 to 1943 from Kelley (1949, p. 140); for the fiscal years 1944 to 1957, from the State Mine Inspector's annual reports.
† Estimated from the number of cars.

CAPITAN DISTRICT

Capitan Deposits

Location and access. The Capitan deposits are located 6 miles north of Capitan. They can be reached by following State Highway 48 north from Capitan for 4 miles and then traveling 2 miles to the northeast on unimproved roads through the Davis ranch.

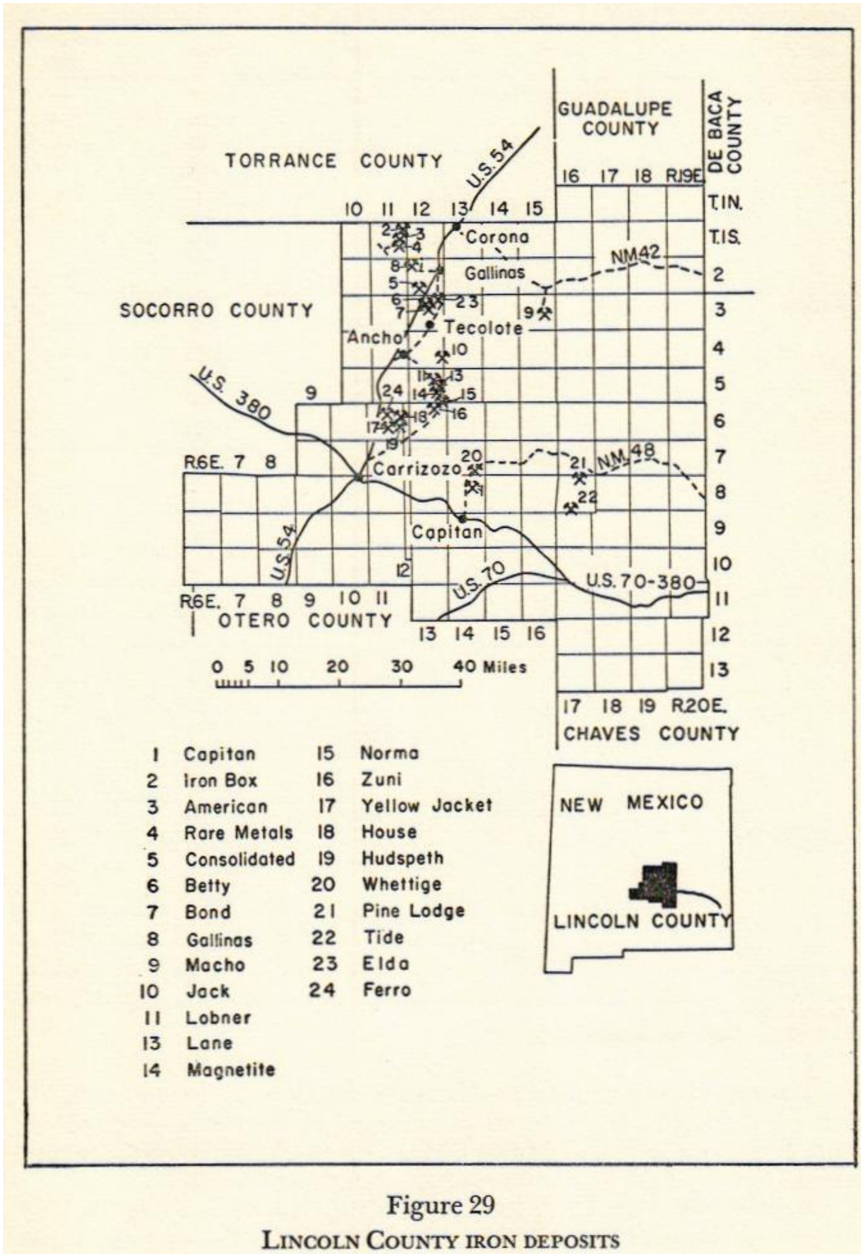


Figure 29

LINCOLN COUNTY IRON DEPOSITS

TABLE 11. IRON ORE—INDIVIDUAL MINE PRODUCTION

DISTRICT	MINE	YEAR	TONS	PERCENT IRON
White Oaks	Yellow Jacket *	1913	3,700	—
		1914	9,050	—
		1915	5,389	—
		1942	1,869	—
			20,008	—
	Ferro †	1952	1,472	—
		1953	2,644	—
			4,116	—
Jicarilla	Jack *	1918	493	—
		1919	597	—
		1920	1,952	—
		1921	248	—
		1943	446	—
			3,736	—
	Magnetite *	1942	652	—
		1943	1,862	—
			2,514	57.2
	Zuni *	1943	829	—
	Lane *	1943	70	60.0
	Norma *	1942	75	—
	Hoecradle *	1942	304	57.8
Tecolote	Elda *	1915	500	—
		1916	3,504	—
		1917	5,245	—
		1918	3,147	—
		1919	1,947	—
			14,343	
	Consolidated *	1942	50	—
Gallinas	American *	1942	2,785	56.2
		1943	1,159	54.5
			3,944	55.7
	Gallinas *	1942	6,410	48.7
	Undistributed	—	3,326	—
Total			59,725	

* Kelley (1949).
† State Mine Inspector's reports (1952, 1953).

The main deposits are located near the common corner of secs. 10, 11, 14, and 15, T. 8 S., R. 14 E., and are covered by the Grace group, Pittsburg Iron Lode group, and other claims. The majority of the claims are owned by Mrs. Francis A. Hunt, of Roswell, New Mexico.

Exploration. The U. S. Bureau of Mines has done a considerable amount of exploratory drilling and sampling on the deposit. From March 1, 1944 to June 1, 1944, 179 wagon drill holes totaling 3,490 feet, and 4 test pits totaling 75 feet, were completed. From November 1947 to February 1948, 7 churn-drill holes totaling 2,488 feet were drilled and sampled. The results of the drilling have been reported by Soule (1947, 1949). In addition, Kelley (1949) has mapped the local geology and correlated the information obtained from the drilling.

The U. S. Bureau of Mines estimated the deposit to be slightly over 1 million tons, averaging approximately 45 percent iron (Kelley, 1949, p. 148).

Geology. The principal rocks in the vicinity of the deposits are those of the San Andres formation, of Permian age. The Chalk Bluff formation and the Dockum group, of Permian and Triassic age respectively, overlie the San Andres formation about 1 mile northwest of the deposits, and the Dakota formation, of Cretaceous age, is downfaulted against the San Andres about three-quarters of a mile south of the deposits. The Capitan alaskite laccolith is exposed about a half mile to the east.

The main deposit appears to be a high-temperature limestone replacement body of magnetite accompanied by lesser amounts of hematite. Kelley (1949, p. 151) states that the replacement was controlled by a preore collapse or sink structure about 1,300 feet in diameter.

The magnetite zone is roughly cylindrical in shape (pl. 12), having a barren central core of San Andres limestone surrounded by a silication zone of tremolite, phlogopite, and epidote, surrounded in turn by magnetite. The southern portion of the central core is occupied by a limestone breccia which has been partially replaced with magnetite. Tongues of magnetite extend outward from the ring parallel to the bedding of the limestone, and numerous isolated lenses or small "mantos" occur still farther out from the main ore zone.

Churn drilling by the U. S. Bureau of Mines proved the presence of the alaskite laccolith underlying the limestone and sandstone of the San Andres formation. The depth to the top of the alaskite ranges from 207 to 323 feet below the surface in the holes drilled.

Several replacement deposits occur about 1 mile east of the Capitan deposit in secs. 13 and 14, T. 8 S., R. 14 E. These deposits follow the contact between the San Andres formation and the Capitan laccolith.

Other Deposits

Several smaller iron deposits are found in the vicinity of the Capitan Mountains. Like the Capitan deposit, they are mainly limestone replacement, but on the whole they do not exhibit the zone of silication surrounding the ore zones as is characteristic of the Capitan deposit.

Whettige deposits. Two outcrops of magnetite were mapped by Dr. J. E. Allen and the writer, one in the NW¼ sec. 35, T. 7 S., R. 14 E., and the other in the SW¼ sec. 26 of the same township. The deposits can be reached by traveling approximately 9 miles north from the town of Capitan on State Highway 48. The deposits are in the vicinity of the Whettige ranch house.

The larger of the two deposits appears to be the one in sec. 35 (fig. 30). The outcrop is approximately dumb-bell shaped, covering 125,000

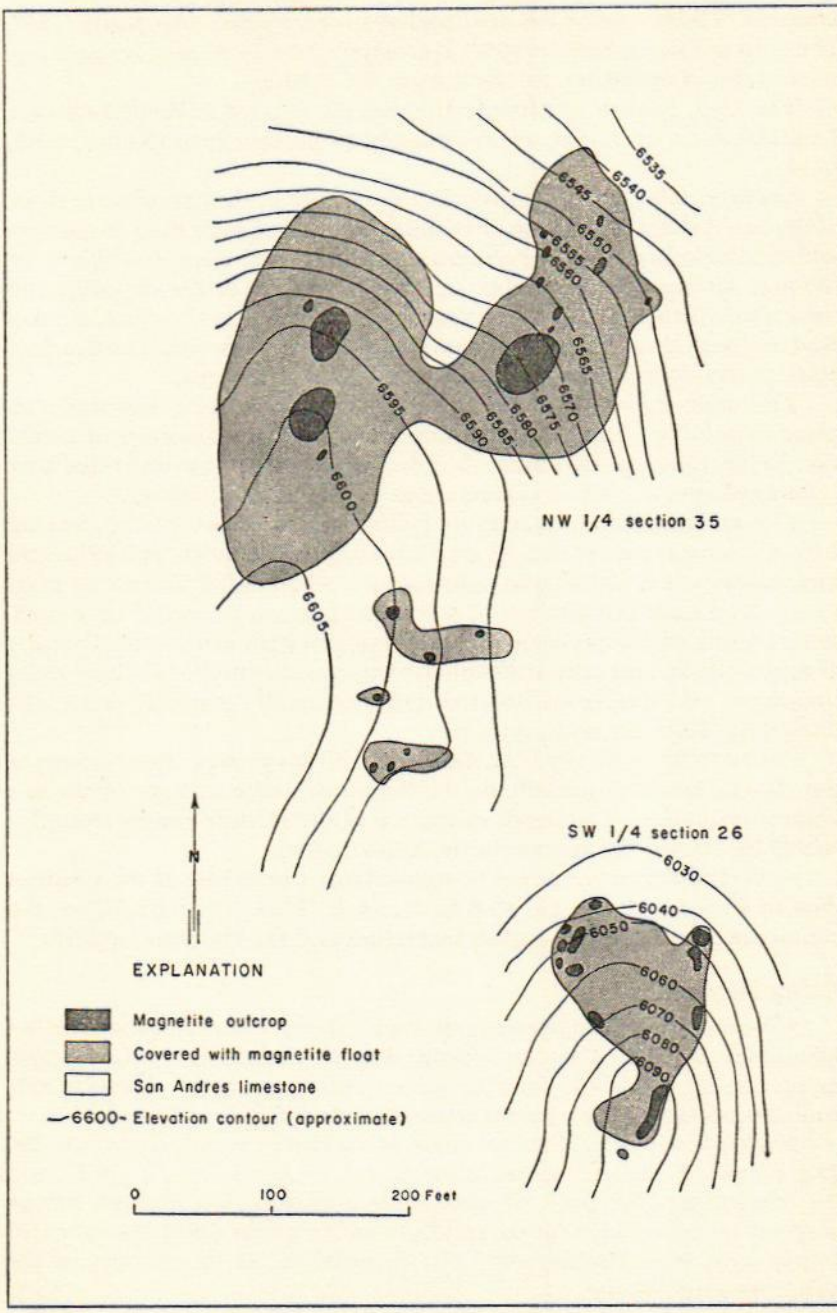


Figure 30

GEOLOGIC MAP OF THE WHETTIGE IRON DEPOSITS, T. 7 S., R. 14 E.

square feet; several isolated outcrops occur farther to the south. Lack of development work prevented an estimation of the depth of the deposit; the area which is underlain by magnetite in place is probably much less than that which is covered by float.

The deposit in section 26 is smaller in plan than the one previously described, but the two deposits are similar in most other respects. Both represent replacement in nearly horizontal limestone members of the San Andres formation, and minor amounts of silicate minerals have been developed adjacent to the magnetite bodies.

Pine Lodge deposits. Several iron deposits have been prospected in the northeast part of the Capitan Mountains near Pine Lodge. Five unpatented claims (Major, Red Wing Nos. 3 and 4, Ajax, and Oslo) cover several small iron outcrops in sec. 3, T. 8 S., R. 16 E.

The deposits have been developed by several shallow pits and two short adits. The deposits are located along the contact between the igneous and sedimentary rocks.

Tide Iron deposit. The Tide Uranium Co., of Fort Worth, Texas, owns 12 claims (Bear Cat Nos. 1-6 and Bumblebee Nos. 1-6), covering an iron deposit in secs. 30, 31, and 32, T. 8 S., R. 17 E. The development work has not exposed the deposit sufficiently to outline its size or shape, but a small trench exposed a fault zone trending east-west which carries magnetite and hematite. The deposit appears to be confined to the alaskite which forms the Capitan laccolith.

WHITE OAKS DISTRICT

In addition to the gold-tungsten deposits of the White Oaks district, several iron deposits are known. The main deposits occur along the periphery of the Lone Mountain monzonite stock northwest and west of the town of White Oaks (fig. 2).

Yellow Jacket Mine

Location and access. The Yellow Jacket mine is located in sec. 22, T. 6 S., R. 11 E., and can be reached from Robsart siding on the Southern Pacific R. R. by traveling north 1 mile on U. S. Highway 54, and 3 miles northeast over a dirt road.

History. The deposit was prospected in the early 1900's along weak copper and gold showings. Mining for iron began in 1913, and by 1919 approximately 17,500 tons of ore had been shipped. The deposit was worked again in 1942. Kelley (1949, p. 153) credits the mine with 30 percent of the county's entire production of iron ore.

Geology. The geology is complicated by close folding of the sedimentary rocks and the intrusion of dikes and sills. The limestone member of the San Andres formation is the ore host, but in contrast to most of the Lincoln County iron deposits, the principal ore mineral is hematite. Magnetite and specularite are present in subordinate amounts.

The mineralization appears to be limited to a synclinal structure that pitches from 15 to 25 degrees to the north-northwest. Sills of monzonite occur immediately above and below the San Andres formation, and both these rock types have been cut by later syenite(?) porphyry dikes.

Owing to the pitching synclinal structure, the surface outcrop of the iron-bearing zone is U-shaped, with the open end of the "U" oriented to the north. The limbs and trough of the syncline are mineralized, the trough and west limb having been the most productive zones. In the east limb, the ore zone thins rapidly to the north, although mineralization can be traced for some 250 feet. The west limb is mineralized for approximately 500 feet, and two principal ore bodies have been mined from this part of the syncline. Another ore body, approximately 35 feet thick, is located in the trough of the syncline; this ore body was mined downdip for about 125 feet.

Mining methods. The ore was mined from the limbs of the syncline by open pits and trenches. The ore in the trough was mined first by open pit and then by an underground room-and-pillar method. As previously stated, the total production from the deposit has been estimated at approximately 17,500 tons. The ore was trucked to Robsart siding, where it was transferred into railroad cars for shipment to the steel mills.

A short adit has been driven from the west limb some 150 feet to the southeast toward the trough of the syncline. Unfortunately, this adit was not driven far enough to reach the downdip projection of the previously mined ore body in the trough.

Ferro Mine

J. B. Close owns a group of claims covering an iron deposit, known as the Ferro mine, located near the boundary between secs. 16 and 17, T. 6 S., R. 11 E. Access to the mine is gained by traveling approximately 1 mile south of Coyote parallel to the railroad and then 2 miles to the east. A vein of magnetite striking northeast and dipping 30 to 90 degrees east has been exposed for approximately 500 feet along the strike by a series of pits and trenches. The principal ore mineral is magnetite accompanied by hematite and some pyrite.

The ore is localized along the contact of the San Andres formation and the Lone Mountain syenite intrusive (fig. 4). Actinolite, epidote, hedenbergite, and probably other types of silicate minerals were formed in the limestone members of the San Andres formation in the immediate vicinity of the contact with the intrusive. The iron-ore vein, which ranges from 1 to 6 feet in width, appears to be a replacement of limestone near this contact. A small pit about 300 yards west of the main deposit has exposed a magnetite band in limestone, which strikes N. 45° E. and dips 50 degrees to the northwest.

Reports of the State Mine Inspector indicate that 4,116 tons of ore was shipped from the mine in 1952-53. Personal communication with the owner revealed that 165 railroad cars (50-ton capacity) were shipped during this period, indicating a total tonnage of 8,250 tons if the cars were loaded to capacity.

House Mines

John W. House, of Carrizozo, owns an iron deposit in sec. 14, T. 6 S., R. 11 E., on the north side of Lone Mountain. The deposit has also been called the Carolyn 0, Las Cinco Reinas, and Prince mine. The prospect can be reached by traveling east of Coyote for approximately 5 miles. The mine has been prospected and explored for a number of years, but there is no official record of production.

Magnetite is the principal ore mineral, and the host rock appears to be a limestone member of the Yeso formation, of Permian age. The deposit occurs adjacent to the contact between the sedimentary rocks and the intrusive syenite stock which forms Lone Mountain. The deposit also contains a minor amount of uranium associated with the iron mineralization. The occurrence of the uranium has been discussed in detail by Walker and Osterwald (1956), who conclude that the uranium, probably as the mineral metatorbernite, was introduced contemporaneously with the magnetite. The percentage of uranium present is considered to be below economic amounts.

Other Deposits

Several small deposits occur in sec. 23, T. 6 S., R. 11 E., on the southeast side of Lone Mountain. These deposits are covered by claims belonging to the A. H. Hudspeth Estate. No production from these deposits has been recorded.

JICARILLA DISTRICT

The Jicarilla district is similar to the White Oaks district in that the iron deposits are pyrometasomatic replacements of limestone surrounding a monzonite stock, and both districts were noted for their gold deposits prior to the mining of the iron.

The Jicarilla Mountains are an oblong series of intrusions of monzonite about 10 miles long and from 2 to 5 miles wide, which intrude pre-Tertiary sedimentary rocks.

Iron-ore mining was conducted in the district from 1918 to 1921 and then again in 1942-43. The total production from the district is slightly less than 8,000 tons, most of which came from the Jack and Magnetite mines (Kelley, 1949, p. 159).

Jack Mines

Location and access. Three claims, Jack Nos. 1-3, cover an iron outcrop in sec. 36, T. 4 S., R. 12 E., and sec. 1, T. 5 S., R. 12 E. The deposit can be reached from Ancho by traveling 4 miles to the southeast on the

Ancho-Jicarilla dirt road, and thence 4 miles to the northeast on an unimproved road.

History. The deposits were mined first in 1918-21 by the Beeth brothers, and then again in 1942-43 by Vincent Moore and H. A. Livingston. During the earlier operation, a narrow gage railroad is said to have serviced the mine. The total production from the mine is estimated to be about 3,700 tons, most of which was mined during 1918 and 1919 (Kelley, 1949, p. 161).

Geology. Magnetite and some hematite occur as replacements in limestone of the Yeso(?) formation along a north-trending outcrop which can be traced discontinuously for several thousand feet. The iron appears to have replaced the limestone parallel to the bedding. The sedimentary beds have been arched up against a monzonite dike that runs approximately north-south and bounds the deposit on the east. The thickness of the iron replacement ranges from a few inches to 10 feet.

Mining methods. Mining was confined to the Jack No. 1 claim on the north end, and Jack No. 3 claim on the south end, of the deposit. The larger operation was on the Jack No. 1 claim, where the ore was mined by open-pit and underground "gophering" methods. At the Jack No. 3 claim, mining was done by trenching along the ore outcrop.

Other Deposits

Magnetite mine. The Magnetite mine is located in sec. 26, T. 5 S., R. 12 E., and is owned by Herbert and Marvin Ellis. The deposit can be reached by traveling 3 miles south from Jicarilla on the Jicarilla-White Oaks road, and thence 1 mile west. The deposit was worked under a lease to Jesse Wade, of Corona, in 1942-43. It is estimated that about 2,500 tons of iron ore was shipped (Kelley, 1949, p. 162).

The deposit appears to be a hook-shaped vertical vein of magnetite and hematite in monzonite. The ore is banded, and minor amounts of skarn-type silicates are present; the vein could represent replacement of a limestone inclusion in the monzonite.

Zuni mines. H. A. Livingston and Vincent Moore mined and shipped about 800 tons of magnetite ore from the Zuni Nos. 1-4 claims in 1943. The deposits are located in secs. 3 and 4, T. 6 S., R. 13 E., and can be reached by traveling about 6 miles south of Jicarilla on the road to White Oaks. The deposits occur in limestone adjacent to monzonite in trusives.

Lobner deposit. Adolph Lobner, of Jicarilla, owns several claims in sec. 14, T. 5 S., R. 12 E., which cover an iron deposit about 1 mile north of Jicarilla. A shallow prospect shaft and several pits have been sunk on magnetite showings in limestone. Lack of outcrops and development work prevent an estimation of the size or shape of the deposit.

Lane deposit. In 1943, about 70 tons of magnetite ore was shipped from a deposit known as the Lane lode, which is located in sec. 24, T.

5 S., R. 12 E., approximately 1 mile southeast of Jicarilla. At this deposit, magnetite has replaced limestone parallel to the bedding near a monzonite dike.

Norma deposit. The deposit is located in sec. 36, T. 5 S., R. 12 E., about 4 miles south of Jicarilla. Magnetite occurs along the contact between limestone and an overlying monzonite sill. According to Kelley (1949, p. 164), 75 tons of ore was shipped from the deposit in 1942.

Hoecradle deposit. Wade, Jarnigan, and Smith, of Corona, shipped about 300 tons of magnetite ore in 1942 from a deposit in Hoecradle Canyon about 3½ miles northeast of Jicarilla. Later, in 1942 and 1943, an additional 290 tons was shipped from the same deposit by Smith and Reischman, of Ancho.

Deposits along Ancho Gulch. Several magnetite occurrences are known along Ancho Gulch, about 2 miles south of Jicarilla. More detailed descriptions of these deposits are given on p. 84.

TECOLOTE DISTRICT

A group of iron deposits have been worked intermittently in the vicinity of Tecolote, a small village on the Southern Racific R. R. The deposits represent replacement of limestones of the San Andres and Yeso formations near intrusive masses of syenite, monzonite, and diorite. The intrusive is a pronglike extension of the larger igneous mass which makes up the Gallinas Mountains to the north (pl. 1). The prong appears to be a laccolith, because the sediments are gently arched upward on the flanks of the intrusive.

Production from the district has been estimated at 14,750 tons of iron ore, most of which came from the Elda mine (Kelley, 1949).

Elda Mine

Location and access. The deposits are located in sec. 11, T. 3 S., R. 12 E. The mine can be reached by traveling 1½ miles south of Elda, a station on the Southern Pacific R. R.

History. Ore was produced in 1915-19 by Lon Jenkins, of Corona. This is the only record of production from this mine. According to Finlay (1921-22), 8,066 tons of ore was shipped from the Iron Chief mine in 1917 and 1918. It is believed that the Iron Chief and Elda mines are the same property. During World War II, the deposit was held by three claims (Consolidated No. 3, Iron Rail, and Iron Contact) belonging to the Lincoln Ore and Metals Co., but the company apparently did not ship any ore from the property.

Geology. The ore is magnetite, which has probably replaced limestone parallel to the bedding. Monzonite sills occur above and below the ore horizon, and numerous barren vertical dikes of porphyry cut the ore zone. The ore bed is about 5 feet thick and dips from 20 to 30 degrees to the east.

Mining methods. According to Kelley (1949, p. 169), 14,343 tons of ore was shipped from the property during the period 1915-19 (including, it would appear, the 8,066 tons reported by Finlay). Mining was by underground room-and-pillar methods, but occasional timber supports were needed. The mine workings are now totally inaccessible.

Other Deposits

Consolidated prospect. Two claims, Consolidated and Consolidated No. 1, cover an iron deposit in sec. 32, T. 2 S., R. 12 E., about 1 mile northwest of Tecolote Peak. The claims were staked by C. E. Degner in 1942. About 50 tons of ore was shipped from the deposit in 1942 by the Lincoln Ore and Metals Co., which held a lease on the claims obtained from Degner. Magnetite and some hematite occur on the east side of a vertical north-trending monzonite dike which cuts flat-lying sediments.

Betty prospect. A small lens of magnetite is exposed in sec. 9, T. 3 S., R. 13 E., about 3 miles west of the Bond ranch. The ore dips steeply west, with monzonite forming the hanging wall and limestone the foot-wall. The U. S. Bureau of Mines (Sheridan, 1947) explored the property by several trenches and pits in 1943, but there is no record of production from the property.

Bond prospect. The prospect is situated in sec. 10, T. 3 S., R. 12 E., about 1 mile east of the Betty deposit. Magnetite occurs parallel to the bedding of east-dipping limestones and shales. Sills of monzonite form the hanging and foot walls. There is no record of ore shipment from the deposit.

Iron City prospect. Magnetite crops out along a contact between monzonite and sedimentary rocks about 1 mile northwest of the Bond ranch. The ore is 2 to 6 feet thick, strikes N. 55° E., and dips 50 degrees to the northwest. Sandstone forms the hanging wall and monzonite the footwall. Skarn-type silicates are present, indicating that the host rock for the magnetite was probably limestone.

GALLINAS DISTRICT

Several iron deposits occur in limestone near the contact of the large syenite laccolith which forms the Gallinas Mountains, west of Corona. The district produced about 10,000 tons of iron ore during World War II. Plate 8 is a detailed geologic map of the district made by Kelley et al. (1946). The district has produced fluorspar, copper, lead, and rare earths in addition to iron.

American Mine

Location and access. The deposit is located in the NE¼ sec. 22, T. 1 S., R. 11 E., along the west side of Crashed-Bomber Ridge. The deposit can be reached by traveling approximately 12 miles west, and then northwest, from Gallinas station.

History. The Lincoln Ore and Metals Co. shipped approximately 3,000 tons of ore from the deposit in 1942. The property then was leased to A. F. Denison, who mined approximately 800 tons. In 1943, the lease was transferred to the Mineral Materials Co., of Alhambra, California. The latter company did considerable development, but failed to ship any ore. The property is controlled now by the New Mexico Copper Corp.

Geology. The deposit occurs at the contact between syenite porphyry and the Yeso formation (pl. 8). The outcrop of the deposit is shaped like a hairpin, with the open end of the structure oriented to the southwest. The odd shape of the deposit could be due to a plunging fold in the sedimentary rocks adjacent to the igneous contact; a somewhat similar condition occurs at the Yellow Jacket mine in the White Oaks area. The total strike length of the exposed portion of the deposit is approximately 400 feet. The principal ore mineral is magnetite, but considerable hematite is also present. Epidote and tremolite are present in the ore zone.

Mining methods. The ore was mined by open cuts on the outcrop and was trucked to Gallinas siding for shipment to the Colorado Fuel and Iron Co., at Pueblo, Colorado. A short adit was driven about 60 feet below the surface operations, but the heading failed to expose ore.

Rare Metals Prospect

Location and access. The deposit is located in sec. 22, T. 1 S., R. 11 E., about one-quarter of a mile southwest of the American mine.

History. The deposit was prospected by the Lincoln Ore & Metals Co. during World War II. The U. S. Bureau of Mines did a minor amount of stripping in 1943 for the purpose of sampling the deposit. Two short adits and two shallow shafts antedate the work of the Lincoln Ore *&* Metals Co., but the exact date when this work was done is not known. No ore has been shipped from the property.

Geology. Magnetite and subordinate amounts of hematite occur at the contact between syenite porphyry and the Yeso formation; the contact appears to be the same as that exposed on the American deposit to the northeast. The ore host is limestone, and silicate minerals are common in the ore.

Gallinas Mine

Location and access. The Gallinas deposit is located in sec. 7, T. 2 S., R. 12 E., about 4 miles east of Gallinas station, on the road leading to Gran Quivira National Monument.

History. The Gallinas mine was operated in 1942 by Dudley Cornell, P. C. Teas, and Vincent Moore. During this period, approximately 6,400 tons of iron ore was shipped to Pueblo, Colorado, making this mine the largest iron producer in the district.

Geology. Magnetite occurs as a replacement in relatively flat-lying limestone and sandstone beds of the upper part of the Yeso formation (pl. 8). Glorieta sandstone caps a small knoll immediately to the north, but this formation has been removed by erosion in the mine area. A few minor outcrops of syenite porphyry occur in the vicinity, and it is possible that a porphyry sill underlies the deposit.

Mining methods. The operators strip-mined the deposit to a depth of about 10 feet in 2 separate pits, both north of the road, The south pit is the larger, measuring about 200 feet long and 100 feet wide. In contrast to the horizontal ore bed in the south pit, the ore in the north pit dips at about 25 degrees to the northeast; the outcrop was mined for about 100 feet along its strike.

Other Deposits

Two additional iron deposits are known in the district, the Iron Box, in sec. 11, and the Iron Lamp, in sec. 23, T. 1 S., R. 11 E. Production has not been recorded from either deposit.

HALL (MACHO) DEPOSIT

Frank S. Hall is the owner of an iron deposit situated some 20 miles southwest of Corona, in sec. 22, T. 3 S., R. 15 E. The remoteness of the deposit prevents its classification in a particular mining district. For this reason, the occurrence is described separately.

Magnetite occurs at the contacts of a north-trending monzonite(?) dike with flat-lying San Andres limestone. Magnetite float can be traced for approximately one-half mile along the strike of the dike. The deposit has been explored by several deep bulldozer cuts, but at the time of the writer's visit to the property, recent rains had flooded these excavations, preventing a detailed examination.

According to Hall (personal communication), several thousand tons of iron ore was shipped by him from the deposit during the period 1951-53; records of the State Mine Inspector fail to note these shipments.

OTHER DEPOSITS

COAL

The coal resources of Lincoln County have been described in considerable detail by Wegemann (1914), Campbell (1907), and Bodine (1956). Although several mines were rather active in the past, the workings are now totally inaccessible, owing to the long period of shutdown (more than 50 years for some mines). For these reasons, it is desirable to give here only a brief description of the coal occurrences.

Several coal horizons are present in the Mesaverde group, of Cretaceous age. The Mesaverde group crops out in an elliptical pattern around the outer margin of the Sierra Blanca (pl. 2). (For a more complete description of the Mesaverde group, see the section dealing with the geology of Lincoln County.) Bodine (1956) has further defined the coal horizons as being in the *middle shale unit* of his division of the Mesaverde group in the vicinity of Capitan. The coal beds are generally underlain by carbonaceous shale, but the overlying beds may be sandstone or shale. The coal is ranked as bituminous, but it is not of superior quality. The thickness of the beds is variable; thicknesses of 30 inches are rare.

The major coal production was derived from the Capitan and White Oaks districts, with token amounts from the Willow Hill and other areas (pl. 1). As given in Table 3, the total coal production recorded for the county is 673,785 tons, of which 628,854 tons was produced prior to 1906. The first coal mining operations were conducted near Capitan to provide fuel for nearby Fort Stanton. The exact date of the commencement of mining is uncertain, but it was probably as early as the middle 1870's. In 1889, the New Mexico Fuel Co. was organized to exploit the Capitan field on a large scale. A railroad line was laid from Carrizozo to Capitan to provide adequate transportation for the project. In the brief period 1900 to 1905, approximately 600,000 tons was shipped from the district, making it one of the most productive in the State at that time. The principal producing mines were the following:

MINE	LOCATION
Capitan No. 1 (Akers No. 1)	NE¼ sec. 5, T. 9 S., R. 14 E.
Capitan No. 2 (Akers No. 4)	SE¼ sec. 5, T. 9 S., R. 14 E.
Linderman	SW¼ sec. 7, T. 9 S., R. 14 E.

The Capitan district was beset from the start by a number of problems; namely, thin beds (6 to 30 inches), many faults and dikes offsetting the coal horizons, the low quality of the coal, and difficult transportation problems. These obstacles made it very difficult to compete with the Raton and other coal fields in the northern part of New Mexico, and the Capitan district fell idle in 1906, just 6 years after the commencement of large-scale mining. Only minor amounts of coal, mainly for local use, were mined thereafter.

The White Oaks coal district, not to be confused with the White Oaks gold district (fig. 1), was first opened to provide fuel for the nearby gold mining operations. The principal producers were the Old Abe and Wild Cat mines, located in the NW¼ sec. 5, T. 7 S., R. 13 E. Coal was produced at a slow but fairly steady rate from 1900 until 1939, and the district is considered to have had the longest active career of any in Lincoln County.

OSCURO (ESTEY) DISTRICT

The Oscuro district, sometimes referred to as the Estey district, now lies within the White Sands Missile Range, which is closed to the general public. This fact prevented an examination of the area. Old reports indicate that copper ore was discovered in the area around the turn of the present century, and the district experienced a mild boom shortly thereafter. A few carloads of ore was produced, but the spotty occurrences of the ore and its refractory nature (mostly oxide copper) prevented profitable exploitation. The following description of the district is taken from Lasky and Wootton (1933, p. 76):

> Estey is 14 miles northwest of Oscuro, a station on the Southern Pacific railroad (formerly the El Paso & Southwestern railway). It lies at the southeastern edge of the Oscura Mountains, which extend southward from Socorro County. Although the presence of copper minerals had been known for many years, it was not until 1900 that an effort was made to mine the ore. The district has been idle for 20 years or more, and only a few carloads of ore have ever been shipped.
>
> The ore occurs in the Abo "Red Beds" formation, which is repeated at the surface by a number of faults. Ore is found at three horizons, the most important of which is the arkose at the base of the "Red Beds." The copper-bearing layers are thin, for the most part a few inches to 3 feet thick. Ore also occurs in cross fractures and prominent joints. Malachite is the chief ore mineral. The sulphide ore consists chiefly of chalcocite which has replaced the calcite cement of arkose and sandstone. The chalcocite is very commonly associated with coaly matter in the arkose and occurs also in rounded nodules in limestone. The ores carry a minor amount of silver and a trace of gold. No gangue minerals other than a small quantity of coal and other carbonaceous matter have been noted.

GYPSUM

The Yeso, San Andres, and Chalk Bluff formations, all of Permian age, contain gypsum interbedded with limestone, shale, and sandstone. At various localities, some of the gypsum beds are rather thick and pure, particularly in the San Andres formation. Such beds are exposed in the vicinity of Ancho and the Phillips Hills, north and south of Carrizozo respectively. To date, the gypsum deposits of the county have been exploited only in the Ancho area. Shortly after 1900, the Rock Island Cement & Plaster Co. built and briefly operated a gypsum-crushing and calcining plant of 100 tons daily capacity at Ancho (Jones, 1904). Information as to the total amount of gypsum produced by this operation is lacking.

The future of gypsum mining in this region is uncertain. If and when it should become commercially feasible to exploit the gypsum deposits in New Mexico, it is certain that the occurrences of the mineral, to be economically exploitable, will have to be of exceptional quality and quantity, and will have to enjoy the advantage of excellent transportation facilities. In comparison with other gypsum occurrences within the State, the deposits in Lincoln County probably would fail to meet these specifications.

FIRE CLAY

A minor occurrence of fire clay is located about 1½ miles southeast of Ancho, just north of the road leading from Ancho to Jicarilla. The ownership of the deposit is unknown, nor is anything known of the history of the small amount of development done at the property. The clay occurs as thin beds in Triassic sediments. The deposit is of minor extent.

JULIE ANN FLUORSPAR PROSPECT

The Julie Ann claim, owned by John W. House, of Carrizozo, is on the southwest side of Lone Mountain, about 8 miles north of Carrizozo. It is about half a mile south of the Yellow Jacket iron mine. A cut exposes an impure vein of fluorspar, approximately 4 feet wide, in a brecciated zone that cuts limestone and gypsum of the Yeso formation. The deposit could not be traced on the surface because of soil cover. It appears to have been formed by the incomplete replacement of breccia fragments. Channel samples taken by the U. S. Bureau of Mines across the face assayed from 42 to 47 percent CaF_2 (Rothrock et al., 1946).

ARABELA MINES, INC. MANGANESE PROSPECT

Location and Access

A promising manganese prospect is located on the northeast end of the Capitan Mountains; the exact location is believed to be in sec. 11, T. 8 S., R. 17 E. The prospect can be reached from the village of Arabela by traveling approximately 5 miles northeast on a dirt road leading to Pine Lodge. The prospect is located a few hundred yards south of the road.

Ownership

The deposit is covered by a group of unpatented claims owned or held under lease by Arabela Mines, Inc. Stanley Duvall, A. W. Anderson, and John Ellison are among the principal owners of this company.

Geology

The deposit lies near the contact of the Capitan Mountains alaskite intrusive mass and the San Andres formation (mainly limestone) to the north. Talus and soil cover prevent the accurate location of the contact in the immediate area.

Figure 31 is a sketch map of the principal manganese outcrop in the area, located on the Rose Quartz claim. A vein approximately 2 feet wide, trending N. 60° W. and dipping 25 to 35 degrees to the northeast, is exposed in a bulldozer cut and a short trench. The vein could not be traced more than a few feet in either strike direction from the trench because of a cover of soil and dump material. The host rock is altered to such an extent as to preclude exact identification, but the rock, both hanging wall and footwall, is composed principally of a white to gray clay. The clay in the footwall is bentonic (expanding), whereas the clay of the hanging wall appears to resemble a kaolin type. The writer tenta-

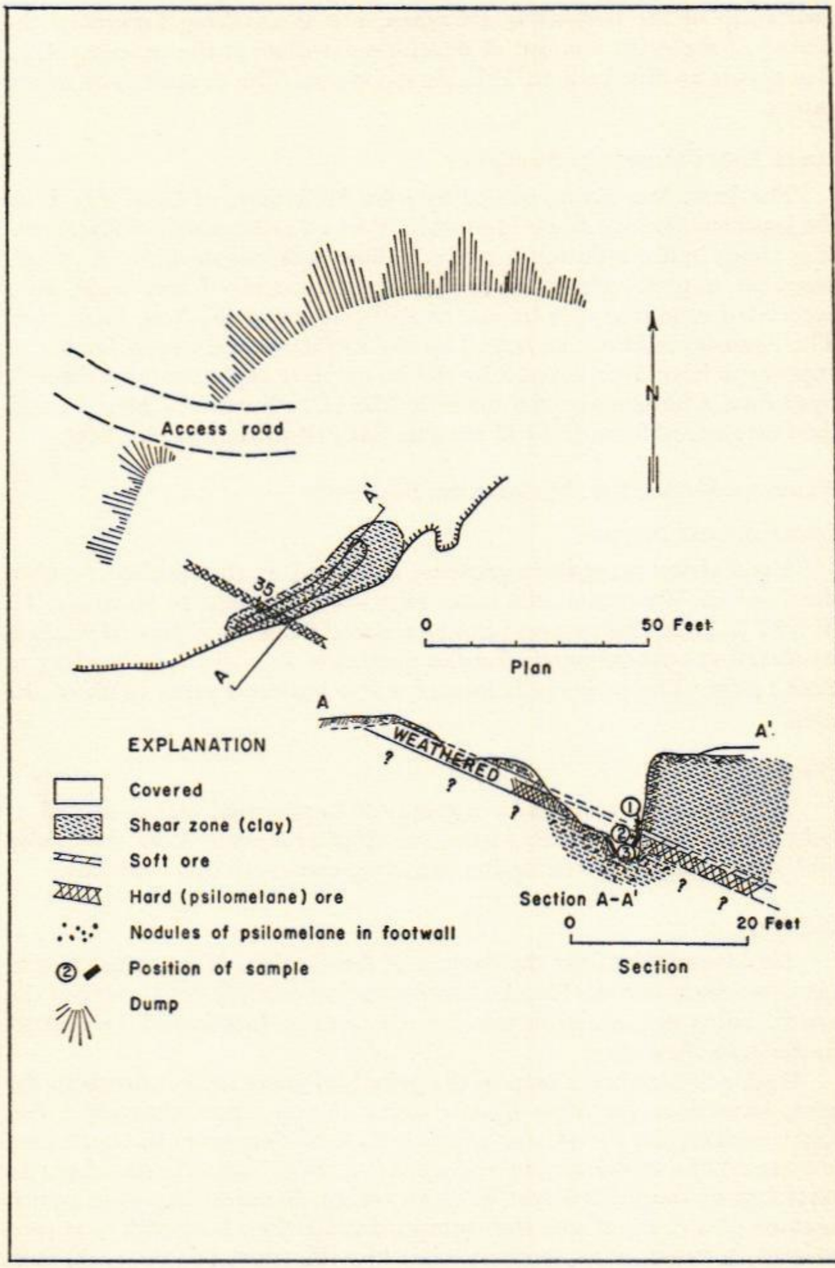


Figure 31
ARABELA MINES, INC. MANGANESE PROSPECT
Geology by G. B. Griswold, 1959.

tively would term the host rock a shear zone in order to account for the presence of clay in an area where alaskite and San Andres limestone are the only rock types known.

The vein averages 2 feet thick, with an undetermined thickness of mineralization extending into the footwall in the form of scattered nodules of psilomelane as much as 6 inches in diameter. The main vein consists of two distinct zones: (a) a 6-inch hanging-wall zone of soft ferruginous manganese oxides, designated "soft ore" in Figure 31, and (b) an 18-inch "hard ore" zone of psilomelane fragments cemented by a clayey matrix. The "hard ore" fragments are smaller and more angular than the nodules occurring in the footwall. Although the depth to which the nodular manganese mineralization extends into the footwall is not known, 2 feet of the zone has been exposed in the bottom of the trench.

Manganese assays of chip samples taken across the vein in the bottom of the trench yielded the following results:

ZONE	TRUE THICKNESS		PERCENT MANGANESE	
"Soft ore"	6 inches	24 inches	15.21	40.87
"Hard ore"	18 inches		49.42	
Footwall	24 inches		7.92	
	48 inches		24.39	

The exceptional grade of the "hard ore" zone, plus the fair grade of the "soft ore" and footwall zones, makes this deposit a promising prospect for shipping manganese ore under the Government manganese stockpile program. To date (February 1959), the owners have shipped only 1 ton of ore, which ran 54 percent manganese after handsorting and washing; shipment was made to the Socorro Manganese Co. in Socorro. The Government stockpile program is due to terminate before the end of 1959. This will allow little time to put the property into production.

Appendix

(By Roy W. Foster)

SUMMARY OF WELL LOGS

MORROW No. I FRANKS WELL

Sec. 23, T. 2 S., R. 15 E.
Total depth, 2,120 feet.

INTERVAL (feet)	DESCRIPTION
0-20	San Andres formation (+ 20 feet). Limestone.
20-360	Glorieta sandstone (340 feet). Medium-grained in upper 250 feet, fine-grained below; very light gray and grayish-orange.
360-1,740	Yeso formation (1,380 feet). Interbedded moderate reddish-brown to orange mudstone, moderate reddish-orange sandstone, medium-gray argillaceous limestone, and white gypsum.
1,740-1,990	Abo formation (250 feet). Interbedded moderate to dark reddish-brown mudstone and claystone, and arkose.
1,990-2,120	Precambrian (130 feet drilled). Pink biotite granite.

STANDARD OF TEXAS No. 1 HEARD WELL

Sec. 33, T. 6 S., R. 9 E. Total depth, 8,049 feet.

INTERVAL (feet)	DESCRIPTION
0-215	San Andres formation (+ 215 feet). Limestone, with some Glorieta-like sandstone and minor gypsum.
215-4,480	Yeso formation (4,265 feet). Interbedded limestone, salt, gypsum, sandstone, and mudstone. Approximately 900 *feet* of salt is present in this well; after subtraction from the total thickness of the Yeso, there is still an unusual amount present. It is thought that part of this is due to folding and faulting of the Yeso beneath the more competent San Andres limestone on the Carrizozo anticline. A similar situation can be seen in the outcrops of the Yeso in this area. The thickest measured section of the Yeso formation in this area is about 1,700 feet, in T. 7 S., R. 6 E.
4,480-6,040	Abo formation (1,560 feet). Interbedded dark reddish-brown mudstone, claystone, and arkosic conglomerate. Mostly arkosic conglomerate in lower 700 feet. The thickest known surface section of the Abo formation in this area is in T. 7 S., R. 6 E., where it is about 800 feet thick.
6,040-7,740	Pennsylvanian (1,700 feet). Upper 650 feet interbedded limestone, dark-gray claystone, dark reddish-brown mudstone and arkosic conglomerate. Underlain by 910 *feet* of gray limestone and claystone, with some light-gray sandstone and 140 *feet* of sandstone and clay-stone. This thickness for the Pennsylvanian is not unusual in this area, although it is only about 1,400 feet thick in the Oscura Mountains. Equivalents of the Bursum formation of Permian Wolfcampian age are included here with Pennsylvanian strata. The combined thickness (3,260 feet) of the Abo (which may also include some Bursum) and the Pennsylvanian is about 400 feet more than the maximum expectation in this area.
7,740-8,049	Precambrian (309 *feet* drilled). Diorite (plagioclase feldspar and hornblende).

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Numbers in **boldface** indicate main references.